BMW 7 Series

Service Manual

735i, 735iL, 740i, 740iL, 750iL
1988, 1989, 1990, 1991, 1992, 1993, 1994



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7 Series



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`http://www.BentleyPublishers.com/errata/`

WARNING—important safety notice

Do not use this manual unless you are familiar with basic automotive repair procedures and safe workshop practices. This manual illustrates the workshop procedures required for most service work. It is not a substitute for full and up-to-date information from the vehicle manufacturer or for proper training as an automotive technician. Note that it is not possible for us to anticipate all of the ways or conditions under which vehicles may be serviced or to provide cautions as to all of the possible hazards that may result.

The vehicle manufacturer will continue to issue service information updates and parts retrofits after the editorial closing of this manual. Some of these updates and retrofits will apply to procedures and specifications in this manual. We regret that we cannot supply updates to purchasers of this manual.

We have endeavored to ensure the accuracy of the information in this manual. Please note, however, that considering the vast quantity and the complexity of the service information involved, we cannot warrant the accuracy or completeness of the information contained in this manual.

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Your common sense and good judgment are crucial to safe and successful service work. Read procedures through before starting them. Think about whether the condition of your car, your level of mechanical skill, or your level of reading comprehension might result in or contribute in some way to an occurrence which might cause you injury, damage your car, or result in an unsafe repair. If you have doubts for these or other reasons about your ability to perform safe repair work on your car, have the work done at an authorized BMW dealer or other qualified shop.

Part numbers listed in this manual are for identification purposes only, not for ordering. Always check with your authorized BMW dealer to verify part numbers and availability before beginning service work that may require new parts.

Before attempting any work on your BMW, read the **WARNINGS** and **CAUTIONS** on pages **vii and viii** and any **WARNING** or **CAUTION** that accompanies a procedure in the service manual. Review the **WARNINGS** and **CAUTIONS** each time you prepare to work on your BMW.

Special tools required to perform certain service operations are identified in the manual and are recommended for use. Use of tools other than those recommended in this manual may be detrimental to the car's safe operation as well as the safety of the person servicing the car.

Copies of this manual may be purchased from most automotive accessories and parts dealers specializing in BMW automobiles, from selected booksellers, or directly from the publisher.

The publisher encourages comments from the reader of this manual. These communications have been and will be carefully considered in the preparation of this and other manuals. Please contact Robert Bentley, Inc., Publishers at the address listed on the top of this page.

This manual was published by Robert Bentley, Inc., Publishers. BMW has not reviewed and does not vouch for the accuracy of the technical specifications and procedures described in this manual.

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7 Equipment and Accessories
720 Seat Belts
721 Airbag System (SRS)

Electrical Wiring Diagrams

Foreword and Disclaimer

For the BMW owner with basic mechanical skills and for independent auto service professionals, this manual includes many of the specifications and procedures that were available in an authorized BMW dealer service department as this manual went to press. The BMW owner with no intention of working on his or her car will find that owning and referring to this manual will make it possible to be better informed and to more knowledgeably discuss repairs with a professional automotive technician.

The BMW owner intending to do maintenance and repair should have screwdrivers, a set of metric wrenches and sockets, and metric Allen and Torx wrenches, since these basic hand tools are needed for most of the work described in this manual. Many procedures will also require a torque wrench to ensure that fasteners are tightened properly and in accordance with specifications. Additional information on basic tools and other tips can be found in **010 General**. In some cases, the text refers to special tools that are recommended or required to accomplish adjustments or repairs. These tools are usually identified by their BMW special tool number and illustrated.

Disclaimer

We have endeavored to ensure the accuracy of the information in this manual. When the vast array of data presented in the manual is taken into account, however, no claim to infallibility can be made. We therefore cannot be responsible for the result of any errors that may have crept into the text. Please also read the **Important Safety Notice** on the copyright page at the beginning of this book.

A thorough pre-reading of each procedure, and **WARNINGS and CAUTIONS** at the front of the book and those that accompany the procedure is essential. Reading a procedure before beginning work will help you determine in advance the need for specific skills, identify hazards, prepare for appropriate capture and handling of hazardous materials, and the need for particular tools and replacement parts such as gaskets.

Bentley Publishers encourages comments from the readers of this manual with regard to errors, and/or suggestions for improvement of our product. These communications have been and will be carefully considered in the preparation of this and other manuals. If you identify inconsistencies in the manual, you may have found an error. Please contact the publisher and we will endeavor to post applicable corrections on our website. Posted corrections (errata) should be reviewed before beginning work. Please see the following web address:

`http://www.BentleyPublishers.com/errata/`

BMW offers extensive warranties, especially on components of the fuel delivery and emission control systems. Therefore, before deciding to repair a BMW that may be covered wholly or in part by any warranties issued by BMW of North America, LLC, consult your authorized BMW dealer. You may find that the dealer can make the repair either free or at minimum cost. Regardless of its age, or whether it is under warranty, your BMW is both an easy car to service and an easy car to get serviced. So if at any time a repair is needed that you feel is too difficult to do yourself, a trained BMW technician is ready to do the job for you.

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Vehicle Identification and VIN Decoder

Vehicle Identification Number (VIN), decoding

Some of the information in this manual applies only to cars of a particular model year or range of years. For example, 1988 refers to the 1988 model year but does not necessarily match the calendar year in which the car was manufactured or sold. To be sure of the model year of a particular car, check the Vehicle Identification Number (VIN) on the car.

The VIN is a unique sequence of 17 characters assigned by BMW to identify each individual car. When decoded, the VIN tells the country and year of manufacture; make, model and serial number; assembly plant and even some equipment specifications.

The BMW VIN is on a plate mounted on the top of the dashboard, on the driver's side where the number can be seen through the windshield. The 10th character is the model year code. The letters I, O, Q and U are not used for model year designation for US cars. Examples: J for 1988, K for 1989, L for 1990, M for 1991, etc. The table below explains some of the codes in the VIN for E32 cars.

Sample VIN: WBA GD83 2XR DE91004

position 1 2 3 4 5 6 7 8 9 10 11 12-17

VIN position	Description	Decoding information	
1	Country of Manufacture	W	Germany
2	Manufacturer	B	BMW AG
3	Manufacturing division	A S	BMW BMW Motorsport
4–7	Series, model	GB43 GC43 GD43 GD83 GC83	735i, 6-cylinder 3.5 liter (M30) 735iL, 6-cylinder 3.5 liter (M30) 740i, 8-cylinder 4.0 liter (M60) 740iL, 8-cylinder 4.0 liter (M60) 750iL, 12-cylinder 5.0 liter (M70)
8	Restraint system	0 1 2	Manual belts Manual belts with supplemental restraint Manual belts with dual SRS airbags
9	Check digit		0–9 or X, calculated by NHTSA
10	Model year	J K L M N P R S	1988 1989 1990 1991 1992 1993 1994 European model
11	Assembly plant	A, F, G, K B, C, D E, J	Munich, Germany Dingolfing, Germany Regensburg, Germany
12–17	Serial number		Sequential production number for specific vehicle

Please read these warnings and cautions before proceeding with maintenance and repair work.

WARNINGS—
*See also **CAUTIONS** on next page.*

- Read the important safety notice on the copyright page at the beginning of the book.

- Some repairs may be beyond your capability. If you lack the skills, tools and equipment, or a suitable workplace for any procedure described in this manual, we suggest you leave such repairs to an authorized BMW dealer service department or other qualified shop.

- A thorough pre-reading of each procedure, and the **WARNINGS** and **CAUTIONS** that accompany the procedure is essential. Posted corrections (errata) should also be reviewed before beginning work. Please see `www.BentleyPublishers.com/errata/`

- If any procedure, tightening torque, wear limit, specification, or data presented in this manual seems to be inappropriate for your specific application, contact the publisher or the vehicle manufacturer for clarification before using the information in question.

- BMW is constantly improving its cars. Sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, before starting any major jobs or repairs to components on which passenger safety may depend, consult your authorized BMW dealer about Technical Bulletins that may have been issued.

- Do not re-use any fasteners that are worn or deformed in normal use. Many fasteners are designed to be used only once and become unreliable and may fail when used a second time. This includes, but is not limited to, nuts, bolts, washers, self-locking nuts or bolts, circlips and cotter pins. Always replace these fasteners with new parts.

- Never work under a lifted car unless it is solidly supported on stands designed for the purpose. Do not support a car on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a car that is supported solely by a jack. Never work under the car while the engine is running.

- If you are going to work under a car on the ground, make sure that the ground is level. Block the wheels to keep the car from rolling. Disconnect the battery negative (–) terminal (ground strap) to prevent others from starting the car while you are under it.

- Never run the engine unless the work area is well ventilated. Carbon monoxide kills.

- Finger rings, bracelets and other jewelry should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.

- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.

- Do not attempt to work on your car if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medication or any other substance that may keep you from being fully alert.

- Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the car. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel, vapors or oil.

- Catch draining fuel, oil, or brake fluid in suitable containers. Do not use food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.

- Always observe good workshop practices. Wear goggles when you operate machine tools or work with battery acid. Gloves or other protective clothing should be worn whenever the job requires working with harmful substances.

- Greases, lubricants and other automotive chemicals contain toxic substances, many of which are absorbed directly through the skin. Read the manufacturer's instructions and warnings carefully. Use hand and eye protection. Avoid direct skin contact.

- Disconnect the battery negative (–) terminal (ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Friction materials (such as brake pads or shoes or clutch discs) contain asbestos fibers or other friction materials. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing dust. Breathing any friction material dust can lead to serious diseases and may result in death.

- Batteries give off explosive hydrogen gas during charging. Keep sparks, lighted matches and open flame away from the top of the battery. If hydrogen gas escaping from the cap vents is ignited, it will ignite gas trapped in the cells and cause the battery to explode.

- Battery acid (electrolyte) can cause severe burns. Flush contact area with water, seek medical attention.

- Connect and disconnect battery cables, jumper cables or a battery charger only with the ignition switched off. Do not disconnect the battery while the engine is running.

- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.

- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high rate can cause an explosion.

- The air conditioning system is filled with chemical refrigerant, which is hazardous. The A/C system should be serviced only by trained technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.

continued on next page

Please read these warnings and cautions before proceeding with maintenance and repair work.

WARNINGS— (continued)

- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.

- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.

- Connect and disconnect a battery charger only with the battery charger switched off.

- Sealed or "maintenance free" batteries should be slow-charged only, at an amperage rate that is approximately 10% of the battery's ampere-hour (Ah) rating.

- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.

- The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme care when working on a car with the engine running or the ignition switched on.

- Place jack stands only at locations specified by manufacturer. The vehicle lifting jack supplied with the vehicle is intended for tire changes only. A heavy duty floor jack should be used to lift vehicle before installing jack stands. See **010 General**.

- Aerosol cleaners and solvents may contain hazardous or deadly vapors and are highly flammable. Use only in a well ventilated area. Do not use on hot surfaces (engines, brakes, etc.).

- Do not remove coolant reservoir or radiator cap with the engine hot. Danger of burns and engine damage.

CAUTIONS—
*See also **WARNINGS** on previous page.*

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized BMW dealer or other qualified shop.

- BMW is constantly improving its cars and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized BMW dealer parts department for the latest information.

- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly, and do not attempt shortcuts. Use tools appropriate to the work and use only replacement parts meeting BMW specifications. Makeshift tools, parts and procedures will not make good repairs

- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque specification listed.

- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond or lake. Dispose of in accordance with Federal, State and Local laws.

- The control module for the anti-lock brake system (ABS) cannot withstand temperatures from a paint-drying booth or a heat lamp in excess of 203°F (95°C) and should not be subjected to temperatures in excess of 185°F (85°C) for more than two hours.

- Before doing any electrical welding on cars equipped with ABS, disconnect the battery negative (–) terminal (ground strap) and the ABS control module connector.

- Always make sure ignition is off before disconnecting battery.

- Label battery cables before disconnecting. On some models, battery cables are not color coded.

- Disconnecting the battery may erase fault code(s) stored in control module memory. Using special BMW diagnostic equipment, check for fault codes prior to disconnecting the battery cables.

- If a normal or rapid charger is used to charge battery, the battery must be disconnected and removed from the vehicle in order to avoid damaging paint and upholstery.

- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.

- Connect and disconnect a battery charger only with the battery charger switched off.

- Sealed or "maintenance free" batteries should be slow-charged only, at an amperage rate that is approximately 10% of the battery's ampere-hour (Ah) rating.

- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.



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GENERAL

Although the BMW is a sophisticated and complex machine, basic maintenance can be accomplished by an interested owner with mechanical skills and the right information. Most of the preventive maintenance that is required in the lifetime of the average BMW is well within the capabilities of the do-it-yourselfer.

WARNING—
Do not use this manual unless you are familiar with basic automotive repair procedures and safe workshop practices. This manual illustrates the workshop procedures required for most service work; it is not a substitute for full and up-to-date information from the vehicle manufacturer or for proper training as an automotive technician. Note that it is not possible for us to anticipate all of the ways or conditions under which vehicles may be serviced or to provide cautions as to all of the possible hazards that may result.

WARNING—

Your common sense and good judgment are crucial to safe and successful service work. Read procedures through before starting them. Think about whether the condition of your car, your level of mechanical skill, or your level of reading comprehension might result in or contribute in some way to an occurrence that might cause you injury, damage your car, or result in an unsafe repair. If you have doubts for these or other reasons about your ability to perform safe repair work on your car, have the work done at an authorized BMW dealer or other qualified shop.

This section of the manual is intended to help the beginner get started. To begin with there is a discussion on **How To Use This Manual**. Tips on mechanic's skills and workshop practices that can help the beginner do a faster and more thorough job can be found under **Getting Started.** The basic tools needed to do most of the procedures in this manual are found under **Tools**. The section ends with a quick reference guide to **Emergencies**, including basic troubleshooting and information on how to gauge the seriousness of a problem.

HOW TO USE THIS MANUAL

The manual is divided into nine sections:

0 GENERAL DATA AND MAINTENANCE
1 ENGINE
2 TRANSMISSION
3 SUSPENSION, STEERING AND BRAKES
4 BODY
5 BODY EQUIPMENT
6 ELECTRICAL SYSTEM
7 EQUIPMENT AND ACCESSORIES
ELECTRICAL WIRING DIAGRAMS

0 GENERAL DATA AND MAINTENANCE covers the recommended maintenance schedules and service procedures needed to perform BMW scheduled maintenance work. Also within this section is the **010 General** section, which contains basic instructions, tips and helpful hints for do-it-yourself maintenance and repair.

The next seven sections (1 through 7) are repair based and are further broken down into three digit repair groups. Each major section begins with a **General** repair group, e.g. **100 Engine–General.** These "00" (double zero) groups are mostly descriptive in nature, covering topics such as theory of operation and troubleshooting. The remainder of the repair groups contain the more involved repair information. The last major section contains detailed electrical wiring diagram schematics.

A master listing of the 9 major sections and the corresponding individual repair groups can be found on the inside front cover.

Each repair group begins with a Table of Contents listing the major subject headings within the group. Page numbers throughout the manual are organized according to the repair group system. For example, you can expect to find repair information on brakes (Repair Group **340**) beginning on page **340**-1. A comprehensive index can be found at the back of the manual.

Warnings, Cautions and Notes

Throughout this manual are many passages with the headings **WARNING**, **CAUTION** or **NOTE**. These very important headings have different meanings.

WARNING—
The text under this heading warns of unsafe practices that are very likely to cause injury, either by direct threat to the person(s) performing the work or by increased risk of accident or mechanical failure while driving.

CAUTION—
A caution calls attention to important precautions to be observed during the repair work that will help prevent accidentally damaging the car or its parts.

NOTE—
A note contains helpful information, tips that will help in doing a better job and completing it more easily.

Please read every **WARNING**, **CAUTION** and **NOTE** at the front of the manual and as they appear in repair procedures. They are very important. Read them before you begin any maintenance or repair job.

Some **WARNING**s and **CAUTION**s are repeated wherever they apply. Read them all. Do not skip any. These messages are important, even to the owner who never intends to work on the car.

GETTING STARTED

Most of the necessary maintenance and minor repair that an automobile will need can be done with ordinary tools, even by owners with little or no experience in car repair. Below is some important information on how to work safely, a discussion of what tools will be needed and how to use them.

Safety

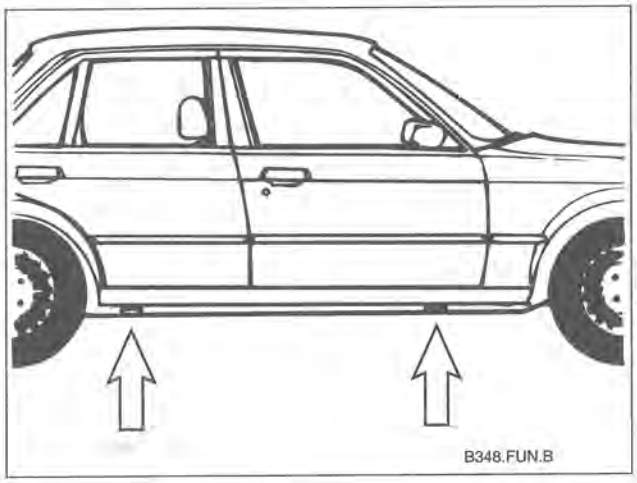
Although an automobile presents many hazards, common sense and good equipment can help ensure safety. Many accidents happen because of carelessness. Pay attention and stick to these few important safety rules.

WARNING —

- *Never run the engine in the work area unless it is well-ventilated. The exhaust should be vented to the outside. Carbon monoxide (CO) in the exhaust kills.*
- *Remove all neckties, scarfs, loose clothing, or jewelry when working near running engines or power tools. Tuck in shirts. Tie long hair and secure it under a cap. Severe injury can result from these things being caught in rotating parts.*
- *Remove rings, watches, and bracelets. Aside from the dangers of moving parts, metallic jewelry conducts electricity and may cause shorts, sparks, burns, or damage to the electrical system when accidentally contacting the battery or other electrical terminals.*
- *Disconnect the battery negative (–) cable whenever working on or near the fuel system or anything that is electrically powered. Accidental electrical contact may damage the electrical system or cause a fire.*

WARNING —

- *Never work under a lifted car unless it is solidly supported on jack stands that are intended for that purpose. Do not support a car on cinder blocks, bricks, or other objects that may shift or crumble under continuous load. Never work under a car that is supported only by the lifting jack.*
- *Fuel is highly flammable. When working around fuel, do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*
- *Illuminate the work area adequately and safely. Use a portable safety light for working inside or under the car. A fluorescent type light is best because it gives off less heat. If using a light with a normal incandescent bulb, use rough service bulbs to avoid breakage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.*
- *Keep sparks, lighted matches, and any open flame away from the top of the battery. Hydrogen gas emitted by the battery is highly flammable. Any nearby source of ignition may cause the battery to explode.*
- *Never lay tools or parts in the engine compartment or on top of the battery. They may fall into confined spaces and be difficult to retrieve, become caught in belts or other rotating parts when the engine is started, or cause electrical shorts and damage to the electrical system.*
- *The fuel system is designed to retain pressure even when the ignition is off. When working with the fuel system, loosen the fuel lines slowly to allow the residual pressure to dissipate gradually. Take precautions to avoid spraying fuel.*



Lifting the Car

BMW jacking points (**arrows**).

- For those repairs that require raising the car, the proper jacking points should be used to raise the car safely and avoid damage. There are four jacking points from which the car can be safely raised. The jack supplied with the car by BMW can only be used at the four side points—just behind the front wheel or just in front of the rear wheel.

WARNING—

- *When raising the car using a floor jack or a hydraulic lift, carefully position the jack pad to prevent damaging the car body. A suitable liner (wood, rubber, etc.) should be placed between the jack and the car to prevent body damage.*
- *Watch the jack closely. Make sure it stays stable and does not shift or tilt. As the car is raised, the car may roll slightly and the jack may shift.*


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Raising car safely

- Park car on flat, level surface.
- Place jack fully into position under jacking point. Make sure jack is resting on flat, solid ground. Use board or other support to provide a firm surface for jack, if necessary.
- Raise car slowly while constantly checking position of jack and car.
- Once car is raised, block wheel that is opposite and farthest from jack to prevent car from unexpectedly rolling.

> ***WARNING—***
> • *Do not rely on the transmission or the emergency brake to keep the car from rolling. They are not a substitute for positively blocking the opposite wheel.*
>
> • *Never work under a car that is supported only by a jack. Use jack stands that are properly designed to support the car. See* **Tools**.

Working under car safely

- Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

- Raise car slowly as described above.
- Use at least two jack stands to support the car. A jack is a temporary lifting device and should not be used alone to support the car while you are under it. Use jack stands designed for the purpose of supporting a car. For more information on jack stands, see **Tools** below.

> ***WARNING—***
> *Do not use wood, concrete blocks, or bricks to support a car. Wood may split. Blocks or bricks, while strong, are not designed for that kind of load, and may break or collapse.*

- Place jack stands on firm, solid surface. If necessary, use a flat board or similar solid object to provide a firm footing.
- Lower car slowly until its weight is fully supported by jack stands. Watch to make sure that the jack stands do not tip or lean as the car settles on them.
- Observe all jacking precautions again when raising car to remove jack stands.

ADVICE FOR THE BEGINNER

The tips in the paragraphs that follow are general advice to help the do-it-yourself BMW owner perform repairs and maintenance tasks more easily and more professionally.

Planning Ahead

Most of the repairs and maintenance tasks described in this manual can be successfully completed by anyone with basic tools and abilities. To prevent getting in too deep, know what the whole job requires before starting. Read the procedure thoroughly, from beginning to end, in order to know just what to expect and what parts will have to be replaced.

Cleanliness

Keeping things organized, neat, and clean is essential to doing a good job. When working under the hood, fender covers will protect the finish from scratches and other damage. Make sure the car is relatively clean so that dirt under the cover does not scratch the finish.

Any repair job will be less troublesome if the parts are clean. For cleaning old parts, there are many solvents and parts cleaners commercially available.

For cleaning parts prior to assembly, commercially available aerosol cans of parts cleaner or brake cleaner are handy to use, and the cleaner will evaporate completely.

> ***WARNING—***
> *Virtually all solvents used for cleaning parts are highly flammable, especially in aerosol form. Use with extreme care. Do not smoke. Do not use these products near any source of heat, sparks or flame.*

Let any solvent or cleaning product dry completely. Low-pressure, dry compressed air is helpful if available. Also, use only lint-free rags for cleaning and drying.

> ***WARNING—***
> *Avoid getting tools or clothing near the battery. Battery electrolyte is a corrosive acid. Be careful with brake fluid, as it can damage the car's paint. Finally, keep rubber parts such as hoses and belts free from oil or gasoline, as they will cause the material to soften and fail prematurely.*

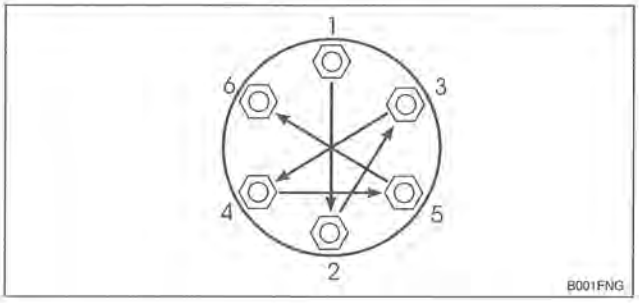
Non-reusable Fasteners

Many fasteners used on the cars covered by this manual must be replaced with new ones once they are removed. These include but are not limited to: bolts, nuts (self-locking, nylock, etc.), cotter pins, studs, brake fittings, roll pins, clips and washers. Genuine BMW parts should be the only replacement parts used for this purpose.

Some bolts are designed to stretch during assembly and are permanently altered rendering them unreliable once removed. These are known as torque-to-yield fasteners. Always replace fasteners where instructed to do so. Failure to replace these fasteners could cause vehicle damage and personal injury. See an authorized BMW dealer for applications and ordering information.

Tightening Fasteners

When tightening the bolts or nuts that attach a component, it is always good practice to tighten the bolts gradually and evenly to avoid misalignment or over stressing any one portion of the component. For components sealed with gaskets, this method helps to ensure that the gasket will seal properly and completely.



Where there are several fasteners, tighten them in a sequence alternating between opposite sides of the component. Repeat the sequence until all the bolts are evenly tightened to the proper specification.

For some repairs a specific tightening sequence is necessary, or a particular order of assembly is required. Such special conditions are noted in the text, and the necessary sequence is described or illustrated. Where no specific torque is listed, **Table a** can be used as a general guide for tightening fasteners.

WARNING—
Table a *is a general reference only. The values listed in the table are not intended to be used as a substitute for torques specifically called out in the text throughout this manual.*

NOTE—

- *Metric bolt classes or grades are marked on the bolt head.*
- *Do not confuse wrench size with bolt diameter size. For a listing of the common wrenches used on various bolt diameters, see* **Basic Tool Requirements**.

Table a. General Bolt Tightening Torques in Nm (max. permissible)

Bolt diameter	Bolt Class (according to DIN 267)					
	5.6	5.8	6.8	8.8	10.9	12.9
M5	2.5	3.5	4.5	6	8	10
M6	4.5	6	7.5	10	14	17
M8	11	15	18	24	34	40
M10	23	30	36	47	66	79
M12	39	52	62	82	115	140
M14	62	82	98	130	180	220
M16	94	126	150	200	280	340
M18	130	174	210	280	390	470

Gaskets and Seals

The smoothest metal mating surfaces still have imperfections that can allow leakage. To prevent leakage at critical joints, gaskets of soft, form-fitting material are used to fill in the imperfections.

To be most effective, gaskets are designed to crush and become thinner as the mating parts are bolted together. Once a gasket has been used, it is no longer capable of making as good a seal as when new, and is much more likely to leak. For this reason, gaskets should not be reused. Always plan to use new gaskets for any reassembly. Some gaskets—such as head gaskets—are directional. Make sure that these are installed correctly. This same logic applies to any part used for sealing, including rubber O-rings and copper sealing washers.

In places where a shaft must pass through a housing, flexible lip seals are used to keep the lubricating oil or grease from leaking out past the rotating shaft. Seals should never be reused once they have been removed. When removing a seal, be careful not to scratch or otherwise damage the metal surfaces. Even minor damage to sealing surfaces can cause seal damage and leakage.

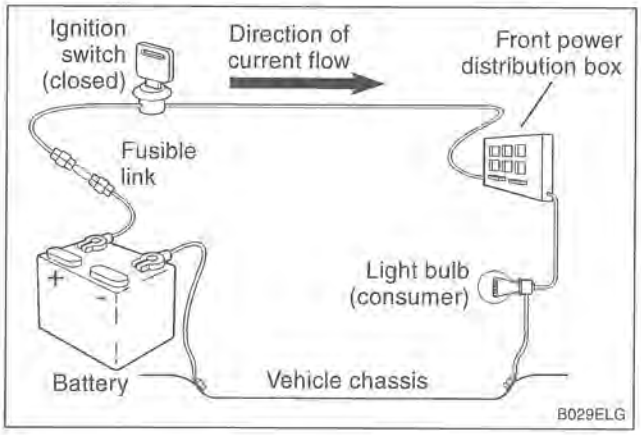
The key to seal installation is to get the seal in straight without damaging it. Use a seal driver that is the same diameter as the seal housing to gently and evenly install into place. If a proper size seal driver is not available, a socket of the right size will do.

When installing a seal, it a good idea to coat the seal with oil to aid installation. Some seals are directional and special installation instructions apply. Make sure it is installed with the lip facing the correct way. Normally the lip faces the inside. Note the installation direction of the old seal before removing it.

Electrical Testing

Many electrical problems can be understood and solved with only a little fundamental knowledge of how electrical circuits function.

Electric current only flows in a complete circuit. To operate, every electrical device in the car requires a complete circuit including a voltage source and a path to ground. The positive (+) side of the battery is the original voltage source, and ground is any return path to the negative (–) side of the battery, whether through the wiring harness or the car body. Except for portions of the charging system, all electrical current in the car is direct current (DC) and flows from positive (+) to negative (–).



Switches are used to turn components on or off by completing or interrupting the circuit. A switch is "open" when the circuit is interrupted, and "closed" when the circuit is completed. See **600 Electrical System–General** for electrical troubleshooting.

Wire Repairs

Repairs to a wiring harness require special care to make the repair permanent. The wire ends must be clean. If frayed or otherwise damaged, cut off the end. If the wire is too short, splice in a new piece of wire of the same size and make two connections.

Use connectors that are designed for the purpose. Crimped-on or soldered-on connectors are best. Crimp connectors and special crimping pliers are widely available. If soldering, use needlenose pliers to hold the wire near the solder joint and create a "heat dam". This keeps the heat and the solder from traveling up the wire. Always use a solder made specifically for electrical work (rosin core).

NOTE—

Twisting wires together to make a repair is not recommended. Corrosion and vibration will eventually spoil the connection and may lead to irreparable damage to sensitive electronic components.

Insulate the finished connection. Electronics stores can supply heat-shrinkable insulating tubing that can be placed onto the wire before connecting, slid over the finished joint, and shrunk to a tight fit with a heat gun or hair dryer. The next best alternative is electrical tape. Make sure the wire is clean and free of solder flux or other contamination. Wrap the joint

tightly to seal out moisture. See **600 Electrical–General** for more information.

BUYING PARTS

Many of the maintenance and repair tasks in this manual call for the installation of new parts, or the use of new gaskets and other materials when reinstalling parts. Most often, the parts that will be needed should be on hand before beginning the job. Read the introductory text and the complete procedure to determine which parts will be needed.

NOTE—
For some bigger jobs, partial disassembly and inspection are required to determine a complete parts list. Read the procedure carefully and, if necessary, make other arrangements to get the necessary parts while your car is disassembled.

Genuine BMW Parts

Genuine BMW replacement parts from an authorized BMW dealer are designed and manufactured to the same high standards as the original parts. They will be the correct material, manufactured to the same specifications, and guaranteed to fit and work as intended by the engineers who designed the car. Some genuine BMW parts have a limited warranty.

Many independent repair shops make a point of using genuine BMW parts, even though they may at times be more expensive. They know the value of doing the job right with the right parts. Parts from other sources can be as good, particularly if manufactured by one of BMWs original equipment suppliers, but it is often difficult to know.

BMW is constantly updating and improving their cars, often making improvements during a given model year. BMW may recommend a newer, improved part as a replacement, and your authorized dealer's parts department will know about it and provide it. The BMW parts organization is best equipped to deal with any BMW parts needs.

Non-returnable Parts

Some parts cannot be returned for credit, even if they are the wrong parts for the car. The best example is electrical parts, which are almost universally considered non-returnable because they are so easily damaged internally.

Buy electrical parts carefully, and be as sure as possible that a replacement is needed, especially for expensive parts such as electronic control units. It may be wise to let an authorized BMW dealer or other qualified shop confirm your diagnosis before replacing an expensive part that cannot be returned.

Information You Need to Know

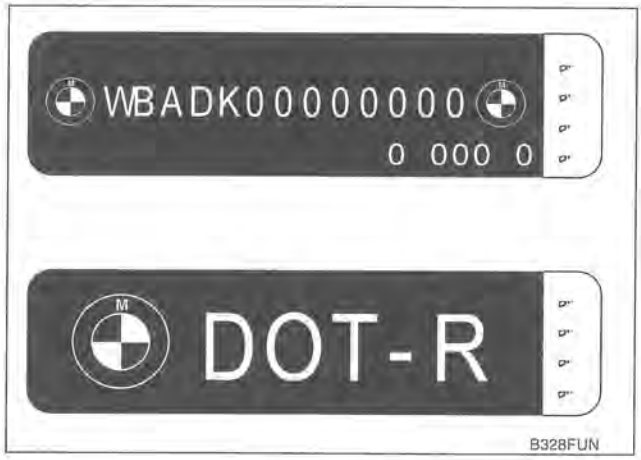
Model. When ordering parts it is important that you know the correct model designation for your car. Models covered in this manual are E32 7 Series in 6, 8 and 12-cylinder configurations.

Model Year. This is not necessarily the same as date of manufacture or date of sale. A 1993 model may have been manufactured in late 1992, and perhaps not sold until early 1993. It is still a 1993 model. Model years covered by this manual are 1988 to 1994.

Date of Manufacture. This information is helpful when ordering replacement parts or determining if any of the warranty recalls are applicable to your car. The label on the driver's door below the door latch will specify the month and year that the car was built.

Vehicle Identification Number (VIN). This is a combination of letters and numbers that identify the particular car. The VIN appears on the state registration document, and on the car itself. One location is in the rear of the engine compartment, another in the lower left corner of the windshield.

The National Highway Traffic Safety Administration (NHTSA) requires passenger cars with a high theft rate to have the VIN marked on specific parts of the car when manufactured. On BMW cars, these parts are identified by an adhesive label.



Original body panels and other large components are identified by a label bearing the VIN and two BMW roundel logos. Replacement parts have a similar label, bearing one BMW roundel logo and the letters DOT-R. Parts or assemblies bearing the label are the engine, transmission, front and rear bumpers, front fenders, rear quarter panels, hood, trunk lid and doors. These labels should not be removed as they will tear apart.

Engine. 7 Series cars covered in this manual are powered by a 6, 8 or 12-cylinder engine. For information on engine codes and engine applications, see **100 Engine–General**.

Transmission. The transmission type with its identifying code may be important when buying clutch parts, seals, gaskets, and other transmission-related parts. For information on transmission codes and applications, see **200 Transmission–General**.

SERVICE

BMW dealers are uniquely qualified to provide service for BMW cars. Their authorized relationship with the large BMW service organization means that they are constantly receiving new tools and equipment, together with the latest and most accurate repair information.

The BMW dealer's service technicians are highly trained and very capable. Unlike most independent repair shops, authorized BMW dealers are intensely committed to supporting the BMW product. They share the owner's interest in BMW value, performance, and reliability. On the other hand, there are many independent shops that specialize in BMW service and are capable of doing high quality repair work. Checking with other BMW owners for recommendations on service facilities is a good way to learn of reputable BMW shops in your area.

TOOLS

Most maintenance can be accomplished with a small selection of the right tools. Tools range in quality from inexpensive junk, which may break at first use, to very expensive and well-made tools for the professional. The best tools for most do-it-yourself BMW owners lie somewhere in between.

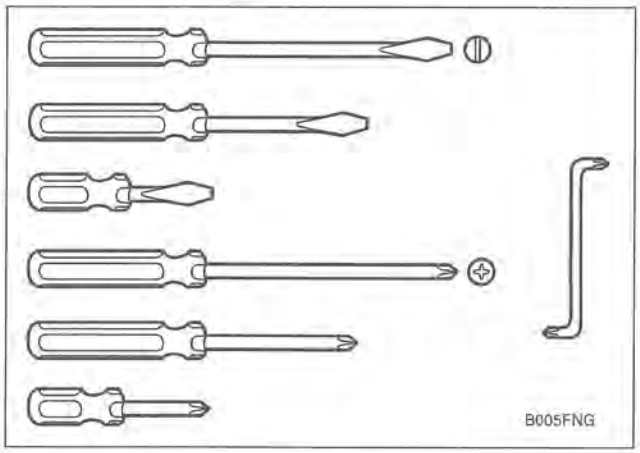
Many reputable tool manufacturers offer good quality, moderately priced tools with a lifetime guarantee. These are your best buy. They cost a little more, but they are good quality tools that will do what is expected of them. Sears Craftsman® line is one such source of good quality tools.

Some of the repairs covered in this manual require the use of special tools, such as a custom puller or specialized electrical test equipment. These special tools are called out in the text and can be purchased through an authorized BMW dealer. As an alternative, some special tools mentioned may be purchased from the following tool manufacturers and/or distributors:

- Assenmacher Specialty Tools
  6440 Odell Place, Boulder, CO 80301
  (303) 530-2424
- Baum Tools Unlimited, Inc.
  P.O. Box 87, Longboat Key, FL 34228
  (800) 848-6657
- Schley Products Inc.
  5350 E. Hunter Ave., Anaheim Hills, CA 92807
  (714) 693-7666
- Zelenda Machine and Tool Corp.
  66-02 Austin Street, Forest Hills, NY 11375
  (718) 896-2288

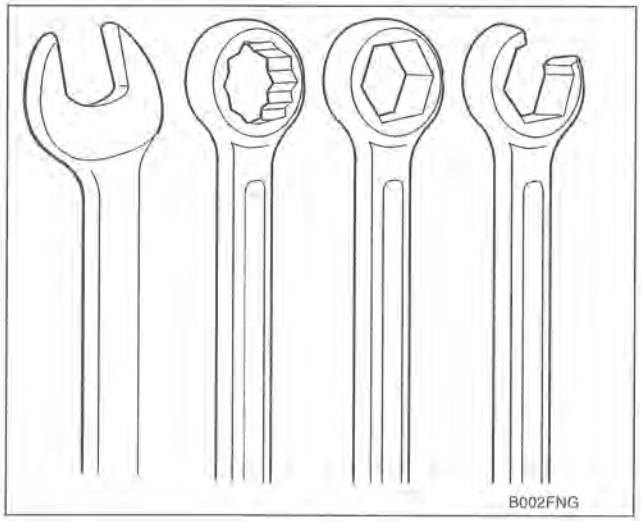
Basic Tool Requirements

The basic hand tools described below can be used to accomplish most of the simple maintenance and repair tasks.



Screwdrivers. The common flat-blade type and the Phillips type will handle almost all screws used on BMWs. Two or three different sizes of each type will be required, since a screwdriver of the wrong size will damage the screw head.

A complete set of screwdrivers should also include Torx® type screwdrivers.



Wrenches. Wrenches come in different styles for different uses. The basic open-end wrench is the most widely used, but grips on only two sides. It can spread apart and slip off more easily. The box-end wrench has better grip, on all six sides of a nut or bolt.

A 12-point box-end can loosen a nut or bolt where there is less room for movement, while a 6-point box-end provides better grip. For hex fasteners on fluid lines, like brake lines and fuel lines, a flare-nut wrench offers the advantages of a box-end wrench with a slot that allows it to fit over the line.

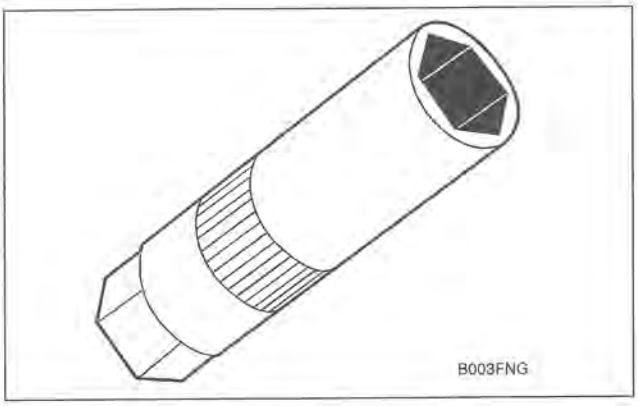
The combination wrench is the most universal. It has one open-end and one box-end. 10mm and 13mm wrenches are the most common sizes needed. A more complete set of wrenches would include 6mm through 19mm sizes.

Sockets. Sockets perform the same job as box-end wrenches, but offer greater flexibility. They are used with a ratchet handle for speed and convenience and can be combined with extensions and universal joints (swivels) to reach fasteners more easily. Sockets come with different size connections to drive handles or extensions, called the drive size. The most common drive sizes are ¼ in., 3/8 in., and ½ in.

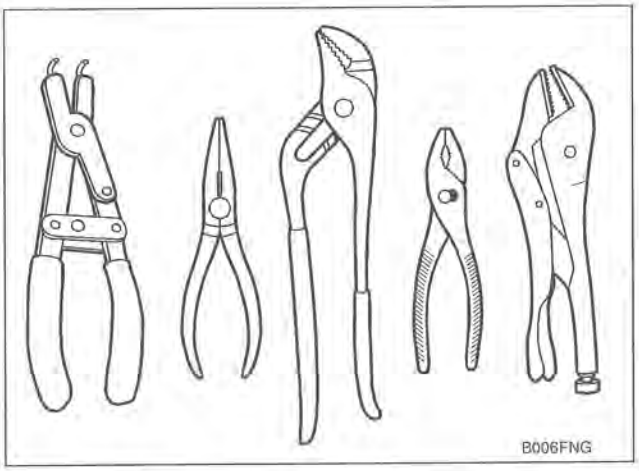
Sockets come in 6-point and 12-point styles. For use with a ratchet, the 6-point offers a better grip on tight nuts and bolts. 6mm to 19mm sockets are the most needed sizes. Below is a list of typical bolt diameters and the corresponding wrench sizes.

Bolt Diameter and Wrench Size

- M5 . . . . . 8 mm
- M6 . . . . . 10 mm
- M8 . . . . . 12 mm or 13 mm
- M10 . . . . . 17 mm
- M12 . . . . . 19 mm
- M14 . . . . . 22 mm



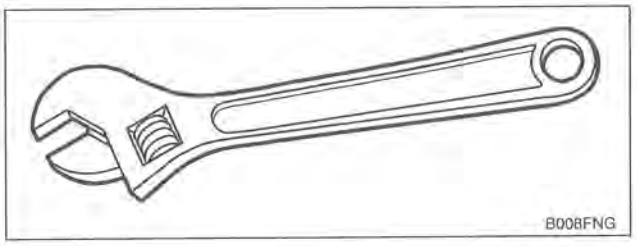
Spark Plug Socket. A special socket for spark plugs is the correct size, is deep enough to accommodate a spark plug's length, and includes a rubber insert to both protect the spark plug from damage and grip it for easier removal.



Pliers. Most are used for holding irregular objects, bending, or crimping. Some have special applications.

A needlenose plier is used for gripping small and poorly accessible objects, and is useful for wiring and other electrical work. A locking plier such as the Vise-Grip® is useful because of its tight grip.

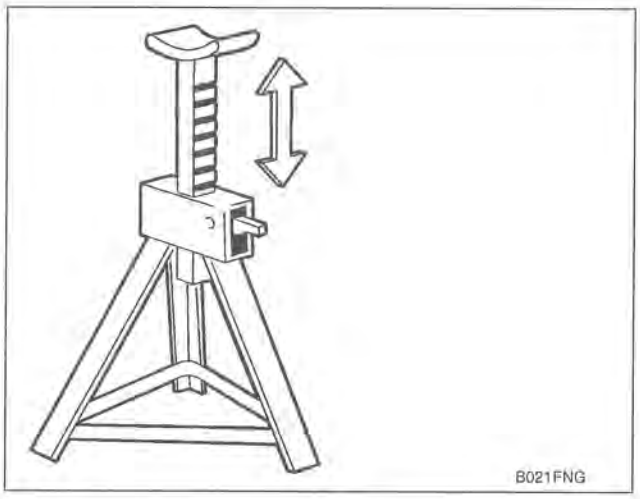
Snap-ring and circlip pliers with special tipped jaws are used to remove and install snap-rings or circlips. A Channellock® or water pump plier has adjustable jaws that can be quickly changed to match the size of the object being held to give greater leverage.



An adjustable wrench can be a useful addition to a small tool kit. It can substitute in a pinch, if two wrenches of the same size are needed to remove a nut and bolt. Use extra care with adjustable wrenches, as they tend to loosen, slip and damage fasteners.

Compared to a wrench of the correct size, an adjustable wrench is always second best. They should only be used when the correct size wrench is not available. Choose one of average size range, about 6 to 8 inches in length.

Jack Stands

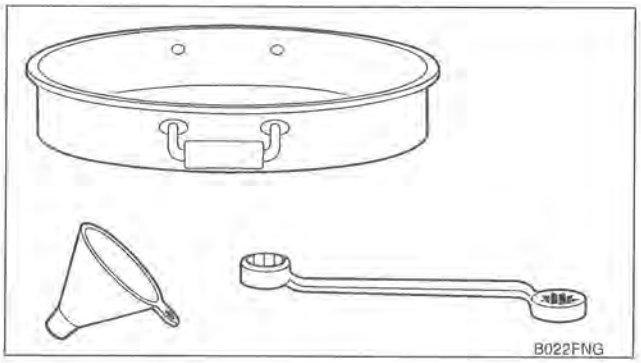


Strong jack stands are extremely important for any work that is done under the car. Use only jack stands that are designed for the purpose. Blocks of wood, concrete, bricks, etc. are not safe or suitable substitutes.

> ***WARNING—***
> *A jack should be used only to raise the vehicle and should not be used to support the car for a long period. Always use jack stands to support a raised vehicle.*

Jack stands are available in several styles. The best ones are made of heavy material for strength, have a wide base for stability, and are equipped to positively lock in their raised positions. Get the best ones available.

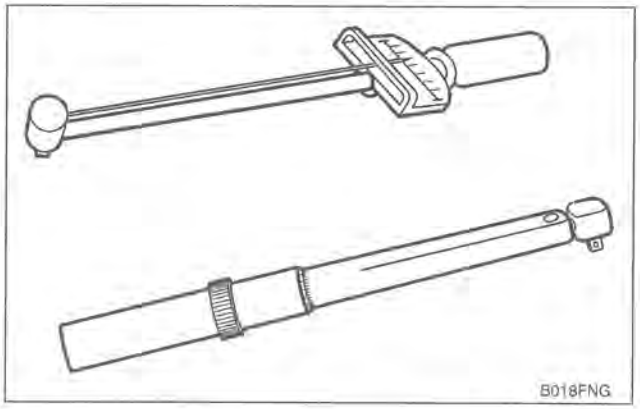
Oil Change Equipment



Changing engine oil requires a 17mm socket or wrench to loosen and tighten the drain plug and a drain pan (at least 8 qt. capacity). An oil filter wrench is not required. A wide, low drain pan will fit more easily under the car. Use a funnel to pour the new oil into the engine.

Torque Wrench

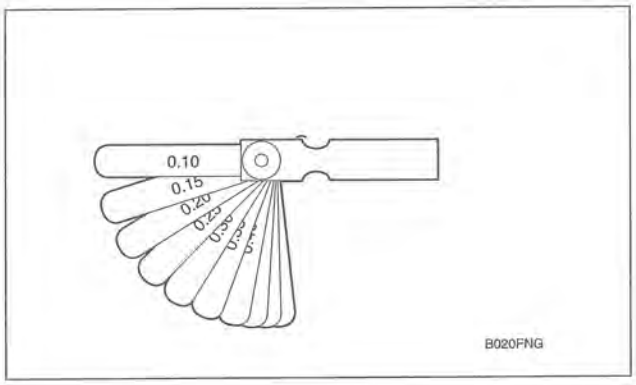
A torque wrench is used to precisely tighten threaded fasteners to a predetermined value. Many of the repair procedures in this manual include BMW-specified torque values in Newton-meters (Nm) and the equivalent values in foot-pounds (ft-lb).



Several types of torque wrenches are available. They all do the same job, but offer different convenience features at different prices. The most convenient ones have a built-in ratchet, and can be preset to indicate when a specific torque value has been reached. Follow the wrench manufacturer's directions for use to achieve the greatest accuracy.

A torque wrench with a range up to about 150 Nm (185 ft-lb) has adequate capacity for most of the repairs covered in this manual. For recommended torque values of 10 Nm or below, the English system equivalent is given in inch-pounds (in-lb). These small values may be most easily reached using a torque wrench calibrated in inch-pounds. To convert inch-pounds to foot-pounds, divide by 12.

Feeler Gauges



Feeler gauges are thin metal strips of precise thickness, used to measure small clearances. They are normally available as a set, covering a range of sizes.

Digital Multimeter



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Many of the electrical tests in this manual call for the measurement of resistance (ohms) or voltage values. For safe and accurate tests of ignition, fuel injection, and emission control systems, the multi-meter, should be digital, with high (at least 10,000 ohms) input impedance. Some meters have automotive functions such as dwell and pulse width that are useful for troubleshooting ignition and fuel injection problems.

CAUTION—
The DME system, central body electronics, and other electronic systems may be damaged by the high current draw of a test light with a normal incandescent bulb. As a general rule, use a high impedance digital multimeter or an LED test light for all electrical testing.

BMW Special Tools

Some of the more challenging repairs covered in this manual call for the use of BMW special tools. This, however, does not automatically mean that the job is too complicated or out of reach of the novice.

Many of the BMW special tools mentioned in this manual are simply the best thing to use to do the job correctly. In these cases, the tool is identified with a BMW part number. See your authorized BMW dealer parts department for information on how to order special tools.

There are some jobs for which expensive special tools are essential, and not a cost-effective purchase for one-time repair by the do-it-yourself owner. This manual includes such repairs for the benefit of those with the necessary experience and access to tools. For the do-it-yourselfer, the need for special tools is noted in the text, and whether or not BMW dealer service is recommended.

EMERGENCIES

Changing a Tire

Stop the car on as flat a surface as possible, in a place where you can be easily seen by other drivers. Avoid stopping just over the crest of a hill. Turn on the emergency flashers, and set out flares or emergency markers well behind the car. Chock the wheel (wheel chock located in trunk) diagonally opposite to the one being changed. Passengers should get out of the car and stand well away from the road. Remove the spare tire from the spare tire storage tray, as described later.

> ***WARNING—***
> *If a tire goes flat while driving, pull well off the road. Changing a tire on a busy street or highway is very dangerous. If necessary, drive a short distance on the flat tire to get to a safe place. It is much better to ruin a tire or rim than to risk being hit.*

Take the jack and tools from the tool area beneath the trunk mat. Remove the spare tire from the tire storage tray.

Loosen the wheel bolts while the car is on the ground, but leave them a little snug. Place the jack at the lifting point nearest the wheel being changed (lifting points are shown in Fig. 1 and Fig. 2). Use a board to provide a firm footing for the jack if the ground is soft. Raise the car only far enough so that the wheel is fully off the ground and then remove the wheel nuts and the wheel.

Install the spare wheel. Install the wheel nuts and tighten them by hand, then lower the car. With all wheels on the ground, fully tighten the nuts in a crisscross pattern. Torque the wheel nuts when installing the wheel. Check the inflation pressure of the spare tire.

Tightening torques

- Wheel to wheel hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

Car Will Not Start

If the engine turns over slowly or not at all, especially on cold mornings, the battery may not be sufficiently charged. Jump-starting the battery from another car may help.

WARNING—
On cars with manual transmission, push starting (or tow starting) a car is not recommended by BMW.

NOTE—
Be sure to read the cautions under **Jump Starting Car** *prior boosting a low battery. Failure to follow the cautions may result in damage to the electronic components in the car.*

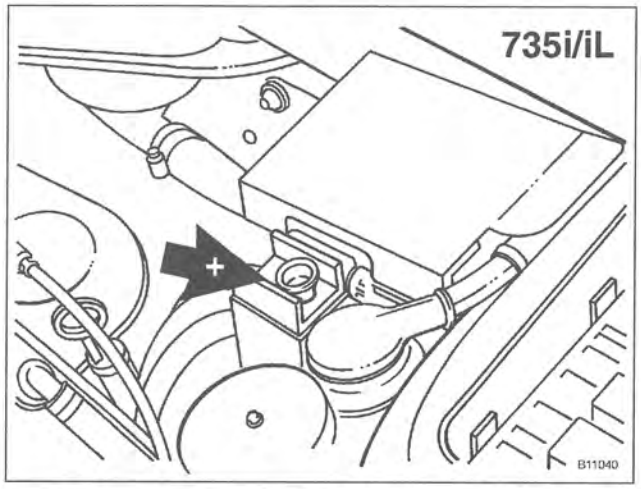
If the engine is turning over at normal speed with the starter motor, the battery and starter are fine. Check to make sure that there is fuel in the tank. Do not rely on the fuel gauge, it may be faulty. Instead, remove the gas filler cap and rock the car. If there is gas in the tank, you should hear a sloshing sound at the filler neck. If there is plenty of fuel in the tank, see **100 Engine–General** for in-depth diagnostics and troubleshooting procedures.

Jump Starting Car

Cars with discharged or dead batteries can be jump-started using the good battery from another car. When jump-starting the engine, always note the following warnings.

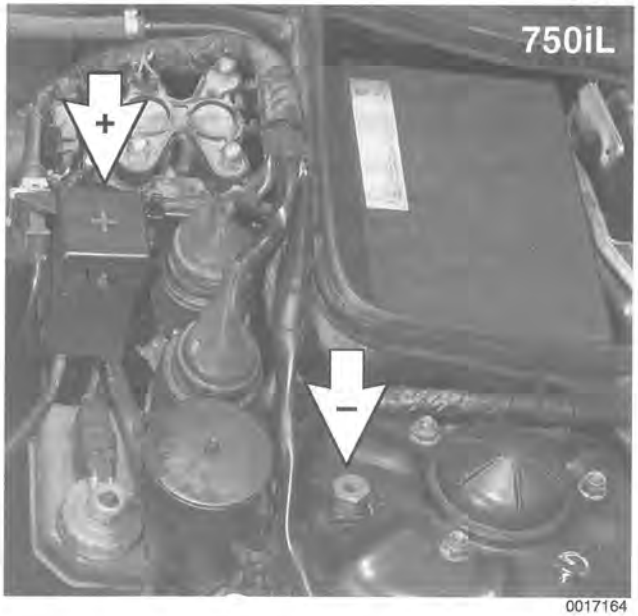
WARNING—
- *Battery acid (electrolyte) can cause severe burns, and will damage the car and clothing. If electrolyte is spilled, wash the surface with large quantities of water. If it gets into eyes, flush them with water for several minutes and call a doctor.*
- *Batteries produce explosive and noxious gasses. Keep sparks and flames away. Do not smoke near batteries.*
- *Do not jump-start the engine if you suspect that the battery is frozen. Trapped gas may explode. Allow the battery to thaw first.*
- *Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 15 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.*
- *Some electrical system "comfort" features may not function correctly once battery power is restored. For example, the front window one-touch-up function may be disabled. Some electrical systems will need to be reinitialized. Consult the appropriate repair group for more specific information.*

– Place cars close together, but do not allow them to touch each other. Turn off the engine of the car with the good battery.





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- Connect one end of the positive (+) cable to the positive (+) post or jump starting post of the good battery. Location of battery jump starting posts varies by model. Remove the cover from the positive (B+) junction post in the engine compartment of the dead car and connect the other end of the positive (+) cable to the junction post.
- Connect one end of the negative (–) cable to the negative (–) battery post of the good battery. Connect opposite end of the negative cable (–) to the engine block of the car with the dead battery.
- Start the car with the good battery and run the engine at about 2,000 rpm, then start the car with the dead battery.
- With the engine at idle, switch on the headlights, blower motor and rear window defogger to avoid damaging the cars electrical system. Carefully disconnect the jumper cables, starting with the negative cable on the engine block. Turn all electrical consumers off.

NOTE—

The engine should be run for at least an hour to recharge the battery.

Overheating

If the temperature gauge needle goes into the red band on the gauge face, the coolant temperature is too high. Find a safe place to stop and turn the engine off. Open the hood and allow the engine to cool until the temperature gauge needle is at the lower third of the scale. Continuing to drive an overheated car can cause extensive engine damage.

WARNING—
Do not remove the coolant reservoir or radiator cap with the engine hot. Undoing either could spray hot coolant and cause burns or damage the engine.

CAUTION—
Do not add cold water or coolant to a hot engine. Engine damage could result from the sudden temperature change.

NOTE—
If the engine cannot be safely turned off, make sure the air conditioner is off and turn the heater to high. This will help cool the engine until a safe stopping place can be reached.

Overheating may be caused by low coolant level or a damaged engine drive belt. Visually check the coolant level and engine belts as described in **020 Maintenance**. If the coolant level is low, check the filler cap, hoses, clamps and radiator for signs of leakage. Check for leaks at the water pump on the front of the engine.

If no leaks are found, add coolant after the engine has cooled. The car can be driven, but have the cooling system thoroughly checked as soon as possible. If replacement coolant is not available, then plain water can be used, but the coolant should later be drained and refilled with the proper mixture of anti-freeze and water.

If steam is coming from the engine compartment then there is most likely a burst coolant hose or a large leak in the cooling system. To find the leak, look for signs of coolant leakage on hoses, at hose connections, or on the radiator. Let the engine cool thoroughly, then add coolant or water to fill the system and start the engine. If a great deal of water or coolant flows out of the hole, then the car should not be driven until repairs are made. If there is slight seepage, then it may be possible to drive a short distance, adding coolant as needed.

Low Oil Pressure

If the red engine oil pressure warning light illuminates, immediately stop the car and turn off the engine. Have the vehicle flat-bedded or towed to an authorized service center and have the engine oil pressure checked.

NOTE—
Detailed information on checking the oil pressure is covered in **119 Lubrication System**.

Brake Fluid Level

The brake fluid level warning light may be an indicator of brake fluid loss. Problems with the brake system should be checked and repaired immediately. See **340 Brakes** for more information.

Check Engine Warning Light

If the "CHECK ENGINE" warning light comes on or flashes, it indicates that an emissions-related fault has occurred. Faults such as a failed oxygen sensor or a faulty fuel injector can turn the light on, causing the exhaust or evaporative emissions to exceed a specified limit. The engine can be safely driven with the light on, although the emission systems should be checked as soon as possible. See **100 Engine–General** for more information on the Check Engine Light and the On-board diagnostic system.

Dim Lights

Headlights and instrument panel illumination that are dim or gradually getting dimmer generally indicate a problem with the battery or charging system. The battery charge indicator light may come on as the lights are dimming. In either case, the engine and accessories are running off of the battery alone, and will soon discharge it altogether.

If possible, do not stop the engine unless you have the capability to jump start it. There may not be enough power in the starting system to restart the engine. Instead, turn off as many electrical consumers as possible. This will reduce the current drain and will allow the car to be driven farther before you lose all battery power.

With the engine and ignition off, check for loose or corroded battery cables or wires at the battery or the alternator. Disconnecting, cleaning, and reinstalling corroded wires and connectors may solve the problem. Also check drive belt tension as described in **020 Maintenance**.

Towing

The cars covered by this manual should be towed with a tow truck using wheel lift or flat bed equipment. Do not tow the car on all four wheels except for very short distances to move it to a safe place.

Tow hooks are located behind tow hook covers in the front and rear bumpers.

When towing the car from the front with the rear wheels on the ground, a maximum distance of 20 miles is acceptable. If the car needs to be towed further, have the rear wheels placed on dollies.

CAUTION—

- *Do not tow with sling-type equipment. The front spoilers and bumper covers may sustain damage.*
- *Towing a BMW with an automatic transmission with the rear wheels on the ground can result in transmission damage due to lack of lubrication and should be avoided.*

If necessary, cars with automatic transmissions can be towed with the rear wheels on the ground, but the tow distance should not exceed 25 miles (40 km), at speeds at or below 30 mph (35 km/h). Be sure the transmission fluid has been topped off before starting the tow. Always tow the car with the transmission lever in "N" (neutral). If the tow must exceed 25 miles (40 km), add one quart of ATF to the transmission, or better yet, remove the driveshaft. Be sure to drain or pump out the added fluid once the tow has been completed.

NOTE—

- *ATF draining and filling is covered in* **240 Automatic Transmission**.
- *Driveshaft removal is covered in* **260 Driveshaft**.

Spare Parts Kit

Carrying a basic set of spare parts can prevent a minor breakdown from turning into a major annoyance. Many of the following items won't allow you to do major repair work on the car, but they will help in the event of the failure of something that can disable the car or compromise its safety.

Spare Parts Kit - Basic Contents

- Drive belt (V-belt or poly-ribbed)
- Engine oil (one or two quarts)
- Engine coolant (1 gallon of premixed 50/50 anti-freeze and water)
- Fuse assortment (7.5A, 10A, 15A, 20A)
- Radiator hoses (upper and lower)

Spare Parts Kit - Additional Contents

- Exterior lighting bulbs (headlight, brakelight, turn signal, and taillight)
- Wiper blades
- Brake fluid (new unopened bottle, DOT 4 specification)
- Main relay for DME system

Abbreviations

- ABS. . . . . antilock brakes
- A/C . . . . . air conditioning
- ADS . . . . . auxiliary throttle valve system
- ASC/ASC+T . . . . automatic stability control/ + traction
- DME . . . . . digital motor electronics
- DWA . . . . . anti-theft system
- ECM . . . . . electronic control module
- EDC . . . . . electronic damping control
- EML . . . . . electronic throttle control
- IHKA . . . . . automatic heating/A/C control
- LAD. . . . . load absorption damping
- SRS . . . . . supplemental restraint system-airbag
- TCM . . . . . transmission control module
- ZKE . . . . . central body electronics



020 Maintenance

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GENERAL

The information given in this repair group includes the routine checks and maintenance steps that are both required by BMW under the terms of the vehicle warranty protection and recommended by BMW to ensure long and reliable vehicle operation.

NOTE—

Aside from keeping your car in the best possible condition, proper maintenance plays a role in maintaining full protection under BMW's new-car warranty coverage. If in doubt about the terms and conditions of your car's warranty, an authorized BMW dealer should be able to explain them.

BMW has taken a unique approach to establishing maintenance intervals. BMW's Service Indicator System computes maintenance intervals based not only on elapsed mileage, but also on such inputs as engine speed, engine temperature, number of starts, and lengths of trips. At the appropriate time, the system indicates, through lights in the instrument cluster, when the next routine maintenance is due.

NOTE—

BMW is constantly updating their recommended maintenance procedures and requirements. The information contained here is as accurate as possible at the time of publication. If there is any doubt about what procedures apply to a specific model or model year, or what intervals should be followed, remember that an authorized BMW dealer has the latest information on factory-recommended maintenance.

BMW Service Indicator



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The BMW Service Indicator notifies the driver when maintenance is required. The service indicator consists of multiple light emitting diodes (LEDs)—typically five green, one yellow, and one red—as well as OIL SERVICE and INSPECTION indicators.

When the ignition is turned on, the green LEDs come on. They go out when the engine is started. After the Service Indicator is reset, all green LEDs will be illuminated with the key on. As the car is driven in normal use, fewer and fewer green LEDs will be illuminated before start-up, indicating that the next maintenance interval is approaching.

When the car has accumulated sufficient use to require the next maintenance interval, the yellow LED will come on along with either the OIL SERVICE indicator or the INSPECTION indicator. These LEDs will stay on after the engine is started. If maintenance service is delayed, the red LED will also illuminate as a reminder that maintenance service is overdue.

An OIL SERVICE interval will always be followed by an INSPECTION interval, which will then be followed by an OIL SERVICE interval, and so on.

Oil Service

The Oil Service indicator signals the need for the most basic level of routine maintenance. BMW's required oil service specifies changing the engine lubricating oil and the engine oil filter after the engine has been warmed up. BMW-recommended additional maintenance for this service is listed in **Table a**.

NOTE—

- *For reference, the BMW oil service requirements are approximately equivalent to the maintenance that other European manufacturers specify at intervals with a maximum of every 7,500 miles or 6 months.*
- *Be sure to follow the instructions for resetting the Oil Service indicator light. The Inspection indicator can be accidentally reset rendering its function inaccurate.*

Inspection I and Inspection II

The Inspection indicator signals the need for more comprehensive maintenance and inspection. There are two sets of inspection requirements, Inspection I and Inspection II. These inspections alternate throughout a car's maintenance history. If the last inspection interval was Inspection I, the next inspection interval (following an Oil Service) will be Inspection II, the next after that will be Inspection I, and so on.

Inspection I tasks are listed in **Table b**. Inspection II includes most of the tasks from Inspection I with additional Inspection II tasks. A complete listing of Inspection II tasks are listed in **Table c**.

NOTE—

For reference, the BMW Inspection I and Inspection II requirements are approximately equivalent to the maintenance requirements that other European manufacturers specify. Inspection I is normally due at intervals with a maximum of 15,000 miles or 12 months. Inspection II is normally due at intervals with a maximum of 30,000 miles or 24 months. Later cars may have different Inspection intervals.



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Resetting Service Indicator

When the specified maintenance has been carried out, the service indicator memory should be reset.

The service indicator is reset using a special tool. The tool is plugged into the diagnostic connector in the engine compartment.

CAUTION—

Follow the manufacturer's directions when resetting the service indicator. If the reset procedures are done incorrectly, the reset tool or the electronic service indicator may be damaged.

Aftermarket reset tools can be purchased from one of the following manufacturers:

Assenmacher Specialty Tools
Boulder CO 80301
(303) 530-2424

Peake Research, Automotive Products Division
P.O. Box 28776
San Jose CA 95159
(408) 369-0406

MAINTENANCE TABLES

Table a through **Table d** on the following pages list the routine maintenance tasks specified by BMW. The intervals for most of these tasks are determined by the Service Indicator. The maintenance intervals for a few additional items are based on either elapsed mileage or time. These intervals are clearly indicated in separate tables.

Except where noted, the maintenance items listed apply to all models and model years covered by this manual. The columns on the right side of each table give quick-reference information about the job. The bold text references the repair group where additional repair information can be found.

Table a. Oil Service

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Engine compartment maintenance				
Change oil and oil filter	*	*	*	
Check fluid levels (coolant, steering, brake/clutch, ATF)		*	*	
Under car maintenance				
Check steering box and steering linkages for leaks and excess play. **Repair Group 320**				
Inspect brake system. Check brake calipers, rotors, and brake pad thickness. Inspect for damaged hoses and lines, leaks or damage. Check hand brake, adjust cable if necessary. **Repair Group 340**				
Check and adjust tire pressures, including spare	*			
Body and interior maintenance				
Check operation of exterior and interior lights, including glove box light, engine compartment light, trunk light, instrument panel lights, horns, headlight flasher and dimmer switch. Check headlight and driving light aiming. **6 Electrical System**				
Check condition and function of seat belts. **Repair Group 720**				

Continued on next page

Table a. Oil Service

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Check windshield washer fluid level and concentration, add as necessary. Check operation of washer system. Check condition of wiper blades. **Repair Group 611**		*		
Road Test				
Check braking performance, steering, heating and ventilation, manual or automatic transmission, and mirrors				

Table b. Inspection I Service

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Engine compartment maintenance				
Check and adjust valve clearance (M30 engine). **Repair Group 116**	*	*		
Change oil and oil filter.	*	*	*	
Check brake/clutch fluid level		*		
Check battery acid level and correct as necessary. **Repair Group 020**	*			
Check engine coolant level and anti-freeze protection and add as necessary. Inspect for cooling system leaks **Repair Group 170**	*	*		
Lubricate throttle linkage				
Under car maintenance				
Check transmission for external leaks				
Check manual transmission oil level and add as necessary **Repair Group 230**	*	*		
Check final drive lubricant and add as necessary. **Repair Group 331**	*	*		
Check fuel tank, fuel lines, and all connections for leaks				
Inspect exhaust system. **Repair Group 180**				
Check steering box and steering linkages. Check power steering system for leaks. Check fluid level. **Repair Group 320**		*		*
Inspect brake system for damaged hoses and lines, leaks or damage. Remove calipers and check brake pad wear. Check brake rotors for scoring damage. **Repair Group 340**	*			
Check parking brake operation, adjust cable if necessary. **Repair Group 340**	*			

Table b. Inspection I Service (continued)

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Inspect front and rear suspension, including wheel bearings, for play. **Repair Groups 310/330**				*
Inspect wheels and tires, including spare, check tire pressure and condition	*			
Check hydraulic fluid level for Level Control System (LAD), if applicable. See **Repair Group 330**		*		
Body and Interior Maintenance				
Lubricate door hinges and hood latch, hood hinges				
Check headlight and driving light aiming and adjust as necessary.	*			*
Check operation of headlights, parking lights, back-up lights, license plate lights, interior lights, glove box light, engine compartment light, trunk light, instrument panel lights, turn signals, emergency flashers, stop lights, horns, headlight flasher and dimmer switch				
Check active check control panel for faults. **6 Electrical System**				
Check function of air conditioning. Check refrigerant charge at sight glass, where applicable. Tighten A/C compressor mounting bolts. **Repair Group 640**	*			
Check function of seat belts. **Repair Group 720**				
Check windshield washer fluid level and concentration, add as necessary. Check operation of washer system. Check condition of wiper blades **Repair Group 611**		*		
Tighten nuts and bolts for door locks and striker plates				
Replace intake dust/pollen microfilter in A/C unit. **Repair Group 640**	*	*		
Replace batteries for alarm/remote control in master key (1995 models)		*		
Road Test				
Check braking performance, steering, HVAC, manual or automatic transmission, and mirrors				

Table c. Inspection II Service

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Engine compartment maintenance				
Check and adjust valve clearance (M30 engine). **Repair Group 116**	*	*		
Inspect V-belt /Poly-ribbed drive condition. Check V-belt tension (M30 engines).	*			
Lubricate throttle linkage.				

Table c. Inspection II Service (continued)

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Change air filter.	*	*		
Change oil and oil filter.	*	*	*	
Check brake/clutch fluid level.		*		
Check battery acid level and correct as necessary. **Repair Group 020**				
Check engine coolant level and anti-freeze protection and add as necessary. Inspect for cooling system leaks. **Repair Group 170**	*	*		
Under car maintenance				
Change automatic transmission fluid (except 740i/iL models). **Repair Group 240**	*	*	*	*
Change manual transmission oil. **Repair Group 230**	*	*	*	*
Check clutch plate for wear. **Repair Group 210**	*			
Check drive axle boots for leaks. **Repair Group 330**				
Change final drive fluid (1995 models: change synthetic oil every 2nd Inspection II).	*	*	*	*
Replace fuel filter.	*	*		
Replace air filter element.	*	*		
Check fuel tank, fuel lines and all connections for leaks.				
Inspect exhaust system. **Repair Group 180**				
Check steering box and steering linkages. Check power steering system for leaks. Check fluid level. **Repair Group 320**		*		*
Inspect brake system for damaged hoses and lines, leaks or damage. Remove calipers and check brake pad wear. Check brake rotors for scoring damage. **Repair Group 340**	*			
Check parking brake operation, adjust cable if necessary. Check thickness of parking brake linings. **Repair Group 340**	*			
Inspect front and rear suspension, including front and rear wheel bearings, for play. **Repair Group 310/330**	*			*
Inspect wheels and tires, including spare, check tire pressure and condition.	*			
Cars with traction control ASC+T: replace ASC+T filter.	*	*		
Check hydraulic fluid level for Level Control System (LAD), if applicable. See **Repair Group 370**		*		
Body and Interior Maintenance				
Lubricate door hinges and hood latch, hood hinges.	*			
Check headlight and driving light aiming and adjust as necessary.	*			*

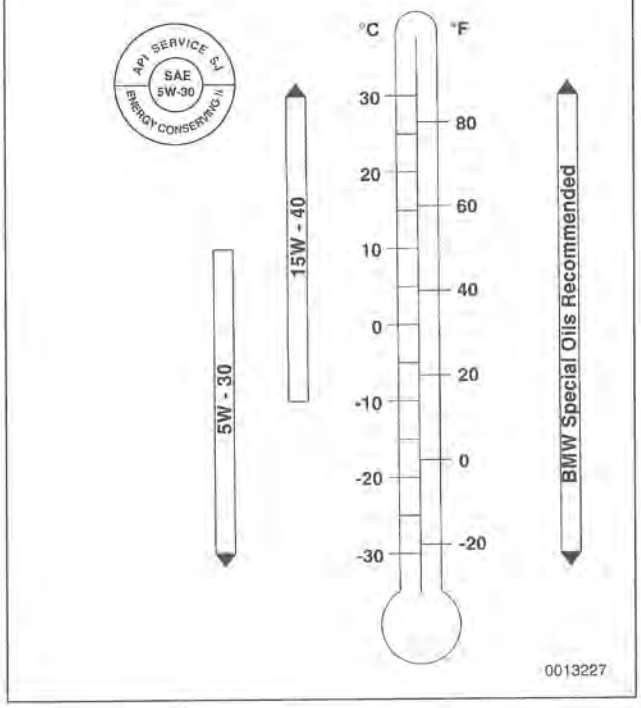
Table c. Inspection II Service (continued)

Maintenance item	Tools required	New parts required	Warm engine required	Dealer service recommended
Check operation of headlights, parking lights, back-up lights, license plate lights, interior lights, glove box light, engine compartment light, trunk light, instrument panel lights, turn signals, emergency flashers, stop lights, horns, headlight flasher and dimmer switch.				
Check active check control panel for faults. **6 Electrical System**				
Body and Interior Maintenance (cont.)				
Check function of air conditioning. Check refrigerant charge at sight glass, where applicable. Tighten A/C compressor mounting bolts. **Repair Group 640**	*	*		
Check function of seat belts. **Repair Group 320**				
Check windshield washer fluid level and concentration, add as necessary. Check operation of washer system. Check condition of wiper blades **Repair Group 611**		*		
Tighten nuts and bolts for door locks and striker plates.	*			
Replace intake dust/pollen microfilter in A/C unit. **Repair Group 640**	*	*		
Replace batteries for alarm/remote control in master key.		*		
Check ground connection of SRS (airbag) front sensor to body, if applicable. **Repair Group 721**	*			*
Road Test				
Check braking performance, steering, HVAC, manual or automatic transmission and mirrors				

Table d. Scheduled Maintenance—Time/Mileage Intervals

Maintenance item	every 12 months	every 24 months	every 48 months	every 50,000 miles	every 60,000 miles	every 100,000 miles	New parts required	Dealer service recommended
Replace oxygen sensor. **Repair Group 180**					*		*	
Flush and replace brake fluid/clutch fluid. **Repair Group 340**		*					*	
Drain and flush cooling system and replace coolant. **Repair Group 170**		*					*	
Anti-corrosion warranty inspection.	*							*

Engine Oil Viscosity Requirements vs. Temperature



FLUID AND LUBRICANT SPECIFICATIONS

Engine oil viscosity (SAE grade) vs. operating temperature range shown for BMW engines covered in this manual.

The fluids and lubricants specified by BMW are listed in **Table e.**

WARNING—
The use of fluids that do not meet BMW's specifications may impair performance and reliability, and may void warranty coverage.

Table e. Fluids and Lubricants

Fluid	Approximate capacity	Specification
Engine oil with filter change		
735i/iL (M30)	5.75 L (6.1 US qt.)	API service SH or SJ
740i/iL (M60)	7.50 L (7.9 US qt.)	
750iL (M70)	7.50 L (7.9 US qt.)	
Manual transmission oil	Gear oil, depending on application and model year. See **230 Manual Transmission**	
Automatic transmission fluid (ATF) (drain and fill)		
735i/iL	3.0 L (3.2 US qt.)	Dexron III®ATF
740i/iL	Lifetime fill 5.5 L (5.8 US qt.) dry 3.7 L (3.9 US qt.) drain & refill	Shell LA 2634 ATF fluid or contact BMW dealer
750iL	3.5 L (3.7 US qt.)	Dexron III®ATF
Final drive (drain and fill)		
735i/iL/750iL	1.9 L (2.0 US qt.)	Hypoid gear oil SAE 90 (GL-5)
740i/iL/750iL (1993-1994)	1.9 L (2.0 US qt.)	BMW Synthetic Final Drive Oil or Castrol SAF-XO
Power steering fluid		
All models	Consult owner's manual and reservoir tank label Dexron III Pentosin 7.1 Pentosin CHF 11S from 09/1991	
Brake fluid		
All models	—	SAE Dot 4
Engine coolant		
735i/iL	12.5 L (13.2 US qt.)	50% BMW anti-freeze/ 50% water
740i/iL	12.5 L (13.2 US qt.)	
750iL	15 L (15.8 US qt.) (to 9/90) 13 L (13.7 US qt.) (from 9/90)	

CAUTION—
Multi-viscosity engine oils should not be used in manual transmissions. Use of such an oil could shorten the service life of the transmission.

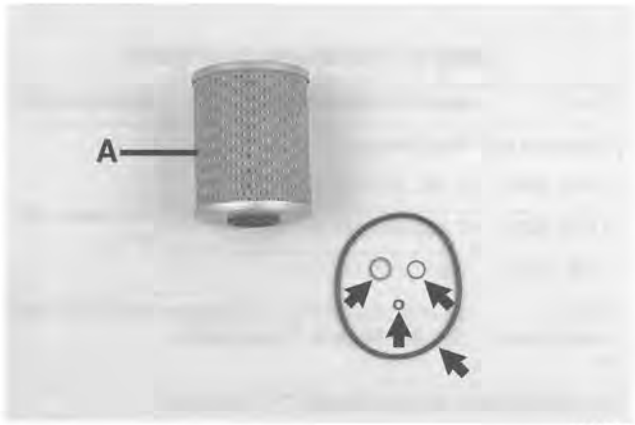
NOTE—
Changing the manual transmission gear oil to a less viscous engine oil (lower SAE viscosity rating) or ATF may increase the level of gear noise in the passenger compartment.

ENGINE OIL SERVICE

The OIL SERVICE light in the service interval indicator should be the basic guide to scheduling oil changes. The oil service light should come on at or before 7,500 miles. If the car is used primarily for short trips in slow moving traffic, or routinely operated aggressively, the oil service light should come on earlier.

Engine oil and filter, changing

– Run engine for a few minutes to warm engine and then turn engine off.



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➢ Remove oil filter.

- On all engines, loosen oil filter cover or oil filter cover mounting bolt.
- On all engines, remove old O-ring(s) from cover and from end of bolt (**arrows**).
- Lubricate and install new O-ring(s) in filter cover and on filter bolt (M30 engines only). Install new filter cartridge (**A**) and cover.

Tightening Torque

- Oil filter cover to oil filter housing

M10 or M 12 bolt . . . . . 33 Nm (24 ft-lb)
Screw-on cover . . . . . 25 Nm (18 ft-lb)

CAUTION—
Overtightening the oil filter will make the next change much more difficult, and may deform the gasket, causing leaks.


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➢ With car on level ground, place a drain pan under oil drain plug (**arrow**).

NOTE—
The car will not need to be raised if a shallow drain pan is used.

– Using a socket or box wrench, loosen drain plug from bottom of oil sump. By hand, remove plug and let oil drain into pan.

CAUTION—
- *Pull the loose plug away from the hole quickly to avoid being burned by the hot oil. It will run out quickly when the plug is removed.*
- *Use gloves to protect your hands.*

– When oil flow has diminished to an occasional drip, reinstall drain plug with a new metal sealing washer and tighten plug.

Tightening Torques
- Engine oil drain plug to oil sump
  M12 bolt . . . . . 25 Nm (18 ft-lb)
  M22 bolt . . . . . 60 Nm (44 ft-lb)

– Refill crankcase with oil. Check oil level when finished adding oil. Oil specifications are found under **Fluid and Lubricant Specifications**.

– Start engine and check that oil pressure warning light immediately goes out. Allow engine to run for a few minutes to circulate new oil. Check for leaks at drain plug and oil filter. Stop engine and recheck oil level.

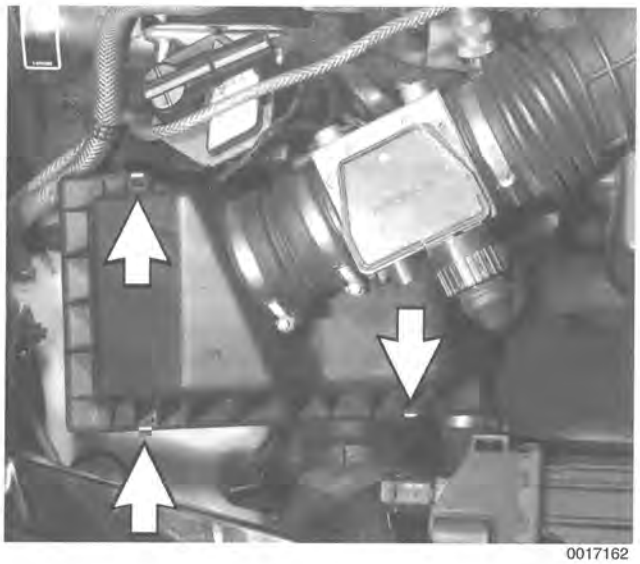
CAUTION—
- *Dispose of used oil properly. Use tight-sealing containers and mark them clearly. Check with the place of purchase about disposal.*
- *If the oil pressure warning light does not immediately go out after the engine is started, quickly turn the engine off. Loosen the oil filter or filter cover slightly. Restart the engine. As soon as oil begins to run out of the filter or filter cover, turn the engine off and tighten the filter or cover. This will release any trapped air that is blocking oil flow.*

ENGINE COMPARTMENT MAINTENANCE

Air filter element, replacing

The specified maintenance intervals for replacing the air filter element are based on normal use. If the car is operated primarily in dusty conditions, the air filter should be serviced more frequently. A dirty air filter starves the engine for air, reducing power output.

NOTE—
- *On the M30 or M60 engine, the air filter housing is in the front right corner of the engine compartment.*
- *The M70 engine has two air filters, on in each front corner of the engine compartment.*



0017162

➤ Upper and lower parts of air filter housing are fastened together with spring clips around outside edge (**arrows**).

- To replace air filter element, unfasten clips as necessary.



0017163

➤ Separate upper air filter housing from lower part just enough to remove filter element.

– Take note of installed position of filter.

- Wipe clean inside of air filter housing using a lint-free cloth and install new filter.
- Reinstall upper air filter housing, making sure that two halves are mated correctly.
- Refasten spring-clips and tighten mounting nuts.

> ***WARNING—***
> *When reinstalling a used air filter element, reinstall the filter in the same position that it was in before removal. Reversed installation will allow accumulated dirt to be drawn into the engine.*

Spark plugs, replacing

High temperature and high-voltage sparks eventually wear out the spark plug electrodes, and the spark plugs must be replaced.

– On M30 or M70 engine: Label and gently remove spark plug wire by pulling on protective boot. Blow or brush away any dirt from around the base of the plug to prevent it from entering the engine when the plug is removed.

> ***CAUTION—***
> *Spark plugs should be replaced one at a time so that the spark plug wires do not get mixed up. If all of the wires need to be removed together, label each wire so that they can be reinstalled on the correct spark plug.*



➢ On M60 engine: Individual ignition coils are mounted above each spark plug.

- To access plugs, remove ignition coil mounting bolts and electrical harness connectors (**arrows**). See **120 Ignition System**.

– Use a 13/16 in. or 5/8 in. spark plug socket to remove and reinstall spark plugs.

- Correct spark plugs for different engines covered by this manual are listed in **Table f**.
- Use a spark plug gap gauge to check gap, if applicable. If necessary, bend outer electrode slightly to adjust gap to meet specification.
- Do not bend or file center electrode.
- Lubricate spark plug threads with anti-seize compound.
- Thread plugs into cylinder head by hand to prevent cross-threading.
- Torque spark plugs.

Tightening Torque

- Spark plug to cylinder head . . . . . 30 Nm (22 ft-lb)

NOTE—

Abnormal spark plug condition or engine damage could also result from spark plugs of the wrong specification. Check replacement plugs carefully and follow the spark plug manufacturer's recommendations.

Table f. Spark Plug Applications

Model/ (Engine code)	Spark plug (Bosch)	Electrode gap
735i/iL (M30)	W8 LCR	0.7-0.8 mm (0.028-0.032 in.)
740i/iL (M60)	F7 L DCR	non-adjustable
750iL (M70)	F8 LCR	0.7-0.8 mm (0.028-0.032 in.)

Distributor cap/rotor/spark plug wires, replacing

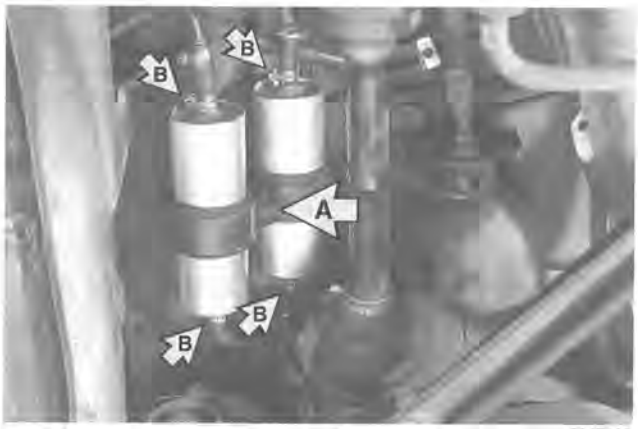
The distributor cap, rotor, and spark plug wires deliver high-voltage spark to the spark plugs. They are subject to insulation breakdown, corrosion fouling, and electrode wear and damage. The components should be inspected and replaced as necessary at the intervals listed under **Table b** or **Table c** to ensure maximum engine efficiency. Guidelines for visual inspection and testing, and instructions for replacement are found in **120 Ignition System**.

Fuel filter, replacing

NOTE—
All twelve and some eight cylinder models (from March 1993) are equipped with two fuel filters.

The fuel filter(s), located beneath the right rear of the car, just in front of the fuel tank, should be replaced at the specified interval.

– Disconnect negative (–) battery cable as described later in this group.



0017168

Clamp filter inlet and outlet hoses to lessen fuel spillage.

- Loosen clamping bracket (**A**) and then hose clamps (**B**).
- Install filter and use new hose clamps.

NOTE—
The direction of fuel flow is indicated on the filter(s).

> ***WARNING—***
> *Fuel will be spilled when the filter is removed. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.*

> ***CAUTION—***
> *Clean thoroughly around the filter connections before removing. Make sure no dirt gets into the fuel lines.*

Valve clearance, adjusting (M30 engine)

1988–1992 735i/iL models require periodic valve clearance checking and adjusting. The complete valve adjustment procedure is covered in **116 Cylinder Head and Valvetrain.**

Battery maintenance

Simple maintenance of the battery and its terminal connections will ensure maximum starting performance, especially in colder temperatures. For a more detailed discussion of the battery and charging system, see **121 Battery, Starter, Alternator**.

NOTE—
- *The battery is mounted beneath the rear seat. See* **520 Seats**.
- *A secure battery hold-down is important in order to prevent vibrations and road shock from damaging the plates.*

Battery cable clamps should be tight. The terminals, the cable clamps, and the battery case should be clean and free of white deposits. Even a thin layer of dust containing conductive acid salts can cause battery discharge.

To remove battery corrosion, begin by disconnecting the cables. Disconnect the negative (–) cable first. Clean the terminal posts and the cable clamps with a wire brush. Clean the main chassis ground terminal next to the battery.

Corrosion can be washed away with a baking soda and water solution that will neutralize the acid. Apply the solution carefully, though, since it will also neutralize the acid inside the battery. Reconnect the cable clamps, positive (+) cable first. Lightly coat the outside of the terminals, hold down screw, and clamps with petroleum jelly, grease, or a commercial battery terminal corrosion inhibitor.

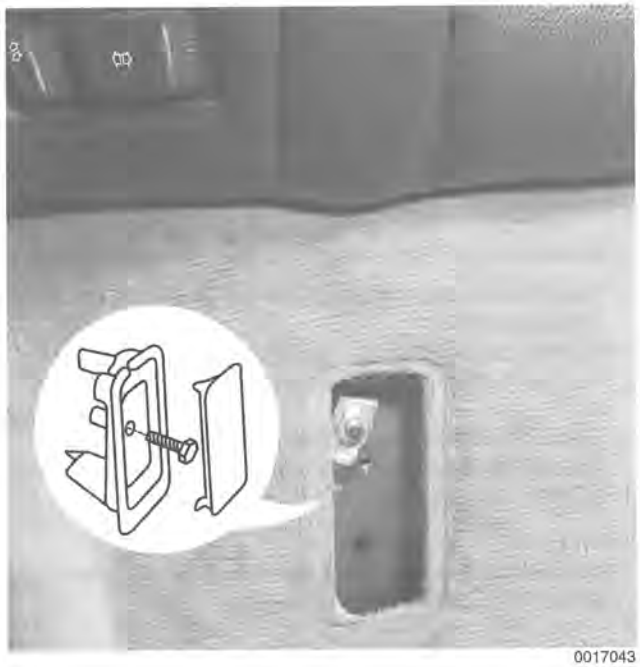
WARNING —

- *Battery acid is caustic and dangerous. Take care to keep it from contacting eyes, skin, or clothing. Wear eye protection. Extinguish all smoking materials and do not work near any open flames.*
- *Hydrogen gas given off by the battery during charging is explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.*

CAUTION —

- *Disconnecting the battery cables with the engine running, or reconnecting the cables to the incorrect posts will damage the electrical system.*
- *Be sure to have the radio code on hand before disconnecting battery.*
- *To avoid causing battery acid damage to the interior, remove battery from car before using a battery charger.*

Battery electrolyte should be maintained at the correct level just above the battery plates and their separators. The correct level is approximately 5 mm (1/4 in.) above the top of battery plates or to the top of the indicator marks (if applicable). The battery plates and the indicator marks can be seen once the filler caps are removed. If the electrolyte level is low, replenish it by adding distilled water only.



0017043

Battery, disconnecting

Always disconnect the negative (–) cable first, and connect it last.

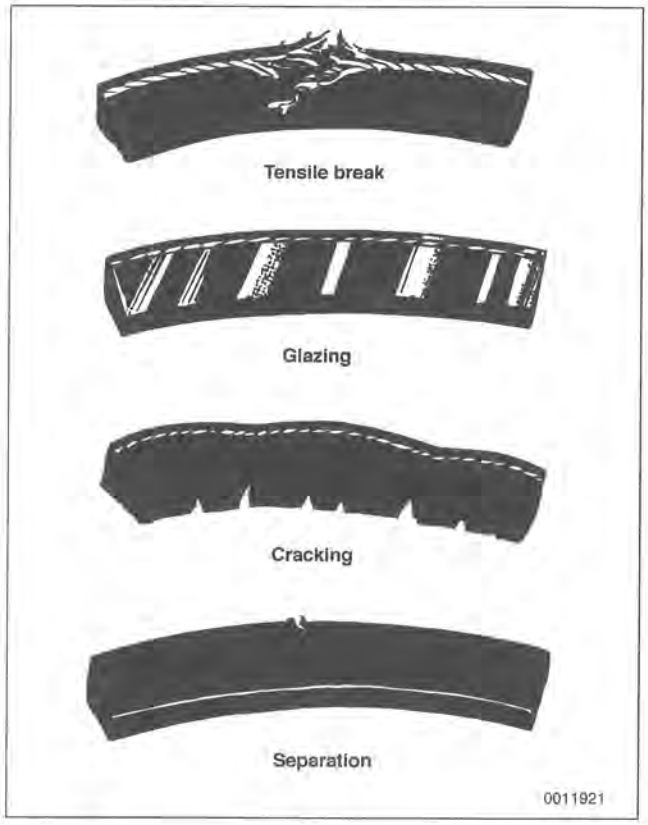
The negative battery cable can be disconnected through an access panel in the carpeting below right rear seat.

- Insulate removed battery cable end to prevent accidental reconnection.

Throttle housing and linkage, lubricating

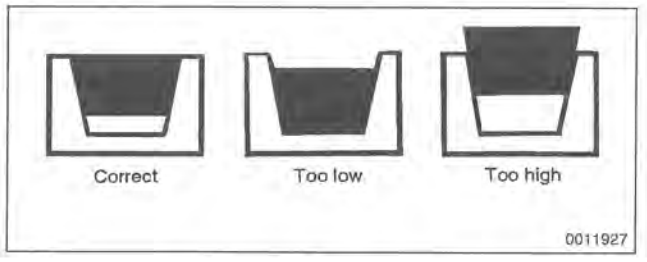
The linkage at the throttle housing should be lubricated at the normal maintenance intervals. Use a general purpose oil on the joints and bearings of the linkage. Use a multipurpose grease on the bearing points of the throttle plate.

V-belts, checking and replacing (M30 engine)



V-belts should be inspected during regular maintenance intervals. Incorrect tension can decrease the life of the belt and the component it drives. Inspect belts with the engine off. Twist the belt to inspect its sidewalls and bottom. Belt structural damage, glazed or shiny sidewalls caused by a loose belt, or separation caused by oil contamination are all reasons to replace a belt.

Belt squealing is normally caused by loose belt tension. Loud squealing may only be corrected by belt replacement. Belt dressings should not be used to correct the problem.



A worn belt may ride too low in the pulley grooves. A belt that is too wide for the application may ride too high in the pulley grooves.

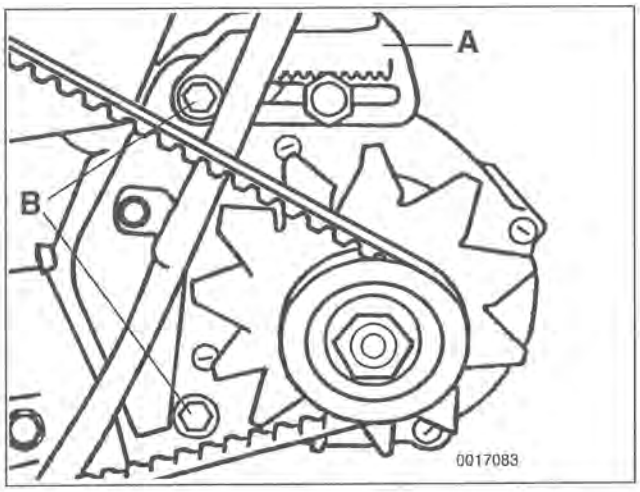
– Replacement of V-belts every four years is recommended.

- Loosen mounting bolts and adjust until belt tension is as loose as possible.
- Remove belt by slipping it over pulleys. In some cases it may be necessary to remove one V-belt to get to another.
- Cross section and length determine belt size.
- Use old belt for comparison, or make sure that new belt fits into pulley groove.

NOTE—

When belts are replaced with new ones, store the old set in the luggage compartment for emergency use.

– When installing a new belt, gently pry it over pulleys. Too much force may damage belt or accessory. Tension belt(s), run engine for a few minutes (at least 1500 rpm), then re-check belt tension.



➢ V-belt tension is adjusted through a toothed-rack mechanism (**A**). Adjust V-belts by first loosening mounting nuts/bolts (**B**) until unit pivots freely. Use a torque wrench and a crowfoot wrench to turn tensioning gear bolt. Hold wrench steady and tighten locknut on rear of tensioning gear bolt. Tighten all other mounting nuts.

NOTE—
V-belt tension should be checked using a V-belt tension gauge.

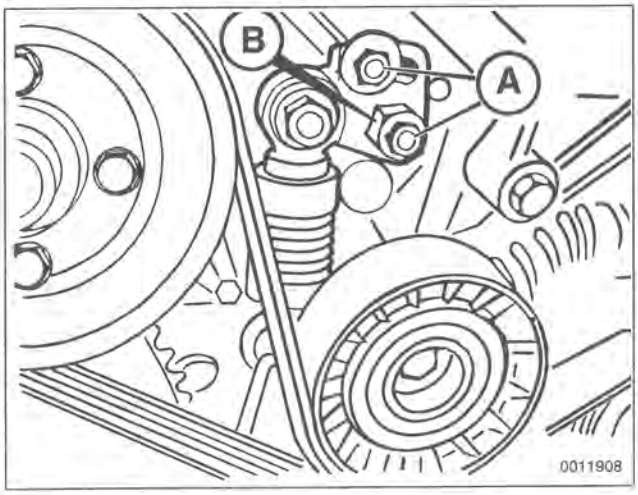
Tightening Torques

- A/C belt tension . . . . . 7 - 8.5 Nm (62 - 75 in-lb)
- Alternator belt tension) . . . . . .7 Nm (62 in-lb)
- Power steering belt tension) . 8 - 8.5 Nm (71 -75 in-lb)
- Tensioning gear locking nut . . . . . 24 Nm (18 ft-lb)

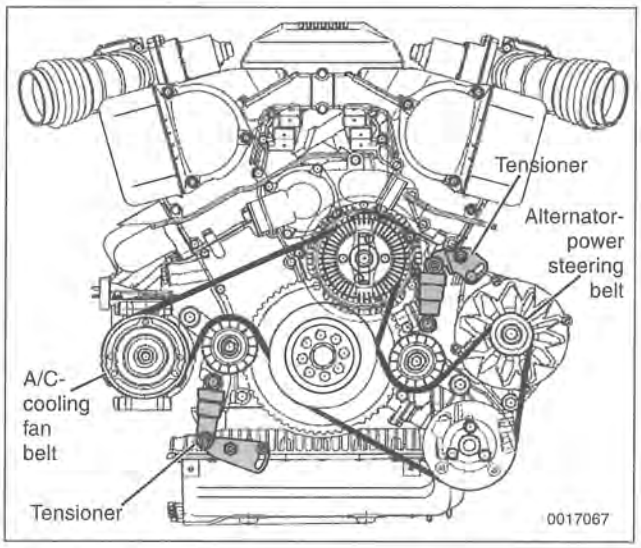
CAUTION—
Do not over tighten the V-belts. Overtightening will cause shaft bearings to fail prematurely

Poly-ribbed belts, checking and replacing (M60 or M70 engine)

The automatic-tensioning poly-ribbed belt(s) should be inspected during regular maintenance intervals. Inspect the belt with the engine off. Twist the belt to inspect its sidewalls and bottom. Belt structural damage, glazed or shiny contact surfaces, cracking, or oil contamination are all reasons to replace a belt.



➢ To replace the poly-ribbed belts on M60 or M70 engines, loosen the mounting nuts on the belt tensioner (**A**). Then use an open end wrench to rotate the tensioner counter-clockwise (**B**), releasing belt tension. Tighten the tensioner mounting nuts to hold the tensioner in position. Remove the belt. Install the new belt and then loosen the tensioner mounting nuts. Tighten the nuts once the belt is tensioned.



➤ M70 engine poly-ribbed belts and tensioners.

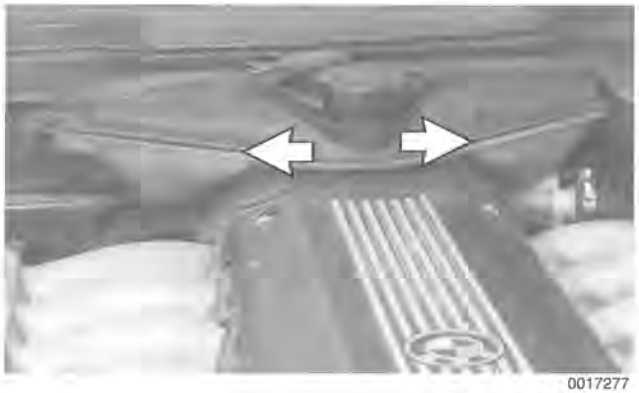
NOTE—
If reinstalling belt, label rotation direction.

Cooling system maintenance

Cooling system maintenance consists of maintaining the coolant and inspecting coolant hoses. Because the coolant's anti-corrosion and anti-freeze additives gradually lose their effectiveness, replacement of the coolant every 2-3 years is recommended. As a preventive measure, replacement of the cooling system hoses every 4 years is also recommended.

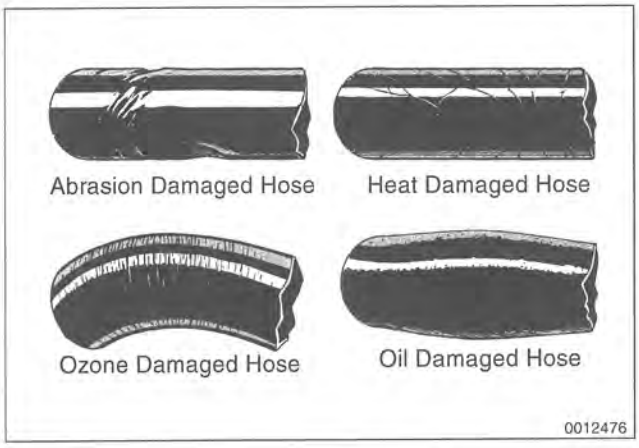
CAUTION—
Use only BMW-approved long life anti-freeze when filling the cooling system. Use of anti-freeze containing phosphates or a high silicate content is considered to be harmful to the cooling system.

A translucent expansion tank in the rear of the engine compartment provides easy monitoring of coolant level. Because the expansion tank is translucent, the coolant level can be checked visually without opening the system.


0017277

➤ Always check the coolant level with the engine cold. The coolant level should be at the maximum mark on the expansion tank (**arrows**).

– Coolant hose connections should be tight and dry. Coolant seepage indicates either that the hose clamp is loose, that the hose is damaged, or that the connection is dirty or corroded. Dried coolant has a chalky appearance.



- Hoses should be firm and springy. Replace any hose that is cracked, that has become soft and limp, or has been contaminated by oil.

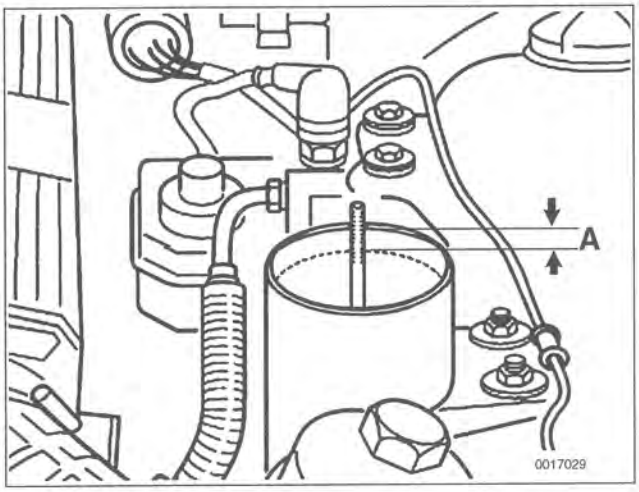
Power steering fluid level, checking

Check the power steering fluid level in the fluid reservoir, just to left of engine behind the front power distribution box. The car should be parked on level ground with the engine off.

NOTE—
The power steering system is filled with either Dexron III automatic transmission fluid (ATF) or one of two types of Pentosin hydraulic fluid.



- In cars that use ATF: The fluid level is correct if it is between the MAX and MIN marks on the dipstick.
  - If the level is below the MIN mark, start the engine and add fluid to the reservoir to bring the level up. Stop the engine and recheck the level.
  - Hand-tighten the reservoir cap.



- In cars that use hydraulic fluid: With engine off, fill reservoir until fluid level (**A**) is approximately 25 mm (1 in.) below reservoir rim.

NOTE—
- *Early E32 cars use Pentosin® CHF 7.1 hydraulic fluid.*
- *Beginning with cars produced in September 1991, Pentosin® CHF 11 S is used in the hydraulic system.*

CAUTION—
Check the hydraulic reservoir for a label identifying the type of fluid used. Do not mix fluids.

Hydraulic brake booster fluid, checking

Early 735i/iL models (to 3/88) and all 750iL models are equipped with a hydraulic brake booster system. The hydraulic fluid reservoir for this system is shared with the power steering system, shown earlier.

Brake/clutch fluid level, checking



0017286

The level of the brake fluid will drop slightly as the brakes wear.

- Check the fluid level is between the MIN and MAX (**arrow**) marks on the brake fluid reservoir. W
- When filling the reservoir, use only new brake fluid from previously unopened containers. See **Fluid and Lubricant Specifications.**

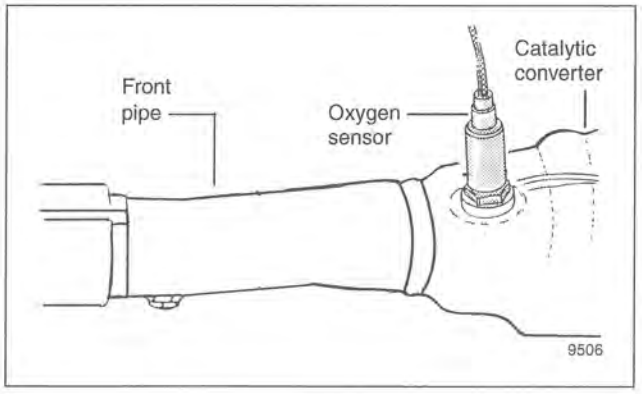
NOTE—

- *The brake fluid also serves as the hydraulic fluid for the clutch on cars with manual transmission.*
- *Low fluid level in the brake fluid reservoir may be due to leaks in the brake system or in the hydraulic clutch.*

Oxygen sensor, replacing

The oxygen sensor monitors engine combustion efficiency by measuring the oxygen content of the exhaust gasses. The output signal from the sensor is used to precisely control fuel delivery. Any problems with the oxygen sensor will directly affect exhaust emissions and the way the engine runs.

Replacement of the oxygen sensor at the specified interval ensures that the engine and emission control system will continue to operate as designed.



The sensor is mounted the catalytic converter. For more information on testing the oxygen sensor system, see **130 Fuel injection**. See **180 Exhaust System** for oxygen sensor replacement procedures.

NOTE—

Special sockets for replacing the oxygen sensor are available from most automotive parts stores. The socket has a groove cut down one side to allow the sensor to be installed without damaging the wire harness. See **010 General** *for information on sources.*

UNDER-CAR MAINTENANCE

Tires, checking inflation pressure

Correct tire inflation pressures are important to handling and stability, fuel economy, and tire wear. Tire pressures change with temperature. Pressures should be checked often during seasonal temperature changes. Correct inflation pressures can be found on the driver's door pillar and in the owner's manual. Note that tire pressures should be higher when the car is more heavily loaded.

WARNING —
Do not inflate any tire to a higher pressure than the tire's maximum inflation pressure listed on the sidewall. Use care when adding air to warm tires. Warm tire pressures can increase as much as 4 psi (0.3 bar) over their cold pressures.

Tires, rotating

BMW does not recommend tire rotation. Owing to the car's suspension design, the front tires begin to wear first at the outer shoulder and the rear tires begin to wear first at the middle of the tread or inner shoulder. Rotating the tires may adversely affect road handling and tire grip.

NOTE —
The main purpose of tire rotation is to promote even wear and maximum tire life. Tire life may be decreased slightly if the tires are not rotated.

Wheels, aligning

BMW recommends checking the front and rear alignment once a year and whenever new tires are installed. See **320 Steering and wheel alignment** for a more detailed discussion of alignment requirements and specifications.

Brake system, inspecting

Routine maintenance of the brake system includes maintaining an adequate level of brake fluid in the reservoir, checking brake pads for wear, checking hand brake function, and inspecting the system for fluid leaks or other damage.

Brake hoses and lines, inspecting

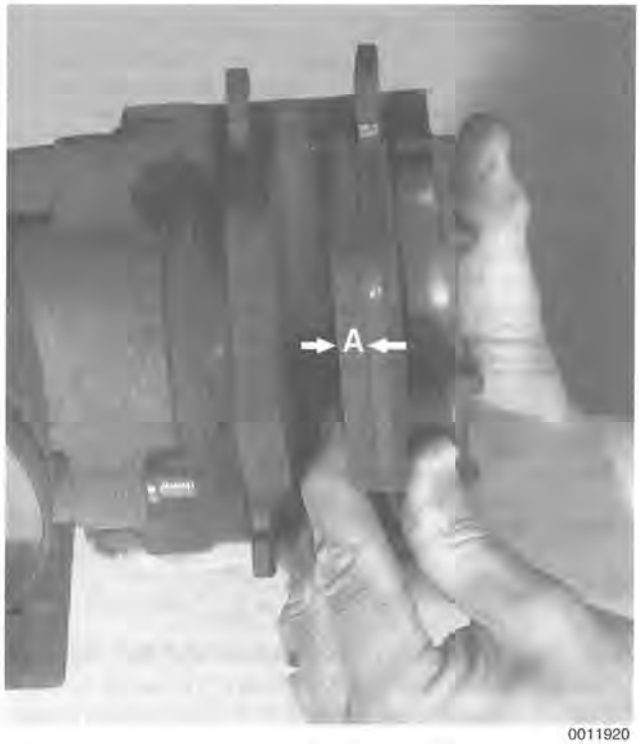
Check that all brake hoses are correctly routed to avoid chafing or kinking. Inspect unions and brake calipers for signs of fluid leaks. Inspect rigid lines for corrosion, dents, or other damage. Inspect flexible hoses for cracking. Replace faulty hoses or lines as described in **340 Brakes**.

CAUTION—

- *Incorrect installation or overtightening hoses, lines, and unions may cause chafing or leakage. This can lead to partial or complete brake system failure.*
- *Brake fluid is poisonous. Do not siphon brake fluid by mouth. Wear gloves when working with brake fluid or brake pads to prevent contamination of cuts.*

Brake pad/rotor wear, checking

Although the cars covered by this manual are equipped with a brake pad warning system, the system only monitors one wheel per axle. There can be slight variations in brake pad wear at each wheel, so brake pad thickness should be checked whenever the wheels are off or brake work is being done.



0011920

The brake caliper should be removed to properly inspect brake pad thickness (**A**) and rotors. Brake caliper removal and installation procedures are given in **340 Brakes**.

Brake Pad Lining Minimum Thickness (Dimension A)

- Front and rear disc brake pads . . . . . 2.0 mm (0.08 in)

NOTE—

For parking brake lining wear, see **Parking brake, checking** *below.*

WARNING—

Friction materials such as brake linings may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing asbestos fibers and asbestos dust, as it may result in serious diseases such as asbestosis and cancer, or in death.

Brake fluid, replacing

BMW strictly recommends replacing the brake fluid every year. This will help protect against corrosion and the effects of moisture in the fluid. See **340 Brakes** for brake fluid flushing procedures.

Parking brake, checking

The parking brake system is independent of the main braking system and may require periodic adjustment depending on use. Adjust the parking brake if the brake lever can be pulled up more than 8 clicks on the ratchet mechanism. Check that the cable moves freely. A complete description of the parking brake and parking brake adjustment can be found in **340 Brakes**.

NOTE—

The parking brake may lose some of its effectiveness over time if it is not used frequently. This is due to corrosion build-up on the parking brake drum. To remove corrosion, apply the parking brake just until it begins to grip, then pull the lever up one more stop (click). Drive the car approximately 400 meters (1,300 ft.) and release the brake. To recheck the adjustment of the parking brake see **340 Brakes**.

Exhaust system, inspecting

Exhaust system life varies widely according to driving habits and environmental conditions. If short-distance driving predominates, the moisture and condensation in the system will not fully dry out. This will lead to early corrosion damage and more frequent replacement.

Scheduled maintenance of the exhaust system is limited to inspection. Check for restrictions due to dents or kinks. Check for weakness or perforation due to rust. Check to see that all the hangers are in place and properly supporting the system and that the system does not strike the body. Alignment of the system and the location of the hangers are described in **180 Exhaust System**.

Manual transmission service

Manual transmission service consists of inspecting for leaks, checking and changing the gear oil, checking the clutch fluid level, and checking the clutch disc for wear.

Evidence of transmission leaks is most likely to be seen around the drive shaft mounting flange, and at the bottom of the bellhousing between the transmission and the engine. For more information on identifying oil leaks and their causes, see **230 Manual Transmission** and **210 Clutch**.

Manual transmission oil, checking and filling

BMW recommends checking the manual transmission oil level and changing the oil at specified intervals. Check and fill the transmission with the car on a level surface. Transmission oil level checking and oil replacement procedures are covered in **230 Manual Transmission**.

Automatic transmission service

Several different automatic transmissions are used in the cars covered by this manual, depending on engine and model year. Some early transmissions are equipped with a dipstick, while most later transmissions are not. On automatic transmissions not equipped with a dipstick, checking the ATF level is an involved procedure that requires measuring and maintaining a specified ATF temperature during the checking procedure.

NOTE—
The automatic transmission in 740i/IL models uses a special ATF oil that does not require changing for the life of the transmission.

For complete ATF service, including checking ATF level and ATF filter replacement procedures, see **240 Automatic Transmission**.

Front suspension and steering linkages, inspecting

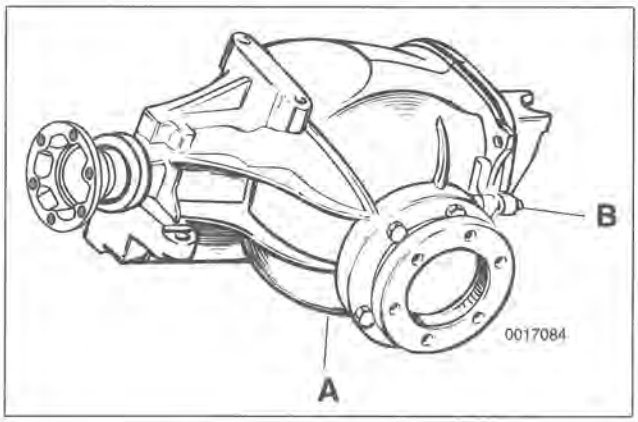
Inspection of the front suspension and steering includes a check of all moving parts for wear and excessive play. Also inspect the rubber seals and boots for cracks or tears that could allow the entry of dirt, water, and other contaminants. See **310 Front Suspension.**

Rear suspension, inspecting

Final drive and rear drive axle service consists of checking and changing the gear oil, inspecting for leaks, and checking the rear drive axle rubber boots for damage.

The areas where leaks are most likely to occur are around the drive shaft and drive axle mounting flanges. For more information on identifying oil leaks and their causes, see **330 Rear Suspension** and **331 Final Drive**.

Final drive oil level, checking



Check the oil level with the car level. Remove the oil filler plug (**B**). The level is correct when the fluid just reaches the edge of the filler hole. Remove oil through drain plug (**A**). Install and tighten the oil filler plug when the oil level is correct.

NOTE—
- *Use a 14 mm or 17 mm allen bit socket to remove the drain plug. Alternatively, cut approximately 30 mm (1.2 in.) from an allen key and use an open-end wrench on the key stub.*
- *Oil specifications vary depending on type of final drive unit installed. See* **331 Final Drive** *for more information. To identify differential type (limited slip vs. open), locate the sheet metal data tag on the left-hand side of final drive unit. This tag identifies type and final drive ratio. For example S 3,10 means that it is a limited slip differential (S) with a 3.10 final ratio.*

Tightening Torque

- Final drive filler plug to final drive housing . . . . . 70 Nm (52 ft-lb)

CV joint boots, inspecting

The rear drive axle protective boots, generally referred to as CV joint boots, should be inspected for cracks and any other damage that will allow contaminants to get into the joint. If the rubber boots fail, the water and dirt that enters the joint will quickly damage it. Replacement of the CV joint boots and inspection of the joints are described in **330 Rear Suspension**.

Fuel tank and fuel lines, inspecting

— Inspect the fuel tank, fuel lines, and fuel system for damage or leaks.

- Check for fuel leaks in the engine compartment or fuel odors in the passenger compartment.
- Check for faulty fuel lines by bending them. If any leaks are present, fuel or fuel vapors will be expelled.
- Check for a damaged fuel tank. Incorrectly raising the car can damage the tank.
- Check for any evaporative emissions hoses that may have become disconnected, checking carefully at the charcoal canister and evaporative emissions purge valve (where applicable).
- See **130 Fuel Injection** and **160 Fuel Tank and Fuel Pump** for component locations and additional information.

WARNING—
When checking for fuel leaks, the engine must be cold. A hot exhaust manifold or exhaust system could cause the fuel to ignite or explode causing serious personal injury. Ventilate the work area and clean up spilled fuel immediately.

BODY AND INTERIOR MAINTENANCE

Windshield wiper blades, replacing

BMW recommends replacing the wipers blades at specified time intervals. Normally twice a year (before and after the cold season) works well. See **611 Wipers and Washers** for more information wiper troubleshooting and wiper blade replacement.

NOTE—
When replacing the wiper blades, check the tightness of the wipers arm nuts. Loose wiper arms can lead to damaged wiper linkages. If found to be loose, align wiper arms and tighten the nuts to the torque listed in **611 Wipers and Washers**.

Ventilation microfilter, replacing (1991 and later)

The ventilation system filters pollen and airborne particles before it enters the passenger compartment. The paper-element should be replaced at every Inspection I, or every 15K miles. A dirty filter will restrict air flow into the passenger compartment and lead to poor performance of the heating and A/C system. Microfilter replacement is covered in **640 Heating and Air Conditioning.**

Body Lubrication

The body and door hinges, the hood latch, and the door check rods can be lubricated with a medium weight engine oil. Lubricate the seat runners with multipurpose grease.

Lubricate the sunroof guide rails with silicone spray. If door weatherstrips are sticking, lubricate them with silicone spray or talcum powder. Do not apply any oil to rubber parts.

The hood release cable should be lubricated as well. The radio antenna mast should be cleaned and lubricated with a product such as WD-40®.

The door locks and lock cylinders can be lubricated with an oil that contains graphite. Such a lubricant is available from BMW, Part No. 81 22 9 407 421

Seat Belts

Dirt and other abrasive particles will damage seat belt webbing. If it is necessary to clean seat belts, use a mild soap solution. Bleach and other strong cleaning agents may weaken the belt webbing.

> ***WARNING —***
> *Do not clean the seat belt webbing using dry cleaning or other chemicals. Allow wet belts to dry before allowing them to retract.*

The condition of the belt webbing and the function of the retractor mechanisms should be inspected. See **720 Seat Belts** for seat belt inspection information.

CLEANING AND PRESERVING

Exterior finish care

The longer dirt is left on the paint, the greater the risk of damaging the glossy finish, either by scratching or by the chemical effect dirt particles may have on the painted surface.

Washing

Do not wash the car in direct sunlight. If the engine hood is warm, allow it to cool. Beads of water not only leave spots when dried rapidly by the sun or heat from the engine, but also act as tiny magnifying glasses that can burn spots into the finish. Wash the car with a mixture of lukewarm water and a mild soap made expressly for washing cars. Rinse using plenty of clear water under as little pressure as possible. Wipe the body dry with a soft terry-cloth towel or chamois to prevent water-spotting.

Waxing

For a long-lasting, protective, and glossy finish, apply a hard wax after the car has been washed and dried. Use carnauba or synthetic based products. Waxing is not needed after every washing. You can tell when waxing is required by looking at the finish when it is wet. If the water coats the paint in smooth sheets instead of forming beads that roll off, a new coat of wax is needed. Wax should not be applied to black trim pieces, rubber, or other plastic parts.

Chassis washing

Periodic washing of the underside of the car, especially in Winter, will help prevent accumulation of road salt and rust. The best time to wash the underside is just after the car has been driven in wet conditions. Spray the chassis with a powerful jet of water. Commercial or self-service car washes may not be best for this, as they may recycle the salt-contaminated water.

Special cleaning

Tar and insect spots can be removed with a bug and tar remover. Never use gasoline, kerosene, nail polish remover, or other unsuitable solvents. This method can also be used to remove spotting from tree sap.

Interior care

Dirt spots can usually be removed with lukewarm soapy water. Use spot remover for grease and oil spots. Do not pour the liquid directly on the carpet, but dampen a clean cloth and rub carefully, starting at the edge of the spot and working inward. Do not use gasoline, naptha, or other flammable substances to clean the carpeting.

Vinyl and cloth upholstery and trim

Use a dry foam cleaner. Grease or paint spots can be removed by wiping with a cloth soaked with this cleaner. Use the same cleaner, applied with a soft cloth or brush, on the headliner and side trim panels. For cloth-covered seat areas, use the techniques described previously for cleaning the carpeting.

Leather upholstery and trim

Leather upholstery and trim should be periodically cleaned using a slightly damp cotton or wool cloth. The idea is to get rid of the dirt in the creases and pores that can cause brittleness and premature aging. On heavily soiled areas, use a mild detergent (such as Woolite®). Use two tablespoons to one quart of cold water. Dry the trim and upholstery completely using a soft cloth. Regular use of a good quality leather conditioner will reduce drying and cracking.



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GENERAL

There are three different engine configurations used in the 7 Series cars covered by this manual: the 3.5 liter M30 (straight-six) engine, the 4.0 liter (V-8) M60 engine and the 5.0 liter (V-12) M70 engine. See **Table a**.

Cylinder Block and Crankshaft

The cylinder block contains oil drillings for the lubrication system. All three engine block castings are unique and are not interchangeable.

Table a. Engine Specifications

Year & Model	Engine code	Cylinders	Valves/ cylinder	Displacement liters (in^3.)	Compression ratio	Horsepower lb-ft @ rpm (Kw @ rpm)	Torque lb-ft @ rpm (Nm @ rpm)
1988 - 1992 735i/iL	M30	6	2	3.5 (209.3)	9.0:1	182 @ 5,700 155 @ 5,700	225 @ 4,000 305 @ 4,000
1993 - 1994 740i/iL	M60	8	4	4.0 (243)	10:1	282 @ 5,800 210 @ 5,800	295 @ 4,500 400 @ 4,500
1988 - 1994 750iL	M70	12	2	5.0 (304)	8.8:1	296 @ 5,200 220 @ 5,200	332 @ 4,100 450 @ 4,100

On 6-cylinder engines, the cylinder block is cast iron with integral cylinders that are exposed on all sides to circulating coolant.

On V-8 engines, the cylinder block is cast aluminum alloy. Instead of steel cylinder liners, the cylinders have a "Galnikal" lining. This lining or coating is created by depositing a "dispersion layer" of nickel on the aluminum cylinder walls.

The V-12 engine cylinder block is also cast aluminum alloy, with silicon-coated cylinder walls.

The fully counterweighted crankshaft rotates in replaceable split-shell main bearings. Oilways drilled into the crankshaft provide bearing lubrication. Flexible lip seals pressed into alloy seal housings or covers are installed at both ends of the crankshaft.

Connecting Rods and Pistons

The connecting rods use replaceable split-shell bearings at the crankshaft end and solid bushings at the piston pin end. The pistons are of the three-ring type with two upper compression rings and a lower one-piece oil scraper ring. Full-floating piston pins are retained with circlips.

The V-12 engine uses a drop-forged steel crankshaft and connecting rods. The connecting rod big ends are machined asymmetrically

Cylinder Head and Valvetrain

On 6-cylinder engines, the cylinder head is an aluminum alloy casting that bolts to the cylinder block. V-8 engines use two 4-cylinder aluminum alloy cylinder heads. The V-12 cylinder heads are identical aluminum alloy castings.

The cylinder head casting(s) employs a crossflow design for greater power and efficiency. Intake air enters the combustion chamber from one side while exhaust gasses exit from the other. Oilways in the head provide lubrication for the camshaft(s) and valvetrain.

M30 engines use a single chain-driven camshaft operating two valves per cylinder. The valve-lifters are mechanical. Valve clearance needs to be adjusted at the rockers periodically. See **116 Cylinder Head and Valvetrain**.

On M60 engines, chain-driven twin camshafts (intake and exhaust) operate four valves per cylinder through hydraulic lifters.

On M70 engines, each bank of cylinders has a single camshaft. Both camshafts are driven by a single chain. The two valves per cylinder are operated through rockers. Valves have dual springs. Each rocker arm is anchored by a hydraulic valve adjuster (HVA).

M60 and M70 engines do not require valve adjustment.

Lubrication System

The lubrication system is pressurized whenever the engine is running. The oil pump draws oil through a strainer in the bottom of the oil pan, then forces it through a replaceable oil filter and into the engine oil passages. A pressure relief valve limits the maximum system pressure. A bypass valve prevents the oil filter from bursting and insures engine lubrication should the filter become plugged.

BMW engines are equipped with a dynamic oil pressure warning system and an oil level warning system. See **119 Lubrication System** for additional information.

Fuel Supply System

The fuel supply system stores fuel and provides the injection system with pressurized fuel. The fuel tank is installed under the rear of the car. The fuel gauge sending unit and the electric fuel pump(s) are mounted in the tank. One or more in-line fuel filters clean the fuel before it reaches the engine. See **160 Fuel Tank and Fuel Pump** for additional information.

Engine Management System

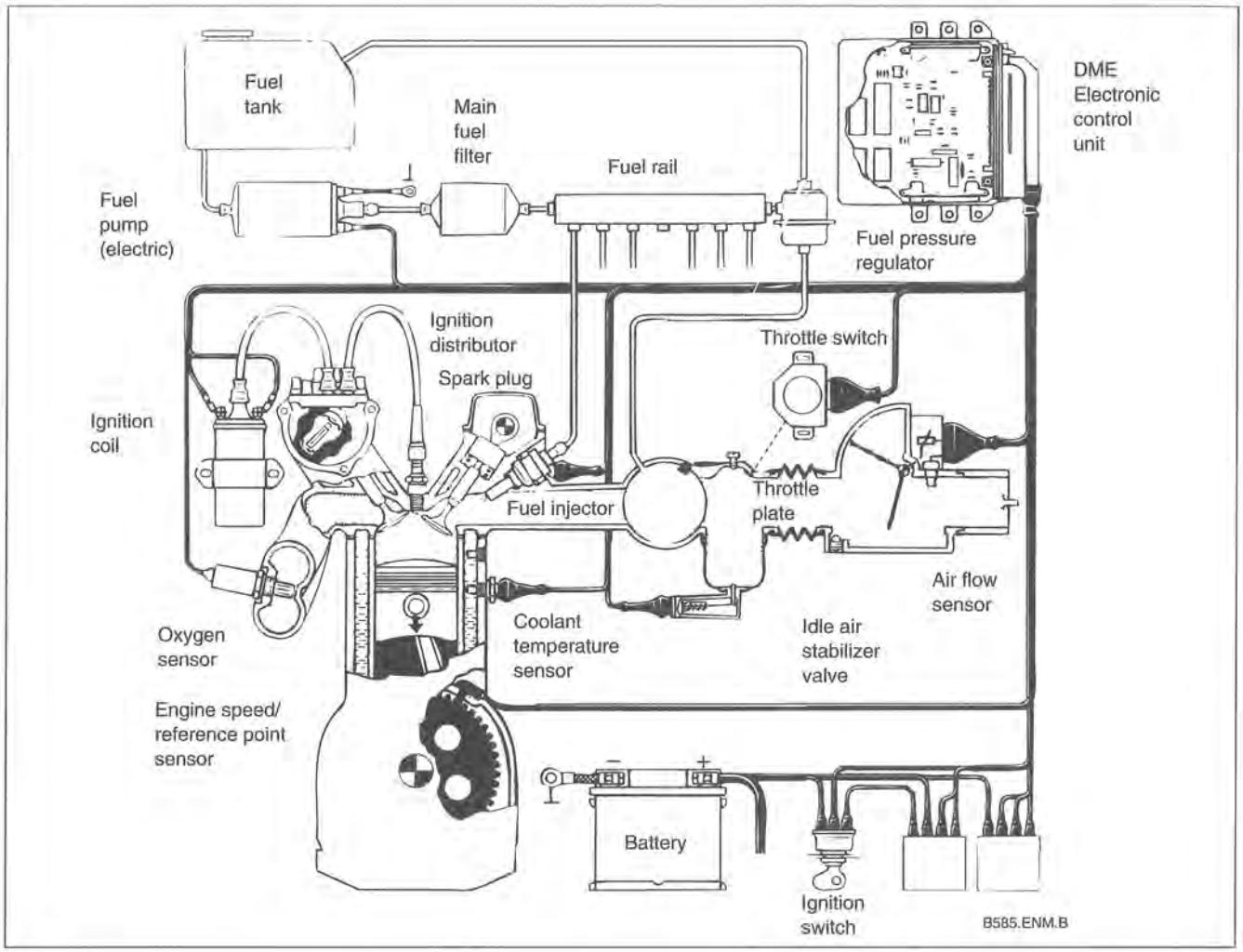
All engines covered by this manual use an advanced engine management system called Digital Motor Electronics (DME) or Motronic. In the DME system, fuel injection, ignition, and other functions are combined under the control of one engine control module (ECM).

The DME engine management system uses the electrical signals from the volume air flow sensor with the M30 engine and the mass air flow (MAF) sensor with the M60 and M70 engines. Signals from the air and coolant temperature sensors, the speed/reference point sensor and oxygen sensor(s) are also used as its primary inputs to electronically calculate fuel delivery and ignition timing.

On M30 and M70 engines, the distributor is part of the upper timing chain cover at the front of the cylinder head, with the ignition rotor being driven directly off the camshaft. On M60 engines, individual ignition coils are located directly at the spark plugs, eliminating the distributor.

Fuel under pressure is injected via electronically controlled solenoid-type fuel injectors. The ECM electrically controls the opening and closing of the injectors by switching the ground side of each injector circuit. The exact amount of fuel injected is determined by the amount of time the injectors are open.

Four versions of DME systems are used on the cars covered by this manual, as listed below. The differences between the systems are mainly in the electronic circuitry, although some major differences do exist and most parts are not interchangeable between systems. All systems have adaptive abilities that adjust and reprogram the system to compen-



sate for things such as engine wear and vacuum leaks. For more information on DME engine management systems, see **130 Fuel Injection.**

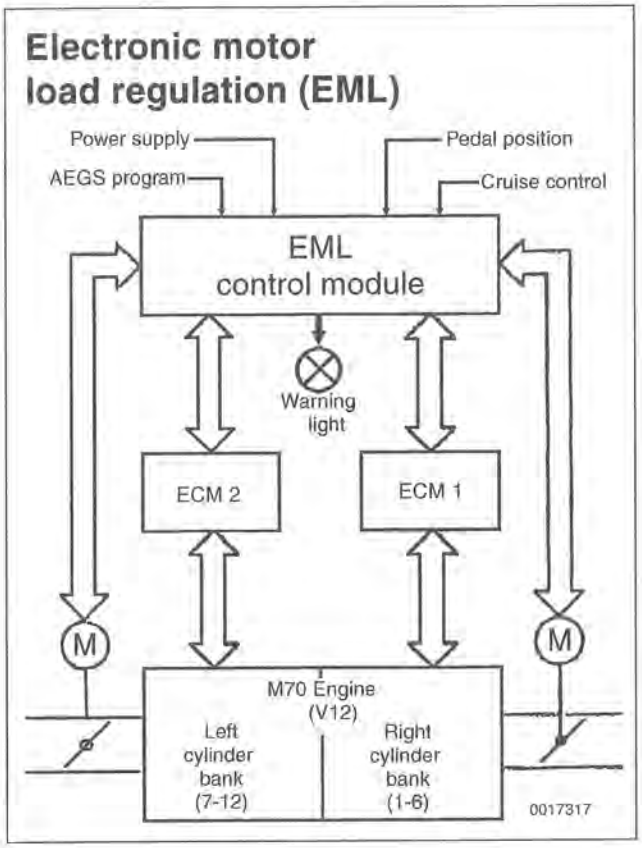
The illustration on this page shows the DME 1.3 Motronic system with volume air flow sensor. Most components in the various systems are similar.

DME (Motronic) Engine Management Systems

Model	Year	System
735i/iL	1988 - 1992	DME 1.3
740i/iL	1993 - 1994	DME 3.3
750iL	1988 - 1990 1991 - 1994	DME 1.2 DME 1.7

NOTE—

The information in this manual labeled "Motronic" or "DME" applies to all versions, unless a particular version is specifically mentioned.



Electronic Throttle Control (EML or ADS)

Electronic motor load regulation (EML) operates the throttle valve(s) electrically via a throttle position actuator instead of a mechanical throttle cable. Idle speed is controlled by EML, eliminating the need for a idle speed control valve.

735i/iL models with the ASC option are equipped with EML. The presence of EML in these cars can be determined by checking for the presence of a throttle cable at the throttle housing end of the intake manifold.

In 750iL models the two banks of cylinders are configured to operate as two separate 6-cylinder engines with a shared cylinder block and crankshaft. The two DME control modules are synchronized by the EML control module.

See **130 Fuel Injection** for additional details.

NOTE—
740i/iL models with the ASC+T option have a conventional throttle cable and an additional throttle housing operated by a second throttle cable controlled by the automatic throttle valve system (ADS). EML is not used on 740i/iL models.

Cooling System

Whenever the engine is running, a coolant pump circulates coolant through the engine and, if either heater control valve(s) is open, through the heater core(s) in the passenger compartment. The coolant absorbs excess engine heat and carries it to the radiator where it is transferred into the passing airstream. A thermostat controls the flow of coolant through the radiator based on engine temperature.

MECHANICAL TROUBLESHOOTING

The troubleshooting information under this heading deals only with problems that affect the basic engine assembly: The cylinder block, the cylinder head and their internal parts. For problems relating to how the engine runs, see **Driveability Troubleshooting** later in this repair group.

Only a few basic mechanical functions are required of the engine. The cylinder block, the cylinder head and their internal moving parts must fit together properly, operate smoothly and seal well enough to create and maintain compression while keeping the pistons, valvetrain and ignition properly timed in relation to one another.

Warnings and Cautions

For personal safety, as well as the protection of sensitive electronic components, the following warnings and cautions must be adhered to during all troubleshooting, maintenance, and repair work.

WARNING —

- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme caution when working on a car with the ignition switched on or the engine running.*
- *Do not touch or disconnect any high voltage cables from the coil(s), distributor(s), or spark plugs while the engine is running or being cranked by the starter.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched off.*
- *Disconnecting the battery will erase any fault code(s) stored in memory. To ensure driver safety, check for fault codes prior to disconnecting the battery cables. If the Check Engine light is illuminated, see* **On-Board Diagnostics (OBD)** *below for DME Motronic fault code information. If any other system faults have been detected (indicated by an illuminated warning light), see an authorized BMW dealer. Additional systems with self-diagnostic capabilities include; ABS (anti-lock brakes), SRS (airbags), EML/ASC (traction control).*
- *Gasoline is highly flammable and its vapors are explosive. Do not smoke or work on a car near heaters or other fire hazards when diagnosing and repairing fuel system problems. Have a fire extinguisher available in case of an emergency.*

CAUTION —

- *Do not connect any test equipment that delivers a 12-volt power supply to terminal 15 (+) of the ignition coil. The current flow may damage the DME ECM. In general, connect test equipment only as specified by BMW, this manual, or the equipment maker.*
- *Do not attempt to disable the ignition system by removing the center coil wire or by removing the distributor cap (where applicable). High voltage may arc to other electrical components causing extensive damage.*
- *Do not disconnect the battery with the engine running.*
- *Do not run the engine with any of the spark plug wires disconnected. Catalytic converter damage may result.*

Noise

Most internal engine noises are the result of excessive clearance caused by wear, component failure or a lack of lubrication.

A high-pitched metallic tapping noise occurring under load often signals pre-ignition or detonation of the air-fuel mixture in the combustion chamber. Most such problems can be resolved by repairs or adjustments to the fuel, ignition or emission control systems. In high-mileage engines, however, carbon buildup in the combustion chambers may cause pre-ignition or detonation that can only be eliminated by removing the cylinder head and cleaning away the deposits.

High-pitched metallic tapping noises may also be caused by excessive clearance between small, lightweight parts such as those in the valvetrain. Often a simple valve adjustment (where applicable) will cure the problem. However, valvetrain noise accompanied by blue-gray exhaust smoke, particularly when the engine is started, often indicates worn valve guides.

Low-pitched metallic knocking sounds are usually caused by excessive clearance between heavy components. Piston slap, caused by too much clearance between the piston skirt and cylinder wall, is worst when the engine is cold, and may decrease or go away entirely as the engine warms.

Crankshaft bearing problems produce a deep, hollow knock that usually gets worse as the engine warms. An intermittent knock that lessens or disappears when the clutch pedal is depressed may indicate excessive crankshaft end play, the result of worn crankshaft thrust bearings.

A rumbling or groaning from the engine compartment may not indicate an engine problem, but rather a worn bearing or bushing in an engine-driven accessory. Possible noise sources include the coolant pump, alternator, power steering pump and air conditioning compressor. To check each accessory, run the engine briefly with the drive belt disconnected and see if the noise stops. With the belt removed and the engine off, turn the pulley and shaft by hand to check for a bad bearing or bushing. With the exception of the air conditioning compressor, a properly functioning engine accessory should turn smoothly.

NOTE—

- *The air conditioning compressor is equipped with an electromagnetic clutch-type pulley. A bad compressor makes noise when the A/C is engaged. The noise should change or disappear when A/C is turned off.*
- *A bad A/C compressor clutch bearing will make a louder noise when the A/C is disengaged. The noise should change or disappear when A/C is engaged.*

Fluid Leaks

Fluid leaking from the engine compartment may be gasoline, oil, coolant, brake fluid, or automatic transmission fluid. For all types of leaks, look for wet areas to help pinpoint the source. It is helpful to start by cleaning the suspected area.

Smoking

Blue-gray smoke in the exhaust is caused by burning oil that has entered the combustion chamber by getting past the piston rings, valve guides, cylinder head gasket or some combination of the three. See **Compression Test** below to help pinpoint the source.

Oil smoke or white smoke (steam) that appears in the exhaust, combined with low compression in one or more cylinders, is most likely the result of a failed cylinder head gasket. Look for bubbles in the coolant or coolant loss, oil in the radiator, or water in the oil that turns the oil an opaque, creamy brown.

Black smoke in the exhaust results from the engine receiving too much fuel. See **Driveabilty Troubleshooting** below for additional diagnostic information.

Excessive Oil Consumption

Some oil consumption is normal and indicates the proper distribution of lubricant to the piston rings. This is why the oil level must be checked, and occasionally corrected, between oil changes. Aside from leaks, high oil consumption is usually accompanied by smoking, however slight. The causes of excessive oil consumption are generally the same as those for oil smoke in the exhaust. As with smoking symptoms, gradual increases are usually caused by engine wear.

High Fuel Consumption and Low Power

High fuel consumption and low power usually indicate problems with the fuel or ignition systems, particularly on a low-mileage engine. On an engine with high mileage, low compression from accumulated wear may be the cause. Normal wear of the valves, valve seats, piston rings and cylinder walls decreases their ability to seal. As a result, the engine becomes less efficient and has to work harder, using more fuel, to produce the same amount of power. See **Compression Test** below to help evaluate engine condition.

Engine Not Running

If the battery, fuel and ignition systems are OK, an engine problem that affects valve or ignition timing may prevent the engine from starting and running. The timing chain and sprockets are responsible for synchronizing the movements of the camshaft and valves with those of the crankshaft and pistons.

Compression Test

The compression pressures in the individual cylinders can tell a lot about the condition of an engine without the need to take it apart.

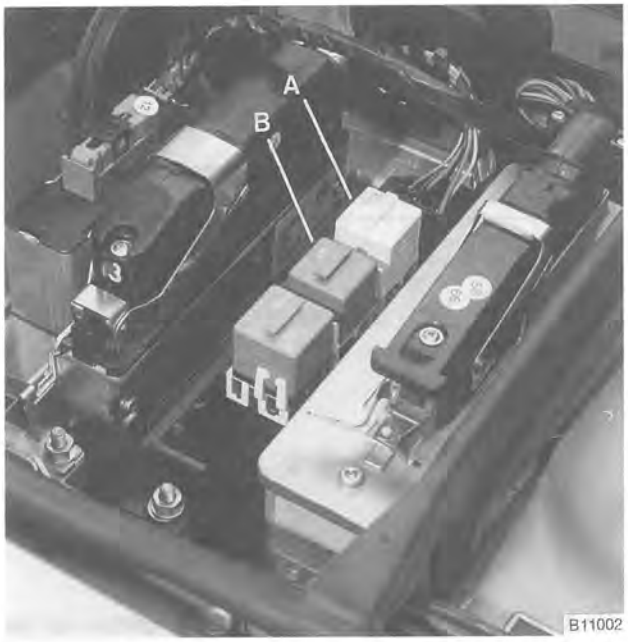
NOTE—
If a compression gauge is not available, a compression test can be performed by an authorized BMW dealer or other qualified shop at a reasonable cost.

To obtain accurate test results, the battery and starter must be capable of cranking the engine at 250–300 rpm, and the engine should be at normal operating temperature.

CAUTION—
Clean around the spark plugs before removal to prevent debris from entering the engine.

Compression, testing

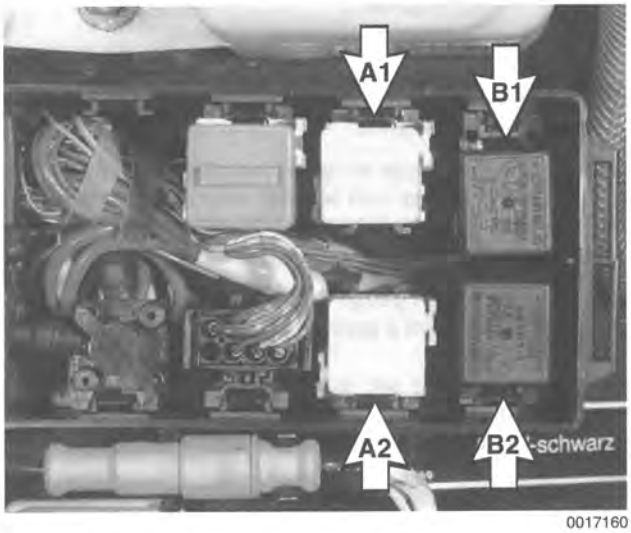
– On all engines except those with EML: Remove main DME and fuel pump relays.



➢ Relay locations for M30 or M60 engine in electronics box (E-box).

- Main DME relay (**A**).
- Fuel pump relay (**B**).

NOTE—
Relay positions may vary. The main DME relay is normally white in color. To confirm that the main DME relay has been correctly identified, check for a large (6 mm^2) red wire at terminal 30 of the relay socket.



➢ Relay locations for M70 engine in auxiliary relay panel II.

- Main DME 1 relay (**A1**).
- Main DME 2 relay (**B1**).
- Fuel pump 1 relay (**B1**).
- Fuel pump 2 relay (**B2**).

– On engines with EML: Remove fuel pump relay(s).

– On M30 engine: Disable ignition by disconnecting wire at terminal 1 of ignition coil.

NOTE—
On 735i/iL models, the ignition coil is mounted at the front right (passenger) side shock tower. Be sure to insulate the disconnected wire end using electrical tape.

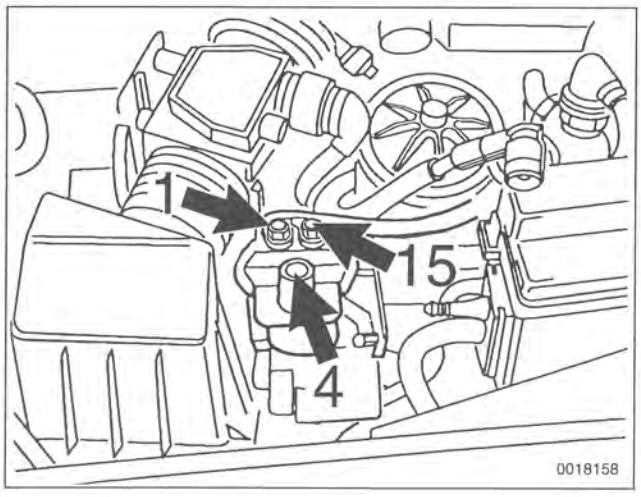
- Remove air cleaner assembly.
- Disconnect spark plug wires and then remove spark plugs.



➢ On M60 engine: Remove engine cover from top of engine by prying off nut covers and removing mounting nuts.

- On M60 engine: disconnect harness connectors from ignition coils by lifting up on retaining clip (**A**). Remove coil mounting nuts (**B**) and remove coils.
- Remove spark plugs.

CAUTION—
Note location of coil ground straps before removing coils. Always reinstall in same location.



➢ On M70 engine: Detach wiring from each ignition coil (**arrows**).

– Remove all spark plugs.

NOTE—
- *Use a 5/8 in. spark plug socket to remove the spark plugs on M60 and M70 engines.*
- *Check the spark plugs for oil deposits that may indicate poor cylinder sealing, then set them aside in order. Used spark plugs should be reinstalled in the same cylinder from which they were removed.*

– Install compression gauge in cylinder no. 1 spark plug hole tight enough to form a good seal.

– With parking brake set, transmission in **Park** or **Neutral**, and accelerator pedal pressed to floor, crank engine with starter. Record highest value indicated by gauge.

NOTE —

- *The compression gauge reading should increase with each compression stroke, and reach its maximum reading in 4 to 6 strokes.*
- *All cylinders should reach maximum compression in the same number of strokes. If a cylinder needs significantly more strokes to reach maximum compression, there is a problem.*
- *On engines with EML, check that the throttle plate opens when the starter is actuated.*

– Release pressure with compression gauge valve, then remove gauge from spark plug hole. Repeat test for all cylinders and compare results with values given below.

Compression Pressure

- Minimum . . . . . 10-11 bar (142-156 psi)
- Maximum difference between cylinders . . . . . 0.5 bar (7 psi)

– Reinstall spark plugs and spark plug wires or ignition coils to their original locations. Remainder of installation is reverse of removal. Be sure to reinstall all wires disconnected during test.

Spark Plug Tightening Torques

- M30 engine . . . . . 30 Nm (22 ft-lb)
- M60 or M70 engine . . . . . 23 Nm (18 ft-lb)

Low compression, or gauge readings that increase gradually over many engine strokes, indicates a poorly sealed combustion chamber. Relatively even pressures that are below specification indicate worn piston rings and/or cylinder walls. Readings that change erratically during successive compression tests of the same cylinder tend to indicate valve leakage. Consistent large differences, such as good values in some cylinders and low values in one or two other cylinders are often the sign of a localized failure like a blown head gasket, burned valve, or broken piston ring.

Table b lists the symptoms of common engine mechanical problems, their probable causes and the suggested corrective actions. The bold type indicates the repair groups where applicable test and repair procedures can be found.

Table b. Engine Mechanical Troubleshooting

Symptom	Probable cause and corrective action
1. Engine will not start or run. Starter cranks engine at normal speed.	a. No fuel reaching engine, fuel tank empty. Check for fuel in tank. b. No voltage to spark plugs. Check ignition system. **120 Ignition system** c. Incorrect valve timing. Check timing chain. **117 Camshaft Timing Chain** d. Fuel pump not operating. **160 Fuel Tank and Fuel Pump**
2. Check Engine warning light illuminated.	a. Engine management system self-diagnostic fault detected. Check fault codes described below under **On-Board Diagnostics (OBD).**
3. Blue-gray exhaust smoke and oily spark plugs. Indicates oil burning in combustion.	a. Contaminated or gasoline-diluted engine oil. Change engine oil and replace oil filter. b. Faulty valve guide seals or valve guides. Replace valve guide oil seals or overhaul cylinder head. **116 Cylinder Head and Valvetrain** c. Worn piston rings. Overhaul or replace engine. d. Failed cylinder head gasket. Replace gasket. **113 Cylinder Head Removal and Installation**
4. White exhaust smoke (steam).	a. Failed cylinder head gasket (probably accompanied by low compression readings). Replace gasket and resurface cylinder head if necessary. **113 Cylinder Head Removal and Installation** b. Warped or cracked cylinder head. Resurface or replace cylinder head. **113 Cylinder Head Removal and Installation** c. Cracked cylinder block. Replace engine or short block.
5. Pinging or rattling when under load, traveling uphill, or accelerating (especially from low speeds). Indicates pre-ignition or detonation.	a. Ignition timing too advanced. Knock sensors faulty (M60 engines only) **120 Ignition system** b. Fuel octane level too low. Use higher octane fuel. c. Engine running too hot or overheating. Check cooling system. **170 Radiator and Cooling System** d. Wrong spark plug (incorrect heat range). Replace spark plugs. **120 Ignition system** e. Air/fuel mixture too lean. **130 Fuel injection** f. Excessive carbon deposits in combustion chambers. Remove cylinder head and decarbonize combustion chamber. **116 Cylinder Head and Valvetrain**
6. Light metallic tapping that varies directly with engine speed. Oil pressure warning light **not** illuminated.	g. Valve clearances out of adjustment or hydraulic lifter(s) faulty. Adjust valve clearances (M30 engine) or replace hydraulic lifters (M60 engine) or hydraulic valve adjusters (HVA) (M70 engine). **116 Cylinder Head and Valvetrain** h. Low oil pressure or defective warning light. Check oil pressure and warning light circuit. **119 Lubrication System**
7. Light metallic knock that varies directly with engine speed. Oil pressure warning light blinking or fully illuminated; may be most noticeable during hard stops or cornering.	a. Low oil level. Check and correct oil level. b. Contaminated or gasoline-diluted engine oil. Change engine oil and replace oil filter. c. Low oil pressure/worn or faulty oil pump. Oil pump pickup restricted/clogged. Check oil pressure.**119 Lubrication System**
8. Screeching or squealing under load that goes away when coasting.	a. Slipping drive belt due to looseness, wear or damage. Inspect, replace, or tighten V-belt (M30 engine) or poly-ribbed belt (M60/M70 engines). **020 Maintenance**
9. Growling or rumbling that varies with engine rpm.	a. Bad bearing or bushing in an engine-driven accessory. Remove drive belt(s) to identify faulty component. Check for play, bearing roughness or loose mountings. Refer to appropriate repair group in this section for repair procedures.

DRIVEABILITY TROUBLESHOOTING

DME engine management systems have self-diagnostic capabilities. When a problem is detected, a fault code is stored in the engine control module (ECM). When a fault code is set, the Check Engine warning light may also come on, indicating an emissions-related fault. Always check for fault codes as the first step in troubleshooting a driveability problem. Check Engine light fault codes and the most common reasons for the malfunctions are given below.

On-Board Diagnostics (OBD)

An On-Board Diagnostic (OBD) system is incorporated into the DME Motronic control module. This system detects certain emissions-related engine management malfunctions and turns on the Check Engine light in the instrument cluster. The Check Engine light will stay on until the code(s) are called up and the memory is erased.

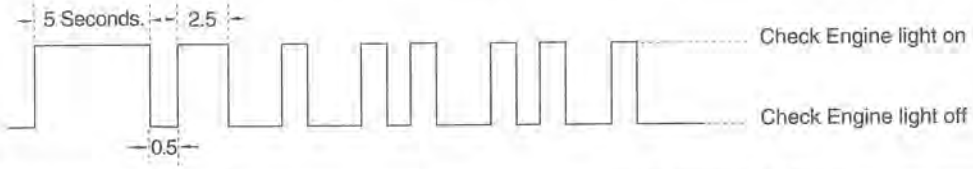
Fault codes can be read by turning the ignition key on and fully depressing the accelerator pedal to the floor five times within five seconds. The light will then remain on for five seconds, blink off, come on for 2.5 seconds, then go off for 2.5 seconds. At this point, the fault codes will begin to flash. See **Table c** or **Table d**.

If more than one fault has been detected, each code will be separated by a 2.5 second pause. When all fault codes have been displayed, there will be 0.5 second flash and then the light will remain off. To read the codes again, turn the key off and then on again. Depress the accelerator pedal to the floor five times quickly (within 5 seconds). The codes will begin to repeat.

To erase the fault code memory, first make sure the fault code 1000 (short blink and then light goes out for long period) is present, then depress the throttle fully for at least 10 seconds. Reactivate the fault code memory as described earlier and check for the 1444 code (no faults stored).

Table c. DME 1.3 or 3.3 Check Engine Light Fault Codes
M30 or M60 Engine

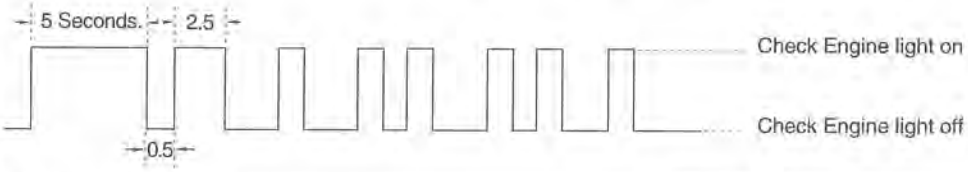
Graphic representation of flashing Check Engine light fault code: 1221



Fault code and meaning	Corrective action
Code 1211: DME engine control module (ECM)	This code appears if ECM fails self test. Check inputs to ECM. **130 Fuel Injection**
Code 1215: Mass air flow (MAF) sensor	Check MAF sensor and wiring to sensor. **130 Fuel Injection**
Code 1216: Throttle potentiometer	Test throttle potentiometer resistance and wiring. **130 Fuel Injection**
Code 1218: Output stage, group #1 (DME 3.3 only)	Test DME control module input/outputs. **130 Fuel Injection**
Code 1219: Output stage, group #2 (DME 3.3DME 3.3 only)	Test DME control module input/outputs. **130 Fuel Injection**
Code 1221: Oxygen sensor #1	Check sensor output signal to DME control module. **130 Fuel Injection**
Code 1212: Oxygen sensor #2 (DME 3.3 only)	Check sensor output signal to DME control module. **130 Fuel Injection**
Code 1222: Oxygen sensor #1 lean/rich control stop	Check for intake air leaks or reasons for rich mixture. See **Driveability Troubleshooting** given earlier in this repair group
Code 1213: Oxygen sensor #2 lean/rich control stop (DME 3.3 only)	Check for intake air leaks or reasons for rich mixture. See **Driveability Troubleshooting** given earlier in this repair group
Code 1223: Engine coolant temperature (ECT) sensor	Test ECT sensor. **130 Fuel Injection**

Table c. DME 1.3 or 3.3 Check Engine Light Fault Codes
M30 or M60 Engine (continued)

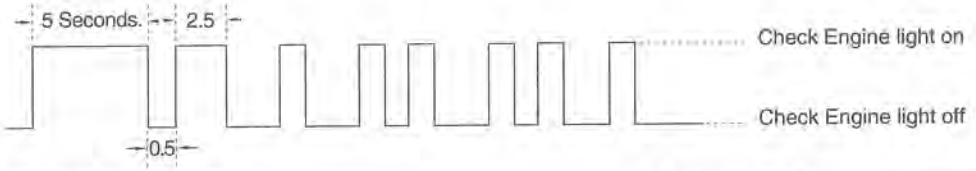
Graphic representation of flashing Check Engine light fault code: 1221



Fault code and meaning	Corrective action
Code 1224: Intake air temperature (IAT) sensor	Test IAT sensor. **130 Fuel Injection**
Code 1225: Knock sensor #1 (DME 3.3 only)	Check knock sensor and sensor wiring. **120 Ignition System**
Code 1226: Knock sensor #2 (DME 3.3 only)	Check knock sensor and sensor wiring. **120 Ignition System**
Code 1227: Knock sensor #3 (DME 3.3 only)	Check knock sensor and sensor wiring. **120 Ignition System**
Code 1228: Knock sensor #4 (DME 3.3 only)	Check knock sensor and sensor wiring. **120 Ignition System**
Code 1231: Battery voltage monitor	Test battery voltage and battery, check charging system and starter. **121 Battery, Starter, Alternator**
Code 1232: Idle position signal (DME 1.3 only)	Test closed throttle (idle) signal to DME control module. **130 Fuel Injection**
Code 1233: Full throttle position signal (DME 1.3 only)	Check full throttle signal to DME control module. **130 Fuel Injection**
Code 1234: Speedometer "A" signal (DME 3.3 only)	Check wiring between instrument cluster and DME control module. **Electrical Wiring Diagrams**
Code 1237: A/C compressor cutoff (DME 3.3 only)	Test DME control module inputs/outputs from A/C system. **130 Fuel Injection**
Code 1242: A/C compressor signal (DME 3.3 only)	Test DME control module inputs/outputs from A/C system. **130 Fuel Injection**
Code 1243: Crankshaft position sensor (DME 3.3 only)	Test crankshaft position/rpm sensor and wiring from sensor to DME control module. **120 Ignition System**
Code 1244: Camshaft position sensor (DME 3.3 only)	Test camshaft position sensor and wiring from sensor to DME control module. **130 Fuel Injection**
Code 1245: Electronic transmission control intervention (DME 3.3 only)	Check wiring between DME control module and automatic transmission control module
Code 1247: Ignition secondary monitor (DME 3.3 only)	Check secondary voltage to ignition coils. Check wiring at ignition coils. **120 Ignition System**
Code 1251: Fuel injectors (DME 1.3 only- cylinders 1, 3, 5)	Test injector operation/signal to injectors. **130 Fuel Injection**
Code 1252: Fuel injectors (DME 1.3 only - cylinders 2, 4, 6)	Test injector operation/signal to injectors. **130 Fuel injection**
Code 1251: Fuel injector #1 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1252: Fuel injector #2 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1253: Fuel injector #3 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1254: Fuel injector #4 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1255: Fuel injector #5 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1256: Fuel injector #6 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1257: Fuel injector #7 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1258: Fuel injector #8 (DME 3.3 only)	Test injector operation/signal to injector. **130 Fuel injection**
Code 1261: Fuel pump control	Test fuel pump relay and fuel pump circuit. **Repair Group 160**
Code 1262: Idle speed control	Test idle air control valve and signal to valve. **130 Fuel injection**
Code 1263: Fuel tank evaporative (EVAP) system	Test EVAP purge valve. **Repair Group 160**
Code 1264: Oxygen sensor heater	Test oxygen sensor heater and heater relay. **130 Fuel injection**
Code 1265: Check Engine lamp (DME 3.3 only)	Test for faulty bulb or wiring. **Electrical Wiring Diagrams**
Code 1267: Air pump relay control (DME 3.3 only)	Test air pump relay and wiring (where applicable) **Electrical Wiring Diagrams**
Code 1271: Ignition coil #1 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1272: Ignition coil #2 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1273: Ignition coil #3 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**

Table c. DME 1.3 or 3.3 Check Engine Light Fault Codes M30 or M60 Engine (continued)

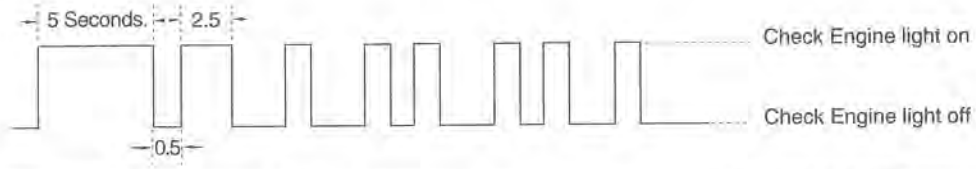
Graphic representation of flashing Check Engine light fault code: 1221



Fault code and meaning	Corrective action
Code 1274: Ignition coil #4 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1275: Ignition coil #5 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1276: Ignition coil #6 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1277: Ignition coil #7 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1278: Ignition coil #8 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. **120 Ignition system**
Code 1281: DME control module memory supply (DME 3.3 only)	Check voltage supply from battery to DME control module. **Electrical Wiring Diagrams**
Code 1282: Fault code memory (DME 3.3 only)	Check DME control module inputs/outputs. Control module may be faulty. **130 Fuel injection**
Code 1283: Fuel injector output stage (DME 3.3. only)	Check DME control module inputs/outputs. Control module may be faulty. **130 Fuel injection**
Code 1286: Knock control test pulse (DME 3.3 only)	Check DME control module inputs/outputs. Control module may be faulty. **130 Fuel injection**
Code 1000 (light remains off):	End of fault code output—all fault codes have been displayed. No corrective action necessary. Repeat test if necessary
Code 1444:	No more faults. No corrective action necessary. This code must be present to erase fault memory

Table d. DME 1.7 Check Engine Light Fault Codes M70 Engine

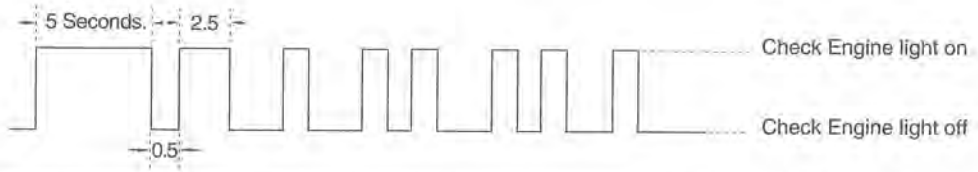
Graphic representation of flashing Check Engine light fault code: 1221



DME I fault code	DME II fault code	Meaning	Corrective action
1111	2111	Ignition problem	Diagnose ignition system. **120 Ignition System**
1211	2211	DME engine control module	This code appears if ECM fails self test. Check inputs to ECM. **130 Fuel Injection**
1215	2215	Mass air flow sensor	Check mass air flow sensor and wiring to sensor. **130 Fuel Injection**
1216	2216	Throttle potentiometer	Test throttle potentiometer resistance and wiring. **130 Fuel Injection**
1221	2221	Oxygen sensor	Check sensor output signal to DME control module. **130 Fuel Injection**
1222	2222	Oxygen sensor lean/rich control stop	Check for intake air leaks or reasons for rich mixture. See **Driveability Troubleshooting** given earlier in this repair group

Table d. DME 1.7 Check Engine Light Fault Codes
M70 Engine

Graphic representation of flashing Check Engine light fault code: 1221



DME I fault code	DME II fault code	Meaning	Corrective action
1223	2223	Engine coolant temperature (ECT) sensor	Test ECT sensor. **130 Fuel Injection**
1224	2224	Intake air temperature (IAT) sensor	Test IAT sensor. **130 Fuel Injection**
1231	2231	Battery voltage monitor	Test battery voltage and battery, check charging system and starter. **121 Battery, Starter, Alternator**
1232	2232	Idle position signal	Test closed throttle (idle) signal to DME control module. **130 Fuel Injection**
1233	2233	Full throttle position signal	Check full throttle signal to DME control module. **130 Fuel Injection**
1251	2251	Fuel injectors	Test injector operation/signal to injectors. **130 Fuel Injection**
1252	2252	Fuel injectors	Test injector operation/signal to injectors. **130 Fuel Injection**
1261	2261	Fuel pump control	Test fuel pump relay and fuel pump circuit. **160 Fuel Tank and Fuel Pump**
1262	2262	Idle speed control	Test idle air control valve and signal to valve. **130 Fuel injection**
1263	2263	Fuel tank evaporative (EVAP) system	Test EVAP purge valve. **160 Fuel Tank and Fuel Pump**
1264	2264	Oxygen sensor heater	Test oxygen sensor heater and heater relay. **130 Fuel injection**
1268	2268	Idle speed, CO potentiometer	Check ECM inputs/outputs. **130 Fuel Injection**
1278	2278	Ignition timing correction	Test ignition system. **120 Ignition System**
1444	2444	No faults stored	No more faults. No corrective action necessary. This code must be present to erase fault memory

Mechanical Condition

When troubleshooting an engine that fails to start or runs poorly, first check its mechanical condition — particularly if the engine has high mileage. See **Compression Test** earlier in this repair group to help determine whether the engine has mechanical problems.

On M30 engines, check that the valves are correctly adjusted. If the clearances are too small, the valves may not close all the way, resulting in low compression and a loss in power. If the clearances are too large, the valves may not fully open, causing a reduction in engine efficiency. Procedures for checking and adjusting valve clearances are described in **116 Cylinder Head and Valvetrain**.

NOTE—
M60 engines are equipped with hydraulic lifters. M70 engines are equipped with hydraulic valve adjusters (HVA). Neither require periodic adjustment.


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Carbon Deposits

Carbon deposits on injectors and intake valves can cause driveability problems such as rough idle, stalling or hesitation. Problems are likely to occur after a cold start and during engine warm-up. Severe fouling can be identified by a visual inspection, but special equipment is required to check for minor carbon build-up on the injectors. Intake valve inspection is more difficult, as the intake manifold must first be removed. Carbon deposits on intake valves and injectors should be removed prior to troubleshooting a driveability problem.

NOTE—
Always consult an authorized BMW dealer for approved fuel injector and intake valve cleaning methods and/or chemicals.

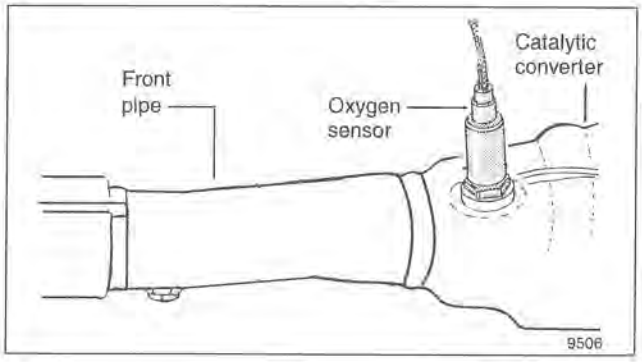
Preventive Maintenance

The condition of the fuel, ignition and emission control system components has a direct effect on engine performance and driveability. BMW specifies maintenance of certain parts at regular intervals to keep the engine in proper tune. Extending maintenance intervals beyond the time or mileage recommended by the manufacturer can adversely affect the way the engine runs. When troubleshooting driveability problems, a good starting point is to perform a major engine service, particularly if one is overdue. For maintenance schedules, major engine service and other driveability-related maintenance procedures, see **020 Maintenance**.

Basic Engine Settings

Idle speed, idle mixture (%CO), and ignition timing are not adjustable on the DME systems covered by this manual. The adaptive DME system is designed to automatically compensate for changes in engine operating conditions, although the adaptive range is limited. Once these limits are exceeded, driveability problems usually become noticeable.

NOTE—
If the DME adaptive limits are exceeded, the Check Engine light will come on, indicating an emission related fault. For Check Engine light diagnostics and On-Board Diagnostic fault codes, see **On-Board Diagnostics** *given above.*



Oxygen Sensor

A high oxygen level in the engine exhaust indicates a lean air-fuel mixture and a low oxygen level indicates a rich mixture. The oxygen sensor measures the oxygen content in the exhaust gas and generates a variable voltage signal. Using that feedback signal as an input, the engine control module (ECM) fine tunes the air-fuel mixture.

NOTE—
The oxygen sensor signal is ignored until the engine reaches a specified minimum temperature. Therefore, when troubleshooting cold engine driveability problems, the oxygen sensor can be ruled out as a possible cause.

As the oxygen sensor ages, its ability to react quickly to changing conditions deteriorates, and it may eventually cease to produce any signal at all. To check the operation of the oxygen sensor, see **130 Fuel Injection**.

Air Flow Measurement and Vacuum Leaks

The primary input used by the fuel injection system to determine how much fuel should be delivered is the signal from the volume air flow sensor (M30 engine) or mass air flow sensor (M60/M70 engines) in the intake air ductwork.

Because proper fuel metering depends on accurate measurement of the incoming air, any unmeasured air that enters the engine downstream of the mass air flow sensor will cause a lean air-fuel mixture and possibly affect driveability.

There are many places for unmeasured air to enter the engine. First, inspect all hoses, fittings, ducts, seals and gaskets in the intake air tract for cracks or looseness. It may be necessary to remove parts that cannot be fully checked in their installed positions. Also make sure all of the intake manifold and throttle body mounting nuts are tight.

In addition to air leaks, air restrictions can also cause driveability problems. Remove the air filter(s) and hold up to a strong light source. If the filter does not pass light, it is restricted and should be replaced. Also, remove the intake air ductwork and check for oily deposits at the throttle plate(s). Buildup in this area can cause an erratic idle. Clean away any deposits using a cloth wetted with carburetor cleaner and reinstall the ductwork.

CAUTION—
Do not spray carburetor cleaner directly into the throttle area. Spraying cleaner may force it into the throttle position switch or sensor and cause damage.

Battery Voltage

All of the electrical components in the fuel injection and ignition systems require a minimum voltage to operate properly. When troubleshooting engine driveability problems, one of the first checks should be to make sure the battery is fully charged and capable of delivering all its power to the electrical system.

To make a quick check of battery charge, measure the voltage across the battery terminals with all cables attached and the ignition off. A fully charged battery will measure 12.6 volts or slightly more, compared to 12.15 volts for a battery with a 25% charge.

Even a fully charged battery cannot deliver power unless it is properly connected to the electrical system. Check the battery cables for corrosion and loose connections. If the battery does not maintain the proper voltage, the charging system may be at fault. See **121 Battery, Starter, Alternator**.

If a battery cable connection has no visible faults, but is still suspect, measure the voltage drop across the connection. A large drop indicates excessive resistance, meaning the connection is corroded, dirty or damaged. Clean or repair the connection and retest.

NOTE—
For instructions on conducting a voltage drop test, and other general electrical troubleshooting information, see **600 Electrical System–General**.

Wiring and Harness Connections

The electronic fuel injection and ignition systems operate at low voltage and current values, making them sensitive to small increases in resistance. The electrical system is routinely subjected to corrosion, vibration and wear, so faults or corrosion in the wiring harness and connectors are common causes of driveability problems.

NOTE—
A faulty engine control module (ECM) is seldom the cause of a driveability problem. These control modules are very reliable and failures are rare. Most driveability problems are caused by incorrect or missing signals to the ECM, or by other defective components.

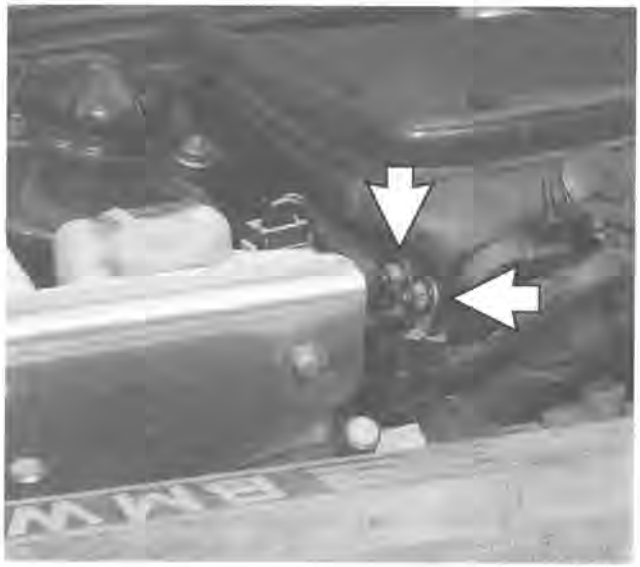
Visually inspect all wiring, connectors, switches and fuses in the system. Loose or damaged connectors can cause intermittent problems, especially the small terminals in the ECM connectors. Disconnect the wiring harness connectors to check for corrosion, and use electrical cleaning spray to remove contaminants. Often, simply disconnecting and reconnecting a dirty connector several times will clean the terminals and help to reestablish good electrical contact.

If a wiring harness connector has no visible faults, but is still suspect, measure the voltage drop across the connector. A large drop indicates excessive resistance, meaning the connector is corroded, dirty or damaged. Clean or repair the connector and retest.

Ground Connections

For any electrical circuit to work, it must make a complete path, beginning at the positive (+) battery terminal and ending at the negative (–) terminal. The negative (–) battery cable is attached to the car chassis. Therefore, any wire or metal part attached to the chassis provides a good ground path back to the negative (–) battery terminal.

Poor ground connections are a major source of driveability problems.



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If any of the main ground connections for the ignition system or the DME system (**arrows**) (where applicable) are faulty, the increased resistance in that circuit will cause problems.

Visually inspect all ground wires and connections for breaks, looseness or corrosion. Be careful because wires sometimes break internally or in areas not easily visible. Also check the main fuel pump ground under the right side of the rear seat cushion.

If a ground connection has no visible faults, but is still suspect, measure the voltage drop across the connection. A large drop indicates high resistance, meaning the connection is corroded, dirty or damaged. Clean or repair the connection and retest.

NOTE—
Instructions for making voltage drop test and other general electrical troubleshooting information can be found in **600 Electrical System–General**.

Fuel Supply

For the engine to start and run properly under various operating conditions, the injection system must deliver fuel in precise proportion to the amount of air entering the engine. To do this, the injection system requires an unrestricted supply of fuel from the fuel pump.

If the fuel pump is not working, the engine will not run. If the fuel filter or a fuel line is restricted, the engine may run poorly. If the restriction is severe enough the engine will not start. If fuel delivery problems are suspected, perform the tests described in **160 Fuel Tank and Fuel Pump**.

The fuel pressure created by the fuel pump is controlled by a pressure regulator that returns excess fuel to the tank. Any change in fuel pressure will cause a change in the base air-fuel mixture delivered to the engine. If the fuel pressure is too low, the base air-fuel mixture will be lean. If the fuel pressure

is too high, the base mixture will be rich. Fuel pressure tests are described in **160 Fuel Tank and Fuel Pump**.

NOTE—
Fuel pressure tests require a pressure gauge. If this tool is not available, the tests can be performed by an authorized BMW dealer or other qualified shop.

Properly operating fuel injectors play a major role in fuel delivery. The engine control module (ECM) switches the injectors on and off at the negative (–) or ground side of the connectors. Positive (+) battery voltage is always present at the connectors when the engine is running. An injector that fails or loses power will not open, creating a lean air-fuel mixture and causing the engine to run poorly when cold or stumble on acceleration. An injector that shorts to ground will remain open constantly when the engine is running, creating a rich air-fuel mixture that can dilute engine oil, foul the spark plugs, cause a rough idle, and eventually destroy the catalytic converter. See **130 Fuel Injection** for fuel injection system troubleshooting and repair.

The fuel injectors must deliver the fuel in a fine, even, cone-shaped mist for optimum combustion. Restricted fuel injectors typically have poor spray patterns that result in overall driveability problems. Carbon deposits and fuel contaminants are the common causes of fuel injector restrictions. Severe injector fouling can be identified by deposit buildups on the injector tips; less extreme restrictions can be identified by checking the injector spray pattern.

Basic Requirements

The following list contains basic checks that should be made when experiencing driveability problems.

- Check the intake (induction) system for leaks.
- Check for cracked, loose, or disconnected hoses and duct work.
- Check that all hose clamps are tight.

NOTE—
An air leak allows unmeasured air to enter the engine, often resulting in an in overly lean fuel mixture and causing driveability problems and an illuminated Check Engine *light.*

- Check that the battery is in good condition.
- Check that the battery cables are tight and free of corrosion.
- Check that all related ground points are firmly connected and in good condition. Don't forget to check the main ground at the battery.
- Check all of the harness connectors for damage and corrosion.
- Check for power and ground at the DME ECM.
- Check the fuses.
- Check for sufficient fuel in the tank. If the engine ran out of fuel, it will take a little time to restore fuel pressure. See **160 Fuel Tank and Fuel Pump**.
- Check for spark at the spark plugs. If the tachometer needle bounces while the engine is cranked by the starter then the ignition system is probably working correctly. See **130 Ignition System**.
- Check for any faults through the on-board diagnostics system. See **On-Board Diagnostics (OBD)**.

Table e lists additional symptoms of common engine driveability problems, their probable causes, and the suggested corrective actions. The entries in bold type in the corrective action column indicate the repair groups where applicable test and repair procedures can be found.

NOTE—

Most of the symptoms listed in **Table e** *will also cause the* Check Engine *light to come on. If the light is on, check for any stored faults as the first step in troubleshooting driveability complaints.*

Table e. Engine Driveability Troubleshooting

SYMPTOMS

a. Engine fails to start
b. Engine starts but stops immediately
c. Erratic engine idle
d. Poor engine response on acceleration
e. Erratic engine operation in all speed ranges
f. Excessive fuel consumption
g. Poor engine power, fails to rev up
h. CO content too low
i. CO content too high

a	b	c	d	e	f	g	h	i	CAUSES	CORRECTIVE ACTION
a									Fuel pump faulty	Test fuel pump. **160 Fuel Tank and Fuel Pump**
a				e					DME ignition system faulty	Test ignition system. **120 Ignition system**
a									DME main relay or fuel pump relay faulty	Test DME main relay. **130 Fuel injection**
a									DME speed/reference sensor faulty	Test speed/reference sensor. **120 Ignition system**
	b	c					h	i	Idle stabilizer valve faulty	Test idle stabilizer valve. **130 Fuel injection**
		c	d	e					Throttle position switch or sensor faulty or idle signal to DME control module missing.	Test throttle position switch/sensor and adjust if necessary. **130 Fuel injection**
a		c	d		f		h	i	Air flow or mass air flow sensor faulty	Test air flow or mass air flow sensor. **130 Fuel injection**
a	b	c	d	e			h		Large air intake system leak	Check for major intake air leaks downstream of air flow or mass meter.
a		c	d	e		g	h		Fuel pressure too low	Test fuel pressure. **130 Fuel injection**
		c			f			i	Fuel pressure too high	Test fuel pressure. **130 Fuel injection**
	b		d	e		g	h		Fuel pump delivery volume too low	Test fuel pump delivery volume. **130 Fuel injection**
a		c		e	f		h	i	Coolant temperature sensor faulty	Test coolant temperature sensor. **130 Fuel injection**
		c			f				Oxygen sensor faulty	Test oxygen sensor(s). **130 Fuel injection**
		c		e	f			i	Fuel injectors leaking	Check fuel injectors and replace leaking injectors. **130 Fuel injection**
		c							Throttle plate binding or incorrectly adjusted	Check throttle plate and adjust if necessary. **130 Fuel injection**
a		c							Electrical connections loose, broken, or corroded	Visually inspect connectors and correct any faults. **600 Electrical System–General**
a		c	d	e					Ground connections loose, broken, or corroded	Visually inspect ground connections and correct any faults. **600 Electrical System–General**
		c		e	f				CO content too high	Test air flow or mass air flow sensor. **130 Fuel injection**
	b	c	d	e		g			CO content too low	Test air flow or mass air flow sensor. **130 Fuel injection**
	b	c	d	e	f	g	h	i	Input signals to ECM missing, ECM in limp home mode	Make electrical tests at DME ECM connector. **130 Fuel injection**
a	b	c	d	e	f	g	h	i	ECM faulty	Test DME ECM inputs. If all inputs are correct, replace ECM. **130 Fuel injection**



110 Engine Removal and Installation

GENERAL 110-1

M30 ENGINE

Engine, removing and installing (M30 engine) 110-1

M60 ENGINE (V-8)

Engine, removing and installing (M60 engine) . 110-6

M70 ENGINE (V-12)

Engine, removing and installing (M70 engine) . . 110-9

GENERAL

Some special tools are required for removal and installation of the engine. Be sure to have the necessary equipment on hand before starting the job. Label all components, wires, and hoses before removing them as an aid to installation.

Engine removal procedures are organized according to engine code. For engine code and application information, see **100 Engine–General**.

CAUTION—

- *Engine removal requires disconnecting the battery. This may erase system fault code(s) that have been stored in control unit memories. Check for fault codes prior to detaching the battery cables.*
- *If the **Check Engine** light is illuminated with the engine running, see **100 Engine–General** for On-Board Diagnostics fault code information.*
- *If any other system faults have been detected (indicated by an illuminated ANTI LOCK, SRS, EML or ASC warning light, see the appropriate repair group in this manual or an authorized BMW dealer for more information on fault codes.*

M30 ENGINE

Engine, removing and installing (M30 engine)

Cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Use new gaskets, O-rings and seals during reassembly.

WARNING—

Be sure the engine is cold before beginning the removal procedure.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise hood fully and support.

– Raise car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove splash shield under engine, if applicable.

– Remove transmission from car. See **230 Manual Transmission** or **240 Automatic Transmission**.

> ***CAUTION—***
> *Do not reuse alignment sleeves. Use new alignment sleeves when installing transmission.*

NOTE—
On cars with automatic transmission, detach the ATF cooler lines bracket from the side of the engine oil pan.

– Remove front exhaust pipe from exhaust manifold. See **180 Exhaust System**.

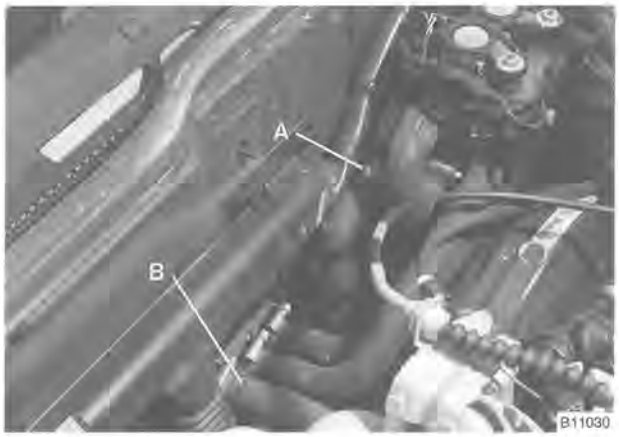
– Drain engine coolant from engine block and from radiator. See **170 Radiator and Cooling System**.

– Detach coolant hoses from radiator. On cars with automatic transmission, carefully detach ATF cooler lines from radiator. Cap off open ATF lines.

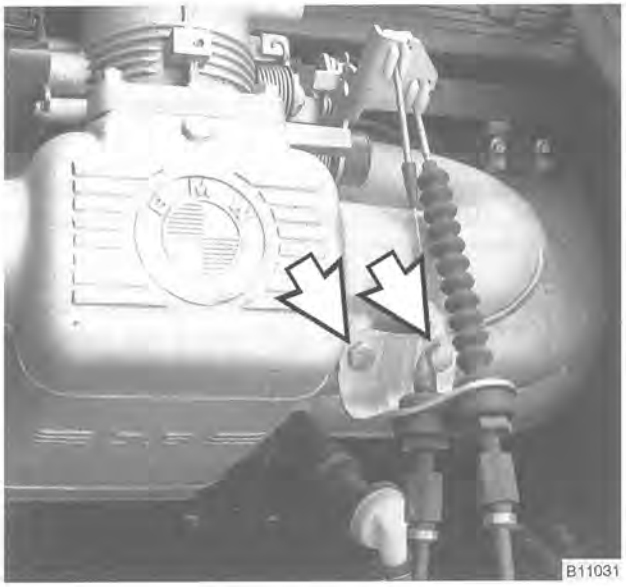
– Working at rear of engine compartment, detach hoses at coolant expansion tank. Detach electrical connector for coolant level sensor. Remove coolant expansion tank from car.

– Remove radiator and cooling fan. See **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan mounting nut (32 mm wrench) has left-hand threads.



➤ Detach heater hoses from heater valve (**A**) and heater core (**B**).


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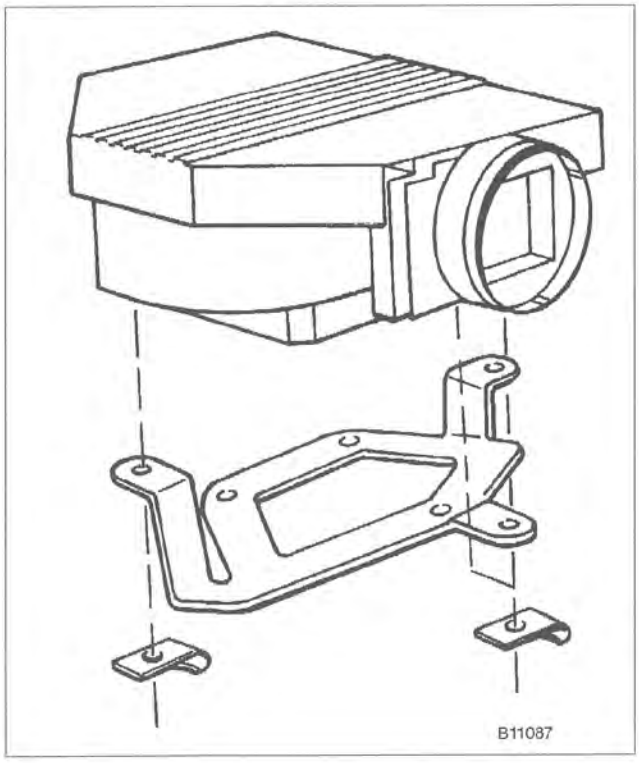
➤ Unhook accelerator and cruise control cables from throttle levers. Remove bolts (**arrows**). Remove cable bracket from intake manifold.

– Remove V-belt from A/C compressor and remove compressor from its mounting bracket without detaching any refrigerant lines.

NOTE—

Move the A/C compressor out of the way without distorting or damaging any lines. Support the compressor by hanging it from the chassis using stiff wire

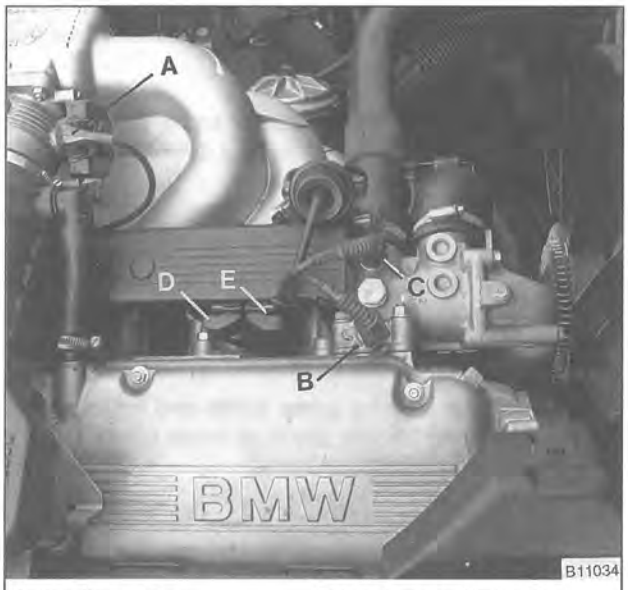
– Remove power steering pump V-belt and remove pump from its mounting bracket. Leave all hoses connected. Use stiff wire to hang pump from body.


B11087

➤ Remove intake air hoses/ducts from air flow sensor and from alternator. Detach electrical connector from air flow sensor. Remove air flow sensor by removing three retaining clips from below.

– Remove air cleaner housing and duct work, loosening hose and mounting clamps as necessary.

– Detach high tension lead from ignition coil.



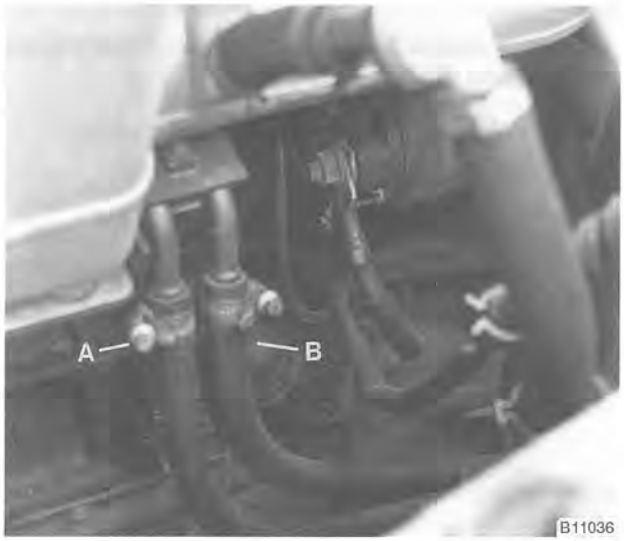
A. Throttle switch
B. Coolant temperature sensor
C. Temperature gauge sender
D. Engine speed/reference point sensor
E. Cylinder identification sensor

➢ Working at side of cylinder head, detach electrical connectors.

– Detach electrical connector from oil pressure switch at left rear corner of cylinder head.

– Detach evaporative purge hose from charcoal canister on left fender. Detach wires from starter motor and alternator. See **121 Battery, Starter, Alternator**.

– Working beneath intake manifold, detach electrical connectors for oxygen sensor, oil level sensor, and evaporative purge valve.



➢ Label and then remove fuel supply (**B**) and return lines (**A**).

> ***WARNING—***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before detaching fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

– Remove large hose from brake system vacuum booster. Plug opening in vacuum booster.



- Remove access plugs (**arrows**) and mounting nuts from fuel injection wiring harness bracket. Lift bracket and harness off and set it aside.

- Working under car, remove nuts and ground strap from engine mounts.

- Using an engine lifting device, carefully raise engine out of car, checking for any wiring, fuel lines, or mechanical parts that might become snagged as engine is removed.

- Installation is reverse of removal.
  - Check that guide pins in engine mounts correctly engage alignment holes in subframe as engine is lowered into place.
  - Adjust tension of all drive belts.
  - Change engine oil and filter and check all other fluid levels. See **020 Maintenance**.
  - Refill cooling system as described in **170 Radiator and Cooling System**.
  - Use new gaskets when installing front exhaust pipe, as described in **180 Exhaust System**.

> ***CAUTION—***
> *Do not reuse alignment sleeves. Use new alignment sleeves when installing transmission.*

Tightening Torques (M30 Engine)

- ATF cooler lines to radiator (use new O-rings) . . . . . 20 Nm (15 ft-lb)
- Coolant drain plug to cylinder block . . 25 Nm (18 ft-lb)
- Engine mount to engine bracket or subframe (M10) . . . . . 47 Nm (34 ft-lb)
- Exhaust pipe to exhaust manifold (use new nuts)
  1st stage . . . . tighten evenly 10 ± 2 Nm (89 ± 12 in-lb)
  2nd stage . . . . . .loosen nuts 1½ turn
- Radiator cooling fan to coolant pump (left threads) . . . . . 40 Nm (30 ft-lb)
- Radiator drain screw to radiator . . . . 2.5 Nm (22 in-lb)
- Wiring to alternator (M8 nut) . . . . . .13 Nm (9.5 ft-lb)
- Wiring to starter
  M6 nut . . . . . .6 Nm (53 in-lb)
  M8 nut . . . . . 12 Nm (9 ft-lb)

M60 ENGINE (V-8)

Engine, removing and installing (M60 engine)

Cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires and hoses before removing them. Use new gaskets, O-rings and seals during reassembly.

> ***WARNING—***
> *Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.*

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise hood fully and support.

– Raise car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove splash shield under engine, if applicable.

– Working beneath car, remove heat shields from left and right side of front suspension crossmember. Detach front exhaust pipes from exhaust manifolds. See **180 Exhaust System**.

– Detach harness connector from oil level sensor in oil pan. Detach wiring from wiring guide.

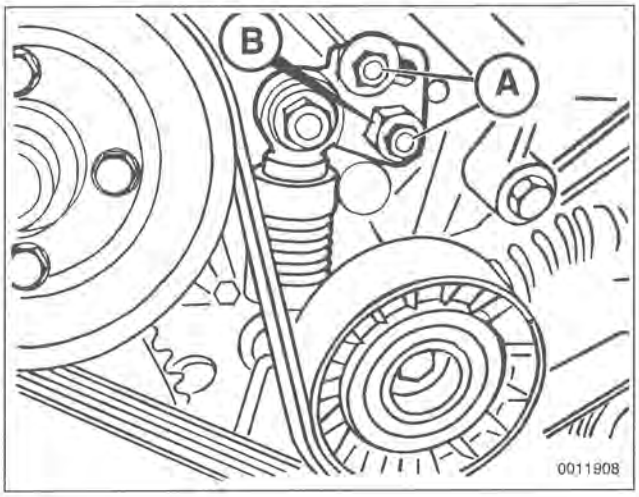
– Remove transmission. See **240 Automatic Transmission**.

– Drain engine coolant from engine block and radiator. Remove radiator and radiator cooling fan. See **170 Radiator and Cooling System**.

NOTE—

- *The radiator cooling fan mounting nut (32 mm wrench) has left-hand threads.*
- *Cap off the open ATF cooler lines. Remove any brackets holding the lines to the engine block.*

– Remove coolant expansion tank from rear of engine compartment, detaching hoses and electrical connector.



➤ Loosen mounting nuts on belt tensioner (**A**). Use an open end wrench to rotate tensioner hex (**B**) counterclockwise and remove belt. Remove belt tensioner from engine.

– Detach oil filter housing from bracket on body. Detach harness connector from oil pressure switch at oil filter housing. Unclip wire from wiring guide.

NOTE—
Leave oil lines attached to filter housing.

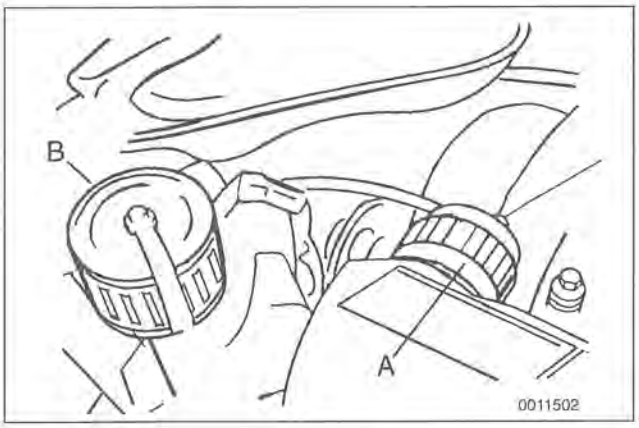
– Remove alternator cooling duct. See **121 Battery, Starter, Alternator**.

– Detach wiring leads from starter and alternator at positive (+) battery junction block in rear of engine compartment. See **121 Battery, Starter, Alternator**.

– Remove upper section of air cleaner housing complete with mass air flow sensor, detaching and labeling connectors, ducting and hoses as necessary.

– Detach throttle cable from throttle housing and cable bracket. Detach evaporative purge hose from underside of throttle housing.

– Detach vacuum hose from brake vacuum booster. Plug opening in vacuum booster.



➤ Separate main wiring harness plug (**A**). Unclip diagnostic connector (**B**) from bracket.

– Remove plastic engine covers. Detach harness connectors from ignition coils.

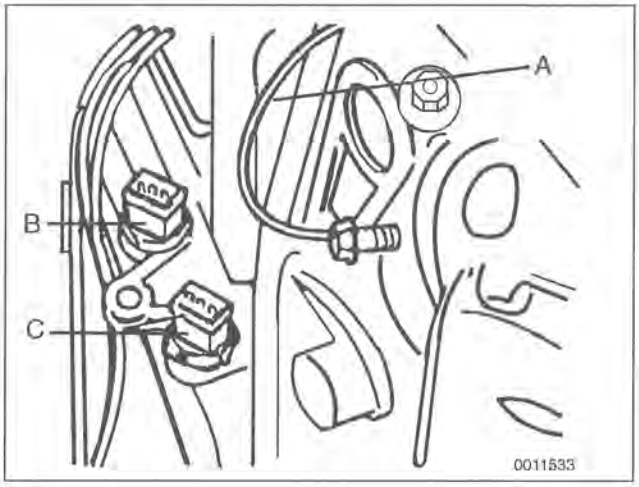
NOTE—
Note ground strap at cylinders #3 and #7. See **120 Ignition System**.

– Working in center of engine, detach and label all harness connectors from left and right wiring harness ducting. These include:

- Knock sensors
- Cylinder position sensor
- Intake air temperature sensor
- Throttle potentiometer
- Camshaft position sensor
- Idle actuator

CAUTION—
Be sure to label the connectors to aid installation.

– Unbolt wiring harness ducting from left and right cylinder heads. Remove ducting from cylinder heads and lay to one side.



- At rear of engine near engine lifting bracket, detach ground wire for ignition coils (**A**) and coolant temperature sensors, white connector (**B**), black connector (**C**).
- Remove power steering pump from pump bracket without detaching any lines. Use stiff wire to hang pump from body. See **320 Steering and Wheel Alignment**.
- Remove A/C compressor from its mounting bracket without detaching any refrigerant lines. Use stiff wire to hang compressor from body.

CAUTION—
The A/C refrigerant lines must not be loosened or detached. Use care to avoid kinking or bending refrigerant lines.

- Detach fuel supply and return lines from fuel injector rail.

WARNING—
Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before detaching fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.

- Detach all coolant hoses from coolant cross-pipe (accumulator) at rear of engine.
- Install engine lifting device to front and rear lifting points Raise engine slightly until its weight is supported.
- Remove nuts from left and right engine mounts. Detach ground strap from engine mount bracket. Carefully raise engine out of car.

NOTE—
Check for any wiring, fuel lines, or mechanical parts that might become snagged as engine is removed.

- Installation is reverse of removal.
  - On cars with automatic transmission, use new O-rings at ATF cooler lines.
  - Use new alignment sleeves when installing transmission.
  - Be sure engine drive belts properly engage pulley grooves. When installing belt, preload tensioner to stop (toward belt), then tighten tensioner clamping nut.
  - Change engine oil and filter. Check all other fluid levels as described in **020 Maintenance**.
  - Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
  - Install front exhaust pipes using new gaskets and copper paste and new mounting hardware. See **180 Exhaust System**.

CAUTION—
Do not interchange knock sensor harness connectors. Serious engine damage may result.

Tightening Torques (M60 Engine)

- ATF cooler lines to radiator (use new O-rings)
  M18 cap nut . . . . . 20 Nm (15 ft-lb)
  M22 cap nut . . . . . 22 Nm (17 ft-lb)
- Coolant drain plug
  to cylinder block (M14) . . . . . 25 Nm (18 ft-lb)
- Engine mount to engine bracket
  or subframe (M10) . . . . . 47 Nm (35 ft-lb)
- Radiator cooling fan to
  coolant pump (left-hand threads) . . . . 40 Nm (30 ft-lb)
- Radiator drain screw to radiator . . . . 2.5 Nm (22 in-lb)
- Wiring to alternator (M8 nut) . . . . . .13 Nm (9.5 ft-lb)
- Wiring to starter
  Terminal 30h (M5) . . . . . .5 Nm (44 in-lb)
  Terminal 50 (M6) . . . . . .6 Nm (53 in-lb)
  Terminal 30 (M8) . . . . . 12 Nm (9 ft-lb)

M70 ENGINE (V-12)

Engine, removing and installing (M70 engine)

Cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Use new gaskets, O-rings and seals during reassembly.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Raise hood fully and support.

– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Remove splash shield under engine, if applicable.

– Remove transmission. See **240 Automatic Transmission**.

– Remove poly-ribbed drive belts. See **020 Maintenance**.

CAUTION—
Use a wooden block or other stop to support the engine on top of the suspension cross-member. Allowing the engine to sag during or after transmission removal can cause damage to heater hose connections at the engine compartment rear bulkhead.

– Drain engine coolant from engine block and radiator. Remove radiator and radiator cooling fan. See **170 Radiator and Cooling System**.

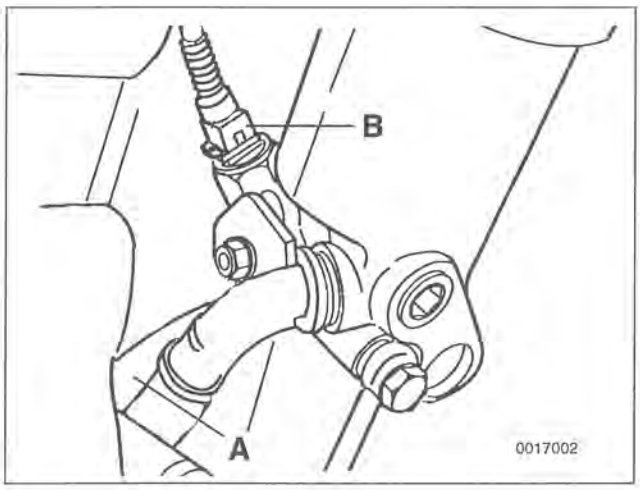
NOTE—
- *The radiator cooling fan mounting nut (32 mm wrench) has left-hand threads.*
- *Cap off the open ATF cooler lines. Remove any brackets holding the lines to the engine block.*

Working from above:

– Remove both mass air flow sensors, air intake bellows, and air filter housings.

– Drain windshield washer fluid tank, detach hoses and harness connectors, and remove tank.

– Detach heater hoses at rear of engine.



➤ Drain oil filter housing by loosening oil filter cap. Detach oil pipes (**A**) on oil filter housing. Disconnect oil pressure switch harness connector (**B**).

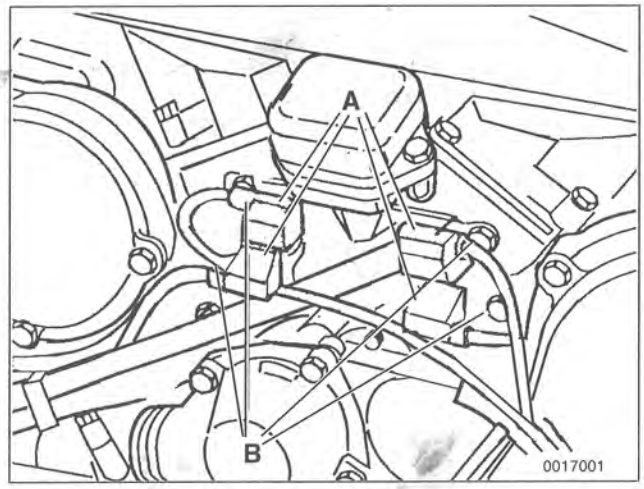
– Unclip data link connector from left side of engine.



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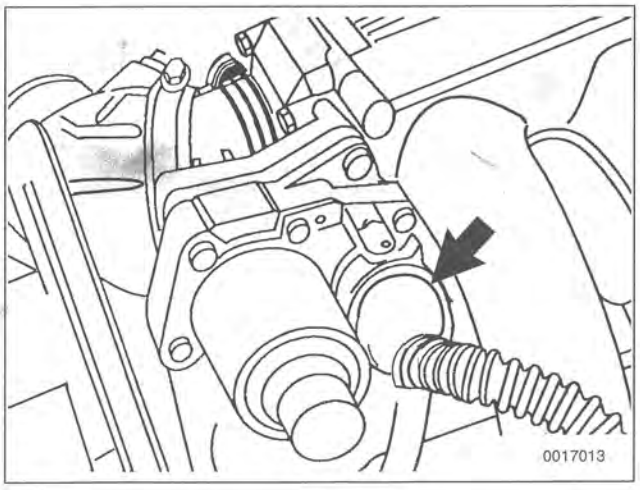
- Detach ignition coil connectors (**A**). Remove mounting fasteners (**B**) and remove right ignition coil.

– Detach alternator harness connectors at alternator.



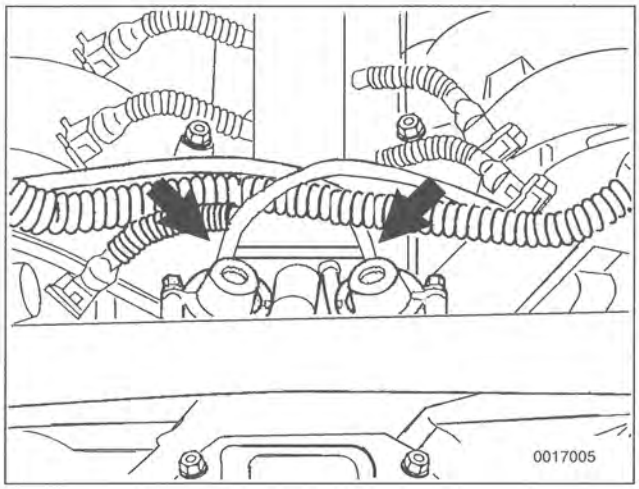
0017001

- Working at front of engine in front of oil filler cap, pull off oil drip shield. Label and detach electrical harness connectors (**A**). Remove fasteners (**B**), remove bracket and detach harness plugs.


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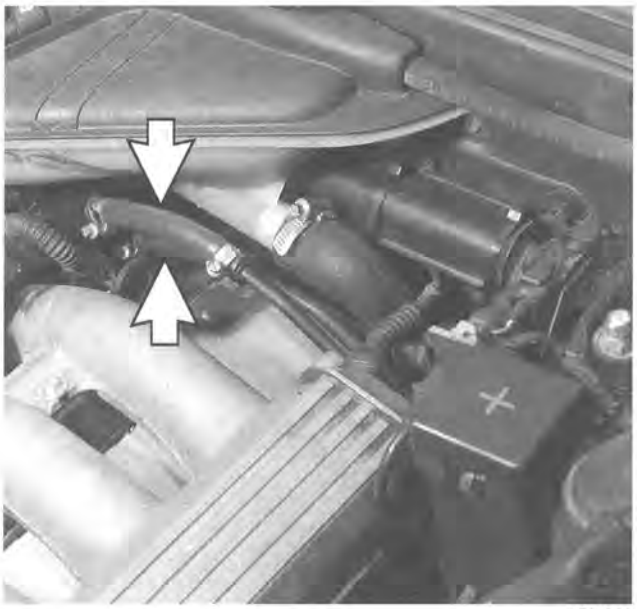
- Disconnect throttle valve assembly harness connectors (**arrow**), left and right sides.

– Remove fuel injector harness cover at top of engine.



➤ Detach fuel pressure regulator vacuum hoses (**arrows**).

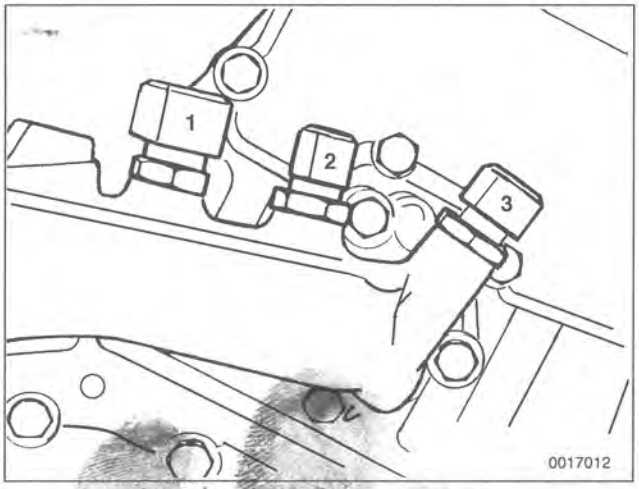
– Detach fuel return hose at right rear of engine.



➤ Remove fuel supply hoses (**arrows**) at top rear of engine.

> ***WARNING—***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before detaching fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

– Disconnect intake manifold harness connectors.



➤ Disconnect temperature sensor harness connectors for fuel injection (**1**), EML (**2**) and temperature gauge (**3**) from cooler crosspipe at rear of engine.

– Pull off fuel injector harness connectors

– Working at engine compartment rear bulkhead, cut off wire ties and remove retaining screws for wiring harness bracket. Lift off harness and set aside.

– Detach alternator harness wires at battery (+) junction block.

– Detach starter harness wires at right strut tower.

– Drain power steering reservoir, then detach fluid supply hose from reservoir.

NOTE—
Power steering pump remains attached to engine during engine removal.

Working underneath engine:



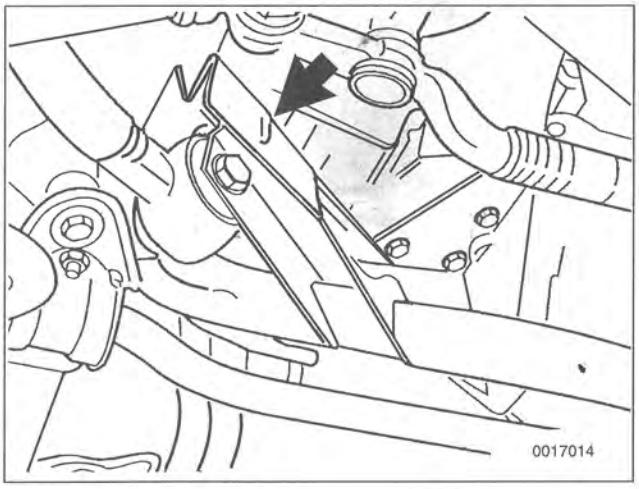
➢ Remove A/C compressor mounting bolts (**arrows**) and remove A/C compressor from its mounting bracket without detaching any refrigerant lines.

NOTE—
Move the A/C compressor out of the way without distorting or damaging any lines. Support the compressor by hanging it from the chassis using stiff wire

– Remove alternator cooling duct.

– Detach harness connectors and detach hoses at evaporative purge valves.

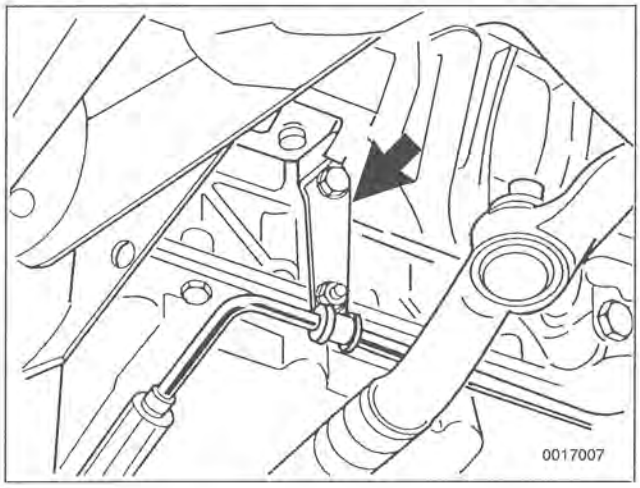
CAUTION—
Mark connectors so they go back in their original locations.



➢ Remove heat shields (**arrow**) from front suspension members.

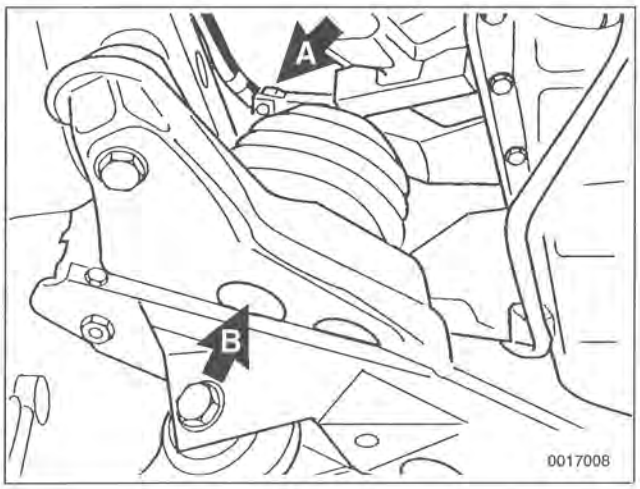
– Remove exhaust manifold heat shields. Then detach exhaust pipes from manifolds. See **180 Exhaust System**.

– Remove harness connector from oil level sensor in oil pan. Detach wiring from wiring guide.



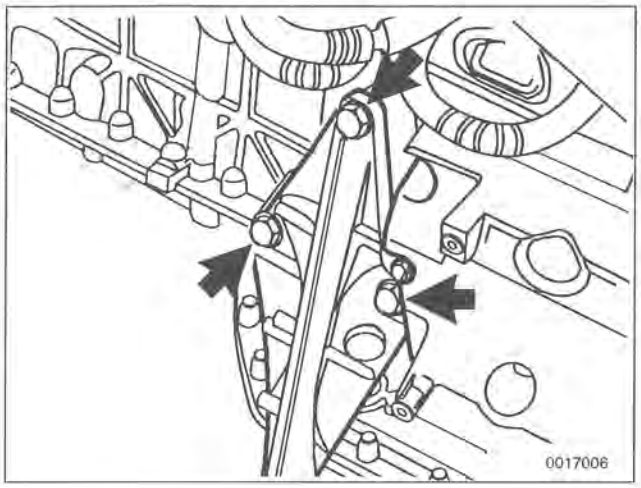
➢ Remove ASC+T pipe bracket and starter support bracket (**arrow**) on block. Remove starter.

– Detach ASC+T pipe from filter in front right of engine.



➢ Using engine lifting equipment, raise engine slightly and support it. Detach ground strap (**A**) at right engine mount. Remove engine mount fasteners (**B**).

– Detach oil dipstick guide tube.



➢ Raise engine slightly and unbolt right engine bracket (**arrows**).

– Raise engine, twisting rear end to right.

NOTE—
Be sure the left exhaust manifold clears the steering shaft.

– Installation is reverse of removal.

- Place oil cooler and ASC+T pipes in correct positions before engine reinstallation.
- Use new O-rings at ATF cooler lines.
- Be sure engine drive belts properly engage pulley grooves.
- Change engine oil and filter. Check all other fluid levels as described in **020 Maintenance**.
- Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
- Install front exhaust pipes using new gaskets and copper paste and new mounting hardware. See **180 Exhaust System**.

Tightening Torques (M70 Engine)

- ATF cooler lines to radiator (use new O-rings)
  M18 cap nut . . . . . 20 Nm (15 ft-lb)
  M22 cap nut . . . . . 22 Nm (17 ft-lb)
- Coolant drain plug
  to cylinder block (M14) . . . . . 28 Nm (21 ft-lb)
- Engine mount to engine bracket
  or subframe (M10) . . . . . 47 Nm (35 ft-lb)
- Radiator cooling fan to
  coolant pump (left-hand threads) . . . . 40 Nm (30 ft-lb)
- Radiator drain screw to radiator . . . . 2.5 Nm (22 in-lb)
- Wiring to alternator (M8 nut) . . . . . 13 Nm (9.5 ft-lb)
- Wiring to starter
  Terminal 30h (M5) . . . . . 5 Nm (44 in-lb)
  Terminal 50 (M6) . . . . . 6 Nm (53 in-lb)
  Terminal 30 (M8) . . . . . 12 Nm (9 ft-lb)



113 Cylinder Head Removal and Installation

GENERAL 113-1

M30 CYLINDER HEAD 113-1
- Cylinder head cover gasket, replacing (M30 engine) 113-1
- Cylinder head, removing (M30 engine) 113-3
- Cylinder head, installing (M30 engine) 113-7

M60 CYLINDER HEADS 113-10
- Cylinder head cover gaskets, replacing (M60 engine) 113-10
- Intake manifold, removing and installing (M60 engine) 113-11
- Left cylinder head, removing (M60 engine) . . 113-13
- Left cylinder head, installing (M60 engine) . . 113-16
- Right cylinder head, removing (M60 engine) . 113-19
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M70 CYLINDER HEADS 113-24
- Intake manifolds, removing and installing (M70 engine) 113-24
- Cylinder head cover gaskets, replacing (M70 engine) 113-26
- Cylinder heads, removing (M70 engine) 113-27
- Cylinder heads, installing (M70 engine) 113-28

TABLE

a. V-12 Piston Height Specifications 113-29

GENERAL

For cylinder head, camshaft and valvetrain disassembly and reconditioning information, see **116 Cylinder Head and Valvetrain.**

The procedures are organized according to engine code. If necessary, see **100 Engine–General** for engine code and application information.

NOTE—
If a head gasket problem is suspected, a compression test will usually detect a faulty gasket. See **100 Engine–General** *for compression testing information.*

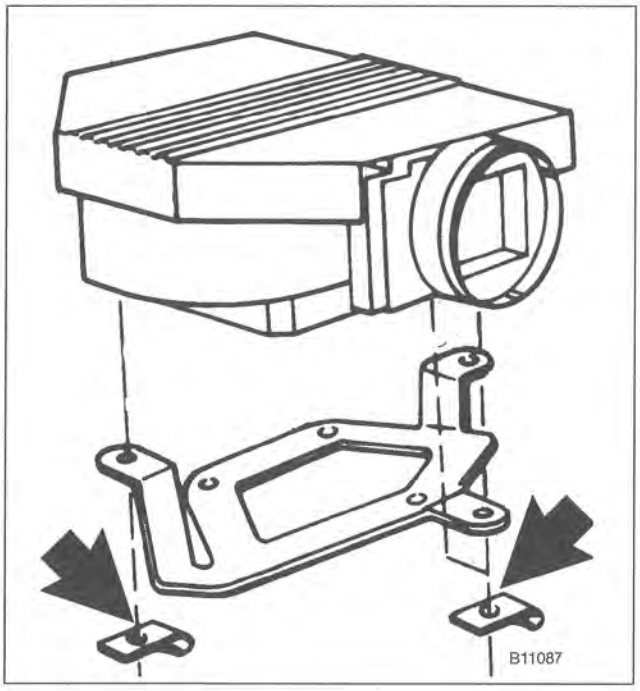
M30 CYLINDER HEAD

Cylinder head cover gasket, replacing (M30 engine)

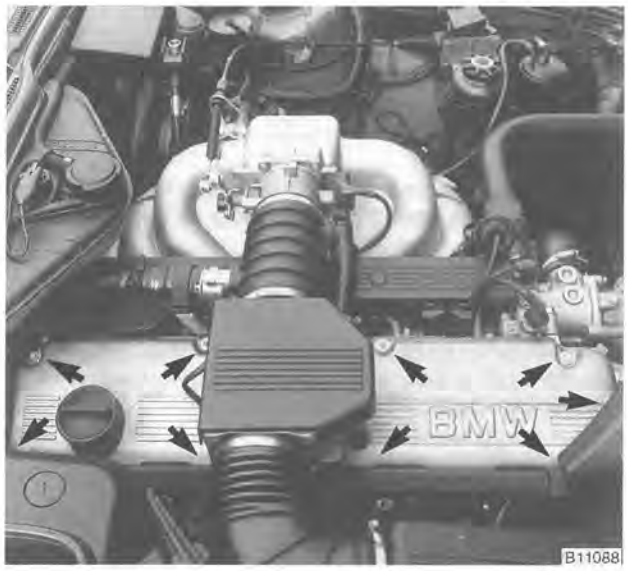
WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning work on the cylinder head cover.



Loosen hose clamps for intake air ducts (**A**), disconnect harness connector from air flow sensor (**B**) and remove idle air stabilizer bracket mounting nut (**C**). Pull idle air valve out of intake boot.



- Remove retaining clips (**arrows**) from underside of air flow sensor. Remove sensor and air ducts.
- Disconnect center wire from ignition coil. Disconnect ignition wires from spark plugs. Remove ignition wiring harness mounting nuts and place harness aside.



- Remove cylinder head cover nuts and bolts (**arrows**).
- Disconnect crankcase (PCV) breather hose from cylinder head cover.
- Lift off cylinder head cover and its gasket.
- Clean old gasket and sealant from sealing surfaces. Install a new gasket, then reinstall cylinder head cover.
- Installation is reverse of removal.
  - Starting with inner fasteners, tighten cylinder head cover mounting nuts and bolts using a crisscross pattern.
  - Be sure to reconnect all hoses.

Tightening Torque

- Cylinder head cover to cylinder head . . . . . 10 Nm (89 in-lb)

Cylinder head, removing (M30 engine)

Cover all painted surfaces before beginning the cylinder head removal procedure. As an aid to installation, label all components, wires and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

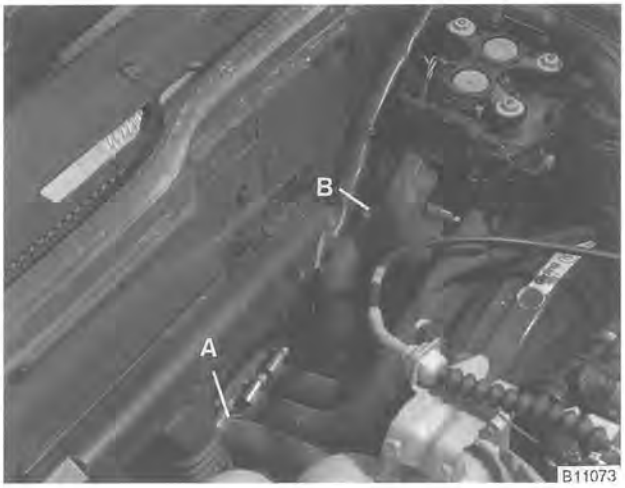
– Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.



NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Disconnect coolant hoses from thermostat housing.

➤ Disconnect harness connector and hoses (**arrows**) from coolant reservoir. Remove mounting bolts (**A**) and set reservoir aside.

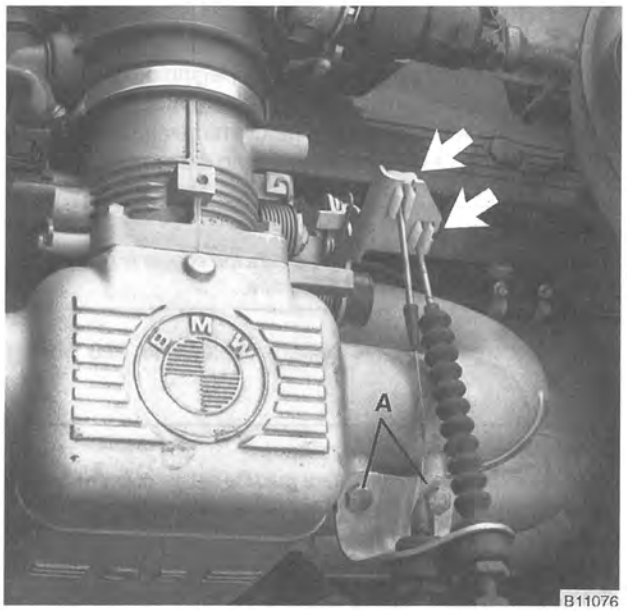


➤ Disconnect heater hoses (**A** and **B**).

– Remove front exhaust pipes from manifolds.

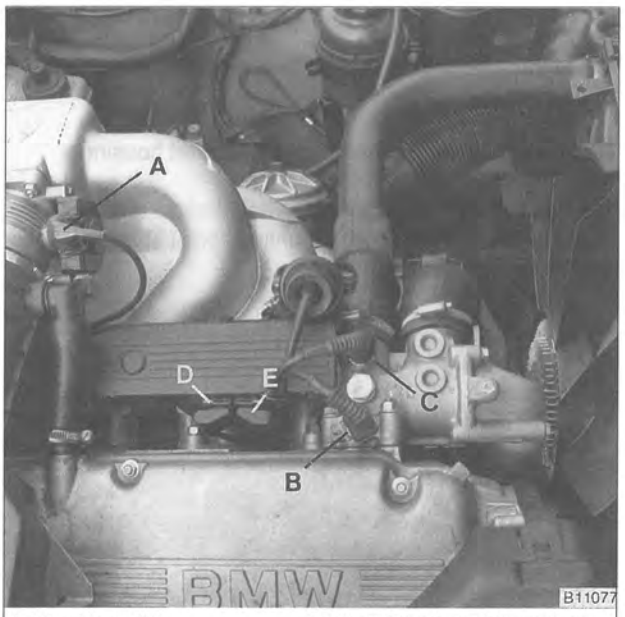
– Loosen air cleaner housing mounting nuts. Loosen intake air boot hose clamps. Disconnect intake air hose and lift air cleaner housing out of car.

NOTE—
Some hoses may be secured with one-time crimp-type hose clamps. The clamps may be pried loose with a small screwdriver. During reinstallation, replace with standard screw-type clamps.



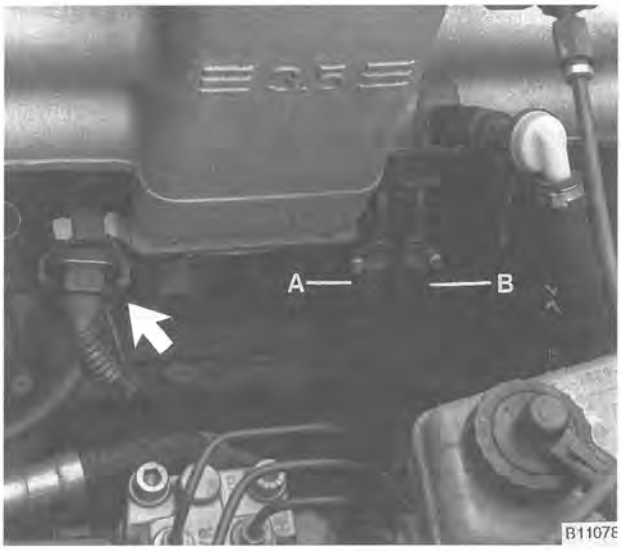
➢ Detach cables at throttle lever (**arrows**).

- Remove cable bracket bolts (**A**) from intake manifold and move bracket with cables aside.



A. Throttle switch
B. Coolant temperature sensor
C. Temperature gauge sender
D. Crankshaft position sensor
E. Cylinder identification sender

➢ Disconnect engine harness connectors **A** through **E**.



➢ Disconnect harness connector from evaporative control purge valve (**arrow**)

– Disconnect fuel supply (**B**) and return (**A**) lines beneath intake manifold. Label fuel lines.

> ***WARNING—***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

– Disconnect large vacuum hose from brake vacuum booster. Plug opening in vacuum booster.

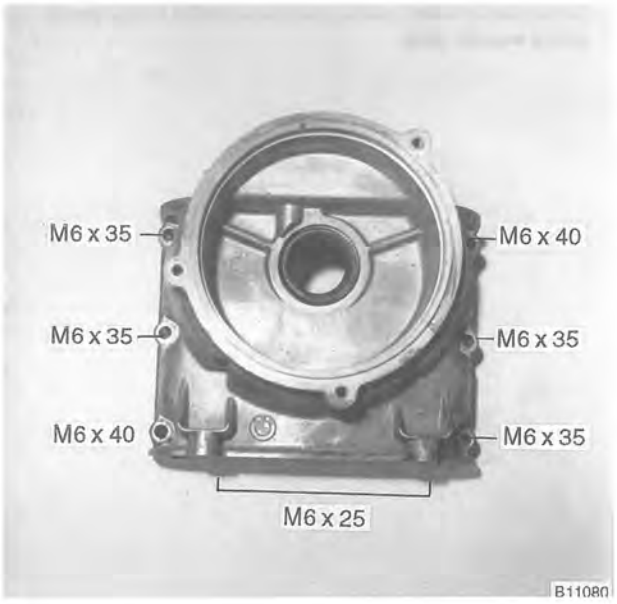
– Disconnect harness connector from oil pressure switch at left rear corner of cylinder head. Remove main harness from its mounting studs, disconnecting any remaining connectors. Set harness aside.

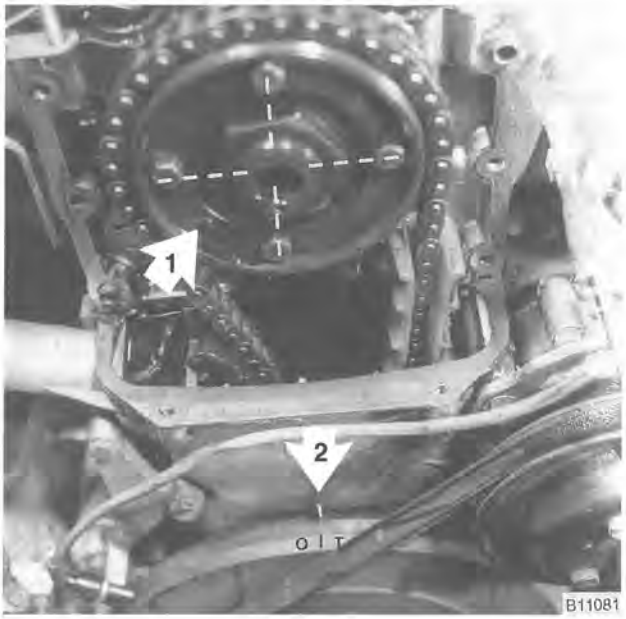
– Remove distributor cap, spark plug wires and distributor rotor. Remove rotor adaptor and black dust shield from front of camshaft. See **120 Ignition System**.

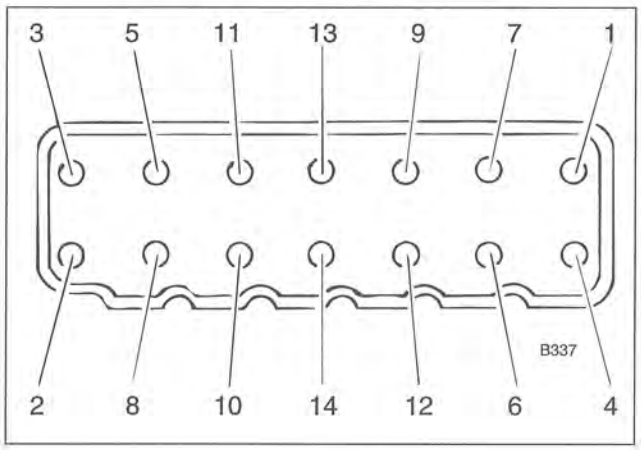
– Working beneath intake manifold, remove intake manifold support bracket.

– Remove cylinder head cover as described earlier.

➢ Remove upper camshaft timing chain cover.







➢ Set crankshaft and camshaft to TDC position.

- Position sprocket bolts straight up and down with locating dowel (**1**) in lower left corner.
- Check 0/T mark on vibration damper alignment with mark on timing chain cover (**2**).

– Remove timing chain tensioner from side of lower timing chain cover.

> ***CAUTION—***
> *Remove the tensioner slowly. There is a long compressed spring beneath the tensioner plug.*

– Remove camshaft sprocket mounting bolts and remove sprocket. Tie chain up using stiff wire.

> ***CAUTION—***
> *The crankshaft should not be allowed to rotate once the camshaft timing chain is removed.*

– Check carefully for any remaining connectors, wiring, hoses, brackets, wire ties, clamps or components that will interfere with removal of cylinder head.

➢ Gradually and evenly loosen and remove cylinder head bolts in sequence shown.

- Remove cylinder head.

> ***NOTE—***
> *If the head is stuck, use a soft-faced mallet or pry gently with a wooden stick.*

Cylinder head, installing (M30 engine)

– Prior to installation, clean cylinder head and gasket surface of cylinder block.

- Clean threads of head bolts and bolt holes with a thread chaser and remove all foreign matter and any liquid from bolt holes.
- Avoid letting debris fall into cylinders or oil passages in cylinder block.

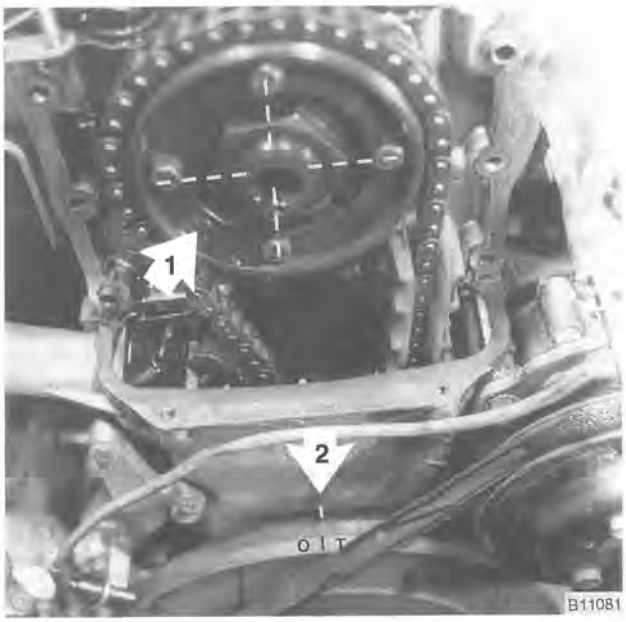
> ***CAUTION—***
> *Do not use a metal scraper or wire brush to clean the aluminum engine parts. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.*

- Using a straight edge, check gasket surface of cylinder head and cylinder block for warpage.

NOTE—
If cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer.

– Place a new cylinder head gasket on surface of cylinder block. Gasket will fit correctly in only one orientation. Check that two locating dowels are correctly positioned in block and are not damaged.

NOTE—
The word "OBEN", printed on the gasket, should face up.



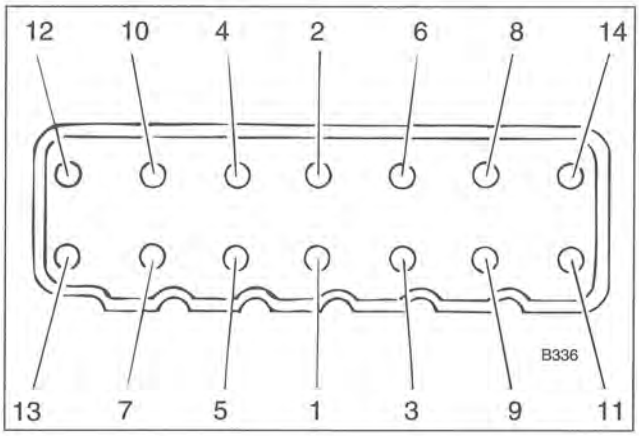
➢ Set crankshaft and camshaft to TDC position.

- Position sprocket bolts straight up and down with locating dowel (**1**) in lower left corner.
- Check 0/T mark on vibration damper alignment with mark on timing chain cover (**2**).

– Place cylinder head on cylinder block. Lubricate head bolts lightly. Loosely install head bolts and their washers.

CAUTION—

- *Always use new head bolts.*
- *Head bolts should be tightened in three stages. The final stage requires using a special tool (BMW Tool no. 11 2 110) or a suitable protractor to tighten the bolts to a specified torque angle.*
- *The engine must be fully assembled and run for twenty-five minutes before tightening the head bolts to their final torque.*



➢ Tighten new cylinder head bolts in sequence shown.



➢ Protractor and pointer are used to tighten bolts to specified torque angle.

Tightening Torques (M30 Engine)

- Cylinder head to cylinder block
  - Stage 1 . . . . . 60 ± 2 Nm (43 ± 1 ft-lb)
  - Wait 20 minutes
  - Stage 2 . . . . . 80 ± 2 Nm (58 ± 1 ft-lb)
  - Run engine for 25 minutes
  - Stage 3 . . . . . 35°

– Mount camshaft sprocket and timing chain so that all chain slack is on tensioner side of chain. Tighten sprocket mounting bolts.

– Install camshaft chain tensioner piston, spring, a new seal and chain tensioner end plug. Leave end plug a little loose.

NOTE—

The tapered end of the spring should face the plug. The cutout in the tensioner piston should engage the tensioner rail.

– Pour a small amount of oil down side of camshaft timing chain cover. Move tensioner rail back and forth slowly until oil runs out past end plug and resistance can be felt at rail, then tighten plug.

Tightening Torque

- Camshaft timing chain tensioner to lower timing chain cover . . . . . 40 Nm (30 ft-lb)

– Turn engine over by hand at least two full crankshaft rotations. Recheck that camshaft and crankshaft TDC timing marks are correctly aligned.

– Installation of remaining parts is reverse of removal.

- Adjust valve clearances as described in **116 Cylinder Head and Valvetrain.**
- Install exhaust front pipe to exhaust manifold using new nuts. Coat exhaust pipe flanges with copper paste prior to installing pipes to manifold, tightening pipe with corrugated section last.
- Refill cooling system and bleed any trapped air as described in **170 Radiator and Cooling System.**
- Change engine oil and filter as described in **020 Maintenance.**
- Adjust accelerator cable as described in **130 Fuel Injection.**
- When reinstalling upper timing chain cover, use new gaskets and seal lower corners of cover (where cover meets head gasket) using 3-Bond®1207 or equivalent silicon sealer.

Tightening Torques (M30 Engine)

- Camshaft sprocket to camshaft flange . . . . . 10 Nm (89 in-lb)
- Coolant drain plug to cylinder block . . . . . 35Nm (25 ft-lb)
- Cylinder head cover to cylinder head . . . . . 10 Nm (89 in-lb)
- Exhaust pipe to exhaust manifold (coat flanges with copper paste)
  Stage 1 . . . . . .tighten nuts evenly to 10 Nm (89 in-lb)
  Stage 2 . . . . . loosen nuts 1½ turns
- Ignition rotor adaptor to camshaft (install with thread locking compound) . . . . . 23 Nm (17 ft-lb)
- Radiator cooling fan to coolant pump . . . . . 40 Nm (30 ft-lb)
- Radiator drain screw to radiator . . . . 2.5 Nm (22 in-lb)
- Upper timing chain cover to cylinder head . . . . . 10 Nm (89 in-lb)

M60 CYLINDER HEADS

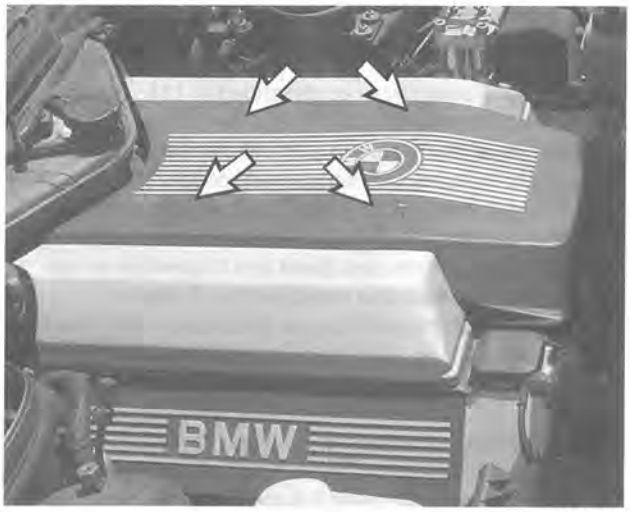
Cylinder head cover gaskets, replacing (M60 engine)

This procedure covers replacement of both left and right cylinder head cover gaskets.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning work on the cylinder head cover.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.



0011500a

➢ Remove plastic covers from top of engine.

- Pry out plugs (**arrows**) from covers.
- Remove nuts and bolts from beneath plugs.
- Lift off covers, removing center cover first.

– Remove upper section of air filter housing.

- Loosen hose clamps for intake air ducts.
- Disconnect harness connector from mass air flow sensor.
- Remove air flow sensor and ducting.



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➢ Disconnect harness connectors from ignition coils. Remove ignition coil mounting nuts (**arrows**) and pull coils straight up.

NOTE—
Ground straps are at cylinders no. 3 and no. 7. See **120 Ignition System**.

– Detach left and right wiring harness ducts and fold inward.

– Disconnect positive (+) jumper junction from top of cylinder head cover, if applicable.

– Remove cylinder head cover cap nuts and remove covers. Remove inner and outer gaskets.

– Clean gasket residue off sealing surfaces. Apply a thin coating of glycerine or suitable rubber lubricant to new inner and outer gaskets.

– Install inner gasket evenly into inner gasket groove in cylinder head cover, pressing four corners into position first and working evenly into groove.

– Apply thin bead of sealer (Hylomar® SQ 23 or equivalent) to gasket surface at joint where upper timing chain cover meets cylinder head, at corners of half-moon sections.

– Install outer gasket evenly into outer gasket groove in cylinder head, pressing rear corners into position first and working evenly into groove.

– The remainder of installation is reverse of removal.

• Install all cylinder head cover cap nuts by hand, then tighten evenly and in stages, working diagonally from inside to outside.

CAUTION—
Be sure harness connectors are correctly installed, especially at knock sensors. Incorrect installation of connectors at knock sensors may result in serious engine damage.

Tightening Torques

• Cylinder head cover to cylinder head and timing chain cover
M6 . . . . . 10 Nm (89 in-lb)
M7 . . . . . 15 Nm (11 ft-lb)

Intake manifold, removing and installing (M60 engine)

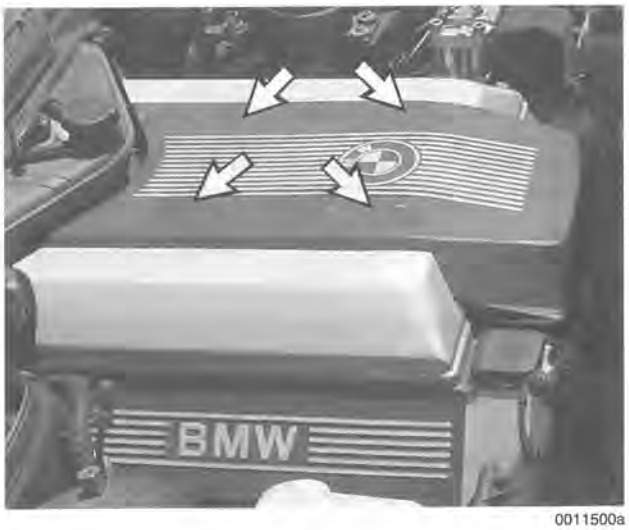
WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning work on the intake manifold.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Raise car and support in a safe manner.

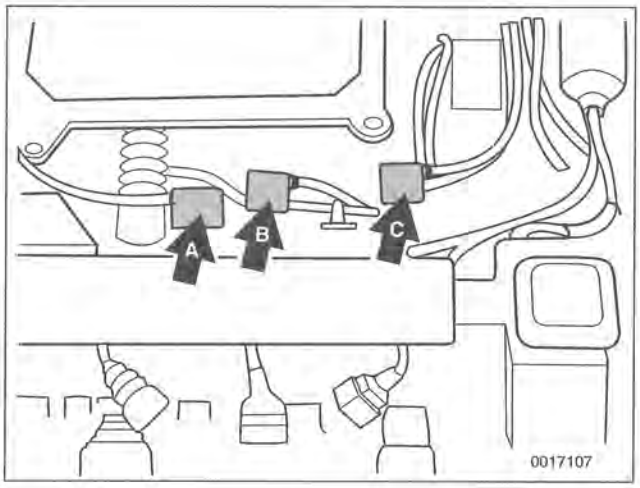
WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.



0011500a

➢ Remove plastic covers from top of engine.

• Pry out plugs (**arrows**) from covers.
• Remove nuts and bolts from beneath plugs.
• Lift off covers, removing center cover first.



– Remove upper section of air filter housing.
  - Loosen hose clamps for intake air ducts.
  - Disconnect harness connector from mass air flow sensor.
  - Remove air flow sensor and ducts.

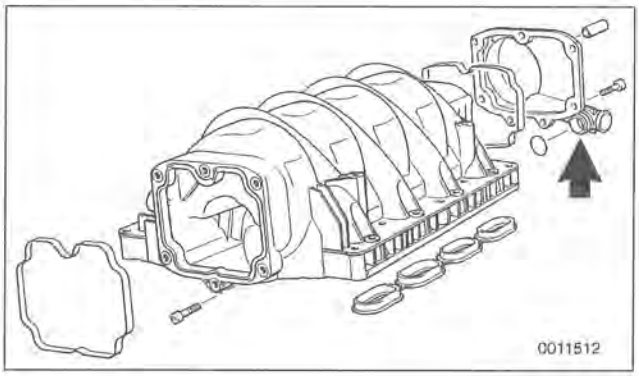
– Disconnect harness connectors from ignition coils.

➢ Disconnect engine electrical harness connectors.
  - Knock sensor connectors for cylinders 3 and 4 (**A**) and cylinders 1 and 2 (**B**). **Connectors must not be interchanged**.
  - Crankshaft position sensor (**C**).
  - Throttle position sensor and throttle position switch (ASC+T cars).
  - Crankshaft position sensor.
  - Automatic transmission control connector.
  - Cooling system harness connectors.

– Disconnect hoses and electric harness connectors from coolant expansion tank, then remove tank from engine compartment rear bulkhead.

– Remove mounting nuts from left and right wiring harness ducting. Lift wire duct off cylinder head covers and set aside.

– Detach bowden cables from throttle housing, if applicable. Disconnect electrical harness connectors and vacuum hoses from throttle housing, as applicable.



➢ Disconnect crankcase ventilation valve ducting (**arrow**) from rear intake manifold cover.

– Disconnect brake booster vacuum hose from booster and plug openings.

– Disconnect fuel tank purge valve hoses.

– Disconnect fuel rail electrical harness connectors and lay harness aside.

– Label and then disconnect fuel supply and return lines.

> ***WARNING—***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

NOTE—
On some later production engines, a special fitting is used to retain the fuel lines to the fuel rail. Use BMW special tool no. 16 1 050 to expand the locking clip inside the end of the fuel line fittings.

– Remove intake manifold nuts from left and right cylinder heads, noting arrangement of rubber grommets beneath nuts.

– Lift intake manifold together with throttle housing from cylinder heads.

– Installation is reverse of removal.
  - Use new gaskets when mounting manifold.
  - Tighten nuts finger tight first, then torque to specification in stages working diagonally from inside to outside.

Tightening Torque
- Intake manifold to cylinder heads . . . . 15 Nm (11 ft-lb)

Left cylinder head, removing (M60 engine)

This procedure covers removal of the left (driver side) cylinder head only.

NOTE—
- *When removing the cylinder heads on the M60 engine, it may be simpler to remove the engine due to an extremely crowded engine compartment.*
- *Special service tools are required to adjust camshaft timing as part of cylinder head installation. Be sure to review the adjustment procedure outlined in* **117 Camshaft Timing Chain** *before removing the cylinder head.*

Cover all painted surfaces before beginning the cylinder head removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

NOTE—

- *The radiator cooling fan nut (32 mm wrench) has left-hand threads.*
- *There are two block drains, one on either side of the engine. It is not necessary to remove both plugs if only one head is being removed.*

– Remove left exhaust manifolds. See **180 Exhaust System**. Discard mounting nuts.

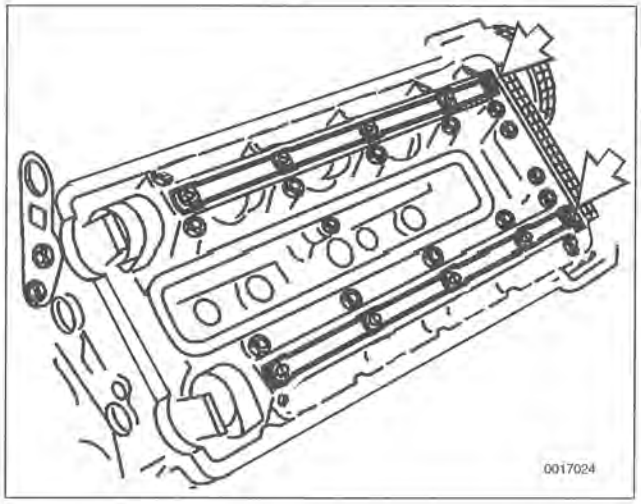
– Remove intake manifold as described earlier.

– Remove cylinder head covers as described earlier.

– Remove spark plugs. See **120 Ignition System**.

– Remove oil filter housing.

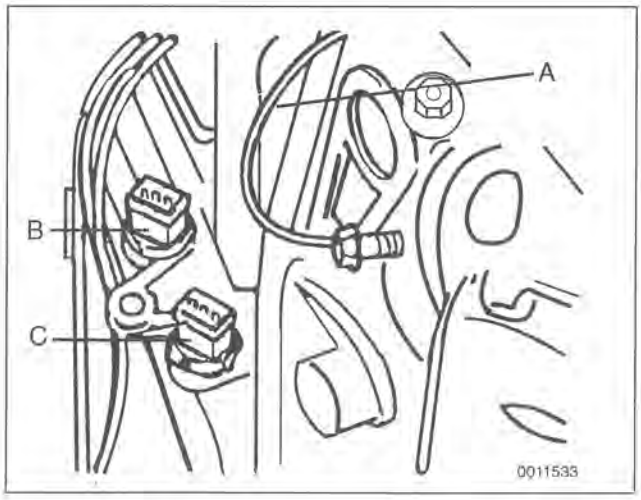
- Remove filter housing cap to allow oil to drain back.
- Disconnect oil pressure lines.



➤ Remove oil supply lines (**arrows**) and oil deflector baffles above camshafts.

– Remove coolant crosspipe (accumulator) from rear of engine.

- Unbolt coolant expansion tank and set aside.
- Disconnect and label harness connectors at crosspipe.
- Disconnect all coolant hoses from crosspipe.
- Remove crosspipe mounting bolts and carefully remove pipe.



➤ Disconnect ground wire for ignition coils (**A**), coolant temperature gauge (**B**, black connector) and DME coolant temperature sensor (**C**, white connector) near rear engine lifting bracket.

– Remove upper timing chain cover from front of left cylinder head.

- Remove secondary air injection ducting, if applicable.
- Remove timing chain cover mounting bolts (qty. 9) and carefully separate cover from cylinder head.

– Remove timing chain tensioner from side of right cylinder head.

– Turn engine over in direction of normal rotation until cylinder no. 1 is at TDC overlap position (i.e. intake and exhaust valves open, 360° away from TDC ignition).

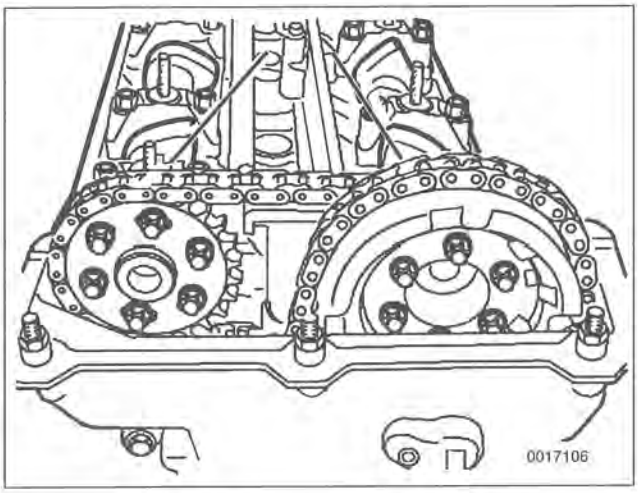
NOTE—

- *Cylinder no. 1 is on the front right (passenger) side.*
- *TDC position is marked on the crankshaft vibration damper as 0/T.*

– Loosen by ½ turn top camshaft sprocket mounting bolts on each cylinder head.

CAUTION—

- *Hold camshaft stationary (at hex on camshaft) when loosening or tightening camshaft sprocket mounting bolts.*
- *Do not damage cylinder head casting when using open end wrench at camshaft hex. If necessary, grind or machine wrench to fit into opening in cylinder head.*



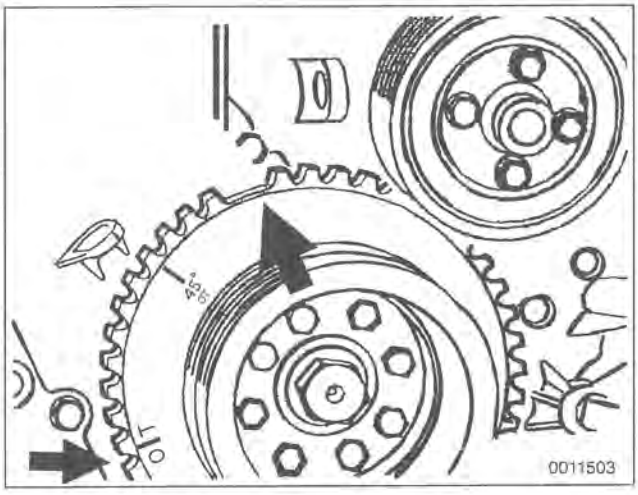
➢ Turn engine in direction of normal rotation until cylinder no. 1 is at TDC. Cylinder no. 1 camshaft lobes pointing up and toward each other indicates TDC.

– Loosen remaining camshaft sprocket bolts on camshafts.

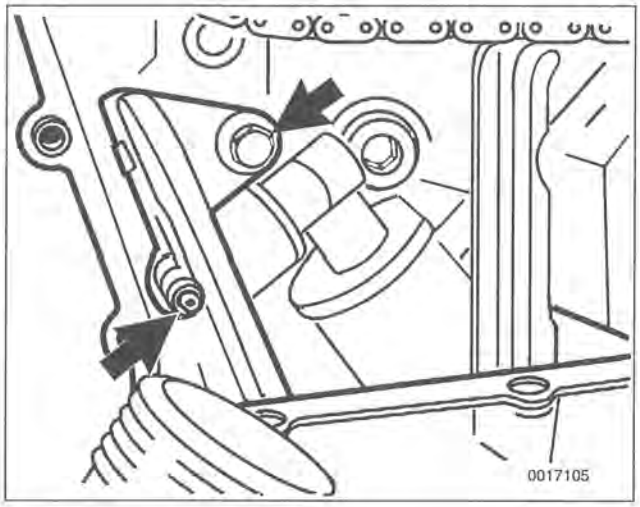
– Remove all left intake camshaft sprocket bolts. Remove large sprocket and suspend main timing chain with wire.

NOTE—

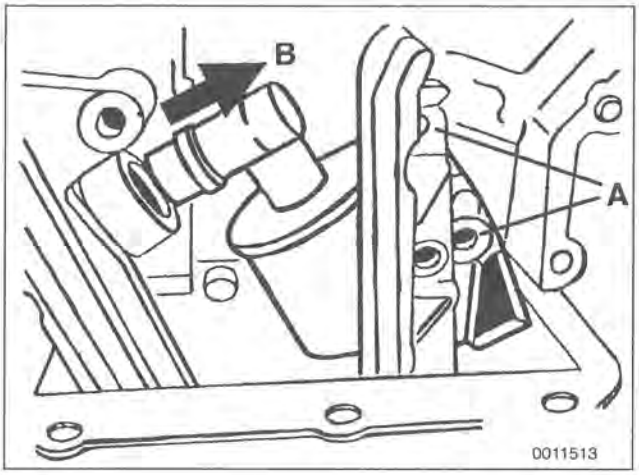
Replace two sprocket bolts and secure them finger tight to prevent remaining chain and sprocket from falling off intake camshaft.



➢ Keeping chain under manual tension, slowly turn engine away from direction of normal rotation until cylinder no. 1 is at 45° before TDC (BTDC). Note position of 0/T mark and gap in toothed wheel (**arrows**).



➢ Remove bolt and grub screw (**arrows**) from main timing chain guide rails.



➢ Pull crankcase ventilation oil separator (**B**) away from cylinder head. Timing chain guide rail mounting bolt hole is at **A**

– Using BMW special tool no. 11 2 250 or equivalent, loosen cylinder head bolts in stages, working diagonally from outermost bolts toward center of head. Remove cylinder head.

CAUTION—
Be sure to lift crankcase ventilation oil separator away as head is lifted off.

Left cylinder head, installing (M60 engine)

– Prior to installation, clean cylinder head and gasket surfaces.

- Remove all foreign matter and liquid from head bolt holes in cylinder block.

CAUTION—
Do not use a metal scraper or wire brush to clean the aluminum engine parts. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.

NOTE—
If the cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer.

– Apply thin bead of sealer (Hylomar® SQ 32 M or equivalent) to corner-joint where lower timing chain cover mates with cylinder block.

– Place new cylinder head gasket into position. Make sure dowel sleeves are correctly positioned in block and not damaged.

– With crankshaft at 45° BTDC for cylinder no. 1, set cylinder head in position.

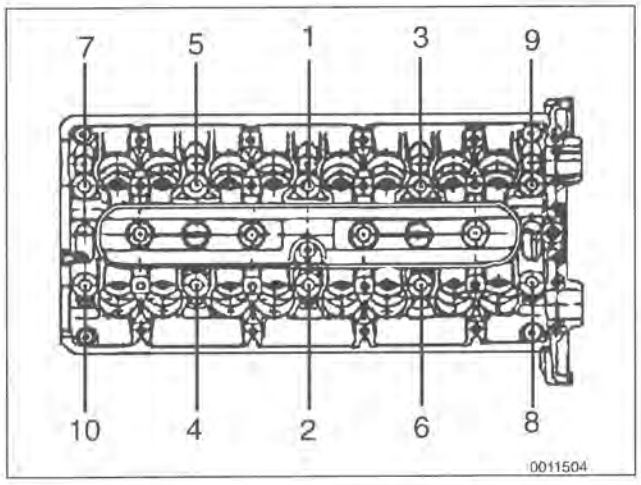
NOTE—

Be sure to lift crankcase ventilation oil separator away from head as the head is lowered into position.

– Lightly lubricate new cylinder head bolts. Loosely install bolts with washers. Thread all bolts in finger tight.

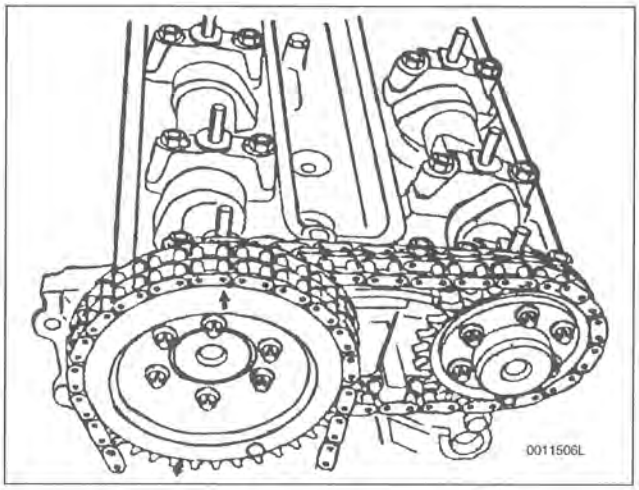
CAUTION—

- *Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.*
- *Do not wash protective coating from new bolts.*
- *Check that all washers for the head bolts are in place before installing bolts. Some washers may be staked to the cylinder head.*
- *The use of a special tool (BMW Tool No. 11 2 110) or a suitable protractor is required to tighten head bolts to a specified torque angle.*



➢ Tighten cylinder head bolts in stages, alternately and diagonally, as shown.





➢ Use protractor and pointer to tighten bolts to specified torque angle

Tightening Torques (M60 Engine)

- Cylinder head to cylinder block
  - Stage 1 ..... 30 Nm (22 ft-lb)
  - Stage 2 ..... +80°
  - Stage 3 ..... +80°

– Make sure crankcase breather oil separator is correctly attached to return pipe at bottom. Fit oil separator to guide rail and fit guide rail assembly to cylinder head.

NOTE—

Use the original grub (shoulderless) screw when mounting the guide rail to the cylinder head. Tighten the screw to 2 - 3 Nm (15 - 22 in-lb).

– Position camshafts and crankshaft at cylinder no. 1 TDC and lock all shafts in position using BMW special tools. See **117 Camshaft Timing Chain**.

➢ Install intake sprocket (left cylinder head) to timing chain and camshaft with **arrow** on sprocket pointing up.

- Bolt holes in sprocket should be centered to threaded bores in camshaft.
- Tighten sprocket bolts finger tight.

– Adjust camshaft timing, tighten sprocket mounting bolts, and install timing chain tensioner as described in **117 Camshaft Timing Chain**.

– Remainder of installation is reverse of removal.

- When installing front timing chain cover, use new gaskets. Remove protective film from gaskets.
- Seal lower corners of chain cover to cylinder head before installing cover.
- Tighten bolts in two stages, tightening cover-to-cylinder block bolts first.
- Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance**.

CAUTION—

To prevent damaging engine electronic systems, be sure to install all ground wires removed earlier.

Tightening Torque (M60 engine)

- Coolant drain plug to cylinder block . . 28 Nm (20 ft-lb)
- Camshaft timing chain sprocket to camshaft (M6) . . . . . 15 Nm (11 ft-lb)
- Camshaft timing chain tensioner to cylinder head . . . . . 40 Nm (30 ft-lb)
- Camshaft timing chain cover to cylinder head/cylinder block . . . . . .10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/timing chain cover
  M6 . . . . . .10 Nm (89 in-lb)
  M7 . . . . . 15 Nm (11 ft-lb)
- Exhaust manifold to cylinder head . . . 22 Nm (17 ft-lb)
- Oil pressure lines to oil filter housing or oil pan (Banjo bolts) . . . . . 30 Nm (22 ft-lb)
- Radiator cooling fan to coolant pump . . . . . 40 Nm (30 ft-lb)
- Spark plugs to cylinder head. . 23 ± 3 Nm (17 ± 2 ft-lb)

Right cylinder head, removing (M60 engine)

This procedure covers removal of the right (passenger side) cylinder head only.

NOTE—

- *When removing the cylinder heads on the M60, it may be simpler to remove the engine due to an extremely crowded engine compartment.*
- *Special service tools are required to adjust camshaft timing as part of cylinder head installation. Be sure to review the adjustment procedure outlined in* **117 Camshaft Timing Chain** *before removing the cylinder head.*

Cover all painted surfaces before beginning the cylinder head removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

NOTE—

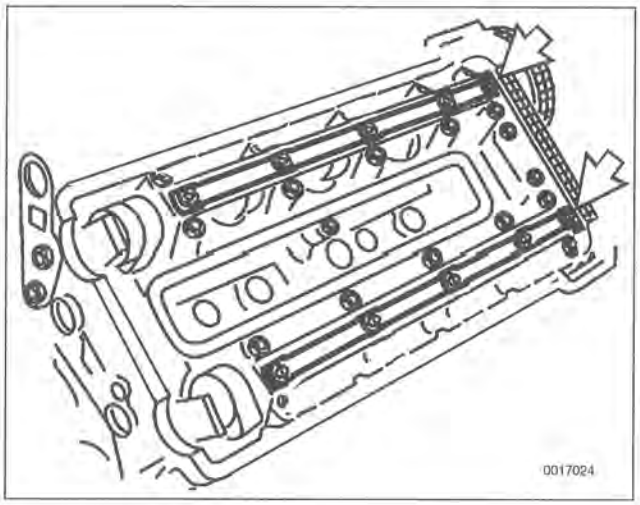
- *The radiator cooling fan nut (32 mm wrench) has left-hand threads.*
- *There are two block drains, one on either side of the engine. It is not necessary to remove both plugs if only one head is being removed.*

– Remove right exhaust manifolds. See **180 Exhaust System**. Discard mounting nuts.

– Remove intake manifold as described earlier.

– Remove cylinder head cover as described earlier.

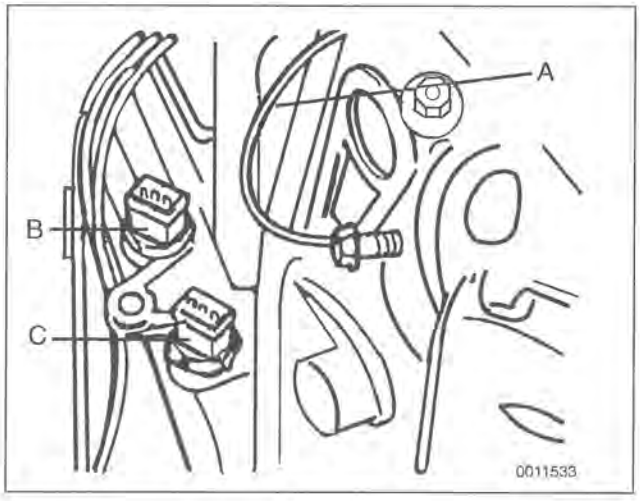
– Remove spark plugs. See **120 Ignition System.**



➤ Remove oil supply lines (**arrows**) and oil deflector baffles above camshafts.

– Remove coolant crosspipe (accumulator) from rear of engine.

- Unbolt coolant expansion tank and set aside.
- Disconnect and label harness connectors at crosspipe.
- Disconnect all coolant hoses from crosspipe.
- Remove crosspipe mounting bolts and carefully remove pipe.



➤ Disconnect ground wire for ignition coils (**A**), coolant temperature gauge (**B**, black connector) and DME coolant temperature sensor (**C**, white connector) near rear engine lifting bracket.

– Remove upper timing chain cover from front of right cylinder head.

- Remove secondary air injection ducting, if applicable.
- Remove timing chain cover mounting bolts (qty. 9) and carefully separate cover from cylinder head.

– Remove timing chain tensioner from side of right cylinder head.

– Turn engine over in direction of normal rotation until cylinder no. 1 is at TDC overlap position (i.e. intake and exhaust valves open, 360° away from TDC ignition)

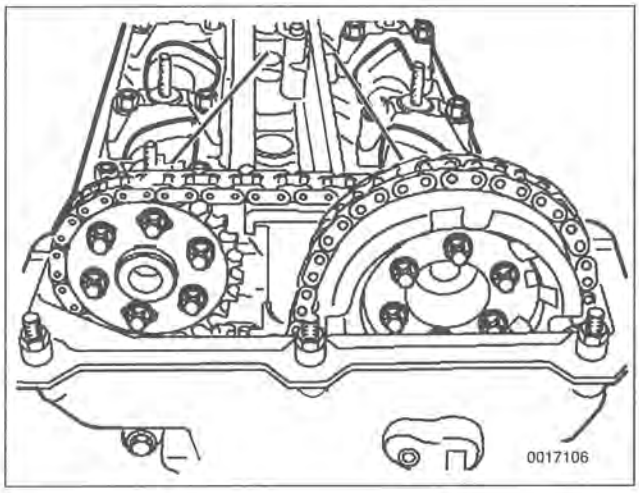
NOTE—

- *Cylinder no. 1 is on the front right (passenger) side.*
- *TDC position is marked on the crankshaft vibration damper as 0/T.*

– Loosen by ½ turn top camshaft sprockets mounting bolts on each cylinder head.

CAUTION—

- *Hold camshaft stationary (at hex on camshaft) when loosening or tightening camshaft sprocket mounting bolts.*
- *Do not damage cylinder head casting when using open end wrench at camshaft hex. If necessary, grind or machine wrench to fit into opening in cylinder head.*



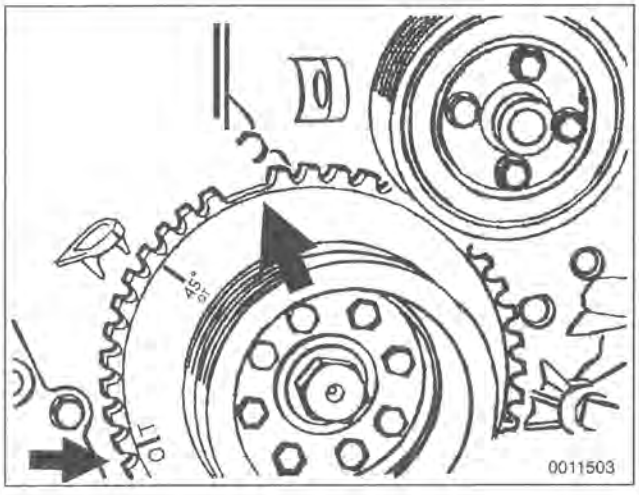
➢ Turn engine in direction of normal rotation until cylinder no. 1 is at TDC. Cylinder no. 1 camshaft lobes pointing up and toward each other indicates TDC.

– Loosen remaining camshaft sprocket bolts.

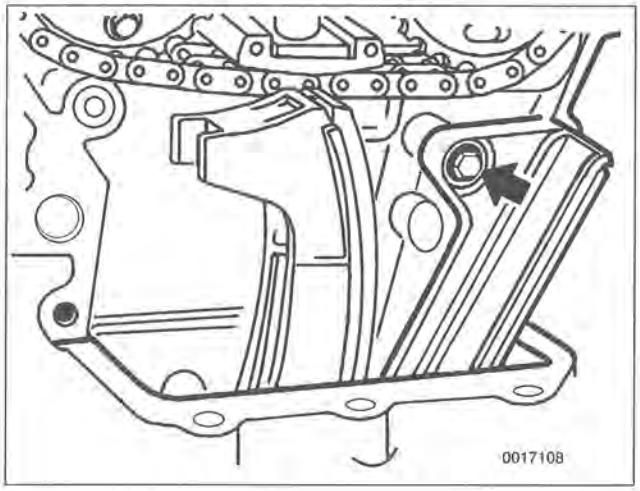
– Remove all right intake camshaft sprocket bolts. Remove large sprocket and suspend main timing chain with wire.

NOTE—

Replace two sprocket bolts and secure them finger tight to prevent remaining chain and sprocket from falling off intake camshaft.



➢ Slowly turn engine away from direction of normal rotation until cylinder no. 1 is at 45° before TDC (BTDC). Note position of 0/T mark and gap in toothed wheel (**arrows**).



➢ Remove camshaft timing chain guide rail mounting bolt (**arrow**) on right cylinder head. Disconnect timing chain guide rail from cylinder head.

– Using BMW special tool no. 11 2 250 or equivalent, loosen cylinder head bolts in stages, working diagonally from outermost bolts toward center of head. Remove cylinder head.

Right cylinder head, installing (M60 engine)

– Prior to installation, clean cylinder head and gasket surfaces.

• Remove all foreign matter and liquid from head bolt holes in cylinder block.

CAUTION—
Do not use a metal scraper or wire brush to clean the aluminum engine parts. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.

NOTE—
If the cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer.

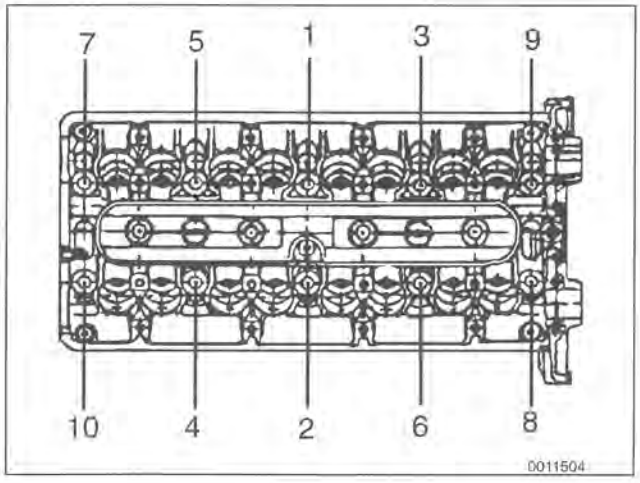
– Apply thin bead of sealer (Hylomar® SQ 32 M or equivalent) to corner-joint where lower timing chain cover mates with cylinder block.

– Place a new cylinder head gasket into position. Make sure dowel sleeves are correctly positioned in block and not damaged.

– With crankshaft at 45° BTDC for cylinder no. 1, set cylinder head in position.

– Lightly lubricate new cylinder head bolts. Loosely install bolts with washers. Thread all bolts in finger tight.

➢ Tighten cylinder head bolts in stages, alternately and diagonally, in sequence shown.



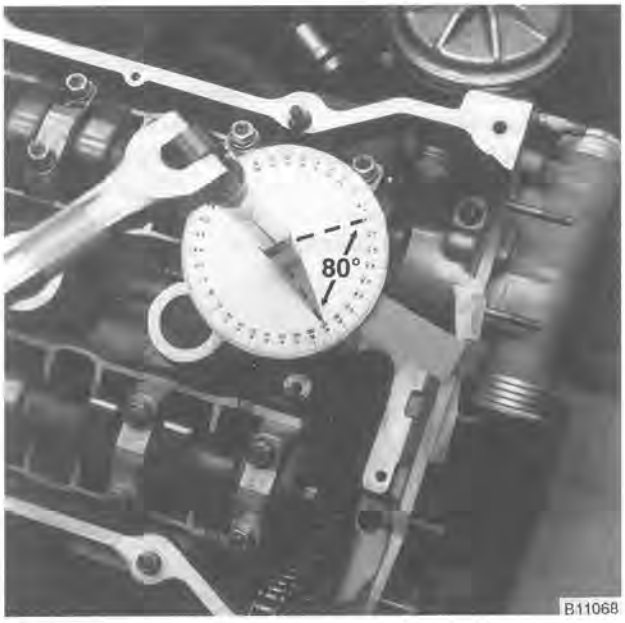
M60 CYLINDER HEADS

CAUTION—

- *Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.*
- *Do not wash protective coating from new bolts.*
- *Check that all washers for the head bolts are in place before installing bolts. Some washers may be staked to the cylinder head.*
- *The use of a special tool (BMW Tool No. 11 2 110) or a suitable protractor is required to tighten head bolts to a specified torque angle.*

Tightening Torques (M60 Engine)

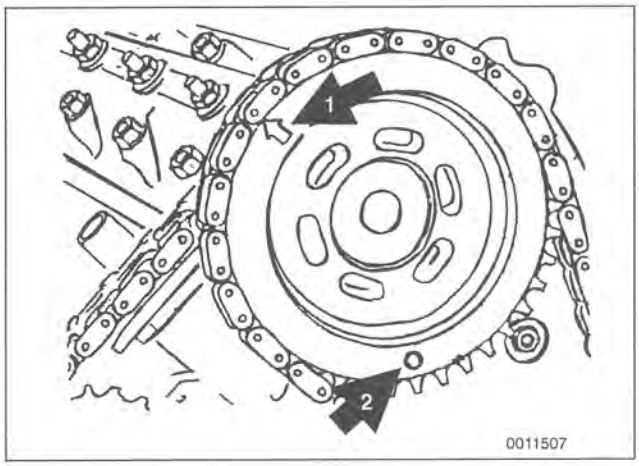
- Cylinder head to cylinder block
  - Stage 1 . . . . . 30 Nm (22 ft-lb)
  - Stage 2 . . . . . +80°
  - Stage 3 . . . . . +80°



➢ Use protractor and pointer to tighten bolts to specified torque angle

– Fit timing chain guide rail to cylinder head and install bolt.

– Position camshafts and crankshaft at TDC and lock all shafts in position using BMW special tools. See **117 Camshaft Timing Chain**.



➢ Install intake sprocket (right cylinder head) to timing chain and camshaft with arrow on sprocket (**1**) pointing up and dowel pin for camshaft position sensor in lower left (**2**).

- Bolt holes in sprocket should be centered to threaded bores in camshaft.
- Tighten sprocket bolts finger tight.

– Adjust camshaft timing, tighten sprocket mounting bolts, and install timing chain tensioner, as described in **117 Camshaft Timing Chain**.

– Remainder of installation is reverse of removal.
  - When installing front timing chain cover, use new gaskets. Remove protective film from gaskets.
  - Seal lower corners of chain cover to cylinder head before installing cover.
  - Tighten bolts in two stages, tightening cover-to-cylinder block bolts first.
  - Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
  - Change engine oil and filter as described in **020 Maintenance**.

> ***CAUTION—***
> *To prevent damaging engine electronic systems, be sure to install all ground wires removed earlier.*

Tightening Torques (M60 engine)
- Coolant drain plug to cylinder block . . 28 Nm (20 ft-lb)
- Camshaft timing chain sprocket to camshaft (M6) . . . . . 15 Nm (11 ft-lb)
- Camshaft timing chain tensioner to cylinder head . . . . . 40 Nm (30 ft-lb)
- Camshaft timing chain cover to cylinder head/cylinder block . . . . . 10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/timing chain cover
  M6 . . . . . 10 Nm (89 in-lb)
  M7 . . . . . 15 Nm (11 ft-lb)
- Exhaust manifold to cylinder head . . . 22 Nm (17 ft-lb)
- Radiator cooling fan to coolant pump . . . . . 40 Nm (30 ft-lb)
- Spark plugs to cylinder head . . . 23±3 Nm (17±2 ft-lb)

M70 CYLINDER HEADS

Intake manifolds, removing and installing (M70 engine)

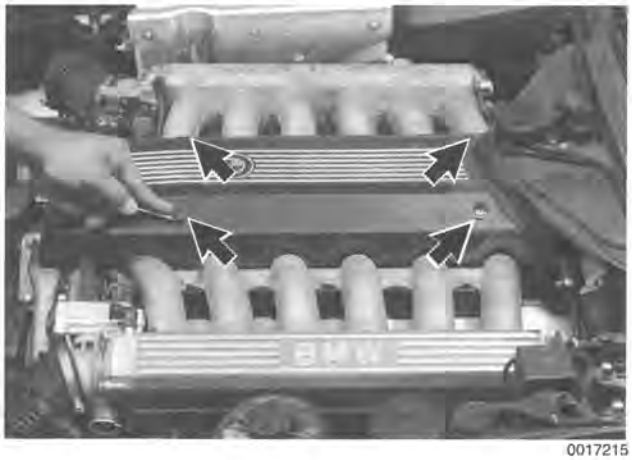
This procedure covers replacement of the intake manifold assembly.

> ***WARNING—***
> *Due to risk of personal injury, be sure engine is cold before beginning work on cylinder head.*

– Drain coolant expansion tank and disconnect coolant hoses at tank. Remove expansion tank from engine compartment rear bulkhead.

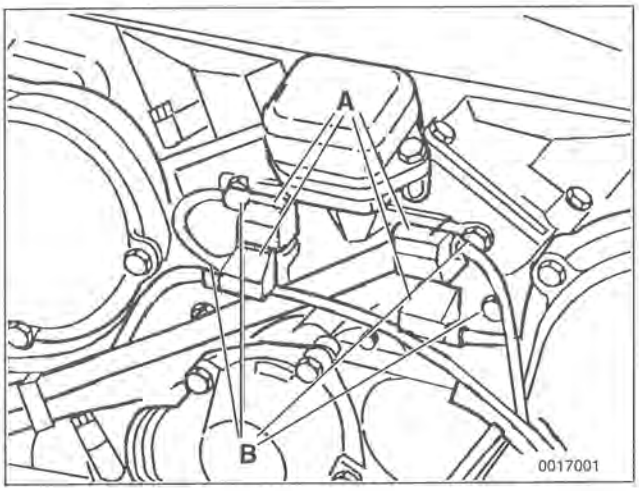
➢ Remove cover from top of engine.
  - Pry out 4 plugs from cover. Turn screws 1/4 turn to release. Lift off cover.

– Drain windshield washer tank. Disconnect washer fluid hose and electrical harness connector from washer pump.



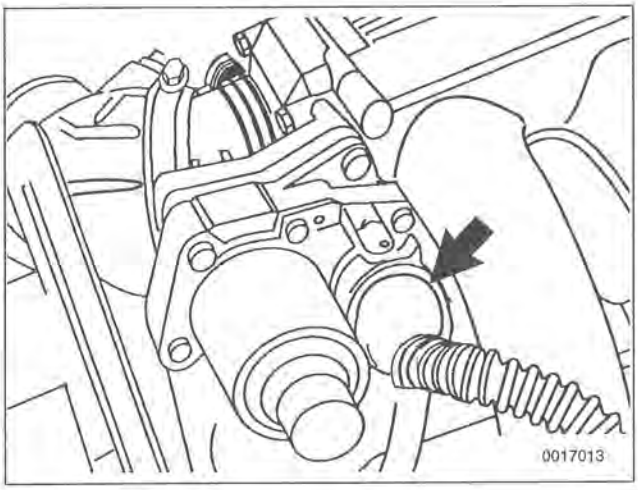
0017215

M70 CYLINDER HEADS

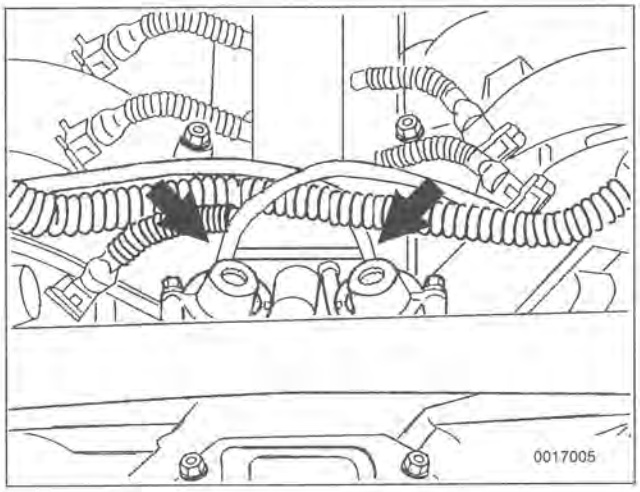


- Working at front of engine in front of oil filler cap, pull off oil drip shield. Disconnect engine sensor connectors (**A**). Remove pulse sender bracket bolts (**B**), lift of bracket and disconnect harness plugs from it.

NOTE—
Label harness connections before disconnecting.



- Disconnect harness connectors at left and right EML throttle actuators.



- Disconnect vacuum hoses (**arrows**) at fuel pressure regulator.
- Disconnect fuel return hose at right rear of engine.
- Disconnect fuel supply hoses at top rear of engine.

> ***WARNING—***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

NOTE—
On some late production engines, a special fitting is used to retain the fuel lines to the fuel rail. Use BMW special tool no. 16 1 050 to expand the locking clip inside the end of the fuel line fittings.

- Disconnect harness connectors at intake manifold.

– Pull off fuel injector harness connectors.

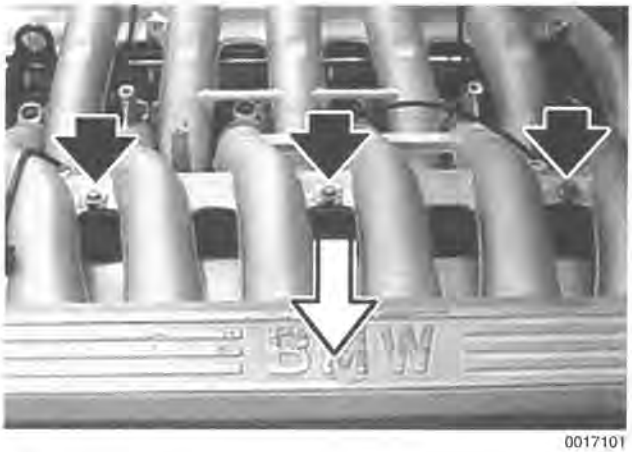
– Working at engine compartment rear bulkhead, cut off wire ties and remove retaining screws for wiring harness bracket. Lift off harness and set aside.

– Disconnect air filter housing clamps and remove mass air flow sensors and intake air ducting.

– Remove throttle housings from intake manifolds.

– Detach and remove ignition wire loom.

– Disconnect crankcase breather hoses from cylinder head covers.



0017101

◁ Loosen intake manifold support brackets, then unbolt intake manifolds and lift off.

NOTE—
Where necessary, remove crankcase ventilation valve from end of manifold.

– Installation is reverse of removal.
- Use new gaskets and O-rings.
- Place manifold noise insulation strip on cylinder head cover first.
- Oil dipstick guide tube is mounted with same fasteners as ignition wire loom.
- Fuel rail is mounted with front two fasteners of right (passenger side) manifold.

Tightening Torque
- Intake manifold to cylinder head . . . . . 22 Nm (17 ft-lb)

Cylinder head cover gaskets, replacing (M70 engine)

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning work on the cylinder head cover.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

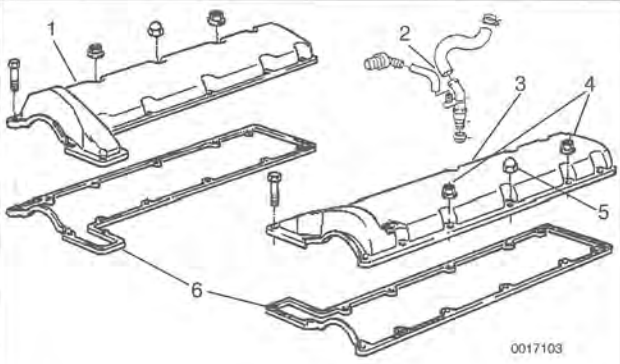
CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove intake manifolds as described earlier.

◁ Remove cylinder head covers.

– Clean old gasket and sealer material from sealing surfaces.

– Install gasket on cylinder head.



0017103

1. Left cylinder head cover
2. Crankcase breather hoses
3. Right Cylinder head cover
4. Rubber buffer
5. M6 bolt (tighten to 9 Nm (7 ft-lb)
6. Cylinder head cover gaskets.

– Apply thin bead of sealer (Hylomar® SQ 23 or equivalent) to gasket surface at joint where upper timing chain cover meets cylinder head.

– The remainder of installation is reverse of removal.
  • Install all cylinder head cover cap nuts by hand, then tighten evenly and in stages, working in a crisscross pattern.

Tightening Torque
• Cylinder head cover to cylinder head and timing chain cover
M6 . . . . . 10 Nm (89 in-lb)

Cylinder heads, removing (M70 engine)

NOTE—
• When removing the cylinder heads on the M70 engine, it may be simpler to remove the engine due to an extremely crowded engine compartment.

• Special service tools are required to adjust camshaft timing as part of cylinder head installation. Be sure to review the adjustment procedure outlined in **117 Camshaft Timing Chain** *before removing the cylinder head.*

Cover all painted surfaces before beginning the cylinder head removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

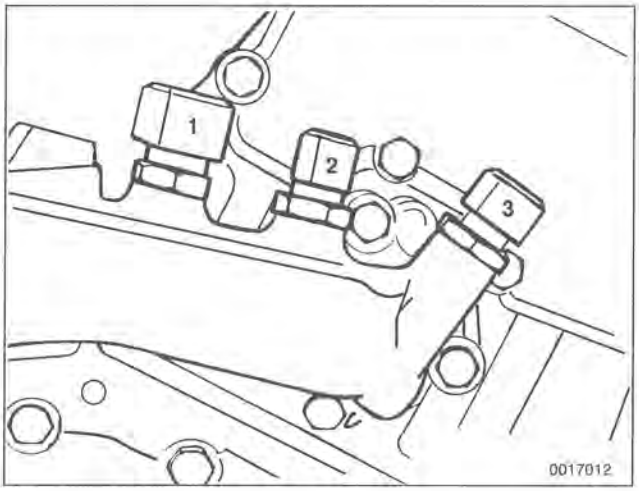
– Remove exhaust manifold heat shields, then unbolt front exhaust pipes from exhaust manifolds.

– Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

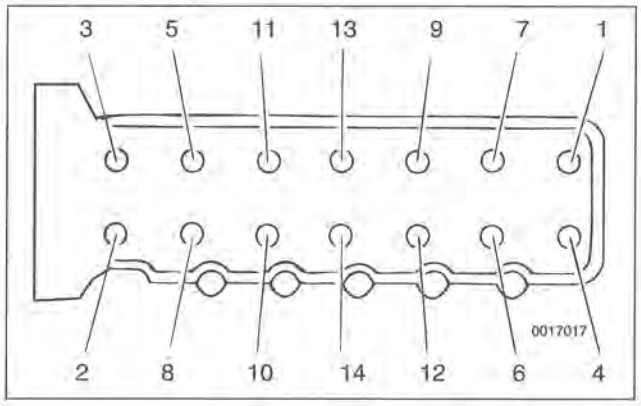
NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Remove intake manifolds as described earlier.

– Remove cylinder head covers as described earlier.



- Disconnect harness connectors from temperature sensor connectors at coolant crosspipe:
  - **1.** DME
  - **2.** EML
  - **3.** Temperature gauge
- Remove crosspipe.
- Left cylinder head: Disconnect electrical harness connectors and coolant hoses from heater valve, then remove valve.
- Remove upper timing case and timing chain sprockets as described in **117 Camshaft Timing Chain.**
- Use wire to tie chain to camshaft chain sprockets. Remove sprockets with chain attached and support.

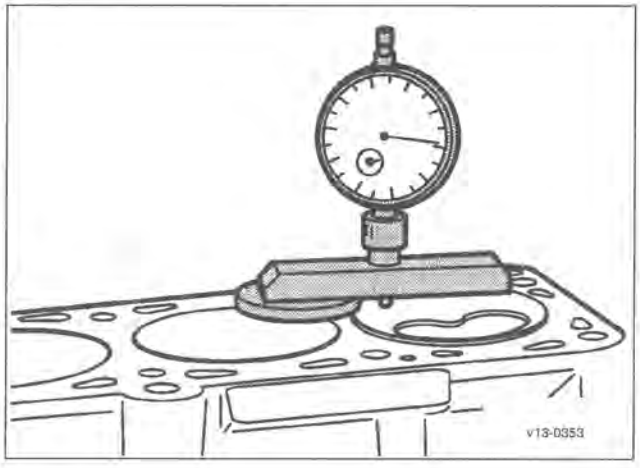


- Using BMW special tool no. 11 2 250 or an equivalent, loosen cylinder head bolts in stages, working diagonally from outermost bolts toward center of head, as shown. Remove cylinder head.

Cylinder heads, installing (M70 engine)

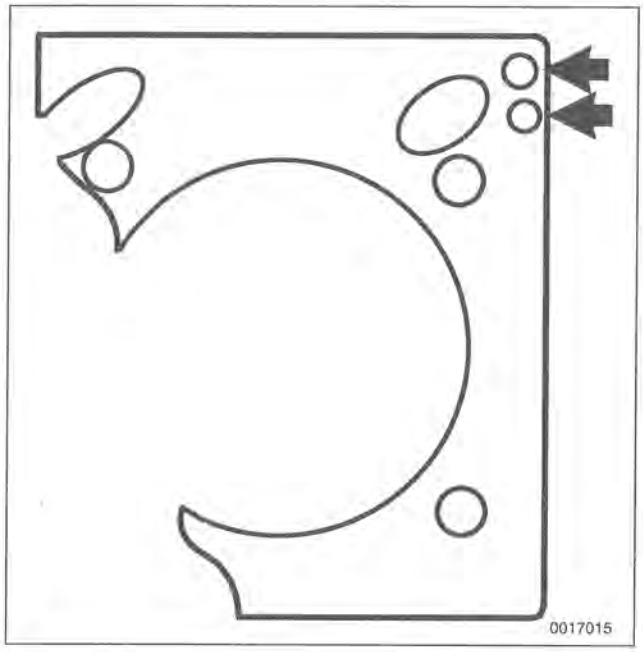
- Prior to installation, clean cylinder head and cylinder block gasket surfaces.
  - Remove all foreign matter and liquid from head bolt holes in cylinder block.

> ***CAUTION—***
> *Do not use a metal scraper or wire brush to clean the aluminum engine parts. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.*



M70 CYLINDER HEADS

- Check cylinder head and cylinder block sealing surfaces for warpage using a straight edge
- Check piston protrusion above gasket surface.
  - Lay dial indicator flush across top of shim of known thickness. Measure piston height at two different spots, then average.
  - Turn engine over, bringing each piston to top of its travel. Clean each piston surface, then measure piston height above cylinder block surface.



➢ Cylinder head gasket thickness identification holes (**arrows**).

- Use **Table a** to select each cylinder head gasket based on maximum piston height for each bank of cylinders.

Table a. V-12 Piston Height Specifications

Maximum piston height	No. head gasket holes
0.388 - 0.610 mm (0.015 - 0.024 in)	1
0.610 - 0.832 mm (0.024 - 0.033 in)	2

– Place new cylinder head gasket on each cylinder block surface with "top/oben" up and "front/vorn" toward timing chain.

NOTE—

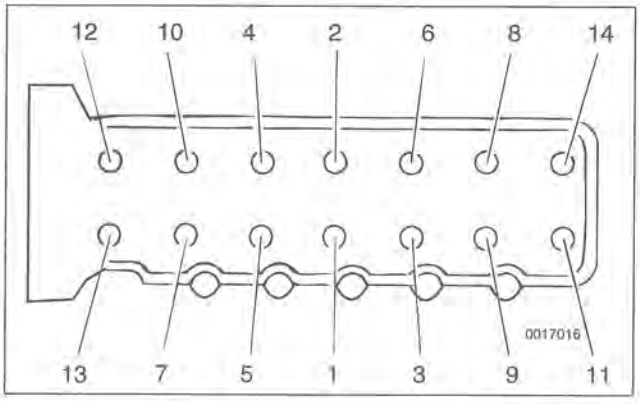
- *Make sure head gasket alignment dowels are in place.*
- *Left and right head gaskets are different.*

– Align cylinder heads with guide dowels and set in position.

– Lightly lubricate new cylinder head bolts. Loosely install bolts with washers. Thread all bolts in finger tight.

CAUTION—

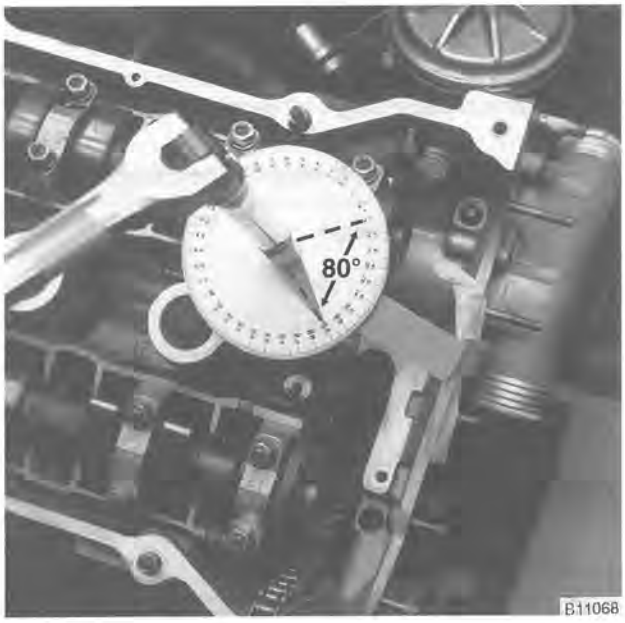
- *Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.*
- *Do not wash protective coating from new bolts.*
- *Check that all washers for the head bolts are in place before installing bolts. Some washers may be staked to the cylinder head.*
- *The use of a special tool (BMW Tool No. 11 2 110) or a suitable protractor is required to tighten head bolts to a specified torque angle (Stage 2).*



➢ Tighten cylinder head bolts in stages, alternately and diagonally, as shown.

Tightening Torque (M70 Engine)

- Cylinder head to cylinder block
  - Stage 1 . . . . . 30 Nm (22 ft-lb)
  - Stage 2 . . . . . + 60°
- Stage 3 . . . . . + 60°



➢ Use protractor and pointer to tighten bolts to specified torque angle

– Install chain guides, camshaft sprockets and timing covers as described in **117 Camshaft Timing Chain**. Adjust camshaft timing.

– The remainder of installation is reverse of removal.

- Use new gaskets when mounting intake manifold. Tighten nuts finger tight first, then torque to specification in stages working diagonally from inside to outside.
- Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance**.

> ***CAUTION—***
> *To prevent damaging engine electronic systems, be sure to install all ground wires previously removed.*

Tightening Torques (M70 engine)

- Coolant drain plug to cylinder block . . 28 Nm (20 ft-lb)
- Camshaft timing chain sprocket to camshaft . . . . . .10 Nm (7.5 ft-lb)
- Camshaft timing chain tensioner to cylinder head . . . . . 40 Nm (30 ft-lb)
- Camshaft timing chain cover to cylinder head/cylinder block . . . . . .10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/timing chain cover
- M6 . . . . . .10 Nm (89 in-lb)
- M7. . . . . 15 Nm (11 ft-lb)
- Exhaust manifold to cylinder head (M8) . . . . . 22 Nm (17 ft-lb)
- Radiator cooling fan to coolant pump . . . . . 40 Nm (30 ft-lb)
- Spark plugs to cylinder head . 23 ± 3 Nm (17 ± 2 ft-lb)



116 Cylinder Head and Valvetrain

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GENERAL

This repair group covers cylinder head and valvetrain service and repair. Most of the repairs described here require that the cylinder head first be removed as described in **113 Cylinder Head Removal and Installation**.

NOTE—

- *For cylinder head cover replacement information see* **113 Cylinder Head Removal and Installation**.
- *For timing chain repair information see* **117 Camshaft Timing Chain**.

Special tools are required for most cylinder head service, disassembly and reconditioning described in this repair group. Be sure to read each procedure thoroughly before starting a job to determine which tools and equipment will be necessary.

NOTE—

If it is determined that the cylinder head will require significant reconditioning work, a remanufactured cylinder head may be a good alternative. Remanufactured cylinder heads are available from an authorized BMW dealer.

The information given in this repair group is organized according to engine code. **Table a** is a basic list of engine application codes. For additional engine application information, see **100 Engine–General**.

Table a. Engine Application Codes

Model	Engine code
735i/735iL	M30 (single overhead cam 6-cylinder, 3.5 liter)
740i/740iL	M60 (dual overhead cam V-8, 4 liter)
750iL	M70 (single overhead cam V-12, 5 liter)

VALVE CLEARANCE

Only the M30 engine has mechanically adjustable valve clearances. The M60 and the M70 engines are designed using hydraulic cam followers or hydraulic valve adjusters (HVA) which need no adjustment.

Valve clearance, adjusting (M30 engine)

Valve adjustment on the M30 engine should be done as part of scheduled maintenance. For a listing of recommended adjustment intervals, see **020 Maintenance**.

A special tool (BMW Tool No. 11 3 070) is available to help turn the rocker arm eccentric when setting valve clearances. As an alternative, a tool can be easily fabricated from stiff wire (approximate diameter of 3/32 in.). The valves can be adjusted with the engine hot or cold.

– Remove cylinder head cover as described in **113 Cylinder Head Removal and Installation**.

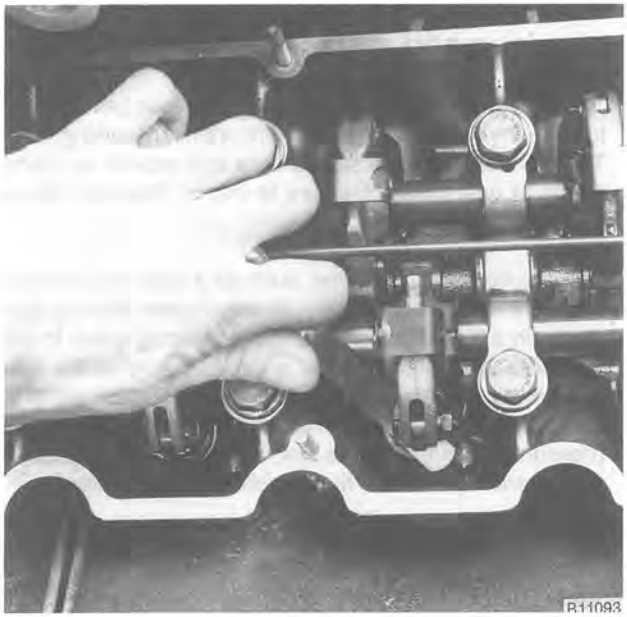
– Using socket wrench on vibration damper nut, hand-turn crankshaft clockwise until no. 1 cylinder camshaft lobes are pointing approximately down (valves fully closed).

NOTE—

• No. 1 cylinder is closest to the radiator.

*• It is much easier to reach the crankshaft vibration damper nut after removing the radiator cooling fan and plastic radiator cowling as described in **170 Radiator and Cooling System**.*

• Crankshaft rotation is easier if you remove the spark plugs.



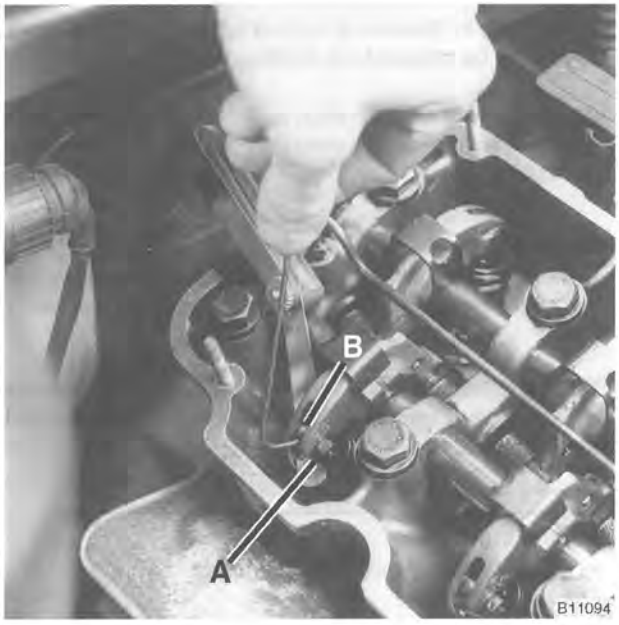
➢ Measure valve clearances of no. 1 cylinder intake and exhaust valves using a feeler gauge. Compare measured clearance values with specifications listed in **Table b.**

Table b. Valve Clearance Specifications

Engine	Engine warm— coolant temp. above 176°F (80°C)	Engine cold— coolant temp. below 95°F (35°C)
M30	0.35 mm (0.014 in)	0.30 mm (0.012 in)

NOTE—

Valve clearance specifications for both intake and exhaust valves are the same.



➢ To adjust valve clearance, loosen setscrew locknut (**A**) with a 10 mm box-end wrench. Rotate eccentric (**B**) until specified clearance is obtained and tighten nut.

Tightening Torque

- Rocker arm eccentric locknut . . . . . 10 ± 1 Nm (89 ± 0.9 in-lb)

– Repeat adjusting procedure for each pair of valves. Follow sequence listed below. Rotate crankshaft until camshaft lobes for next cylinder are pointing approximately down (valves fully closed).

NOTE—

Rotate crankshaft approximately 1/3 of a turn (120°) between adjustments.

Valve Adjustment Sequence

- Cylinder no. 1–5–3–6–2–4

– Recheck all clearances before installing cylinder head cover. This will require two complete rotations of crankshaft pulley.

Hydraulic cam followers, checking and replacing (M60 engine)

The M60 engine uses self-adjusting hydraulic cam followers to keep the valve clearances within a limited working range. The cam followers are sealed units and require no maintenance or adjustment. Be sure to inspect the cam follower bores for wear or scoring.

Under some circumstances, such as a cold start, the cam followers may become noisy. Hydraulic cam follower noise is usually a high-pitched tapping or chattering noise. In most instances, this is considered normal as long as the noise goes away in a few minutes (maximum 20 minutes). If the noise does not go away, either the follower is faulty or the oil pressure to the follower is low. Hydraulic cam follower replacement requires that the camshaft first be removed.

– Run engine until it reaches normal operating temperature.

– Turn engine off and remove top engine covers, ignition coils, and cylinder head covers. See **113 Cylinder Head Removal and Installation**.

– Turn engine in direction of normal rotation until cam lobes of follower to be checked are pointing away from follower.


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◁ Using plastic or wooden stick, press down on top of follower. If there is any noticeable clearance, lifter is faulty and should be replaced.

NOTE—
When checking the lifter, makes sure the camshaft lobe is facing up so that there is no valve spring pressure on the cam follower.

– If a cam follower is faulty, remove camshaft and withdraw follower as described under **Camshafts, removing and installing (M60 engine)**.

Tightening Torque

- Cylinder head cover to cylinder head/ timing chain cover
  M6 . . . . . 10 Nm (89 in-lb)
  M7 . . . . . 15 Nm (11 ft-lb)

Hydraulic valve adjusters (HVA), checking and replacing (M70 engine)

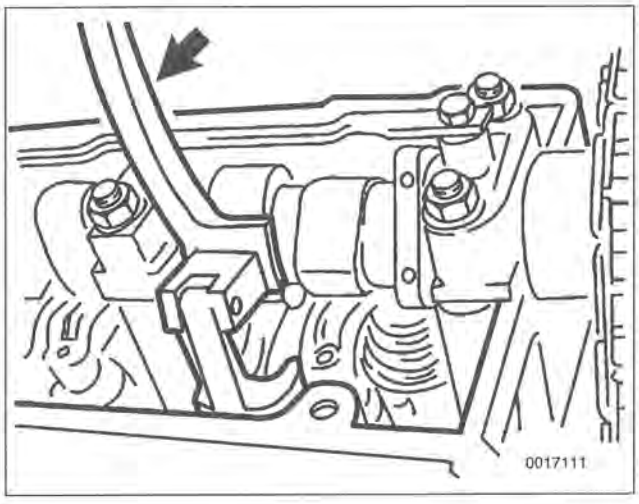
The M70 engine uses hydraulic valve adjusters (HVA) to keep valve clearances within a limited working range. HVAs are sealed units and require no maintenance.

Under some circumstances, such as a cold start, the hydraulic units may become noisy. HVA noise is usually a high-pitched tapping or chattering noise. In most instances, this is considered normal as long as the noise goes away in a few minutes (maximum 20 minutes). If the noise does not go away, either the HVA is faulty or the oil pressure to it is low.

NOTE—
Before checking valve adjusters, make sure engine oil is fresh and at proper level.

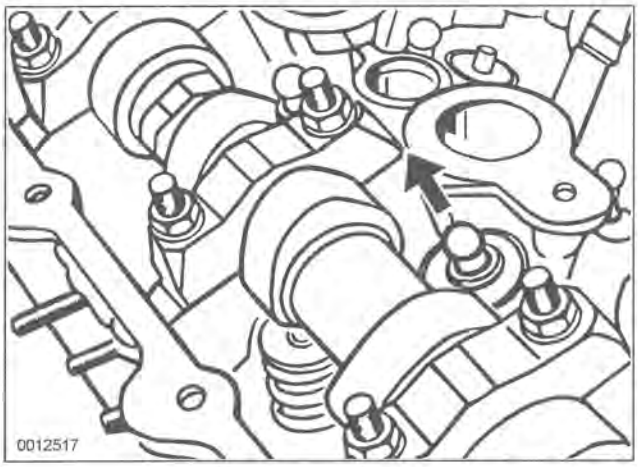
- Run engine until it reaches normal operating temperature.
- Turn engine off and remove cylinder head covers. See **113 Cylinder Head Removal and Installation.**
- Rotate engine in normal direction until cam lobe points away from lifter to be checked.
- Use a plastic or wooden stick to press down on top of rocker arm end (side away from camshaft). If any play can be detected, the HVA is faulty and should be replaced.

NOTE—
When checking the HVA, make sure the camshaft lobe is facing up so that there is no valve spring pressure on the adjuster.



To remove an HVA, turn engine over until camshaft lobe points straight up. Using BMW special tool no. 11 5 180 (**arrow**), depress valve spring and remove rocker arm from under camshaft.

CAUTION—
Removed rocker arms must be reinstalled in the same locations.



➢ Pull hydraulic valve adjuster straight out (**arrow**) of cylinder head.

– Installation is reverse of removal. Be sure to inspect HVA bore in the cylinder head for wear or scoring.

NOTE—
Store removed HVAs upright to prevent oil leakage.

Tightening Torque

- Cylinder head cover to cylinder head/timing chain cover
  M6 bolt . . . . . 10 Nm (89 in-lb)
  M7 bolt . . . . . 15 Nm (11 ft-lb)

CAMSHAFT REPLACEMENT

Some of the disassembly procedures recommend the use of BMW special tools. Many of these tools are expensive and are only available through an authorized BMW dealer. If the special tools are not available, one alternative is to remove the cylinder head and have it disassembled by an authorized BMW dealer. Be sure to read each procedure thoroughly before starting a job to determine which special tools and equipment will be necessary.

NOTE—
On the M30 engine the cylinder head must be removed before removing the camshaft.

Camshaft, removing and installing (M30 engine)

– Remove cylinder head as described in **113 Cylinder Head Removal and Installation**.

– Remove oil sprayer bar mounting bolt from center of head. Discard bolt and crush-type washers.

– Adjust all valve clearances so that hole in eccentric cam points inward (maximum clearance).

– Rotate camshaft until cutouts in front flange are aligned with guide plate mounting bolts on front of cylinder head. Remove two bolts.

NOTE—
At this point, valve spring pressure on the camshaft must be relieved. This can be done in one of two ways. The first method requires the BMW special tool (BMW tool no. 11 1 060), which is a large press that mounts over the top of the entire head and presses down on all of the rocker arms. The second method is to manually lever the necessary rocker arms down using appropriate tools. Once the pressure on the camshaft is relieved, it can be easily withdrawn from the head.

– Where available, install BMW special tool no. 11 1 060 to top of cylinder head and tighten clamping nuts on exhaust side first. Then tighten intake side clamping nuts, making sure valve heads don't contact each other. Pull camshaft out of head.

CAUTION—

• When tightening down the BMW special tool, be sure to tighten the exhaust side first to prevent damaging the valves.

• The BMW special tool may not work on cylinder heads with non-factory (aftermarket) camshafts. If an aftermarket camshaft is installed, watch the valves as the tool is slowly tightened into place.

– If special tool is not available, rotate camshaft until least number of rocker arms are exerting pressure on camshaft. Relieve pressure on remaining rocker arms by levering them down using a helper(s), and pull camshaft out of head.

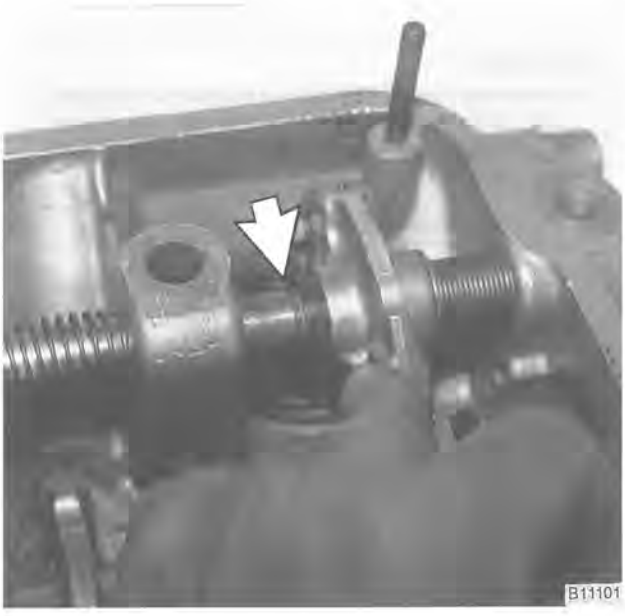
WARNING—

The valves are under considerable pressure from the valve springs. Use extreme care when depressing the rocker arms. Wear hand and eye protection.

– Remove rear cover plate from back of head. Note location of sealing washer and O-ring on one of cover mounting bolts.

NOTE—

Always replace the rear cover sealing washer and O-ring to prevent oil leaks.



➤ Remove rocker arm retainers (**arrow**) by sliding rocker arms and thrust rings to side and prying off thin retaining rings.

– Remove threaded end plugs from front and rear of rocker arm shafts.

NOTE—

If the shaft turns while trying to remove the plug, place a cylinder head bolt in a cylinder head bolt hole.

– Remove rocker arm shafts by either driving them out using a long drift or pulling them out using a slide hammer that threads into threaded end of rocker arm shaft. Catch springs as shafts are removed.

CAUTION—

If drifting the shaft out, strike the drift using firm, hard blows while holding the head steady. Tapping on the drift will cause the end of the shaft to mushroom, making it difficult to remove and possibly damaging the head. If the end of the shaft does become mushroomed, use a small grinding stone or equivalent to redress the end of the shaft.

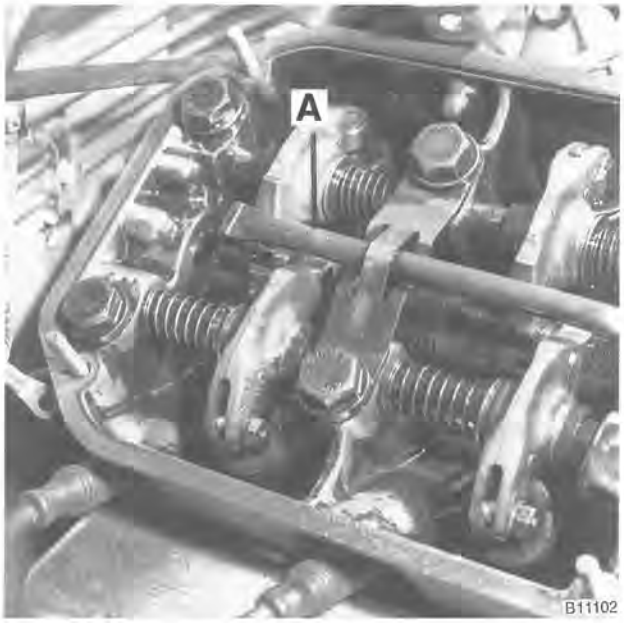
NOTE—

Label all parts as they are removed so they can be reinstalled in their original positions. The M30 cylinder head uses a two-piece rocker arm shaft. The intake-side shafts are different from the exhaust side shafts as are the front and rear sections of each shaft.

– Remove valves using a standard C-type valve spring compressor. Label each valve assembly as it is removed. Remove and discard valve stem oil seals from valve guides.

– Reassembly is reverse of disassembly.

- Prior to installation, check all components for wear as described below under **Cylinder Head and Valvetrain Reconditioning**.
- Be sure all parts are installed in their original positions. When installing rocker arm shafts, the longer of two shafts goes toward front of cylinder head, with plugged ends facing out.
- Make sure cutouts for head bolts are correctly aligned and oil holes for rocker arms face valve stems.
- Use Loctite® 270 or equivalent when installing rocker shaft end plugs.
- Lubricate camshaft prior to installation. If camshaft is being replaced, transfer camshaft flange parts from old shaft to new shaft.



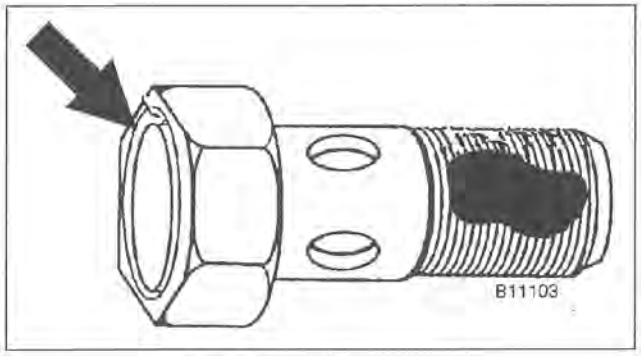
When installing oil sprayer bar, make sure arrow (**A**) on tube faces front of cylinder head and new center mounting bolt has a new crush-type washer on either side of tube.

NOTE—

If the arrow is not visible, turn the tube upside down and position it on the cylinder head. The oil holes should be directly above the cam lobes.

CAUTION—

- *An incorrectly installed or loose oil sprayer bar will cause accelerated camshaft wear. Be sure to use a new center bolt and new washers. If the old bolt is reinstalled, there is danger of it loosening.*
- *Hollow bolt has to be installed in bearing cap #3.*



➢ Use new sprayer bar hollow bolt with machined groove (**arrow**) in bolt head.

- Bolt is pre-coated with a locking compound and should not be reused once torqued.

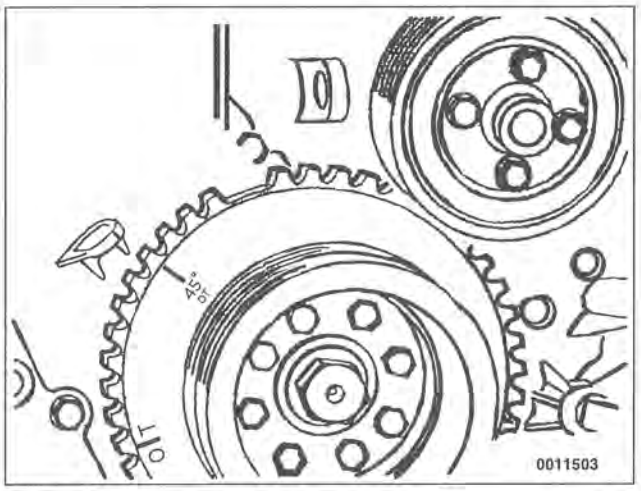
Tightening Torques

- Flange to camshaft (large nut) . . . . 145 Nm (107 ft-lb)
- Ignition rotor adaptor (install with Loctite® 270 or equivalent) . . . . . 23 ± 1 Nm (16.5 ± 0.5 ft-lb)
- Oil sprayer bar to cylinder head (new hollow bolt and washers) . . . . . 11 to 13 Nm (8 to 10 ft-lb)

Camshafts, removing and installing (M60 engine)

NOTE—

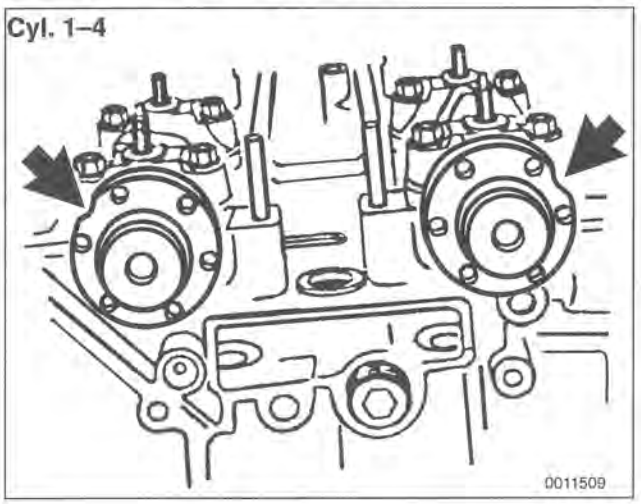
- *Be sure all used parts are reinstalled in their original positions.*
- *Cylinder no. 1 is at the front right (passenger) side of the engine. The right cylinder head is for cylinders 1 though 4. The left cylinder head is for cylinders 5 through 8.*



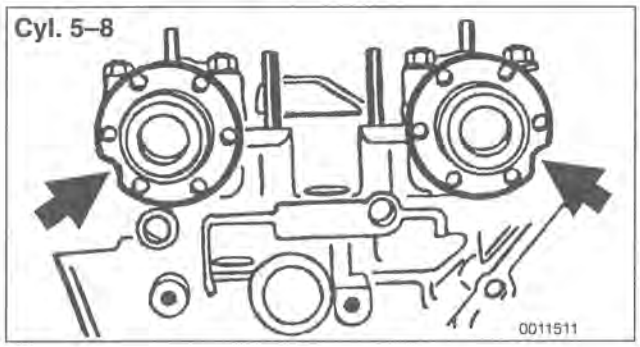
– Remove camshaft timing chain and sprockets from camshaft. See **117 Camshaft Timing Chain**.

➢ Rotate engine to 45° before TDC setting.

CAUTION—
Rotate engine in opposite direction of normal rotation.



➢ **Right Cylinder Head** (passenger side): Carefully turn camshafts so that cutouts (**arrows**) in camshaft flanges are pointing **up** approximately 30° - 40° from horizontal plane.

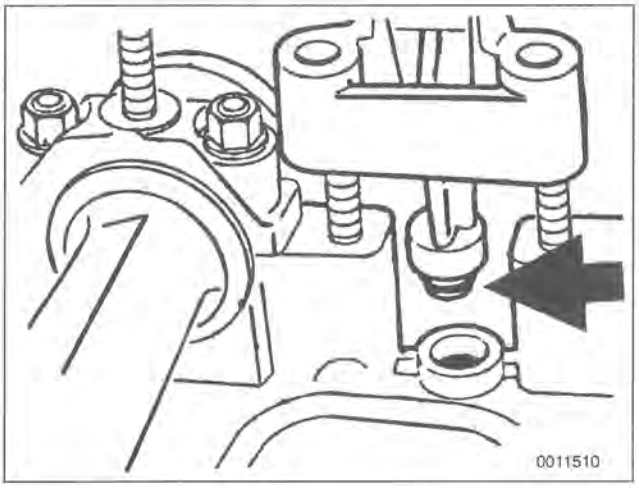


Left Cylinder Head (driver side): Carefully turn camshafts so that cutouts (**arrows**) in camshaft flanges are pointing **down** approximately 30° - 40° from horizontal plane.

NOTE—
A special jig (BMW special tool no. 11 2 430) is available to check the removal and installation positions of the camshafts.

- Loosen camshaft bearing cap mounting nuts in stages (½ turn per stage), working from outside to inside until valve spring pressure is relieved.
- Remove camshaft bearing caps. Remove camshafts.
- Carefully remove hydraulic cam followers. Label each follower as it is removed.

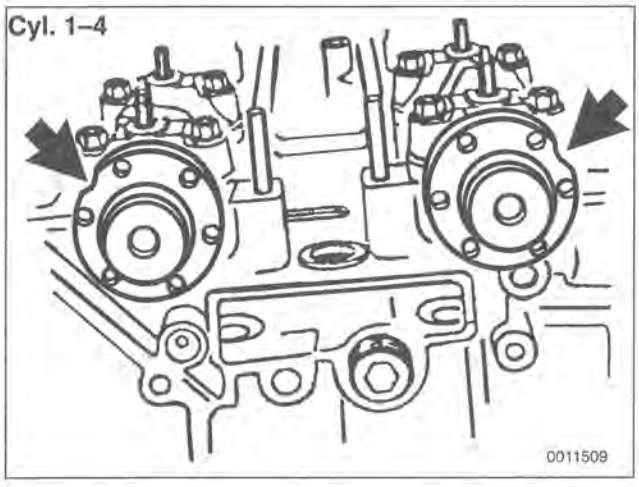
CAUTION—
- *Use care not to damage the cam follower bores when removing the cam followers. Special suction cups are available from BMW (special tool no. 11 3 250) to remove the followers from the cylinder head.*
- *The removed cam followers should be stored in an upright position.*



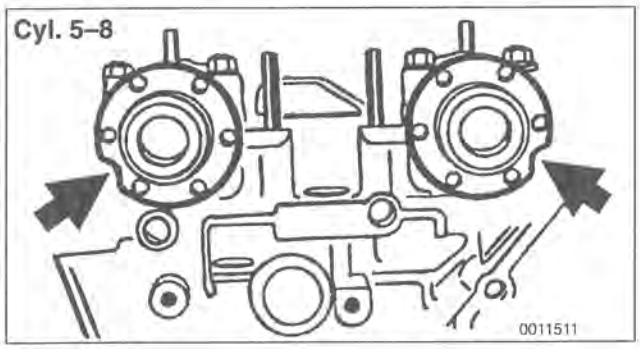
- Check all components for wear as described below under **Cylinder Head and Valvetrain Reconditioning**.

When reinstalling hydraulic timing chain tensioner, be sure to use correctly positioned new O-ring (**arrow**).

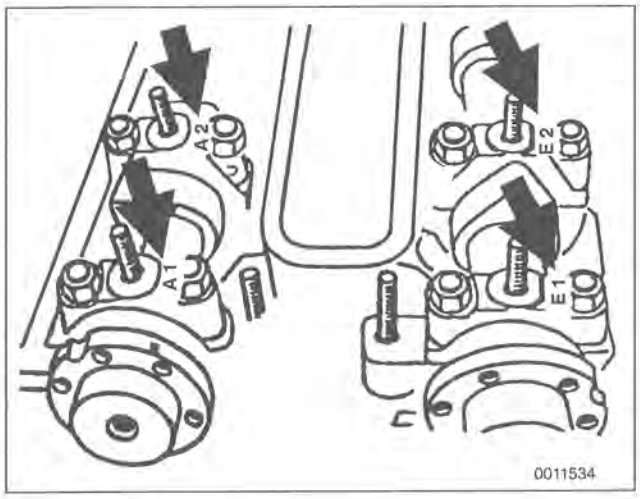
- Lubricate camshafts prior to installation.



Right Cylinder Head (passenger side): Before reinstalling timing chain, carefully turn camshafts so that cutouts (**arrows**) in camshaft flanges are pointing **up** approximately 30° - 40° from horizontal plane.

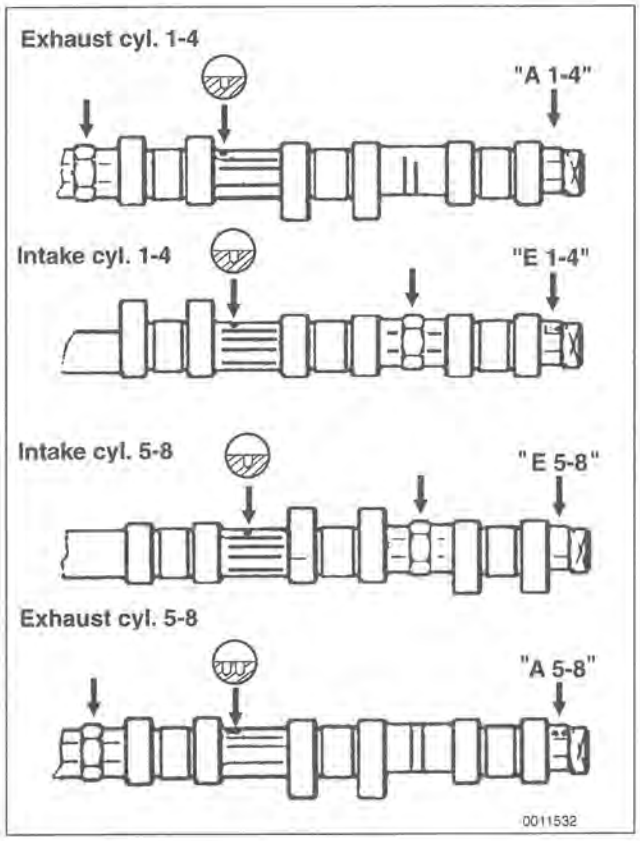


➢ **Left Cylinder Head** (driver side): Before reinstalling timing chain, carefully turn camshafts so that cutouts (**arrows**) in camshaft flanges are pointing **down** approximately 30° - 40° from horizontal plane.



➢ Camshaft bearing caps (**arrows**) are coded with a letter and a cylinder number. For example, "**A1**" is the exhaust camshaft bearing cap for cylinder no. 1 and "**E1**" is the intake camshaft bearing cap for cylinder no. 1.

CAUTION—
Bearing caps A1 to A4 are for exhaust camshaft.
Bearing caps E1 to E4 are for intake camshaft.



➢ Similarly, camshafts are marked with a code letter and cylinder number. For example, "E1-4" is the intake camshaft for cylinders 1 through 4. Refer to **Table c** for a listing of camshaft identification markings.

Table c. Camshaft Identification (M60 engine)

Identification/ markings	Right cylinder head (cylinders 1-4)	Left cylinder head (cylinders 5-8)
Installed position		
Intake	E1-4	E5-8
Exhaust	A1-4	A5-8
Hexagon location		
Intake	between cyl. 3/4	between cyl. 7/8
Exhaust	between cyl. 1/2	between cyl. 5/6
Hole marking		
Intake	one hole	one hole
Exhaust	one hole	two holes

– Reset camshaft timing as described in **117 Camshaft Timing Chain**.

– Remainder of reassembly is reverse of disassembly.

Tightening Torques (M60 engine)

- Camshaft bearing caps to cylinder head . . . . . 15 Nm (11 ft-lb)
- Camshaft sprocket to camshaft . . . . . 15 Nm (11 ft-lb)

Camshafts, removing and installing (M70 engine)

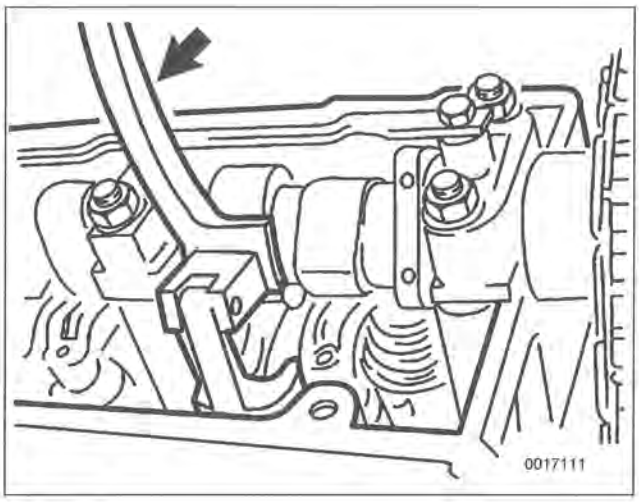
The procedures used to remove either the left or the right camshaft in the M70 engine are similar. A camshaft can be removed with the cylinder head installed on the engine or removed and mounted on a work bench.

– Remove both cylinder head covers as described in **113 Cylinder Head Removal and Installation**.

– If a valve job or other cylinder head work is necessary, remove cylinder head as described in **113 Cylinder Head Removal and Installation**.

– Remove all spark plugs.

– Remove camshaft oil sprayer bar.



➤ Turn camshaft over until camshaft lobe points straight up. Using BMW special tool no. 11 5 180 (**arrow**), depress valve spring and remove rocker arm from under camshaft.

CAUTION—
Removed rocker arms must be reinstalled in the same locations.

– Remove distributor housings, top timing case cover and camshaft timing chain sprockets as described in **117 Camshaft Timing Chain**.

– Remove camshaft position sensor, if necessary.

– Remove camshaft bearing caps and lift out camshaft.

CAUTION—
Camshaft bearing caps must be reinstalled in the same locations. Note the factory numbering on the castings.

– Carefully remove hydraulic valve adjusters (HVA) as described earlier. Label each HVA as it is removed.

CAUTION—
- *Use care not to damage the HVA bores when removing the HVAs.*
- *The HVAs should be stored in an upright position.*

– Reassembly is reverse of disassembly.

- Check all components for wear as described below under **Cylinder Head and Valvetrain Reconditioning.**
- Be sure all parts are installed in their original positions.
- Lubricate camshafts and HVAs prior to installation.
- Install camshaft oil sprayer bar with oil injector bores pointing toward camshaft.
- Use new copper sealing gaskets when installing camshaft oil sprayer bar.

Tightening Torques (M70 engine)

- Camshaft bearing caps to cylinder head (M7) . . . . . 15 Nm (11 ft-lb)
- Camshaft oil sprayer bar (M8) . . . . . 12 Nm (98 in-lb)
- Camshaft sprocket to camshaft (M6) . 10 Nm (89 in-lb)

CYLINDER HEAD AND VALVETRAIN RECONDITIONING

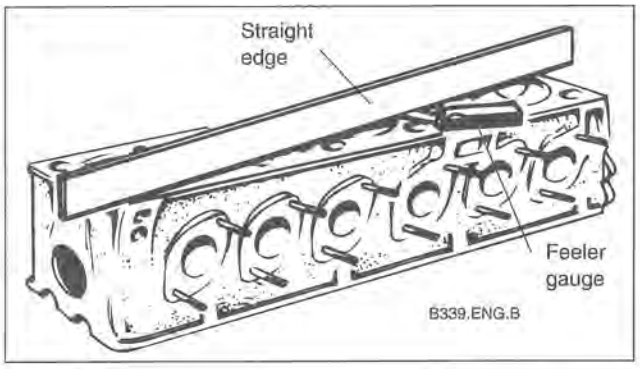
This section provides the specifications and special reconditioning information necessary to repair the cylinder heads covered by this manual.

NOTE—

All procedures in this repair group require removal of cylinder head(s) and camshafts(s).

If machine shop services are not readily available, one alternative is to install a remanufactured cylinder head. Remanufactured cylinder heads are available from an authorized BMW dealer parts department.

Cylinder head



Straight edge and feeler gauge used to check straightness of cylinder head gasket surface.

The disassembled cylinder head should be inspected for warpage and cracks. Check the valve guides and valve seats for wear before machining a warped head. Always decarbonize and clean the head before inspecting it. A high-quality straight edge can be used to check for warpage.

Visually inspect the cylinder head for cracks. If a cracked cylinder head is suspected and no cracks are detected through the visual inspection, have the head further tested for cracks by an authorized BMW dealer. A cracked cylinder head should be replaced.

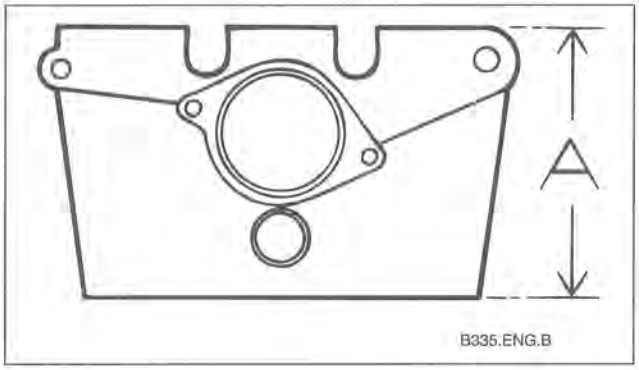
NOTE—

BMW does not give cylinder head warpage specifications for the engines in the 7 Series cars.

A warped cylinder head can be machined provided no more than 0.3 mm (0.012 in.) of material is removed. If further machining is required, the head should be replaced. Removing more than this amount will reduce the size of the combustion chamber and adversely affect engine performance. A 0.3 mm thicker gasket is available from an authorized BMW parts department.

Before machining the head to correct for warpage, measure the total height of the cylinder head. Minimum resurfacing height specifications are given below. If the cylinder head height will not meet the minimum height dimension after machining, the cylinder head should be replaced.

NOTE—
When machining cylinder heads on M30 and M60 engines, the upper camshaft timing chain cover and the rear cover (M30 only) should be bolted to the cylinder head before machining.



Front view of cylinder head showing minimum resurfacing dimension (**A**). (Single cam cylinder head shown. Dual cam head similar.)

Table d. Cylinder Head Height

Engine	New	Minimum permissible height (dimension A)
M30	129.0 ± 0.1 mm (5.079 ± 0.004 in)	128.6 mm (5.063 in)
M60	140.0 ± 0.05 mm (5.512 ± 0.002 in)	139.7 ± 0.05 mm (5.500 ± 0.002 in)
M70	140.0 ± 0.05 mm (5.512 ± 0.002 in)	139.8 ± 0.05 mm (5.504 ± 0.002 in)

Camshaft

Camshaft wear is usually caused by insufficient lubrication. On M30 and M70 engines the installation of the oil sprayer bar is critical. A clogged sprayer bar or a loose sprayer bar mounting bolt will reduce oil flow to the camshaft. Visually inspect the removed camshaft lobes and journals for wear. Camshaft wear specifications are given in **Table e.**

Table e. Camshaft Specifications

Axial play	
M30 engine	0.03-0.18 mm (0.0012 to 0.0071 in)
M60 engine	0.10-0.28 mm (0.004-0.011 in)
M70 engine	0.15-0.33 mm (0.006-0.013 in)
Radial play (Plastigage)	
M30 engine	N/A
M60 engine	0.040-0.074 mm (0.0016-0.0029 in)
M70 engine	0.040-0.074 mm (0.0016-0.0029 in)
Camshaft lobe height	
1994– M60 engine	
Intake	47.7 ± 0.06 mm (1.8780 ± 0.0024 in)
Exhaust	47.4 ± 0.06 mm (1.8661 ± 0.0024 in)

NOTE—

- *If the camshaft is being replaced due to cam lobe wear, the corresponding rocker arms or cam followers should also be replaced to avoid damaging the new camshaft.*
- *On an M30 engine experiencing camshaft wear, a special hardened camshaft may be available from BMW. Check with an authorized BMW dealer parts department for the latest parts information. (BMW Service-Information Bulletin 11 07 88–1767.)*

Rocker arms and rocker arm shafts (M30 engine)

Rocker arms and rocker arm shafts are components that wear and are usually the cause of valve train noise. Although valve train noise may indicate worn rocker arms or rocker arm shafts, valve train noise may also be caused by incorrect valve clearances or other engine wear. Valve clearance adjustment is described above under **Valve clearance, adjusting (M30 engine)**.

NOTE—

To replace rocker arms or rocker arm shafts, the cylinder head must be removed. See **113 Cylinder Head Removal and Installation.**



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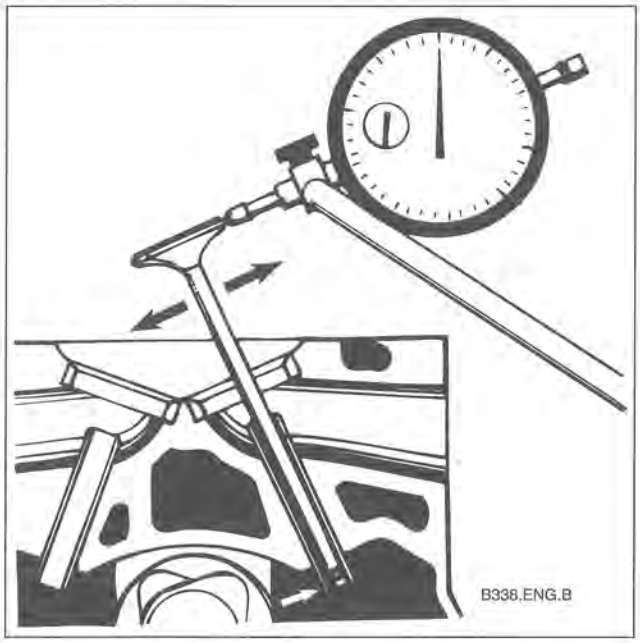
First check the rocker arm bushings for wear. If the lower part of the bushing is shiny and rough, the rocker arm is worn. A good rocker arm bushing surface will have a dull, smooth finish all around. Continue checking the rocker arms by installing them on a known good rocker arm shaft. There should be no noticeable play in any direction. The exhaust-side rocker arms are the most susceptible to wear. If the rocker arm or shafts show any visible signs of wear, they should be replaced.

CAUTION—

Some M30 engines produced between September 1992 and April 1993 may have faulty rocker arms installed. On vehicles so equipped, the rocker arm bushings can slide out of the rocker arms, causing the valves to jam at the rocker arm eccentrics and result in engine damage. Contact an authorized BMW dealer for vehicle chassis ranges and additional information on this problem.

Rocker Arm Specifications

- Radial play . . 0.016 to 0.052 mm (0.0006 to 0.002 in)



Valve guides

BMW does not supply valve guides as replacement parts. If a valve guide is excessively worn, the valve guides should be reamed to accept oversized valve stems. Valve guide specifications are listed in **Table f**.

Valve guide wear being checked with dial indicator. Insert new valve until stem end is flush with end of guide (**white arrow**). See **Table f** for wear limits.

Valve guides must be checked for wear using a new valve. Be sure to inspect the valve seats to ensure that the cylinder head can be reconditioned before reworking the valve guides.

NOTE—

- *International Organization for Standardization (ISO) tolerance classes are listed in* **Table f**. *ISO allowances are based on nominal sizes and should be used to determine proper fits. Most machine shops should have this information readily available.*
- *BMW supplies oversize valves. See* **Valves** *for additional information.*
- *Replacement valve guides may be available through aftermarket suppliers. Valve guide replacement requires special tools and a press. It is also necessary to heat the cylinder head and chill the valve guides when replacing the guides.*

Table f. Valve Guide Specifications

Specification	M30 Engine	M60 Engine	M70 Engine
Valve guide wear, maximum (valve tilt clearance measured with new valve)	0.8 mm (0.031 in)	0.5 mm (0.020 in)	0.5 mm (0.020 in)
Valve guide inside diameter, installed (tolerance per ISO allowance H7)			
Standard	8.0 mm (0.315 in)	6.0 mm (0.236 in)	7.0 mm (0.275 in)
Oversize 1	8.1 mm (0.319 in)	6.1 mm (0.240 in)	7.1 mm (0.280 in)
Oversize 2	8.2 mm (0.323 in)	6.2 mm (0.244 in)	7.2 mm (0.283 in)

Valves

Valve specifications are listed below in **Table g**. Remove carbon deposits from the valves using a wire brush or wire wheel.

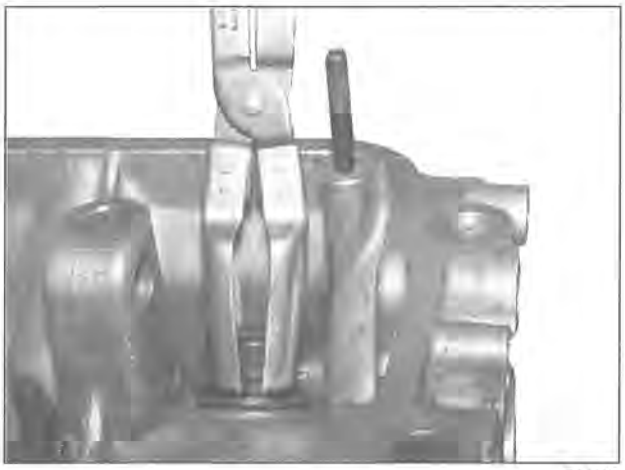
> ***CAUTION—***
> *Special procedures are required when disposing of sodium filled exhaust valves.*

Table g. Valve Specifications

Specification	M30 Engine	M60 Engine	M70 Engine (to 4/90)	M70 Engine (from 4/90)
Valve head diameter				
Intake	47 mm (1.850 in)	35.0 mm (1.378 in)	42.0 mm (1.654 in)	42.0 mm (1.654 in)
Exhaust	38 mm (1.496 in)	30.5 mm (1.201 in)	35.0 mm (1.378 in)	36.0 mm (1.417 in) (sodium filled exhaust)
Min. valve head thickness				
Intake	1.3 mm (0.051 in)	N/A	N/A	N/A
Exhaust	2.0 mm (0.079 in)	N/A	N/A	N/A
Valve stem diameter				
Standard				
Intake	8.0 mm (0.315 in)	5.975 –0.015 mm (0.235 –0.0006 in)	6.975 –0.015 mm (0.2746 –0.0006 in)	6.975 –0.015 mm (0.2746 –0.0006 in)
Exhaust	8.0 mm (0.315 in)	5.960 –0.015 mm (0.2346 –0.0006 in)	6.960 –0.015 mm (0.2740 –0.0006 in)	6.960 –0.015 mm (0.2740 –0.0006 in)
Oversize 1				
Intake	8.1 mm (0.319 in)	6.075–0.015 mm (0.239–0.0006 in)	7.075 –0.015 mm (0.2785 –0.0006 in)	7.075 –0.015 mm (0.2785 –0.0006 in)
Exhaust	8.1 mm (0.319 in)	6.060–0.015 mm (0.239–0.0006 in)	7.060 –0.015 mm (0.2779 –0.0006 in)	7.060 –0.015 mm (0.2779 –0.0006 in)
Oversize 2				
Intake	8.2 mm (0.323 in)	6.175–0.015 mm (0.243–0.0006 in)	7.175 –0.015 mm (0.2824 –0.0006 in)	7.175 –0.015 mm (0.2824 –0.0006 in)
Exhaust	8.2 mm (0.323 in)	6.160–0.015 mm (0.243–0.0006 in)	7.160 –0.015 mm (0.2818 –0.0006 in)	7.160 –0.015 mm (0.2818 –0.0006 in)

Testing valves for leakage

To test the valves for leakage, the camshaft and rocker arm assemblies (where applicable) should first be removed. Install the valve assemblies and the spark plugs in each cylinder. Place the cylinder head on a workbench with the combustion chamber facing upward. Fill each combustion chamber with a thin non-flammable liquid, such as a parts cleaning fluid. After fifteen minutes, check the level of the fluid. If the fluid level in any cylinder drops, that cylinder is not sealing properly.



B11109

Valve stem oil seals

The purpose of the valve stem oil seal is to prevent excess oil from entering the combustion chamber. The sign of faulty valve stem oil seals is excessive oil consumption and smoke from the exhaust immediately after starting and during deceleration.

NOTE—
Valve stem oil seals should not be reused. If the valves are removed, new valve stem oil seals should be installed.

Using BMW special tool no. 11 1 250, remove the valve stem oil seals on M30 valves. As an alternative, standard valve seal removal tools are available from most automotive parts stores.

When installing the valve stem oil seals, the use of BMW special tool 11 1 200 is recommended. Lubricate the new seals and install them using hand pressure only. Be sure to install the valve spring seat before installing the seal.

Valve seats

The valve seats should be resurfaced whenever new valves or valve guides are installed. Cutters are required to resurface the seats. Always check the valves for leaks after reconditioning a valve seat as described above.

NOTE—
Standard size replacement valve seats are not available from BMW. Replacement valve seats are only available from BMW in 0.4 mm oversize (oversized in both height and diameter).

Replacing the valve seats requires heating the cylinder head and chilling the valve seats to a specific temperature as listed in **Table h**. When installing new valve seats, they should be installed flush to the cylinder head surface.

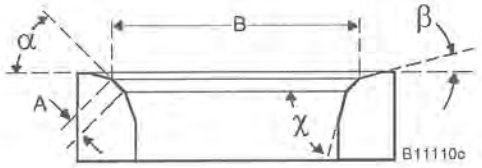
Table h lists valve seat dimensions. **Table i** lists valve seat replacement specifications, including correct installation temperatures.

Valve springs

Valve springs should be checked for squareness and fatigue. To quickly check the springs, line them up in a row. Place a straight edge across the top of the springs. Any spring that is significantly shorter than the others is significantly worn and should be replaced. Use a high quality square to check spring out of squareness. Any spring that is out of square should be replaced.

NOTE—
Valve spring specifications and wear limits are not available from BMW.

Table h. Valve Seat Dimensions



Specification	M30 Engine	M60 Engine	M70 Engine
Valve seat angle (α)	45°	45°	45°
Correction angle, outside (β)	15°	15°	15°
Correction angle, inside (χ)	60°	60°	60°
Valve seat width (**A**)			
Intake	1.4 ± 0.4 mm (0.055 ± 0.016 in)	1.25 ± 0.25 mm (0.049 ± 0.014 in)	1.65 ± 0.25 mm (0.065 ± 0.014 in)
Exhaust	1.7 ± 0.4 mm (0.067 ± 0.016 in)	1.65 ± 0.25 (0.065 ± 0.014 in)	2.00 ± 0.25 mm (0.079 ± 0.014 in)
Valve seat outside dia.(**B**)			
Intake	46.4 mm (1.827 in)	34.5 mm (1.358 in)	41.5 mm (1.634 in)
Exhaust	37.6 mm (1.480 in)	30.0 mm (1.181 in)	Non-sodium: 34.6 mm (1.362 in) Sodium: 35.6 mm (1.402 in)

Table i. Valve Seat Replacement Specifications

Specification	M30 Engine	M60 Engine	M70 Engine
Valve seat insert outside diameter tolerance per ISO allowance: G6 for M30 and M70 engines K6 for M60 engine			
Intake			
Standard	48.15 mm (1.8957 in)	—	43.15 mm (1.699 in)
+ 0.4 mm	48.55 mm (1.9114 in)	36.5 mm (1.437 in)	43.55 mm (1.715 in)
Exhaust			
Standard	40.15 mm (1.5807 in)	—	37.65 mm (1.482 in)
+ 0.2 mm			37.85 mm (1.490 in)
+ 0.4 mm	40.55 mm (1.5965 in)	32.0 mm (1.260 in)	38.05 mm (1.498 in)
Valve seat bore diameter (tolerance per ISO allowance H7)			
Intake			
Standard	48.00 mm (1.8898 in)	—	43.00 mm (1.693 in)
+ 0.4 mm	48.40 mm (1.9055 in)	36.4 mm (1.433 in)	43.40 mm (1.709 in)
Exhaust			
Standard	40.00 mm (1.5748 in)	—	37.50 mm (1.476 in)
+ 0.2 mm	—	—	37.70 mm (1.484 in)
+ 0.4 mm	40.40 mm (1.5905 in)	31.9 mm (1.256 in)	37.90 mm (1.494 in)
Valve seat insert height (tolerance per ISO allowance H11)			
Intake and exhaust			
Standard	7.5 +0.1 mm (0.295 +0.004 in)	—	7.3 -0.1 mm (0.287 -0.004 in)
+ 0.2 mm	—	—	7.5 -0.1 mm (0.295 -0.004 in)
+ 0.4 mm	7.9 +0.1 mm (0.311 + 0.004 in)	7.7 –0.1 mm (0.303 –0.004 in)	7.7 -0.1 mm (0.303 -0.004 in)
Valve seat bore depth			
Intake and exhaust			
Standard	—	—	7.5 ± 0.1 mm (0.295 ± 0.004 in)
+ 0.2 mm	—	—	7.7 ± 0.1 mm (0.303 ± 0.004 in)
+ 0.4 mm	—	—	7.9 ± 0.1 mm (0.311 ± 0.004 in)
Valve seat installation temperatures			
Cylinder head	+50°C (+120°F)	+20°C (+68°F)	+20°C (+68°F)
Valve seat insert	–150°C (–240°F)	–150°C (–240°F)	–150°C (–240°F)



117 Camshaft Timing Chain

GENERAL 117-1

M30 TIMING CHAIN 117-1
Camshaft timing chain, removing (M30 engine) 117-1
Camshaft timing chain, installing (M30 engine) 117-5

M60 TIMING CHAIN 117-8
Camshaft timing, checking and adjusting (M60 engine) 117-8

M70 TIMING CHAIN 117-11
Camshaft timing, checking and adjusting (M70 engine) 117-11

GENERAL

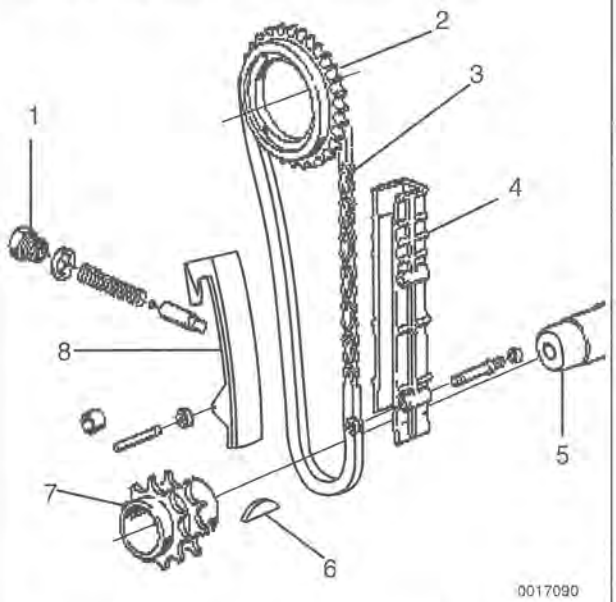
This repair group covers timing chain repair information for the M30, M60 and M70 engines.

The timing chains are lubricated by engine oil and do not require maintenance. A worn timing chain and sprockets can lead to noisy operation and erratic valve timing. A faulty timing chain tensioner can also cause noise in the timing chain.

M30 TIMING CHAIN

The M30 engine uses a single row chain to drive the single overhead camshaft. The chain is tensioned by a hydraulic chain tensioner supplied with engine oil.

M30 engine timing chain components



1. Hydraulic chain tensioner
2. Cam sprocket
3. Camshaft timing chain
4. Chair guide
5. Crankshaft
6. Woodruff key
7. Crankshaft sprocket
8. Chain tensioner rail

Camshaft timing chain, removing (M30 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

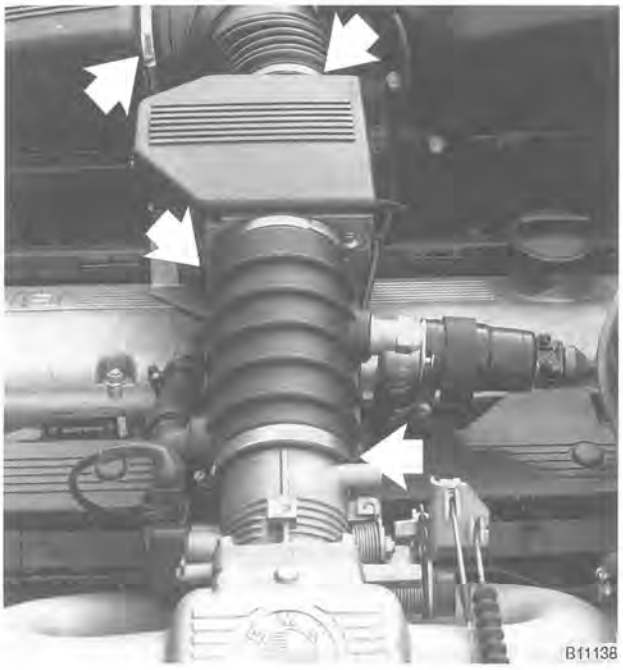
– With engine cold, drain engine coolant from radiator and from cylinder block. See **170 Radiator and Cooling System**.

> ***WARNING—***
> *Allow the cooling system to cool before opening or draining the system. Hot coolant can scald and burn.*

NOTE—
The cylinder block drain is on the exhaust side of the engine, near cylinder no. 5.

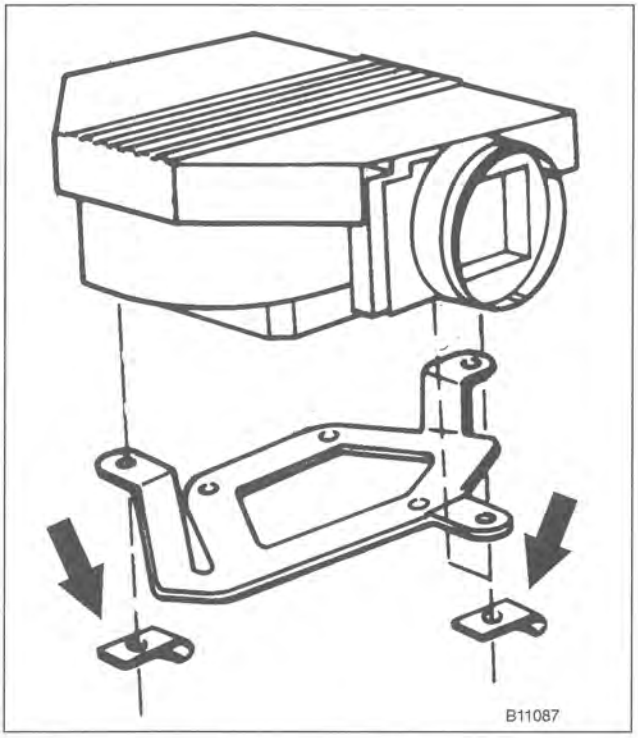
– Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.



➢ Loosen intake air boot hose clamps at intake manifold, air flow sensor, and air cleaner (**arrows**). Remove boots while disconnecting any hoses or fittings in boots.

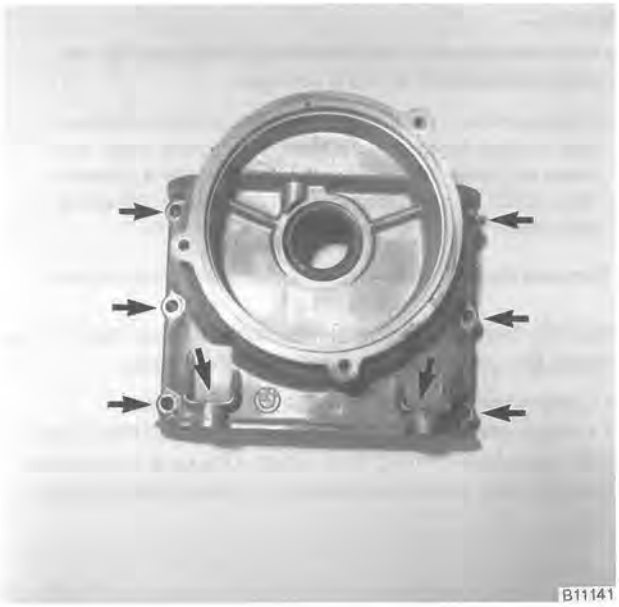
NOTE—
Some hoses may be secured with one-time crimp-type hose clamps. The clamps may be pried loose with a small screwdriver. Replace the clamps with standard screw-type clamps.



➢ Remove air flow sensor by disconnecting harness connector and removing retaining clips (**arrows**) from underside of meter.

– Remove cylinder head cover mounting nuts. Disconnect crankcase breather hose and remove cover.

– Remove distributor cap and rotor from front of camshaft. Remove rotor adaptor from camshaft.


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➢ Remove bolts (**arrows**) from upper timing chain cover. Carefully separate cover from cylinder head.

> ***CAUTION—***
> *Use care when removing the cover from the cylinder head gasket. If the cover is stuck, use a sharp knife to separate it from the head gasket.*

– Remove all V-belts. See **020 Maintenance**.

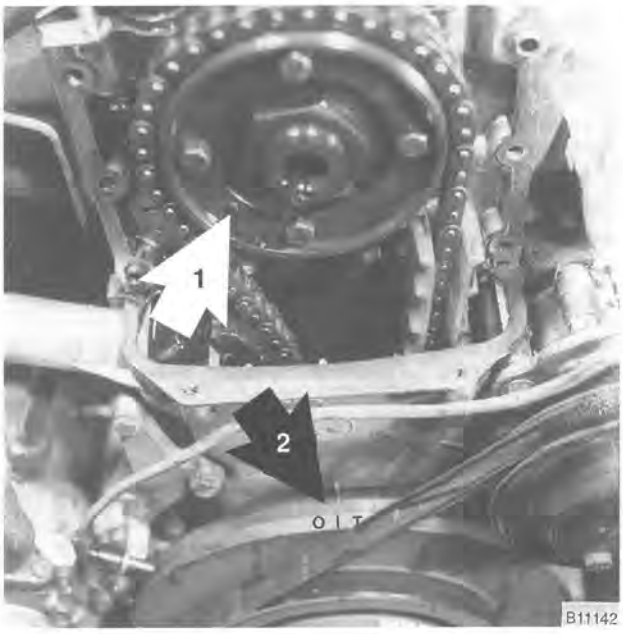
– Remove coolant pump pulley from pump. Remove reference/speed sensor mounting bolt and pull sensor from its mount on lower timing chain cover.

– Remove power steering pump and its brackets. Hang power steering pump from chassis using a stiff wire. See **320 Steering and Wheel Alignment**.

– Secure crankshaft hub/vibration damper to prevent crankshaft from turning. Using a 36 mm socket, loosen but do not remove crankshaft hub center nut.

NOTE—
The crankshaft hub center nut is tightened to a torque of 440 Nm (318 ft-lb). A heavy duty holding device, such as BMW special tool no. 11 2 220, should be used to hold the crankshaft hub stationary. Use a heavy duty ¾-inch drive socket and breaker bar to break the nut free.

– Remove holding device and rotate crankshaft clockwise until engine is at TDC on compression stroke of no.1 cylinder.



B11142

➢ Set crankshaft and camshaft to TDC position.

- Position sprocket bolts straight up and down with locating dowel (**1**) in lower left corner.
- Check that 0/T mark on vibration damper aligns with mark on timing chain cover (**2**).

– Remove timing chain tensioner from side of upper timing chain cover. Be ready to catch piston spring as tensioner is removed. Pull tensioner piston from its bore.

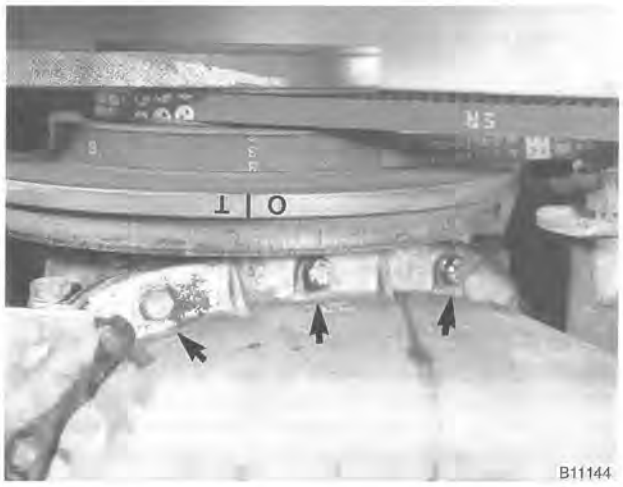
NOTE—
Check the removed piston for free movement of the check ball by shaking the piston. The ball should rattle freely. Blow air into the closed end of the piston. No air should pass. Blow air into the slotted guide end of the piston. Air should pass freely. If any faults are found, try disassembling and cleaning the piston. If the piston cannot be made to operate correctly, it should be replaced.

– Without disturbing position of crankshaft, remove hub/vibration damper mounting nut and hub/damper assembly from front of crankshaft. Remove woodruff key from crankshaft.

NOTE—

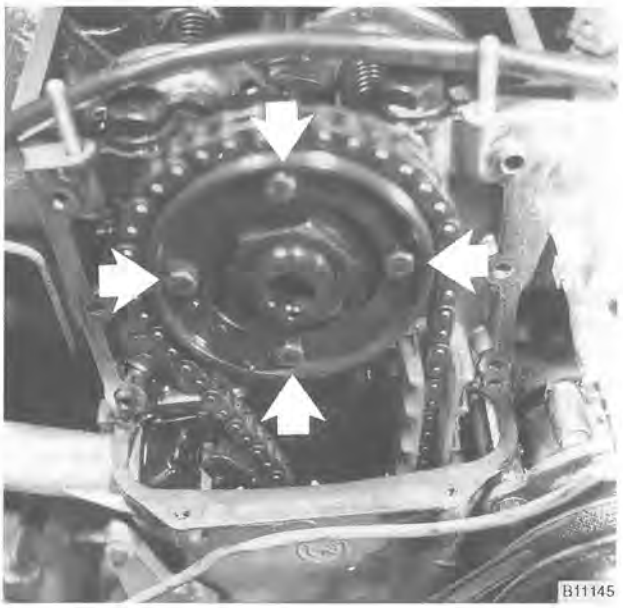
- *Note the orientation of the woodruff key in the keyway. Replace the woodruff key if it is damaged.*
- *If the hub/vibration damper assembly is difficult to remove, first remove the pulley and damper mounting bolts. Remove the pulley and the damper and then use a puller on the hub. Do not try to lever the vibration damper off, as this may distort the harmonic balance of the damper.*

– Remove mounting bolts from lower timing chain cover.



➢ Working beneath engine, remove oil pan mounting bolts (**arrows**) that are threaded into timing chain cover.

- Loosen remainder of oil pan mounting bolts.
- Using a sharp knife, separate oil pan gasket from cover.
- Remove lower timing chain cover. Use care to not damage oil pan gasket on bottom, nor head gasket on top.



➢ Camshaft sprocket mounting bolts (**arrows**).

- Remove bolts from camshaft sprocket and remove sprocket. Carefully remove chain from sprockets and tensioning rails.

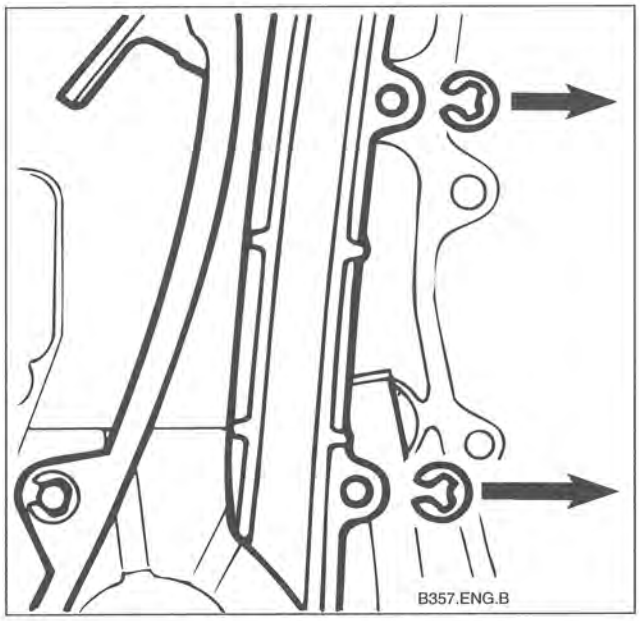
CAUTION—

Do not rotate the crankshaft or the camshaft while the timing chain is removed. The pistons can contact the open valves

– Inspect timing chain sprockets. Sprockets that have worn or missing teeth should be replaced.

NOTE—

- *If any of the sprockets are being replaced due to wear, the chain should also be replaced.*
- *If the crankshaft sprocket requires replacement, the oil pan and the oil pump drive sprocket must be removed as described in* **119 Lubrication System**. *The crankshaft sprocket can be removed from the crankshaft using a puller. Prior to installing the replacement sprocket, it must first be heated in an oil bath to a maximum temperature of 390°F (200°C). At this temperature, the sprocket can be driven onto the crankshaft while aligning the woodruff keyway.*

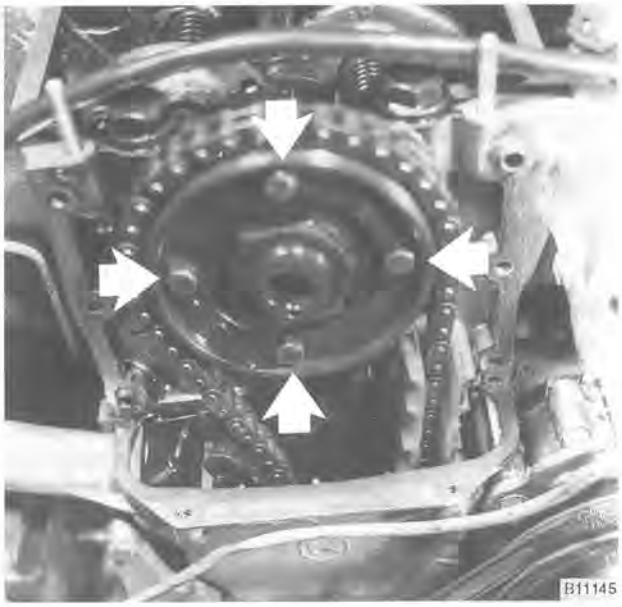


➢ Guide rail mounting circlips (**arrows**).

- Inspect guide rail and tensioner rail for deep grooves caused by chain contact. Rails can be replaced after removing circlips from mounting pins. Always use new circlips.

Camshaft timing chain, installing (M30 engine)

– Install timing chain, guiding it up through guide rails and cylinder head gasket. Make sure chain is properly engaged on crankshaft sprocket.



➢ Camshaft sprocket mounting bolts (**arrows**).

- Temporarily install lower cover.
- Temporarily install crankshaft woodruff key together with crankshaft hub/vibration damper.
- Check that both camshaft and crankshaft are set at TDC.

– Install camshaft sprocket with chain to camshaft so that all chain slack is on tensioner side of chain. Tighten sprocket mounting bolts.

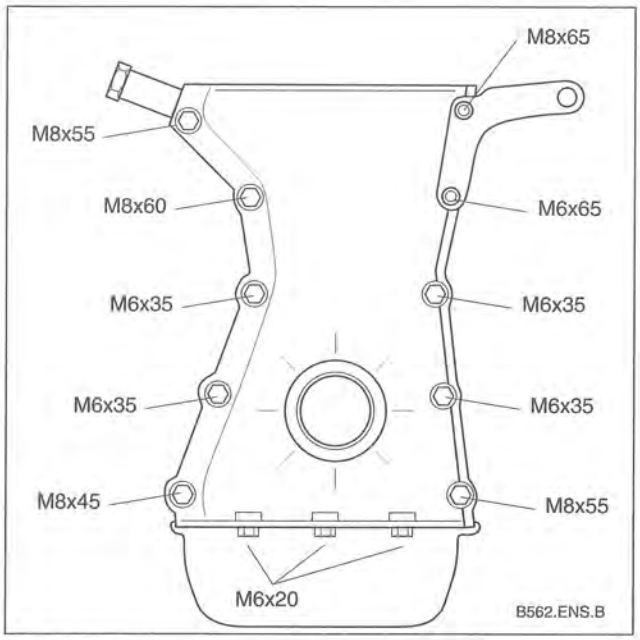
Tightening Torque

- Camshaft sprocket to camshaft . . . . . .10 ± 1 Nm (89 ± 9 in-lb)

– Remove hub/vibration damper and lower timing chain cover.

– Apply a light coat of gasket sealer to lower camshaft timing chain cover gaskets. Install gaskets on cylinder block. Apply a light coating of sealant to exposed portion of oil pan gasket. Apply extra amount of sealer (3-Bond®1207 or equivalent) to each corner of oil pan/cylinder block surface area.

– Install a new crankshaft oil seal in lower timing chain cover and apply a light coat of engine oil to seal.



– Apply a light coat of engine oil to lip of crankshaft oil seal in lower cover. Install cover and loosely install its mounting bolts.

➤ Lower timing chain cover mounting bolt locations.

- Various sizes of bolts are used in the lower timing chain cover.

– Loosely install power steering pump bracket.

– When all brackets and bolts are installed, tighten front cover and oil pan bolts in an alternating pattern.

Tightening Torques

- Lower timing chain cover to cylinder block
  M6 bolts . . . . . 10 ± 1 Nm (89 ± 9 in-lb)
  M8 bolts . . . . . 22 ± 2 Nm (16 ± 1 ft-lb)
- Oil pan to cylinder block . . . . 10 ± 1 Nm (89 ± 9 in-lb)

– Install camshaft timing chain tensioner piston, spring, a new seal, and chain tensioner plug. Tapered end of spring should face plug. Leave plug a little loose.



➤ Timing chain tensioner with cutout positioned to properly engage chain rail.

- Install the camshaft timing chain tensioner piston so that the cutout in the piston engages the chain rail.

– Pour a small amount of oil down side of camshaft timing chain cover. Move tensioner rail back and forth slowly until oil runs out past plug and resistance can be felt at rail. Tighten plug.

Tightening Torque

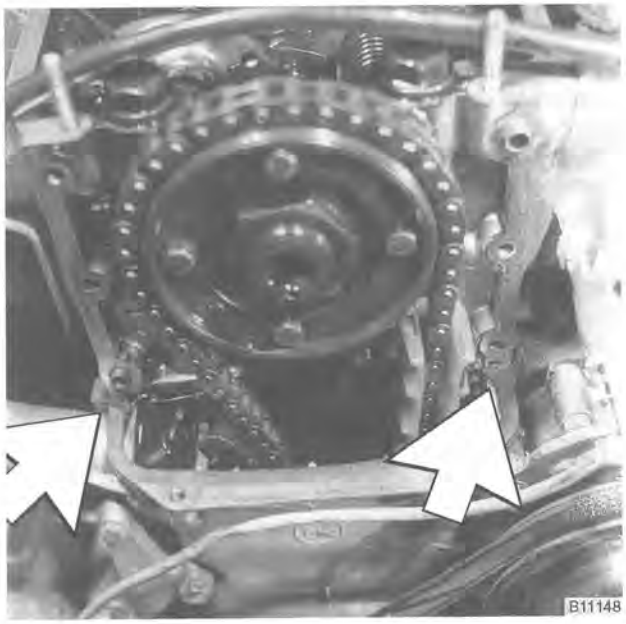
- Camshaft timing chain tensioner
  to front timing chain cover. . . . . 40 Nm (30 ft-lb)

– Install crankshaft hub/vibration damper to crankshaft, while aligning keyway with key. Hold hub stationary and tighten nut.

Tightening Torques

- Crankshaft hub
  to crankshaft . . . . . 440 ± 10 Nm (317 ± 7 ft-lb)
- Vibration damper and pulley
  to crankshaft hub . . . . . 22 ± 2 Nm (16 ± 1 ft-lb)

– Turn engine over two complete revolutions and recheck timing marks.



➤ Apply a light coat of sealer to two upper camshaft timing chain cover gaskets.

- Set gaskets into position on cover.
- Apply a sealer (3-Bond®1207 or equivalent) to each corner of cylinder head/upper timing chain cover surface area (**arrows**).

– Apply a light coat of engine oil to lip of camshaft oil seal in upper timing chain cover. Install cover and hand-tighten mounting bolts. Tighten bolts in stages.

- Upper timing chain cover mounting bolts vary in size.

Tightening Torque

- Front timing chain cover to cylinder head and lower timing chain cover . . . . . .10 Nm (89 in-lb)

– Install cylinder head cover.

Tightening Torque

- Cylinder head cover to cylinder head . . . . . .10 Nm (89 in-lb)

– Install coolant pump pulley.

– Install all engine drive belts. See **020 Maintenance**.

– Install radiator fan, fan shroud and thermostat housing. Refill cooling system. See **170 Radiator and Cooling System**.

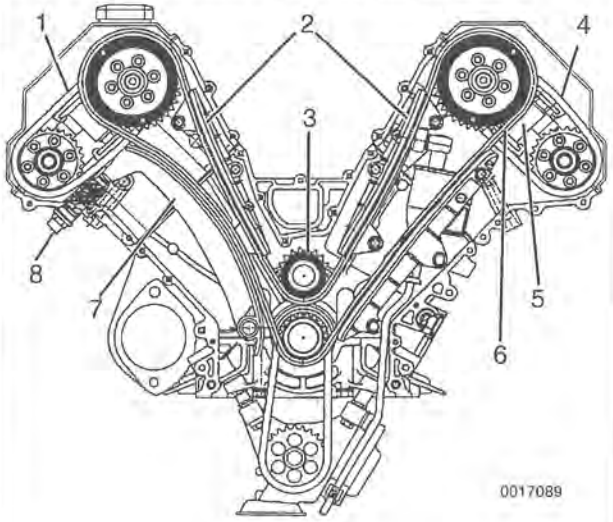
– Install ignition components.

Tightening Torque

- Ignition rotor adaptor to camshaft (install with thread locking compound). . . . 23 ± 1 Nm (17 ± 1 ft-lb)

– Reconnect battery. Check all fluid levels.

M60 camshaft timing chain components



1. Secondary chain, right side
2. Primary chain guides
3. Idler sprocket
4. Secondary chain, left side
5. Secondary chain tensioner
6. Double row primary chain
7. Primary chain tensioner rail
8. Primary chain tensioner

M60 TIMING CHAIN

The M60 engine uses a double-row primary chain to drive the intake camshaft sprockets on each cylinder bank. The exhaust camshaft sprockets are driven by the secondary chains off the intake camshaft sprockets. The chains are tensioned by three hydraulic chain tensioners, one for each chain.

NOTE—
The engine must be removed for M60 timing chain replacement. See **110 Engine Removal and Installation**.

Camshaft timing, checking and adjusting (M60 engine)

CAUTION—
Special BMW service tools are needed for this procedure. Read the procedure through before beginning the job. If the camshafts are not properly timed, the pistons can contact the valves.

– Disconnect negative cable (–) from battery under rear seat.

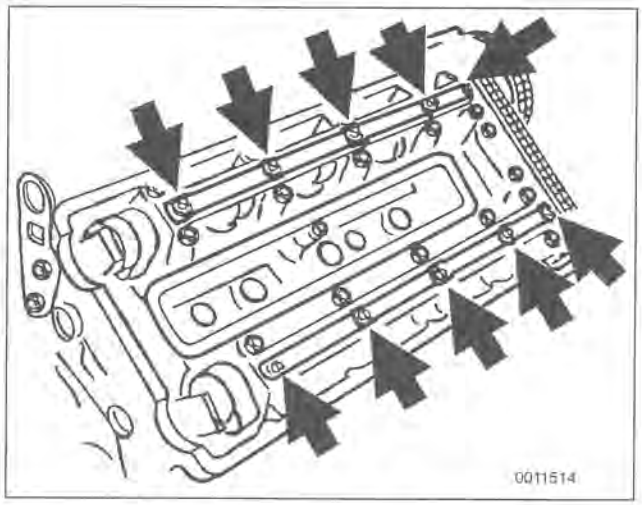
CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Remove spark plugs. See **020 Maintenance**.

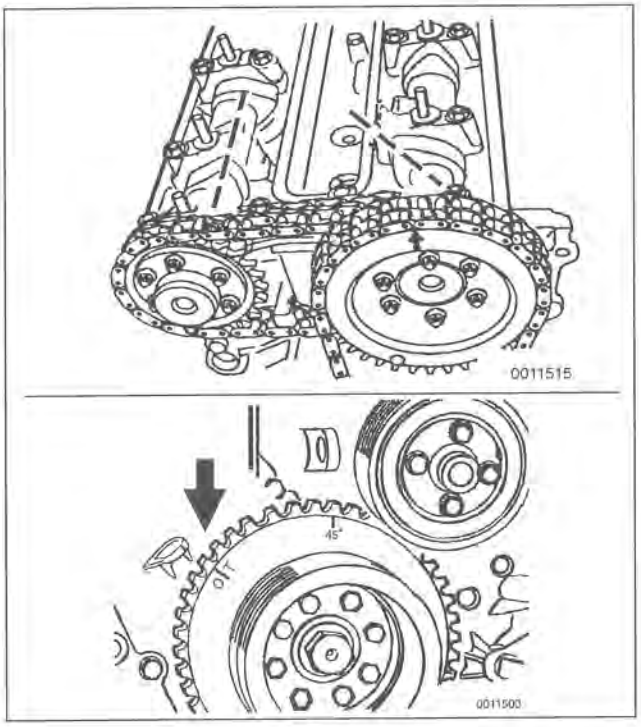
– Remove cylinder head covers from left and right cylinder heads. See **117 Cylinder Head Removal and Installation**.



Unbolt oil pipes from both cylinder heads.

– Remove timing chain tensioner from side of right timing chain cover. Install in its place BMW special tool no. 11 3 390. Thread special tool in until no slack is present in chain, tightening to 1.3 Nm (12 in-lb).

NOTE—
- *BMW special tool no. 11 3 390 is a dummy primary chain tensioner and simulates the function of the hydraulic tensioner.*
- *Assume left/right orientation sitting in driver seat.*



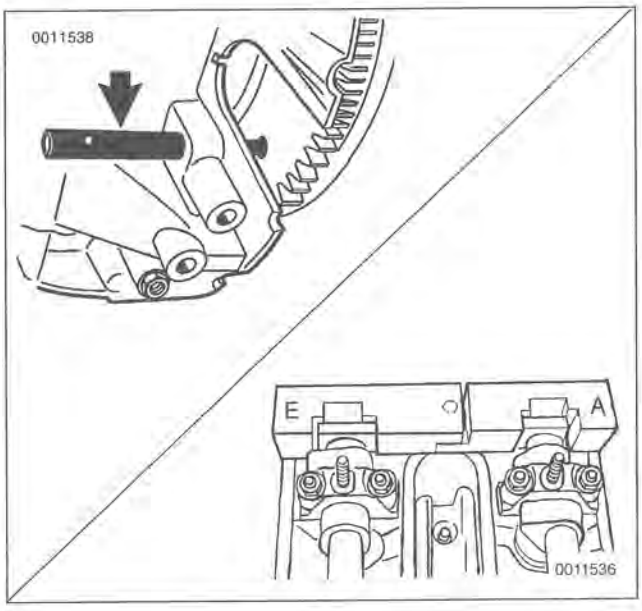
➤ Set cylinder no. 1 to TDC by rotating engine in normal operating direction.

- Arrows on intake camshaft sprockets point up.
- Camshaft lobes at cylinder no. 1 face in.
- 0/T mark on vibration damper aligns with pointer on front timing chain cover.

– Loosen 3 accessible bolts on camshaft sprockets at left and right cylinder heads.

NOTE—
Hold the camshaft stationary (at hex on camshaft) when loosening or tightening the camshaft sprocket mounting bolts.

– Turn engine over one complete revolution. Loosen remaining bolts on camshaft sprockets.



➤ Turn engine over to TDC and lock crankshaft at TDC using BMW special tool no. 11 2 300 (**arrow**).

– Lock camshafts at TDC using BMW special tools 11 2 442/446 (cyl. 5-8) and tools 11 2 445/441 (cyl. 1-4). Install camshaft tools with letter **A** on exhaust side and letter **E** on intake side.

- Using hex casting on camshafts, turn camshafts slightly from side to side to ensure proper fit of camshaft locking tools.

CAUTION—
The camshafts must be locked in the TDC position using BMW special tools at the rear of the camshafts. The arrows on the sprockets should not be used to set the engine at TDC.

– Tighten top three camshaft sprocket bolts using sequence listed.

Tightening Torques

- Camshaft sprocket tightening sequence
  1. exhaust, left cylinder head . . . . . 15 Nm (11 ft-lb)
  2. exhaust, right cylinder head . . . . . 15 Nm (11 ft-lb)
  3. intake, left cylinder head . . . . . 15 Nm (11 ft-lb)
  4. intake, right cylinder head . . . . . 15 Nm (11 ft-lb)

– Remove crankshaft and camshaft locking tools. Turn engine over in normal operating direction one complete revolution. Tighten remaining sprocket mounting bolts using sequence and torques listed earlier.

– Remove dummy chain tensioner and install chain tensioner.

– The remainder of installation is reverse of removal.

Tightening Torques

- Timing chain tensioner to timing chain cover . . . . . 40 Nm (30 ft-lb)
- Camshaft lubrication pipe to camshaft bearing caps . . . . . 10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/ timing chain cover
  M6 . . . . . 10 Nm (89 in-lb)
  M7 . . . . . 15 Nm (11 ft-lb)
- Radiator cooling fan to coolant pump . . . . . 40 Nm (30 ft-lb)
- Spark plug to cylinder head . . . . 23±3 Nm (17±2 ft-lb)

M70 TIMING CHAIN

The M70 engine uses one single-row chain to drive the single camshaft on each bank of cylinders. Two stationary guide rails and one pivoting guide rail with a spring-loaded tensioner are used to keep the chain tensioned.

NOTE—

To replace the M70 timing chain, the engine must be lifted and the oil pan removed. See **119 Lubrication System**.

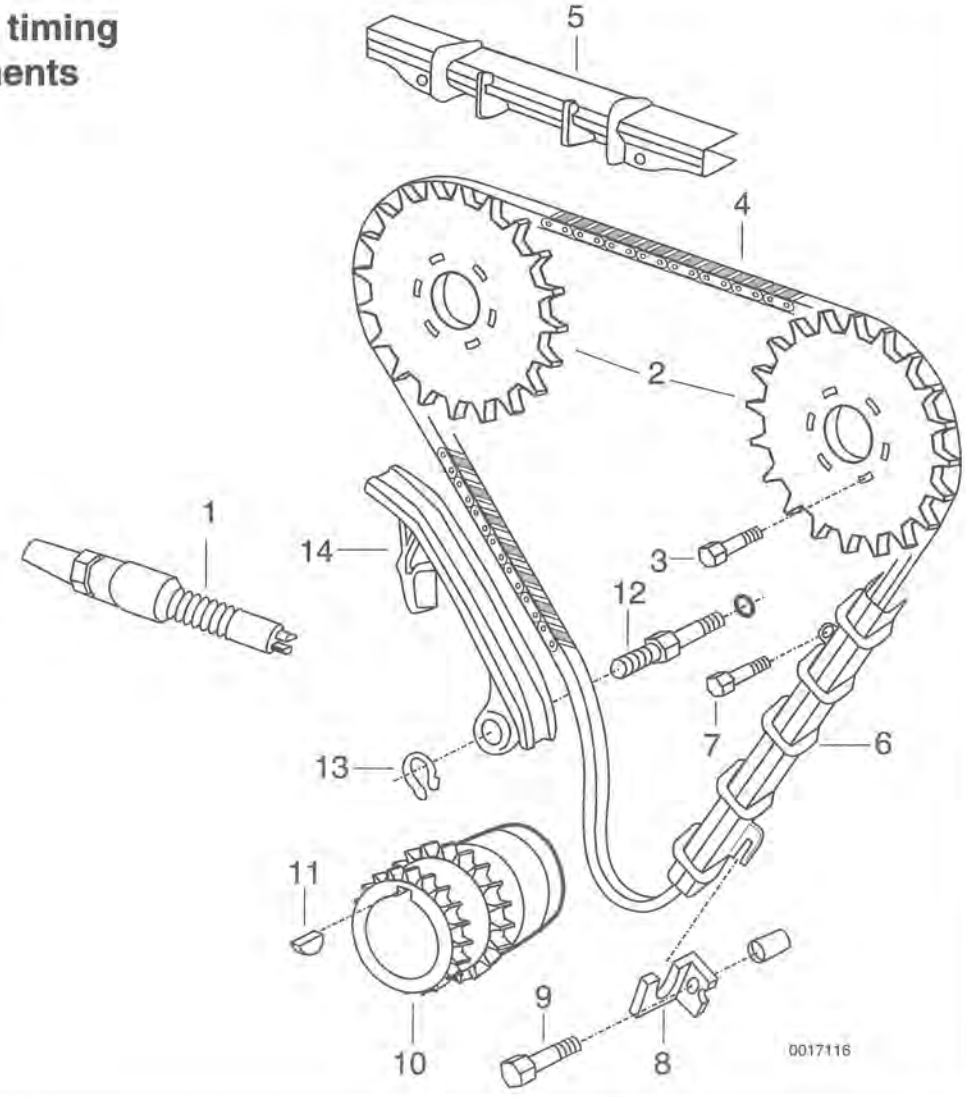
Camshaft timing, checking and adjusting (M70 engine)

CAUTION—

Special BMW service tools are needed for this procedure. Read the procedure through before beginning the job. If the camshafts are not properly timed, the pistons can contact the valves.

M70 camshaft timing chain components

1. Chain tensioner
2. Camshaft sprocket
3. Sprocket bolt
4. Timing chain
5. Top guide rail
6. Left guide rail (will slip up off lower bracket after top bolt is removed)
7. Left guide rail top bolt
8. Left guide rail lower bracket (hidden behind lower timing cover)
9. Left guide rail bracket bolt
10. Crankshaft sprocket
11. Woodruff key
12. Pivoting guide mounting stud
13. Pivoting guide retaining circlip
14. Right pivoting guide rail (with sprocket wheel as of 4/90)



M70 TIMING CHAIN

NOTE—
If the upper timing case cover is removed to check/adjust timing chain, the inner case must also be removed to replace the lower gaskets.

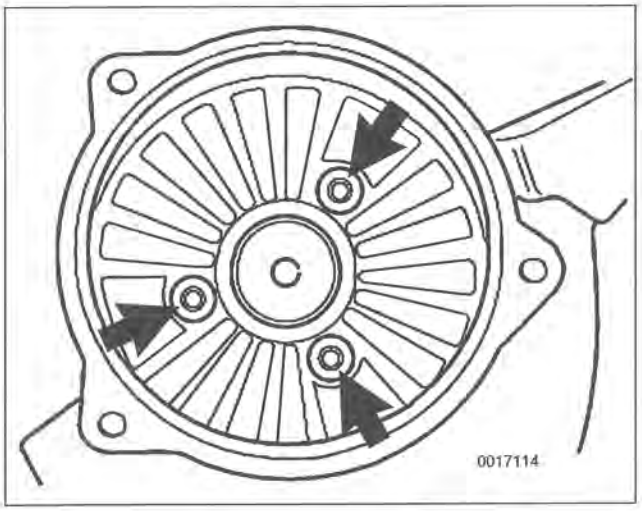
– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove both intake manifolds and cylinder head covers as described in **113 Cylinder Head Removal and Installation**.

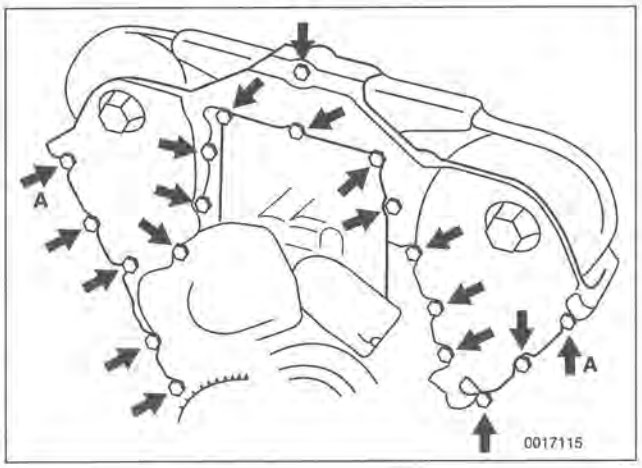
– Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.



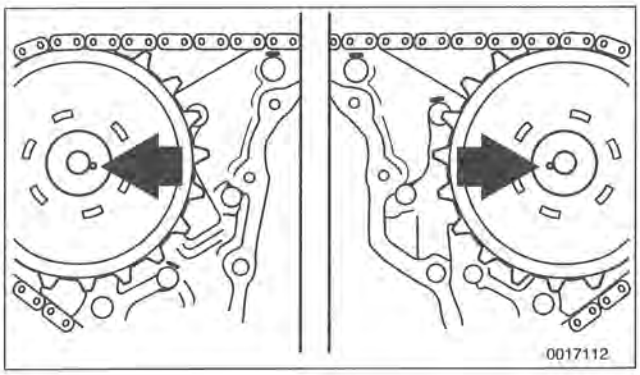
➢ Remove both distributor caps, ignition rotors and rotor adaptors. Remove distributor housing mounting screws (**arrows**) and remove both distributor housings.

– Remove alternator drive belt and tensioner.

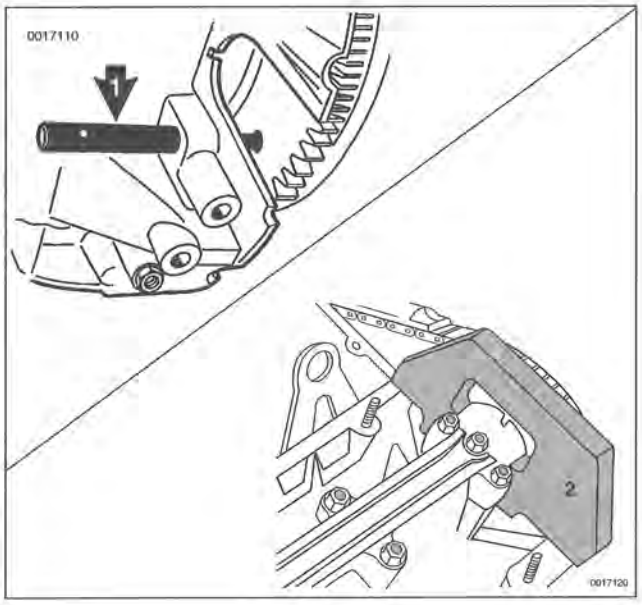


➢ Remove upper timing case cover bolts (**arrows**) and lift off cover.

CAUTION—
*Ensure that locating dowel sleeves at **A** do not fall into timing case.*



➤ Using crankshaft pulley bolt, turn engine over until left and right camshaft sprocket dowel pins (**arrows**) face in with cylinder no. 1 approximately at TDC.



➤ Lock crankshaft at TDC using BMW special tool no. 11 2 300 (**1**).

– Lock camshafts at TDC using BMW special tool 11 3 190 (**2**, one tool per cylinder head).

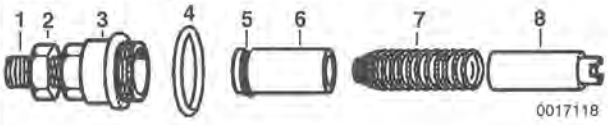
> ***CAUTION—***
> *The camshafts must be locked in the TDC position using BMW special tools. The marks on the sprockets should not be used to set the engine at TDC.*

– Loosen all camshaft sprocket bolts.

➤ Remove top and left chain guide rails and main chain tensioner.

- To reduce spring tension before removing main chain tensioner, remove plastic anti-tamper cap, loosen lock nut, and back off adjusting stud.

M70 timing chain tensioner

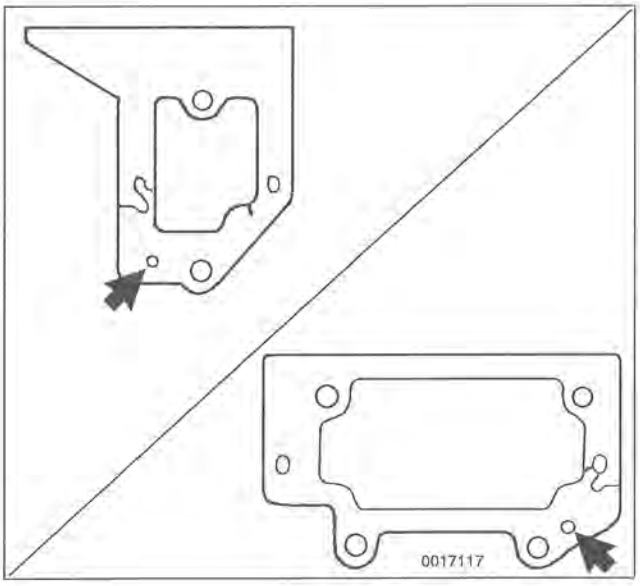


1. Adjusting stud
2. Lock-nut
3. Tensioner sleeve tighten to 40 Nm (30 ft-lb)
4. Gasket (replace)
5. O-ring (replace)
6. Spring seat
7. Tensioner spring (Install with cylindrical section toward chain)
8. Tensioner piston

– Tie chain to camshaft sprockets with wire. Unbolt camshaft chain sprockets and pull forward, keeping chain under tension.

– Unbolt upper timing case and remove.

NOTE —
On M70 engines built up to 8/88, the right camshaft must be removed before the upper timing case can be removed. See **116 Cylinder Head and Valve Train**.



➢ To reinstall, use new gaskets between upper and lower timing case. Match gasket thickness to original using thickness identifying holes in timing case gaskets (**arrows**)

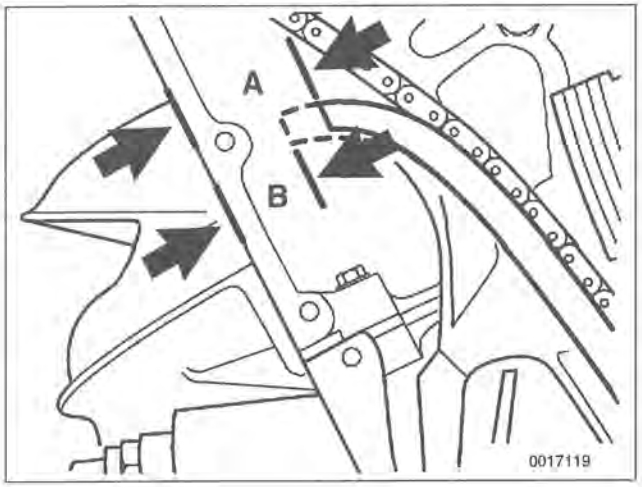
- Use 3-Bond®1207 or equivalent sealing compound to seal corners of mating surfaces.

– Hold timing case in position by tightening bolts to cylinder heads finger tight at first. Tighten bolts to lower timing case first, then bolts to cylinder heads.

– With all chain slack at tensioner side, install camshaft sprockets. Tighten bolt finger tight only. Before installing upper timing case cover or cylinder head covers, set camshaft timing as described below.

– Reinstall chain guides and tensioner. Back off chain tensioner adjusting stud.

NOTE —
- *When reinstalling chain tensioner, make sure slot at end of tensioning piston engages pivoting guide rail correctly.*
- *Drain oil from chamber between sleeve and piston to make tensioner assembly and installation easier.*



With crankshaft and camshafts locked in TDC position, camshaft sprocket bolts loose, and chain tensioner adjusting stud backed off fully, measure chain slack at pivoting rail.

- Push pivoting tensioner rail toward chain and measure dimension **A**.
- Push rail back firmly against spring tension and measure dimension **B**.
- Subtract **B** from **A** and compare to nominal value in table below.
- Screw in tensioner adjusting stud by distance derived from chain slack measurement and tighten lock nut.

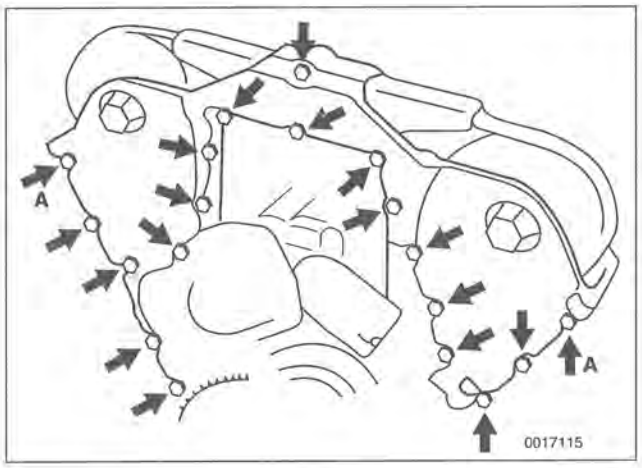
Timing Chain Slack Nominal Values (M70 Engine)

- Pivoting rail without sprocket (to 4/90) . . . . . 6.0 ± 0.5 mm (0.236 ± 0.020 in)
- Pivoting rail with sprocket (from 4/90) . . . . . 5.0 ± 0.5 mm (0.197 ± 0.020 in)

NOTE—

If measured slack exceeds nominal value, inspect timing chain assembly for wear.

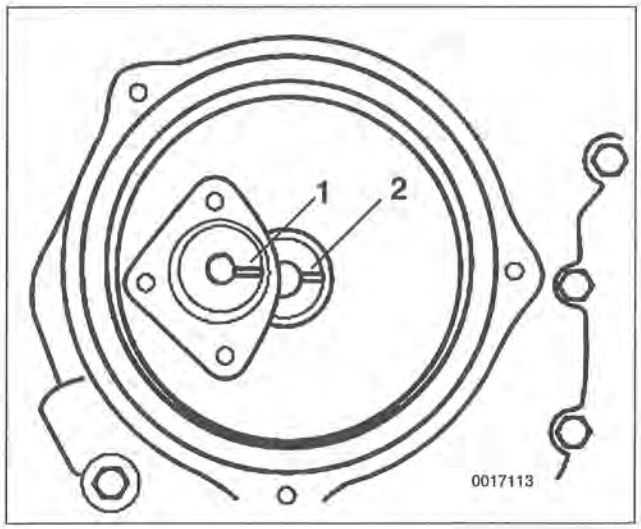
– Tighten all camshaft sprocket bolts, then remove special BMW tools.



Reinstall upper timing case cover and tighten bolts (**arrows**).

CAUTION—

*Ensure that dowel sleeves at **A** do not fall into timing case.*



➢ Be sure to install ignition rotor adaptors correctly.

- Ignition rotor adaptor spline (**1**) should fit recess in camshaft (**2**).

NOTE—

- *Always replace seal at base of distributor housing.*
- *Install distributor housing screws using new copper gaskets.*

– Remainder of reassembly is reverse of disassembly.

Tightening Torques

- Camshaft sprocket to camshaft (M6) . 15 Nm (11 ft-lb)
- Distributor cap to distributor housing . . 4 Nm (35 in-lb)
- Ignition rotor to rotor flange. . . . . 2.8 Nm (25 in-lb)
- Ignition rotor adaptor to camshaft (install with thread locking compound). . . . 23 ± 1 Nm (17 ± 1 ft-lb)
- Timing chain tensioner to cylinder head . . . . . 40 Nm (30 ft-lb)
- Timing case/cover fasteners
  M6. . . . . 10 Nm (89 in-lb)
  M8. . . . . 22 Nm (17 ft-lb)
  M10. . . . . 47 Nm (35 ft-lb)



119 Lubrication System

GENERAL 119-1

TROUBLESHOOTING 119-1
Oil pressure, testing 119-2
Oil pressure warning system, testing 119-2
Oil level sensor, testing 119-3

OIL PAN (M30 ENGINE) 119-5
Oil pan, removing and installing (M30 engine) 119-5

OIL PANS (M60 ENGINE) 119-6
Oil pans, removing and installing (M60 engine) 119-6

OIL PANS (M70 ENGINE) 119-8
Oil pans, removing and installing (M70 engine) 119-8

OIL PUMP 119-11
Oil pump, removing and installing 119-11

TABLE
a. Oil Level Sensor Continuity Test 119-4

GENERAL

Engine oil pressure is generated by a gear-type pump mounted to the bottom of the engine block. On all 7 Series engine variants the oil pump is chain driven by the crankshaft.

The oil pan and the oil pump can be removed with the engine installed, although engine lifting equipment is necessary.

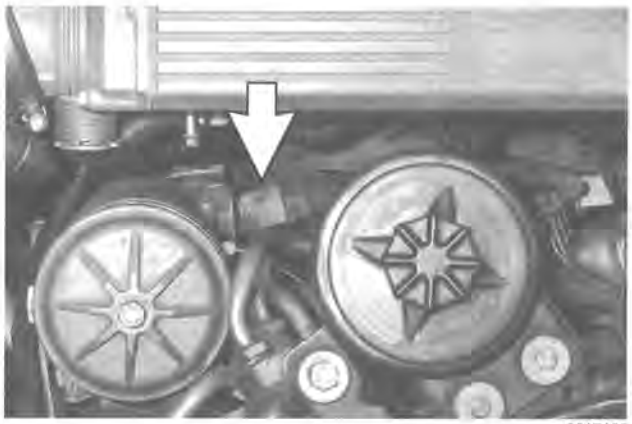
All engines are equipped with an oil pressure warning system and an oil level warning system to help prevent serious engine damage. Other safety features include a filter bypass to guard against bursting the filter due to over pressure and an oil pump pressure relief valve to prevent excessive system pressure.

Oil pan removal procedures in this section are organized according to engine code. If necessary, see **100 Engine–General** for engine code and application information.

NOTE—
Oil change procedure and oil filter replacement are covered in **020 Maintenance.**

TROUBLESHOOTING

The lubrication warning system consists of an oil pressure switch mounted in the oil circuit, an oil level sensor mounted in the oil pan, an instrument panel warning light, and graphic check control displays. The check control display will also warn the driver if either the oil level sensor or the oil pressure sensor are faulty or disconnected.


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CAUTION—
If the check control displays ENGINE OIL PRESS after the engine is started, or if the red oil pressure warning light comes on or flashes on while driving, always assume that the oil pressure is low.

Oil pressure, testing

◁ Oil pressure switch location (**arrow**) on M70 engine. Switch locations vary depending on engine.

- Disconnect harness connector from oil pressure switch. Thoroughly clean around switch and then remove it. Install in its place an oil pressure gauge.

Oil pressure switch locations

- 735i/iL, M30 engine . . .rear corner of engine, left side
- 740i/iL, M60 engine . . . . . .on oil filter housing
- 750iL, M70 engine . . . . . .on oil filter housing

CAUTION—
Some oil may drain out as the oil pressure switch is removed. Use a rag to soak up any spills and install the gauge as quickly as possible.

– With gauge installed, start engine and check oil pressure. Oil pressure specifications are listed below.

NOTE—
For the most accurate test results, the engine oil should be new and of the correct grade.

Oil Pressure Specifications

- At idle (engine warm) . . . . . 0.5 bar (7 psi)
- At maximum engine speed (engine warm). . . . . 5.0 bar (73.5 psi)

– If testing shows low oil pressure, one or more of the following conditions may be indicated:

- Worn or faulty oil pump
- Worn or faulty bearings
- Severe engine wear.

Any of these conditions indicate the need for major repairs.

Oil pressure warning system, testing

When the ignition is turned on, the oil pressure warning light comes on. When the engine is started and the oil pressure rises, the oil pressure switch opens and the warning light goes out.

NOTE—
Make sure the oil level is correct before doing the tests listed below.

– Turn ignition switch on. The warning light on instrument panel should light up. Remove connector from oil pressure switch. The light should go out and check control should display "OIL PRESS SENSOR".

NOTE—
If the light does not go out, the wiring to the switch is most likely grounded somewhere between the switch terminal and the warning light. See **600 Electrical System–General** *for electrical wiring troubleshooting information.*

– If warning light does not light when ignition is on, remove connector from oil pressure switch and use a jumper wire to ground connector terminal to a clean metal surface.

NOTE—
If the warning light comes on, check the switch as described in the next step. If the warning light does not come on, the wiring circuit to the dash light or the light itself is faulty.

– To test switch, connect an ohmmeter between terminal in switch body and ground. With engine off, there should be continuity. With engine running, oil pressure should open switch and there should be no continuity. Replace a faulty switch.

WARNING—
Keep in mind that low oil pressure may be preventing the switch from turning the light out. If the light remains on while the engine is running, check the oil pressure as described above. Do not operate the engine to drive the car until the problem is corrected. The engine may be severely damaged.

Tightening Torques

- Oil pressure switch (lubricate threads)
  M30 engine . . . . . 37 Nm (27 ft-lb)
  M60/M70 engine . . . . . 27 Nm (20 ft-lb)

Oil level sensor, testing

The oil level sensor is similar in operation to the fuel level sensor in the fuel tank. When the oil level falls below a safe level, a warning is displayed in the check control module. Check that the oil level is correct before testing the sensor.

The oil level sensor is mounted in the oil pan and contains two switches. The static switch senses the oil level when the engine is off and the ignition is on and the dynamic switch senses the level when the engine is running.

– Check that oil level is correct on dipstick.



With ignition key off, separate main engine harness connector.

- On 735i models, engine connector is near left front strut tower.
- On 740i/iL models, connector is on right cylinder head, beneath top engine cover.
- On 750iL models, connectors are near left front strut tower.



Blue/yellow wire (**1**) is for dynamic switch and blue/white wire (**2**) is for static switch.

- Working at side of connector leading to sensor, make resistance checks given below. If any faults are found, sensor should be replaced.

Table a. Oil Level Sensor Continuity Test

Test terminals	Test results
Blue/yellow wire and ground (static switch)	
correct oil level	1k ± 1% ohms (switch open)
low oil level	0-0.2 ohm (switch closed)
Blue/white wire and ground (dynamic switch)	
low oil level	No continuity (switch open)

NOTE—

- *Use a new O-ring when replacing the oil level sensor.*
- *On models with the oil level sensor mounted in the bottom of the oil pan, drain the engine oil before removing the sensor.*

OIL PAN (M30 ENGINE)

On the M30 engine the oil pan can be removed with the engine installed, but the procedure requires lifting the engine far enough to remove the pan.

Oil pan, removing and installing (M30 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Drain engine oil as described in **020 Maintenance.**

– Disconnect oil level sensor harness connector.

– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

> ***NOTE—***
> *The radiator cooling fan nut (32 mm wrench) has left hand threads.*

– Remove air cleaner housing from car.

– Remove coolant expansion tank mounting bolts. Disconnect overflow hose and coolant level sensor harness connector from expansion tank.

– On cars with automatic transmission, remove brackets that hold ATF cooler lines to oil pan and cylinder block.

– Working from below, remove engine splash shield.



– Remove bellhousing reinforcement plate by removing mounting bolts (**arrows**).

– Without disconnecting any fluid lines, remove power steering pump with bracket from engine. Support pump from body using stiff wire.

– Disconnect exhaust pipe-to-transmission support bracket.

– Using an engine lifting device at front and rear engine lifting points, raise engine just until weight of engine is supported.

– Working from below, remove engine mount retaining nuts and ground strap (if applicable). Then raise engine as much as possible.

– Remove oil pan retaining bolts and lower oil pan.

> ***WARNING—***
> *If the oil pan does not separate easily from the engine cylinder block, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.*

– Rotate crankshaft so that no. 6 connecting rod journal is at its highest point (TDC) and withdraw oil pan. Rotate crankshaft as pan is being removed, if necessary.

– Installation is reverse of removal.

- Thoroughly clean all old gasket material from mating surfaces.
- Coat mating surfaces on timing case cover and end cover with a sealing compound.
- Install oil pan using a new gasket.
- Tighten oil pan mounting bolts evenly in stages.
- Reconnect oil level sensor harness connector.
- Fill engine with oil as described in **020 Maintenance**.

Tightening Torques

- Motor mount bracket to motor mount. . . . . 45 Nm (33 ft-lb)
- Oil pan to engine block . . . . . 9 - 11 Nm (6.5 - 8 ft-lb)

OIL PANS (M60 ENGINE)

There is an upper and a lower oil pan on the M60 engine. The oil pans can be removed with the engine installed, but the procedure requires lifting the engine far enough to remove the pans.

Oil pans, removing and installing (M60 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Loosen oil filter cover at top of oil filter housing. Drain engine oil.

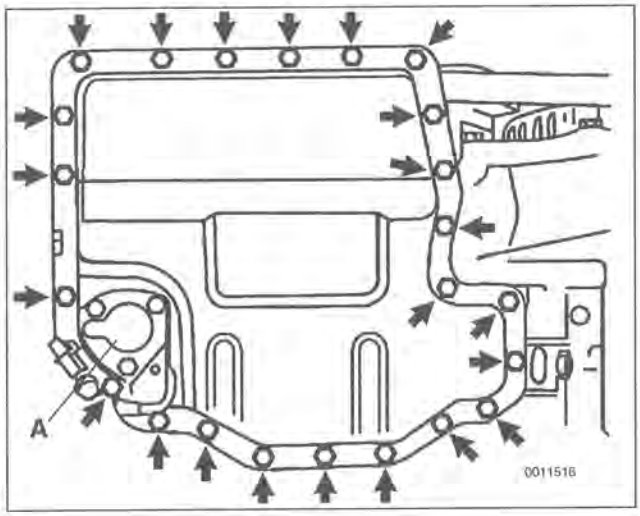
– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left hand threads.

– Remove oil dipstick guide tube completely.

NOTE—
The guide tube is sealed in the oil pan using an O-ring. Check that the O-ring comes out with the tube. Use a new O-ring when installing the tube. Also note the "top" marking on the guide tube clamping bracket during installation.

CAUTION—
Do not reuse the nut at the guide tube clamping bracket. It is a single-use nut and should be replaced.



– Remove engine and transmission splash shields from beneath car.

– Disconnect harness connector at oil level sensor.

◀ Remove oil pan lower section mounting bolts (**arrows**).

- Remove oil pan lower section.
- Oil level sensor is at **A**.

– Remove engine drive belt. See **020 Maintenance**.

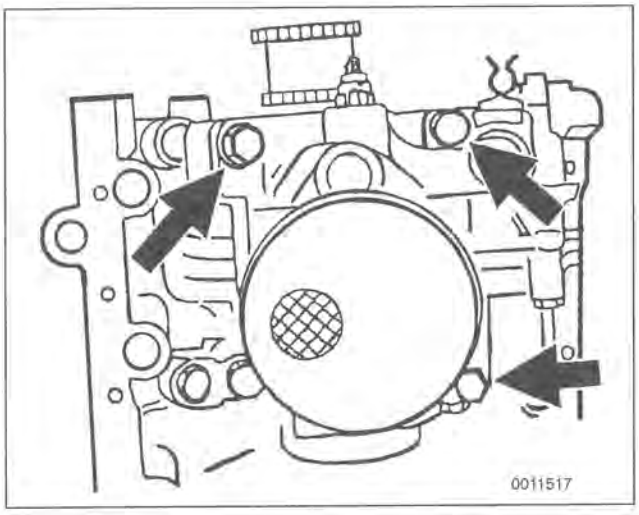
– Without disconnecting any fluid lines, remove power steering pump and its bracket from engine block. Support pump from body using stiff wire.

– Using an engine lifting device at front and rear engine lifting points, raise engine slightly and support it.

– Remove engine mount retaining nuts and ground strap from left and right mounts.

– Remove ATF cooler line brackets from oil pan and cylinder block.

– Raise engine off mounts as much as possible with lifting equipment.



◀ Unbolt oil pump mounting fasteners (**arrows**). Oil pump drive sprocket shown removed.

- Remove oil pump and pipes as described in **Oil pump, removal and installation**.

CAUTION—
Do not reuse the oil pump mounting nuts. They are single-use nuts and should be replaced.

– Remove oil return line fitting (banjo bolt) at top of oil pan.

– Remove mounting bolts from upper oil pan and remove pan.

> ***CAUTION—***
> *If the oil pan does not separate easily from the cylinder block, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.*

– Installation is reverse of removal.

NOTE—
When mounting the oil pans, note that the longer M6 bolts (20 mm) are used in the upper pan and the slightly shorter M6 bolts (18 mm) are used in the lower pan.

- When installing upper oil pan, apply a bead of non-hardening sealing compound (3-Bond®1207B or equivalent) to front and rear end cover seam areas on block.
- Install oil pump pipes using new O-rings.
- Install oil pump and tension drive chain as described below under **Oil pump, removal and installation.**
- Reconnect oil level sensor harness connector.
- Use a new O-ring when installing dipstick guide tube.
- Reinstall ground wire at engine mount.
- Fill engine with oil as described in **020 Maintenance.**

Tightening Torques

- Engine mount to mount carrier . . . . . 47 Nm (35 ft-lb)
- Lower oil pan to upper oil pan (M6) . . 10 Nm (89 in-lb)
- Oil pan to engine block (M6) . . . . . 10 Nm (89 in-lb)
- Oil pump sprocket to pump shaft . . . . 47 Nm (35 ft-lb)
- Oil pump to engine block (use new nuts) . . . . . 22 Nm (17 ft-lb)
- Oil return line to oil pan (banjo bolt) . . . . . 30 Nm (22 ft-lb)

OIL PANS (M70 ENGINE)

There is an upper and a lower oil pan on the M70 engine. The oil pans can be removed with the engine installed, but the procedure requires removing the transmission as well as raising the engine far enough to remove the pans from the rear.

Oil pans, removing and installing (M70 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance.**

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left hand threads.

– Remove engine and transmission splash shields from beneath car.

– Remove transmission as described in **240 Automatic Transmission**.

– Loosen oil filter cover at top of oil filter housing. Drain engine oil.


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➢ Working underneath car, disconnect oil level sensor harness plug (**arrow**) at right side of pan.

– Remove lower oil pan bolts, then remove lower pan.

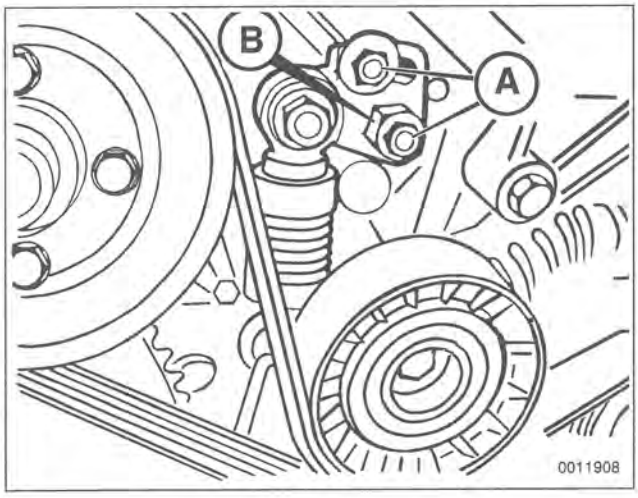
– Unbolt oil pump as described in **Oil pump, removal and installation**.

CAUTION—
Do not reuse the oil pump mounting nuts. They are single-use nuts and should be replaced.

– Remove top engine plastic cover.

– Remove windshield washer fluid tank after detaching harness connector and fluid hose.

– Detach coolant expansion tank from bulkhead and lift up slightly to allow engine to be raised. Detach hoses and harness connector as necessary.



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➢ Loosen mounting nuts on belt tensioner (**A**). Use an open end wrench to rotate tensioner hex (**B**) counterclockwise and remove belt. Remove belt tensioner from engine.

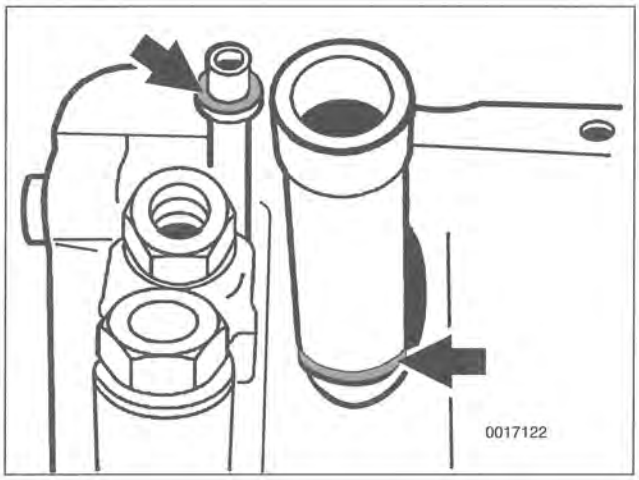
– Remove oil dipstick guide-tube.

– Detach oil filter housing supply and return hoses at oil pan.



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- Turn engine to TDC so that 0/T mark on harmonic balancer (**arrow**) aligns with mark on engine.
- Unbolt flywheel.
- Detach oil pipe from self-levelling suspension (LAD) system pump and remove pump bracket from oil pan, if applicable.



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- Sealing O-rings on oil pump pipes (**arrows**). Note O-rings in oil pipes.
  - Use hair-dryer to soften sealing O-rings.
  - Remove oil pump pipes from upper oil pan.
- Remove oil pump mounting bracket at crankshaft bearing journal.
- Detach left and right engine mounts from suspension cross-member. Detach grounding strap as necessary.
- Using a lifting device at front and rear engine lifting points, raise engine off mounts as much as possible until upper oil pan can be removed from rear.
- Remove upper oil pan bolts.
- Installation is reverse of removal.
  - When installing upper oil pan, apply bead of non-hardening sealing compound (3-Bond®1207B or equivalent) to front and rear end cover seam areas on block.
  - Install oil pump pipes using new O-rings. Make sure O-rings do not snag or tear on sharp oil pan edges.
  - Install oil pump and tension drive chain as described below under **Oil pump, removal and installation**.
  - Reconnect oil level sensor harness connector.
  - Use a new O-ring when installing dipstick guide tube.
  - Reinstall ground wire at engine mount.
  - Fill engine with oil as described in **020 Maintenance.**
  - Bleed self-levelling suspension (LAD) system as described in **330 Rear Suspension**.

Tightening Torques

- Drive belt tensioner to engine block . . 24 Nm (17 ft-lb)
- Engine mount to mount carrier . . . . . 45 Nm (33 ft-lb)
- Flywheel to crankshaft . . . . . 100 Nm (72 ft-lb)
- Lower oil pan to upper oil pan (M6) . . 10 Nm (89 in-lb)
- Oil drain plug to lower oil pan (M12) . . 33 Nm (24 ft-lb)
- Oil line to lower oil pan (Banjo bolt) . . 30 Nm (22 ft-lb)
- Oil pan to engine block (M6) . . . . . 10 Nm (89 in-lb)
- Oil pump bracket to crankshaft journal 34 Nm (25 ft-lb)
- Oil pump sprocket to pump shaft . . . . 47 Nm (35 ft-lb)
- Oil pump to engine block (use new nuts) . . . . . 22 Nm (17 ft-lb)
- Oil return line to oil pan (banjo bolt) . . . . . 30 Nm (22 ft-lb)

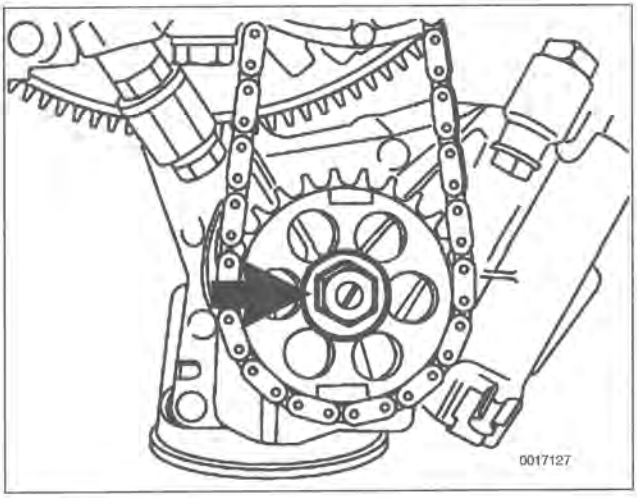
OIL PUMP

The oil pump is mounted to the bottom of the cylinder block inside the engine oil pan. When the engine is running, oil is drawn from the oil pan by the oil pump's pickup tube and circulated through the engine.

Oil pump, removing and installing

– Remove oil pan as described earlier.

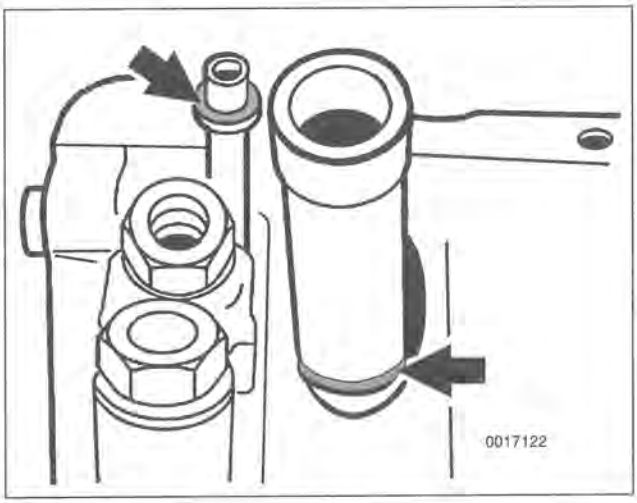
NOTE—
When working on the M60 or the M70 engine, just remove the lower oil pan.



Remove oil pump sprocket mounting nut (**arrow**). Lift sprocket off pump together with drive chain.

– Remove oil pump mounting fasteners and withdraw pump. Note any spacers between pump and engine block.

CAUTION—
Do not reuse the oil pump mounting nuts. They are single-use nuts and should be replaced.

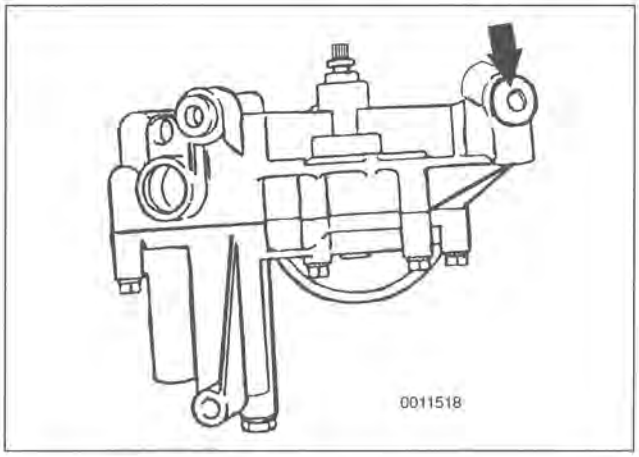


– Remove two oil pipes from engine block.

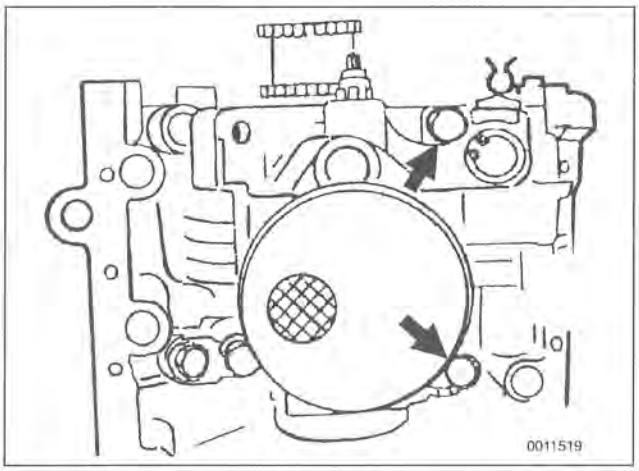
– Remove oil pump cover and check for wear or scoring. Spin oil pump shaft and check that gears turn smoothly. If gears spin with difficulty or any wear is present, pump should be replaced.

Installation is reverse of removal, noting the following:

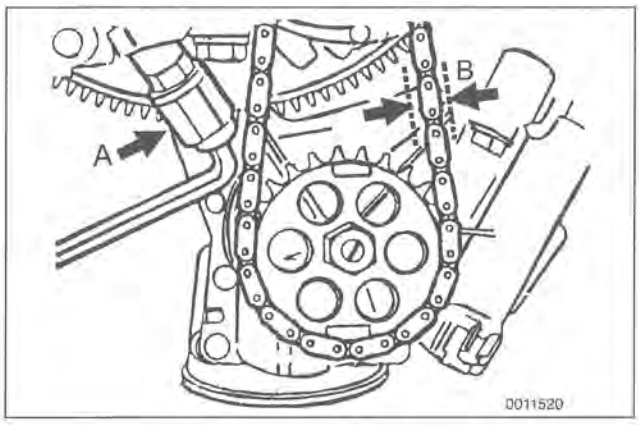
- Align sprocket splines to oil pump shaft splines before tightening sprocket nut.
- Before installing pump, install oil pipes into block using new O-rings (**arrows**).



➢ Turn threaded spacer (**arrow**) on pump fully to stop.



➢ Install oil pump and tighten two nuts on left side of pump (**arrows**).



➢ Adjust chain slack by turning threaded spacer (**A**) using hex wrench.

Oil Pump Chain Adjustment

- Slack **B** . . . . . 10 ± 2 mm (0.394 ± 0.079 in.)

– Install and tighten final mounting bolt.

– Remainder of installation is reverse of removal.

Tightening Torques

- Oil pump cover to oil pump (M6) . . . . . 10 Nm (89 in-lb)
- Oil pump to engine block (use new nuts) . . . . . 22 Nm (16 ft-lb)
- Oil pump sprocket to oil pump shaft
  M30 engine (M10x1) 25 Nm (18 ft-lb)
  M60/M70 engine (M10) . . . . . 47 Nm (35 ft-lb)



120 Ignition System

GENERAL 120-1
Disabling ignition system 120-2
Warnings and cautions 120-3

TROUBLESHOOTING 120-4
Basic troubleshooting principles 120-4
Checking for spark (M30/M70 engine only) . . 120-5

IGNITION SYSTEM SERVICE 120-6
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a. Ignition Coil Diagnostics 120-5
b. Ignition System Resistance Specifications (M30/M70 Engine) 120-7
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GENERAL

This repair group covers troubleshooting and testing of the ignition specific components of the DME engine management system. Additional DME troubleshooting and testing is covered in **130 Fuel Injection**.

The DME engine management system (also known as Motronic) controls both the fuel and the ignition functions via an electronic control module (ECM). Various versions of DME are used on the cars covered by this manual.

NOTE—

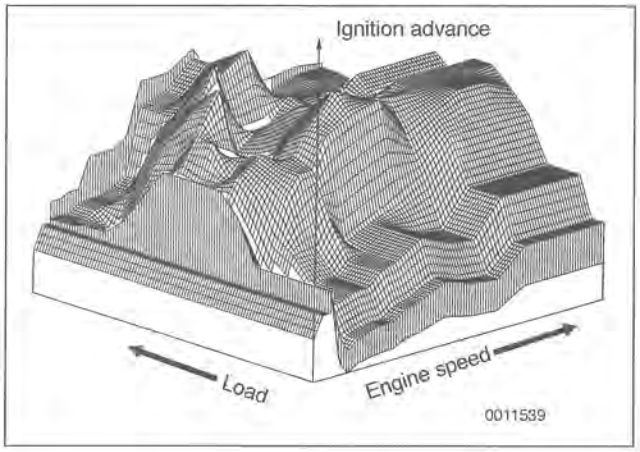
- *The M70 (V12) engine uses two separate engine management systems. This includes two DME modules, two mass air flow sensors, two oxygen sensors, two crankshaft position sensors, etc. In essence, the V12 engine is managed as two 6-cylinder engines.*
- *Spark plug replacement is covered in* **020 Maintenance**.
- *Information in this repair group labeled "Motronic" or "DME" applies to all versions, unless specifically noted otherwise.*

DME Engine Management Systems

- 735i/iL (M30 engine) . . . . . DME 1.3
- 740i/iL (M60 engine) . . . . . DME 3.3
- 750iL (M70 engine)
  1988-1990 . . . . . DME 1.2
  1991-1994 . . . . . DME 1.7

Ignition timing is electronically controlled and not adjustable. The DME control module uses engine load, engine speed,

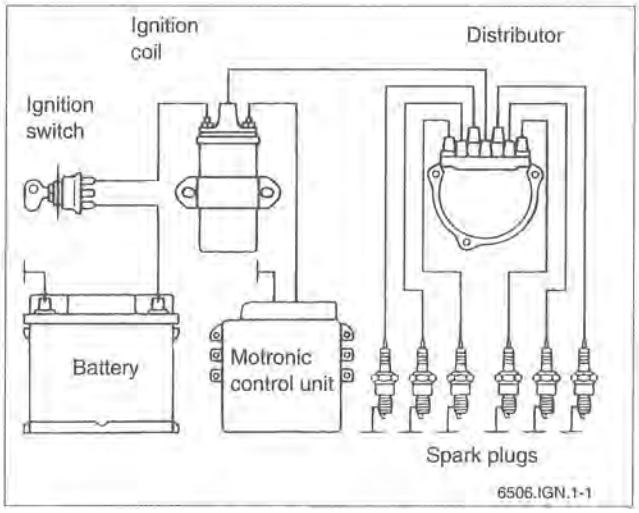
coolant temperature, and intake air temperature as the basic inputs for timing control. On cars with DME 3.3 (M60 engine), knock detection is also an input to the DME control module.



Motronic ignition characteristic map.

The initial ignition point is determined by the crankshaft position/rpm sensor during cranking. Once the engine is running, timing is continually adjusted based on operating conditions. A DME ignition characteristic map is digitally stored in the Motronic control module.

> ***WARNING—***
> *The ignition system is a high-energy system operating in a dangerous voltage range that could prove to be fatal if exposed terminals or live parts are contacted. Use extreme caution when working on a car with the ignition on or the engine running.*



Distributor ignition system (DME 1.3 system).

M30 and M70 engines use a distributor ignition system. A distributor cap is mounted to the front of each cylinder head. The ignition rotor is driven directly off the front of each camshaft. The only function the distributor serves is to distribute high voltage to the spark plugs. There are no adjustments that can be made.

On M60 engine, a direct ignition system is used—there is no distributor cap or ignition rotor. Individual coils are mounted directly above each spark plug. Each coil can be selectively controlled by the DME control module on a cylinder-by-cylinder basis.

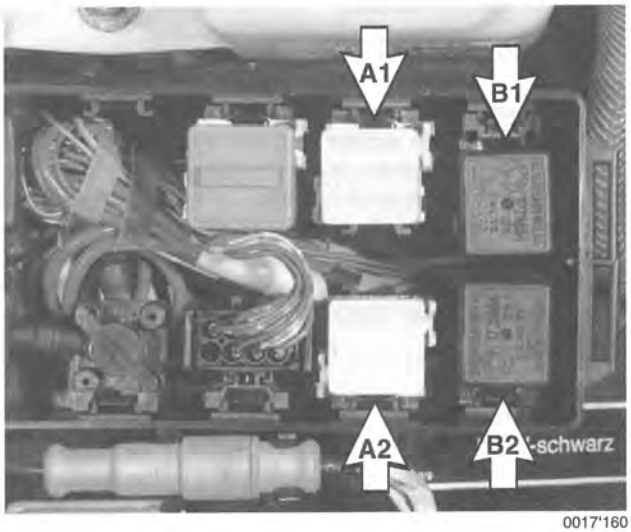
Disabling ignition system

The ignition system operates in a lethal voltage range and should therefore be disabled any time service or repair work is being done on the engine that requires the ignition to be switched on.



Main DME relay (**A**) and fuel pump relay (**B**) in right rear of engine compartment (E-Box). M30 engine shown. Relay positions on M60 engine are similar.

- The DME engine management system can be disabled by removing the DME main relay. Relays locations vary depending on engine application.



Main DME relays (**A1**, **A2**) and fuel pump relays (**B1**, **B2**) in auxiliary relay panel II, ahead of right front strut tower, in 750iL.

Warnings and cautions

The DME system contains sensitive electronic components. To protect the system and for general safety, the following warnings and cautions should be observed during ignition system troubleshooting, maintenance, or repair work.

WARNING—

- *Do not touch or disconnect any of the high tension cables at the coil, distributor, or spark plugs while the engine is running or being cranked by the starter. Fatal voltages are present.*
- *Before operating the starter without starting the engine (for example when making a compression test) always disable the ignition. See* **Disabling Ignition System**.

CAUTION—

- *Connect or disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is off. Switch multimeter functions or measurement ranges only with the test probes disconnected.*
- *On M30 or M70 engines, do not disconnect terminal 4 (center terminal) from the coil or remove the distributor cap to disable the ignition.*
- *Do not disconnect the battery while the engine is running.*
- *Many of the tests of ignition system components require the use of high-impedance test equipment to prevent damage to the electrical components. A high impedance digital multimeter should be used for all voltage and resistance tests. An LED test light should be used in place of an incandescent-type test lamp.*
- *Do not connect test instruments with a 12-volt supply to terminal 15 (+) of the ignition coil. The voltage backflow can damage the DME control module. In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument's manufacturer.*

TROUBLESHOOTING

Poor driveability may have a variety of causes. The fault may lie with the ignition system, the fuel system, parts of the emission control system, or a combination of the three. Because of the interrelated functions of these systems and their effects on each other, it is often difficult to know where to begin looking for problems. For this reason, effective troubleshooting should always begin with an interrogation of the On-Board Diagnostic (OBD) system. See **100 Engine–General**.

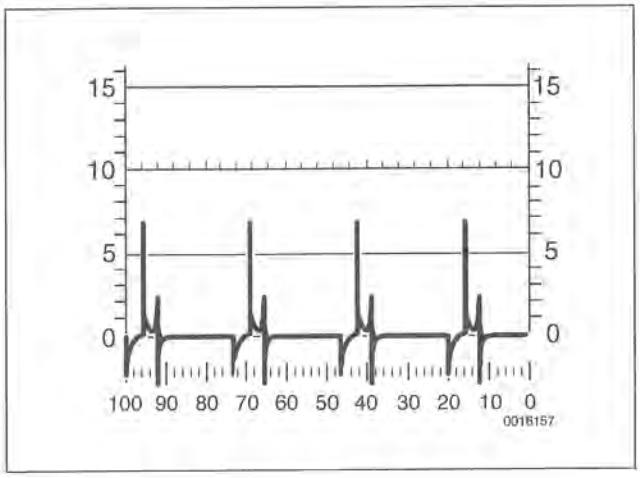
Basic troubleshooting principles

An engine that starts and runs indicates that the ignition system is fundamentally working—delivering voltage to the spark plugs. A hard-starting or poor-running engine, however, may indicate a problem with how well the spark is delivered. Faulty or worn ignition components, such as old spark plugs, may be the cause of reduced spark intensity and inefficient combustion.

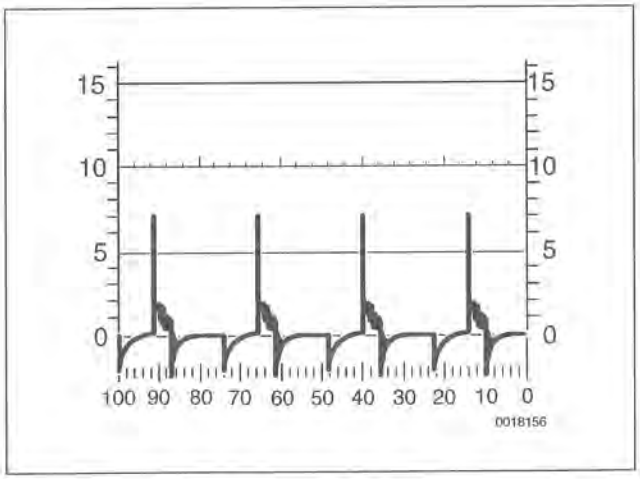
WARNING—

Inefficient combustion (rich air/fuel mixture) can cause the catalytic converter to overheat and plug. An overheated catalytic converter can also be a fire hazard.

— The most effective way to diagnose a faulty coil on a car that is running is to use an oscilloscope to analyze spark quality.



➢ Scope trace at idle (4-cylinder engine shown–voltage spike values are lower than actual).



➢ Scope trace at elevated engine speed (approx. 2,000 rpm).

– **Table a** lists common ignition coil voltage faults and the related cause.

NOTE—

Note the length of sparking period and the up-down voltage attenuations. A short sparking period and/or an irregular/low voltage attenuations usually indicates a faulty coil.

Table a. Ignition Coil Diagnostics

	Ignition voltage low	Ignition voltage high
Spark plug electrode gap	too small	too big
Spark plug electrode condition	new/correct	worn/burnt
Spark plug electrode temperature	too high	too low
Engine compression	too low	too high
Spark plug wire(s)	—	faulty
Fuel air mixture	correct	too lean

Checking for spark (M30/M70 engine only)

On engines with distributor ignition, the most fundamental step in troubleshooting a no-start condition is to determine if the spark plugs are making spark. The battery should be fully charged when making the test.

NOTE—

On M60 engine with individual coils, checking for spark is difficult. Try removing the plugs and inspecting for differences between them. Note that late DME systems, the fuel injector will be electrically disabled if a faulty coil is detected.

– Turn ignition off. Remove connector from spark plug. Connect plug wire to known good spark plug, preferably a new plug.

> ***WARNING —***
> *Do not hold the spark plug or its connector, even if using insulated pliers. The ignition system is a high-energy system operating in a dangerous voltage range which could prove to be fatal if exposed terminals or live parts are contacted.*

– Position plug so that outer electrode is grounded on engine.

> ***CAUTION —***
> *Any test set-up other than the one described above may cause damage or inconclusive tests.*

– While a helper briefly actuates starter, look and/or listen for spark.

NOTE —

- *On M70 engine, be sure to check the spark on both sides of the engine. The M70 engine uses two independent DME systems, one for each bank of cylinders.*
- *A bright blue spark indicates a good spark. A yellow-orange spark indicates a weak spark. Test the coil, the spark plug wires, the distributor cap and rotor and replace any faulty components found (where applicable). If there is no spark, begin by testing the crankshaft position/rpm sensor.*

> ***WARNING —***
> *If ignition system failure is not the problem, the engine may start during this test. Be prepared to turn off the ignition immediately. Running the engine with a spark plug wire disconnected may damage the catalytic converter.*

IGNITION SYSTEM SERVICE

Ignition components, testing (M30/M70 engine)

The following procedures checks the ignition coil(s), the distributor caps, and the rotor(s) on M30 and M70 engines.

◄ Connect a voltmeter between terminal **15** (+) of ignition coil and ground. Turn ignition on and check for voltage.

- If battery voltage is not present, check wire between terminal 15 and ignition switch. See **Electrical Wiring Diagrams**.

> ***CAUTION —***
> *The wiring to terminal 15 (+) of the coil (via the ignition switch) is not fused. Use care when testing this circuit.*

– Label and remove wiring from coil. Use a digital multimeter to test coil primary and secondary circuits. Resistance values are listed in **Table b**.

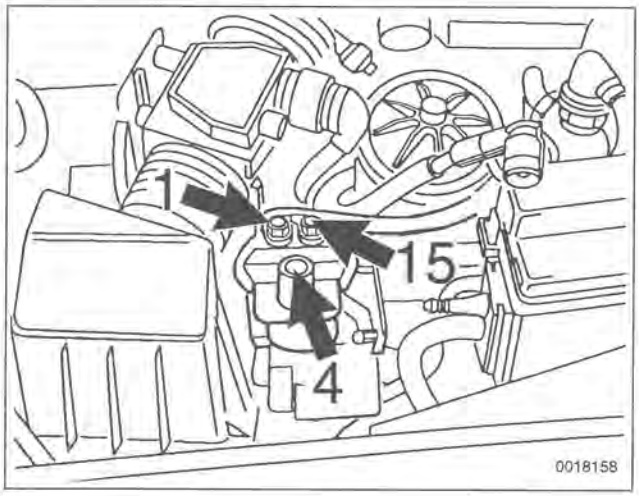


Table b. Ignition System Resistance Specifications (M30/M70 engine)

Components	Terminals	Resistance
Coil primary		
Coil code no. 2051118335	**1** (–) and **15** (+)	0.50 Ω
Coil code no. 20510171101	**1** (–) and **15** (+)	0.37 Ω
Coil secondary		
Coil code no. 2051118335	**15** (+) and **4** (ctr.)	6.0 k Ω
Coil code no. 20510171101	**15** (+) and **4** (ctr.)	9.0 k Ω
Spark plug ends	–	5.0 ± 10% k Ω
Shielded plugs	–	1.0 ± 20% k Ω
Spark plug wires	–	0 Ω (approx.)
Rotor	–	1.1 ± 10% k Ω

NOTE—

Note that two types of coils are installed, depending on model year. Identify the coil code number on the coil when making the tests.

- Inspect coil housing for hairline cracks or leaks. Replace the coil if any faults are found.

- Check resistance of spark plug end connectors and individual wires. Wires or connectors with high resistance should be replaced. Check for corrosion at connections. Resistance values are listed in **Table b**.

- Remove distributor cap and check condition of ignition rotor. See **Table b** for rotor resistance values.

- Check resistance of removed distributor cap between tower and matching contact inside cap. Resistance should be nearly zero ohms.

- Replace any faulty components found.

NOTE—

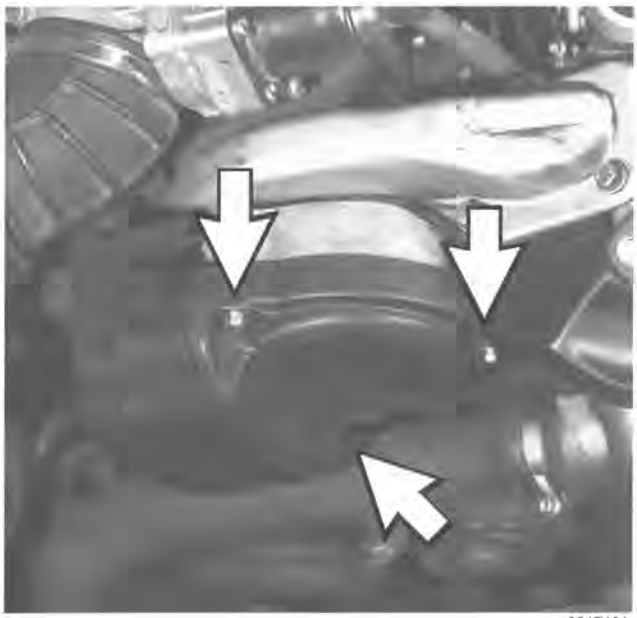
- *On models with DME 1.3, a failed engine control module can sometimes damage the ignition coil. Be sure to check the ignition coil anytime a faulty DME 1.3 control module is replaced and a no-start condition still exists.*
- *Spark plug wire ends are available individually through an authorized BMW dealer parts department.*

Ignition components, replacing (M30/M70 engine)

BMW does not specify a replacement interval for the distributor cap and rotor. Worn and corroded contacts or poor insulation that allows the spark to short to ground are the primary reasons for replacement of these components.

Each spark plug wire leads from a specific terminal on the distributor cap to a specific spark plug. A cylinder number label should be attached to each spark plug wire.

NOTE—
To facilitate easier removal of the cap and rotor, first remove the radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.


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➢ Distributor cap mounting screws (**arrows**). (M70 right side)

- The distributor cap is held in place with three screws. Carefully remove the plastic shield from the cap and then loosen the captive screws. Leave the spark plug wires in the old cap. Mount the new cap and tighten the screws. Change over one wire at a time from the old cap to the new one.
- To remove the rotor mounting screws use a 3mm allen wrench. Installation of the rotor and cap is the reverse of removal. Do not over tighten the rotor mounting screws.

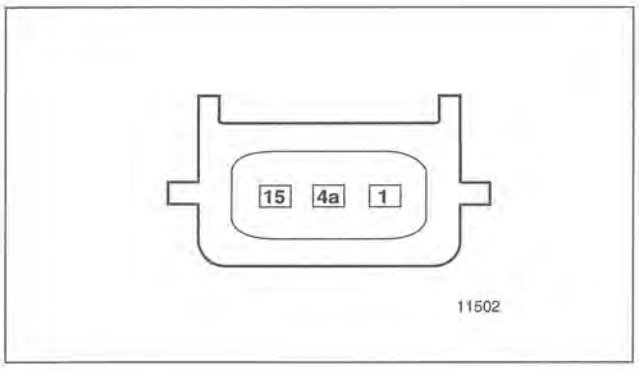
Tightening Torque

- Ignition rotor to rotor adaptor . . . . . 2.8 ± 0.2 Nm (25 ± 1.8 in-lb)

NOTE—
The inductive pickup (cylinder identification sensor) on the spark plug wire is used to sequence the fuel injectors. See **130 Fuel Injection**.

Ignition coil, testing (M60 engine)

– Remove plastic engine cover(s) from top of engine by prying off nut covers and removing cover mounting nuts.



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➢ Disconnect harness connector from coil.

- Connect digital voltmeter between terminal **15** (+) in harness connector and terminal **4a** (ground). Turn ignition on and check for battery voltage.
- If battery voltage is not present, check wire between terminal **15** and ignition switch. Check for continuity to ground at terminal **4a**. See **Electrical Wiring Diagrams**.

CAUTION—
The wiring to terminal 15 of the coil (via the ignition switch) is not fuse protected. Use care when testing this circuit.

– Turn ignition off.

– Use digital multimeter to test coil primary. Resistance values are listed in **Table c.**

Table c. Ignition Coil Resistance (M60 engine)

	Terminals	Resistance
Coil primary	**1** (–) and **15** (+)	0.8 Ω (approx.)
Coil secondary	—	—

– Remove coil and inspect coil housing for hairline cracks or leaking casting material. Replace coil if any faults are found.

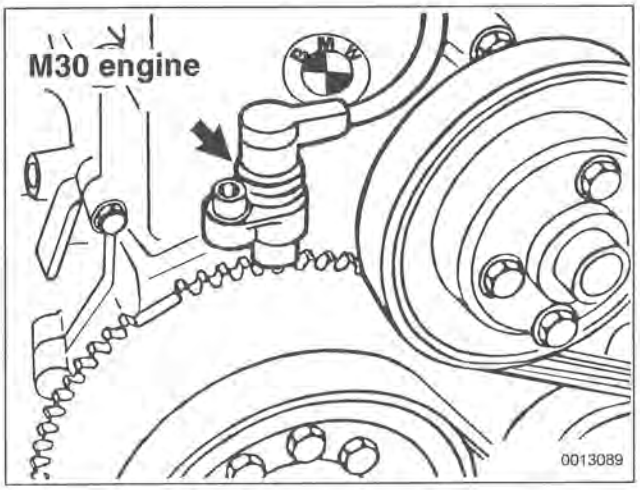
NOTE—

On "May and Christe" manufactured coils, check carefully for thermal stress cracks or signs of leaking casting material. If any of these faults are found, the coil should be replaced before it causes damage to the DME ECM.

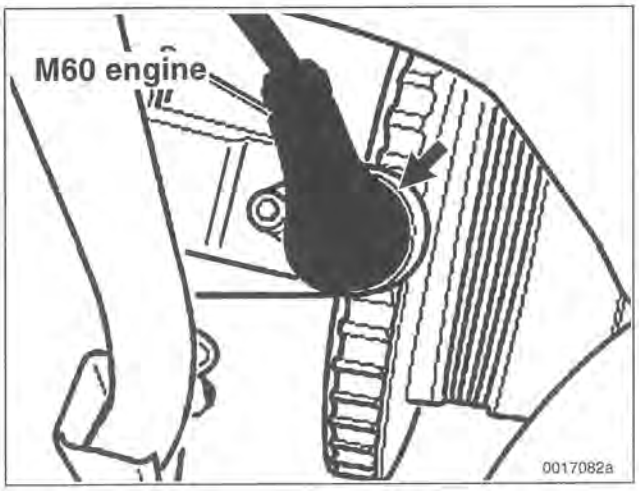
Crankshaft position/rpm sensor, testing and replacing

If the engine control module (ECM) does not receive a crankshaft position signal during cranking, engine will not start.

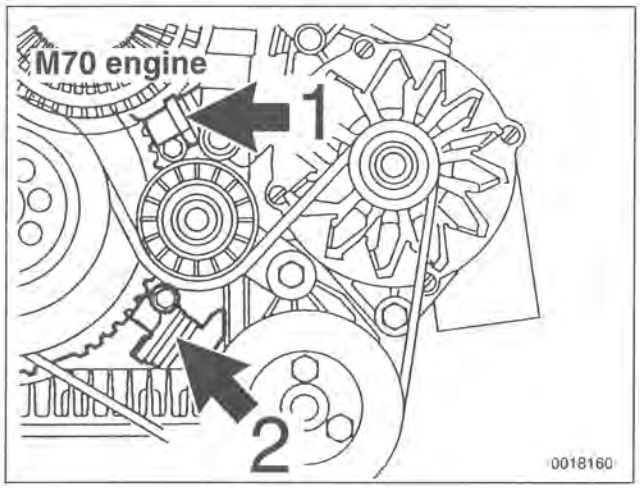
- Engine speed is calculated from rate at which wheel's teeth pass the sensor.
- Crankshaft position is determined by missing-teeth gap on pulse wheel.



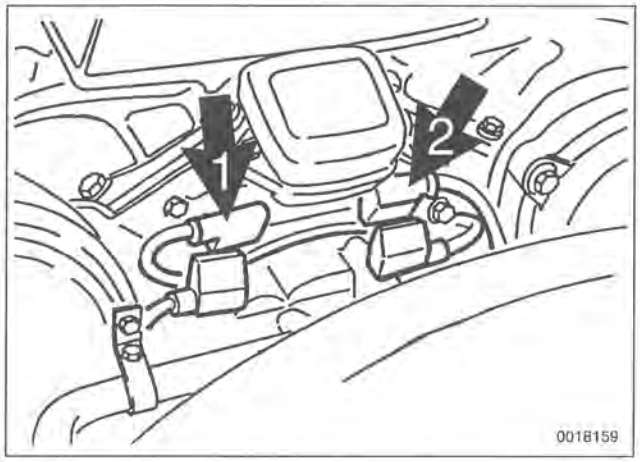
Crankshaft position/rpm sensor (**arrow**) is mounted at front of M30 engine cover and reads the toothed vibration dampener wheel.



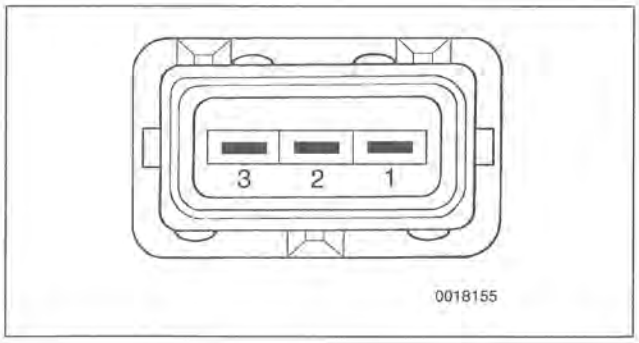
Crankshaft position/rpm sensor (**arrow**) mounted at front of M60 engine.



Crankshaft position/rpm sensors on M70 engine (**arrows**) mounted on front timing chain cover. Upper sensor is for DME 1, lower sensor is for DME 2.



Disconnect crankshaft position/rpm sensor harness connectors on M70 engine for right bank (**1**) and left bank (**2**) of cylinders.



Using digital multimeter, check resistance between terminals **1** and **2** in crankshaft position/rpm sensor connector.

Crankshaft Position/rpm Sensor Specifications

- Coil resistance (approx.) @20°C
  M30/M70 engine . . . . . 540 ± 10% Ω
  M60 engine . . . . . 1280 ± 10% Ω
- Air gap (sensor distance from toothed wheel) . . . . . 1.0 ± 0.3 mm (0.04 ± 0.01 in.)

– If resistance is not correct, sensor is faulty and should be replaced.

NOTE—

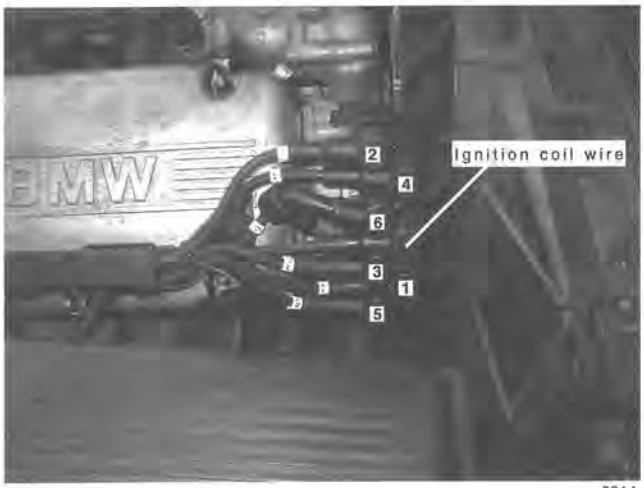
If the sensor resistance is correct, it does not mean the DME is receiving the signal from the pulse sensor. Make a dynamic test using a scope or a digital voltmeter (VAC) at terminals 15 and 1 while cranking the engine. An AC voltage indicates the sensor is functioning.

– On M30 or M60 engine: To replace a faulty sensor, remove sensor mounting bolt using a 5 mm hex wrench.
  - Cut wire ties as necessary to remove electrical harness connector.
  - When installing new sensor, be sure wiring is rerouted in the same orientation.
  - Secure sensor to mounting bracket and use new wire ties on electrical harness.

– On M70 engine: When replacing DME 2 sensor (cyl. 7-12), components listed below must be unbolted to gain access to lower sensor.
  - Once all components have been unbolted and carefully set aside, rotate crank pulley/vibration damper so that gap in toothed wheel aligns with sensor mounting bolt.
  - Remove bolt and sensor.
  - Remove alternator cooling duct.
  - Remove power steering pump pulley.
  - Remove power steering pump mounting bracket and pump.

Tightening Torque
- Crankshaft position/rpm sensor to mounting bracket . . . . . .7 ± 1 Nm (62 ± 9 in-lb)

Ignition firing order

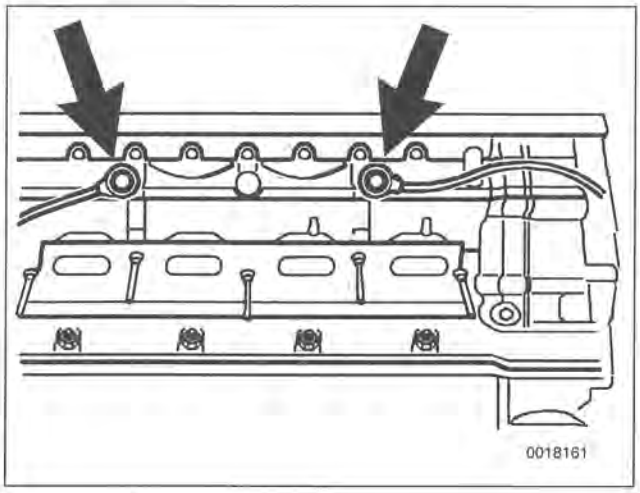


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Spark plugs wires correctly installed in distributor cap (M30 engine).
- On M30 and M70 engine, spark plug wires must be installed so that spark plugs fire in a specified order.
- The rotor turns in a clockwise direction when viewed from the front with the cap removed.

NOTE—
- *On M70 engine: When replacing the spark plug wires in the left distributor cap (cyl. 7-12), note that position 1 on the cap corresponds to cylinder no. 7 and position 2 on the cap corresponds to cylinder no. 8, and so on.*
- *On 6-cylinder engine, cylinder no. 1 is at the front of the engine.*
- *On 8-cylinder and 12-cylinder engines, cylinder no. 1 is at the front of the engine on the right (passenger side) cylinder head.*

Ignition Firing Order
- M30 engine 1-5-3-6-2-4
- M60 engine 1-5-4-8-6-3-7-2
- M70 engine 1-7-5-11-3-9-6-12-2-8-4-10



Knock sensors (M60 engine)

Four knock sensors, 2 per cylinder per bank, are used on DME 3.3 engine management systems.

- Knock sensors are bolted to cylinder block (**arrows**) and monitor combustion chamber for engine-damaging knock.
- If knock is detected, the ignition point is retarded accordingly via DME control module.
- Access to knock sensor requires removal of intake manifold.

NOTE—

- *On M60 engine, intake manifold removal procedures are described as part of cylinder head removal in* **113 Cylinder Head Removal and Installation**.
- *Knock sensor function is monitored by the On-Board Diagnostic (OBD) system. If a knock sensor is determined to be faulty, an appropriate diagnostic trouble code (DTC) may be stored in memory. See* **100 Engine–General** *for information on retrieving DTCs.*

CAUTION—

Do not interchange knock sensor harness connectors. Serious engine damage may result if the sensors are monitoring the wrong cylinders. If the connectors need to be removed, be sure to label them before disconnecting.

Tightening Torque

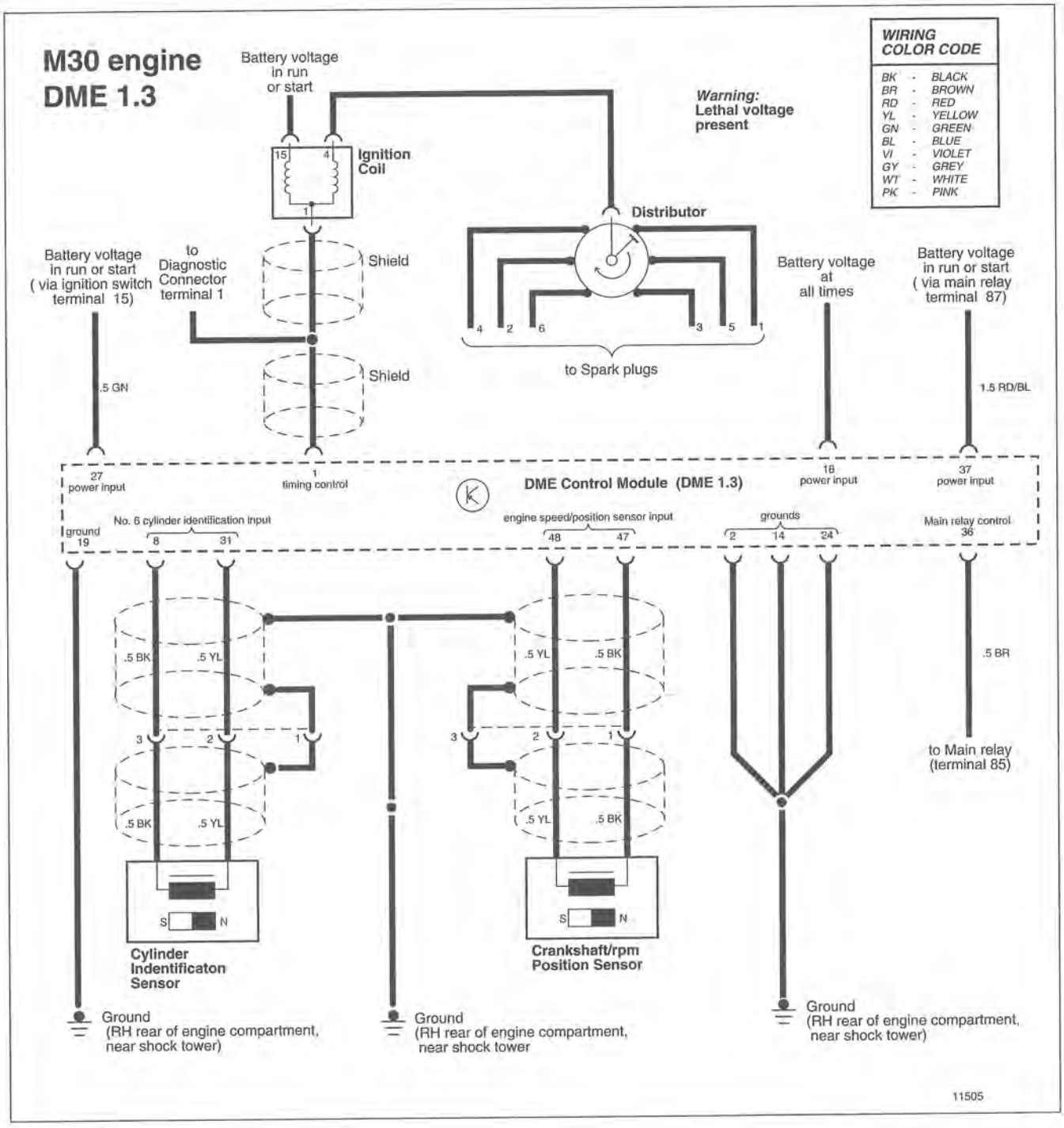
- Knock sensor to cylinder block . . . . . 20 Nm (15 ft-lb)

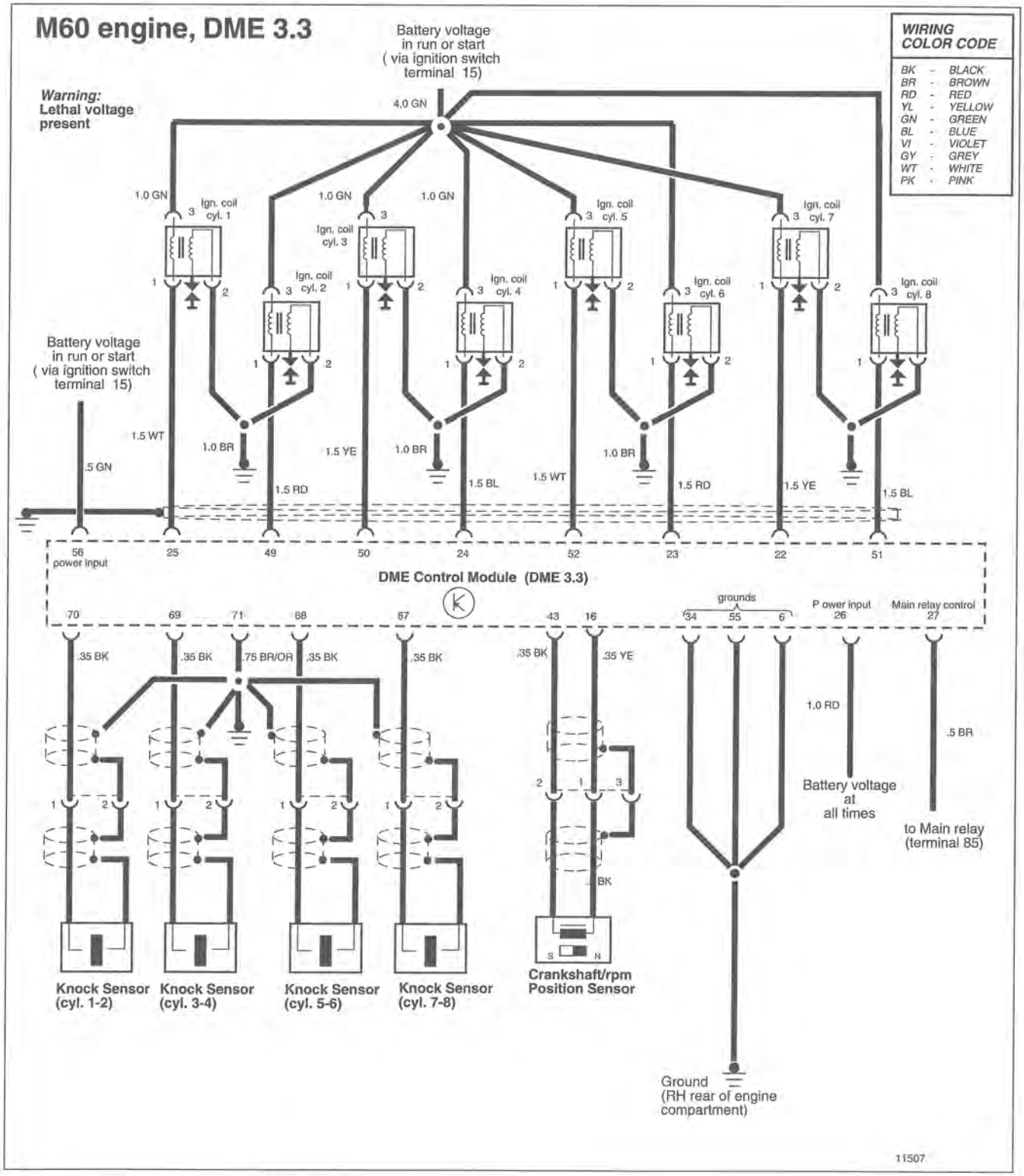
IGNITION SYSTEM CIRCUIT SCHEMATICS

The wiring schematics that follow cover DME ignition system electrical diagrams for 6- and 8-cylinder engines. For 12-cylinder ignition system, including all other additional electrical circuits, see **Electrical Wiring Diagrams**.

WARNING—

Do not touch or disconnect any of the high tension cables from the coil, distributor, or spark plugs while the engine is running or being cranked by the starter. Fatal voltages are present.


M30 engine
DME 1.3
Battery voltage in run or start
Warning: Lethal voltage present
WIRING COLOR CODE
BK - BLACK
BR - BROWN
RD - RED
YL - YELLOW
GN - GREEN
BL - BLUE
VI - VIOLET
GY - GREY
WT - WHITE
PK - PINK
15
4
1
Ignition Coil
Distributor
Battery voltage in run or start (via ignition switch terminal 15)
to Diagnostic Connector terminal 1
Shield
Shield
4 2 6 3 5 1
to Spark plugs
Battery voltage at all times
Battery voltage in run or start (via main relay terminal 87)
.5 GN
1.5 RD/BL
27 power input
1 timing control
DME Control Module (DME 1.3)
18 power input
37 power input
ground 19
No. 6 cylinder identification input
8
31
engine speed/position sensor input
48
47
grounds
2
14
24
Main relay control 36
.5 BK
.5 YL
.5 YL
.5 BK
.5 BR
3 2 1
3 2 1
.5 BK
.5 YL
.5 YL
.5 BK
S N
S N
to Main relay (terminal 85)
Cylinder Indentificaton Sensor
Crankshaft/rpm Position Sensor
Ground (RH rear of engine compartment, near shock tower)
Ground (RH rear of engine compartment, near shock tower
Ground (RH rear of engine compartment, near shock tower)
11505


M60 engine, DME 3.3
Battery voltage in run or start (via ignition switch terminal 15)
Warning: Lethal voltage present
WIRING COLOR CODE
BK - BLACK
BR - BROWN
RD - RED
YL - YELLOW
GN - GREEN
BL - BLUE
VI - VIOLET
GY - GREY
WT - WHITE
PK - PINK
4.0 GN
1.0 GN
Ign. coil cyl. 1
Ign. coil cyl. 2
Ign. coil cyl. 3
Ign. coil cyl. 4
Ign. coil cyl. 5
Ign. coil cyl. 6
Ign. coil cyl. 7
Ign. coil cyl. 8
1.5 WT
1.0 BR
1.5 YE
1.5 RD
1.5 BL
.5 GN
56 power input
25
49
50
24
52
23
22
51
DME Control Module (DME 3.3)
70
69
71
68
67
43
16
grounds
34
55
6
P ower input 26
Main relay control 27
.35 BK
.75 BR/OR
.35 YE
1.0 RD
.5 BR
Battery voltage at all times
to Main relay (terminal 85)
Knock Sensor (cyl. 1-2)
Knock Sensor (cyl. 3-4)
Knock Sensor (cyl. 5-6)
Knock Sensor (cyl. 7-8)
Crankshaft/rpm Position Sensor
Ground (RH rear of engine compartment)
11507



121 Battery, Starter, Alternator

GENERAL 121-1

CHARGING SYSTEM TROUBLESHOOTING 121-2
- Charging system quick-check 121-2
- Static current draw, checking 121-2
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- Battery load voltage test 121-3
- Battery charging 121-4

ALTERNATOR SERVICE 121-4
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TABLES

a. Open-Circuit Voltage and Battery Charge 121-3
b. Battery Load Test–Minimum Voltage 121-4

GENERAL

The charging system consists of a belt-driven alternator with integral voltage regulator and a battery.

Various alternators, voltage regulators, starters, and batteries are used in the E32 7 Series cars. It is important to replace components according to the original equipment specification. Check with an authorized BMW dealer for specific application and parts information.

WARNING—

- *Wear goggles, rubber gloves, and a rubber apron when working around batteries and battery acid (electrolyte).*
- *Battery electrolyte contains sulfuric acid and can cause skin irritation and burning. If acid is spilled on your skin or clothing, flush the area at once with large quantities of water. If electrolyte gets into your eyes, flush them with large quantities of clean water for several minutes and call a physician.*
- *Batteries that are being charged or are fully charged give off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.*

NOTE—

The battery is mounted beneath the rear seat. See **520 Seats**.

CAUTION—

- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*
- *Disconnecting the battery cables may erase fault codes stored in control unit memory.*
- *Always disconnect the negative (–) battery cable first and reconnect it last. Cover the battery post with an insulating material whenever the cable is removed.*
- *Never reverse the battery cables. Even a momentary wrong connection can damage the alternator or other electrical components.*
- *Battery cables may be the same color. Label cable before removing.*

CHARGING SYSTEM TROUBLESHOOTING

Charging system diagnostics requires special test equipment. If the test equipment is not available, charging system fault diagnosis can be performed by an authorized BMW dealer or other qualified repair shop.

Charging system quick-check

As a quick-check, use a voltmeter to measure voltage across the battery terminals with the key off and then again with the engine running. The battery voltage should be about 12.6 volts with key off and approximately 14.0 volts with the engine running. If the voltage does not increase when the engine is running, there is a fault in the charging system.

NOTE—

The regulated voltage (engine running) should be between 13.8 and 14.8, depending on temperature and operating conditions. If the voltage is higher than 14.8 volts, the voltage regulator is most likely faulty.

Check for clean and tight battery cables. Check the ground cable running from the negative (–) battery terminal to the chassis and the ground cable running from the engine to the chassis. Check the alternator drive belt for looseness or wear.

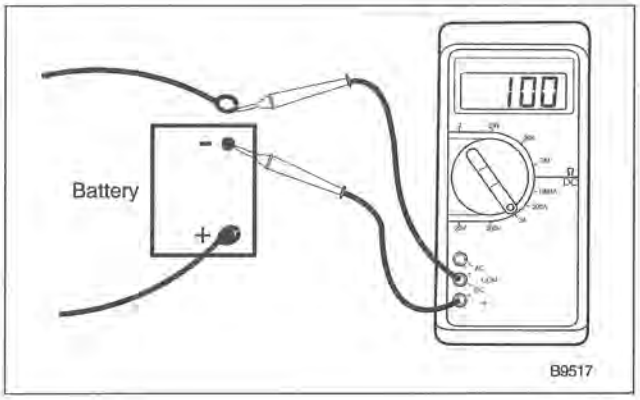
Static current draw, checking

If the battery discharges over time, there may be a constant drain or current draw on the battery. A small static drain on the battery is normal, but a large drain will cause the battery to quickly discharge. Make a static current draw test as the first step when experiencing battery discharge.

– Make sure ignition and all electrical accessories are switched off.

– Disconnect negative (–) battery cable. See **020 Maintenance.**

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*



Connect a digital ammeter between battery negative post and negative battery cable to measure current.

A range of about 0 to 100 milliamps is normal, depending on the number of accessories that need constant power. A current of 500 milliamps (0.5 amp) or more may indicate a problem. To determine the circuit or component causing the problem, remove one fuse at a time until the current drops to a normal range.

Battery open-circuit voltage test

Before making the test, load the battery with 15 amps for one minute with a battery load-tester or turn on the headlights for about one minute without the engine running.Then disconnect the battery negative (–) cable and connect a digital voltmeter across the battery terminals. Open-circuit voltage levels are given in **Table a.**

If the open-circuit voltage is OK but the battery still lacks power for starting, make a load voltage test. If the open-circuit voltage is below 12.4 volts, recharge the battery and retest.

Table a. Open-Circuit Voltage and Battery Charge

Open-circuit voltage	State of charge
12.6 V or more	Fully charged
12.4 V	75% charged
12.2 V	50% charged
12.0 V	25% charged
11.7 V or less	Fully discharged

Battery load voltage test

A battery load tester is required for a load voltage test. The test is made by applying a high resistive load to the battery terminals and then measuring battery voltage. The battery should be fully charged for the most accurate results. Disconnect the battery cables when making the test. If the voltage is below that listed in **Table b**, the battery should be replaced.

WARNING—
Always wear protective goggles and clothing when performing a load test.

Table b. Battery Load Test–Minimum Voltage (apply 200 amp load for 15 seconds)

Ambient temperature	Voltage
80°F (27°C)	9.6 V
60°F (16°C)	9.5 V
40°F (4°C)	9.3 V
20°F (-7°C)	8.9 V
0°F (-18°C)	8.5 V

Battery charging

Battery maintenance is covered in **020 Maintenance**.

Discharged batteries can be recharged using a battery charger. Prolonged charging causes gassing that will evaporate the electrolyte to a level that can damage the battery. It is best to use a low-current charger (6 amp or less) to prevent battery damage caused by overheating.

WARNING—
- *Battery acid is caustic and dangerous. Take care to keep it from contacting eyes, skin, or clothing. Wear eye protection. Extinguish all smoking materials and do not work near any open flames.*
- *Hydrogen gas given off by the battery during charging is explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.*

CAUTION—
- *Disconnecting the battery cables with the engine running, or reconnecting the cables to the incorrect posts will damage the electrical system.*
- *Be sure to have the radio code on hand before disconnecting battery.*
- *To avoid causing battery acid damage to the interior, remove battery from car before using a battery charger.*

ALTERNATOR SERVICE

Before checking the alternator and regulator, make sure the battery is fully charged and capable of holding a charge. Check that the battery terminals are clean and tight and the alternator drive belt is properly tensioned and not severely worn.

Charging system, checking

– Turn ignition key on. Check that charge warning lamp comes on.

NOTE—
If the warning light does not come on, repair any wiring or bulb faults before continuing to check the charging system.

– Remove terminal cover from rear of alternator.



➤ Check for battery voltage between ground and terminal **B+** at back of alternator. Then turn ignition on and check for battery voltage between terminal **D+** and ground. If voltage is not present at either point, check for wiring for faults.

NOTE—
Terminal B+ is supplied battery voltage directly from the battery. Terminal D+ is supplied battery voltage via the charge warning bulb when the key is on or the engine is running.

– If no faults are found up to this point, test alternator output.

– If a load tester is not available, a crude output test can be done by running engine at about 2000 rpm and turning on electrical loads (fans, lights and rear window defroster, wipers). When fully loaded, battery voltage should be at least 12.0 VDC.

Alternator removal and installation

Various alternators with different current ratings and from different manufacturers are installed on E32 7 Series cars. Replacement alternators should be of the same make and rating as originally installed. Alternator manufacturer and ampere rating are marked on the alternator housing.

Alternator removal and installation procedures in this section are organized according to engine code. If necessary, see **100 Engine–General** for engine code and application information.

Alternator, removing and installing (M30 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove alternator drive belt as described in **020 Maintenance**. If necessary, remove radiator cooling fan and fan shroud as described in **170 Radiator and Cooling System**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Working at rear of alternator, disconnect alternator cooling duct. Remove terminal cover and disconnect wiring from alternator.

– Remove upper adjustment mounting bolt and lower bolt(s) from alternator. Remove alternator.

CAUTION—
Protect radiator with heavy cardboard or sheet metal.

– Installation is reverse of removal.

Tightening Torques
- D+ wire to alternator . . . . . 6 Nm (53 in-lb)
- B+ wire to alternator . . . . . 14 Nm (10 ft-lb)
- Pulley to alternator . . . . . 45 Nm (33 ft-lb)

Alternator, removing and installing (M60 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

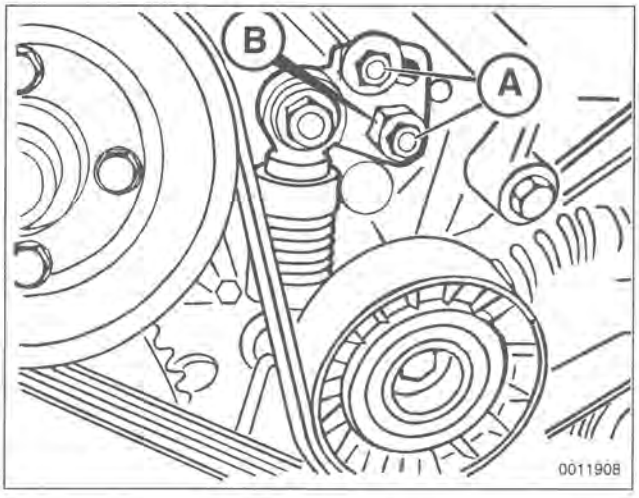
– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Remove engine splash shields from beneath car.

– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

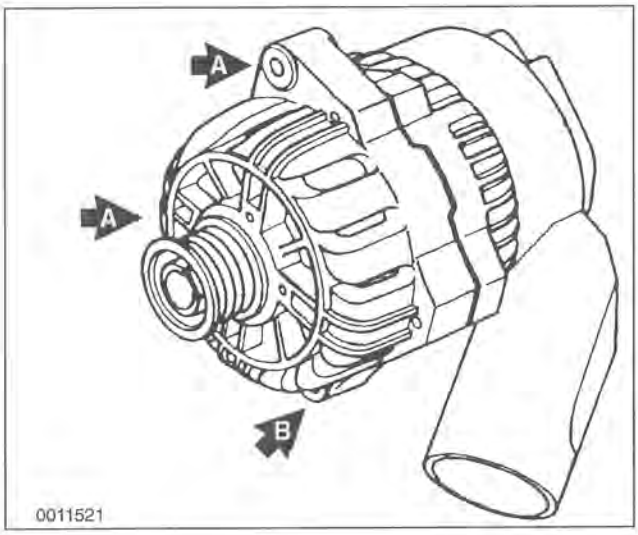
NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.



ALTERNATOR SERVICE

➢ Loosen mounting nuts on belt tensioner (**A**). Use an open end wrench to rotate tensioner hex (**B**) counterclockwise and remove belt. Remove belt tensioner from engine.

– Remove oil filter housing mounting bolts at front of engine and set oil filter housing aside.

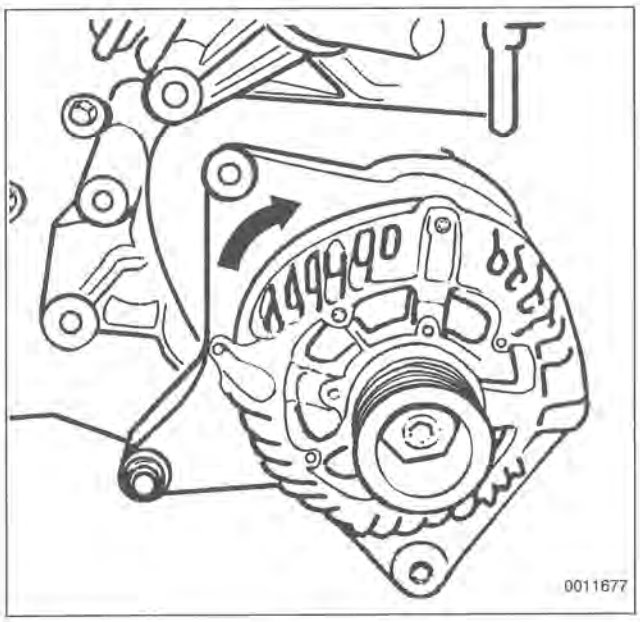


➢ Remove top two alternator mounting bolts (**A**).
- Working underneath car at rear of alternator, disconnect alternator cooling duct.
- Remove lower alternator mounting bolt (**B**).

– Pull alternator forward and remove electrical harness terminal cover. Detach wiring from alternator.

CAUTION—
Protect radiator with heavy cardboard or sheet metal.

NOTE—
During these next steps, unclamp and disengage coolant and vacuum hoses and electrical harness ducts as necessary.



➢ Pull oil filter housing forward while rotating upper alternator mounting clockwise (**arrow**) and under oil filter housing mounting.

– Rotate alternator forward and then up and out of engine compartment, using care not to damage radiator.

– Installation is reverse of removal.

Tightening Torques
- D+ wire to alternator . . . . . 6 Nm (53 in-lb)
- B+ wire to alternator . . . . . 14 Nm (10 ft-lb)
- Pulley to alternator . . . . . 70 Nm (52 ft-lb)

Alternator, removing and installing (M70 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Raise car and support in a safe manner.

– Remove engine splash shields from beneath car.

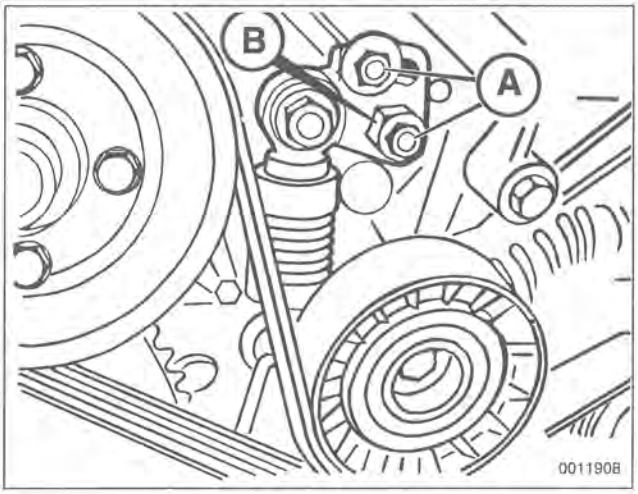
WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Remove left air filter housing assembly, mass air flow sensor and associated ducting from engine compartment.

– Drain coolant, then remove radiator and radiator cooling fan. See **170 Radiator and Cooling System**.

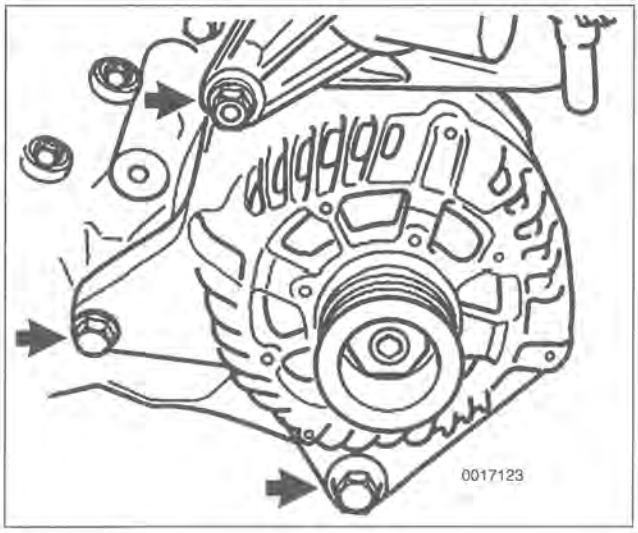
WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the radiator removal procedure.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.



➢ Loosen mounting nuts on belt tensioner (**A**). Use an open end wrench to rotate tensioner hex (**B**) counterclockwise and remove belt. Remove belt tensioner from engine.

– Working underneath car, detach alternator cooling duct.



➢ Remove three mounting bolts (**arrows**) from alternator.

– Tilt alternator forward and remove electrical harness terminal cover. Detach wiring from alternator.

– Remove alternator by lifting up and out of engine compartment.

– Installation is reverse of removal.

Tightening Torques

- D+ wire to alternator . . . . . 6 Nm (53 in-lb)
- B+ wire to alternator . . . . . 14 Nm (10 ft-lb)
- Pulley to alternator . . . . . 70 Nm (52 ft-lb)

Voltage regulator, removing and installing

Different types of voltage regulators were installed on the E32 7 Series cars. Installation of the wrong type can damage the electrical system.

– Disconnect negative (–) battery cable. See **020 Maintenance.**

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

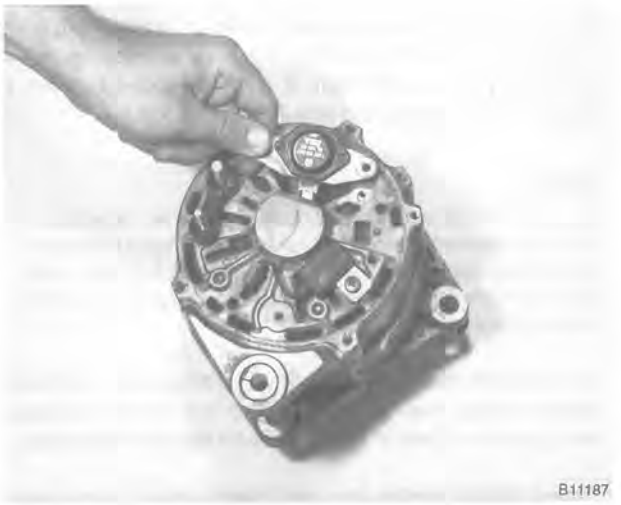
– On models with M60/M70 engine: Remove alternator as described earlier.

– Remove wiring cover and cooling duct from rear of alternator

➢ Remove voltage regulator mounting screws and remove regulator from alternator.

– Installation is reverse of removal.

- Clean brush contact surfaces in alternator and inspect brush protrusion.


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Brushes, inspecting and replacing

– Remove voltage regulator as described earlier.

➢ Clean brush contact surfaces and measure brush protrusion.

Voltage Regulator

- Brush protrusion (minimum) . . . . . 5 mm (¼ in.)


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– To replace brushes, carefully and as quickly as possible, unsolder brush lead from brush holder terminal, withdrawing brush from holder at same time.

> ***CAUTION—***
> *Regulator brushes are not available as replacements parts for all versions of regulators. Check with an authorized BMW dealer for the latest in parts information before unsoldering the brushes.*

- Remove any traces of solder from brush holder terminal.
- Fit spring into brush holder and insert new brush.
- Guide brush lead into terminal and solder into place. Check for free movement of brushes when solder cools.
- Check brush slip rings in alternator for wear. Lightly clean slip rings using fine abrasive cloth.
- Reinstall regulator and alternator.

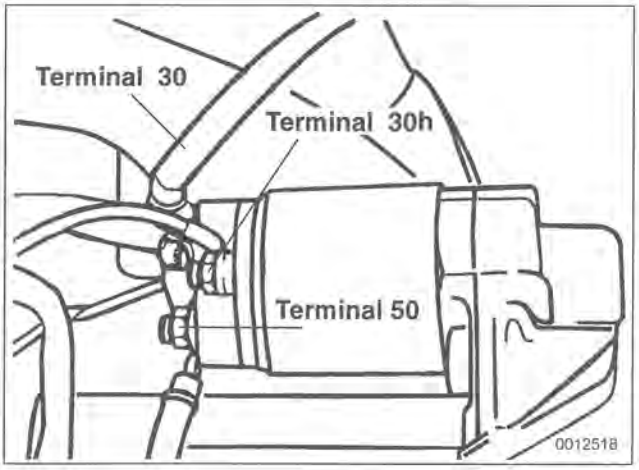
STARTER SERVICE

Starter troubleshooting

If the starter turns the engine slowly or fails to operate when the ignition is in the start position, check the battery first. Inspect the starter wires, terminals, and ground connections for good contact. In particular, make sure the ground connections between the battery, the body and the engine are completely clean and tight. If no faults can be found, the starter may be faulty and should be replaced.

NOTE—
*On cars with automatic transmission, a starter relay and a neutral safety switch are used to prevent the engine from starting in gear positions other than park or neutral. If voltage is not present at terminal **50** with the key in the start position, check these components*

To make the most accurate check of the battery cables and starter wiring, make a voltage drop test on the cables and wiring as described in **600 Electrical System–General**.



Typical starter wiring terminal identification. Large wire at terminal **30** is direct battery voltage. Smaller wire at terminal **50** operates starter solenoid via ignition switch.

- Check for battery voltage at terminal **50** of the starter motor with the key in the start position.
- If voltage is not present, check the wiring between the ignition switch and the starter terminal.
- If voltage is present and no other visible wiring faults can be found, the problem is most likely internal in the starter motor.

NOTE—
*On cars with automatic transmission, a starter relay and a neutral safety switch are used to prevent the engine from starting in gear positions other than park or neutral. If voltage is not present at terminal **50** with the key in the start position, check these components.*

If the solenoid clicks but the motor does not turn, switch on the lights and turn the key to the start position. If the lights go out while attempting to start, the battery cable may be loose or the starter may have a short circuit. If the lights stay on, the solenoid is most likely at fault.

Starter removal and installation

Starter removal and installation procedures in this section are organized according to engine code. If necessary, see **100 Engine–General** for engine code and application information.

Starter, removing and installing (M30 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With engine cold, remove coolant expansion tank.

– Disconnect wiring from starter.

– Loosen and remove starter mounting bolts and nuts. Remove starter.

> ***NOTE—***
> *A bent box wrench is helpful in removing the top bolt.*

– Installation is reverse of removal.

Tightening Torques

- Starter to engine block . . . . . 50 Nm (37 ft-lb)
- Wire to terminal 30h . . . . . 5 Nm (44 in-lb)
- Wire to terminal 50 . . . . . 6 Nm (53 in-lb)
- Wire to terminal 30 . . . . . 12 Nm (9 ft-lb)

Starter, removing and installing (M60 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Working underneath car, remove engine splash pans and heat shields from right side of engine.

– Remove heat shield from front suspension crossmember and from rear of starter motor.

– Disconnect wiring from starter. Label as necessary.

– Loosen and remove starter bolts from transmission side. Remove starter.

– Installation is reverse of removal.

Tightening Torques

- Starter to engine block . . . . . 50 Nm (37 ft-lb)
- Wire to terminal 30h . . . . . .5 Nm (44 in-lb)
- Wire to terminal 50 . . . . . .6 Nm (53 in-lb)
- Wire to terminal 30 . . . . . 12 Nm (9 ft-lb)

Starter, removing and installing (M70 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Working underneath car, remove engine splash pan.

– Drain windshield washer tank, then detach hose and electrical harness and remove tank.

– Working in right side of engine compartment, detach evaporative purge (carbon) canister and move aside without disconnecting ducts or hoses.

– Remove right side exhaust manifold heat shield. Detach right side front exhaust pipe from manifold and lower out of the way.

– Disconnect wiring from starter. Label as necessary.

NOTE—
It is helpful to turn the steering wheel fully to left lock.

– Remove starter motor bolts.

NOTE—
Remove upper starter bolt using a ground down 16 mm wrench.

– Remove starter downward.

– Installation is reverse of removal.

Tightening Torques

- Starter to engine block . . . . . 50 Nm (37 ft-lb)
- Wire to terminal 30h . . . . . .5 Nm (44 in-lb)
- Wire to terminal 50 . . . . . .6 Nm (53 in-lb)
- Wire to terminal 30 . . . . . 12 Nm (9 ft-lb)

Solenoid switch, removing and installing

– Remove starter as described above.

– Remove cover from solenoid switch.

– Disconnect field winding strap between starter motor and solenoid switch.

NOTE —
The condition of the field winding strap is critical. If it is damaged, burned or partially melted through, a new or rebuilt starter motor is needed.

– Remove solenoid switch mounting screws (**arrows**), and separate solenoid from starter.



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CAUTION —
When installing field winding strap to starter, position it so that it does not contact the starter body.

– Installation is reverse of removal. Lubricate solenoid piston with light grease.

Tightening Torque

- Field winding strap to starter (M8) . . . . 12 Nm (9 ft-lb)



130 Fuel Injection

GENERAL 130-2
- Principles of Operation 130-2
- Basic Engine Settings 130-5
- Fault Diagnosis 130-5
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GENERAL

This repair group covers fuel injection component testing and repair. Special equipment may be necessary for some of the procedures given in this repair group. If you do not have the equipment required to do the job, it is recommended that these repairs be left to an authorized BMW dealer. The BMW dealer is equipped with sophisticated diagnostic test equipment that is capable of quickly pinpointing hard-to-find DME fuel injection problems.

NOTE—

- *Wiring diagrams for the DME engine management system, including the electronic throttle control (EML/ADS) circuits, can be found at the rear of the manual in* **Electrical Wiring Diagrams**.
- *For DME ignition repair information, including testing the crankshaft position/rpm sensor and the knock sensors, see* **120 Ignition System**.
- *For fuel supply component testing and repair, including fuel pump relay and electrical circuit, see* **160 Fuel Tank and Fuel Pump**.

Principles Of Operation

BMW E32 cars are equipped with one of four versions of digital motor electronics (DME). The differences among the systems are mainly in refinements of certain operations and additional functions.

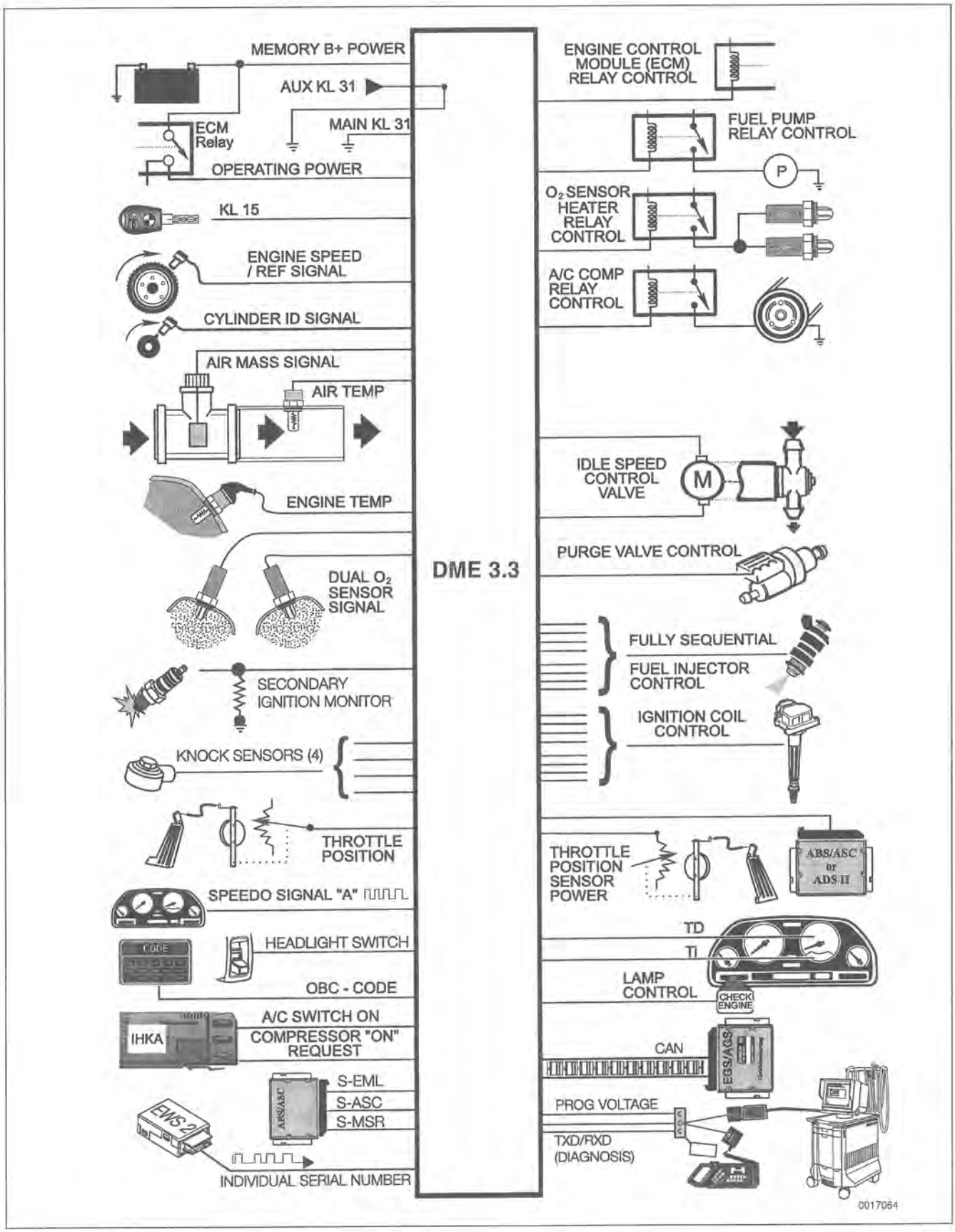
DME System Variants

Model/Year	Variant (engine code)
735i/iL 1988-1992	DME 1.3 (M30)
740i/iL 1993-1994	DME 3.3 (M60)
750iL 1988–1990 1991-1994	 DME 1.2 (M70) DME 1.7 (M70)

The DME system is completely electronic in operation. Air flow is measured electronically and additional sensors supply information about engine operating conditions. The engine control module (ECM), also referred to as the DME control module, calculates the amount of fuel needed for the correct air-fuel ratio and actuates the fuel injectors accordingly. The amount of fuel metered to the engine is determined by how long the injectors are open.

NOTE—

The M70 (V12) engine uses two separate engine management systems. This includes two DME modules, two mass air flow sensors, two oxygen sensors, two crankshaft position sensors, etc. In essence, the V12 engine is managed as if it were two 6-cylinder engines.


MEMORY B+ POWER
AUX KL 31
MAIN KL 31
ECM Relay
OPERATING POWER
KL 15
ENGINE SPEED / REF SIGNAL
CYLINDER ID SIGNAL
AIR MASS SIGNAL
AIR TEMP
ENGINE TEMP
DUAL O_2 SENSOR SIGNAL
SECONDARY IGNITION MONITOR
KNOCK SENSORS (4)
THROTTLE POSITION
SPEEDO SIGNAL "A"
CODE
HEADLIGHT SWITCH
OBC - CODE
IHKA
A/C SWITCH ON
COMPRESSOR "ON" REQUEST
EMS 2
S-EML
S-ASC
S-MSR
INDIVIDUAL SERIAL NUMBER
DME 3.3
ENGINE CONTROL MODULE (ECM) RELAY CONTROL
FUEL PUMP RELAY CONTROL
P
O_2 SENSOR HEATER RELAY CONTROL
A/C COMP RELAY CONTROL
IDLE SPEED CONTROL VALVE
M
PURGE VALVE CONTROL
FULLY SEQUENTIAL FUEL INJECTOR CONTROL
IGNITION COIL CONTROL
THROTTLE POSITION SENSOR POWER
ABS/ASC or ADS II
TD
TI
LAMP CONTROL
CHECK ENGINE
CAN
EGS/AGS
PROG VOLTAGE
TXD/RXD (DIAGNOSIS)
0017064

Air Intake. Air entering the engine passes through a pleated paper air filter in the air cleaner. Air flow into the engine is regulated by the throttle valve and measured by the air flow sensor. Various types of air flow sensors are used depending on the DME version:

Air Flow Sensor Applications

- DME1.3. . . . . Volume air flow (vane type)
- DME 1.2 and DME 1.7 . . . . . Mass air flow (hot wire)
- DME 3.3 . . . . . .Mass air flow (hot film)

NOTE—

- *On cars with Automatic Stability Control+Traction (ASC+T), throttle valve intervention is controlled by an electronic throttle actuator (called EML or ADS). Special electrical testing equipment is required to service these systems. See* **Electrical Wiring Diagrams** *for traction control electrical circuits.*
- *735i/iL models with ASC+T and all 750iL models are fitted with EML. In this "drive-by-wire" system there is no accelerator cable.*
- *740i/iL models with traction control use ADS, with accelerator cable and secondary throttle housing.*

Fuel Metering. The engine control module (ECM), also referred to as the DME control module, meters fuel by changing the opening time (pulse width) of the fuel injectors. To ensure that pulse width is the only factor that determines fuel metering, fuel pressure is maintained by a fuel pressure regulator. The injectors are mounted to a common fuel supply called the fuel rail.

The ECM monitors engine speed to determine the rate of injector openings. Other signals to the ECM help determine injector pulse time for different operating conditions. A temperature sensor signals engine temperature for mixture adaption. A throttle position sensor signals throttle position. An exhaust oxygen sensor signals information about combustion efficiency for control of the air-fuel mixture.

Idle Speed Control. On cars without EML (Electronic Motor Load Regulation), idle speed is electronically controlled via the idle speed control valve. The idle speed control valve maintains idle speed by bypassing varying amounts of air around the closed throttle valve. Idle speed is not adjustable.

On cars with EML, idle speed is electronically controlled via the throttle position actuator(s) which maintain idle speed by constantly adjusting the position of the primary throttle plate. Idle speed is not adjustable.

Knock Control (M60 engine only). The M60 engine is equipped with four knock sensors, two per cylinder bank. Knock sensors monitor and control ignition knock through the ECM. The knock sensors function like microphones and are able to convert mechanical vibration (knock) into electrical signals. The ECM is programmed to react to frequencies that are characteristic of engine knock and vary the ignition timing point accordingly.

Basic Engine Settings

Idle speed, idle mixture (%CO), and ignition timing are not adjustable. The adaptive DME system is designed to automatically compensate for changes in engine operating conditions, although the adaptive range is limited. Once these limits are exceeded, driveability problems usually become noticeable.

NOTE—
If the DME adaptive limits are exceeded, the Check Engine light will most likely come on, indicating an emissions-related fault. For Check Engine light diagnostics, see **100 Engine–General**.

The DME system compensates automatically for changes in the engine due to age, minor wear or small problems, such as a vacuum leak. As a result, idle speed and mixture do not need to be adjusted as part of routine maintenance.

NOTE—
Poor initial driveability may be encountered when the battery is disconnected and reconnected. When the battery is disconnected, the DME adaptive memory is erased. The DME system will readapt after about ten minutes of driving.

Fault Diagnosis

The management of engine functions is controlled through a number of systems—ignition, fuel injection, and emission control. Because these functions are interrelated, it is difficult to isolate general driveability problems by examining individual components. For this reason, engine management and driveability troubleshooting information can be found in **100 Engine–General**. This information is organized to help isolate problems and suggest more specific troubleshooting steps by taking all of the interrelated systems into consideration.

NOTE—
DME systems have an On-Board Diagnostic (OBD) feature that detects engine management malfunctions. When a problem is identified, a fault code (DTC) is stored in the engine control module (ECM) and the Check Engine lamp in the instrument cluster may also illuminate. Always check for fault codes as the first step in troubleshooting a driveability problem. See **100 Engine–General**.

Warnings and Cautions

For personal safety, as well as the protection of sensitive electronic components, the following warnings and cautions should be adhered to when working on the DME system.

WARNING—

- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*
- *Do not touch or disconnect any high voltage cables from the coil, distributor or spark plugs while the engine is running or being cranked by the starter.*
- *Disconnecting the battery will erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched off.*
- *When working on an open fuel system, wear suitable hand protection, as prolonged contact with fuel can cause illnesses and skin disorders.*
- *Before making any electrical tests that require the engine to be cranked using the starter, disable the ignition system as described in* **120 Ignition System**.
- *Gasoline is highly flammable and its vapors are explosive. Do not smoke or work on a car near heaters or other fire hazards when diagnosing and repairing fuel system problems. Have a fire extinguisher available in case of an emergency.*

CAUTION—

- *Connect test equipment only as specified by BMW, this manual, or the equipment maker.*
- *Do not attempt to disable the ignition system by removing the center coil wire or by removing the distributor cap (where applicable). High voltage may arc to other electrical components causing extensive damage.*
- *Do not run the engine with any of the spark plug wires disconnected. Catalytic converter damage may result.*
- *Always wait at least 40 seconds after turning off the ignition before removing control module connectors. Residual power in the system may damage sensitive electronic components.*
- *Cleanliness is essential when working on an open fuel system. Thoroughly clean fuel line connections and surrounding areas before loosening. Avoid the use of compressed air, and avoid moving the car. Only install clean parts.*
- *Fuel system cleaners and other chemical additives other than those specifically recommended by BMW may damage the catalytic converter, the oxygen sensor or other fuel supply components.*

ELECTRICAL CHECKS AND COMPONENT TESTING

The tests given under this heading must be made using a digital multimeter. Always check for On-Board Diagnostic fault codes (DTCs) as the first step in troubleshooting DME problems. See **100 Engine–General**.

CAUTION—

- *Avoid damaging harness connectors or relay panel sockets. Jumper wires should be fabricated with flat-blade end connectors that are the same size as the connector or relay terminals being tested.*
- *Always switch the test meter to the appropriate function and range before making test connections. Connect and disconnect test equipment only with the ignition switched off.*

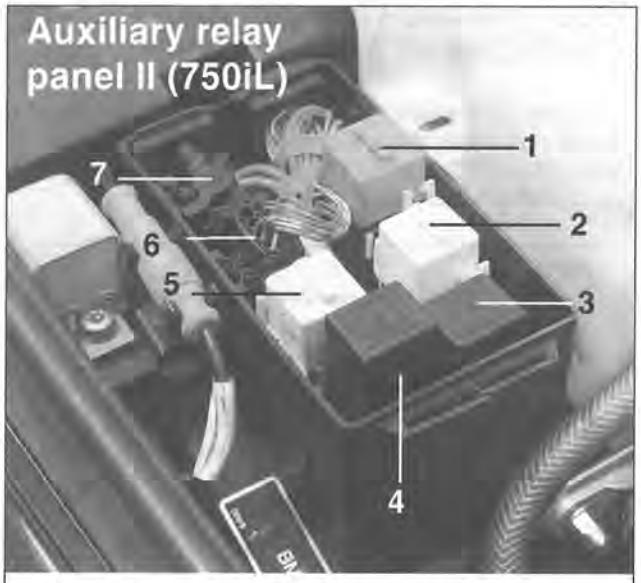
Main DME relay, testing

The main DME relay is energized via the DME engine control module and supplies plus (+) power to the many of the DME components and subsystems, including the fuel pump relay. If this relay is faulty, the engine will not start.



Main DME relay (**A**) is in the electronics box (E-box) on M30 and M60 engines.

- **A**: Main relay
- **B**: Fuel pump relay
- **C**: Oxygen sensor heater relay (where applicable)



1. Oxygen sensor heater relay
2. Main DME relay 1(cyl. 1-6)
3. Fuel pump relay 1(cyl. 1-6)
4. Fuel pump relay 2 (cyl. 7-12)
5. Main DME relay 2 (cyl. 7-12)
6. Harness connector (8 pin)
7. B+ junction post

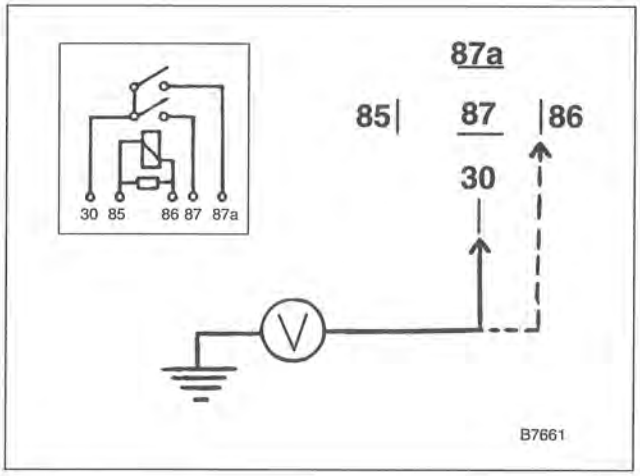
0017259

➢ Main DME relays (**2** and **5**) are in the auxiliary relay panel II in right front of M70 engine compartment.

- With the ignition off, remove main DME relay.

NOTE—

Relay positions may vary. The main DME relay is normally white in color. To confirm that the main DME relay has been correctly identified, check for a large (6 mm^2) red wire at terminal 30 of the relay socket.



➢ Turn ignition on and check for voltage at terminals **30** and **86** of relay socket.

- If battery voltage is present continue testing
- If battery voltage is not present at either point, check large red wire in relay socket. See **Electrical Wiring Diagrams.**

NOTE—

The wiring to terminals 85 and 86 in the main DME relay may be reversed. Electrically, the relay functions the same. If voltage is not present at terminal 86, check for voltage at terminal 85.

– Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal 85 (brown or brown with color trace wire).

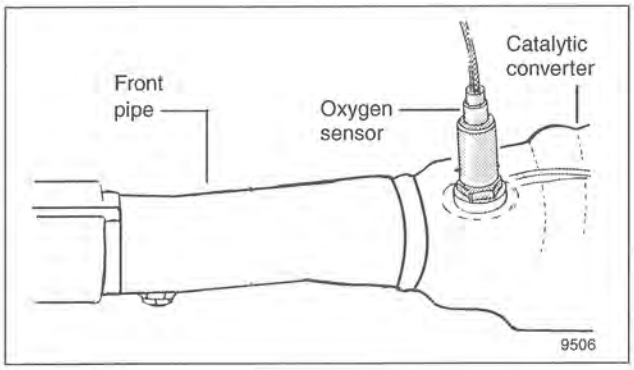
- If ground is present continue testing.
- If ground is not present, the signal from the ECM is missing. Check wire between ECM and relay. If no faults can be found, the ECM may be faulty.

– With the ignition on and the relay installed, check for battery voltage at terminals **87** and **87a**.

- If battery voltage is present, the relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, the relay is faulty and should be replaced.

NOTE—

The relay may be marked with terminal 87 at two of the terminals instead of 87 and 87a.

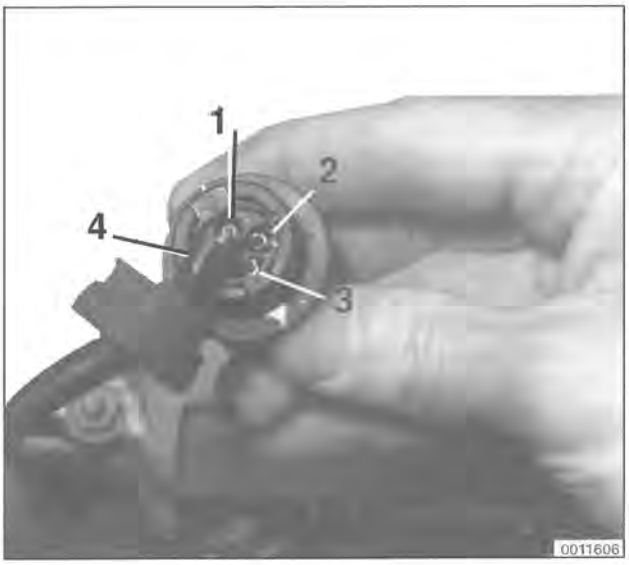


Oxygen sensor, testing

The oxygen sensor provides an input voltage signal (0-1 VDC) to the ECM based on the oxygen content in the exhaust gas. To generate voltage, the sensor temperature must exceed 600°F. Therefore it is electrically heated. M30 engines use one oxygen sensor.

M60 and M70 engines are equipped with two oxygen sensors, one for each catalytic converter.

NOTE—
The test given below is not a conclusive test of oxygen sensor efficiency and does not test how quickly the oxygen sensor reacts to changing conditions. For the most accurate test, an exhaust gas analyzer should be used.



Connect a digital voltmeter to pins **1** and **2** (black wire, yellow wire) in oxygen sensor connector. Leave connector attached.

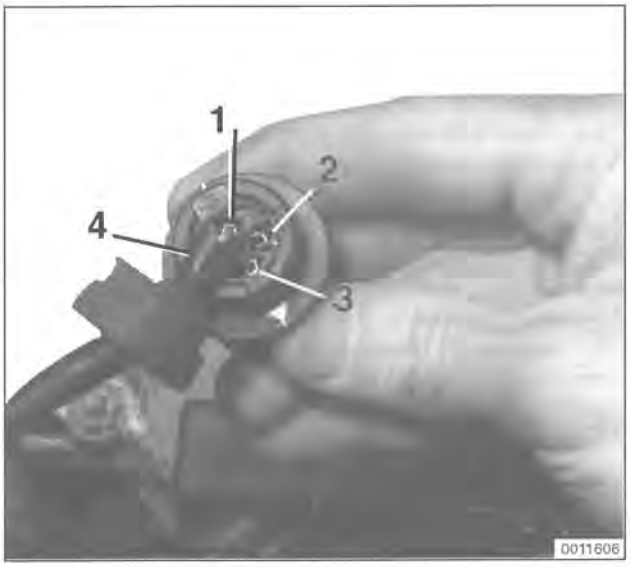
NOTE—
Oxygen sensor terminal identification can vary. Consult **Electrical Wiring Diagrams** *for detailed terminal identification.*

Oxygen Sensor Connector Location (4-pin, Black)

- M30 engine . . . . . rear of engine compartment, lower left-hand side
- M60 engine . . . . . beneath car, under transmission
- M70 engine . . . . . beneath car, under transmission

– Start car and let it idle. The oxygen sensor should start to produce a fluctuating voltage within a short period. If the voltage is incorrect, turn the engine off and check the preheater circuit as described below.

WARNING—
Exhaust manifolds and pipes can be hot enough to cause serious burns. Wear suitable heavy gloves and other appropriate protection.



Oxygen sensor

- Voltage at idle . . . . . .0.2 to 0.8 VDC, fluctuating

– To check sensor response to lean and rich mixtures, create an air leak, or pull vacuum hose off fuel pressure regulator to increase fuel pressure.

Separate sensor harness connector from sensor. Check for battery voltage between terminals **3** and **4** in harness side of connector with engine running. If voltage is not present, check that oxygen sensor heater relay is functioning correctly. See **610 Electrical Component Locations**.

NOTE—

- *The oxygen sensor heater relay is energized with positive (+) battery voltage from the main DME relay and a switched ground from the ECM. See* **Electrical Wiring Diagrams**.
- *On some DME systems, the oxygen sensor heater circuit is not controlled by a relay. See* **610 Electrical Component Locations** *for more specific relay location information.*

– Check heater element resistance between terminals **3** and **4** in sensor side of connector. If element is electrically open (no continuity), replace sensor.

– If oxygen sensor isn't producing a fluctuating voltage and preheater circuit is OK, replace sensor.

Tightening Torque

- Oxygen sensor to exhaust pipe . . . . . 55 Nm (41 ft-lb)

NOTE—

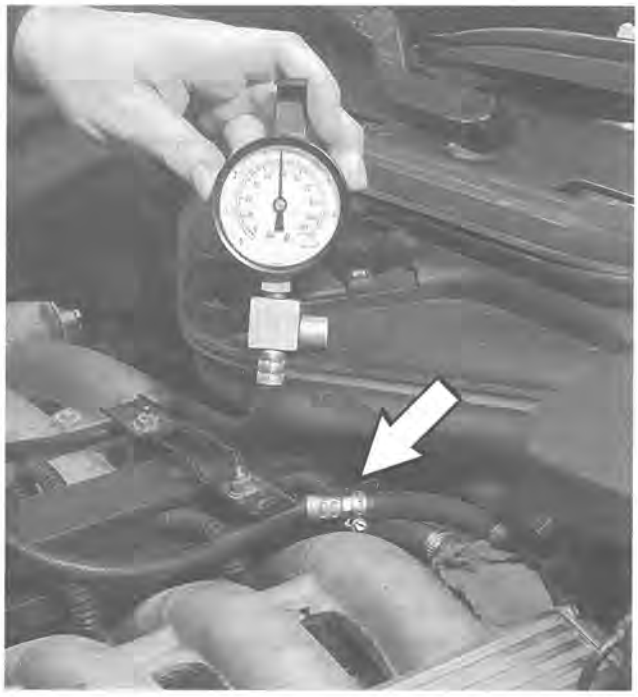
If not already applied, coat oxygen sensor threads with anti-seize compound before installation. Do not get compound on sensor tip.

FUEL PRESSURE TESTS

Checking fuel pressure is a fundamental part of troubleshooting and diagnosing the DME system. Fuel pressure directly influences fuel delivery. An accurate fuel pressure gauge will be needed to make the tests.

There are two significant fuel pressure values:

- **System pressure**–created by the fuel pump and maintained by the pressure regulator
- **Residual pressure**–the pressure maintained in the closed system after the engine (and fuel pump) is shut off.



FUEL PRESSURE TESTS

Relieving fuel pressure and connecting fuel pressure gauge

– To prevent fuel from spraying on a hot engine, relieve system pressure by wrapping a shop towel around fuel supply line and then disconnecting it from fuel rail.

NOTE—

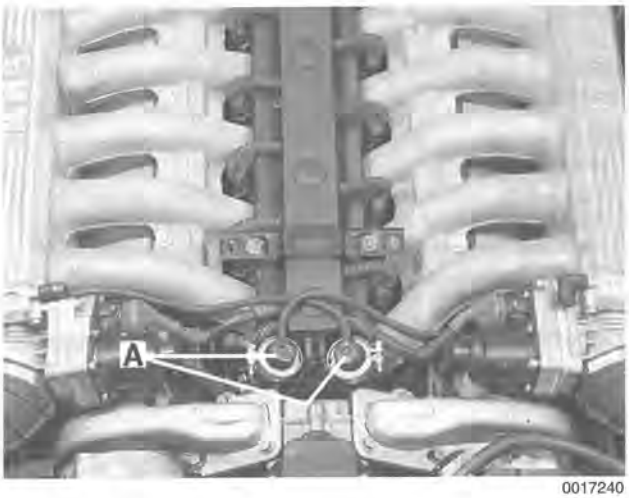
The supply line connects to the fuel rail at the opposite end from where the fuel pressure regulator is connected.

➢ Connect a length of fuel line and a T-fitting to the fuel rail and reconnect the supply line to the T-fitting. Connect the fuel gauge to the T-fitting.

NOTE—
Use BMW pressure gauge (special tool no. 13 3 060) or an equivalent. The fuel pressure gauge should have a range of 0 to 5 bar (0 to 75 psi) and must be securely connected with hose clamps to prevent it from coming loose under pressure.

System pressure, testing

Fuel system pressure is created by the fuel pump and regulated by the pressure regulator. System pressure is not adjustable.



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➤ Fuel pressure deflects diaphragm in fuel pressure regulator(s) (**A**) to return fuel to tank when pressure reaches desired limit (M70 engine shown).

– Relieve fuel pressure and connect a pressure gauge as described earlier.

– Operate fuel pump by bypassing fuel pump relay as described in **160 Fuel Tank and Fuel Pump**.

CAUTION—
The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. If the fuel pump check valve malfunctions (stuck closed), make sure the fuel pressure does not rise above 6.0 bar (87 psi). Damage to the fuel lines or fuel system components could result.

– Compare fuel pressure to specifications.

System Fuel Pressure Specifications

Engine	Fuel pressure
M30	3.0±0.06 bar (43.5 ± 0.9 psi)
M60	3.5±0.06 bar (51 ± 0.9 psi)
M70	3.0±0.06 bar (43.5 ± 0.9 psi)

– When finished testing, disconnect pressure gauge and reconnect fuel line. Tighten hose clamp.

If system pressure is too high, check the return line from the pressure regulator to the fuel tank. Check for kinks in the return hose. Blow compressed air through the line to check for blockages. If no faults can be found, the pressure regulator is faulty and should be replaced.

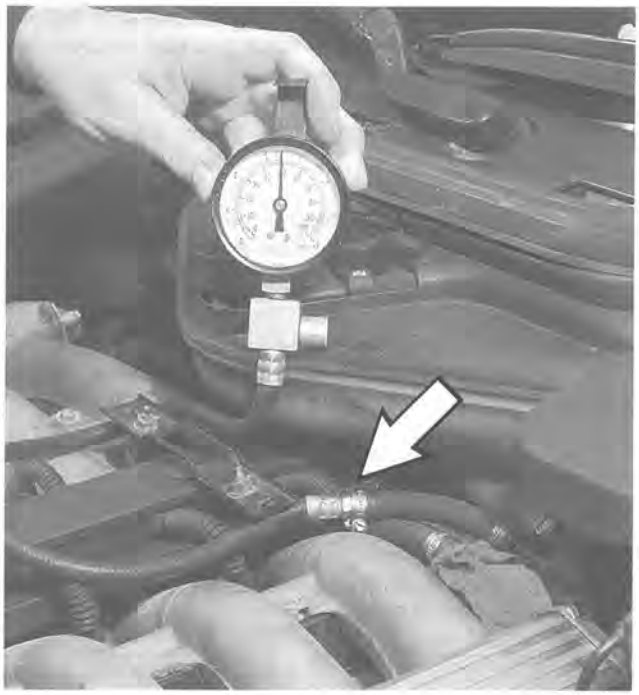
CAUTION—
Do not use compressed air above 40 psi to blow out lines or components. Internal damage to components may result.

If the system pressure is too low, repeat the pressure test while gradually clamping off the fuel return line. The fuel pressure should quickly rise. If the pressure does not respond and no leaks can be found, the fuel pump may be faulty. Test the fuel pump delivery rate as described in **160 Fuel Tank and Fuel Pump**.

Residual pressure, testing

For quick restarts and to avoid vapor lock, the fuel system is designed to retain fuel pressure after the engine has been turned off. This residual pressure is primarily maintained by a check valve at the fuel pump outlet and the fuel pressure regulator.

NOTE —
On some models, the fuel pump check valve may be available as an individual replacement part.



0017073

➢ Fuel pressure gauge attached to fuel supply line (**arrow**).

– Relieve fuel pressure and connect a pressure gauge as described earlier.

> ***WARNING —***
> *Fuel will be discharged. Wrap a shop towel around the fuel line fitting when disconnecting the fuel line. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

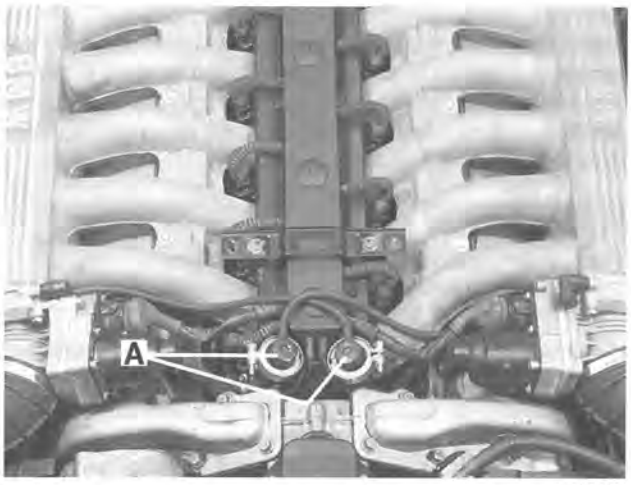
– Operate fuel pump for approximately one minute by bypassing fuel pump relay as described in **160 Fuel Tank and Fuel Pump**.

– Observe fuel pressure gauge after 20 minutes. Pressure should not drop off more than 0.5 bar from system pressure listed earlier.

– When finished testing, disconnect pressure gauge and reconnect fuel line. Tighten hose clamp.

– If fuel system does not maintain pressure, check visually for leaks in fuel lines or at unions. Leaks can also be due to a leaking injector or a faulty fuel pump check valve.

– Check pump check valve by repeating test, but before turning fuel pump off pinch off return line at fuel rail. If pressure is now maintained, the fault is most likely at the fuel pump check valve.



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Fuel pressure regulator response to engine load, testing

– With fuel pressure gauge connected, reinstall fuel pump relay. Start engine and allow it to idle.

NOTE —
The fuel pressure should be slightly lower than the specifications listed earlier. Engine vacuum acting on the fuel pressure regulator diaphragm reduces the fuel pressure.

➢ With engine idling, remove vacuum hose (**A**) from regulator. Pressure should increase. (M70 engine shown)

– Reconnect hose and check that pressure drops.

FUEL PRESSURE TESTS

– When finished testing, disconnect pressure gauge and reconnect fuel line. Tighten hose clamp.

If any faults are found, either the fuel pressure regulator or the vacuum hose at the pressure regulator is faulty.

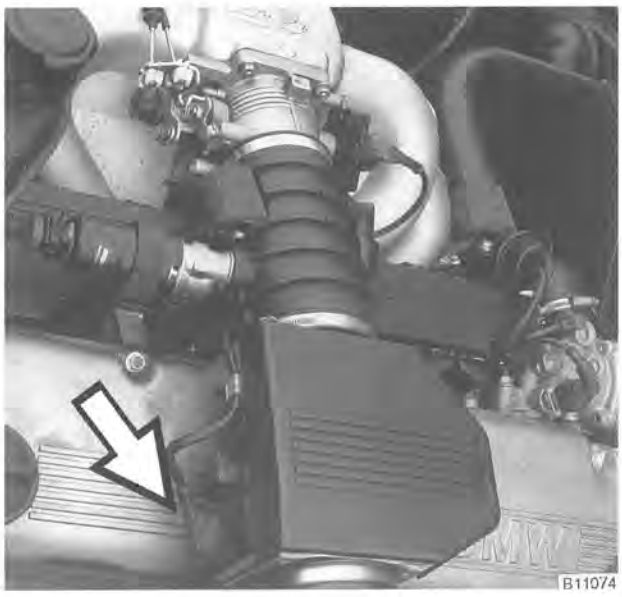
NOTE—
A cracked or leaking pressure regulator vacuum hose may cause an erratic idle.

DME 1.3 (M30 ENGINE)

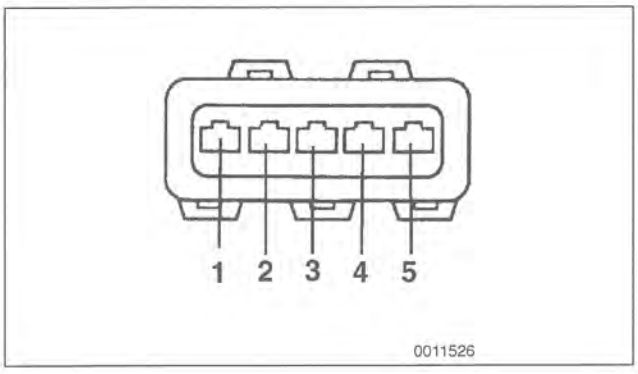
The 6-cylinder M30 engine uses DME 1.3. This system is equipped with On-Board Diagnostics (OBD). Be sure to check for diagnostic fault codes (DTCs) as the first step in diagnosing DME faults. To activate DTC output, see **100 Engine-General**.

Volume air flow sensor, testing and replacing (M30 engine)

DME 1.3 uses a vane-type air flow sensor.



➢ Disconnect harness connector (**arrow**) from air flow sensor.

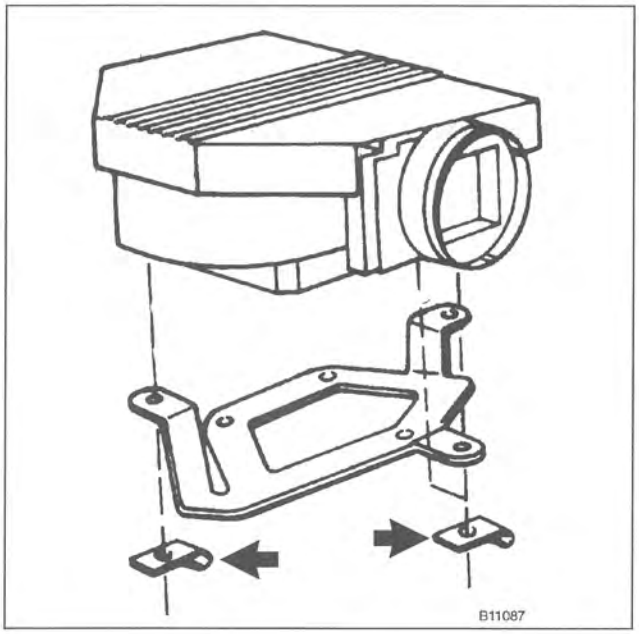


➢ Using a digital voltmeter, test for voltage at terminal **3** in connector. With ignition on there should be approximately 5 volts.

– Turn ignition off and remove intake air boot. Connect a digital ohmmeter across sensor terminals **2** and **3**. Swing air flow sensor vane through its range of travel. Resistance should change steadily without interruption.



➢ To replace sensor, disconnect intake air boots (**A**) and harness connector (**B**) from sensor.

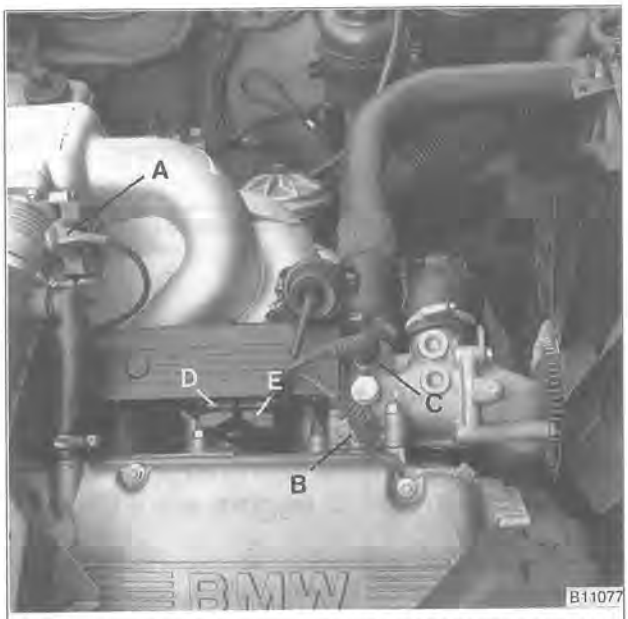


➢ Working underneath sensor, remove sensor retaining clips (**arrows**) and lift sensor off mount.

– Reinstallation is reverse of removal.

Engine coolant temperature (ECT) sensor, testing and replacing (M30 engine)

The engine coolant temperature (ECT) sensor sends continuous engine coolant temperature information to the ECM. The ECT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases.



A. Throttle switch
B. ECT sensor
C. Temperature gauge sender
D. Crankshaft position sensor
E. Cylinder identification sender

➤ Disconnect harness connector from ECT sensor (**B**).

ECT Sensor Location

- M30 engine . . . . . front of engine in coolant flange (blue plug)

– Turn ignition on. Using a digital voltmeter check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

– With harness connector detached use a digital ohmmeter to test resistance across sensor terminals.

Engine Coolant Temperature Sensor (M30 engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (–10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40

– If any faults are found replace sensor.

- Use a new copper sealing washer when installing a new sensor.
- Replace any lost coolant.

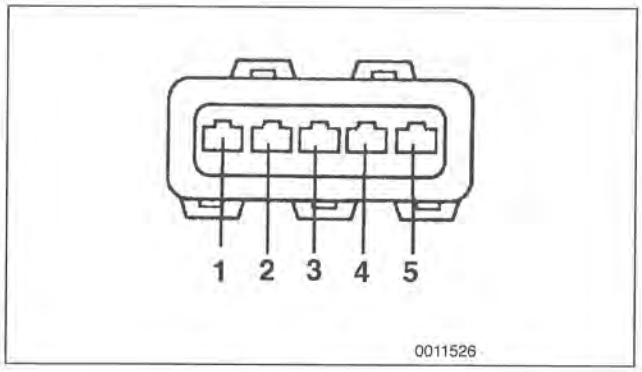
WARNING—
Allow engine to cool to room temperature before removing sensor.

Tightening Torque (M30 Engine)

- ECT sensor to coolant flange . . . . . 18 Nm (13 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing (M30 engine)

The intake air temperature (IAT) sensor is used by the ECM to modify/correct the intake air signal from the air flow sensor based on the temperature of the intake air. The IAT sensor is integrated into the air flow sensor housing and is not separately available as a replacement part.



➤ Using a digital voltmeter, test for voltage across terminals **1** and **4** in volume air flow sensor connector.

– Compare resistance value to values listed below.

Intake Air Temperature Sensor (M30 Engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (–10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40

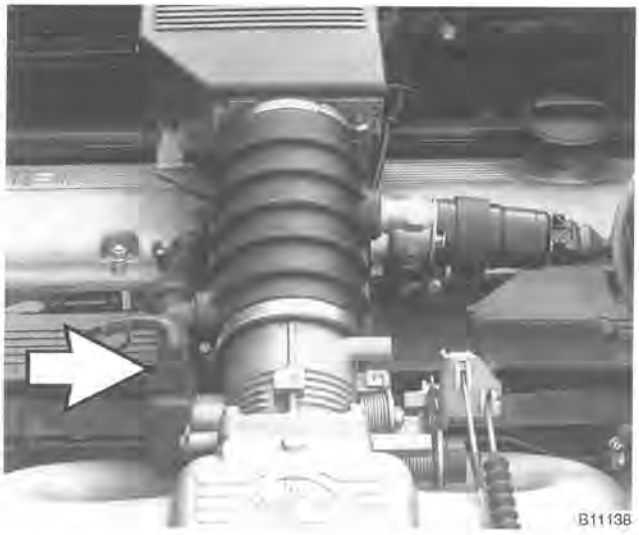
– If any faults are found, replace air flow sensor.

Throttle position switch (TPS), testing and adjusting (M30 engine w/o EML)

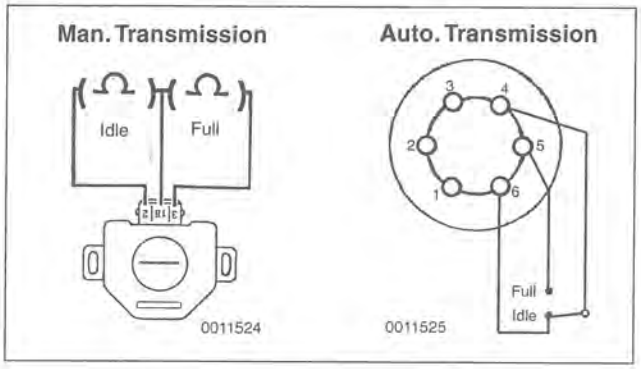
On the M30 engine without EML (electronic throttle control), a throttle position switch (TPS) provides an idle and full throttle position signal to the ECM. The idle position signal is used mainly for activation of the idle speed control valve. The full throttle position signal is used for A/C compressor cutout and fuel enrichment.

The TPS is mounted to the side of the throttle housing. The switch can be checked with the throttle housing installed.

NOTE—
On 735i/iL models (M30 engine) with traction control (ASC), the EML control module provides the throttle position signal to the ECM.



➤ Disconnect harness connector (**arrow**) from throttle switch.



➤ With ignition on, check for supply voltage (VDC) to switch. If voltage is not present, check wiring from ECM.

TPS test terminals (M30 engine)

- Manual transmission
  - Idle position . . . . . **2** and **18**
  - Full throttle position . . . . . **3** and **18**
- Automatic transmission
  - Idle position . . . . . **4** and **6**
  - Full throttle position . . . . . **4** and **5**

– Check for continuity at switch terminals with throttle at idle and at full open positions. Adjust or replace switch if any faults are found.

– To adjust throttle switch, loosen switch screws and connect an ohmmeter across switch terminals. With throttle at idle, rotate switch just until there is continuity. Tighten mounting screws. Seal mounting screws using paint or lacquer.

Idle speed control valve, testing and replacing (M30 engine w/o EML)



On the M30 engine without EML (electronic throttle control), idle speed is maintained through the idle speed control valve (arrow). The idle control function compensates for engine load and engine operating conditions. Idle speed is adaptive through the ECM and no idle speed adjustments can be made.

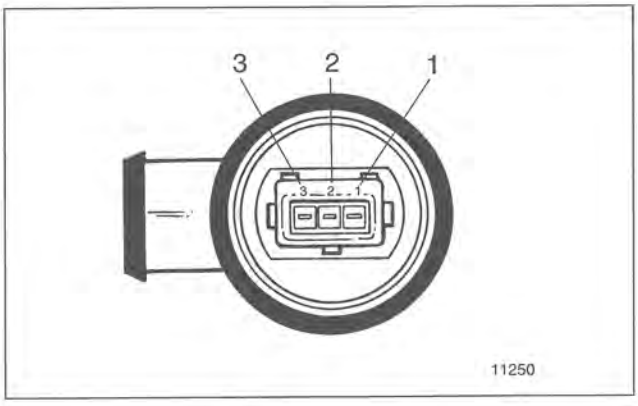
NOTE—

- *Before checking the valve, confirm that the throttle position switch is working correctly.*
- *The test given below is an electrical check only. It does not check the mechanical operation of the valve. If the valve is sticking, hanging up or is sluggish in operation, substituting a known good valve is the best way to check it.*
- *On 735i/iL models with traction control (ASC), an idle speed control valve is not used. Instead, idle speed is controlled via the EML electronic throttle position actuator. See* **EML (M30 or M70 engine)** *later in this repair group.*

– With engine running, check that idle speed control valve is buzzing.

– Turn on A/C or shift car into Drive. Idle should remain steady or increase slightly.

– If valve is not buzzing or if idle decreases, stop engine and disconnect harness connector from valve.



Check resistance of valve across its terminals. Test values are listed below.

Idle Speed Control Valve Coil Resistance Values (M30 engine)

- Terminals **1** and **2** . . . . . .20 ± 2 ohms
- Terminals **2** and **3** . . . . . .20 ± 2 ohms
- Terminals **1** and **3** . . . . . .40 ± 4 ohms

NOTE—

If you suspect an intermittent fault, lightly tap the valve while testing resistance.

– With valve harness connector disconnected, check for battery voltage at red/white wire in connector with ignition on.
  • If there is no voltage, check wiring between connector and main DME relay. See **Electrical Wiring Diagrams**.

NOTE—
The idle speed control valve receives positive (+) battery voltage from the main DME relay.

– If voltage is present as described above, check wiring between ECM and valve. If no wiring faults are found, check ECM output signal to valve.

NOTE—
There are some additional inputs to the control module that affect idle speed, such as throttle position, A/C-on signal or automatic transmission Drive position. Check these signals if idle problems persist. See **ECM Pin Assignments**.

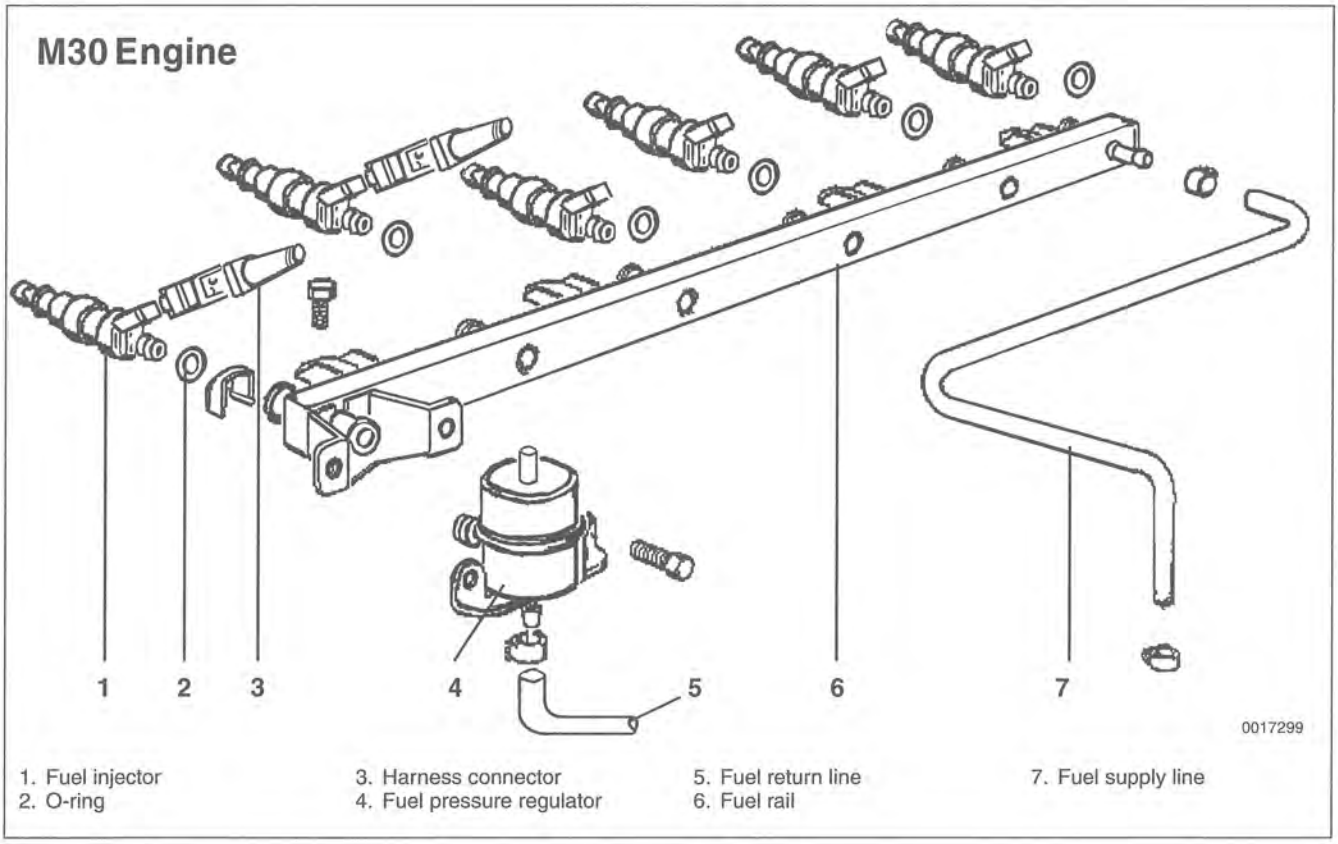


To replace idle speed control valve turn off ignition and disconnect harness connector (**A**).
- Detach rubber retaining strap (**B**) from support bracket.
- Loosen hose clamps (**C**) and remove valve from hoses.
- Installation is reverse of removal.

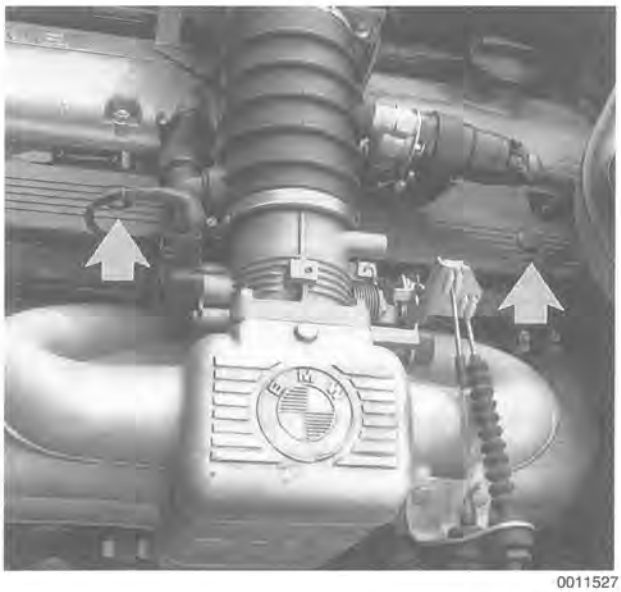
NOTE—
Poor driveability and inconsistent idle may be noticed immediately after replacing idle speed control valve. Drive car for 10 minutes under varying conditions to allow the DME to adapt.

Fuel injectors, testing and replacing (M30 engine)

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common fuel supply called the fuel rail.



1. Fuel injector
2. O-ring
3. Harness connector
4. Fuel pressure regulator
5. Fuel return line
6. Fuel rail
7. Fuel supply line


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NOTE—

The information given here is an electrical test only. The test does not check spray patterns or fuel supply to the injectors.

– Disconnect and remove intake air boot between throttle housing and air filter housing.

➢ Remove plastic trim covers (**arrows**). Remove injector harness cover mounting screws, and then remove cover.



➢ Connect digital voltmeter to wiring in injector housing.

- Operate starter or run engine.
- Check for pulsed voltage (approx. 0.3–1.0 VDC).

> ***CAUTION—***
> *Use a digital multimeter only. Analog meters or test lights may damage the ECM.*

NOTE—
To quick-check a single injector, place a screwdriver or stethoscope on the injector with the engine running. If the injector is operating, there should be an audible buzz.

– If there is no voltage, check for power (+) at red/white wire of each injector connector with ignition key on. If voltage is not present, check main DME relay and wiring to injector using wiring diagrams listed in **Electrical Wiring Diagrams.**

NOTE—
If there is positive (+) battery voltage at injector harness connector, but no response at voltmeter during cranking, check the wire(s) from ECM to injectors. If no wiring faults can be found, the pulsed ground signal from the control module may be missing. Check outputs from ECM.

– If power is present as described in above step, unplug injector connectors and check injector electrical resistance. Replace injector if resistance is incorrect.

Fuel Injector Coil Resistance

- M30 engine . . . . . 16 ohms at 20°C

NOTE—
Injector resistance will vary depending on temperature. In general, the range should be between 10 and 20 ohms.



– If no faults are found up to this point, check pulse-time regulation function of ECM with engine cold.

➢ Connect digital voltmeter to wiring in injector housing as shown.

> ***CAUTION—***
> *Use a digital multimeter only. Analog meters or test lights may damage the ECM.*

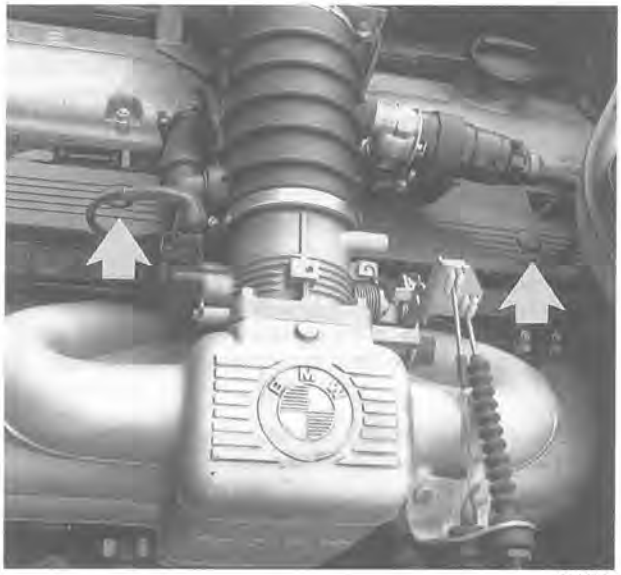
- Start engine.
- Check that voltage decreases as engine warms up.

– If any faults are found, check ECM inputs and outputs as described later.

– To replace injectors, disconnect negative (–) battery cable as described in **020 Maintenance.**

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Disconnect and remove intake air boot between throttle housing and air filter housing.

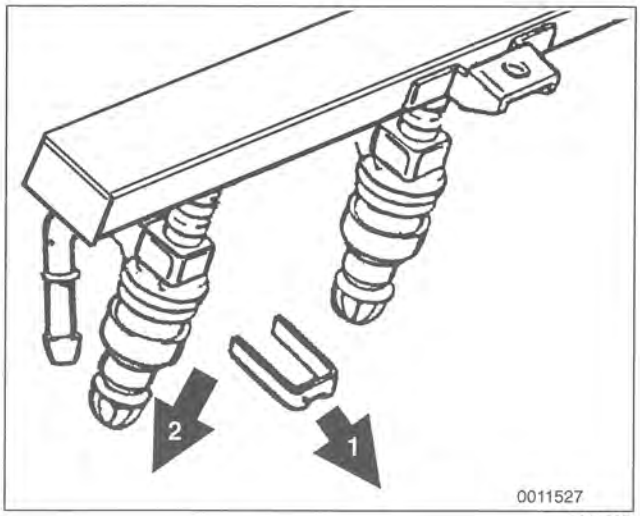


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➢ Remove plastic trim covers (**arrows**). Remove injector harness cover mounting screws, and then remove cover.

– Remove fuel rail mounting bolts.

– Pry up on fuel rail and remove fuel rail and fuel injectors as an assembly.



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➢ Remove injector retaining clip (**1**) and pull injector from rail (**2**).

WARNING—
Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

– Installation is reverse of removal.

- Fit new O-rings when installing injectors.
- Lightly lubricate O-rings with SAE 90w gear lube.

NOTE—
Be sure injector electrical connectors are correctly fitted and injectors are fully seated prior to installing fuel rail mounting bolts.

Tightening Torque (M30 Engine)

- Fuel rail to cylinder head . . . . . 10 Nm (89 in-lb)

Engine control module (ECM), testing and replacing (M30 engine)

DME 1.3 ECM pin assignments are given later in **Table c**. This pinout information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM itself may be faulty.

Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For electrical schematics of the DME system, see **Electrical Wiring Diagrams**.

CAUTION—

- *Always wait at least 40 seconds after turning off the ignition before removing the connector from the engine control module (ECM). If the connector is removed before this time, residual power in the system relay may damage the ECM.*
- *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made by back-probing the connector.



The engine control module (ECM) is mounted in the right rear of the engine compartment, inside the electronics box (E-box) (**arrow**). Terminal numbers are identified on the harness connector and/or on the ECM.

CAUTION—

- *Use only a digital multimeter when making electrical checks at ECM or other solid state DME components.*
- *Control modules and relay locations may vary within the E-box. Consult* **610 Electrical Component Locations** *or* **Electrical Wiring Diagrams** *for supplemental information.*

NOTE—

Electrical parts are not returnable. Before replacing an ECM, run all tests and check harness and connections for possible malfunctions.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Remove cover from electronics box (E-box). The cover is retained with four captive screws. Peel back weather stripping from body for improved access.
- Unplug ECM harness connector by releasing fastener and pivoting connector up and off ECM.
- Remove ECM retaining nuts or clips and lift out ECM.
- Installation is reverse of removal.

> ***CAUTION—***
> *Poor driveability may be noticed immediately after replacing the ECM. Drive for at least 10 minutes under varying conditions to allow ECM to adapt.*

DME 3.3 (M60 ENGINE)

DME 3.3 systems are equipped with advanced On-Board Diagnostics (OBD). Be sure to check for diagnostic fault codes (DTCs) as the first step in diagnosing DME faults. To activate fault code output, see **100 Engine-General** for fault codes.

Mass air flow sensor, testing and replacing (M60 engine)


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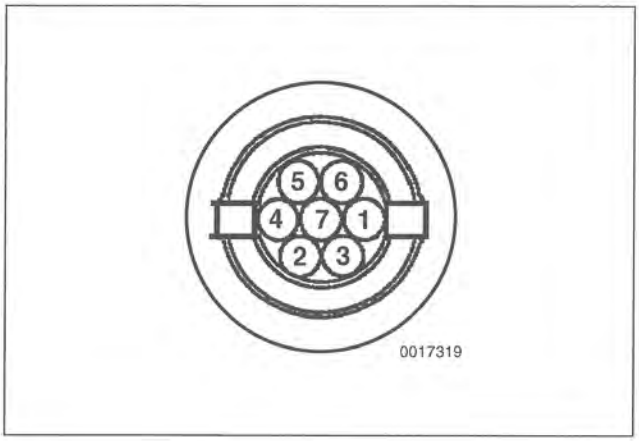
The DME 3.3 system uses a hot film mass air flow sensor. When the engine is running, a current is used to heat a thin film in the center of the meter. The current used to heat the film is electronically converted into a voltage measurement corresponding to the mass of intake air.

NOTE—
A burn-off cycle is not used on hot film sensors.

If the hot film breaks or if there is no output from the air flow sensor, the ECM automatically switches to a "limp-home" mode and turns on the Check Engine light. The engine can usually be started and driven.

The mass air flow sensor has no internal moving parts and cannot be serviced or adjusted.

- Disconnect harness connector from mass air flow sensor.



- Turn ignition on and check for voltage and ground at connector. There should be ground at pin **1** and positive (+) battery voltage at pin **3**.

– If any faults are found, check for wiring breaks between air flow sensor and ECM and between mass air flow sensor and main DME relay.

  • Also check operation of main DME relay.

– To remove mass air flow sensor, detach electrical harness connector and loosen air duct clamps.

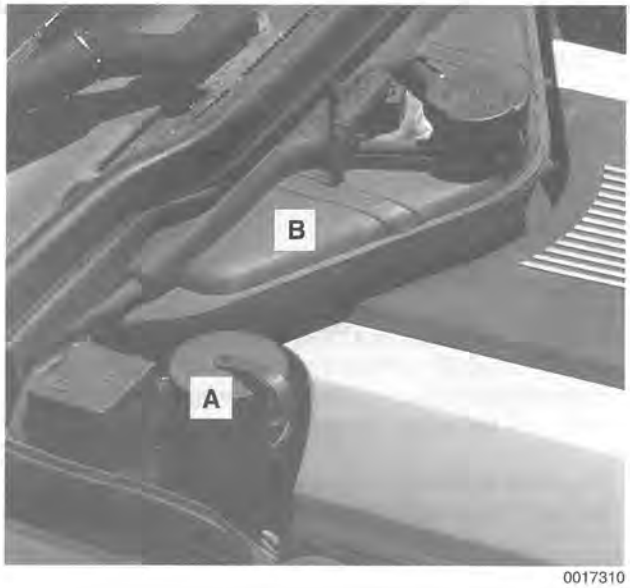
– Installation is reverse of removal.

NOTE—

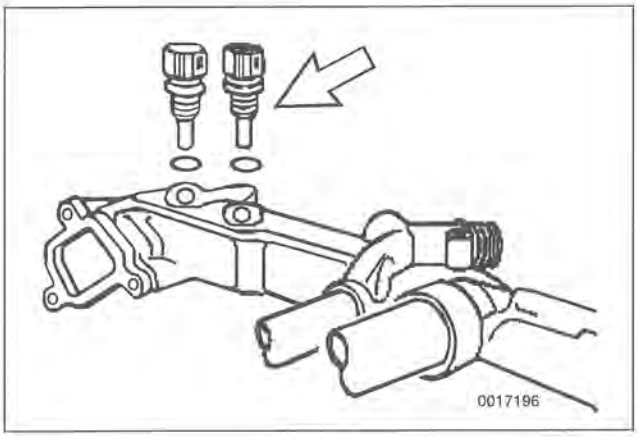
Use only acid free grease or silicone lubricant on gasket and air boot.

Engine coolant temperature (ECT) sensor, testing and replacing (M60 engine)

The engine coolant temperature (ECT) sensor sends coolant temperature information to the ECM. The ECT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases.



- Detach data link (diagnostic) plug (**A**) from holder and unbolt coolant expansion reservoir (**B**) and set aside.



➢ Working at right rear of engine, disconnect harness connector from the ECT sensor (white plug) (**arrow**).

– Turn ignition on. Using a digital voltmeter check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

> ***CAUTION—***
> *Use only a digital multimeter when testing any part of the DME system. Use of an analog meter or test light may damage control modules and sensors.*

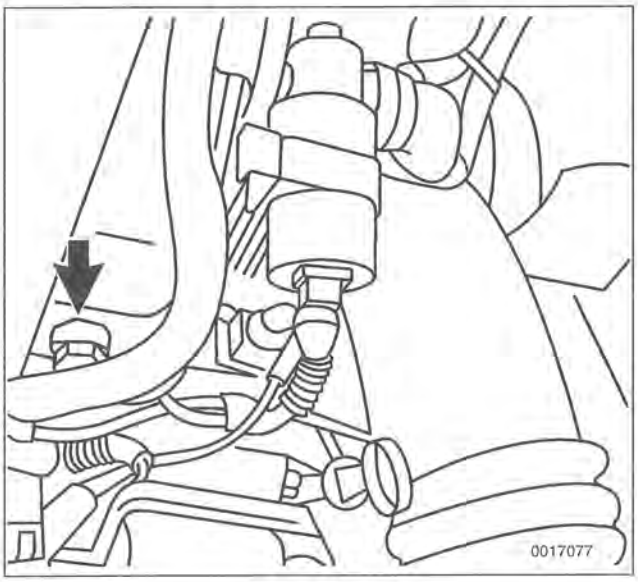
– When replacing ECT sensor, use a new copper sealing washer. Replace any lost coolant.

Tightening Torque (M60 Engine)

- ECT sensor to crosspipe . . . . . 18 Nm (13 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing (M60 engine)

– Remove top engine cover.



➢ Disconnect harness connector from intake air temperature (IAT) sensor (**arrow**).

IAT Sensor Location

- M60 engine . . . . . in intake manifold, right front

– Turn ignition on. Using a digital voltmeter check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

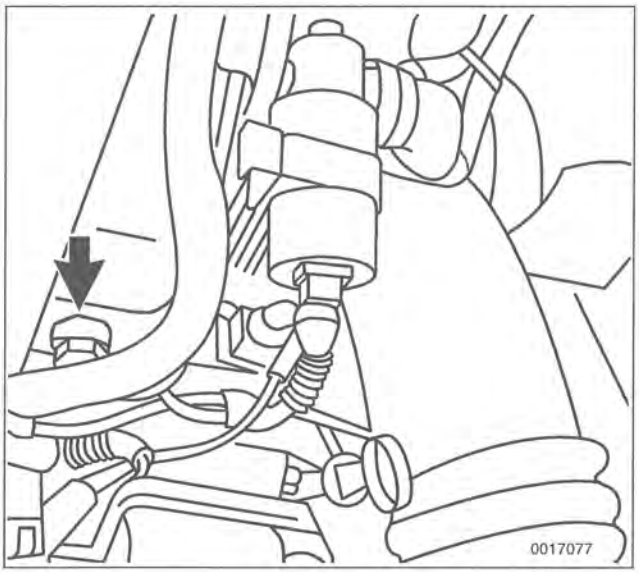
IAT Sensor Voltage Supply

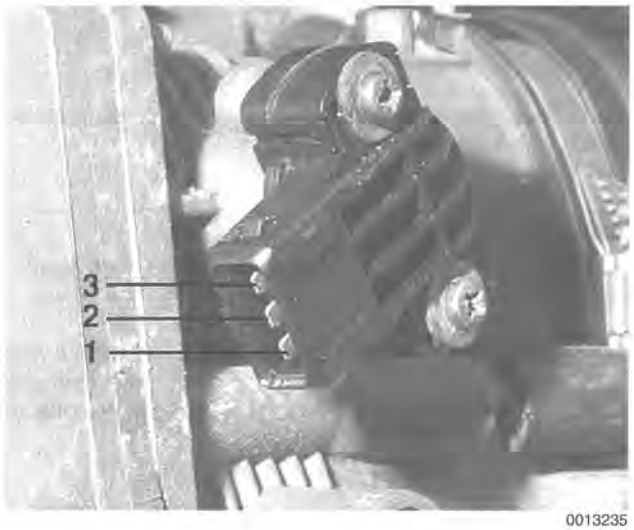
- M60 engine . . . . . yellow/red wire

– With harness connector disconnected, test resistance across sensor terminals. If any faults are found, replace IAT sensor.

Intake Air Temperature Sensor (M60 Engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (–10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40





Throttle position sensor (TPS), testing (M60 engine)

The throttle position sensor (**arrow**) is mounted on the side of the primary throttle housing and is directly connected to the throttle valve shaft. The ECM sends a voltage signal to the potentiometer-type sensor and monitors the voltage that comes back. Resistance decreases (voltage increases) as the throttle opens.

NOTE—

Do not confuse the TPS on the primary throttle housing with the throttle switch on the ADS secondary throttle housing.

Check throttle position sensor function by disconnecting harness connector and checking across terminals.

Throttle position sensor (M60 engine)

test conditions	terminals	test value
Harness connector disconnected, ignition on	**1** in harness connector and ground	5 VDC (approx.)
Harness connector disconnected, ignition off	**1** and **3** at sensor terminals	4.0 k ohms (approx.)
Throttle plate rotated from idle to full throttle position	**1** and **2** at sensor terminals	Continuously variable from 1.0–4.0 k ohms (approx.) without interruption

NOTE—

The throttle position sensor is not adjustable. If test results are incorrect, the sensor should be replaced.

Idle speed control valve, testing and replacing (M60 engine)

Idle speed is maintained by the ECM through the idle speed control valve. The idle control function compensates for engine load and engine operating conditions. Idle speed is adaptive through the ECM and no adjustments can be made.

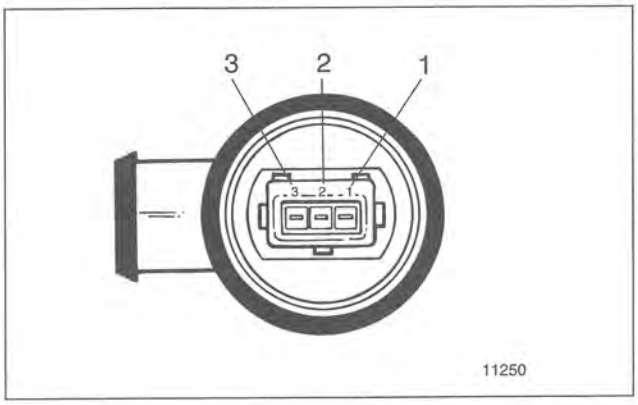
Before checking valve, confirm that throttle position sensor is working correctly.

NOTE—
The test given below is an electrical check only. It does not check the mechanical operation of the valve. If the valve is sticking, hanging up or is sluggish in operation, substituting a known good valve is the best way to check it.



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- With engine running, check that idle speed control valve (**arrow**) is buzzing.
- Turn on A/C or shift car into drive. Idle should remain steady or increase slightly.
- If valve is not buzzing, or if idle decreases in step above, stop engine and disconnect harness connector from valve.



11250

- Check resistance of valve across its terminals. Test values are listed below.

Idle Speed Control Valve Coil Resistance Values (M60 Engine)

- Terminals **1** and **2** . . . . . .20 ± 2 ohms
- Terminals **2** and **3** . . . . . .20 ± 2 ohms
- Terminals **1** and **3** . . . . . .40 ± 4 ohms

NOTE—
If you suspect an intermittent fault, lightly tap the valve while testing resistance.

– With valve harness connector disconnected, check for battery voltage at red/white wire in connector with ignition turned on.

  • If there is no voltage, check wiring between connector and main DME relay. See **Electrical Wiring Diagrams**.

NOTE—
The idle speed control valve receives positive (+) battery voltage from the main DME relay.

– If voltage is present as described above, check wiring between ECM and valve. If no wiring faults are found, check ECM signal to valve.

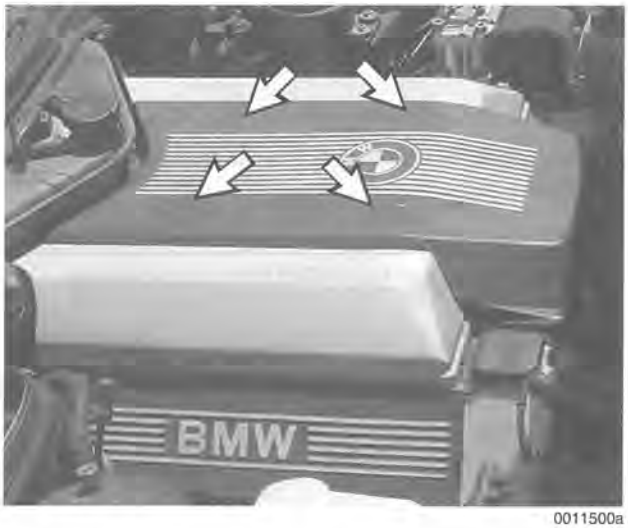
NOTE—
- *The idle speed control valve signal can be checked using a duty cycle meter (or dwell meter). Connect the meter to the valve following the manufacturer's instructions. Turn on the A/C or create a large air leak and check that the valves duty cycle reacts while the idle speed remains steady.*
- *There are some additional inputs to the control module that affect idle speed such as throttle position, A/C-on signal or automatic transmission Drive position. Check these signals if idle problems persist. See* **ECM Pin Assignments**.

– When replacing idle speed control valve, clean and inspect all sealing areas.

  • Inspect sealing ring in throttle body and replace if necessary.

Camshaft position (CMP) sensor, replacing (M60 engine)

The camshaft position (CMP) sensor is located in the front of the right cylinder head, next to the oil dipstick guide tube.



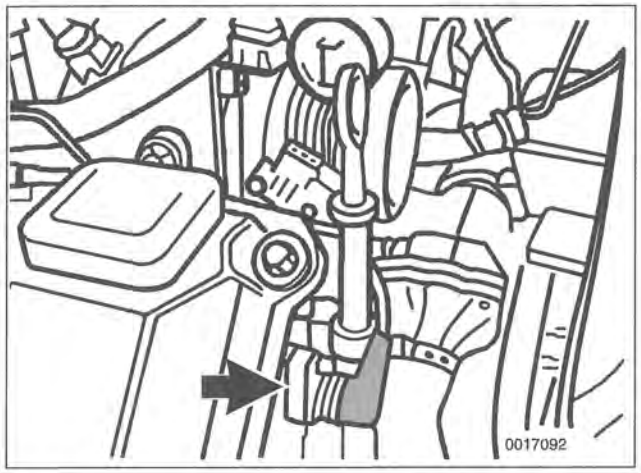
0011500a

➤ Remove plastic cover from top center of engine.

  • Pry out plugs (**arrows**) from covers.
  • Remove nuts and bolts from beneath plugs
  • Lift off cover.

– Detach CMP sensor electrical harness connector and pull harness away from brackets.

– If necessary, remove air intake duct to gain access to front of right cylinder head.



➢ Remove CMP sensor (**arrow**) from front of right cylinder head by unscrewing mounting bolt.

– Installation is reverse of removal.

- Reattach CMP sensor harness with wire ties.
- Check and clear fault memory.

Fuel injectors, testing (M60 engine)

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common fuel supply, called the fuel rail.

NOTE—
The test below is an electrical check only. The test does not check spray patterns or fuel supply to injectors.

– Remove plastic engine covers from top of engine and pry off cover from injector wiring duct.



➢ Connect digital voltmeter to wiring in injector housing as shown.

CAUTION—
Use a digital multimeter only. Analog meters or test lights may damage the ECM.

- Operate starter or run engine.
- Check for pulsed voltage (approx. 0.3–1.0 VDC).

NOTE—
To quick-check a single injector, place a screwdriver or stethoscope on the injector with the engine running. If the injector is operating, there should be an audible buzz.

– If there is no voltage, check for power to injector. There should be battery voltage (+) at red/white wire of each injector connector with ignition key on. If not, check main DME relay and wiring to injectors. See **Electrical Wiring Diagrams**.

NOTE—
If there is positive (+) battery voltage at connector, but there was no response during cranking, check the wire(s) from the ECM to the injectors. If no wiring faults can be found, the pulsed ground signal from the control module may be missing. Check the outputs from the ECM.

– If no faults are found up to this point, check pulse-time regulation function of ECM with engine cold. Connect a voltmeter to wires in connector. Start engine. Check that voltage decreases as engine warms up.

If any faults are found, check the ECM inputs and outputs as described later.

Fuel rail and injectors, removing and installing (M60 engine)

The fuel injectors are removed by first removing the complete injector/fuel rail assembly and then unclipping the injectors from the fuel rail.

Cleanliness is essential when working with fuel circuit components. Thoroughly clean the unions before disconnecting any fuel lines. Use clean tools.

WARNING—
Fuel will be expelled when fuel lines are disconnected. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove plastic engine covers from top of engine and pry off cover from injector wiring duct.

– Unplug ignition coils and fuel injectors.

– Disconnect throttle cable(s) and lay aside.

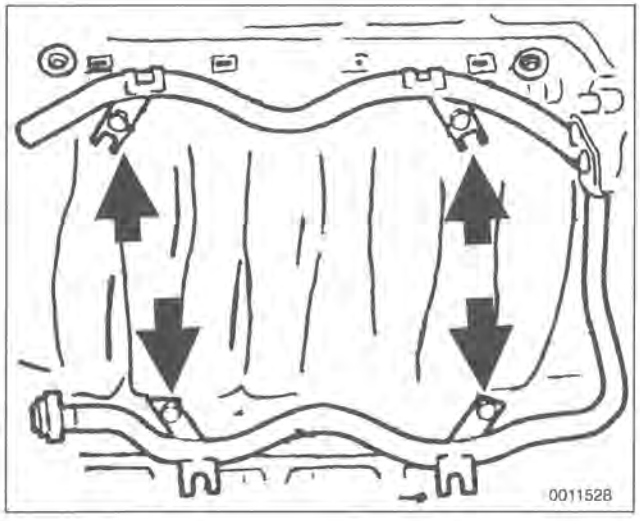
– Detach wiring ducts and lay aside.

– Disconnect fuel lines from fuel rail and fuel pressure regulator.

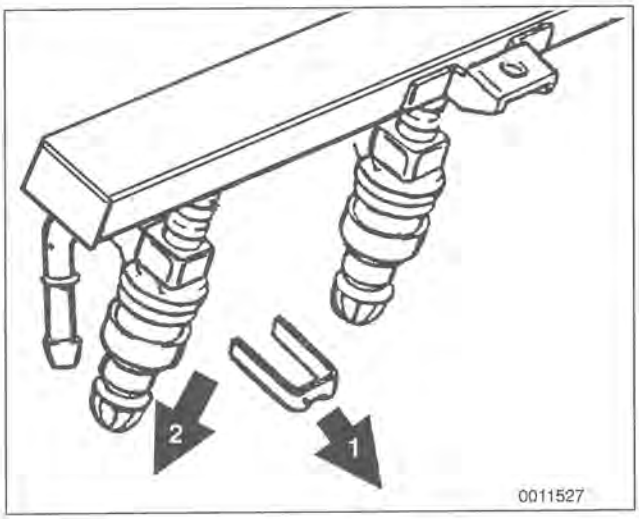
WARNING—
Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

◀ Remove fuel rail mounting bolts (**arrows**).

– Pry up fuel rail and remove with injectors.



DME 3.3 (M60 ENGINE)



➤ Remove injector retaining clip (**1**) and pull injector from rail (**2**).

– Installation is reverse of removal.

- Fit new O-rings when installing injector. For ease of installation, lightly lubricate O-rings with SAE 90w gear lube.
- Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.
- Replace any missing wire ties.
- Install new hose clamps.

Tightening Torque (M60 Engine)

- Fuel rail to cylinder head. . . . . .10 Nm (89 in-lb)

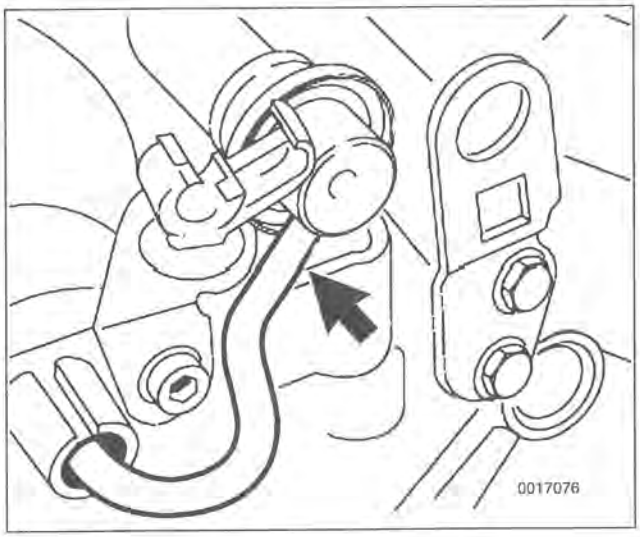
Fuel pressure regulator, replacing (M60 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Detach coolant expansion tank and data link (diagnostic) connector and lay aside.

– Remove top engine cover.



➤ Disconnect fuel pressure regulator vacuum line (**arrow**).

– Note installed position of regulator then remove fuel pressure regulator retaining circlip.

– Wrap a shop rag around regulator. Pull regulator from fuel rail.

> ***WARNING—***
> *Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

– Installation is reverse of removal.

- Tabs on circlip must engage slots in fuel rail.
- Always replace O-rings.

NOTE—
Be sure the part number on the new pressure regulator matches that of the old regulator.

Engine control module (ECM), testing and replacing (M60 engine)

DME 3.3 ECM pin assignments are given later in **Table d**. This pinout information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM itself may be faulty.

Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For electrical schematics of the DME system, see **Electrical Wiring Diagrams**.

CAUTION—

- *Always wait at least 40 seconds after turning off the ignition before removing the connector from the engine control module (ECM). If the connector is removed before this time, residual power in the system relay may damage the ECM.*
- *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made by back-probing the connector.



The engine control module (ECM) is mounted in the right rear of the engine compartment, inside the electronics box (E-box) (**arrow**). Terminal numbers are identified on the harness connector and/or on the ECM.

CAUTION—

Use only a digital multimeter when making electrical checks at ECM or other solid state DME components.

NOTE—

Electrical parts are not returnable. Before replacing the ECM, run all tests and check harness and connections for possible malfunctions.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove cover from electronics box (E-box). The cover is retained with four captive screws. Peel back weather stripping from body for improved access.

– Unplug ECM harness connector by releasing fastener and pivoting connector up and off ECM.

– Remove ECM retaining nuts or clips and lift out ECM.

– Installation is reverse of removal.

CAUTION—
Poor driveability may be noticed immediately after replacing the ECM. Drive for at least 10 minutes under varying conditions to allow ECM to adapt.

DME 1.2 AND DME 1.7 (M70 ENGINE)

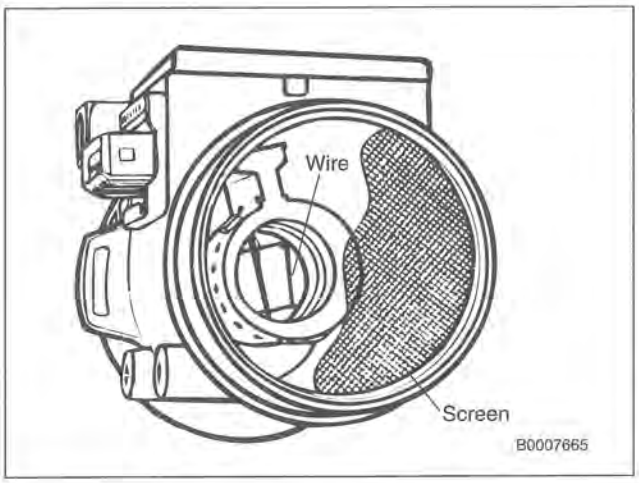
DME systems are equipped with On-Board Diagnostics (OBD). Be sure to check for diagnostic fault codes (DTCs) as the first step in diagnosing DME faults. See **100 Engine-General** for fault codes.

NOTE—
- *M70 V12 engines are managed by two separate 6 cylinder DME systems. Cylinders 1-6 (right bank) use DME control module 1, IAT sensor 1, etc. Cylinders 7-12 (left bank) use DME control module 2, IAT sensor 2, etc.*
- *Each DME control module will store its own fault codes.*

Mass air flow sensor, testing and replacing (M70 engine)

NOTE—
The left mass air flow sensor supplies air to the right bank of cylinders (cyl. 1-6) and the right mass air flow sensor supplies air to the left bank (cyl 7-12).

The mass air flow sensor is not adjustable. Diagnosis of the sensor should be done using specialized diagnosis equipment. The mass air flow sensor operation is monitored by the DME On-Board Diagnostics.



When the engine is running, a current is used to heat a thin wire. The current in the wire is regulated to maintain a temperature of 155°C more than air passing over it. The current is electronically converted into a voltage measurement corresponding to the mass of intake air.

The mass air flow sensor is self-cleaning via the DME control module. Upon engine shut down, the wire is quickly heated to about 1000°C (1830°F) for one second. This "burn-off" cycle takes place automatically.

If the hot wire breaks or if there is no output from the air flow sensor, the ECM automatically switches to a "limp-home" mode and turns on the Check Engine light. The engine can usually be started and driven. The air flow sensor has no internal moving parts and cannot be serviced.



0017237

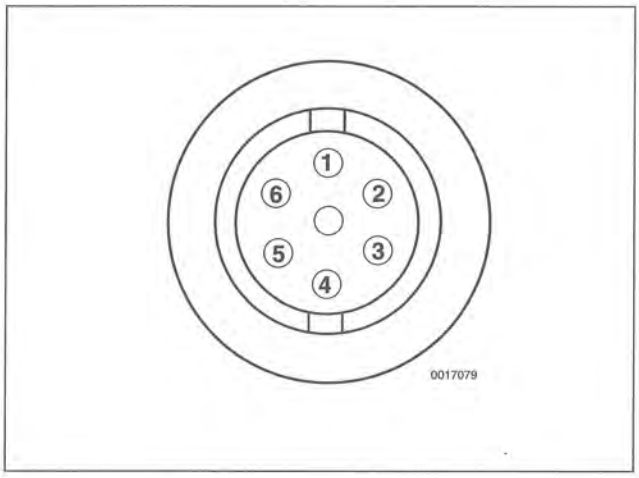
➢ Disconnect air flow sensor from air filter duct only (**A**).
- Leave sensor connected to intake manifold duct (**B**).
- Leave wiring harness connected (**C**).

– Start engine and run to normal operating temperature.

– Rev engine to at least 2,500 rpm, then shut it off. Look through front of meter. After approximately 2 to 4 seconds hot wire should glow brightly for one second.

NOTE—
If the wire glows as specified, then the air flow sensor and ECM are probably operating correctly.

– If glow was not observed, remove air flow sensor and check carefully for a broken wire. If wire is not intact, sensor should be replaced.



0017079

➢ Detach harness connector and test electrical terminals with ignition key in ON position.

Mass Air Flow Sensor Electrical Checks (M70 Engine)
- Left sensor (cyl. 1-6)
  Terminal **2** (red/blue) and ground . . . . . battery voltage
  Terminal **3** (grey/white/yellow) and ground . . . . 5 VDC
  Terminal **4** (brown) and ground. . . . . continuity
- Right sensor (cyl. 7-12)
  Terminal **2** (red-blue) and ground . . . . . battery voltage
  Terminal **3** (grey/white) and ground . . . . . 5 VDC
  Terminal **4** (brown) and ground. . . . . continuity

– If any faults are found, check wiring to sensor harness connector from ECM and main DME relay. See **Electrical Wiring Diagrams**.

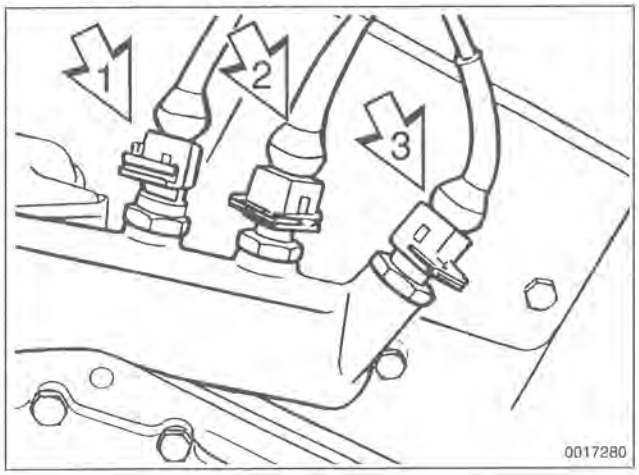


0017237

➢ To replace mass air flow sensor, loosen air duct clamps (**A** and **B**) and detach electrical harness connector (**C**), then lift out sensor, removing mounting fasteners as necessary.

Engine coolant temperature (ECT) sensor, testing and replacing (M70 engine)

The engine coolant temperature (ECT) sensor sends coolant temperature information to the engine control module (ECM). The ECT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases. The ECT sensor housing contains two sensors, one for each DME system.

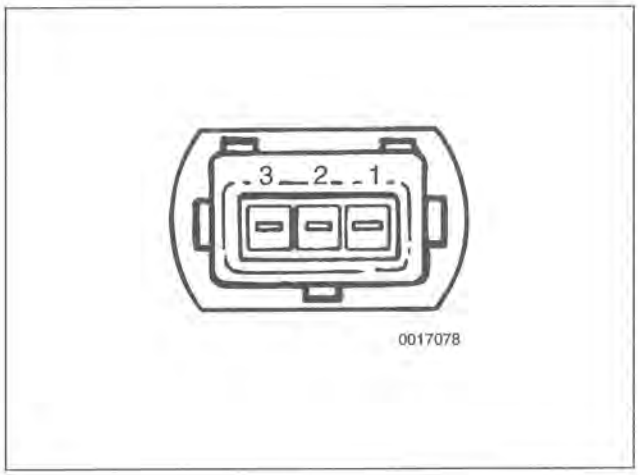


➢ Detach harness connector from ECT sensor (**1**) at right rear of engine on coolant cross pipe.

NOTE—
The coolant reservoir tank may need to be removed to access the ECT sensor.

ECT Sensor Location

- M70 engine . . . . . right rear of engine in coolant cross pipe (3-pin)



➢ Turn ignition on and check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

ECT Sensor Voltage Supply (M70 Engine)

- DME 1. . . . . brown/red wire and ground
- DME 2. . . . . brown/red/yellow wire and ground

ECT Sensor Terminal Identification (M70 Engine)

- ECT sensor 1 . . . . . pin **1**
- ECT sensor 2 . . . . . pin **3**
- Ground . . . . . pin **2**

– With harness connector detached, check resistance across sensor terminals.

- Compare readings to specifications listed.
- If any faults are found, replace sensor.

Engine Coolant Temperature Sensor (M70 Engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (–10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40

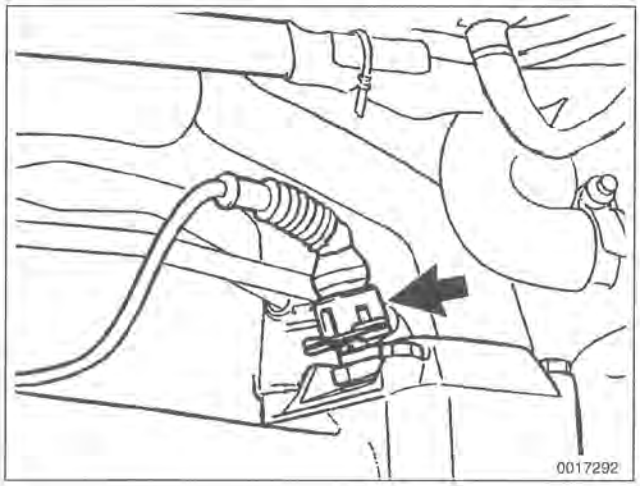
NOTE—
The test values listed represent only three test points from a continuous resistance NTC sensor. For a more accurate test, the sensor can be removed and tested in a bath of hot water using a thermometer.

Use a new copper sealing washer when replacing sensor. Replace any lost coolant.

Tightening Torques (M70 Engine)
- ECT sensor to crosspipe . . . . . 18 Nm (13 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing (M70 engine)

The intake air temperature (IAT) sensor sends intake air temperature information to the ECM. The IAT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases.



➤ Detach harness connector from IAT sensor (**arrow**).

IAT Sensor Location
- M70 engine . . . . . rear of left/right intake manifold.

– Turn ignition on and check for 5 volts between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

– With harness connector detached, check resistance across sensor terminals. Compare resistance readings to specifications listed. If any faults are found, replace sensor.

Intake Air Temperature Sensor (M70 Engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (–10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40

NOTE—
The test values listed represent only three test points from a continuous resistance NTC sensor. For a more accurate test, the sensor can be removed and tested in a bath of hot water using a thermometer.

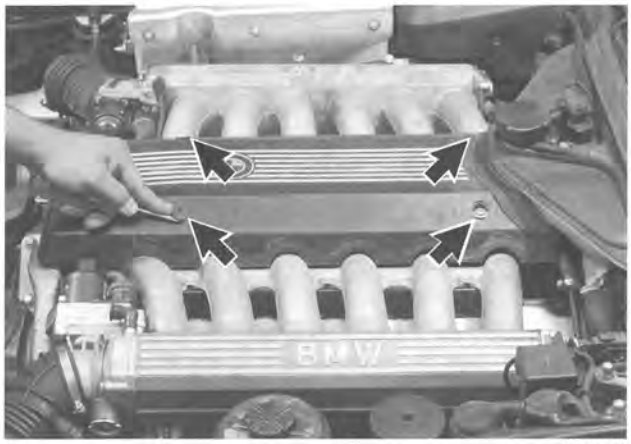
– When replacing IAT sensor, install using a new seal.

Tightening Torque (M70 Engine)
- IAT sensor to intake manifold . . . . . 13 Nm (9.5 ft-lb)

Fuel injectors, testing (M70 engine)

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common fuel supply called the fuel rail.

NOTE—
The test below is an electrical check only. The test does not check spray patterns or fuel supply to the injectors.



0017215

➤ Remove plastic engine cover from top of engine.

- Remove plastic trim covers.
- Remove four retaining screws (**arrows**).



0017075

➤ Pry off connector boot (**arrow**) to access fuel injector electrical connector terminals (connector attached to injector). Connect digital voltmeter to wiring in injector housing as shown.

– Operate starter or run engine and check for pulsed voltage (approx. 0.3–1.0 VDC).

CAUTION—
Use a digital multimeter only. Analog meters or test lights may damage the ECM.

NOTE—
To quick-check a single injector, place a screwdriver or stethoscope on the injector with the engine running. If the injector is operating, there should be an audible buzz.

– If there is no voltage, check for power (+) at red/white wire of each injector connector with ignition key on. If voltage is not present, check wiring from main DME relay or fuel pump relay and wiring to injectors using wiring diagrams See **Electrical Wiring Diagrams.**



0017075

NOTE—

- *On most M70 motors with DME 1.2 (late production 1988-1991), the fuel injectors get positive (+) battery power from the fuel pump relay. On all other models, the fuel injectors get positive (+) battery power from the DME main relay See* **Electrical Wiring Diagrams**.
- *If there is positive (+) battery voltage at injector harness connector, but no response at voltmeter during cranking, the pulsed ground signal from the ECM may be missing. Check outputs from ECM.*

– If power is present as described in above step, unplug injector connectors and check injector electrical resistance. Replace injector if resistance is incorrect.

Fuel Injector Coil Resistance

- M70 engine . . . . . 16 ohms at 68°F (20°C)

NOTE—

Injector resistance will vary depending on temperature. In general, the range should be between 10 and 20 ohms.

➤ If no faults are found up to this point, check ECM pulse-time regulation function of ECM with engine cold. Peel back rubber boot from injector connector (**arrow**) and connect voltmeter to wires in connector. Start engine. Check that voltage decreases as engine warms up.

– If any faults are found, check ECM inputs and outputs as described later.

Fuel rail and injectors, removing and installing (M70 engine)

The fuel injectors are removed by first removing the complete injector/fuel rail assembly and then unclipping the injectors from the fuel rail.

Cleanliness is essential when working with fuel circuit components. Thoroughly clean the unions before disconnecting any fuel lines. Use clean tools.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

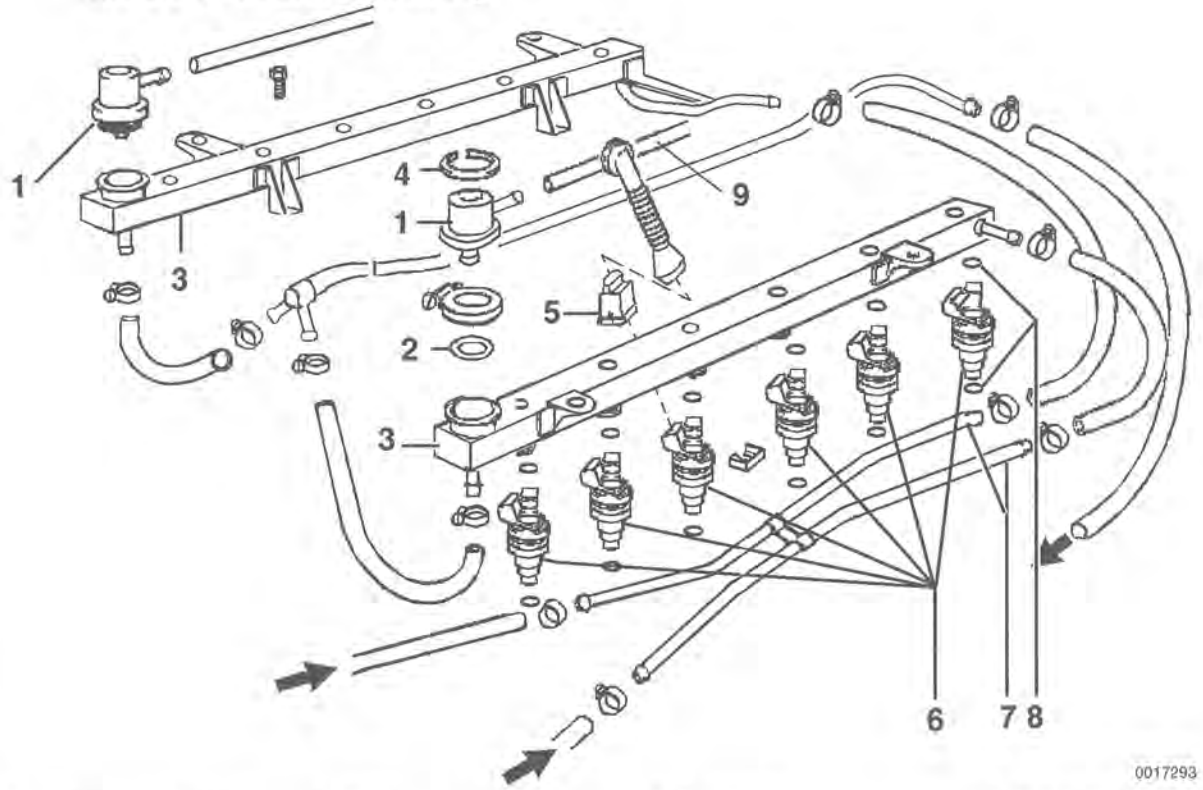
CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove coolant reservoir tank and top engine cover.

– Unplug fuel injectors and throttle position actuators.
  • Label and disconnect other wiring as necessary.
  • Remove wiring duct from above fuel injectors.

M70 Fuel rail assembly



1. Fuel pressure regulators
2. O-ring
3. Fuel rail
4. Circlip
5. Fuel injector harness connector
6. Fuel injector
7. Fuel supply line
8. O-ring
9. Fuel return line

– Disconnect fuel lines from left and right fuel rails.

> ***WARNING—***
> *Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

– Remove fuel rail mounting bolts and pry up fuel rail.

– Remove individual injectors by removing injector retaining clip and pulling injector from rail.

– Installation is reverse of removal.
  • Fit new O-rings when installing injectors.
  • For ease of installation, lightly lubricate O-rings with SAE 90w gear lube.
  • Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.

Tightening Torque

- Fuel rail to cylinder head. . . . . .10 Nm (89 in-lb)

Engine control module (ECM), testing and replacing (M70 engine)

NOTE—

The M70 engine has two identical engine control modules (ECMs). Before beginning work, identify the module to be replaced. When experiencing ECM problems, try switching the ECMs as an aid to diagnosis.

ECM pin assignments are given in **Table e, Table f**, and **Table g**. The pinout information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM(s) may be faulty.

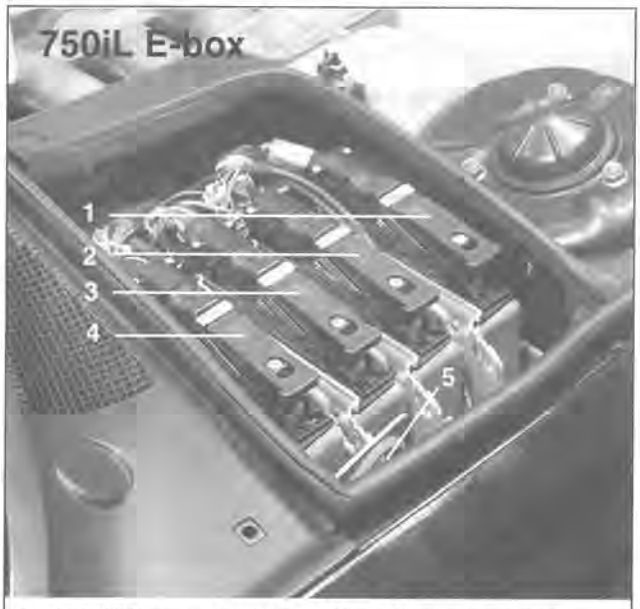
Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For electrical schematics of the DME system, see **Electrical Wiring Diagrams**.

CAUTION—

- *Always wait at least 40 seconds after turning off the ignition before removing the connector from the engine control module (ECM). If the connector is removed before this time, residual power in the system relay may damage the ECM.*
- *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When testing the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical tests can be made by back-probing the connector.

◁ The ECMs are mounted in the right rear of the engine compartment, inside the electronics box (E-box). Terminal numbers are identified on the harness connector and/or on the ECM.



1. ABS/ASC control module
2. ECM 2
3. EML control module
4. ECM 1

0017257

CAUTION—

- *Use only a high-quality digital multimeter (DVOM) when making electrical checks at ECM or other solid state DME components.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Disconnect negative (–) battery cable. See **020 Maintenance**.

– Remove cover from electronics box (E-box). Cover is retained with four captive screws. Peel back E-box weather stripping for improved access.

– To remove ECM, unplug control module harness connector by releasing fastener and pivoting connector up and off ECM.
  - On 1988-1990 models: Remove ECM retaining nuts and lift ECM from its holder.
  - On 1991 and later models: Pry out ECM retaining clips and lift ECM out.

– Installation is reverse of removal.

ELECTRONIC THROTTLE CONTROL SYSTEMS

Most E32 models are equipped with one of two versions of electronic throttle control.

- **EML**– Electronic motor load regulation (M30, M70 engines)
- **ADS**– Automatic throttle valve system (M60 engines)

This section provides basic descriptions of the two systems and some component replacement procedures. System fault diagnosis should be carried out using special BMW dealer test equipment.

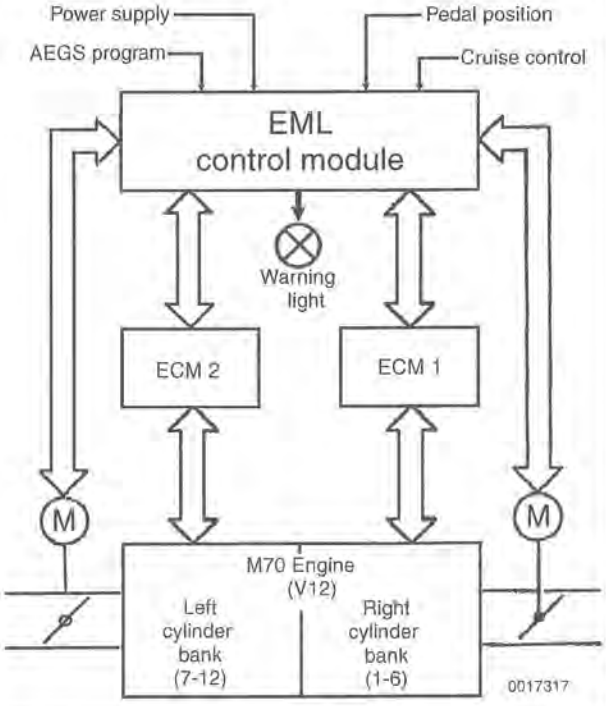
EML (M30 or M70 engine)

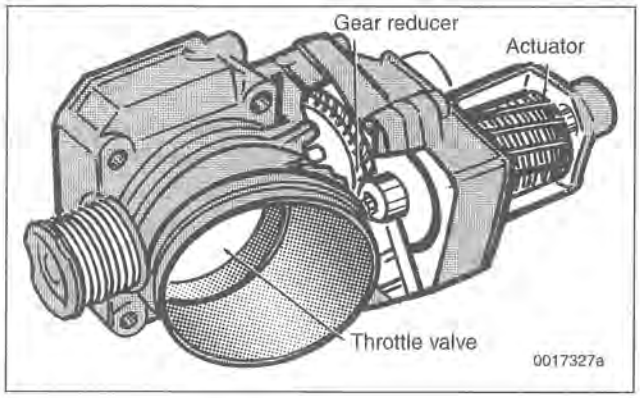
M30 engines with ASC and all M70 engines are equipped with EML (electronic motor load regulation). The EML control module, AEGS (transmission) control module and DME control module(s) are part of an engine management system allowing communication between control modules. The EML system eliminates the need for idle stabilizer valves, cruise control servos and throttle cables.

EML is a "drive-by-wire" system. There are no throttle cables. The EML electronic control module controls idle speed, throttle position and throttle synchronization. Adjustments are not possible.

WARNING —
BMW strictly warns that the external safety path must be checked any time repairs or component replacement are carried out on the EML system. The procedure is described below.

Electronic motor load regulation (EML)





An EML actuator-driven throttle housing assembly is mounted to each manifold (750iL models are equipped with two EML throttle housings). The throttle housing assembly is comprised of two parts, a conventional throttle body and a throttle position actuator or motor.

CAUTION—
Do not disassemble EML throttle housings. Individual throttle housing parts are not available. Throttle housings must be replaced as a complete assembly. Tamper-proof screws are used to assemble throttle housings.

NOTE—
On 750iL models, each intake manifold supplies the opposite bank of cylinders. Cylinders 1-6 (passenger side) use the left intake manifold, left air filter, left mass air flow sensor and left EML throttle housing. Cylinders 7-12 (driver side) use the right intake manifold, etc.

EML warning light

Illumination of the EML warning light signals that the system has detected a fault and one or more fault codes have been stored in the EML control module. Fault code information can be read using BMW diagnostic equipment or an appropriate aftermarket scan tool.

The EML warning light also signals that the EML control module has switched to fail-safe operation. In this condition functions including throttle opening will be limited.

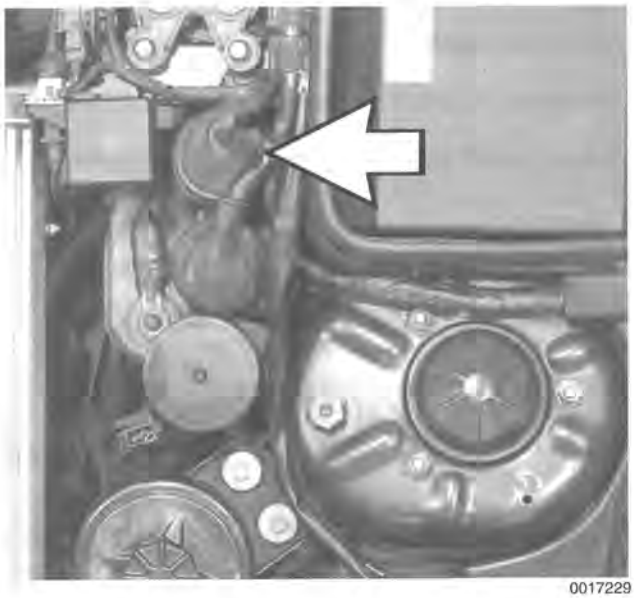
NOTE—
The EML system is highly sensitive to voltage fluctuations. Low battery voltage will set a fault code and turn on the EML warning light.

- If the warning light is on, check to see if the battery or electrical charging system are causing the problem.
  - Check battery connections and battery condition (voltage and specific gravity).
  - Check charging system.

NOTE—
If battery is not properly charging due to driving patterns, consult an authorized BMW parts department for an modified alternator pulley. This will help to keep the battery charge at low engine speeds.)

- Check 50A fusible link near battery (encased in heat shrink tubing).
- Check positive (+) junction under pedal assembly.
- Check grounds (–) and multi-pin connectors for damage or corrosion.
- Check engine oil for proper viscosity for climate. Make sure starter current is not excessive.

External safety path, checking (M30 or M70 engine)

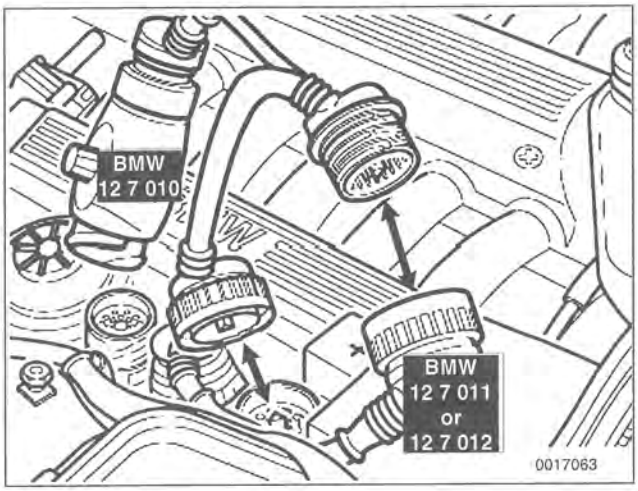

0017229

The external safety path is a safety function built into the EML control module. In the event of an EML malfunction, applying the brake pedal will return the engine speed to idle. BMW recommends that this test be carried out any time an EML component is replaced.

NOTE—

- *A special EML safety path test adapter kit is required to make this test:*
  -BMW special tool 12 7 010: harness with control dial used to manually control engine speed.
  -BMW special tool 12 7 011: adapter for the 20-pin EML harness connector.
  -BMW special tool 12 7 012: adapter for the 25-pin EML harness connector.
- *The BMW special tool numbers are not the part numbers. The above tools can be ordered by adding 88 88 6... to the tool number.*

➢ Switch ignition off and disconnect EML harness connector (**arrow**).



0017063

➢ Install EML safety path test adapter tools.

- On cars with 20 pin plug use BMW special tools no. 12 7 010 and 12 7 011.
- On cars with 25 pin plug use BMW special tools no. 12 7 010 and 12 7 012.

– Turn knob on test harness fully to (–) position.

– Start engine and turn knob to (+) until engine runs at 2,500 rpm.

– Step on brake pedal. Engine speed should immediately drop.

– Remove adapter. Erase fault codes.

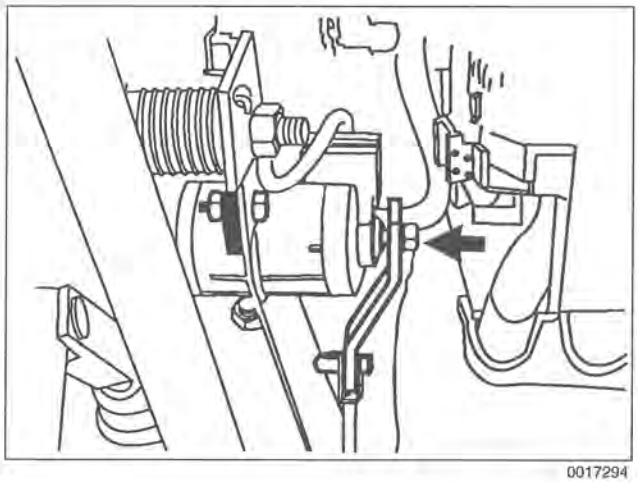
EML throttle synchronization, (M70 engine)

– Disconnect battery for at least 1 hour. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Reconnect battery and start engine. Let engine reach operating temperature without touching accelerator pedal.

> ***CAUTION—***
> *Obey traffic laws. Perform remaining steps in an isolated area.*


0017294

– With transmission in first gear accelerate until engine speed is over 5,000 rpm. Release accelerator pedal and coast until engine is at idle.

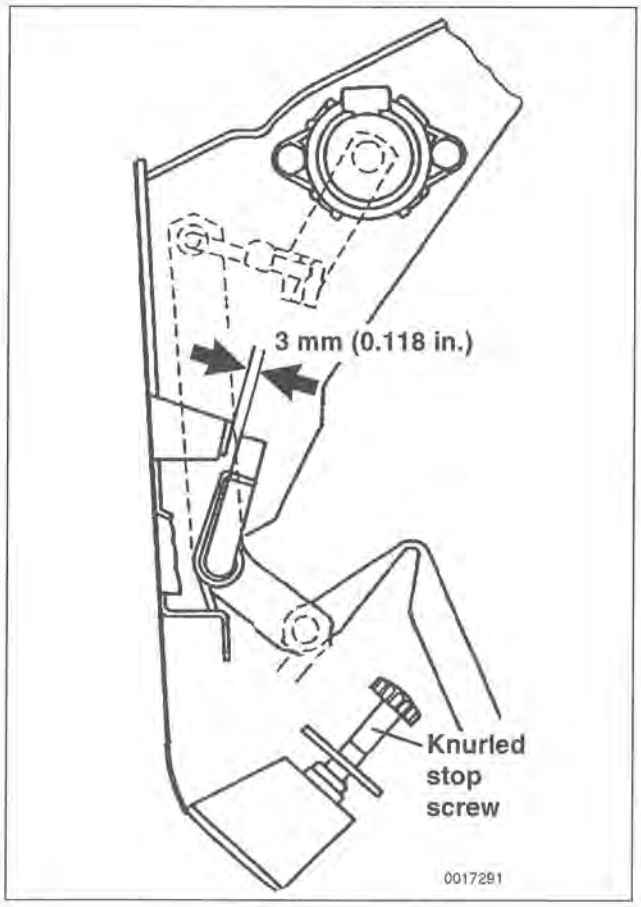
– Repeat above operation two consecutive times.

– Allow engine to idle in neutral or park for at least 5 minutes.

– Turn engine off. EML throttles should now be synchronized.

Pedal position sensor, checking and adjusting (M30 or M70 engine)

➢ Loosen pedal position sensor arm retaining nut (**arrow**).

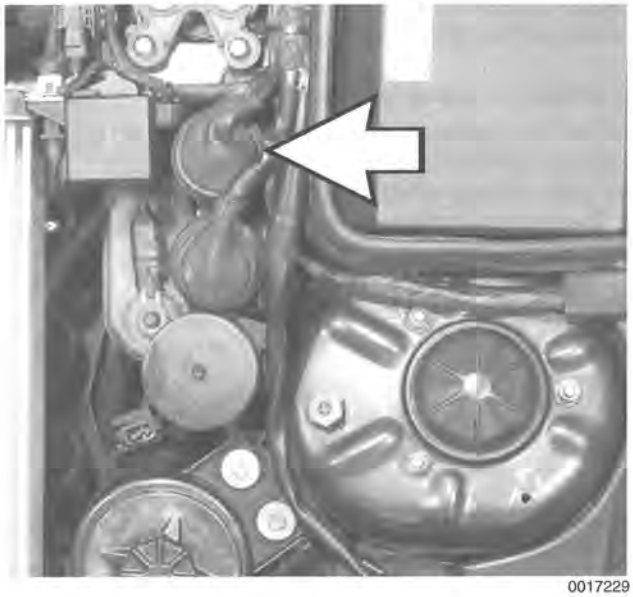


➢ Set gap of 3 mm (0.118 in.) between accelerator pedal bracket and idle stop.

– Support arm and tighten nut. Idle position is now set.

– Adjust pedal travel stop: Press accelerator pedal down by hand just until kickdown pressure point is felt.

- Manual transmission: Adjust knurled stop screw so that pedal travel is stopped (limit stop) at this point. Tighten locknut.
- Automatic transmission: Adjust knurled stop screw so that there is a 6 mm gap between pedal and top of stop screw. Tighten locknut.



0017229

➢ To check adjustment, peel back rubber boot from EML harness connector (**arrow**) and connect digital voltmeter between specified pin in connector and ground.

EML Connector Pedal Position Test Pin

- M30 (DME 1.3)(blue/brown) . . . . . .pin 20
- M70 (DME 1.2)(brown/violet) . . . . . .pin 1
- M70 (DME 1.7)(blue/brown) . . . . . .pin 20

NOTE—

Terminal numbers are molded in the EML connector face. These numbers are very small and may be difficult to read

- Turn ignition on.
- Check signal from pedal position sensor while moving accelerator pedal.

EML Pedal Position Sensor Test

- Pedal at idle position
  Manual transmission. . . . . .0.34-0.43 VDC
  Automatic transmission. . . . . .0.35-0.45 VDC
- Pedal at full throttle
  Manual transmission. . . . . .3.1-3.3 VDC
  Automatic transmission. . . . . .3.7-3.8 VDC

Pedal position sensor, replacing (M30 or M70 engine)

The pedal position sensor is mounted above the accelerator pedal and provides pedal position to the EML control module. An accelerator cable is not used.

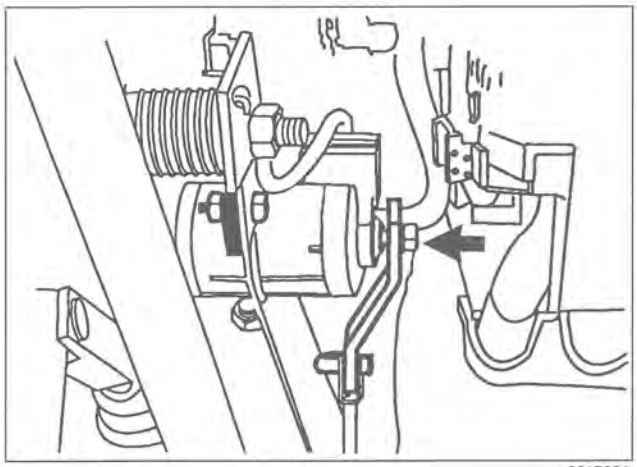
CAUTION—

The throttle position sensor must be adjusted after installation.

– Switch off ignition.

– Remove driver's side knee bolster as described in **513 Interior Trim**.

– Disconnect pedal position sensor lever from accelerator pedal.

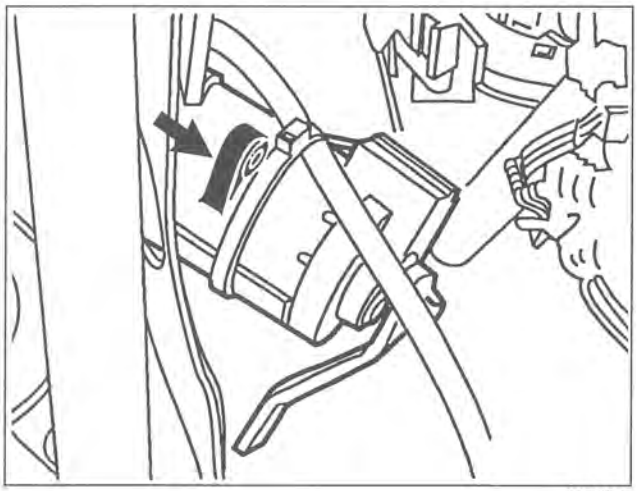


0017294

➢ Remove sensor lever clamping nut (**arrow**) and carefully pry lever from pedal position sensor.

– Unplug harness connector from sensor.

– Remove sensor mounting screws, noting location of spacers.



0017295

➤ Rotate sensor while removing from pedal console. Note eyelet (**arrow**) fits in oval opening of pedal console.

– Installation is reverse of removal.

- Once installation is complete, adjust pedal position sensor as described earlier.
- Check external safety path as described earlier.
- Synchronize throttles if necessary.

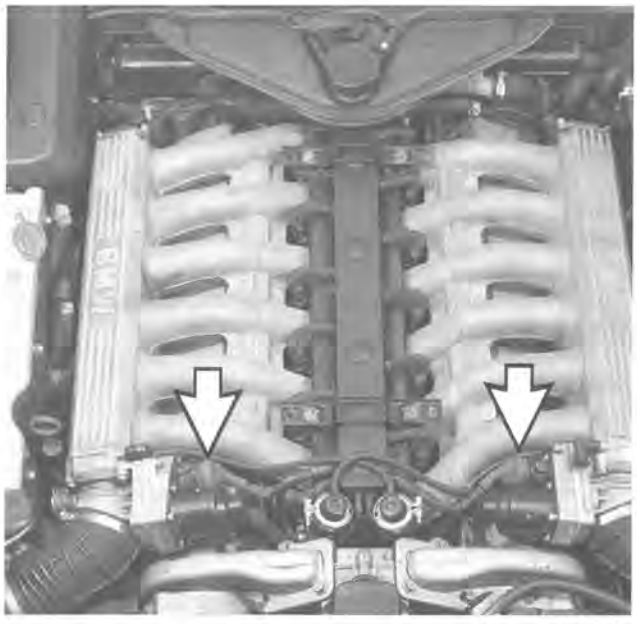
EML throttle housing, testing and replacing (M30 or M70 engine)

An actuator-driven throttle plate is used for each bank of cylinders. The actuator is controlled via the EML control module. Individual parts for throttle housing assemblies are not available..

CAUTION—

- *DO NOT disassemble the throttle housing assembly. Individual parts are not available from BMW and BMW warns that the EML throttle actuator housing must never be disassembled from the throttle body.*
- *The throttle plates in the actuator-driven EML throttle housings may move without warning. Never put fingers or tools in throttle housing.*

– Remove mass air flow sensor and intake boot on EML throttle housing so that throttle plate is visible.



0017240

– Turn on ignition. EML throttle position actuator should hum and throttle plate should flutter.

– Turn ignition off.

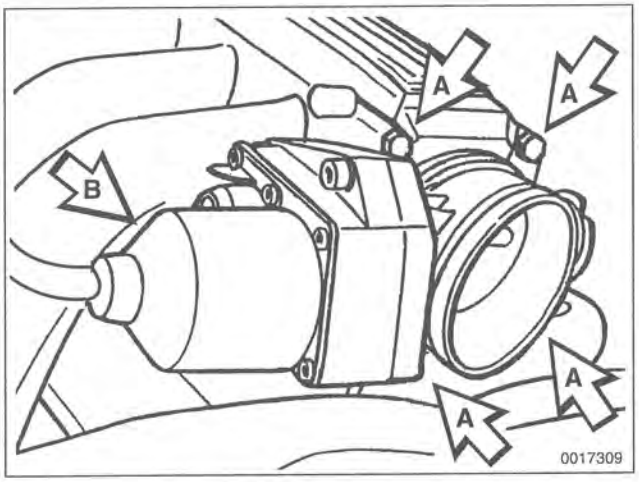
➤ Peel back boot at EML throttle actuator harness connector (**arrow**).

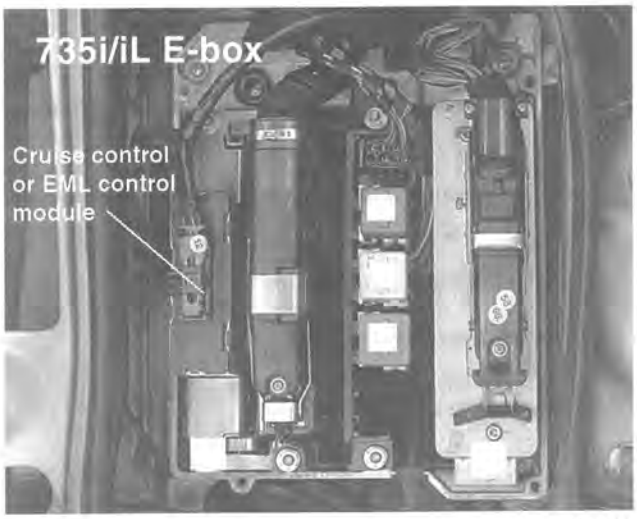
- Connect digital frequency meter between pins 3 and 5 at back of connector.
- Turn ignition on. Meter should read frequency.

– Using a digital multimeter, test for ground and reference voltage at throttle actuator harness connector:

Throttle Position Actuator Check

- Pin 8 and ground . . . . . 0 ohms (approx.)
- Pin 7 and 8 . . . . . 5.0 VDC (approx.)
- Pin 2 and 8 (M30 engine only) . . . . . 5.0 VDC (approx.)







1. ABS/ASC control module
2. ECM 2
3. EML control module
4. ECM 1

– If test fails check wiring and connectors. See **Electrical Wiring Diagrams**.

– Turn ignition off. Disconnect air intake boot from EML throttle housing.

Disconnect harness connector from EML actuator (**B**) and remove 4 bolts (**A**) and remove EML throttle housing assembly.

– Installation is reverse of removal.

- Always replace gaskets.
- Synchronize EML throttles and check external safety path as described earlier.

EML control module, replacing (M30 or M70 engine)

EML control module pin assignments are listed in **Table a** or **Table b**. This information can be helpful when diagnosing faults to or from the EML system. If all inputs and wiring are OK but operational problems still exist, the EML control module may be faulty.

CAUTION—
The EML control module and ECMs must be matched. Under no circumstances may early and late versions of EML and DME be mixed. See an authorized BMW parts department for the latest information.

When replacing EML control module (**3**), switch ignition off.

NOTE—
In some models the cruise control module is in the 3 position.

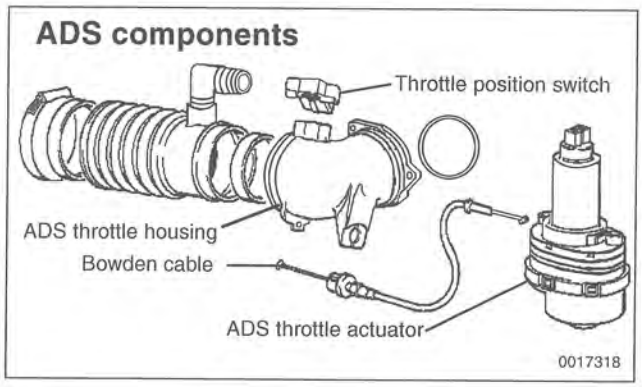
WARNING—
Wait at least 1 minute before disconnecting harness connector. Residual voltage may damage the control module.

– Remove cover from E-box in right rear of engine compartment.

– Release clip and pivot connector up and off EML control module. Remove retaining nuts or clips and remove EML control module.

– Installation is reverse of removal.

- Check external safety path as described earlier.



Auxiliary Throttle Valve (ADS) (M60 engine only)

740i/iL models with ASC+T (traction control) are fitted with a motor-driven auxiliary throttle valve and housing ahead of the standard throttle housing. The ADS throttle valve controls engine throttle intervention based on signals from the DME control module if road conditions (slipping driven wheel) warrant reduced engine power.

ADS throttle housing, replacing

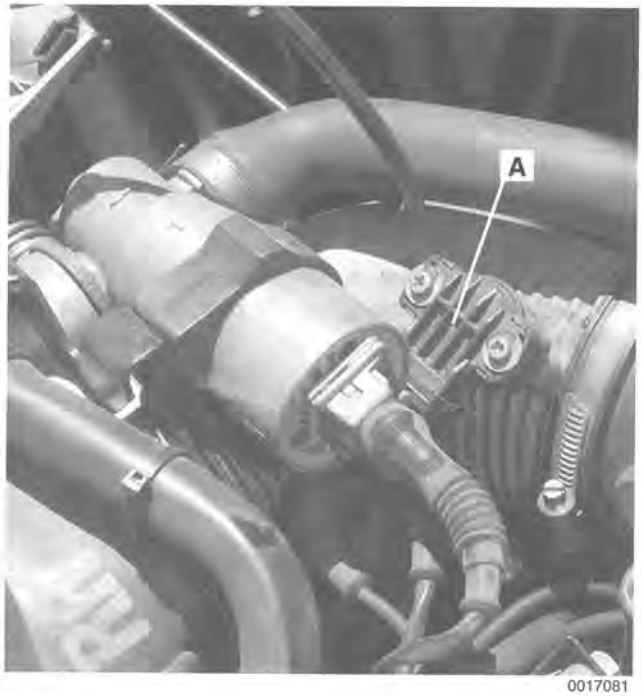
NOTE—
Before replacing the ADS throttle housing read fault codes.

- Switch off ignition and disconnect electrical connector on ADS throttle body.
- Remove hose from idle control valve.
- Loosen hose clamps and remove throttle housing air intake boot.
- Disconnect bowden cable and remove from ADS throttle body.
- Unscrew 3 bolts and remove ADS throttle body.
- Installation is reverse of removal.
  - Replace gasket.
  - Adjust cable to zero backlash.

ADS throttle switch, replacing

NOTE—
Before replacing ADS throttle housing read fault codes.

- Switch off ignition and remove harness connector from ADS throttle switch (**A**).
- Remove mounting screws and remove switch.
- Installation is reverse of removal.
  - Clear fault codes and test drive.
  - Recheck fault codes.



EML PIN ASSIGNMENTS

EML control module pin assignments are listed in **Table a** or **Table b**. The control module is located in the E-box. See **EML control module, replacing (M30 or M70 engine)** earlier in this section.

Table a. EML Pin Assignments–DME 1.3 (M30 engine)

Pin	Signal	Component	Signal/function
1	output	Throttle position sensor	Square wave
2	vacant	—	—
3	input	Instrument cluster	Vehicle speed sensor
4	output	DME control module	Idle signal
5	input	Engine coolant temp sensor	0-5 VDC
6	input/output	Diagnostic connector (Txd)	Diagnosis
7	input	Pedal position sensor	0.4 VDC-4.5 VDC (Approx.)
8	input	A/C relay/DME	12 VDC
9	output	Diagnostic connector (Rxd)	Diagnosis
10	input	Throttle housing assembly	Square wave
11	output	Electronic ground	Component ground
12	output	Instrument cluster	EML warning lamp
13	output	ASC/EGS	Square wave
14	ground	Ground	Ground point
15	input	Pedal position sensor	0.4-4.0 VDC
16	input	Throttle body	Throttle position sensor
17	output	Throttle body	5.0 VDC (approx.)
18	input	DME control module	P/N identifier
19	Input/output	FGR switch	0-5.0 VDC
20	input	Brake light switch	12 VDC (on)
21	input	Throttle housing assembly, 9 switch	5 VDC (on)
22	input	Throttle housing assembly, 17 switch	5 VDC (on)
23	ground	Component ground	Ground
24	input	DME control module	Square wave
25	input	Main relay	12 VDC (approx.)
26	input	Clutch pedal switch	0 VDC (approx.)
27	output	EGS control module	Kick down signal
28	output	DME control module	Full load signal, approx. 0 VDC
29	input	DME control module	Square wave

Table a. EML Pin Assignments–DME 1.3 (M30 engine)

Pin	Signal	Component	Signal/function
30	vacant	—	—
31	input	EGS control module	approx 0 VDC
32	output	PWG potentiometer	approx. 5 VDC (not short circuit proof)
33	input	A/C compressor clutch	approx. 12 VDC (on)
34	input	ABS/ASC control module	Square wave
35	input	ABS/ASC control module	Square wave
36-55	vacant	—	—

Table b. EML Pin Assignments–DME 1.2 and DME 1.7 (M70 engine)

Pin	Signal	Component	Signal/function
1	output	Throttle position sensor	Ignition coil primary control
2	ground	Ground	Ground
3	vacant	—	—
4	input	Slip control module	Square wave
5	output	Full load signal	DME control unit 1
6	output	Idle signal	DME control unit 1
7	input	Throttle position sensor	0.4 VDC-4.5 VDC (Approx.)
8	input	Instrument cluster	Road speed signal
9	output	Throttle position sensor	5 VDC
10	input	Cylinder 7-12 throttle body	Electronic ground
11	output	Cylinder 7-12 throttle body	5 VDC
12	output	Cylinder 1-6 throttle body	5 VDC
13	output	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal
14	ground	Ground	Ground point
15	output input	EML warning lamp, ignition on ignition off	EML lamp control Voltage supply for defect code memory
16	output	Cylinder 7-12 throttle body	Drive throttle (DK) actuator
17	output	Cylinder 1-6 throttle body	Drive throttle (DK) actuator
18	input	Engine control module relay cylinder 1-6	Power supply (terminal 15)
19	ground	Ground	Ground point
20	input	Transmission control module	Kick down signal
21	vacant	—	—
22	input	Slip control module	DK angle increase (DKE)
23	output	ASC/EGS	Throttle position signal (DKV)

EML PIN ASSIGNMENTS

Table b. EML Pin Assignments–DME 1.2 and DME 1.7 (M70 engine)

Pin	Signal	Component	Signal/function
24	vacant	—	—
25	vacant	—	—
26	input	Throttle body, cylinder 1-6	Electronic ground
27	input	Throttle body, cylinder 1-6	throttle position
28	input	Throttle body, cylinder 7-12	Throttle position
29	vacant	—	—
30	ground	Ground	Ground point
31	input	Cruise control switch	Electronic ground
32	output	DME control module, cylinder 7-12	Idle signal
33	output	DME control module, cylinder 7-12	Full load signal
34	output	Throttle body, cylinder 7-12	Drive throttle (DK) actuator
35	output	Throttle body, cylinder 1-6	Drive throttle (DK) actuator
36	input	Engine control module relay, cylinder 7-12	12 VDC (terminal 15)
37	input	Engine control module relay, cylinder 1-6	12 VDC (terminal 15)
38	input	Throttle body, cylinder 1-6	Throttle (17° switch)
39	vacant	—	—
40	input	Throttle body, cylinder 7-12	Throttle (17° switch)
41	input	A/C relay	A/C switch
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	input/output	Cruise control switch	Cruise control switch
44	input	EML control module	A/C compressor on
45	input	Engine temperature sensor	Engine coolant temperature (0-5 V, temperature dependent)
46	input	Cruise control switch	Cruise control
47	input	DME control module, cylinder 1-6	Engine speed signal
48	vacant	—	—
49	input	DME control module, cylinder 1-6	Injection signal
50	input	DME control module, cylinder 7-12	Injection signal
51	vacant	—	—
52	input	Transmission control module	S-program identifier
53	input	Brake light switch	Brake light switch)
54	vacant	—	—
55	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) and RxD (receive) signal

ECM PIN ASSIGNMENTS

ECM control module pin assignments are listed in **Table c** through **Table g**. This information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM control module may be faulty.

Table c. ECM Pin Assignments–DME 1.3 (M30 Engine without EML)

Pin	Signal	Component	Signal/function
1	output	Ignition coil	Ignition coil primary control
2	ground	Ground	Chassis ground
3	output	Fuel pump relay (terminal 85)	Fuel pump relay control (crankshaft position signal must be present for relay to switch)
4	output	Idle speed control valve	Pulsed ground (duty cycle) close signal (see also terminal 22)
5	output	Evaporative purge valve	Pulsed ground (mapped) with engine running at normal temperature and varying engine load
6	output	Instrument cluster	RPM signal to instrument cluster
7	input	Volume air flow sensor	Voltage signal from volume air flow sensor (0-5 VDC, varies with engine load)
8	input	Cylinder identification sensor	Voltage pulse (VAC) between pin 8 and pin 31 when cylinder no. 6 fires (for ignition control)
9	vacant	—	—
10	ground	Oxygen sensor	Ground for oxygen sensor signal
11	vacant	—	—
12	output	Volume air flow sensor	Voltage supply (5 VDC) to volume air flow sensor
13	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to pin 15 in data link connector
14	ground	ground distribution	Ground for fuel injectors output stage
15	output	Check Engine lamp	Check engine lamp control
16	output	Fuel injectors, cyl. 1,3,5	Pulsed ground (injection pulse width in ms)
17	output	Fuel injectors, cyl. 2, 4, 6	Pulsed ground (injection pulse width in ms)
18	input	Power supply (terminal 30)	Battery voltage (B+) at all times (terminal 30)
19	ground	Shielding ground	Ground for ECM and sensor shielding
20	vacant	—	—
21	vacant	—	—
22	output	Idle speed control valve	Pulsed ground (duty cycle) open signal (see also terminal 4)
23	vacant	—	—
24	ground	Ground	Ground for output stages other than injectors and ignition
25	vacant	—	—
26	ground	Volume air flow sensor	Ground for volume air flow sensor
27	input	Power supply (terminal15)	Battery voltage (B+) with key in on or start position

Table c. ECM Pin Assignments–DME 1.3 (M30 Engine without EML) (continued)

Pin	Signal	Component	Signal/function
28	input	Oxygen sensor	Oxygen sensor signal wire (0-1 VDC fluctuating with engine running)
29	input	Instrument cluster	Vehicle speed signal from instrument cluster
30	vacant	—	—
31	input	Cylinder identification sensor	Voltage pulse (VAC) between pin 8 and pin 31when cyl. no. 6 fires (for ignition control)
32	output	Instrument cluster	Fuel consumption output (KVA signal) to instrument cluster
33	vacant	—	—
34	vacant	—	—
35	vacant	—	—
36	output	Main relay (terminal 85)	Main relay activation
37	input	Main relay (terminal 87a)	Voltage supply from main relay to DME control unit
38	input	On-board computer	Drive-away protection enable
39	input	Data link connector	Programming voltage
40	input	A/C compressor on)	A/C refrigerant pressure switch and compressor clutch
41	input	A/C on	Auxiliary fan on signal
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	vacant	—	—
44	input	Intake air temperature	Intake air temperature via volume air flow sensor (0-5 V, temperature dependant)
45	input	Engine temperature	Engine coolant temperature (0-5 V, temperature dependent)
46	vacant	—	—
47	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
48	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
49	vacant	—	—
50	vacant	—	—
51	input	Ignition timing intervention	from Automatic transmission control module
52	input	Throttle position switch	Ground with throttle in idle position via throttle position switch
53	input	Throttle position switch	Ground with throttle in full open position via throttle position switch)
54	input	Electronic transmission control unit	Torque converter clutch WK
55	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) and RxD (receive) signal to/from pin 20 in Data link connector

Table d. ECM Pin Assignments–DME 3.3 (M60 Engine)

Pin	Signal	Component	Signal/function
1	output	Fuel pump relay (terminal 85)	Fuel pump relay switches with engine running or cranking (crankshaft position signal must be present for relay switchover)
2	output	Idle speed control valve	Pulsed ground—close signal (see also pin 29)
3	output	Fuel injector, cyl. 1	Pulsed ground (injection pulse width in ms) cyl. 1
4	output	Fuel injector, cyl. 4	Pulsed ground (injection pulse width in ms) cyl. 4
5	output	Fuel injector, cyl. 6	Pulsed ground (injection pulse width in ms) cyl. 6
6	ground	Ground	Ground point X6452
7	output	Fuel injector, cyl. 7	Pulsed ground (injection pulse width in ms) cyl. 7
8	output	Check Engine lamp	Instrument cluster, Check Engine lamp
9	vacant	—	—
10	vacant	—	—
11	output	Electronic throttle control module	Throttle angle signal to traction control module
12	input	Oxygen sensor #2, (cyl. 5-8)	Oxygen sensor #2 signal (0-1 VDC fluctuating with engine running)
13	input	Oxygen sensor #1, (cyl.1-4)	Oxygen sensor #1 signal (0-1 VDC fluctuating with engine running)
14	ground	Mass air flow sensor	Ground for mass air flow sensor
15	input	Ignition circuit	Ground for ignition circuit monitoring
16	input	Crankshaft position/rpm sensor	Voltage pulse (VAC) between pin 16 and 43)
17	input	Camshaft position sensor	Voltage pulse (VAC) between pin 17 and 44)
18	vacant	—	—
19	vacant	—	—
20	vacant	—	—
21	vacant	—	—
22	output	Ignition coil, cyl. 7	Primary signal, ignition coil 7
23	output	Ignition coil, cyl. 6	Primary signal, ignition coil 6
24	output	Ignition coil, cyl. 4	Primary signal, ignition coil 4
25	output	Ignition coil, cyl. 1	Primary signal, ignition coil 1
26	input	Power supply (terminal 30)	Battery voltage (B+) at all times
27	output	Main relay (terminal 85)	Main relay activation
28	ground	Ground	Ground for ECM and sensor shielding
29	output	Idle speed control valve	Pulsed ground—open signal (see also pin 2)
30	vacant	—	—
31	output	Fuel injector, cyl. 5	Pulsed ground (injection pulse width in ms) cyl. 5
32	output	Fuel injector, cyl. 8	Pulsed ground (injection pulse width in ms) cyl. 8
33	output	Fuel injector, cyl. 3	Pulsed ground (injection pulse width in ms) cyl. 3
34	ground	Ground	Ground for remaining output stages

Table d. ECM Pin Assignments–DME 3.3 (M60 Engine) (continued)

Pin	Signal	Component	Signal/function
35	output	Fuel injector, cyl. 2	Pulsed ground (injection pulse width in ms) cyl. 2
36	output	Evaporative purge valve control	Pulsed ground with engine at normal temperature and varying engine load
37	output	Oxygen sensor relay (terminal 85)	Oxygen sensor relay control
38	vacant	—	—
39	ground	Oxygen sensor #2 (cyl. 5-8)	Oxygen sensor #2 signal ground
40	ground	Oxygen sensor #1 (cyl.1-4)	Oxygen sensor #1 signal ground
41	input	Mass air flow sensor	Mass air flow voltage signal (0-5 VDC, varies with engine load)
42	input	Instrument cluster	Road speed signal from instrument cluster
43	input	Crankshaft position/rpm sensor	Voltage pulse (VAC) between pin 16 and 43)
44	input	Camshaft position sensor	Voltage pulse (VAC) between pin 17 and 44)
45	ground	Ignition signal shield	Ground for ignition circuit monitoring
46	output	Instrument cluster	Fuel consumption output to instrument cluster
47	output	Instrument cluster	Engine speed (TD) signal to instrument cluster
48	output	A/C compressor control relay	A/C compressor disable via A/C compressor relay
49	output	Ignition coil, cyl. 2	Primary signal, ignition coil 2
50	output	Ignition coil, cyl. 3	Primary signal, ignition coil 3
51	output	Ignition coil, cyl. 8	Primary signal, ignition coil 8
52	output	Ignition coil, cyl. 5	Primary signal, ignition coil 5
53	vacant	—	—
54	input	Main relay (terminal 87)	Battery voltage from main relay
55	ground	Ground	Ground point (X6452)
56	input	Power supply (terminal 15)	Battery voltage with key in on or start position
57	vacant	—	—
58	vacant	—	—
59	output	Throttle position sensor (TPS)	Voltage supply to TPS (5 VDC)
60	input	Data link connector	Programming voltage via data link connector
61	vacant	—	—
62	input	Traction control module	Throttle control signal
63	vacant	—	—
64	input	A/C relay (terminal 87a)	A/C ready signal
65	input	A/C pressure switch	from integrated climate control module via A/C pressure switch
66	input	On-board computer	Drive-away protection enable
67	input	Knock sensor #4 (cyl. 7-8)	Knock sensor #4 signal
68	input	Knock sensor #3 (cyl. 5-6)	Knock sensor #3 signal

Table d. ECM Pin Assignments–DME 3.3 (M60 Engine) (continued)

Pin	Signal	Component	Signal/function
69	input	Knock sensor #2 (cyl. 3-4)	Knock sensor #2 signal
70	input	Knock sensor #1 (cyl. 1-2)	Knock sensor #1 signal
71	ground	Ground	Ground for analog signals and knock sensors
72	vacant	—	—
73	input	Throttle position sensor (TPS)	Throttle position signal
74	vacant	—	—
75	vacant	—	—
76	vacant	—	—
77	input	Intake air temperature sensor	Intake air temperature signal (0-5 VDC, temperature dependent)
78	input	Engine coolant temperature sensor	Engine coolant temperature signal (0-5 VDC, temperature dependent)
79	vacant	—	—
80	vacant	—	—
81	input	Light switch	Headlights on signal
82	input	Traction control module	Engine coasting signal
83	input	Traction control module	Traction control regulation signal
84	output	Ground, EGS shield	CAN shield to A/T transmission control module
85	input/output	Automatic transmission control module	A/T transmission control module connection, data signal
86	input/output	Automatic transmission control module, electronic throttle control module	Data link connector
87	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to Data link connector
88	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) signal to Data link connector

Table e. ECM Pin Assignments–DME 1.2 early (M70 Engine)

Pin	Signal	Component	Signal/function
1	output	Ignition coil	Ignition coil primary control, Diagnostic connector
2	ground	Ground	Chassis ground
3	output	Fuel pump relay control	Fuel pump relay switches with engine running or cranking (crankshaft position signal must be present for relay to switch)
4	vacant	—	—
5	output	Evaporative purge valve control	Pulsed ground (mapped) with engine running at normal temperature and varying engine load
6	output	Engine speed	RPM signal to EML control module and instrument cluster
7	input	Mass air flow sensor	Voltage signal from Mass air flow sensor (0-5 VDC, varies with engine load)
8	input	Cylinder identification	Voltage pulse (VAC) between pin 8 and pin 31 for cylinder identification
9	vacant	—	—
10	ground	Oxygen sensor	Ground for oxygen sensor signal
11	vacant	—	—
12	vacant	—	—
13	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to pin 15 in data link connector
14	ground	Fuel injectors	Ground for fuel injectors output stage
15	vacant	—	—
16	output	Fuel injectors, cyl. 1,3,5 (control unit 1) Fuel injectors, cyl. 7,9,11 (control unit 2)	Pulsed ground (injection pulse width in ms)
17	output	Fuel injectors, cyl. 2, 4, 6 (control unit 1) Fuel injectors, cyl. 8, 10, 12 (control unit 2)	Pulsed ground (injection pulse width in ms)
18	input	Power supply (terminal 30)	Battery voltage (B+) at all times (terminal 30)
19	ground	Shielding ground	Ground for ECM and sensor shielding
20	vacant	—	—
21	vacant	—	—
22	vacant	—	—
23	output	Oxygen sensor relay control	Oxygen sensor heater
24	ground	Output stage ground	Ground for output stages other than injectors and ignition
25	input	Mass air flow sensor	—
26	ground	Mass air flow sensor	Ground for Mass air flow sensor
27	input	Power supply (terminal15)	Battery voltage (B+) with key on or engine running (terminal 15)
28	input	Oxygen sensor	Oxygen sensor signal wire (0-1 VDC fluctuating with engine running)
29	vacant	—	—
30	vacant	—	—
31	input	Cylinder identification sensor on no. 6 and no.12 plug wires	Voltage pulse (VAC) between pin 8 and pin 31when cyl. no. 6 fires (for ignition control)

Table e. ECM Pin Assignments–DME 1.2 early (M70 Engine)

Pin	Signal	Component	Signal/function
32	output	Fuel consumption	Fuel consumption output to instrument cluster
33	vacant	—	—
34	vacant	—	—
35	vacant	—	—
36	output	Main relay	Main relay activation (relay terminal 85)
37	input	Main relay	Voltage supply from main relay to ECM (relay terminal 87)
38	input	On-board computer, anti-theft system	Drive-away protection enable
39	input	Data link connector	Programming voltage
40	vacant	—	—
41	vacant	—	—
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	input	Mass air flow sensor	0-5 VDC
44	input	Intake air temperature	Intake air temperature via Mass air flow sensor (0-5 V, temperature dependent)
45	input	Engine coolant temperature	Engine coolant temperature (0-5 V, temperature dependent)
46	vacant	—	—
47	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
48	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
49	vacant	—	—
50	not used	control units 1 and 2 connected	not used
51	input	Ignition timing intervention	from Electronic transmission control module
52	input	Throttle position	Ground with throttle in idle position from EML control module
53	input	Throttle position	Ground with throttle in full open position from EML control module
54	input	Torque converter clutch WK	Electronic transmission control module
55	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) and RxD (receive) signal to/from pin 20 in Data link connector

Table f. ECM Pin Assignments–DME 1.2 late (M70 Engine)

Pin	Signal	Component	Signal/function
1	output	Ignition coil	Ignition coil primary control, Diagnostic connector
2	ground	Ground	Chassis ground
3	input	Switched voltage from main relay	Battery voltage through 1K resistor, approx. 10 VDC
4	vacant	—	—
5	output	Evaporative purge valve control	Pulsed ground (mapped) with engine running at normal temperature and varying engine load
6	output	Engine speed	RPM signal to EML control module and instrument cluster
7	input	Mass air flow sensor	Voltage signal from Mass air flow sensor (0-5 VDC, varies with engine load)
8	input	Cylinder identification	Voltage pulse (VAC) between pin 8 and pin 31 for cylinder identification
9	vacant	—	—
10	ground	Oxygen sensor	Ground for oxygen sensor signal
11	vacant	—	—
12	vacant	—	—
13	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to pin 15 in data link connector
14	ground	Fuel injectors	Ground for fuel injectors output stage
15	vacant	—	—
16	output	Fuel injectors, cyl. 1,3,5 (control unit 1) Fuel injectors, cyl. 7,9,11 (control unit 2)	Pulsed ground (injection pulse width in ms)
17	output	Fuel injectors, cyl. 2, 4, 6 (control unit 1) Fuel injectors, cyl. 8, 10, 12 (control unit 2)	Pulsed ground (injection pulse width in ms)
18	input	Power supply (terminal 30)	Battery voltage (B+) at all times (terminal 30)
19	ground	Shielding ground	Ground for ECM and sensor shielding
20	vacant	—	—
21	vacant	—	—
22	vacant	—	—
23	output	Oxygen sensor relay control	Oxygen sensor heater
24	ground	Output stage ground	Ground for output stages other than injectors and ignition
25	output	Mass air flow sensor	Burn off after engine stops
26	ground	Mass air flow sensor	Ground for Mass air flow sensor
27	input	Power supply (terminal15)	Battery voltage (B+) with key on or start position (terminal 15)
28	input	Oxygen sensor	Oxygen sensor signal wire (0-1 VDC fluctuating with engine running)
29	vacant	—	—
30	vacant	—	—
31	input	Cylinder identification sensor on no. 6 and no.12 plug wires	Voltage pulse (VAC) between pin 8 and pin 31when cyl. no. 6 fires (for ignition control)

Table f. ECM Pin Assignments–DME 1.2 late (M70 Engine)

Pin	Signal	Component	Signal/function
32	output	Fuel consumption	Fuel consumption output to instrument cluster
33	vacant	—	—
34	vacant	—	—
35	vacant	—	—
36	output	Main relay	Main relay activation (relay terminal 85)
37	input	Main relay	Voltage supply from main relay to ECM (relay terminal 87 or 87a)
38	input	On-board computer, anti-theft system	Drive-away protection enable
39	input	Data link connector	Programming voltage
40	ground	—	—
41	vacant	—	—
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	input	Mass air flow sensor	0-5 VDC
44	input	Intake air temperature	Intake air temperature via Mass air flow sensor (0-5 V, temperature dependent)
45	input	Engine coolant temperature	Engine coolant temperature (0-5 V, temperature dependent)
46	vacant	—	—
47	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
48	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
49	vacant	—	—
50	not used	control units 1 and 2 connected	not used
51	input	Ignition timing intervention	from Electronic transmission control module
52	input	Throttle position	Ground with throttle in idle position from EML control module
53	input	Throttle position	Ground with throttle in full open position from EML control module
54	input	Torque converter clutch WK	Electronic transmission control module
55	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) and RxD (receive) signal to/from pin 20 in Data link connector

Table g. ECM Pin Assignments–DME 1.7 (M70 Engine)

Pin	Signal	Component	Signal/function
1	Output	Fuel pump relay, terminal 85	Fuel pump relay control
2	Not used	—	—
3	Output	Fuel injectors 2, 4, 6 DME control unit 1 or Fuel injectors 8, 10, 12 DME control unit 2	Pulsed ground for fuel injection control
4	Not used	—	—
5	Not used	—	—
6	Ground	Ground, fuel injection valve output stages	Ground point
7	Not used	—	—
8	Output	Instrument cluster	"Check engine" indicator control
9	Not used	—	—
10	Not used	—	—
11	Output	Transmission control module (EGS)	DKV potentiometer signal
12	Input	EML control module	Throttle position signal (full throttle)
13	Input	Mass air flow sensor	—
14	Input	Mass air flow sensor	Mass air flow sensor (signal ground)
15	Not used	—	—
16	Input	Cylinder 6 spark plug wire	Spark plug wire sensor (cylinder identification)
17	Output	Instrument cluster	Measurement signal (fuel consumption)
18	Not used	—	—
19	Not used	—	—
20	Not used	—	—
21	Not used	—	—
22	Not used	—	—
23	Not used	—	—
24	Not used	—	Cyl. 3 ignition coil
25	Output	Ignition coil terminal 1	Ignition coil control
26	Input	B + junction point	Battery voltage
27	Output	Main relay, terminal 85	Main relay control
28	Ground	Ground for electronics and shielding of sensors	Ground point
29	Not used	—	—
30	Not used	—	—
31	Not used	—	—
32	Output	Fuel injectors 1, 3, 5 (DME control unit 1) or Fuel injectors 7, 9, 11 (DME control unit 2)	Pulsed ground
33	Not used	—	—

Table g. ECM Pin Assignments–DME 1.7 (M70 Engine)

Pin	Signal	Component	Signal/function
34	Ground	Ground, output stages (except for ignition and fuel injection valves)	Ground point
35	Not used	—	—
36	Output	Evaporative emission valve	Evaporative emission valve control
37	Not used	—	—
38	Not used	—	—
39	Not used	—	—
40	Not used	—	—
41	Input	Mass Air Flow sensor	Mass air flow sensor (voltage varies with engine load)
42	Not used	—	—
43	Ground	Ground for sensors	Engine coolant temperature sensor, intake air temperature sensor
44	Input	Spark plug wire sensor	Spark plug wire sensor (cylinder identification)
45	Not used	—	—
46	Not used	—	—
47	Not used	—	—
48	Not used	—	—
49	Not used	—	—
50	Not used	—	—
51	Not used	—	—
52	Not used	—	—
53	Not used	—	—
54	Input	Main relay terminal 87 or 87a	Battery voltage from main relay
55	Ground	Ground point	Ground, ignition
56	Input	Ignition switch, terminal 15	12V with ignition switch in start or run position
57	Not used	—	—
58	Not used	—	—
59	Not used	—	—
60	Input	Data link connector	Programming voltage
61	Not used	—	—
62	Input	Throttle position sensor	Closed throttle
63	Input	Electronic transmission control unit	Electronic transmission control
64	Input	Electronic transmission control unit	—
65	Input	Automatic transmission range switch	12V in park or neutral
66	Not used	—	—
67	Input	Crankshaft position/RPM sensor	Crankshaft position/RPM

Table g. ECM Pin Assignments–DME 1.7 (M70 Engine)

Pin	Signal	Component	Signal/function
68	Ground	Crankshaft position/RPM sensor	Crankshaft position RPM sensor ground
69	Not used	—	—
70	Input	Oxygen sensor signal	0-1v
71	Ground	Heated oxygen sensor	Oxygen sensor signal ground
72	Not used	—	—
73	Input	Instrument cluster	Vehicle speed sensor
74	Output	Instrument cluster, EML control unit	Engine speed signal
75	Not used	—	—
76	Input	Mass air flow sensor	0-5v
77	Input	Intake air temperature sensor (IAT)	Intake air temperature sensor (IAT)
78	Input	Engine coolant temperature sensor	Engine coolant temperature
79	Not used	—	—
80	Not used	—	—
81	Input	On-board computer, anti-theft module	Drive-away protection signal (code)
82	Input	Automatic stability control (ASC or ASC+T)	Automatic stability control (ASC or ASC+T)
83	Input	Automatic stability control (ASC or ASC+T)	Automatic stability control (ASC or ASC+T)
84	Not used	—	—
85	Ground	Ground point	Ground
86	Not used	—	—
87	Output	RxD diagnosis data line	Data link connector
88	Output-Input	TxD diagnosis data line	Data link connector



160 Fuel Tank and Fuel Pump

GENERAL 160-1

FUEL TANK AND LINES 160-2
- Fuel tank, removing and installing 160-3
- Fuel level sender and fuel pump, removing .. 160-5
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c. Fuel Pump and DME Relay Locations 160-8
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GENERAL

This repair group covers service information specifically for the fuel pump, tank, filter, and fuel lines. Information on the fuel injection system is covered in **130 Fuel Injection**.

NOTE—
Fuel filter replacement is covered in **020 Maintenance**.

The following cautions and warnings should be observed when servicing the fuel system.

WARNING—
- *The fuel system is designed to retain pressure even when the ignition is off. When working with the fuel system, loosen the fuel lines slowly to allow residual fuel pressure to dissipate gradually. Avoid spraying fuel.*
- *Before beginning any work on the fuel system, place a fire extinguisher in the vicinity of the work area.*
- *Fuel is highly flammable. When working around fuel, do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*
- *Do not use a work light near any fuel. Fuel may spray onto the hot bulb causing a fire.*
- *Make sure the work area is properly ventilated.*

CAUTION—

- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*
- *Before making any electrical tests with the ignition turned on, disable the ignition system as described in* **120 Ignition System**. *Be sure the battery is disconnected when replacing components.*
- *To prevent damage to the ignition system or the electronic fuel system components, including the control unit, always connect and disconnect wires and test equipment with the ignition off.*
- *Cleanliness is essential when working with the fuel system. Thoroughly clean the fuel line unions before disconnecting any of the lines.*
- *Use only clean tools. Keep removed parts clean and sealed or covered with a clean, lint-free cloth, especially if completion of the repair is delayed.*
- *Do not move the car while the fuel system is open.*
- *Avoid using high pressure compressed air to blow out lines and components. High pressure can rupture internal seals and gaskets.*
- *Always replace seals and O-rings.*

FUEL TANK AND LINES

The metal fuel tank is located at the rear of the car beneath the luggage compartment. The tank capacity for the different models is listed in **Table a**. Mounted in the fuel tank are the fuel level sender and the fuel pump. Connecting lines for the evaporative emission control system and expansion tank are also attached to the tank.

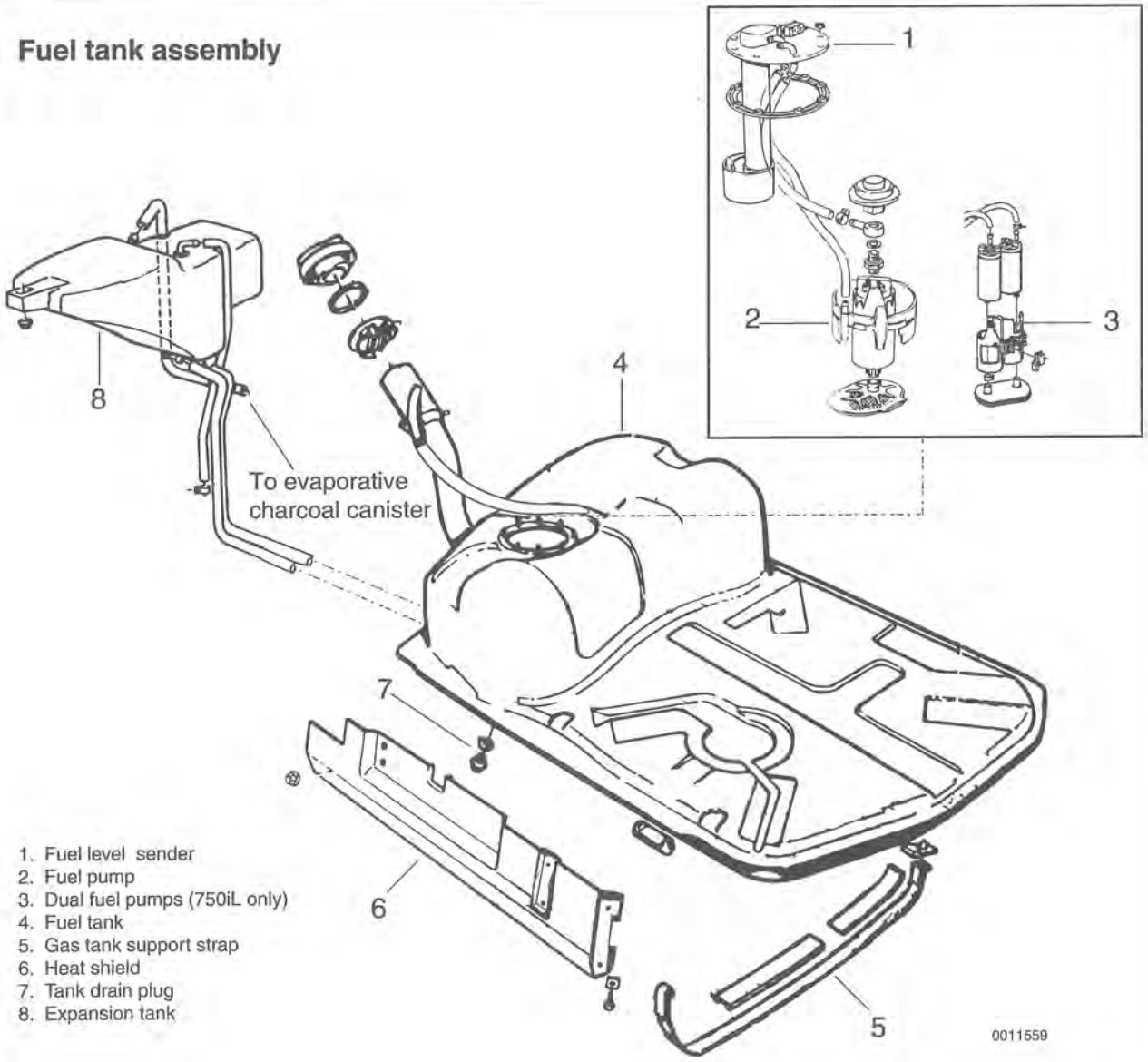
NOTE—

The 750iL model with M70 engine is equipped with two fuel pumps.

Table a. E32 Fuel Tank Capacities

Year & Model	Capacity
735i 1988 - 1992 740i 1993 - 1994	81 liters (21.4 gal)
735iL 1988 - 1992 740iL 1993 - 1994 750iL 1988 - 1994	91 liters (24 gal)

Fuel tank assembly

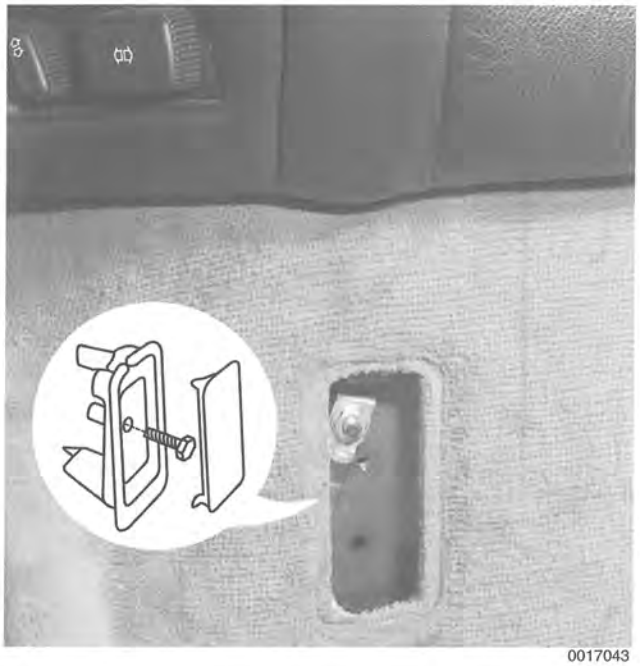


1. Fuel level sender
2. Fuel pump
3. Dual fuel pumps (750iL only)
4. Fuel tank
5. Gas tank support strap
6. Heat shield
7. Tank drain plug
8. Expansion tank

Fuel tank, removing and installing

The fuel tank should be drained into a storage unit prior to removal. Use an approved transfer pump and container. The fuel can be pumped out via a hose inserted in the filler neck. The tank can also be drained through the drain plug in the bottom of the tank.

WARNING—
Before removing the tank, be sure that all hot components such as the exhaust system are completely cooled down.


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➢ Disconnect negative (–) battery cable behind access cover at rear seat bulkhead.

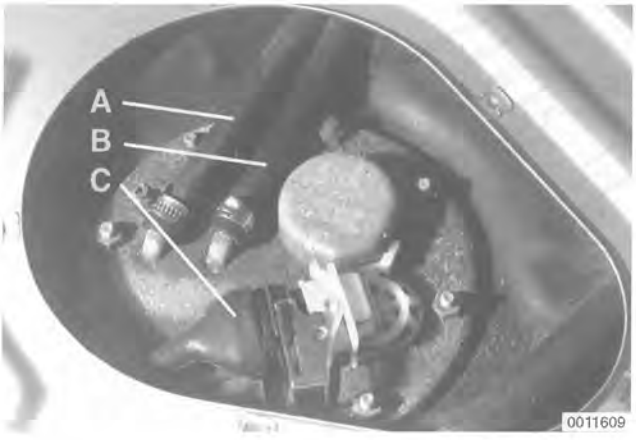
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise rear of car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove fuel tank filler cap and drain fuel tank using an approved evacuation or draining method.

– Working in luggage compartment, remove floor carpeting. Then remove access cover above fuel pump/fuel level sender.



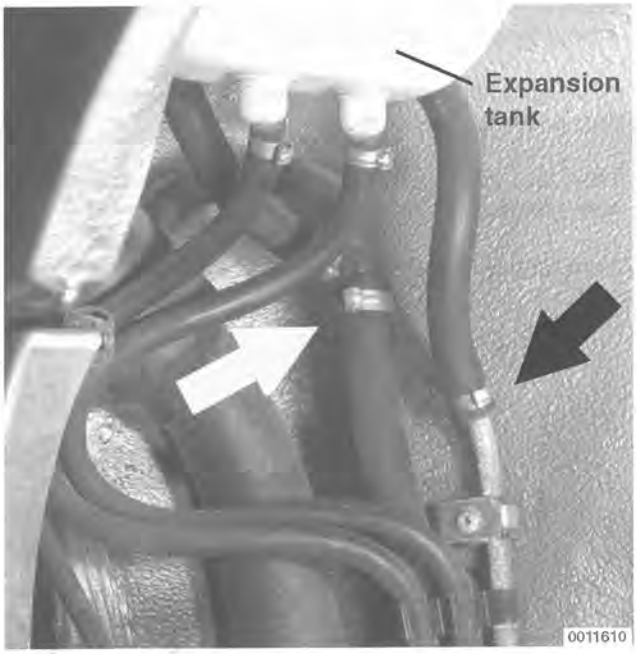
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➢ Supply hose **A**, return hose **B** and electrical harness connector **C**.

• Disconnect hoses and electrical harness connector at fuel pump/fuel level sensor.

NOTE—
Models with M70 engine use an additional supply hose (not shown).

– Working within fuel filler door, pry out rubber sealing gasket.



➤ Remove right rear wheel housing trim. Then disconnect two vent hoses from expansion tank.

NOTE—
Remove the right rear road wheel as necessary for removal of the wheel housing trim.

– While supporting tank from below, remove fuel tank heat shield and support strap mounting bolts. Carefully lower tank from car.

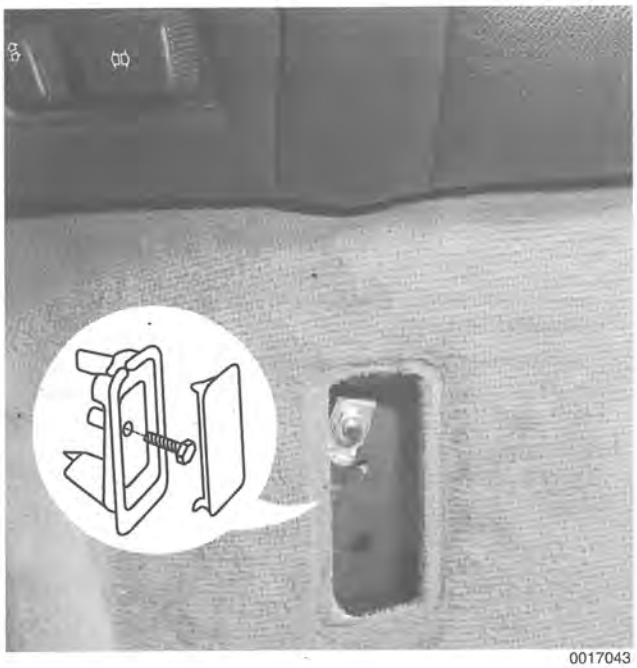
– Installation is reverse of removal.

- Always use new seals, gaskets, O-rings and hose clamps.
- Inspect all rubber parts including hoses and replace any that are chafed, dried out or cracked.
- Inspect heat shield and replace if corroded or damaged.
- Inspect rubber buffers and liners on fuel tank, support straps and on underside of body. Replace rubber parts that are hardened or damaged.

Tightening Torques

- Fuel level sender/fuel pump to fuel tank
  M6 nut . . . . . 10 Nm (89 in-lb)
  M8 bolt . . . . . 23 Nm (17 ft-lb)
- Fuel tank to body . . . . . 23 Nm (17 ft-lb)
- Heat shield to fuel tank (bolts) . . . . . 10 Nm (89 in-lb)
- Fuel tank drain plug
  (use new seal ring) . . . . . 25 Nm (18 ft-lb)
- Hose clamps
  10 mm to 16 mm diameter . . . . . 2.0 Nm (18 in-lb)

Fuel level sender and fuel pump, removing



The fuel level sender is mounted in the fuel tank together with the fuel pump assembly. The sender has a float connected to a variable resistance for fuel level and a switch that closes to turn on the low fuel light. When replacing the sender/pump assembly always replace hose clamps, gaskets and O-rings.

WARNING—
When removing the fuel level sender or the fuel pump assembly, the fuel tank should be drained.

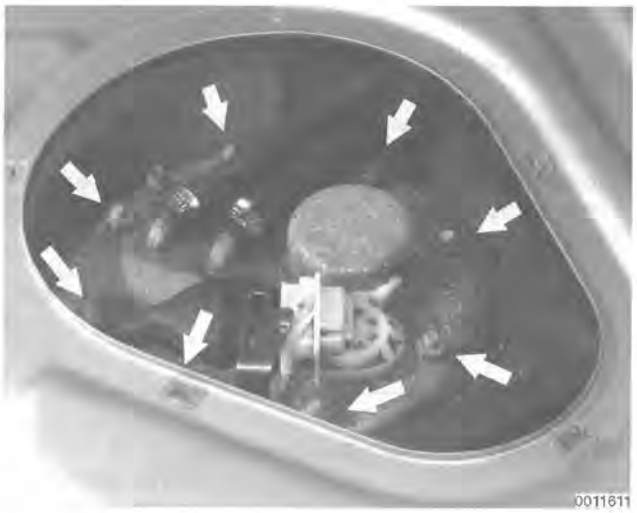
➤ Disconnect negative (–) battery cable behind access cover at rear seat bulkhead. Insulate cable end.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

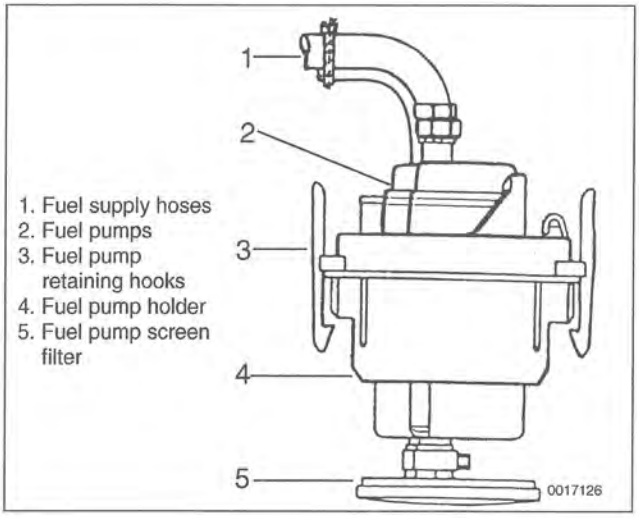
– Remove fuel tank filler cap and drain fuel tank using an approved evacuation or draining method.

– Working in luggage compartment, remove access cover from above fuel level sender/pump assembly.

– Label and disconnect fuel hoses and harness connector from fuel level sender.



➢ Remove fuel level sender mounting nuts or bolts (**arrows**).



➢ Dual fuel pump assembly for M70 engines. (Single fuel pump assembly on M30 and M60 engines is similar.)

- Slowly withdraw sender from tank, allowing fuel to drain off. Release fuel pump retaining hooks (**3**) and remove pump(s), allowing fuel to drain off.

WARNING—
Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.

– Install fuel pump(s) so that retaining hooks are correctly fitted.

NOTE—
Use a new gasket between the level sender and the top of the tank.

Tightening Torques

- Fuel level sender/fuel pump assembly to fuel tank
  M6 (nut) . . . . . 10 Nm (89 in-lb)
  M8 (bolt) . . . . . 23 Nm (17 ft-lb)
- Hose clamps
  10mm to 16mm diameter . . . . . 2.0 Nm (18 in-lb)

– Reconnect harness connector and hoses.

- Fill tank and check for leaks by running engine.
- Install access cover and its mounting screws.
- Reconnect negative (–) battery cable.

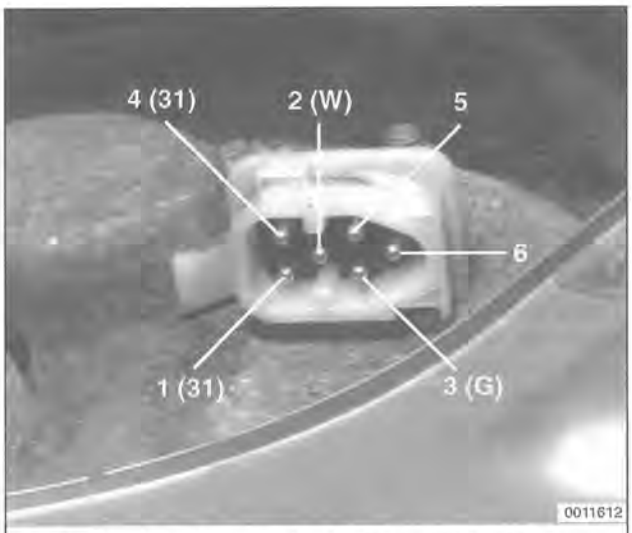
Fuel level sender, testing

Fuel pump/level sender connector.

- The removed sender can be tested using an ohmmeter. **Table b** lists resistance values for the sender at various float positions.

Table b. Fuel Level Sender Resistances

Connector terminals	Float position	Test result (ohms)
G and 31	slowly moving from empty to full position	resistance continuously changing (no breaks)
	Empty	88.7 ± 2.8 ohms
	Full	3.2 ± 0.7 ohms
W and 31	Empty (low fuel warning)	continuity



1. Fuel level sender ground
2. Low fuel warning lamp
3. Fuel level sender signal
4. Fuel pump(s) ground
5. Fuel pump 1
6. Fuel pump 2 (M70 eng. only)

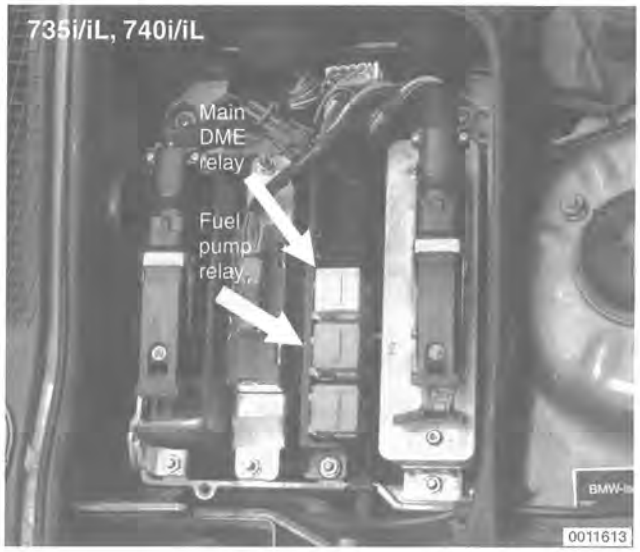
FUEL PUMPS

The electric fuel pump assembly is submersed in the bottom of the fuel tank. The 735i/iL and 740i/iL models are equipped with one fuel pump. The 750iL model is equipped with a pair of fuel pumps mounted side by side.

The fuel pump delivers fuel at high pressure to the fuel injection system. A pressure regulator maintains system pressure. The quantity of fuel supplied exceeds demand, so excess fuel returns to the fuel tank via a return line. See **130 Fuel Injection** for more information on system pressure and the fuel pressure regulator.

NOTE—
Fuel pump removal procedures are given earlier under **Fuel level sender and fuel pump, removing.**

The pump is cooled and lubricated by fuel and may therefore be damaged if allowed to run dry or if the fuel pickup strainer/filter becomes blocked. Access to the pump is from the top of the fuel tank through the luggage compartment.



Fuel Pump Fuse and Relay

Fuel pump relay locations.

- The fuel pump is operated by a fuel pump relay. The fuel pump circuit is protected by fuse no. 23 located in the main fuse box. Fuel pump and DME main relay locations in the various models are listed in **Table c**.

Table c. Fuel Pump and DME Relay Locations

Year & model	Relay locations
735i/iL 1988 - 1992 740i/iL 1993 - 1994	In electronics box (E-box)
750iL 1988–1994	In auxiliary relay panel II (right side of engine compartment)

The engine control module (ECM) and the DME main relay supply power to the fuel pump relay. During starting, the fuel pump runs as long as the ignition switch is in the start position and continues to run once the engine starts. If an electrical system fault interrupts power to the fuel pump, the engine will not run.

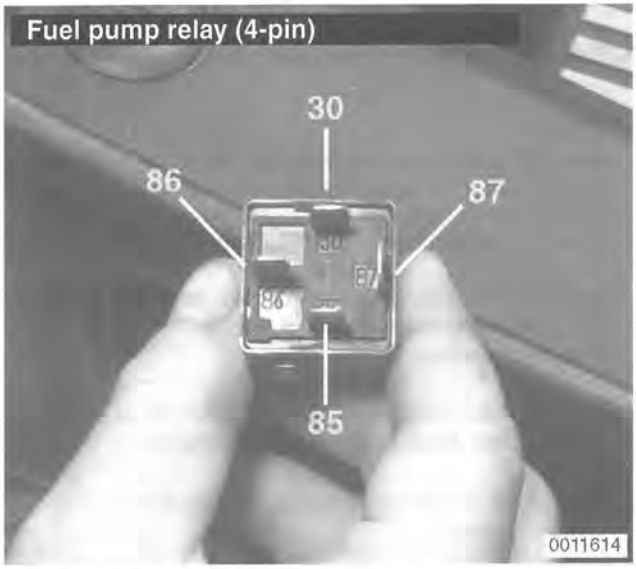
Operating Fuel Pump for Tests

To operate a fuel pump for testing purposes without having to run the engine, the fuel pump relay can be bypassed to power the pump directly.

NOTE—

Two versions of fuel pump relays are used. Except for some 1988-1990 M70 engines, a 4-pin relay is used. On most 1988 through 1990 750iL cars, a 7-pin solid state relay is used. Testing procedures and troubleshooting vary depending on relay type installed.

Fuel pump relay (4-pin)



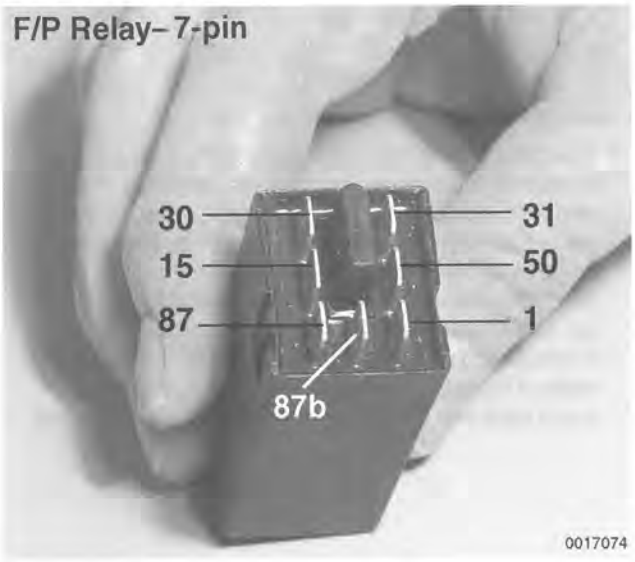
- To run fuel pump, remove relay and identify terminals numbers on relay and match to socket numbers on relay socket.

- Jumper socket terminal 30 to socket terminal 87 with a fused jumper wire. Pump should run. After completing the tests, remove jumper wire.

CAUTION—

- *Relay locations may vary. Use care when identifying relays and when troubleshooting the electrical system at the fuse/relay panel. See* **Electrical Wiring Diagrams** *for complete circuit information.*
- *On cars with 4-pin relay, there is a 1.5 mm² red wire at terminal 30 in the relay socket. If in doubt, consult an authorized BMW dealer.*
- *On M70 engines with 7-pin relays, there is a 2.5 mm² red wire at terminal 30 in the relay socket. The M70 solid state relay uses a tachometer signal and a start signal to run the pumps.*

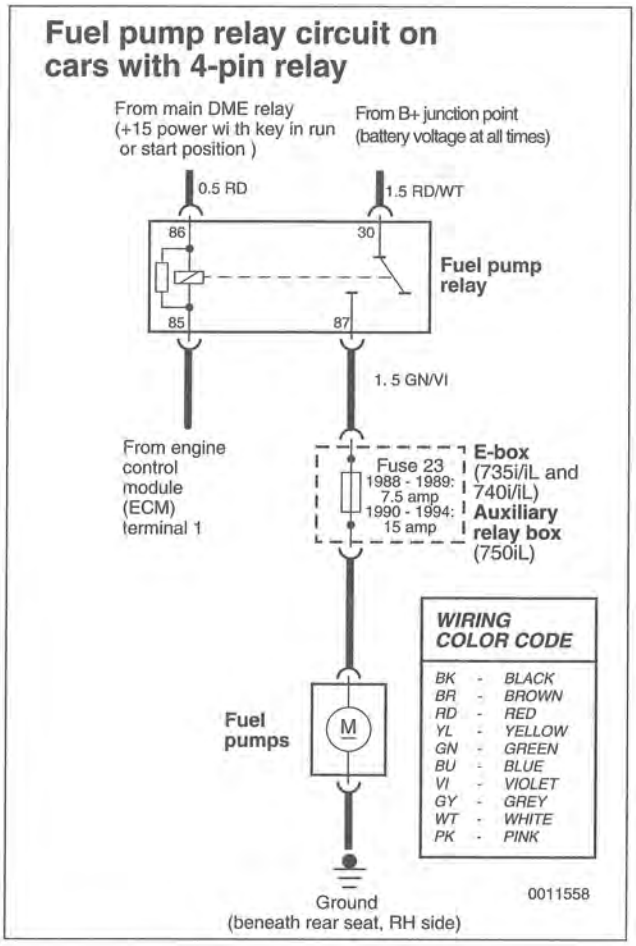
F/P Relay–7-pin



NOTE—

- *On 750iL models, be sure to test both fuel pumps.*
- *The jumper wire should be 1.5 mm² (14 ga.) and should include an in-line fuse holder with a 16 amp fuse. To avoid fuse/relay panel damage from repeated connecting and disconnecting, also include a toggle switch. A heavy-duty jumper, BMW tool no. 61 3 050, is also available from an authorized BMW dealer.*

If the pump does not run with the jumper installed, the fault could be in the fuel pump or the wiring to the pump. Check the pump and its wiring as described below.





Fuel Pump Tests

Troubleshooting of any fuel pump fault should begin with checking the fuel pump fuse and the fuel pump relay. The DME main relay should also be checked. Fuel pressure and rate of fuel delivery are the important fuel pump performance measurements.

NOTE—
Special tools are required for some of the tests described here.

Fuel pump electrical circuit, checking

➢ Fuel pump electrical circuit for all engines with 4-pin relay.

NOTE—
Fuel pump circuit on M70 engines with 7-pin relays varies from circuit shown. The 7-pin relays are solid state relays and use a tachometer input and a starter input to run the pumps. See **Electrical Wiring Diagrams** *for complete circuit information.*

– Working from luggage compartment, remove floor carpeting. Then remove access cover from above fuel level sender/pump assembly.

– Remove fuel pump relay and operate fuel pump as described under **Operating Fuel Pump for Tests**.

- The pump should run. Disconnect relay jumper wire when finished.

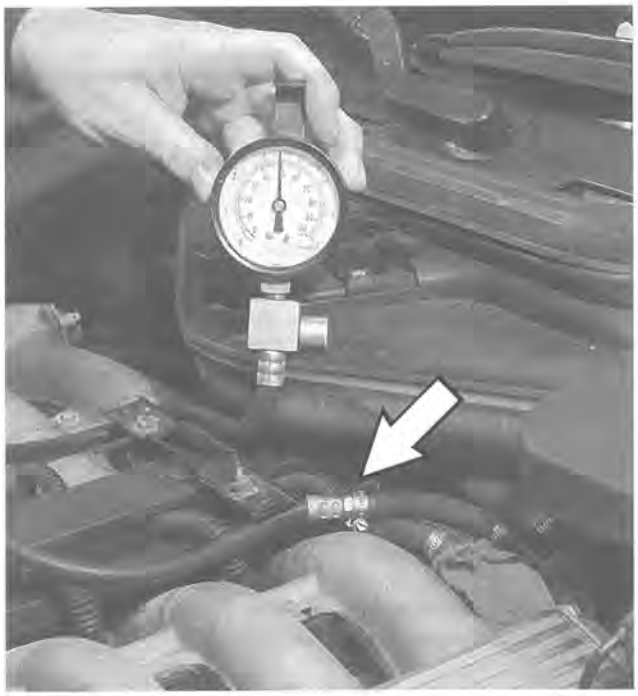
➢ Testing fuel pump with digital voltmeter.

- If fuel pump does not run, disconnect harness connector from level sender/pump assembly. With relay jumper wire reconnected as described above, check for positive (+) battery voltage at terminal 5 (6 for fuel pump II on M70) and ground (–) at terminal 4.
- On 750iL: Repeat procedure with second fuel pump relay. Test for voltage and ground.
- If voltage and ground are present, fuel pump is probably faulty. If there is no voltage, check wiring from fuel pump relay and make sure relay is functioning correctly.

Fuel pump delivery pressure and delivery rate, checking

CAUTION—
The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. In the event the fuel pump check valve is faulty (stuck closed), make sure the fuel pressure does not rise above 6.0 bar (87 psi).

– Remove fuel tank filler cap.



➤ Check fuel pump delivery pressure:

- Connect in-line a T-fitting and fuel pressure gauge to outlet hose at fuel pump or at fuel rail **(arrow)** in engine compartment.
- Operate fuel pump as described under **Operating Fuel Pump for Tests**. Check that fuel pressure corresponds to specifications listed in **Table d**.

WARNING—
Fuel under pressure is present during the test. Use hose clamps at all connections.

Table d. Fuel Pressure Specifications

Engine	Fuel pressure
M30/M70	3.0 ± 0.06 bar (43.5 ± 0.9 psi)
M60	3.5 ± 0.06 bar (51 ± 0.9 psi)

NOTE—
- *On 750iL models test both fuel pumps.*
- *If the system pressure is low, repeat the test while gradually pinching off the return hose. The pressure should rise rapidly. If not, the fuel pump is most likely faulty.*
- *If the system pressure is too high, check the return line from the pressure regulator to the tank. If no faults can be found, the pressure regulator is most likely faulty. See* **130 Fuel Injection** *for testing and replacement procedures.*

CAUTION—
Do not use compressed air above 40 psi to blow out lines or components. Internal damage to components may result.

– When finished, disconnect pressure gauge.

– Check fuel pump delivery rate:

- Disconnect return line from fuel rail in engine compartment.Connect a length of hose to fitting on fuel rail and place open end of hose in a suitable container for catching fuel (2-quart capacity).
- Run fuel pump for exactly 30 seconds as described under **Operating Fuel Pump for Tests** and measure fuel collected. Compare to specifications listed in **Table e**.

NOTE—
On 750iL models test both fuel pumps.

Table e. Fuel Pump Delivery Specifications

Model & Engine	Delivery rate (30 seconds @ 12V)
735i/iL M30 engine 740i/iL M60 engine 750iL M70 engine	0.875 liter (0.93 qt)

– When finished testing, reconnect fuel line. Tighten hose clamps.

Fuel pump power consumption, checking

– Disconnect harness connector from fuel level sender/pump assembly.

– Connect an ammeter between fuel pump harness connector and fuel pump terminal.

➢ Fuel pump/level sender connector.

- Connect ammeter between fuel pump power supply terminal in connector (no. 5 or no. 6, as applicable) and corresponding pump terminal. Connect terminal 4 in connector to corresponding pump terminal using an insulated jumper.

> ***CAUTION—***
> *Do not allow test leads to short to ground.*

NOTE—
See **600 Electrical System–General** *for information on electrical tests using a digital multimeter (DMM).*

– Run pump as described in **Operating Fuel Pump for Tests**.

– Compare ammeter reading with specification listed in **Table f**.

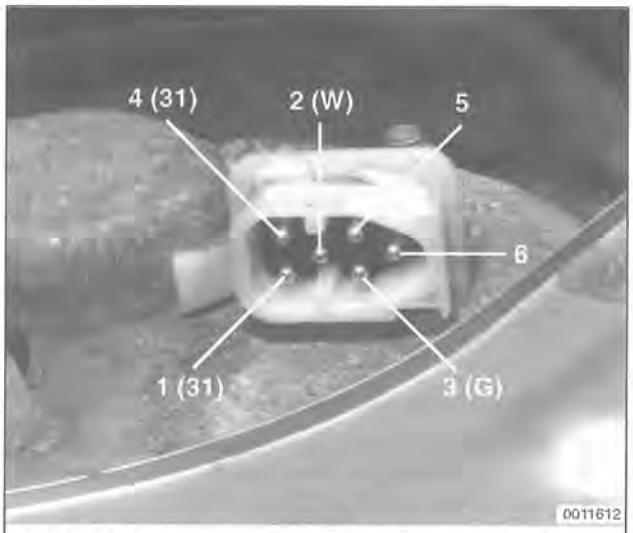
NOTE—
To achieve accurate test results, the battery voltage at the connector should be approximately. 13 volts. Charge the battery as necessary.

Table f. Fuel Pump Current

Current consumption (max.)	5.0 amps

NOTE—
- *It is a common practice to replace the fuel filter any time the fuel pump is replaced.*
- *A higher than normal power consumption usually indicates a worn fuel pump. Be sure to check that the return line and the pump pickup are not obstructed before replacing the pump.*





1. Fuel level sender ground
2. Low fuel warning lamp
3. Fuel level sender signal
4. Fuel pump(s) ground
5. Fuel pump 1
6. Fuel pump 2 (M70 eng. only)

170 Radiator and Cooling System

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GENERAL

This section covers repair and troubleshooting information for the engine cooling system. For heater core and related heating and air conditioning components, see **640 Heating and Air Conditioning**.

Coolant Pump and Thermostat

A centrifugal-type coolant pump is mounted at the front of the cylinder block. The pump is crankshaft-driven by a drive belt and circulates coolant through the system whenever the engine is running. A thermostat controls the flow of coolant into the radiator.

When the engine is cold the thermostat is closed so coolant bypasses the radiator, recirculating from the engine directly back to the pump. When the engine reaches operating temperature, the thermostat opens and coolant circulates through the whole system including the radiator.

Radiator, Coolant Expansion Tank and Cooling Fans

The radiator is a crossflow design. ATF is circulated through an additional heat exchanger (ATF cooler).



Coolant expansion tank hoses and connectors (**arrows**) and mounting bolts (**A**).

- A translucent expansion tank mounted on the engine compartment rear bulkhead, provides for coolant expansion at higher temperatures and easy monitoring of the coolant level.

The primary (belt-driven) cooling fan is mounted to the front of the coolant pump through a fan clutch. The fan clutch is a viscous fluid coupling that controls the speed of the fan based on engine compartment temperature.

A two-speed electric auxiliary cooling fan is mounted behind the front grill, in front of the radiator. This fan is primarily used for the A/C system, but also operates when the coolant temperature exceeds a predetermined level.

The following warnings and cautions should be observed when working on the cooling system.

WARNING—

- *At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening—a minimum of an hour—then release the cap slowly to allow safe release of pressure.*
- *Releasing the cooling system pressure lowers the coolant boiling point and the coolant may boil suddenly. Use heavy gloves and wear eye and face protection to guard against scalding.*
- *Use extreme care when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Consult a veterinarian immediately if coolant is ingested by an animal.*

CAUTION—

- *Avoid adding cold water to the coolant while the engine is hot or overheated. If it is necessary to add coolant to a hot system, do so only with the engine running and coolant pump turning.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

TROUBLESHOOTING

Most cooling system faults can be grouped into one of three categories:

- Cooling system leaks
- Poor coolant circulation
- Radiator cooling fan faults.

When investigating the cause of overheating or coolant loss, begin with a visual inspection.

- Check condition and tightness of coolant pump drive belt.
- Check hoses for cracks or softness.
- Check clamps for looseness.
- Check coolant level and check for evidence of coolant leaks from engine.
- Check that radiator fins are not blocked with dirt or debris. Clean radiator using low-pressure water or compressed air. Blow outward, from engine side out.
- Inspect coolant pump by first removing drive belt from the pump. Firmly grasp opposite sides of pulley and check for play in all directions. Rotate pulley and check that shaft spins smoothly.

NOTE —
The coolant provides some lubrication for the pump shaft, so an occasional drop of coolant leaking from the pump is acceptable. If coolant drips steadily from the vent hole, the pump should be replaced.

The cooling system becomes pressurized at normal operating temperature, which raises the boiling point of the coolant. Leaks may prevent the system from becoming pressurized, allowing the coolant to boil at a lower temperature. If visual evidence is inconclusive, a cooling system pressure test may help to pinpoint hard-to-find leaks.

If the cooling system is full of coolant and holds pressure, the next most probable cause of overheating is the result of poor coolant circulation due to a loose or worn drive belt, a failed thermostat or coolant pump, a pinched or restricted hose, or a partially clogged radiator.

Pressure Test

A cooling system pressure test is used to check for internal leaks. Some of the common sources of internal leaks:

- Faulty cylinder head gasket
- Cracked cylinder head
- Cracked cylinder block.

To do a cooling system pressure test, a special pressure tester is needed. The engine should be fully warm when making the test.

> ***WARNING —***
> *At normal operating temperature the cooling system is pressurized. Allow the system to cool before opening. Then release the cap slowly to allow safe release of pressure.*

With the engine cold, install a pressure tester to the expansion tank. Allow the engine to reach operating temperature, then pressurize the system to the specification listed below. Pressure should not drop noticeably for at least 2 minutes. If the pressure drops rapidly and there is no sign of an external leak, the cylinder head gasket may be faulty. Consider a compression or leak down test, as described in **100 Engine–General.**

Cooling System Test Pressure

- M30 engine (max.) . . . . . 1.0 bar (14.5 psi)
- M60 or M70 engine (max.) . . . . . 1.5 bar (21.75 psi)

CAUTION—
Exceeding the specified test pressure could damage the radiator or other cooling system components.

NOTE—
The screw-on type expansion tank cap should also be tested using a pressure tester and the correct adapter. Carefully inspect the cap for damage. A faulty cap or a damaged cap gasket should be replaced.

Thermostat Quick Check

To check if the thermostat is opening and coolant is circulating through the radiator, allow a cold engine to reach operating temperature (temperature gauge needle approximately centered).

- Feel top radiator hose. If hose is hot to touch, coolant is probably circulating correctly.
- If there are any cool areas in hose or radiator, coolant flow to the radiator is probably restricted. Check for a faulty thermostat or a plugged radiator.

NOTE—
A thermostat that is stuck open will cause the engine to warm up slowly and run below normal temperature at highway speed. A thermostat that is stuck closed will restrict coolant flow to the radiator and cause overheating.

- If engine overheats and no other cooling system tests indicate trouble, radiator may have some plugged passages that are restricting coolant flow.
- Also, air flow may be restricted. Check for debris or restrictions in radiator cooling fins or front grille.

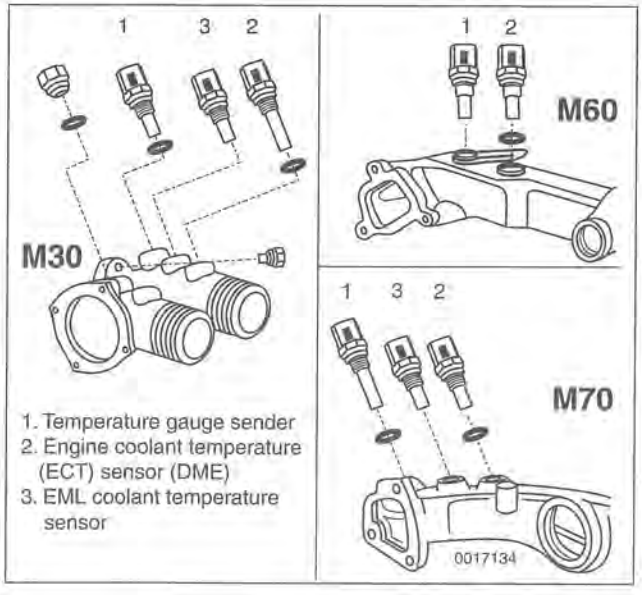
Temperature Gauge Quick Check

Use the information in **Table a** and the diagrams to locate the temperature gauge sender.

Table a. Temperature Gauge Sender Locations

Engine	Sender location
M30	In thermostat housing
M60	In coolant crosspipe at rear of engine
M70	In coolant crosspipe at rear of engine

NOTE—
Relative locations of senders and sensors can vary. Use wiring colors, shown in **Table b**, *to confirm sensor location during the following tests.*



1. Temperature gauge sender
2. Engine coolant temperature (ECT) sensor (DME)
3. EML coolant temperature sensor

Table b. Coolant Temperature Sensor Wire Colors

Engine & year	Gauge sender	ECT sensor (DME)	EML temperature sensor
M30			
1988 - 1992 (DME 1.3)	Brown/violet - brown/yellow	Brown/red - brown/orange	Brown/red - blue/violet
M60			
1993 - 1994 (DME 3.3)	Brown/violet - brown/yellow	Yellow/green - brown/orange	-
M70			
1988 - 1990 (DME 1.2)	Brown/white - brown/yellow	Brown/red/ yellow - brown/red - brown	Brown/red - blue/violet
1991 - 1992 (DME 1.7)	Brown/violet - brown/yellow	Brown/red/ yellow - brown/red - brown	Brown/red - blue/violet
1993 - 1994 (DME 1.7)	Brown/violet - brown/yellow	Brown/red/ yellow - brown/red - brown	Brown/red - white/brown

A quick test at the coolant temperature gauge sender can determine if the gauge is functioning correctly.



➢ On M60 or M70 engine, remove coolant expansion tank to access coolant crosspipe at back of cylinder heads.

- Detach hoses and harness connectors (**arrows**).
- Remove reservoir mounting screws (**A**).

– If gauge needle remains at rest position with engine warm, detach connector from sending unit and jumper two terminals in connector to simulate a high engine temperature.

- Turn ignition on. If gauge needle moves upward, sending unit is faulty.
- If gauge does not respond, wiring to gauge is broken (open circuit) or gauge itself is faulty.

– If gauge needle reads too high when engine is cold, detach connector from sender.

- Turn ignition on. If gauge needle position does not change, wiring or gauge is shorted to ground.
- If gauge needle drops, sender is faulty and should be replaced.

NOTE—

When replacing a faulty coolant temperature sender, gasket ring on sender should also be replaced.

Tightening Torque

- Temperature gauge sender. . . . . 20 Nm (15 ft-lb)

Cooling Fans Quick Check

An otherwise sound cooling system may still overheat, particularly with prolonged idling, due to a failure of the primary cooling fan.

The cooling fan is controlled by a temperature dependent viscous fan clutch. A failed fan clutch may affect air flow through the radiator resulting in overheating or possibly over cooling.

- Inspect fan clutch by spinning fan with engine off and cold. The viscous fan should spin on clutch with slight resistance.
- Check for signs of leaking fluid from clutch. If fan freewheels with little resistance, cannot be turned by hand or there are signs of oil leakage, clutch should be replaced.

The auxiliary (electric) cooling fan provides additional air flow through the radiator when coolant temperature exceeds a predetermined level or whenever the air conditioning is on. The fan assembly is mounted in front of the radiator. A dual-range temperature switch is mounted on the right side of the radiator.

WARNING—

- *Use caution when testing the cooling fan and coolant temperature switches. Keep hands and wires clear of the fan blades. The auxiliary cooling fan can run any time the ignition is ON.*
- *For greatest safety, cooling fan and coolant temperature switch tests should be performed on a cold engine with the air conditioning off.*

Auxiliary Cooling Fan Switching Temperatures

- Low speed . . . . . 196°F (91°C)
- High speed . . . . . 210°F (99°C)

If a faulty thermostat, trapped air or a restriction in the system is not allowing the coolant to circulate through the radiator, the switch will not close and the fan will not run. Before making the tests described below, make sure the thermostat is operating correctly as described earlier.

If the coolant is circulating at normal operating temperature, and the auxiliary cooling fan does not run, disconnect the connector from the radiator temperature switch and make the tests listed in **Table c**.

If the fan runs only when powered directly by the jumpered connector and hot coolant is circulating through the radiator, the radiator temperature switch is faulty. Use a new gasket ring when replacing the switch.

Table c. Auxiliary Fan Temperature Switch Tests

Wires jumpered	Test condition	Test result
Blue/white/yellow and black/brown	Ignition ON	Fan runs at low speed
Black/grey/yellow and black/brown	Ignition ON	Fan runs at high speed

Tightening Torque

- Temperature switch to radiator . . . . . 15 Nm (11 ft-lb)

– If the fan does not run when powered directly, check for battery voltage at switch connector with ignition on.

- If battery voltage is not present, check fuse no. 29 (low-speed) and fuse no. 25 (high-speed).

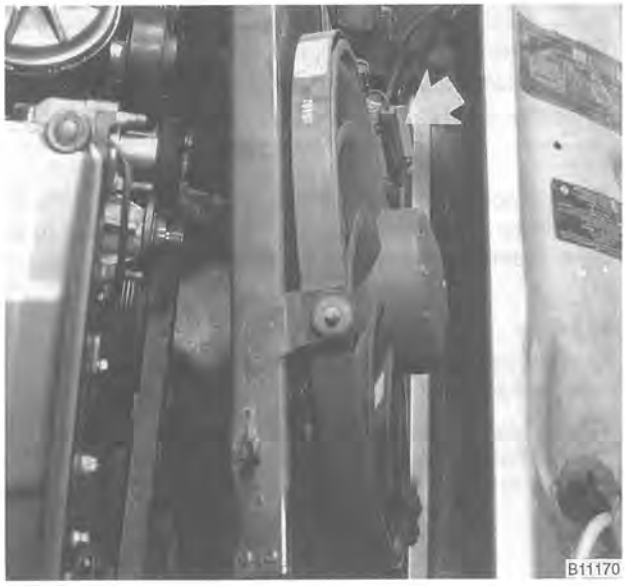


➢ If no faults are found, remove auxiliary radiator cooling fan normal speed relay (**1**) and high speed relay (**2**) in auxiliary relay panel I (ahead of left front strut tower) and turn ignition on.

- Check for power at terminals 30 and 86 of relay block with ignition ON.
- Fix any wiring faults found.

NOTE —

Complete wiring diagrams for the auxiliary radiator cooling fan can be found under **Electrical Wiring Diagrams**.



➢ If fan operates only at high speed and no electrical faults have been found up to this point, use an ohmmeter to check that fan resistor is not electrically open.

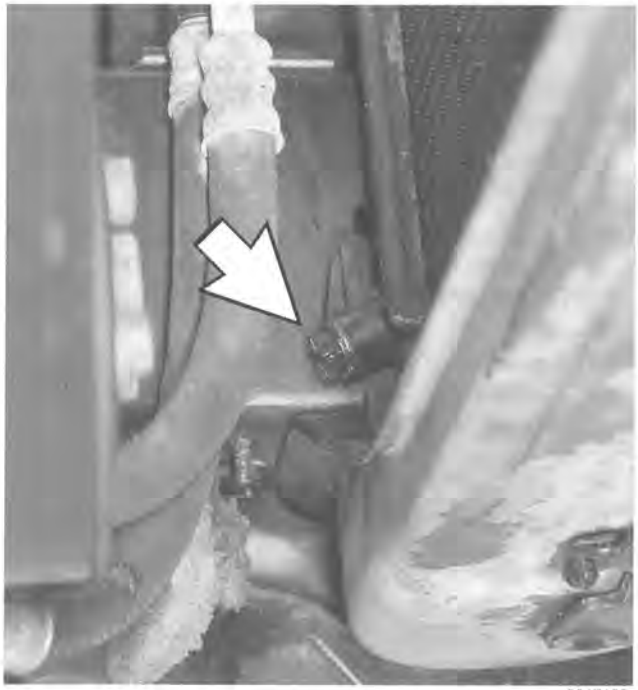
- Resistor (**arrow**) is mounted on auxiliary fan housing behind front grille.

COOLANT

Coolant, draining and filling

– Remove coolant expansion tank cap. Set temperature controls in passenger compartment to full warm.

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*



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➤ Place 3-gallon pail beneath radiator drain plug (**arrow**). Remove drain plug.

> ***WARNING —***
> *Coolant is poisonous and lethal, especially to pets. Clean up spills immediately and rinse the area with water.*

– Place 3-gallon pail beneath rear of engine block. Loosen and remove engine block coolant drain plug(s).

NOTE —

- *On the M30 engine the block drain plug is located on the exhaust side of the engine, below cylinder no. 6.*
- *On the M60 engine the block drains are located below nos. 2 and 3 cylinder exhaust ports, and below nos. 5 and 6 cylinder exhaust ports.*
- *On the M70 engine the block drains are located below the nos. 4 and 10 cylinder exhaust ports.*

– Reinstall radiator and engine block drain plugs using new sealing washers. Be sure heater controls are set to full warm.

Tightening Torques

- Engine block drain plug to block . . . . . 25 Nm (18 ft-lb)
- Radiator drain plug to radiator . . 2-3 Nm (18-27 in-lb)

– Using a coolant mixture of 50% anti-freeze and 50% distilled water, fill system slowly so that air is allowed to escape. Bleed cooling system as described later.

NOTE —

- *Coolant can often be reused provided it is clean and less than two years old.*
- *Do not reuse the coolant when replacing damaged engine parts. Contaminated coolant may damage the engine or cooling system.*

Table d. Cooling System Capacities

Engine	Capacity
M30	12.5 liters (13.2 qts.)
M60	12.5 liters (13.2 qts.)
M70 1988 - 1991 1992 - 1994	 15.0 liters (15.8 qts.) 13.0 liters (13.6 qts.)

Cooling system, bleeding

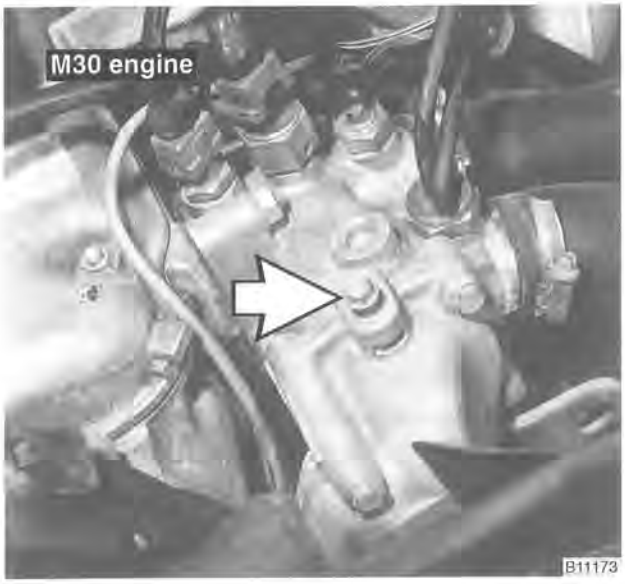
Air may become trapped in the cooling system during filling. Trapped air can prevent proper coolant circulation. Whenever the coolant is drained and filled, the system should be bled of trapped air.

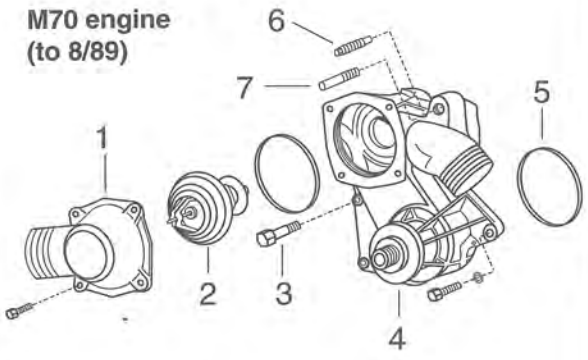
NOTE—
All M60 engines and M70 engines from 8/89 (1990 model year) are equipped with a coolant equalizer hose from thermostat housing to radiator. These models lack a coolant bleeder screw.

– Add coolant to expansion tank until level reaches COLD mark on tank.

➢ On M30 engine: Loosen bleeder screw (**arrow**) on thermostat housing.

– Add coolant to expansion tank until it spills from screw. Tighten screw.





1. Thermostat housing cover
2. Thermostat
3. Thermostat O-ring
4. Coolant pump/thermostat housing
5. Coolant pump O-ring
6. Cooling system bleeder (through 8/89)
7. Equalizer nipple (from 8/89)

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➢ On early M70 engine: Loosen bleeder screw on thermostat housing.

- Add coolant to expansion tank until it spills from screw.
- Tighten screw.
- Set temperature controls in passenger compartment to full warm and start engine.
- With engine idling at normal operating temperature, loosen bleeder screw.
- Tighten screw when coolant spilling from bleeder is free from air bubbles.

– After engine has cooled, recheck coolant level and add coolant as necessary.

CAUTION—
Always use genuine BMW coolant or its equivalent to avoid the formation of harmful, clogging deposits in the cooling system. Use of other anti-freeze solutions may be harmful to the cooling system.

Tightening Torque

- Coolant bleeder screw . . . . . .8 Nm (71 in-lb)

COOLANT PUMP

E32 cars are equipped with a belt-driven coolant pump at the front of the engine which circulates coolant through the engine and the radiator.

In addition to the conventional coolant pump, an electric pump is used to circulate coolant to the heater core. This unit is located below the coolant control valves at the left side of the engine compartment rear bulkhead. For more information on the electric coolant pump and the coolant control valves, see **640 Heating and Air Conditioning**.

Belt-driven coolant pump replacement procedures are organized according to engine codes. For engine code application information, see **100 Engine–General.**

Coolant pump, replacing (M30 engine)

– Drain cooling system as described earlier.

> ***WARNING—***
> *Allow cooling system to cool before opening or draining cooling system.*

– Remove fan clutch assembly and fan shroud as described below under **Cooling fan, removing and installing**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Apply pressure to pump V-belt and loosen coolant pump pulley mounting bolts. Then remove V-belt and remove pulley from pump.

– Remove engine lifting bracket from front of engine.

– Remove coolant hose from pump.

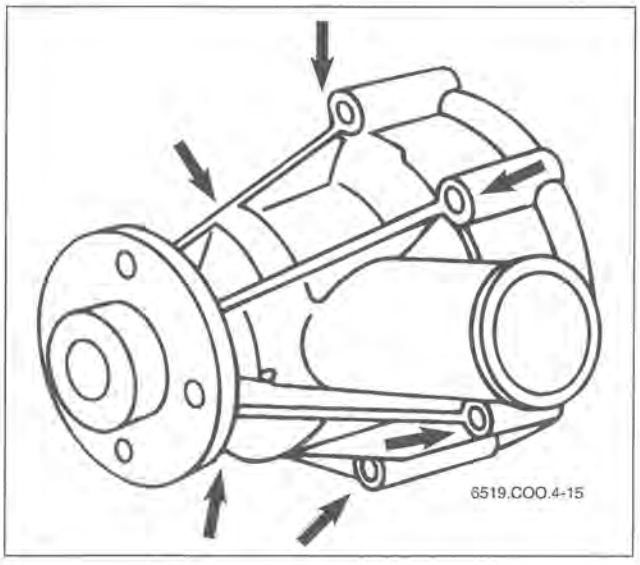
◁ Remove six coolant pump mounting bolts (**arrows**) and remove pump.

– Installation is reverse of removal.

- Use a new gasket and make sure gasket mating surfaces are clean and dry.
- Fill system with coolant and bleed system as described under **Coolant, draining and filling**.

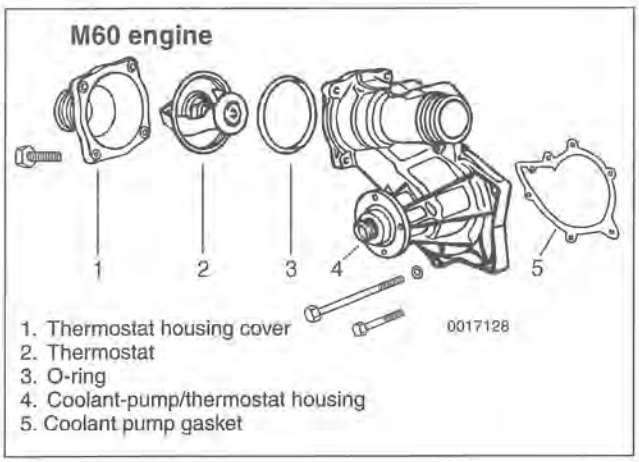
Tightening Torques

- Coolant pump to cylinder block. . . . . 10 Nm (89 in-lb)
- Coolant pump pulley to coolant pump . . . . . 10 Nm (89 in-lb)



COOLANT PUMP

Coolant pump, replacing (M60 engine)



1. Thermostat housing cover
2. Thermostat
3. O-ring
4. Coolant-pump/thermostat housing
5. Coolant pump gasket

M60 engine coolant pump and thermostat housing assembly.

- Drain cooling system as described earlier.

> ***WARNING—***
> *Allow cooling system to cool before opening or draining cooling system.*

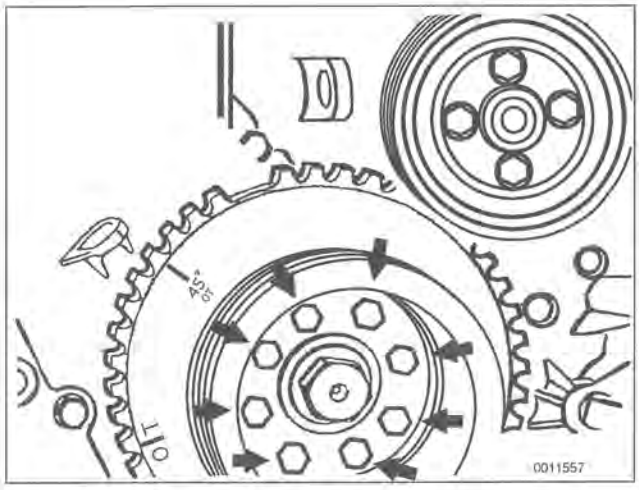
- Raise car and support in a safe manner.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

- Remove fan clutch assembly and fan shroud as described under **Cooling fan, removing and installing**.

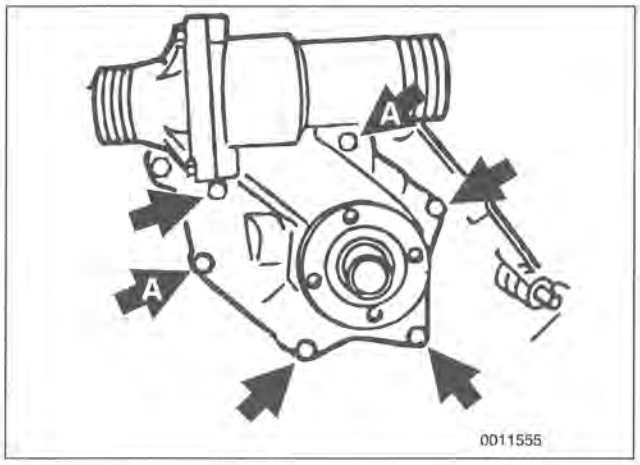
NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Working from below car, remove engine splash shield and then remove heat shields from front suspension crossmember.
- Loosen coolant pump pulley mounting bolts.
- Remove engine drive belt as described in **020 Maintenance**.
- Remove coolant pump pulley mounting bolts and remove pulley from coolant pump.



Remove vibration damper mounting bolts (**arrows**) from crankshaft hub on M60 engine.

- Remove coolant hoses from coolant pump/thermostat housing. Remove pump mounting bolts (qty. 6).



➢ Install coolant pump mounting bolts (**arrows**).

- Be sure pump aligns correctly with dowels (**A**) in timing chain cover during installation.

– Installation is reverse of removal.

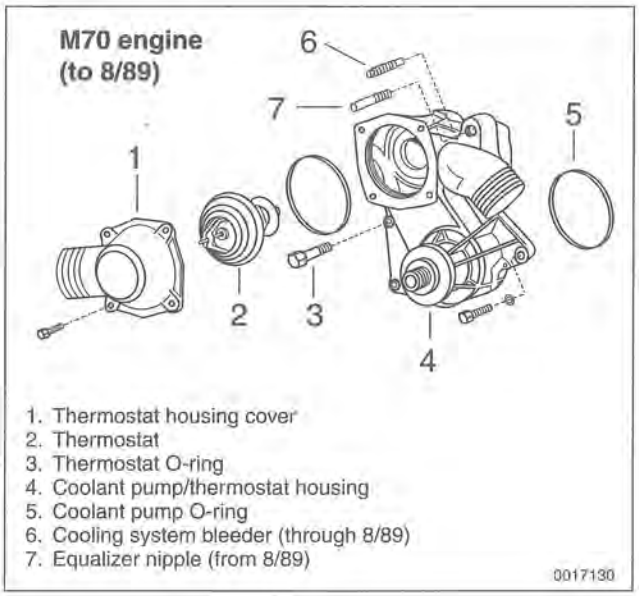
- Transfer thermostat from old pump using new O-ring.
- Fill system with coolant and bleed as described under **Coolant, draining and filling**.

CAUTION—
• The vibration damper is located by dowel pins.
• Use new bolts when installing vibration damper.

Tightening Torques

- Coolant drain plug to engine block . . . . . 25 Nm (18 ft-lb)
- Coolant pump to timing chain cover . . . . . 10 Nm (89 in-lb)
- Coolant pump pulley to coolant pump . . . . . 10 Nm (89 in-lb)
- Thermostat housing to coolant pump . . . . . 10 Nm (89 in-lb)
- Vibration damper to crankshaft hub (M8) . . . . . 22 Nm (17 ft-lb)

Coolant pump, replacing (M70 engine)



1. Thermostat housing cover
2. Thermostat
3. Thermostat O-ring
4. Coolant pump/thermostat housing
5. Coolant pump O-ring
6. Cooling system bleeder (through 8/89)
7. Equalizer nipple (from 8/89)

➢ M70 engine coolant pump and thermostat housing.

– Drain cooling system as described earlier.

WARNING—
Allow cooling system to cool before opening or draining cooling system.

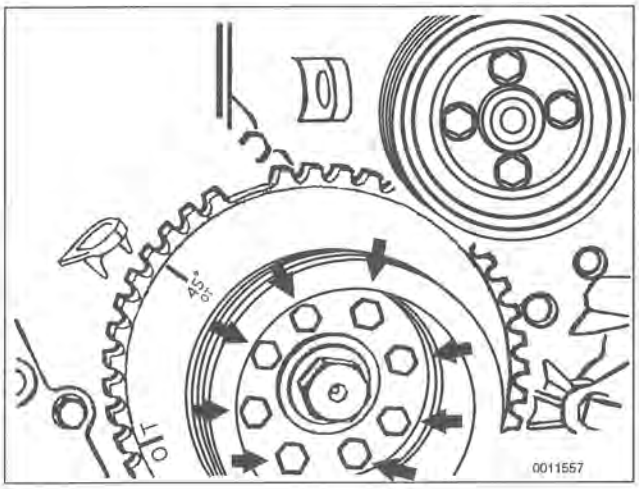
– Raise car and support in a safe manner.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

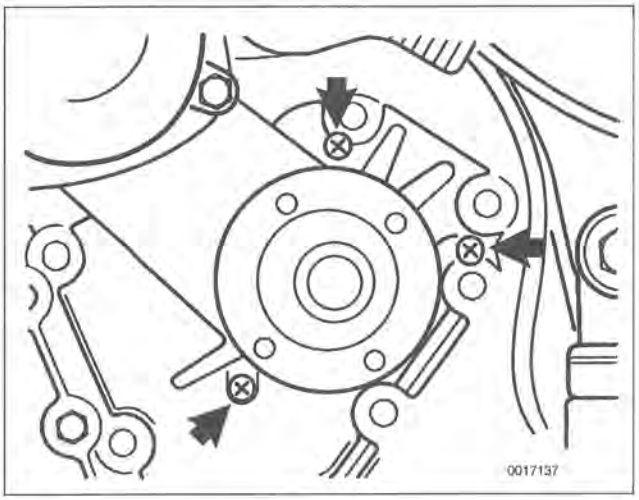
– Remove fan clutch assembly and fan shroud as described under **Cooling fan, removing and installing**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Working below car, remove engine splash shield.



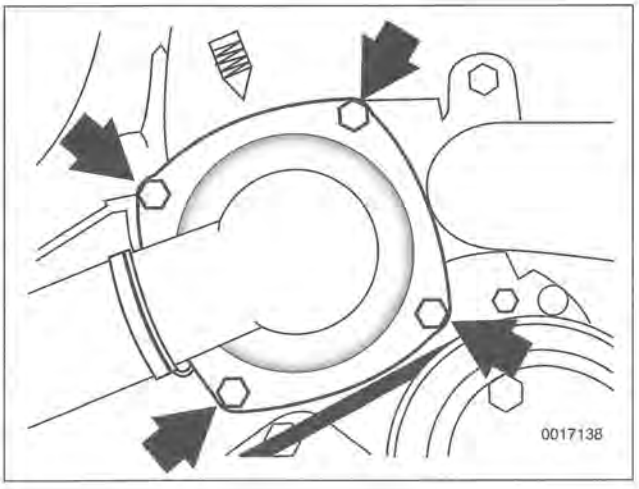
- Remove crankshaft vibration damper mounting bolts (**arrows**) and remove vibration damper on M70 engine.
- Remove water pump pulley and drive belt.
- Remove coolant hoses from coolant pump/thermostat housing. Remove pump mounting bolts (qty. 6).



- Uniformly screw three M5 bolts (**arrows**) into tapped holes in coolant pump housing to push coolant pump out of mounting block.
- Installation is reverse of removal.
  - Transfer thermostat from old pump using a new O-ring. Use HWB® lubricant or equivalent to lubricate O-rings.
  - Fill system with coolant and bleed as described under **Coolant, draining and filling**.

Tightening Torques

- Coolant drain plug to engine block . . . . . 25 Nm (18 ft-lb)
- Coolant pump to timing chain cover . . . . . 10 Nm (89 in-lb)
- Coolant pump pulley to coolant pump . . . . . 10 Nm (89 in-lb)
- Thermostat housing to coolant pump . . . . . 10 Nm (89 in-lb)
- Vibration damper to crankshaft hub (M8) . . . . . 22 Nm (17 ft-lb)

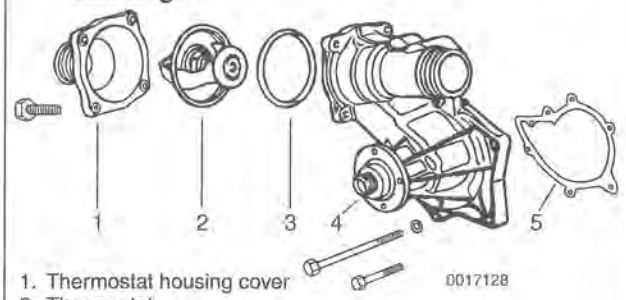


THERMOSTAT

Thermostat, replacing

- With engine cold, drain radiator as described above under **Coolant, draining and filling**.
- On M60 engine: Remove upper section of air cleaner complete with mass air flow sensor.
- On M30 engine: Remove thermostat cover mounting bolts (**arrows**) from thermostat housing on front of engine.

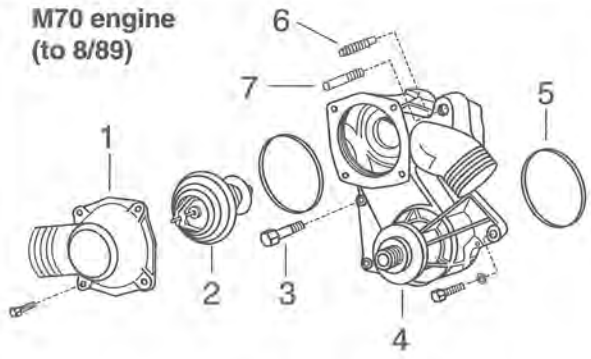
M60 engine



1. Thermostat housing cover
2. Thermostat
3. O-ring
4. Coolant-pump/thermostat housing
5. Coolant pump gasket

On M60 engine: Remove thermostat from coolant pump and thermostat housing assembly.

M70 engine (to 8/89)



1. Thermostat housing cover
2. Thermostat
3. Thermostat O-ring
4. Coolant pump/thermostat housing
5. Coolant pump O-ring
6. Cooling system bleeder (through 8/89)
7. Equalizer nipple (from 8/89)

On M70 engine: Remove thermostat from coolant pump and thermostat housing assembly.

NOTE—

- *On M60 or M70 engine, removal of the cooling fan and fan shroud will provide additional clearance. See* **Cooling fan, removing and installing.**
- *In all engines, note direction and orientation of thermostat before removing.*

– Install new thermostat and thermostat cover using new O-ring and gasket(s) as necessary.

NOTE—

Some thermostats have a direction arrow or vent hole near the edge. Install the thermostat so that either the arrow or hole are at the top.

– Installation is reverse of removal.

- Fill system with coolant and bleed system as described under **Coolant, draining and filling.**

Tightening Torque

- Thermostat housing cover to housing or coolant pump . . . . . 10 Nm (89 in-lb)

RADIATOR

Radiator, removing and installing

– Drain radiator as described earlier under **Coolant, draining and filling.**

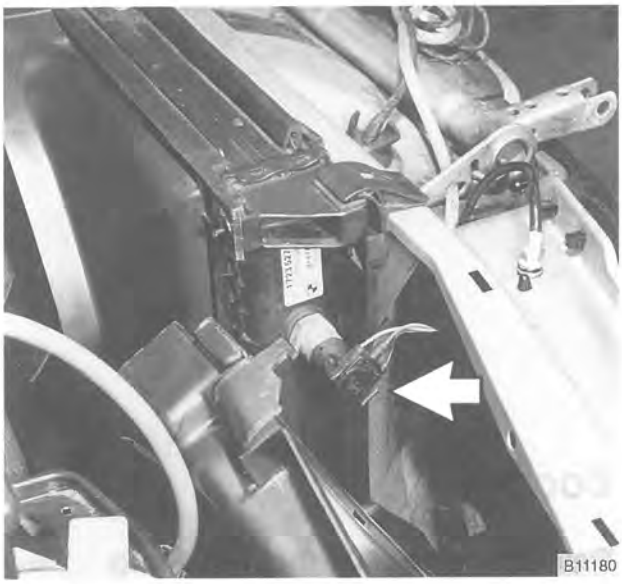
WARNING—

Allow cooling system to cool before opening or draining system.

– Remove fan clutch assembly and fan shroud as described below under **Cooling fan, removing and installing**.

NOTE—
The radiator cooling fan nut (32 mm wrench) has left-hand threads.

– Detach all coolant hoses from radiator.


B11180

➢ Disconnect harness connector from auxiliary fan temperature switch (**arrow**).

– Disconnect automatic transmission fluid (ATF) cooler lines from radiator, where applicable.

NOTE—
Plug the disconnected ATF cooler lines and position them upwards to avoid loss of fluid.


B11181

➢ Push down and pull screwdriver forward to release radiator retaining clip.

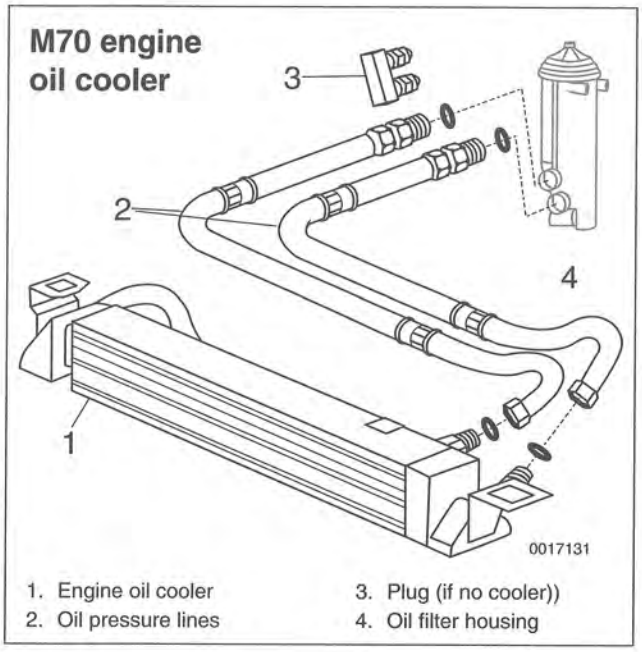
– Pull radiator up and out of car.

NOTE—
The radiator is mounted on two angled rubber buffers halfway down the sides of the radiator.

– Installation of radiator is reverse of removal, noting following:

- Use new sealing rings when installing ATF cooler lines. Check ATF level. See **020 Maintenance**.
- Fill and bleed radiator and cooling system as described under **Coolant, draining and filling.**

Engine Oil Cooler



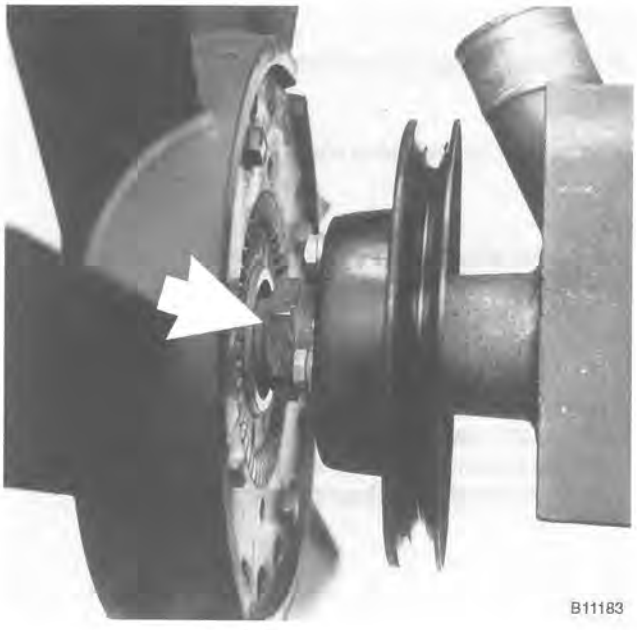
1. Engine oil cooler
2. Oil pressure lines
3. Plug (if no cooler))
4. Oil filter housing

Engine oil cooler on M70 engine. M30 oil cooler is similar.

- The engine oil cooler is mounted below the radiator. The oil pressure lines for the cooler originate at the oil filter housing.

COOLING FANS

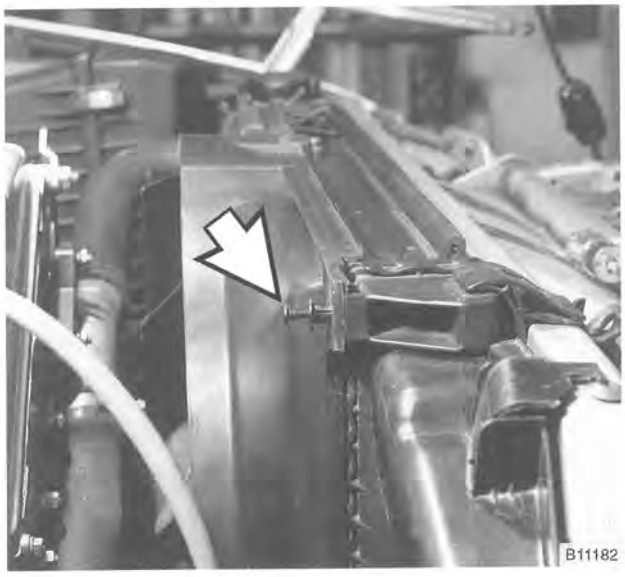
Belt-driven cooling fan, replacing



Place 32 mm wrench on fan clutch nut (**arrow**). Strike wrench sharply in clockwise direction (looking from front of car) to loosen nut. Spin fan off pump.

NOTE—

- *If the nut is difficult to loosen, use a tool to hold the coolant pump pulley stationary. BMW has a special tool for this purpose (BMW special tool no. 11 5 030 for M30 engines or 11 5 050 for M60 engines).*
- *The radiator cooling fan nut (32 mm wrench) has left-hand threads.*


B11182

- Remove expansion rivets (**arrow**) holding shroud to radiator.
- Remove fan and shroud together.

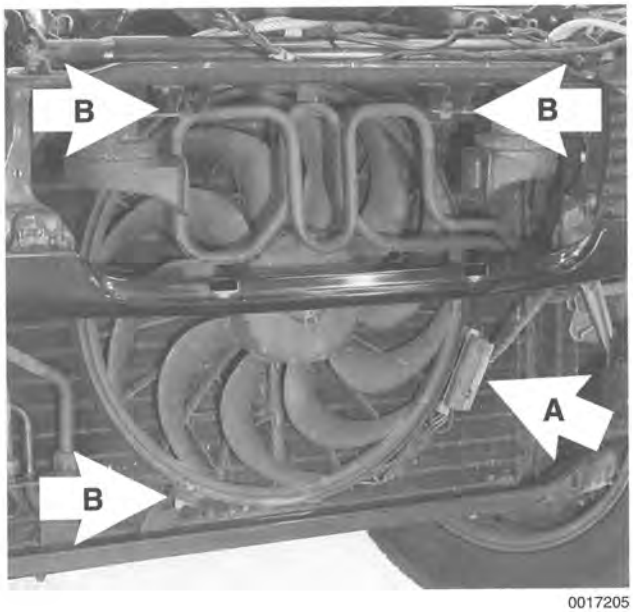
NOTE—
Store the removed fan clutch assembly in an upright position to prevent loss of clutch fluid.

- To replace fan clutch, remove fan mounting bolts (qty. 4) and separate fan from clutch.
- Installation is reverse of removal.

Tightening Torques
- Fan to viscous clutch . . . . . .10 Nm (89 in-lb)
- Clutch nut to coolant pump (left-hand thread)
  Without BMW tool no. 11 5 040 . . . . . 40 Nm (29 ft-lb)
  With BMW tool no. 11 5 040 . . . . . 30 Nm (22 ft-lb)

Auxiliary cooling fan, replacing

- Remove front bumper and center radiator grille as described in **510 Exterior Trim, Bumpers**.
- Detach auxiliary fan harness connector.



0017205

- Auxiliary cooling fan harness connector (**A**) and mounting bolts (**B**).
  - Remove fan mounting bolts and lower fan out of car.
- Installation is reverse of removal.



180 Exhaust System

GENERAL 180-1

EXHAUST SYSTEM 180-1
Exhaust system, removing and installing 180-3

EXHAUST MANIFOLDS 180-5
Exhaust manifolds, removing and installing (M30 engine) 180-5
Exhaust manifolds, left side removing and installing (M60 engine) 180-6
Exhaust manifolds, right side removing and installing (M60 engine) 180-7
Exhaust front pipes, removing and installing (M70 engine) 180-8
Exhaust manifolds, left side removing and installing (M70 engine) 180-9
Exhaust manifolds, right side removing and installing (M70 engine) 180-10

GENERAL

The exhaust system is designed to be maintenance free, although regular inspection is warranted due to the harsh operating conditions. Under normal conditions, the catalytic converter does not require replacement unless it is damaged. The rear exhaust pipe assembly includes intermediate and primary mufflers and must be replaced as a unit.

The oxygen sensor monitors the exhaust and provides feedback about combustion efficiency to the DME control unit. The oxygen sensor should be replaced as a part of routine maintenance at a specified mileage interval. See **020 Maintenance** for replacement information. For information on testing the oxygen sensor see **130 Fuel Injection**.

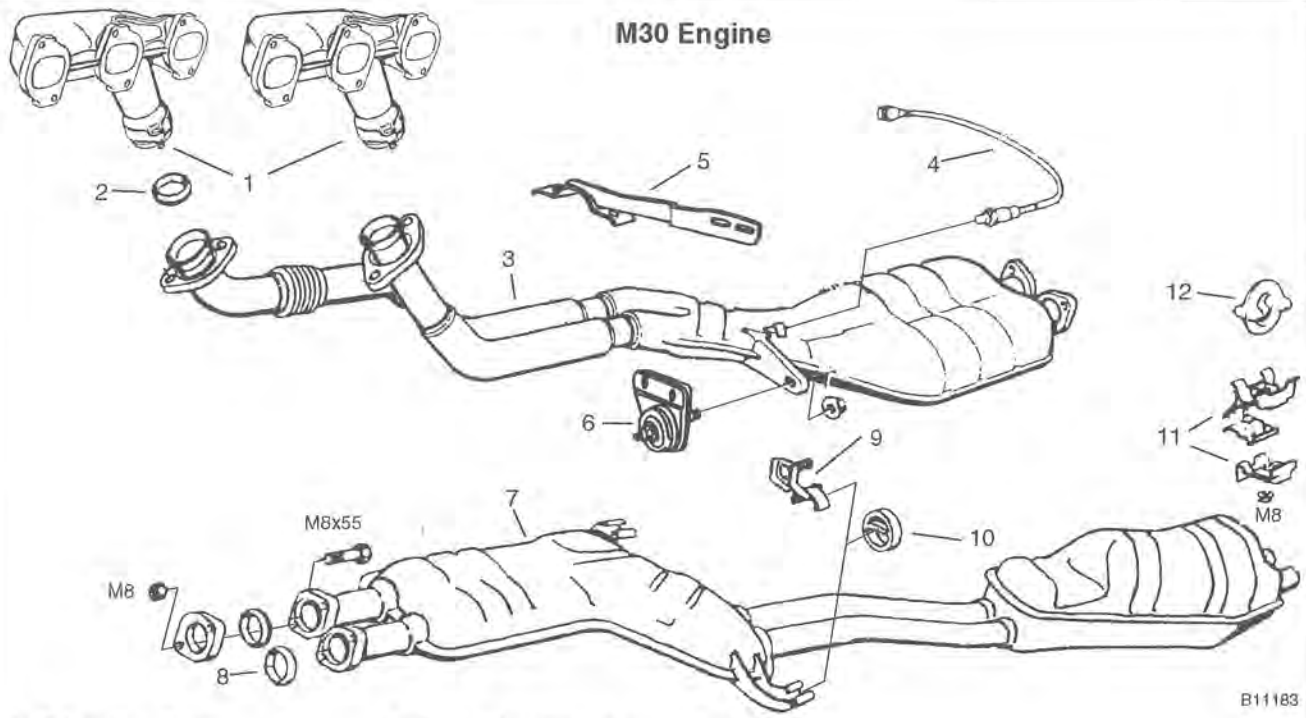
EXHAUST SYSTEM

New fasteners, clamps, rubber mounts and gaskets should be used when replacing exhaust components. A liberal application of penetrating oil to the exhaust system nuts and bolts in advance may make removal easier.

WARNING—

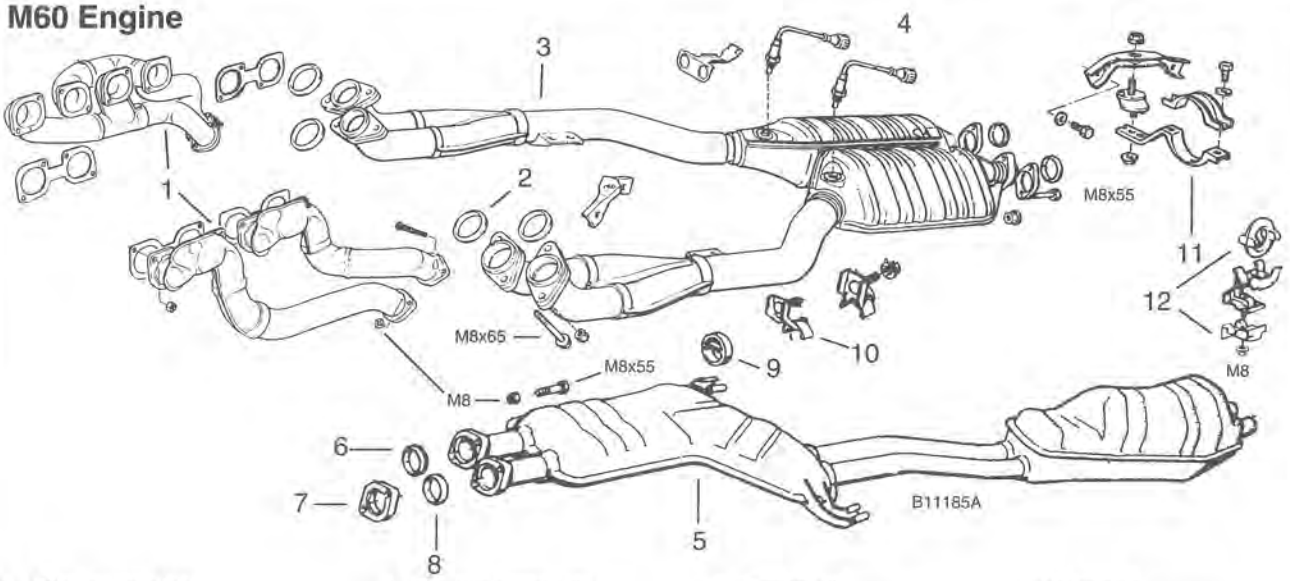
- *The exhaust system and catalytic converter operate at very high temperatures. Allow these components to cool before servicing. Wear protective clothing to prevent burns. Do not use flammable chemicals near a hot catalytic converter.*
- *Old, corroded exhaust system components crumble easily and often have exposed sharp edges. To avoid injury, wear eye protection and heavy gloves when working with old exhaust parts.*

M30 Engine

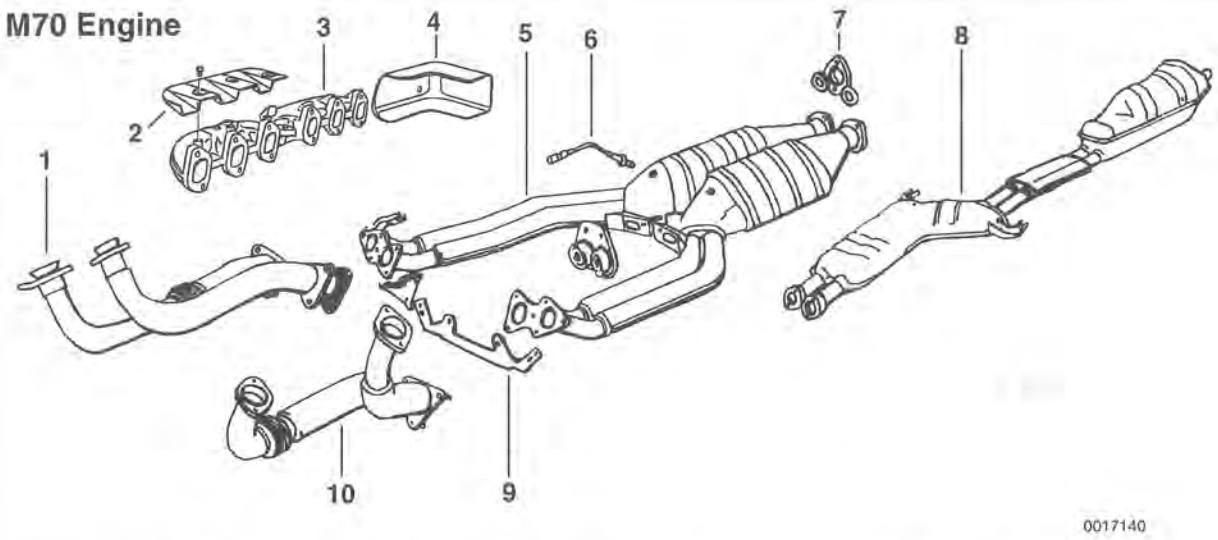


1. Exhaust manifolds
2. Gasket rings
3. Front pipe with catalytic converter
4. Oxygen sensor and shield
5. Bracket (manual trans.)
6. Bracket (automatic trans.)
7. Rear pipe with mufflers
8. Gasket ring
9. Bracket (2)
10. Rubber mounting ring (2)
11. Bracket/clamp(2)
12. Rubber mounting ring (2)

M60 Engine



1. Exhaust manifolds
2. Gasket (2)
3. Front pipe with catalytic converter
4. Oxygen sensor (2)
5. Rear pipe with mufflers
6. Gasket
7. Bracket (2)
8. Gasket ring (50 mm)
9. Rubber mounting ring
10. Bracket
11. Bracket assembly
12. Bracket/clamp



1. Front exhaust pipe, right
2. Exhaust manifold heat shield
3. Exhaust manifold, right
4. Exhaust manifold heat shield
5. Exhaust midsection with catalytic converters
6. Oxygen sensor and shield
7. Gasket ring w/bracket
8. Rear pipe with mufflers
9. Bracket
10. Front exhaust pipe, left

Exhaust system, removing and installing

This section covers removing the exhaust system as a complete unit. Once the complete system is removed from the car, individual pipes and mufflers can be more easily replaced.

WARNING —
Exhaust gases are colorless, odorless, and very toxic. Run the engine only in a well-ventilated area. Immediately repair any leaks in the exhaust system or structural damage to the car body that might allow exhaust gases to enter the passenger compartment.

– With exhaust system fully cold, raise and support car for access to exhaust system.

WARNING —
Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.

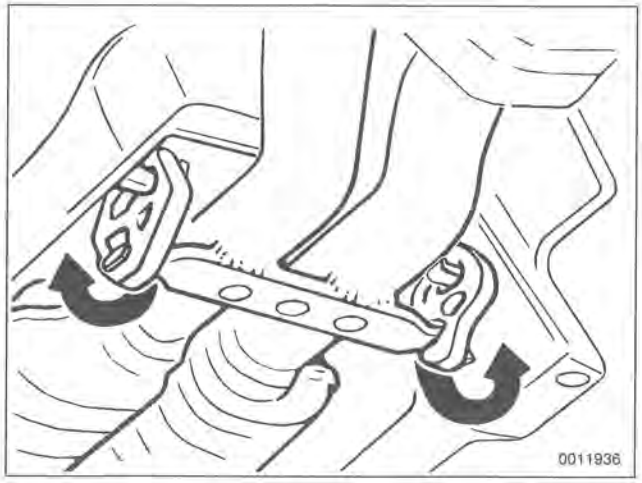
– Disconnect oxygen sensor connector(s).

– Loosen and remove bolts holding front exhaust pipes to exhaust manifolds.

NOTE—
On 750iL model: detach the exhaust midsection from front pipes. Front pipe removal is covered in **Exhaust Manifolds**.

– Support exhaust system

– Disconnect exhaust support bracket assembly from transmission.



➢ Rubber exhaust system hangers. Remove hanger by prying off bracket (**arrows**).

• Detach rubber hangers, where applicable.

– Lower exhaust system to ground.

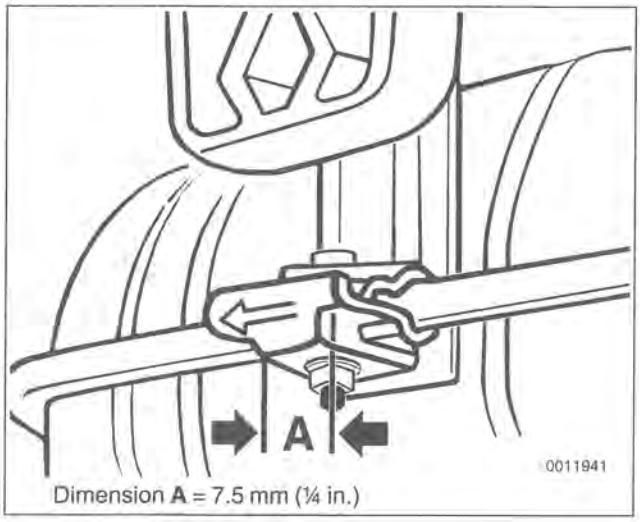
NOTE—
If the catalytic converter/front exhaust pipe assembly is to be replaced, transfer the oxygen sensor to the new pipe(s).

Tightening Torque
• Oxygen sensor to exhaust system . . . 55 Nm (41 ft-lb)

– Installation is reverse of removal.

• Make sure there is at least 20 mm (¾ in.) clearance between exhaust system and car body at every point.
• Loosely install all exhaust system mounting hardware and hangers before tightening fasteners to their final torque.
• Coat manifold studs with copper paste before installing nuts.

NOTE—
• Where applicable, tighten front pipe with semi-flexible compensator (spring-loaded fasteners) last when installing front pipe to manifolds.



Dimension **A** = 7.5 mm (¼ in.)

➢ Preload rear clamping bracket as specified to help prevent system rattling.

Tightening Torques (M30 engine)
• Front exhaust pipe to exhaust manifold
1st stage . . . . . 10 Nm (89 in-lb)
2nd stage . . . . . loosen nuts 1½ turns

To prevent exhaust system rattles and vibration, the system should be slightly preloaded by pushing the rear clamping brackets forward about 7 mm (¼ in.).

Tightening Torques
• Exhaust support bracket to transmission . . . . . 24 Nm (17 ft-lb)
• Exhaust system mounting clamps . . . 22 Nm (16 ft-lb)

EXHAUST MANIFOLDS

Exhaust manifold removal procedures are organized according to engine code. If necessary, see **100 Engine–General** for engine code and application information.

NOTE—
When removing exhaust manifolds or front exhaust pipes on the M60 or M70 engine, it may be simpler to remove the engine, due to an extremely crowded engine compartment.

Exhaust manifolds, removing and installing (M30 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With exhaust system cold, raise and support car for access to exhaust system.

> ***WARNING—***
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

– Unbolt front exhaust pipes from exhaust manifolds.

– Remove exhaust support bracket from transmission.

– Loosen and remove nuts from exhaust manifolds and remove manifolds. Discard nuts and gaskets.

– Installation is reverse of removal.

- Coat exhaust manifold mounting studs with copper paste before installing new nuts.
- Install new manifold gaskets with arched side facing manifolds.

Tightening Torques

- Exhaust manifold
  to cylinder head (M8) . . . . . 22 Nm (17 ft-lb)
- Exhaust pipe to exhaust manifold
  1st stage . . . . . 10 Nm (89 in-lb)
  2nd stage . . . . . loosen nuts 1½ turns

Exhaust manifolds, left side removing and installing (M60 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With exhaust system cold, raise and support car for access to exhaust system.

– Working beneath car, remove engine splash shield and then remove heat shields from left side of front suspension crossmember.

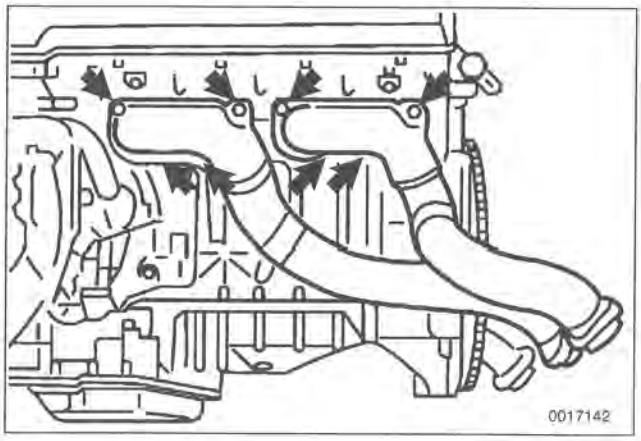
– Remove alternator if necessary. See **121 Battery, Starter, Alternator**.

– Unbolt exhaust pipe from left exhaust manifolds.

– Remove top engine plastic cover. See **113 Cylinder Head Removal and Installation**.

– Working from underside of front suspension crossmember, remove mounting bolts from left and right engine mounts. Disconnect ground strap from engine mount bracket, where applicable.

– Install engine lifting device to front and rear lifting points.



➢ Remove left side exhaust manifold mounting nuts (arrows) and remove exhaust manifolds.

– Raise engine just enough to facilitate removal of exhaust manifolds.

> ***CAUTION—***
> *Check that there is sufficient clearance at rear bulkhead when raising engine.*

– Installation is reverse of removal.

- Coat exhaust manifold mounting studs with copper paste before installing new nuts.
- Install manifold gaskets with arched side facing manifolds.
- Be sure to reinstall all ground straps.

Tightening Torque

- Exhaust manifold to cylinder head (M8) . . . . . 22 Nm (17 ft-lb)

Exhaust manifolds, right side removing and installing (M60 engine)

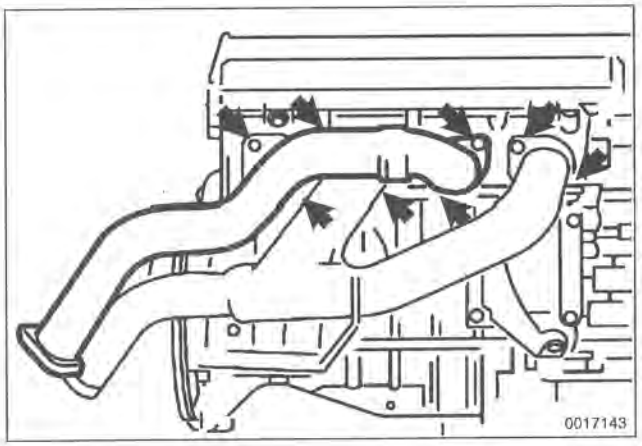
– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With exhaust system cold, raise and support car for access to exhaust system.

> ***WARNING—***
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

– Working beneath car, remove engine splash shield and then remove heat shields from front suspension crossmember.



◄ Remove right side exhaust manifold mounting nuts (**arrows**) and remove manifolds.

– Remove windshield washer reservoir in front of right strut tower and set aside.

– Remove exhaust manifold mounting nuts. Remove manifolds from above, removing manifold for cylinders 2/4 first.

– Installation is reverse of removal.

- Coat exhaust manifold mounting studs with copper paste before installing new nuts.
- Install manifold gaskets with arched side facing manifolds.

Tightening Torque

- Exhaust manifold to cylinder head (M8) . . . . . 22 Nm (17 ft-lb)

Exhaust front pipes, removing and installing (M70 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With exhaust system cold, raise and support car for access to exhaust system.

– Working beneath car, remove engine splash shield and then remove heat shields from front suspension crossmember.

– While supporting exhaust system, detach exhaust midsection from front exhaust pipes.

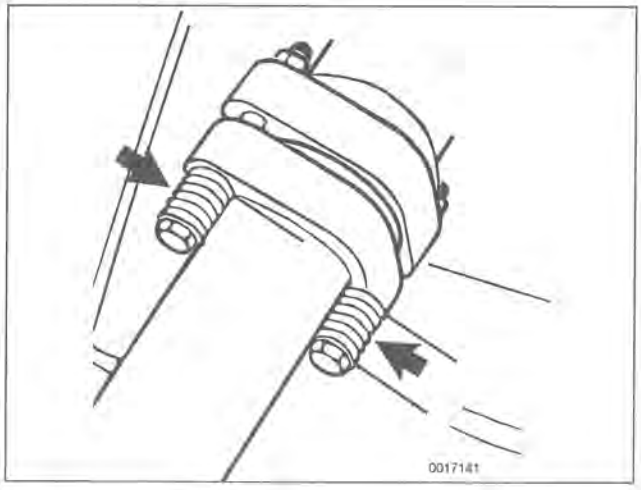
– Unbolt and remove front pipes from exhaust manifolds.

NOTE—

- *Remove the windshield washer reservoir(s) to gain access to the right side exhaust manifolds.*
- *Remove the oil filter housing and the brake booster fluid reservoir to gain access to the left side manifolds.*

– Installation is reverse of removal.

- Replace sealing rings and gaskets.
- Replace mounting hardware as necessary.
- Coat mounting bolts with copper paste before installing new nuts.



➢ Tighten exhaust mounting hardware to compress springs (**arrows**), then back off 1½ turns. Exhaust flanges should end up parallel to each other.

Tightening Torque

- Exhaust pipe to exhaust manifold
  1st stage . . . . . 10 Nm (89 in-lb)
  2nd stage . . . . . loosen nuts 1½ turns

Exhaust manifolds, left side removing and installing (M70 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With exhaust system cold, raise and support car for access to exhaust system.

– Remove front exhaust pipe(s) as described earlier.

NOTE—
- *Remove the windshield washer reservoir(s) to gain access to the right side exhaust manifolds.*
- *Remove the oil filter housing and the brake booster fluid reservoir to gain access to the left side manifolds.*

– Remove left front exhaust manifold nuts and remove front manifold.

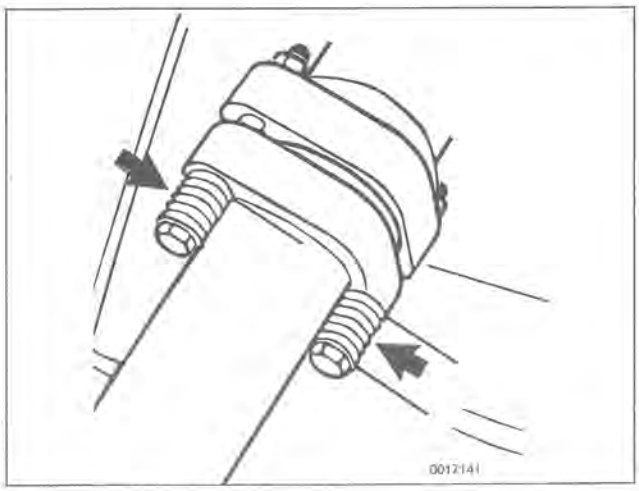
– Detach vacuum hose to brake booster from cylinder head.

– Detach heater hoses leading to heater valve. Detach heater valve and set aside.

– Remove left rear exhaust manifold top nuts and remove rear manifold heat shield.

– Remove lower manifold nuts and remove manifold.

– Installation is reverse of removal.
- Replace gaskets and self-locking nuts.
- Install manifold gaskets with smooth side toward cylinder head.
- Coat mounting bolts with copper paste before installing new nuts.



Tighten exhaust mounting hardware to compress springs (**arrows**), then back off 1½ turns. Exhaust flanges should end up parallel to each other.

Tightening Torques
- Exhaust manifold
  to cylinder head (M8) . . . . . 24 Nm (17 ft-lb)
- Exhaust pipe to exhaust manifold
  1st stage . . . . . 10 Nm (89 in-lb)
  2nd stage . . . . . loosen nuts 1½ turns

Exhaust manifolds, right side removing and installing (M70 engine)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– With exhaust system cold, raise and support car for access to exhaust system.

– Remove front exhaust pipe(s) as described earlier.

– Remove right front exhaust manifold nuts and remove front manifold.

– Remove heat shield on starter motor.

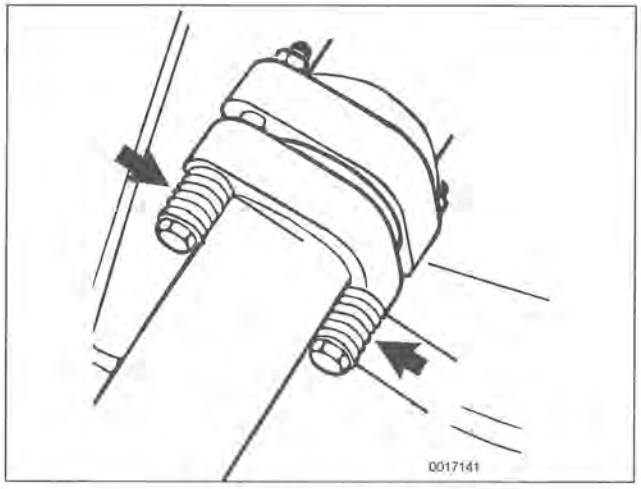
– Remove right rear exhaust manifold top nuts and remove rear manifold heat shield.

– Remove lower manifold nuts and remove manifold.

– Installation is reverse of removal.

- Replace gaskets and self-locking nuts.
- Install manifold gaskets with smooth side toward cylinder head.
- Coat mounting bolts with copper paste before installing new nuts.

Tighten exhaust mounting hardware to compress springs (**arrows**), then back off 1½ turns. Exhaust flanges should end up parallel to each other.



Tightening Torques

- Exhaust manifold to cylinder head (M8) . . . . . 24 Nm (17 ft-lb)
- Exhaust pipe to exhaust manifold
  1st stage . . . . . 10 Nm (89 in-lb)
  2nd stage . . . . . loosen nuts 1½ turns



200 Transmission–General

GENERAL 200-1

AUTOMATIC TRANSMISSION 200-1

MANUAL TRANSMISSION AND CLUTCH 200-2

LOCATING TRANSMISSION CODES . . 200-2

TABLES

a. Automatic Transmission Technical Data 200-2
b. Manual Transmission Technical Data 200-2

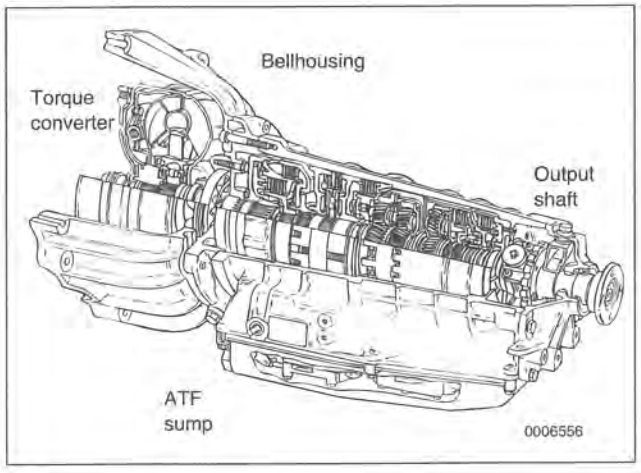
GENERAL

This transmission general repair group covers drivetrain application information for BMW E32 cars.

All of the cars covered by this manual are equipped with an in-line drivetrain. The transmission is bolted directly to the rear of a 6-, 8- or 12-cylinder engine. A driveshaft connects the output shaft of the transmission to the final drive. The final drive is mounted to the rear suspension member and the body. Individual drive axles with integrated constant velocity joints transfer rotational power to the rear driven wheels.

AUTOMATIC TRANSMISSION

Three different automatic transmissions are used, depending on model and model year and/or production date. All of the automatic transmissions are electro-hydraulically controlled with either four or five forward speeds. **Table a** lists automatic transmission application information.



4-speed ZF automatic transmission.

NOTE—

Repair information, including lubricating fluid specifications, for the automatic transmission is covered in **240 Automatic Transmission**.

Table a. Automatic Transmission Technical Data

Model	735i/iL (1988-1993)	740i/iL (1993-1994)	750iL (1988-1994)
Type	ZF 4 HP 22 EH	A5S 560Z	ZF 4 HP 24
Gear ratios			
1st	2.48	3.55	2.48
2nd	1.48	2.24	1.48
3rd	1.00	1.55	1.00
4th	0.73	1.00	0.73
5th	N/A	0.79	N/A
Reverse	2.09	3.68	2.09

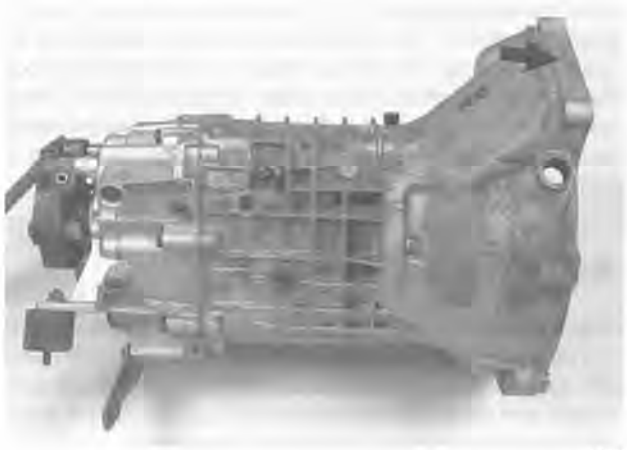
MANUAL TRANSMISSION AND CLUTCH

A small number of 735i models delivered US market were fitted with a Getrag 260/6 5-speed overdrive manual transmission. Manual transmission repair information is covered in **230 Manual Transmission**.

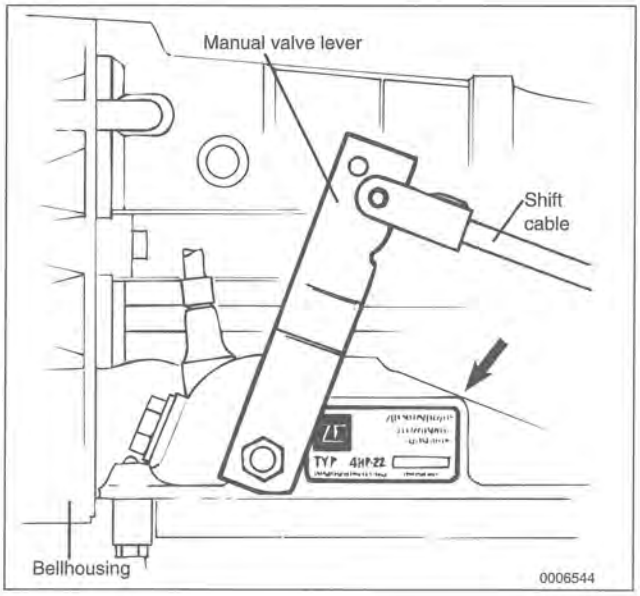
The clutch is hydraulically actuated. For more information on the clutch, see **210 Clutch**.

LOCATING TRANSMISSION CODES

On cars with manual transmission, the transmission code can typically be found on the top of the bellhousing.



6263



LOCATING TRANSMISSION CODES

Table b. Manual Transmission Technical Data

Model	735i (1988–)
Type	Getrag 260/6
Gear ratios	
1st	3.83
2nd	2.20
3rd	1.40
4th	1.00
5th	0.81
Reverse	3.46

On cars with automatic transmission, the transmission code is located on a data plate (**arrow**) on the left side of the transmission housing, just behind the manual valve lever.

NOTE—

When replacing the transmission or related transmission components, such as the torque converter, the code letters on the replacement parts should correspond to those of the original parts.



210 Clutch

GENERAL 210-1

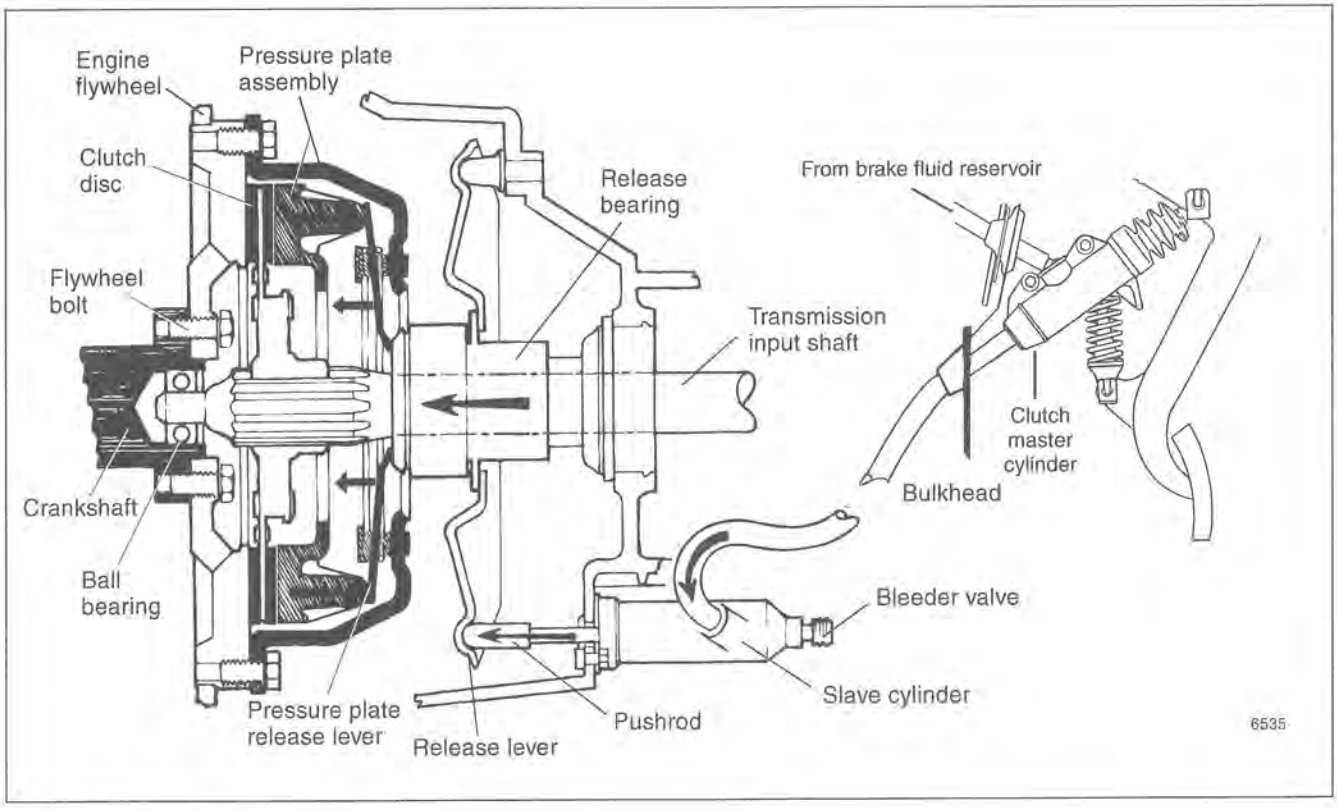
CLUTCH HYDRAULIC 210-2
Clutch hydraulic system, bleeding and flushing. 210-2
Clutch master cylinder, replacing 210-2
Clutch slave cylinder, replacing 210-4

CLUTCH MECHANICAL 210-5
Clutch, removing 210-5
Clutch, inspecting and installing. 210-6

GENERAL

The repair group covers replacement of the clutch mechanical and clutch hydraulic components. Special tools may be required for some of the service described in this repair group. Read the procedures through before beginning a job.

NOTE—
See **200 Transmission–General** *for transmission application information.*



CLUTCH HYDRAULIC

The clutch is hydraulically actuated by master and slave cylinders. Clutch disc wear is automatically taken up by the pushrod travel of the slave cylinder, making periodic adjustment unnecessary.

NOTE—
Although seal rebuild kits are available for the master and slave cylinders, replacement of leaking master or slave cylinders as complete units is suggested.

Clutch hydraulic system, bleeding and flushing

If the clutch/brake fluid is murky or muddy, or has not been changed within the last two years, it should be flushed from the clutch hydraulic circuit. Flushing the old fluid from the clutch lines is done using a brake system pressure bleeder.

- Remove brake fluid reservoir cap and attach appropriate pressure bleeder to fluid reservoir as per manufacturer's instructions.

> ***CAUTION—***
> *Do not exceed 1 bar (14.5 psi) of pressure at the fluid reservoir.*

- Connect a length of clear hose to slave cylinder bleeder valve and place open end of hose into clean container.
- Open bleeder screw on slave cylinder.
- Slowly operate clutch pedal several times. Close bleeder screw once fluid runs clear without air bubbles.
- Check fluid reservoir and top off fluid level.

NOTE—
If there is air trapped in the lines, unbolt the slave cylinder from the transmission. Push the slave cylinder pushrod all the way in and then slowly release it. Repeat process two times. This will force any remaining air in the system into the fluid reservoir.

Clutch master cylinder, replacing

The clutch master cylinder is mounted to the pedal assembly, directly above the clutch pedal.

- Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove brake fluid reservoir cap. Using a clean syringe, remove brake fluid from fluid reservoir.

> ***WARNING—***
> *Brake fluid is poisonous. Do not siphon brake fluid with your mouth. Wear hand and eye protection.*

– Disconnect fluid feeder hose from the master cylinder. Be prepared to catch any leaking fluid.

– Working on engine side of bulkhead, disconnect fluid line fitting from master cylinder.

– Remove lower left instrument panel trim. On cars with SRS (airbag), remove the lower dashboard panel.

➢ Remove clutch pedal pushrod eccentric bolt (**arrow**). Note position of dot on bolt head before loosening nut.



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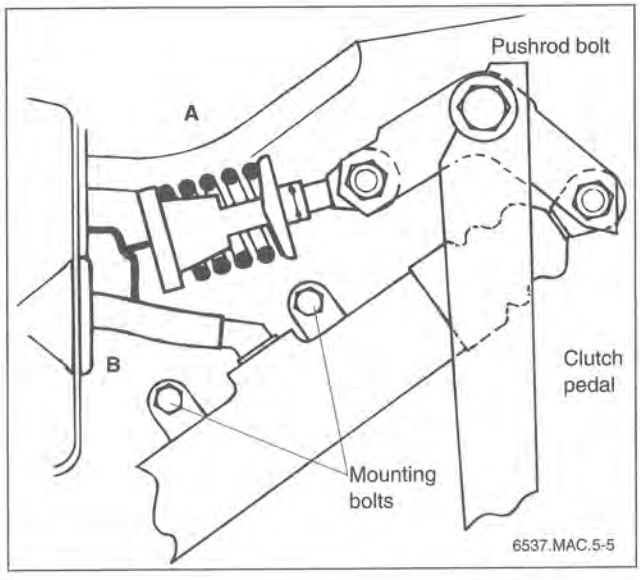
> ***NOTE—***
> *Note the position of the "dot" on the head of the eccentric bolt. The dot must be facing either toward the master cylinder or away from the master cylinder, but not in between.*

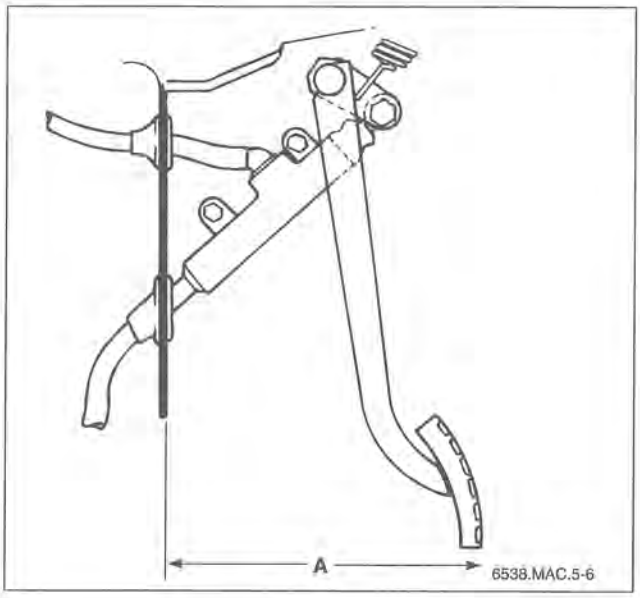
– Remove bolts connecting clutch master cylinder to clutch pedal bracket and remove master cylinder.

> ***CAUTION—***
> *Brake fluid is damaging to paint. Any brake fluid that spills on the car should be cleaned off immediately.*

– Installation is reverse of removal. Install pushrod eccentric bolt with dot on bolt head facing away from clutch master cylinder.

➢ On models with clutch pedal over-center helper spring (**A**), spring must be correctly seated before installing pushrod bolt.





Check clutch pedal height. If pedal adjustment is incorrect, loosen eccentric bolt nut and rotate bolt 180° (dot facing the master cylinder). Refill brake fluid reservoir and then bleed clutch hydraulic system as described under **Clutch hydraulic system, bleeding and flushing.**

Tightening Torques

- Clutch master cylinder to console . . . . .9 Nm (80 in-lb)
- Clutch pushrod to clutch pedal . . . . . 22 Nm (18 ft-lb)
- Fluid line to master cylinder . . . . . 16 Nm (12 ft-lb)

CAUTION—
If making adjustments at the pushrod end, do not screw the pushrod end all the way in. This may cause the locknut to jam against the clutch pedal during operation. If pushrod length is changed significantly, check the locknut clearance with the clutch pedal fully depressed.

Tightening Torque

- Clutch master cylinder pushrod locknut. . . . . .10 Nm (89 in-lb)

Clutch slave cylinder, replacing

The slave cylinder is mounted to the left-hand (driver's) side of the transmission.

– Remove brake fluid reservoir cap. Using a clean syringe, remove brake fluid from reservoir.

WARNING—
Brake fluid is poisonous. Do not siphon brake fluid with your mouth. Always dispose of old fluid properly.

– Loosen fluid line fitting at slave cylinder. Unbolt slave cylinder from transmission and disconnect fluid pipe. Catch excess fluid in a container.

– Inspect pushrod tip and release lever for wear. Pushrod should be worn only on the tip.

NOTE—
The release lever should show wear only in the pushrod recess. Wear on the side of the pushrod tip, or wear on the release lever other than in the pushrod recess indicates misalignment.

Installation is reverse of removal. Lightly coat plastic pushrod tip with molybdenum disulfide grease (Molykote Longterm 2 or equivalent). Be sure pushrod tip engages recess in clutch release lever during installation. Refill brake fluid reservoir and bleed clutch hydraulic system as described in **Clutch hydraulic system, bleeding and flushing.**

Tightening Torques

- Slave cylinder to transmission . . . . . 22 Nm (18 ft-lb)
- Fluid pipe connection to slave cylinder . . . . . .16 Nm (10 to 12 ft-lb)

CLUTCH MECHANICAL

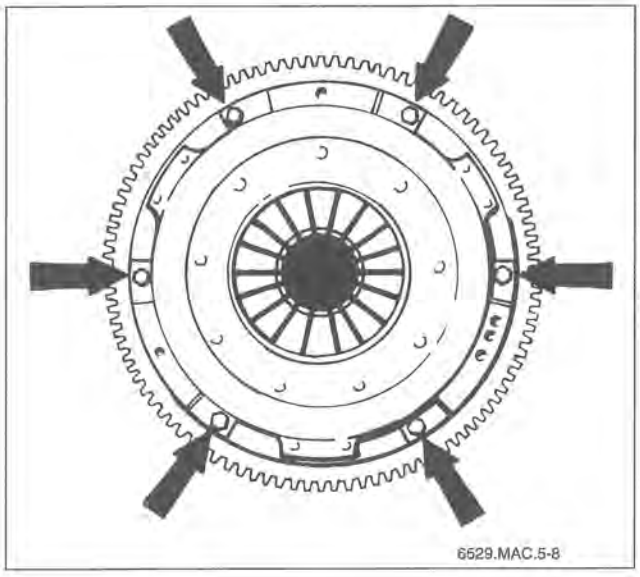
The transmission must be removed from the engine to access the clutch mechanical components. See **230 Manual Transmission**.

If there are signs of oil at the bottom of the transmission, check for a faulty rear crankshaft oil seal. Remove the flywheel to access the rear seal. A faulty seal should be replaced.

NOTE—
If the flywheel is removed, new bolts must be used when remounting the flywheel. The old bolts should not be reused.

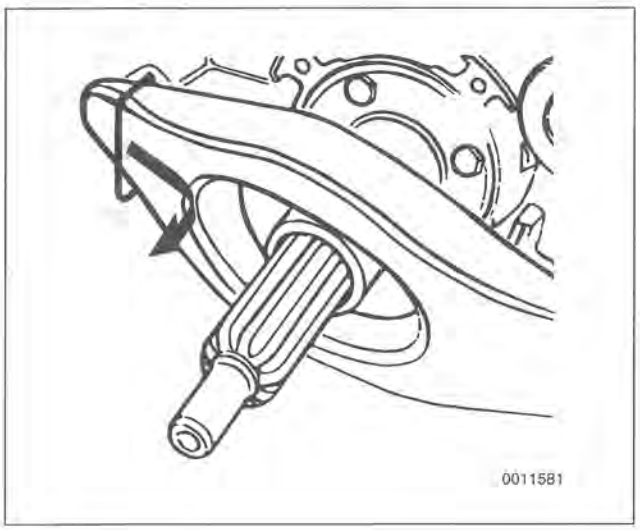
Clutch, removing

– Remove transmission from engine. See **230 Manual Transmission**.



➢ Lock engine flywheel in position and unbolt pressure plate. Loosen bolts (**arrows**) in stages until spring pressure is evenly relieved.

WARNING—
The clutch disc may contain asbestos fibers. Asbestos materials can cause asbestosis. Always wear an approved respirator and protective clothing when handling components containing asbestos. Do not use compressed air, do not grind, heat, weld, or sand on or near any asbestos materials.



➢ Pull release bearing off transmission input shaft. Remove clutch release lever by sliding it out of spring clip in direction of arrow.

Clutch, inspecting and installing

An alignment tool (clutch pilot tool) should be used to center the clutch disc to the pressure plate. Always use new clutch pressure plate bolts when installing the pressure plate to the flywheel.

– Inspect clutch pressure plate for wear or damage. Replace pressure plate if any faults are found.

- loose rivets
- bent or misaligned release levers
- warped, cracked or scored friction surface

NOTE—
New pressure plates are normally coated with a corrosion inhibitor for storage. Use a grease-free solvent to clean the friction surface of new pressure plates before installation.

– Clean flywheel friction surface and inspect for wear, cracks, and scoring. Check for loose or worn guide pins. Replace flywheel if any faults are found.

– Check clutch disc thickness, runout, and general condition. Check friction surface for oil contamination. Replace clutch disc if any faults are found.

Clutch Disc
- Clutch disc runout (max.) . . . . . 0.50 mm (0.020 in.)
- Clutch disc thickness (min.) . . . . . 7.5 mm (0.295 in.)

– Clean release bearing guide sleeve on transmission. Clean input shaft splines.

– Inspect splines of clutch disc and transmission input shaft. Check that clutch disc slides freely on shaft.

- Inspect clutch release bearing for smooth operation. Check for wear on bearing and lever contact surfaces. Check release lever pivot pin for wear. Replace worn parts.
- Check grooved input shaft ball bearing in crankshaft center. Replace bearing if it does not rotate smoothly.
- Assemble clutch disc and pressure plate assembly to flywheel. Thread new pressure plate bolts and hand tighten.

> ***WARNING—***
> *Always use new pressure plate mounting bolts.*

NOTE—

- *Make sure the pressure plate is aligned on the flywheel guide pins.*
- *Be sure the clutch disc is installed correctly. The new disc should be marked with "engine side" and "transmission side".*

- Center clutch disc to crankshaft using a clutch pilot tool. Tighten pressure plate mounting bolts evenly until disc is firmly held in place.
- Remove centering tool and finish torquing bolts in uniform pattern.

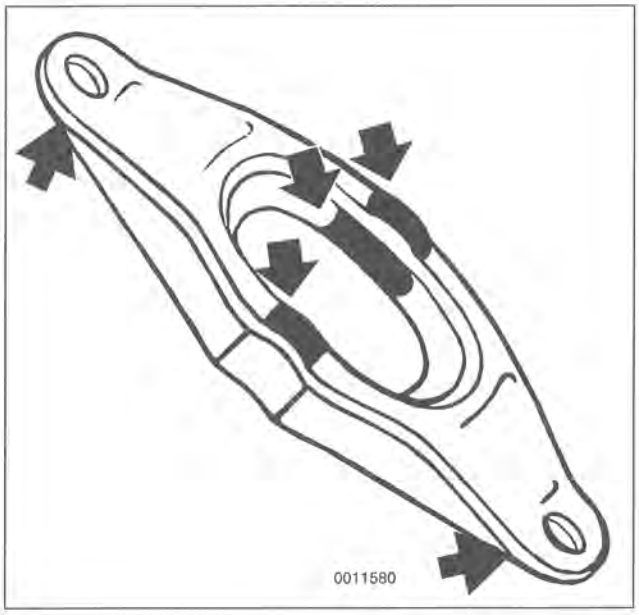
Tightening Torques

- Flywheel to crankshaft
  (use new bolts) . . . . . 105 Nm (77 ft-lb)
- Pressure plate to flywheel (use new bolts)
  8.8 grade . . . . . 24 Nm (18 ft-lb)
  10.9 grade . . . . . 34 Nm (25 ft-lb)

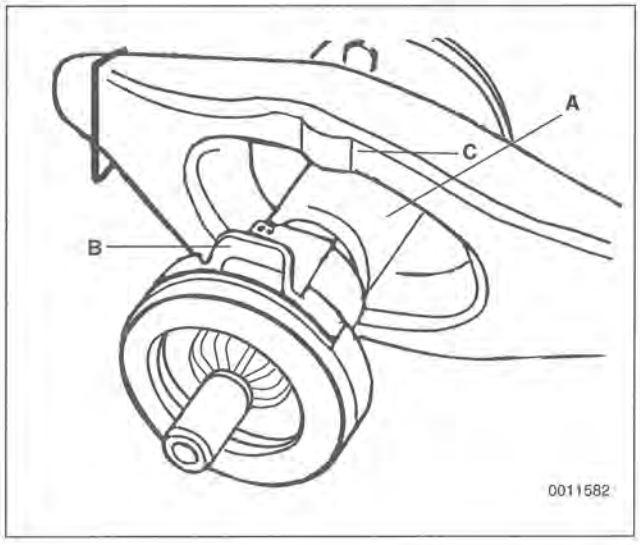
NOTE—
Bolt grade is marked on the bolt head.

- Lightly lubricate clutch disc splines and transmission input shaft splines.

> ***CAUTION—***
> *BMW recommends using a light coat of Microlube GL 261 on the clutch disc and transmission input shaft splines.*



➢ Lightly grease contact points on release lever (**arrows**).



➢ Clutch release bearing correctly installed. Bearing tabs (**A**) align with contact points (**B**) on release lever.

NOTE—

The original release bearings differ from replacement ones. Replacement bearings from BMW have a plastic guide sleeve. Bearings should be lightly lubricated with molybdenum disulfide grease (Molykote Longterm 2 or equivalent).

– Remove flywheel holding fixture and reinstall transmission. See **230 Manual Transmission.**

NOTE—

To help align the input shaft in the clutch disc, rotate the transmission output shaft slowly as the transmission is seated.



230 Manual Transmission

GENERAL 230-1

TRANSMISSION SERVICE 230-1
Transmission oil, checking and replacing 230-1
Transmission Oil Seals 230-2
Output shaft oil seal, replacing (transmission installed) 230-3
Selector shaft oil seal, replacing (transmission installed) 230-4
Input shaft oil seal, replacing (transmission removed) 230-5
Back up light switch, replacing 230-6

TRANSMISSION REMOVAL AND INSTALLATION 230-6
Transmission, removing and installing 230-6

TABLE
a. Manual Transmission Application 230-1

GENERAL

This repair group covers external transmission service, including removal and installation of the transmission unit. Internal transmission repair is not covered here. Special press tools and procedures are required to disassemble and service the internal geartrain. For additional transmission application information, see **200 Transmission–General**.

Table a. Manual Transmission Application

Model	735i (1988–)
Type	Getrag 260/6

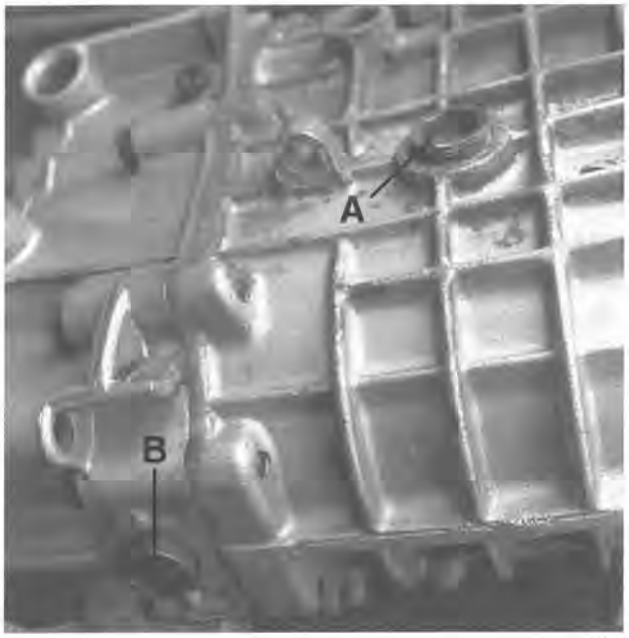
TRANSMISSION SERVICE

Transmission oil, checking and replacing

Manual transmissions installed on the E32 cars are normally filled with automatic transmission fluid (ATF), although alternative lubricants may be used depending on transmission type, gear noise levels, and shifting effort in cold climates.

NOTE—
Manual transmissions filled with ATF use 17mm external hex drain and fill plugs. In addition, a red fluid specification label with the markings "ATF-OIL!" is attached to the right-hand side of the bellhousing.

– Drive car a few miles to warm up transmission oil.



5020

➢ Oil filler plug (**A**) and oil drain plug (**B**).

- Remove filler plug on side of transmission and check oil level.
- Oil level should be just flush with bottom of filler plug hole (i.e. if more oil is added it would run out of hole).

NOTE —
Check and fill transmission with the car on level surface.

– Place drain pan below oil drain plug. Remove drain plug. Reinstall and torque drain plug when oil is completely drained.

– Slowly add oil through filler hole until it begins to overflow. When no more oil can be added, reinstall and tighten filler plug.

Oil Capacity

- Getrag 260/6 . . . . . 1.25 liter (1.3 qts.)

Tightening Torques

- Manual transmission drain or fill plug
  Getrag 260/6 . . . . . 50 Nm (37 ft-lb)

NOTE —
One method of filling the transmission is to use a length of clear plastic tubing (approx. 5 feet) inserted into the fill hole and extended up into the engine compartment. Attach a funnel to one end and slowly fill the transmission from above.

Transmission Oil Seals

The output shaft, selector shaft and input shaft oil seals can be replaced without any major disassembly of the transmission. In addition, two of the three seals can be replaced with the unit installed in the car.

Low gear oil level due to a faulty oil seal may cause problems such as hard shifting, jumping out of gear, and transmission noise. Note that oil at the bottom of the bellhousing can also be due to a leaking rear crankshaft seal.

NOTE —
Before assuming faulty transmission seals, check the vent on the top of the case. A clogged or damaged vent can cause excess internal pressure and oil loss.

Output shaft oil seal, replacing (transmission installed)

– Remove complete exhaust system. See **180 Exhaust System**.

– Disconnect driveshaft from transmission. See **260 Driveshaft**.



6261

◀ Remove output shaft flange.

- Bend back and remove nut lockplate (**arrows**).
- Hold flange steady and remove the collar nut (use 30 mm thin-walled, deep socket).
- Remove flange. If necessary, use a puller.

NOTE—

A thin-wall socket can be made by grinding the outer surface of an ordinary socket.

– Using a seal remover or screwdriver, pry out old seal. Lubricate new seal with oil and drive into place.

> ***CAUTION—***
> *Do not damage the transmission case housing when prying out the old seal. A damaged case can result in oil leaks.*

– Reinstall flange to output shaft (and shims, if applicable). Coat bearing surface of collar nut with sealer and install nut.

NOTE—

BMW recommends the use of a sealer such as Loctite® 242 when installing the collar nut to prevent oil from leaking past the threaded shaft.

– Tighten collar nut in two stages. Install new lockplate. Bend tabs into flange grooves.

Tightening Torques

- Output flange to output shaft
  stage I . . . . . 170 Nm (125 ft-lb)
  stage II (after loosening) . . . . . 120 Nm (89 ft-lb)

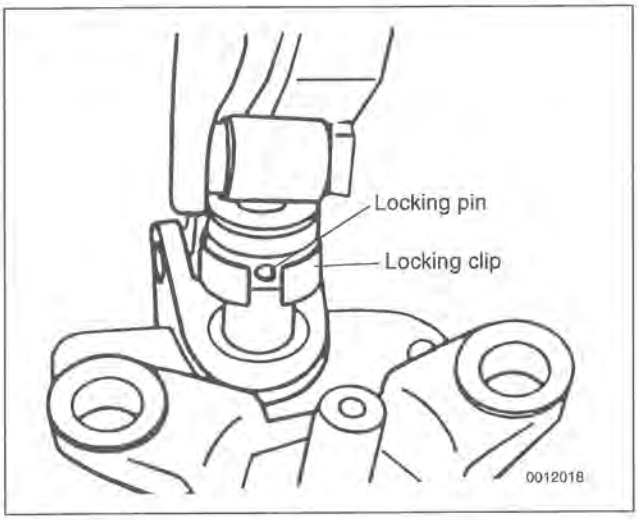
– Reinstall the driveshaft and exhaust system.

– Check gear oil level, topping up as necessary. See **Transmission oil, checking and replacing**.

Selector shaft oil seal, replacing (transmission installed)

– Remove complete exhaust system. See **180 Exhaust System**.

– Disconnect driveshaft from transmission. See **260 Driveshaft**.

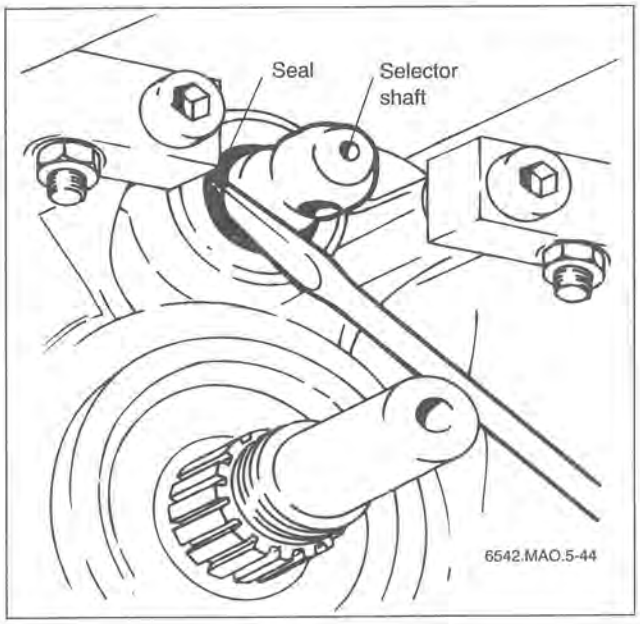


➢ Remove selector rod coupling.

- Slide locking clip and push pin through to remove coupling.
- Place transmission in 5th gear. Disconnect selector rod coupling from selector shaft by releasing spring sleeve and pushing out pin.

> ***WARNING—***
> *Do not mar the housing when removing oil seal.*

NOTE—
To improve access to the selector shaft, support the transmission from below and remove the bolts from the transmission crossmember. Then lower the transmission for better access the selector shaft.



➢ Pry out selector shaft oil seal with screwdriver.

> ***WARNING—***
> *Do not mar the housing when removing the seal.*

– Lubricate new seal with oil and drive into place.

– Reinstall selector rod coupling, driveshaft, and exhaust system.

NOTE—
Install selector rod coupling with the offset toward the left when looking at the rear of the transmission.

Tightening Torque

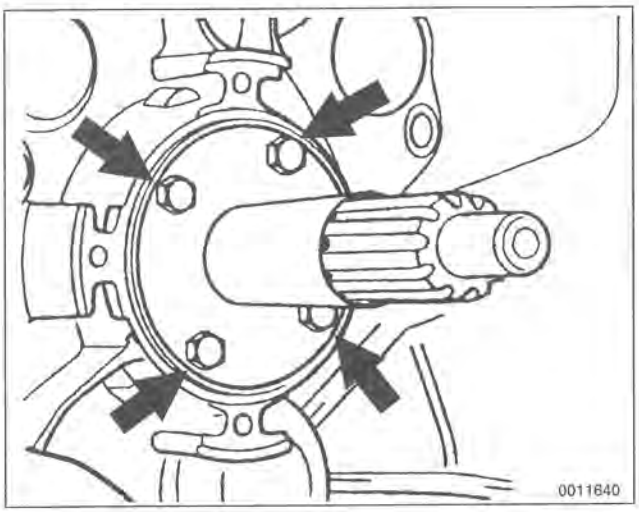
- Rear transmission support to body (bolt) . . . . . 23 Nm (17 ft-lb)

– Check gear oil level, topping up as necessary. See **Transmission oil, checking and replacing**.

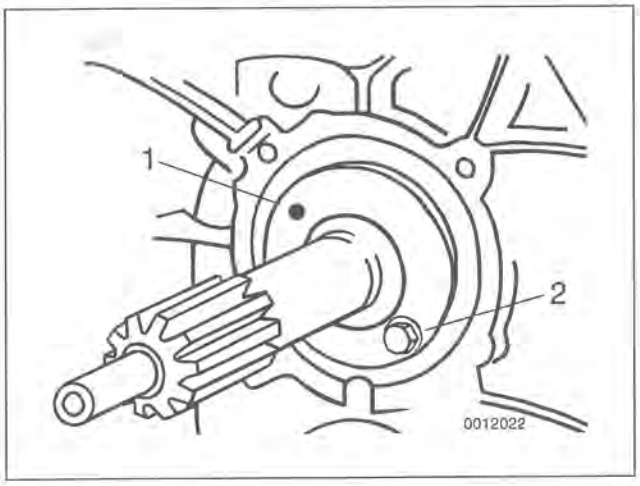
Input shaft oil seal, replacing (transmission removed)

– Remove transmission as described later.

– Remove clutch release bearing and release lever from inside bellhousing.



➤ Remove bolts for clutch release bearing guide sleeve, noting bolt lengths. Remove the sleeve and any spacers under it.



➤ Locate two indents (**1**) in seal housing. Use a punch or scribe to punch holes in housing at indents. Thread two sheet metal screws (**2**) into holes and pull seal out using screws.

NOTE—
Use care not to scratch or damage input shaft. Use a protective sleeve or tape the shaft when removing and installing the input shaft seal.

– Drive old seal from guide tube.

– Lubricate new seal with transmission oil and drive into place.

– Thoroughly clean guide sleeve mounting bolts, sealing surfaces, and threads in case. Apply sealer (Loctite® 243 or equivalent) to guide sleeve sealing surface and bolts. Reinstall guide sleeve and spacer(s).

Tightening Torques

- Guide sleeve to transmission

M8x22	18 Nm (13 ft-lb)
M8x30	25 Nm (18 ft-lb)
M6x10	10 Nm (89 in-lb

Back up light switch, replacing

– Raise vehicle.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Working on the side of the transmission, disconnect harness connector from switch and unscrew switch from transmission.

– Install and tighten new switch. Reconnect harness connector.

> ***CAUTION—***
> *Do not overtighten back-up light switch.*

Tightening Torque

- Back-up light switch to transmission . . . . . ,6–10 Nm (53–89 in-lb)

– Check gear oil level. See **Transmission oil, checking and replacing**.

TRANSMISSION REMOVAL AND INSTALLATION

Transmission, removing and installing

Removal of the transmission is best accomplished on a lift using a transmission jack. Use caution and safe workshop practices when working beneath the car and lowering the transmission.

Torx® head bolts are used to mount the transmission to the bellhousing. Be sure to have the appropriate tools on hand before starting the job.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise vehicle.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove complete exhaust system and heat shields See **180 Exhaust System.**

NOTE—
Disconnect the oxygen sensor harness connector before lowering exhaust system.

– Disconnect harness connector from reverse light switch on transmission.

– Remove driveshaft. See **260 Driveshaft**.

NOTE—
It is not necessary to fully remove the driveshaft. As an alternative, unbolt the driveshaft flex-disc from the transmission flange and unbolt the driveshaft center bearing support from the body. Then bend the driveshaft downwards in the center to disconnect. Use stiff wire to hold the driveshaft in place.

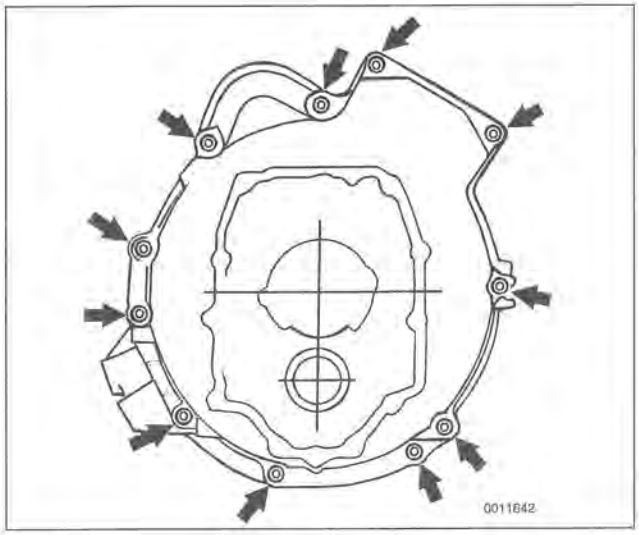
– Disconnect shift rod from transmission selector shaft. Disconnect shift console from top of transmission. See **250 Gearshift Linkage**.

– Unbolt clutch slave cylinder from side of transmission. Do not disconnect fluid hose. Suspend slave cylinder from body using stiff wire.

CAUTION—
Do not operate clutch with slave cylinder removed from transmission.

– Support transmission from below with jack. Unbolt transmission cross-support and bracket. Lower transmission/engine assembly until it rests on front crossmember.

NOTE—
On cars with M30 engine, place a block of wood between the front stabilizer bar and the engine block before lowering the transmission/engine assembly.



Remove transmission mounting bolts (**arrows**) (Torx® head). Note length and location of bolts.

CAUTION—
At no time should the weight of the transmission be supported by the transmission input shaft.

– Separate transmission from engine. Do not place any strain on transmission input shaft. Lower jack and remove transmission. Mark location of aligning dowels in engine block.

WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack alone is not adequate support.

Installation is reverse of removal. Lightly lubricate transmission input shaft with Microlube GL 261 before installing. Be sure cylinder block dowels are correctly located. Center rear of transmission in driveshaft tunnel before tightening transmission support bracket. Installation tightening torques are given below.

CAUTION—
BMW recommends using Microlube GL 261 on the clutch disc and transmission input shaft splines. Otherwise the clutch disc may bind on the input shaft and cause hard shifting. This lubricant is available under the BMW Part No. 81 22 9 407 436.

NOTE—
Washers should always be used with Torx®-head bolts. Installing bolts without washers will make them difficult to loosen.

Tightening Torques

- Transmission to engine (Torx®-head)
  - M8 . . . . . 23 Nm (17 ft-lb)
  - M10 . . . . . 43 Nm (32 ft-lb)
  - M12 . . . . . 72 Nm (53 ft-lb)
- Rear transmission support to body (bolt) . . . . . 23 Nm (17 ft-lb)
- Rubber mount to transmission or bracket (nut) . . . . . 43 Nm (32 ft-lb)
- Transmission drain plug/fill plug . . . . . 50 Nm (37 ft-lb)

Install driveshaft and preload center bearing bracket as described in **250 Driveshaft**. Refill transmission with appropriate lubricant before starting or towing the car. See **Transmission oil, checking and replacing**.



240 Automatic Transmission

GENERAL 240-1

TROUBLESHOOTING 240-3

DIAGNOSTIC TESTING 240-5
Stall speed, checking 240-5
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b. Automatic Transmission Troubleshooting 240-4
c. A/T Stall Speed Specifications 240-6
d. A/T Main Pressures 240-7

GENERAL

This repair group covers basic automatic transmission service, including fluid service and unit removal and installation. Transmission tear down and overhaul is not covered here.

Due to different power characteristics and performance requirements, three different automatic transmissions are used on the cars covered by this manual. All transmissions are electronically-controlled and fully adaptive. See **Table a**.

NOTE—
Additional automatic transmission application information is given in **200 Transmission–General**.

Automatic transmissions are identified by code letters located on a data plate on the left side of the transmission housing, just behind the manual valve lever.

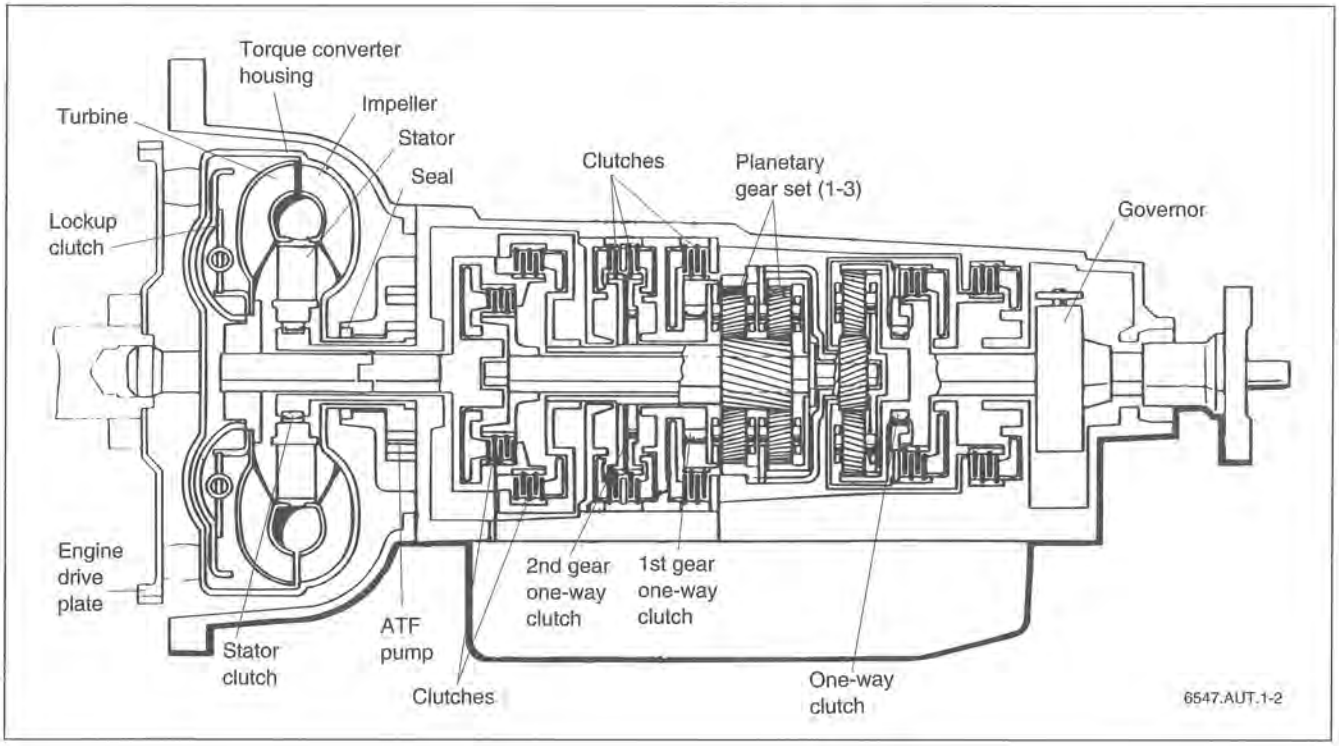
Table a. Automatic Transmission Applications

Model	735i/iL (1988-92)	740i/iL (1993-94)	750iL (1988-94)
Type	4 HP 22 EH	A5S 560Z	4 HP 24
Forward speeds	4-speed	5-speed	4-speed

NOTE—

- *Internal repairs to the automatic transmission require special service equipment and knowledge. If it is determined that internal service is needed, consult an authorized BMW dealer about a factory reconditioned unit or a transmission rebuild.*
- *Driveshaft and final drive repair information is covered in* **260 Driveshaft**.

The transmission case contains the automatic transmission fluid (ATF) pump, the hydraulic controls, and the planetary gear system. The planetary gear system is lubricated by ATF, circulated through the transmission by the ATF pump. The ATF does not circulate unless the engine is running.



TROUBLESHOOTING

Begin troubleshooting by checking the ATF condition and level. Check to see if the fluid is dirty or has a burned odor. A burned odor usually indicates overheated fluid. This may be accompanied by burned clutches, as well as friction material that may be clogging valve body passages. Minor automatic transmission problems can often be corrected by draining and refilling the transmission with new ATF.

NOTE—

The A5S 560Z transmission used on a 740i/iL is not equipped with a fluid level dipstick. Checking the ATF level on these transmissions must be done while monitoring the ATF temperature with the engine idling. The BMW dealer is equipped with the special equipment to make this check. If in doubt about the fluid level, one option is to completely drain the old fluid and add the specified amount of new fluid. See **ATF Service**.

Inspect the transmission for external damage, loose or missing fasteners or electrical connectors and obvious leaks. Many automatic transmission problems can be traced to an incorrect ATF level, or faulty electronic controls.

Table b lists symptoms of automatic transmission problems, their probable causes, and recommended corrective actions. The repair headings or repair groups where the appropriate test and repair procedures can be found are also listed.

NOTE—

Selector lever and gearshift linkage repair information is covered in **250 Gearshift Linkage.**

Table b. Automatic Transmission Troubleshooting

Symptom	Probable cause	Corrective action
1. **Park** does not hold	a. Selector lever linkage misadjusted. b. Parking pawl or pawl spring broken.	a. Adjust selector lever linkage. **250 Gearshift Linkage** b. Transmission must be removed and partially disassembled to access parking pawl.
2. No **Drive** (car will not move)	a. ATF level low. b. Selector lever linkage misadjusted. c. Sticking pressure valves, faulty ATF pump, or broken gear or shaft.	a. Check and if necessary correct ATF level. **ATF Service** b. Adjust linkage. **250 Gearshift Linkage** c. Test ATF main pressure. See **Diagnostic Testing**
3. Irregular drive in all forward gears	a. ATF level low. b. ATF pump strainer (filter) partially clogged. c. Gear position/neutral safety switch faulty. d. Internal transmission damage.	a. Check ATF level. **ATF Service** b. Remove ATF sump. Clean or replace filter screen. **ATF Service** c. Replace gear position/neutral safety switch. **Transmission Service** d. Overhaul or replace transmission.
4. Transmission slips during cornering	a. ATF level low. b. Clogged ATF strainer.	a. Check ATF level. **ATF Service** b. Clean/replace strainer. **ATF Service**
5. ATF smells burned, dark colored	a. Damaged clutch friction linings, internal faults.	a. Overhaul or replace transmission.
6. Selector lever will not move	a. Selector lever linkage binding. b. Internal transmission failure. c. Shift-lock faulty.	a. Check and adjust linkage. **250 Gearshift Linkage** b. Overhaul or replace transmission. c. Check shift-lock solenoid. **250 Gearshift Linkage**
7. Hard jolt when moving selector lever from **N** to **D** or **R**	a. Idle speed too high. b. ATF level low. c. Faulty gear position/neutral safety switch. d. Internal transmission fault.	a. Check engine idle speed. **130 Fuel Injection** b. Check and correct ATF level. **ATF Service** c. Replace gear position/neutral safety switch. **250 Gearshift Linkage** d. Overhaul or replace transmission
8. Hard jolt on upshift or downshift	a. Faulty clutch(es). b. Valve body faulty. c. Transmission electronics faulty.	a. Overhaul or replace transmission b. Replace valve body. *Dealer service recommended* c. Check transmission electronic controls. *Dealer service recommended*
9. Vibration when accelerating quickly from a stop	a. Driveshaft vibration. b. Faulty clutch(es).	a. Check driveshaft U-joints, driveshaft center bearing, driveshaft alignment. **260 Driveshaft** b. Overhaul or replace transmission. *Dealer service recommended*
10. Car cannot be started in **N** or **P**	a. Faulty gear position/neutral safety switch.	a. Replace gear position/neutral safety switch. **250 Gearshift Linkage**
11. No upshift into 2nd, 3rd or 4th gear	a. Faulty gear position/neutral safety switch. b. Transmission electronics faulty (valve body solenoid faulty). c. Valve body faulty. d. Transmission electronics faulty. e. Valve body solenoids faulty.	a. Replace gear position/neutral safety switch. **250 Gearshift Linkage** b. Test valve body solenoid operation. *Dealer service recommended* c. Replace valve body. *Dealer service recommended* d. Check transmission electronic controls. *Dealer service recommended* e. Repair or replace valve body. *Dealer service recommended*
12. Upshift delayed in all gears	a. ATF level low. b. Valve body contaminated or plugged. c. Internal pressure valves sticking or faulty. d. Transmission electronics faulty.	a. Check and correct ATF level. **ATF Service**. b. Remove valve body and clean or replace. *Dealer service recommended* c. Overhaul or replace transmission. d. Check transmission electronic controls. *Dealer service recommended*

DIAGNOSTIC TESTING

NOTE—
In order for automatic transmission diagnostic testing to provide meaningful results, the engine must be running correctly (i.e., no mechanical faults and properly tuned).

Although most internal transmission problems cannot be fully diagnosed unless the unit is removed and disassembled, the tests given here may be helpful in pinpointing faults. To obtain accurate test results, the ATF must be clean, the correct type, in good condition (not previously overheated or burned), and at the proper level.

Stall speed, checking

The stall speed test is used mainly to check the torque converter and planetary gear system when there is no other apparent cause for transmission slippage. The term is somewhat misleading as the car is not actually stalled during the test. A precise tachometer should be used for the rpm measurement.

CAUTION—
The stall speed test should be as short as possible—never longer than 10 seconds. Prolonging the test will overheat the transmission and possibly damage the seals or internal components.

- Drive car to warm engine and transmission to normal operating temperature. Turn engine off.
- Connect tachometer according to instrument manufacturer's instructions. Start engine.

NOTE—
Position tachometer so that it can be read from the driver's seat.

- Set parking brake and depress foot brake firmly.
- Select transmission **Drive** (**D**) range.
- Press accelerator to floor for no more than 10 seconds. Record maximum rpm (stall speed).
  - Engine rpm should increase, then hold steady. **Table c** lists stall speed specifications.

WARNING—
Do not stand in front of or behind the car when the engine is running and tests are being made.

NOTE—
It is normal for the stall speed to be 125 rpm lower than specified for each 1,000 meters (3,200 ft.) above sea level. High ambient air temperature can also cause a drop in stall speed.

Table c. A/T Stall Speed Specifications

Transmission	Stall speed (rpm)
4 HP 22 EH	2,100-2,300
4 HP 24	2,000-2,200
A5S 560Z	1,850-2,050

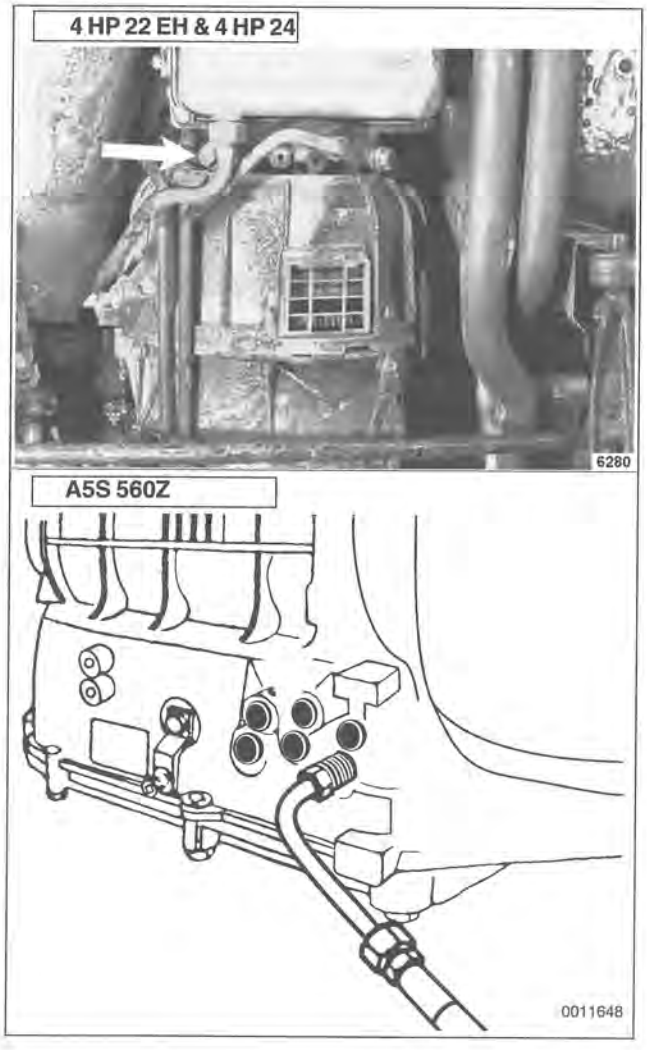
Stall speed that is below the specified range by a few hundred rpm is probably due to reduced engine performance. Stall speed that is below the specified range by 400 rpm or more indicates a faulty torque converter stator or ATF pump. Check the pump pressure as described below.

Stall speed above the specified range is caused either by low ATF level, or by slippage in the hydraulic or one-way clutches.

ATF main pressure, checking

A main pressure test will reveal internal leaks, sticking control valves, or other troubles in the hydraulic controls. The pressure gauge should have a range of 0 to 20 bar (0 to 300 psi) with a hose long enough to reach into the passenger compartment.

NOTE—
Engine idle speed must be correct when making a main pressure check.



Main pressure tap on transmissions.

- Remove main pressure tap plug and connect pressure gauge to transmission tap.

NOTE—
Position pressure gauge so that it can be read from the driver's seat.

– Drive car to warm transmission to normal operating temperature.

– Park car and firmly set parking brake and block wheels. Have an assistant firmly push brake pedal. Be prepared to shut off engine.

> ***WARNING—***
> *Never stand in front of or behind the car when the engine is running and tests are being made.*

– Place selector lever in **D**. Pressure should be as shown in **Table d**.

– On 4 HP 22 EH and 4 HP 24 transmissions, shift transmission into **R**. Pressure should increase as listed.

– Shift back to **D** and road test car. Test pressures are given in **Table d**.

Table d. A/T Main Pressures

Transmission	Test pressure @ engine rpm
4 HP 22 / 4 HP 24	
D (Drive)	5.5-7.7 bar (80-111 psi) at idle 9.0-11.0 bar (130-160 psi) at kickdown
R (Reverse)	11-14 bar (160-189 psi) at idle 17.0-20.0 bar (246-290 psi) at kickdown
2,3,4	4.6-5.8 bar (67-84 psi) at idle
A5S 560Z	
P (Park)	5.4-6.4 bar (78-93 psi) at idle

– When finished, stop engine, remove gauge and replace pressure tap plug. Replace any lost fluid.

Tightening Torque

- Pressure tap plug . . . . . 43 Nm (32 ft-lb)

Pressure that is higher or lower than specified usually indicates a malfunctioning valve body or valve body solenoid valves. The valve body can be removed, cleaned, and reinstalled with the transmission in place by removing ATF sump and filter screen.

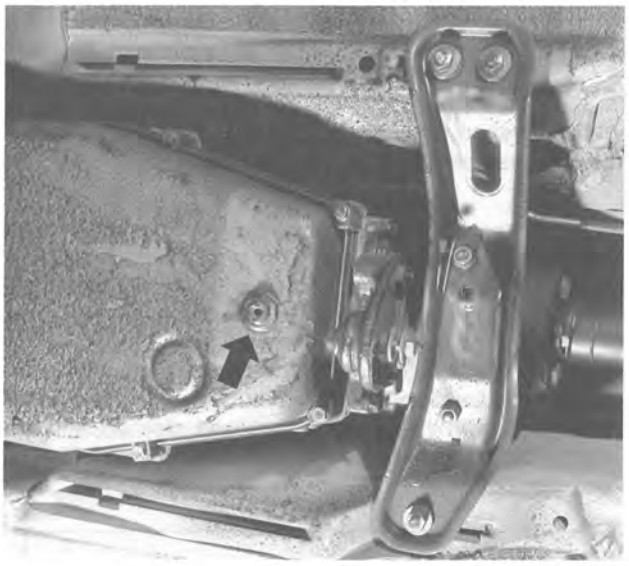
CAUTION—
The valve body contains many precision parts that must be reassembled in their exact locations. It is recommended that valve body repairs be left to an authorized BMW dealer or other qualified repair shop.

Low pressure may also indicate a worn ATF pump or internal ATF pump leak past seals, gaskets or metal mating surfaces. These repairs require that the transmission be removed and disassembled.

ATF SERVICE

4 HP 22 EH or 4 HP 24 transmission ATF service

– Remove dipstick.



5022

Remove ATF drain plug (**arrow**) and drain fluid into container. 4 HP 22 EH transmission shown, 4 HP 24 transmission is similar.

> ***WARNING —***
> *The ATF should be warm when draining. Do not drain the ATF if the engine is hot. Hot ATF can scald.*



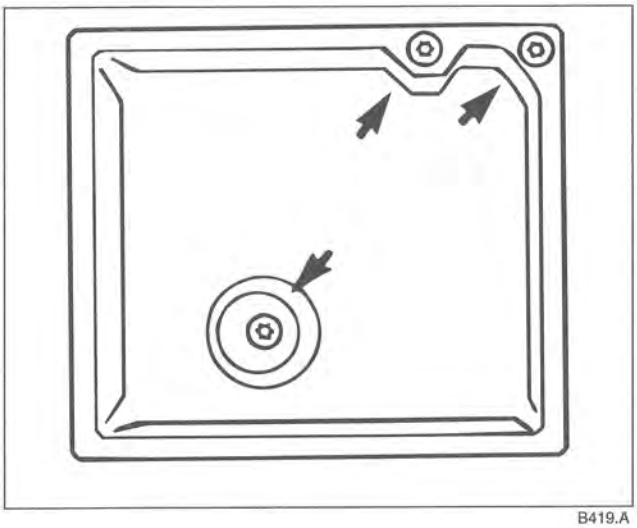
5023

Disconnect oil filler pipe (**arrow**) from oil sump. 4 HP 22 EH transmission shown, 4 HP 24 transmission is similar.



5024

➢ Remove ATF sump mounting bolts and clamping brackets (**arrows**), and remove sump.



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➢ Remove ATF fluid strainer mounting bolts (**arrows**) on 4 HP 22 EH transmission. 4 HP 24 transmission is similar.

NOTE—
Make sure the O-ring is attached to top of strainer when removing.

– Installation is reverse of removal.

- Always replace drain plug seal and all gasket(s).
- Clean sump and sump magnets using a lint-free cloth.
- When mounting sump, mount curved sump clamping brackets at front and rear corners of sump. Mount straight clamping brackets at sump sides. The short legs on clamps should contact oil sump.
- Fill transmission with specified amount of fluid.

NOTE—
*Check the ATF level with the car on level surface, engine running, and selector lever in **Park**. The ATF level should be between the dipstick min. and max. marks when the ATF is at a temperature of approx. 80° C (175° F).*

ATF Change Volume

- Dexron III . . . . . 3.0 L (3.2 qt.)

Tightening Torques

- ATF drain plug to ATF sump . . . . . 16 Nm (12 ft-lb)
- ATF strainer to valve body . . . . . 8 Nm (71 in-lb)
- ATF sump to transmission. . . . . 6 Nm (53 in-lb)

A5S 560Z transmission ATF service

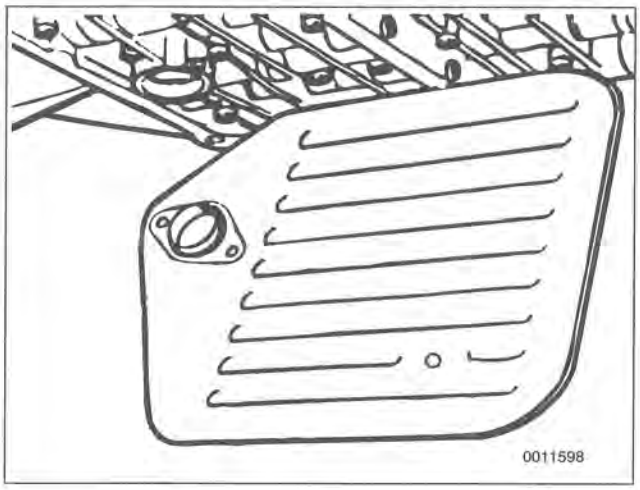
CAUTION—
The A5S 560Z transmission uses a semi-synthetic ATF, only available from an authorized BMW dealer. Dexron ATF must not be used in the A5S 560 Z.

– Remove drain plug and drain fluid into container.

WARNING—
The ATF should be warm when draining. Do not drain the ATF if the engine is hot. Hot ATF can scald.

– Remove oil sump mounting bolts and remove sump and sump gasket.

– Remove strainer mounting screws and remove strainer.



◁ ATF fluid strainer and O-ring on A5S 560Z transmission.

- Make sure the O-ring is attached to top of strainer when removing.

– Installation is reverse of removal.

- Always replace drain plug seal and all gaskets and O-rings.
- Clean sump, expansion tank and sump magnets using a lint-free cloth.
- To remove expansion tank, lift it straight off sump.
- Fill transmission with specified fluid and check fluid level with ATF at temperature of

NOTE—
For the most accurate check of the ATF level, the car must be on level surface and unloaded, preferably on a lift. With the ATF at a temperature between 30-50°C (86-122°F), remove the ATF filler plug. Place the transmission in neutral and start the engine. Add ATF until it spills from the filler hole. Reinstall the filler plug.

ATF Change Volume

- BMW semi-synthetic fluid (Shell LA 2634) . . . . . 5.5 L (5.8 qt.)

Tightening Torques

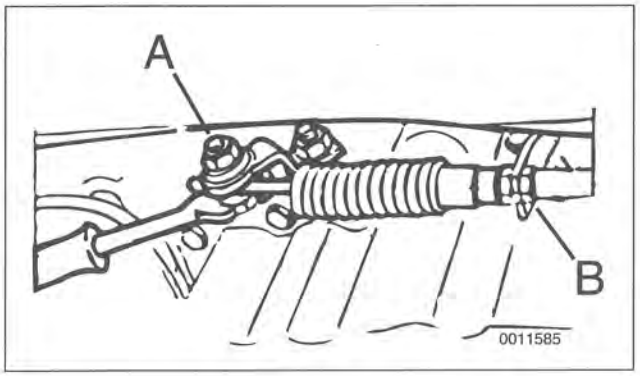
- ATF drain plug to ATF sump . . . . . 50 Nm (37 ft-lb)
- ATF strainer to valve body . . . . . 5 Nm (44 in-lb)
- ATF sump to transmission. . . . . 10 Nm (7 ft-lb)

TRANSMISSION REMOVAL AND INSTALLATION

Removal of the transmission requires a transmission jack or a floor jack with transmission adaptor. Use extreme caution when working beneath the car and lowering the transmission. Torx® sockets will be needed to remove the bellhousing bolts.

When installing a new or rebuilt transmission, the ATF cooler and lines must be blown clean with compressed air and then thoroughly flushed twice with clean ATF.

4 HP 22 EH or 4 HP 24 transmission removing and installing



– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

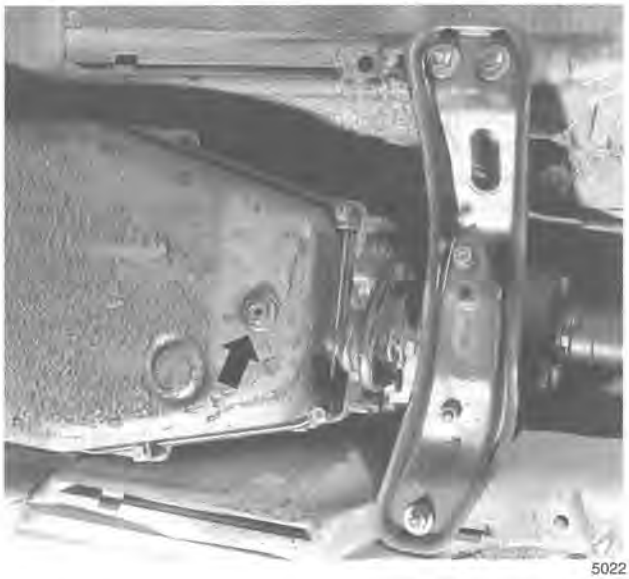
– Remove complete exhaust system and exhaust system heat shields. See **180 Exhaust System**.

➢ Position selector lever in park. Counterhold clamping sleeve and loosen selector lever cable clamping nut (**1**) on lever. Remove cable from bracket (**2**) and slide cable out of selector lever.

– Support transmission from below using transmission jack. Unbolt transmission support crossmember from body.

– Disconnect driveshaft from transmission end.

NOTE—
Discard driveshaft mounting nuts. They are single use self-locking nuts.



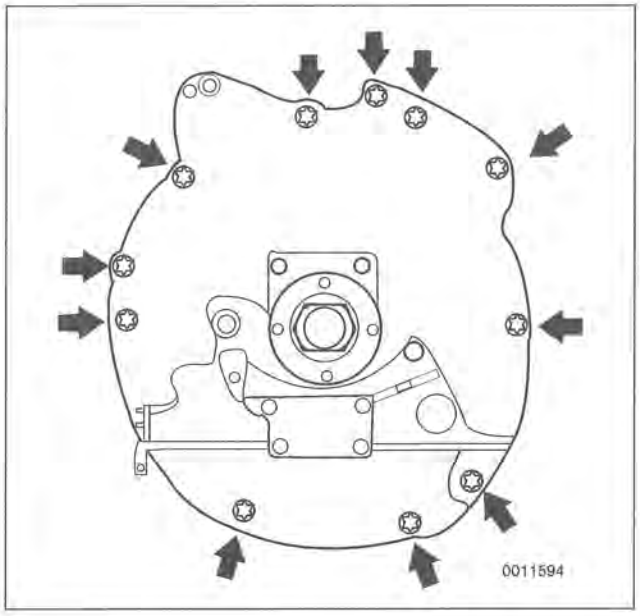
➢ Remove ATF sump drain plug (**arrow**) on 4 HP 22 EH transmission and drain transmission. 4 HP 24 transmission is similar.

– Remove ATF filler tube and ATF cooler lines from transmission. Plug open lines and holes to prevent contamination.

– Disconnect electrical harness connector(s) from transmission.

– Remove torque converter mounting bolts (3) from perimeter of driveplate. Turn driveplate to access bolts.

NOTE—
On 735i/iL models, it is necessary to first remove the cap from the opening in the oil pan to access the torque converter bolts.



➢ Remove transmission bellhousing bolts (**arrows**).

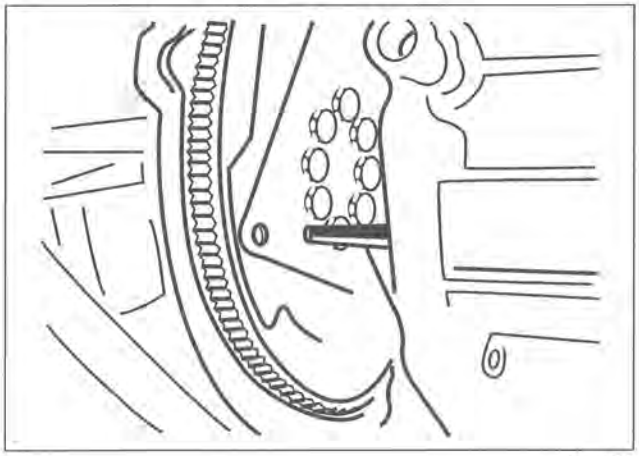
– Remove transmission by pulling back and down. Lower jack to allow transmission to clear vehicle.

> ***CAUTION—***
> *Do not allow the torque converter to fall off the transmission input shaft.*

– Installation is reverse of removal.

- To avoid damage when installing transmission, rotate torque converter back and forth to check that it has engaged its splines and be sure to correctly align torque converter tabs to drive plate indents.

– When installing the transmission to engine, first turn drive plate and torque converter until one of three mounting bores is pointing straight down.



➢ Install BMW special tool 2 42 300 or a wooden dowel into the torque converter as an alignment guide. Remove tool or dowel once torque converter is seated on drive plate.

- Blow out oil cooler lines with low-pressure compressed air and flush cooler with clean ATF twice before reattaching lines to transmission.

> ***CAUTION—***
> *• Wear safety glasses when working with compressed air.*
>
> *• Do not reuse ATF after flushing.*

- Install new sealing washers on hollow bolts.
- Install new O-rings on transmission cooler lines, where applicable.
- Inspect drive plate for cracks or elongated holes. Replace if necessary. Use new bolts.
- Check to be sure torque converter is seated correctly in transmission during final installation.
- Fill transmission with clean ATF until oil level is even with fill hole. Then check fluid level as described earlier.
- When reinstalling driveshaft, always replace nuts securing flexible coupling with new ones. Torque nuts while holding bolt stationary. Do not torque bolt head as coupling will be damaged. See **260 Driveshaft**.
- Adjust gearshift mechanism. See **250 Gearshift linkage**.
- Be sure two dowel sleeves in engine block are not missing and firmly seated.
- Check torque converter installation once transmission is installed. When correctly installed, mounting surface of torque converter should be slightly below edge of transmission case.

NOTE—
Torx bolts should be used with washers. Bolts without washers will increase the effort needed to remove them.

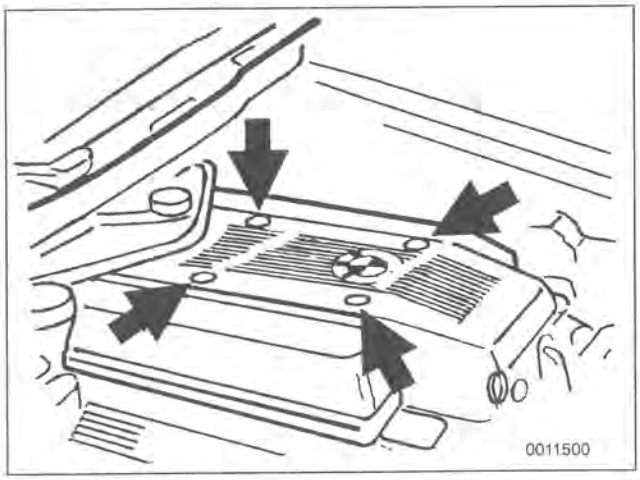
Tightening Torques

- ATF cooler line coupling nuts . . . . . 21 Nm (15 ft-lb)
- ATF cooler line hollow bolt
  M14/M16. . . . . 38 Nm (28 ft-lb)
- ATF filler tube to ATF sump. . . . . 98 Nm (72 ft-lb)
- ATF sump drain plug (M10). . . . . 16 Nm (12 ft-lb)
- Driveplate to crankshaft . . . . . 105 Nm (77 ft-lb)
- Rear transmission support
  (to body) . . . . . 24 Nm (18 ft-lb)
- Torque converter to drive plate
  M8. . . . . 26 Nm (19 ft-lb)
  M10. . . . . 49 Nm (36 ft-lb)
- Transmission reinforcement plate . . . . 24 Nm (18 ft-lb)
- Transmission to engine (Torx®-head)
  M8. . . . . 21 Nm (15 ft-lb)
  M10. . . . . 42 Nm (31 ft-lb)
  M12. . . . . 63 Nm (46 ft-lb)

A5S 560 Z transmission, removing and installing

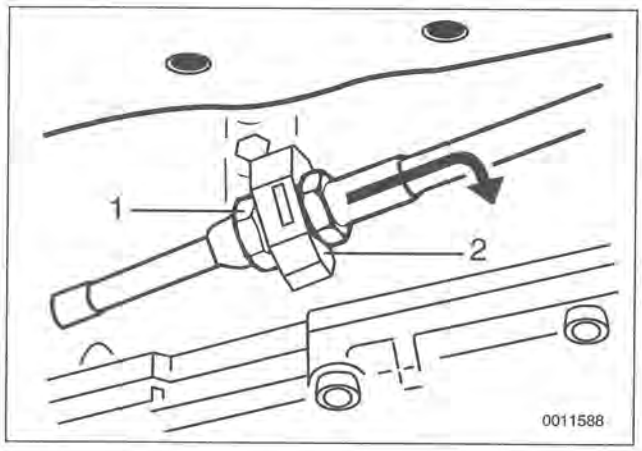
– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.



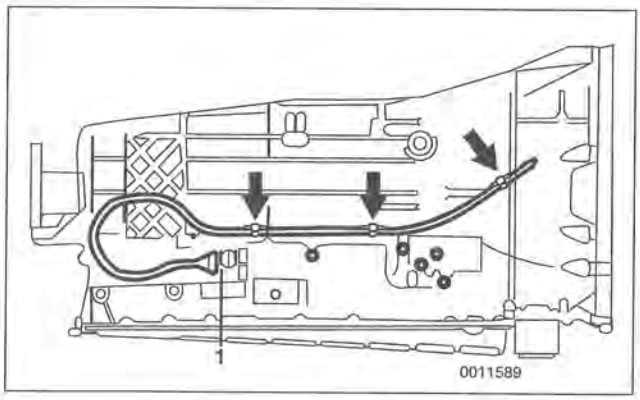
➤ Pry off caps (**arrows**) and remove plastic cover from center top of engine. Remove both plastic covers from top of left and right cylinder head covers.

– Remove complete exhaust system, exhaust system heat shields, and underbody protection. See **180 Exhaust System**.



➢ Position selector lever in park. Counterhold clamping sleeve and loosen selector lever cable clamping nut (**1**) on lever. Remove cable from bracket (**2**) and slide cable out of selector lever.

NOTE—
Counterhold selector cable clamping sleeve when loosening clamping nut. This will prevent bending or distorting cable.

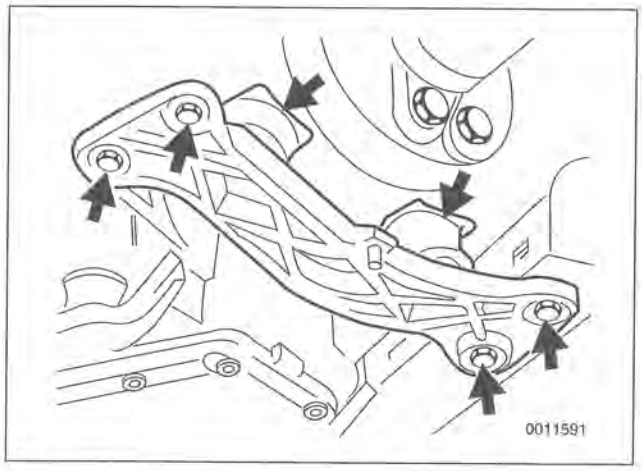


➢ Disconnect main harness connector (**1**) and clips (**arrows**).

– Disconnect left and right coolant pipes from ATF oil cooler.

NOTE—
Approximately one quart of coolant will drain from the cooler when the lines are removed. Use a clean drain pail to catch the fluid.

– Unbolt stabilizer bar U-brackets and lower stabilizer bar.

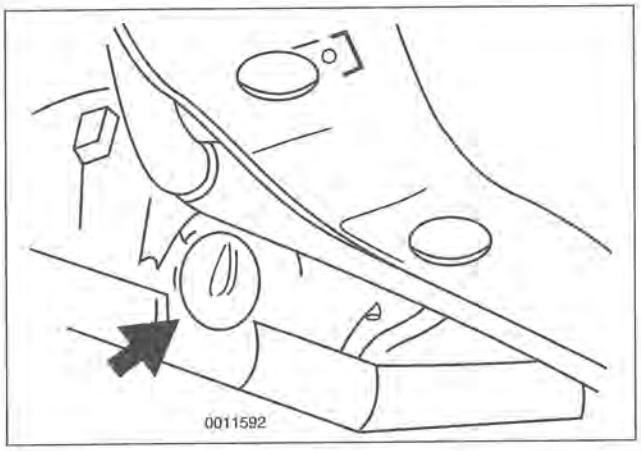


➢ Support transmission from below using transmission jack. Unbolt transmission support crossmember from body (**arrows**).

– Disconnect driveshaft from transmission. Unbolt driveshaft center support from body and suspend driveshaft using stiff wire.

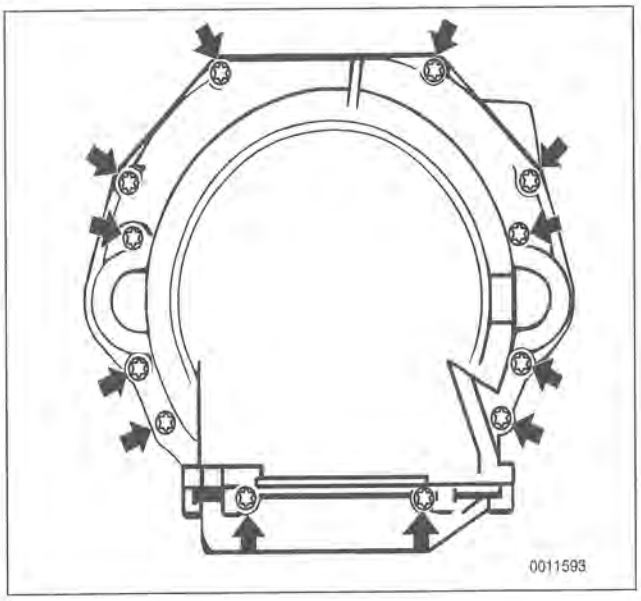
NOTE—
- *When disconnecting the driveshaft, unbolt the flex disc from the transmission flange, and not the driveshaft from the flex disc.*
- *Discard driveshaft mounting nuts. They are single use self-locking nuts.*

– Unbolt left and right heat shields from front lower sides of chassis. Slide heat shields forward as much as a possible.



➢ Rotate steering wheel to left or right lock. Pry out cap from opening in oil sump (**arrow**) to access torque converter mounting bolts.

– Remove torque converter to drive plate mounting bolts (3) from perimeter of driveplate. Turn driveplate to access bolts.



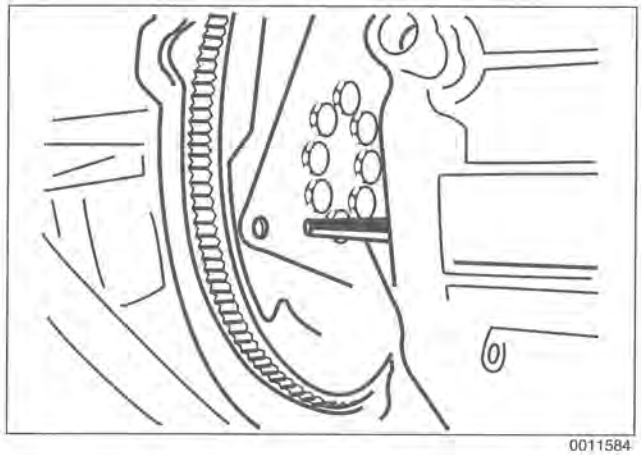
➢ Remove transmission to engine mounting bolts (**arrows**). Bolts at top are T10 size. All others are T12 size. Note that bolts at starter are fitted with nuts at front.

– Pull transmission off engine and lower out of car.

CAUTION—
- *Make sure the exhaust manifolds do not bear any weight when removing the transmission.*
- *Make sure the torque converter is secured in the transmission bellhousing during removal of the transmission.*

NOTE—
Before lowering transmission, wedge a block of hardwood between the engine oil pan and suspension crossmember pipe to hold the engine up.

– Installation is reverse of removal.
- Check driveplate for cracks or damage and replace if any faults are found. Use only new bolts when installing new driveplate.
- Check that torque converter is correctly and fully seated before installing transmission.
- To avoid damage when installing transmission, rotate torque converter back and forth to check that it has engaged its splines and be sure to correctly align torque converter tabs to drive plate indents.



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When installing transmission to the engine, first turn the drive plate and torque converter until one of the three mounting bores is pointing straight down. Install BMW special tool 2 42 300 or a wooden dowel into the torque converter as an installation alignment guide. Remove the tool or dowel through the opening in the oil pan once the transmission is seated.

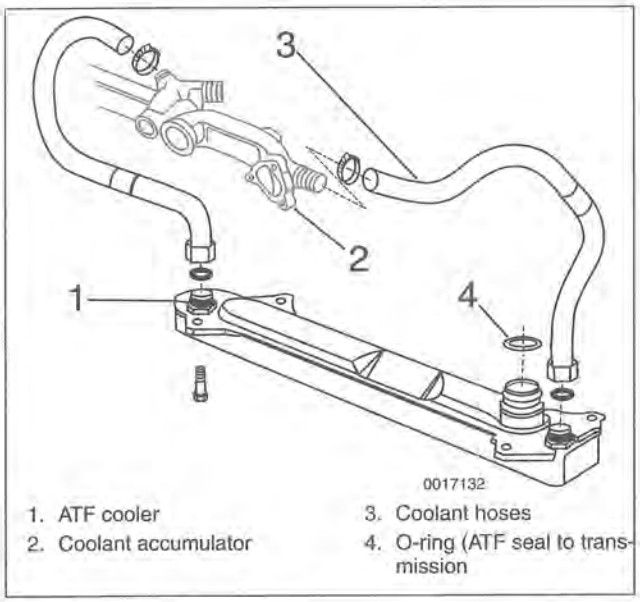
- Use a new gasket on ATF sump drain plug, and new O-rings on ATF filler tube and cooler lines.
- Adjust transmission accelerator cable and selector lever linkage.
- When reinstalling driveshaft always replace nuts securing flexible coupling with new ones. Torque nuts while holding bolt stationary. Do not torque bolt head as the coupling will be destroyed. See **260 Driveshaft**.
- Check condition of O-ring on oil cooler pipes and replace if necessary.
- Fill transmission with ATF.

Tightening Torques(A5S 560Z)

- ATF cooler line coupling nuts ..... 18 $^{+3}_{-0}$ Nm (13 $^{+2}_{-0}$ ft-lb)
- ATF cooler line hollow bolt (M16) ..... 35 $^{+3}_{-0}$ Nm (26 $^{+2}_{-0}$ ft-lb)
- ATF cooler line adaptor coupling M16 to M14 ..... 35 $^{+3}_{-0}$ Nm (26 $^{+2}_{-0}$ ft-lb)
- ATF sump drain plug (M 10) ..... 50 Nm (37 ft-lb)
- Rear transmission support to body ... 21 Nm (15 ft-lb)
- Torque converter to drive plate
  M8 ..... 25–27 Nm (18–20 ft-lb)
  M10 ..... 47–51 Nm (35–38 ft-lb)
- Transmission to engine (hex-head)
  M8 ..... 24 Nm (18 ft-lb)
  M10 ..... 45 Nm (33 ft-lb)
  M12 ..... 78–86 Nm (58–63 ft-lb)
- Transmission to engine (Torx®-head)
  M8 ..... 21 Nm (15 ft-lb)
  M12 ..... 72 Nm (53 ft-lb)
- Transmission reinforcement plate .... 23 Nm (17 ft-lb)

TRANSMISSION SERVICE

ATF Cooler



1. ATF cooler
2. Coolant accumulator
3. Coolant hoses
4. O-ring (ATF seal to transmission

ATF cooler for A5S 560Z transmission is installed to front of transmission.

- The ATF cooler for 4 HP 22 EH or 4 HP 24 transmission is integral with the radiator.

Automatic Transmission Seal Replacement

All of the external oil seals on automatic transmission can be replaced without extensive disassembly. It will however be necessary to remove the transmission to replace the torque converter seal. See **Transmission, Removing and Installing**. It will also be necessary to disconnect the driveshaft from the transmission to replace the output shaft oil seal. See **260 Driveshaft**.

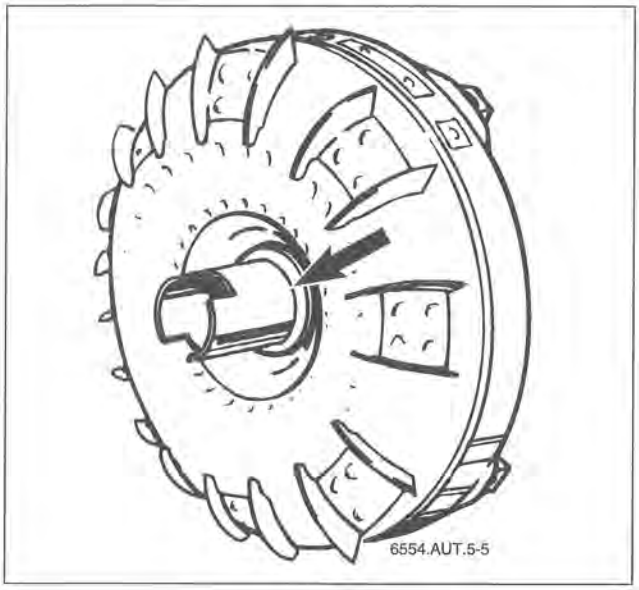
NOTE—

- *To pinpoint the location of leaks, have the undercarriage and transmission degreased. Remember that air turbulence from driving can cause fluids to appear to be leaking from other locations.*
- *A clogged or inoperative transmission vent can cause fluid leaks at other seals in the transmission. If in doubt, replace the vent valve located on the extension housing.*

Torque Converter Oil Seal

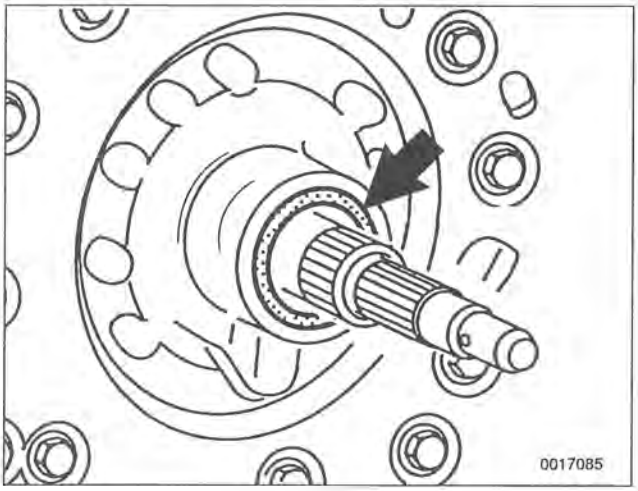
ATF leaking from the torque converter seal will usually be seen at the bottom of the bellhousing.

A leaking torque converter oil seal is often caused by a worn bushing in the torque converter hub. The bushing should always be checked when the seal is replaced. A worn bushing will promote rapid wear of the new seal.



➤ Torque converter removed from engine showing bearing surface (**arrow**) that should be checked for scoring or wear.

- Remove sharp edges and burrs with fine emery cloth. If the hub is deeply scored, the torque converter should be replaced.



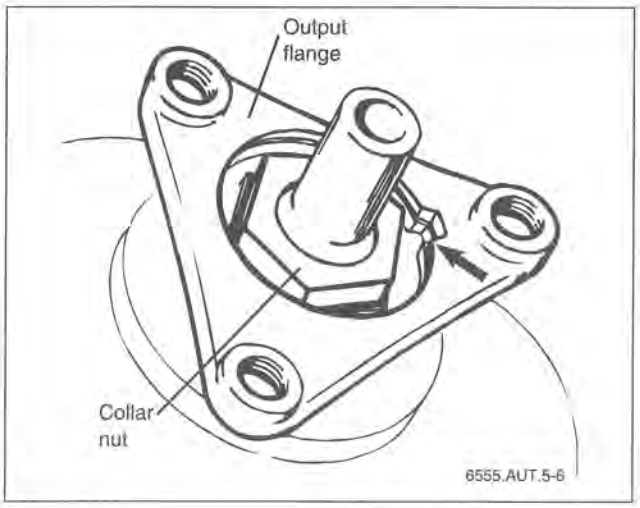
➤ To replace seal, remove converter from transmission. Using a hooked seal tool or screwdriver, pry old seal out of ATF pump/transmission case. Lubricate new seal with ATF and drive into position.

CAUTION—
Be careful not to mar the surface of the housing when removing the seal.

Output Shaft Oil Seal

The output shaft oil seal can be replaced without removing the transmission from the car. A thin-walled 30 mm deep-well socket will be needed to remove the output flange collar nut.

Installation of the collar nut requires a new lockplate, and application of a sealant to prevent transmission fluid leakage. BMW specifies Curil® K2 or Loctite® 572.



➤ To replace output shaft oil seal, bend back locking tab (**arrow**) on lockplate. Hold output flange stationary and remove collar nut, then use a puller to pull off flange. Hold output flange stationary and put transmission in park.

– Pry old seal out of transmission, lubricate new seal with ATF, and drive into place.

– When installing collar nut, lightly coat side that faces output flange with sealer and torque nut.

– Install new lockplate and bend tab into slot.

Tightening Torques

- Output flange collar nut
  4 HP 22 EH, 4 HP 24 . . . . . 100 Nm (74 ft-lb)
  A5S 560Z1 . . . . . 120 Nm (89 ft-lb)

When reinstalling the drive shaft always replace the nuts securing the flexible coupling with new ones. Torque the nuts while holding the bolt stationary. Never torque the bolt head as the coupling will be destroyed. See **260 Driveshaft** for more information.

CAUTION—
Be careful not to mar the surface of the housing when removing the seal.

Manual Valve Oil Seal

The manual valve oil seal can be seen at the side of the transmission case and on the side of the ATF sump.


6287

To replace manual valve oil seal, remove manual valve lever from transmission. Pry out old seal using small screwdriver or hooked tool.

– Lubricate new seal with ATF and drive it into place.

– Install manual lever and torque the nut.

Tightening Torque

- Manual lever to selector . . .8 to 10 Nm (71 to 89 in-lb)

If the linkage was not disconnected from the manual valve lever, it should not be necessary to adjust the shift linkage.

CAUTION—
Be careful not to mar the surface of the housing when removing the seal.



250 Gearshift Linkage

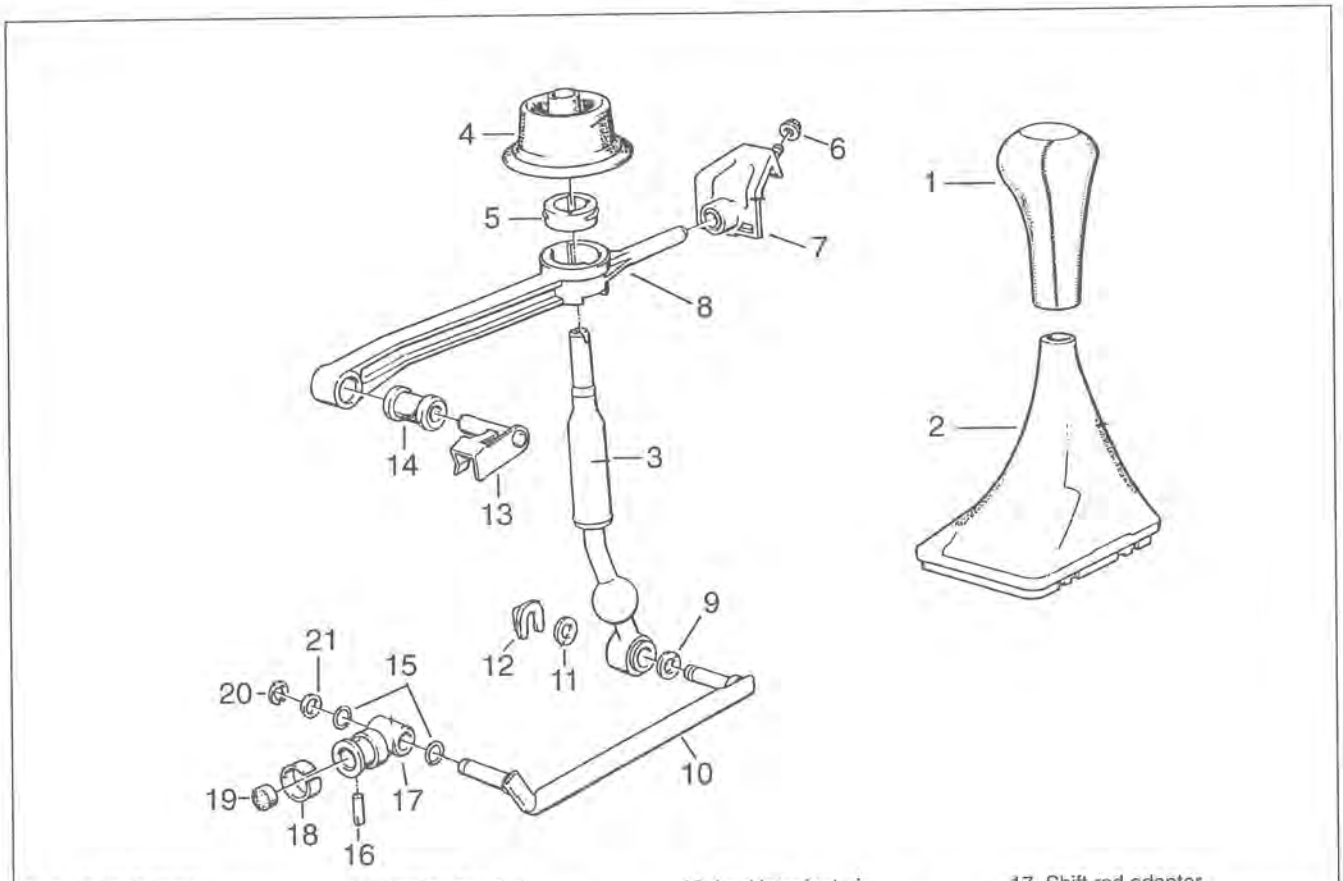
GENERAL 250-1

GEARSHIFT SERVICE 250-2
Gearshift lever, removing and installing 250-2

SELECTOR LEVER SERVICE (Automatic transmission 250-4
Shift mechanism, adjusting 250-3
Gear position/start disable switch, replacing . . 250-4
Automatic Shiftlock, checking function. 250-7
Shift interlock, checking function 250-8

GENERAL

This repair group covers basic gearshift and linkage service for manual and automatic transmission models. Special service tools are required for some of the procedures.



1. Shift knob lever
   - Pull straight up to remove (will require about 90 lbs. of force to remove)
2. Shift boot cover
3. Shift lever
4. Dust boot
5. Shift lever retaining ring
6. Nut
7. Bearing bracket
   - Lubricate bearing surface
   - Attach bracket to retainer lugs when installing
8. Shift console
9. Washer
10. Shift rod
11. Washer
12. Retaining clip
13. Locking pivot pin
    - Lubricate bearing surfaces
14. Bearing sleeve
15. Spacers
    - Install spacer with chamfer (stepped side) facing away from shift rod adapter
16. Cylindrical pin
17. Shift rod adapter
    - Install with offset towards left as viewed from rear of transmission
    - Lubricate bearing points
18. Spring sleeve
19. Spacer (felt or foam)
20. Circlip
21. Washer

0011625

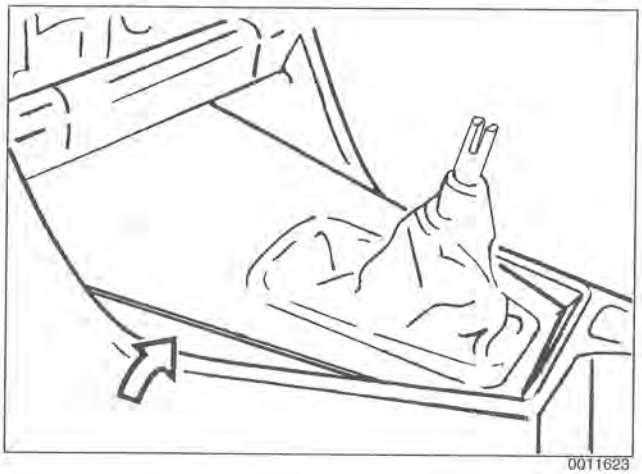
GEARSHIFT SERVICE

Removal of most gearshift components requires that the exhaust system and driveshaft first be removed for access to the complete assembly.

Gearshift lever, removing and installing

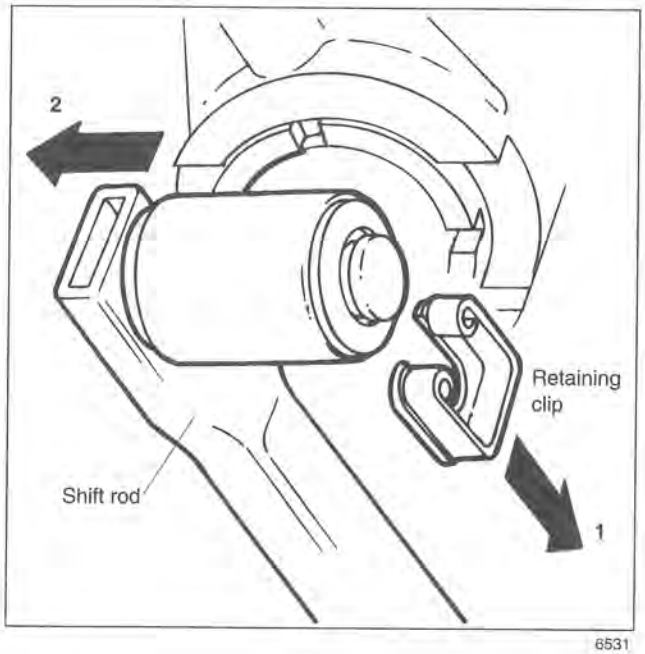
– Pull shift knob up and off of the shift lever.

NOTE—
Removal of the shift knob will require a force of about 90 lbs.


0011623

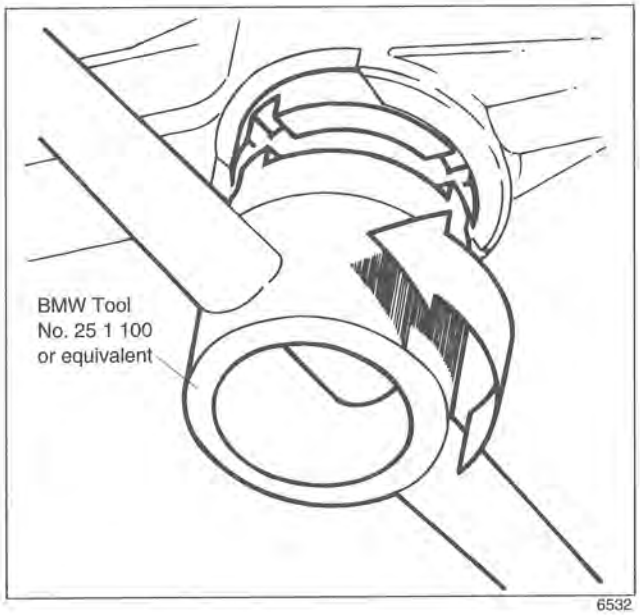
➤ Unclip shift boot cover from retainers at front and remove cover together with shift boot.

– Remove insulation padding and unclip dust boot from body and shift console. Pull dust boot from shift lever.



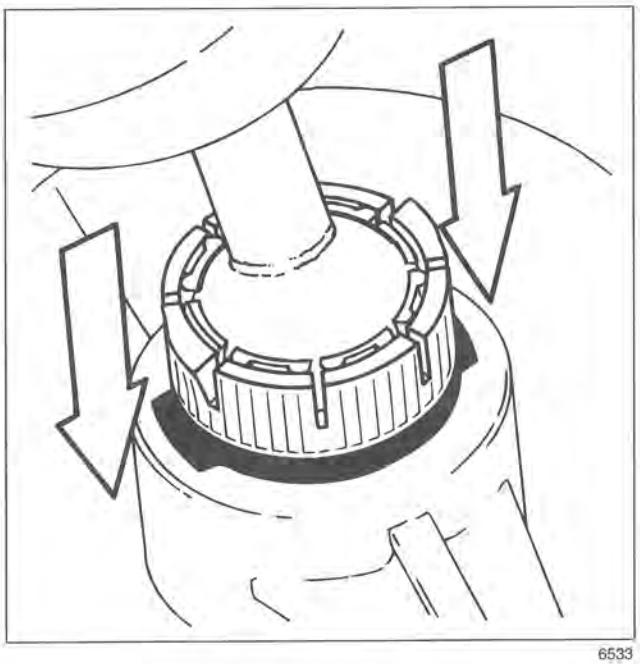
6531

➤ Working underneath car, remove retaining clip in direction of arrow (**1**) and washer from shift rod. Disengage shift rod from bushing (**2**).



6532

- Working underneath car, use BMW special tool 25 1 100 to release bearing retaining ring by turning 90° (1/4 turn) counterclockwise.
- Working from inside passenger compartment, disengage retaining ring and lift shift lever out from above.
- Check condition of rubber and plastic bushings and washers. Replace circlips and any worn parts. Remove old grease from shift lever bearing and lubricate with molybdenum disulfide grease.


6533

- When installing shift lever, align tabs on plastic retaining ring with openings in shift console.

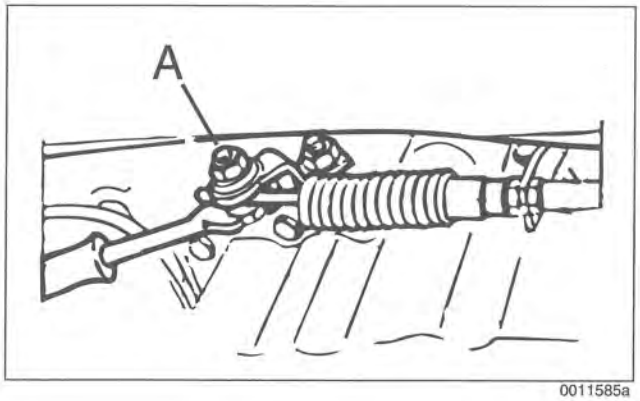
NOTE—

When mounting shift lever retaining ring, make sure locking tabs are aligned with openings in shift console. Push shift lever and retaining ring in until locking tabs click into position.

SELECTOR LEVER SERVICE (Automatic transmission)

Shift mechanism, adjusting

– Position selector lever in park (P).



0011585a

➢ Counterhold clamping bolt when loosening nut. Working at left side of transmission, loosen operating cable clamping nut (**A**).

NOTE—
Hold cable clamping sleeve stationary when loosening nut to prevent bending or damaging cable.

– Push manual valve lever forward toward engine (Park position) while applying light pressure on the cable end.

– Tighten cable clamping nut when counterholding bolt.

Tightening torque
- Shift cable clamping nut . . . . . .10–12 Nm (7.5–9 ft-lb)

Gear position/start disable switch, replacing

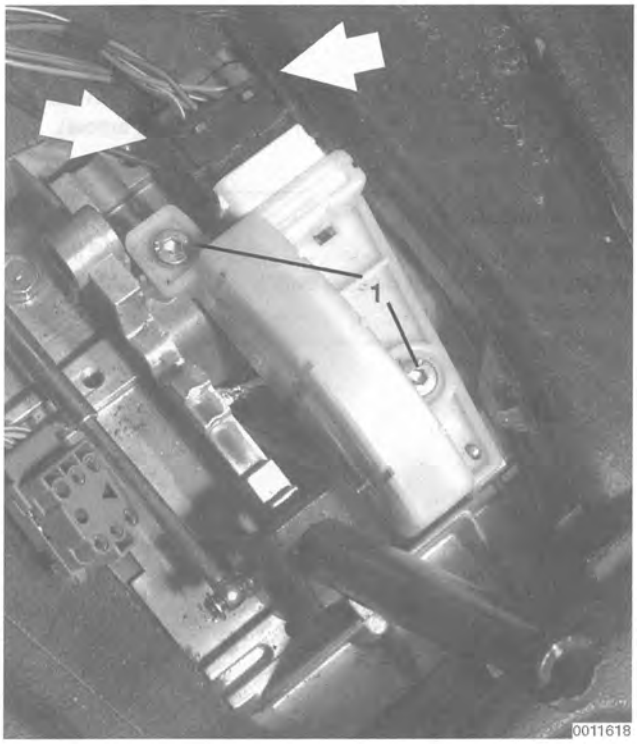

0011617

NOTE—
- *A faulty gear position/start disable switch may cause transmission shifting problems and erratic transmission operation.*
- *Back-up light switch is included in gear position/start disable switch.*

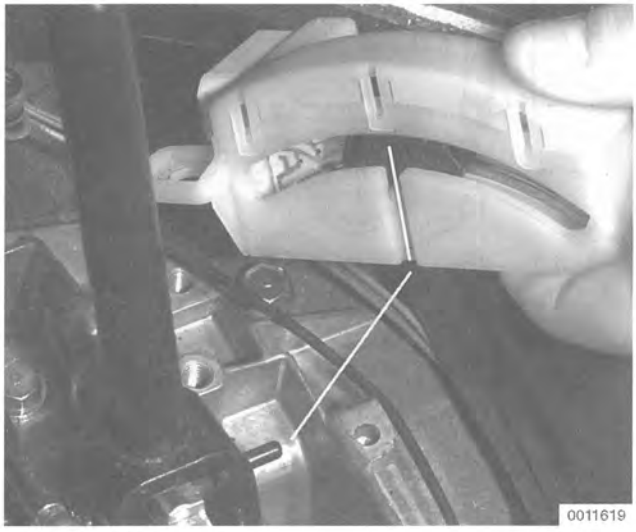
– Pry out transmission program switch from center console cover and disconnect harness connector.

– Remove hex-head screw (3 mm) from shift lever handle and remove handle.

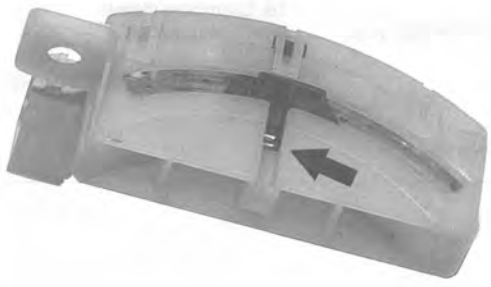
➢ Pry cover up from front and then lift off rear retaining clips (**arrows**) and remove cover from shift lever console.



- Disconnect harness connector from switch by pressing retaining clips together (**arrows**). Remove switch mounting screws (**1**).



- Remove gear position/start disable switch by aligning drive slot with drive pin on lever.



- Installation is reverse of removal. Before installing switch, align drive slot in switch housing (**arrow**) with switch sliding piece.

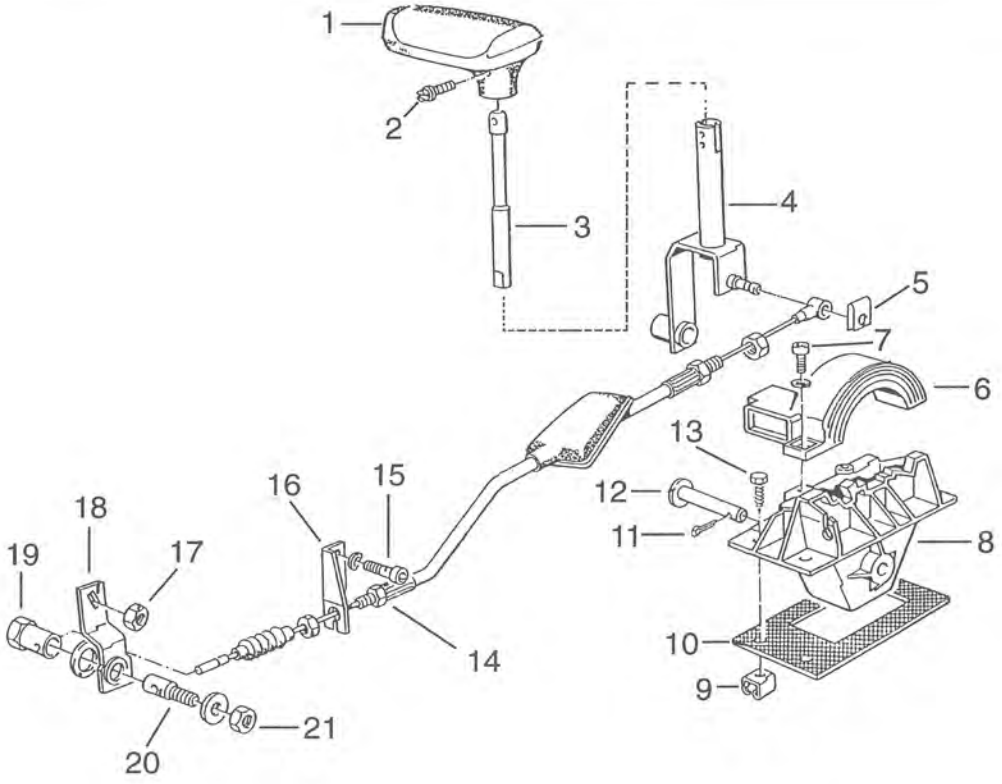


– Install switch so that sliding piece on switch aligns drive pin on lever.

➢ When installing shift lever handle, engage pin on release button (**white arrow**) to hole in pull rod (**black arrow**).

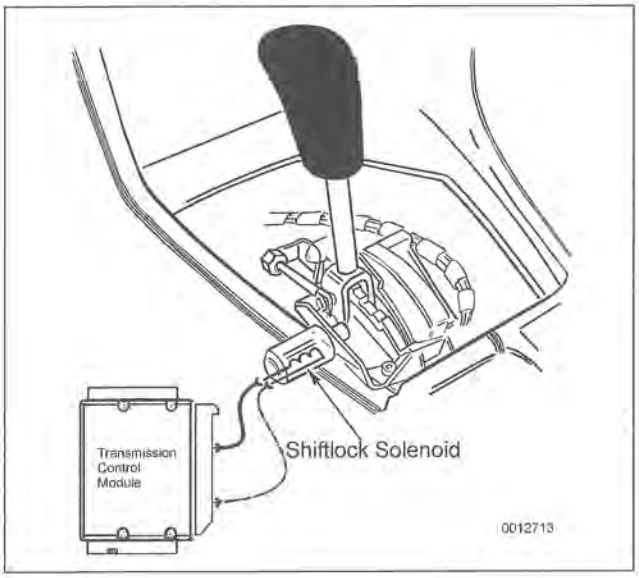
Tightening Torques

- Console to body . . . . . .7 Nm (62 in-lb)
- Gear position/start disable switch to shift console . . . . . 4.5 Nm (40 in-lb)



1. Shift handle
2. Setscrew
3. Pull rod
4. Selector lever shaft
5. Retaining clip
6. Gear position/ start disable switch
7. Screw
   - tighten to 4.5 Nm (40 in-lb)
8. Console
9. Nut
10. Gasket
11. Cotter pin
12. Selector lever shaft
13. Screw
    - tighten to 7 Nm (62 in-lb)
14. Cable
15. Screw
16. Bracket
17. Nut
18. Manual valve lever
19. Clamping sleeve
20. Clamping bolt
21. Nut
    - tighten to 10 Nm (89 in-lb)

6530

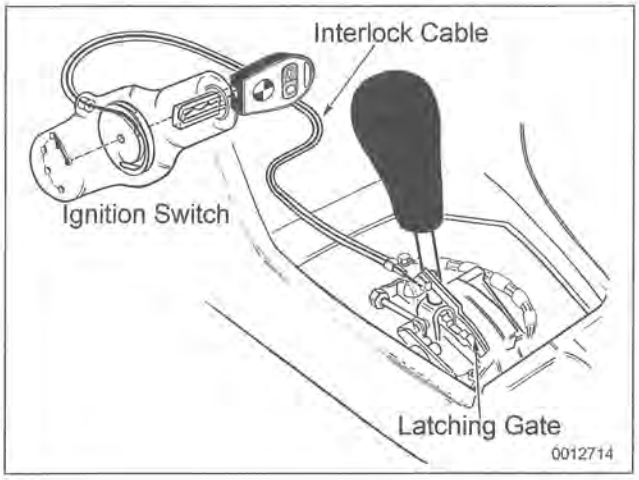


Automatic shiftlock, checking function

1992 and later models are equipped with automatic shiftlock. The shiftlock feature uses an electric solenoid to lock the selector lever in P or N. Depressing the foot brake with the ignition on energizes the solenoid, allowing lever to be moved into a drive gear. The solenoid is energized only when the engine speed is below 2,500 rpm and the vehicle speed is below 3 mph. The solenoid is mounted in the right-hand side of the selector lever housing.

- With engine running and car stopped, place selector lever in P or N.
- Without depressing brake pedal, check that selector lever is locked in position (P or N).
- Depress brake pedal firmly.
- Check that the selector lever can now be moved out of P or N. The solenoid should be heard to energize.
- With the selector lever in P or N and the brake pedal depressed, raise the engine above 2,500 rpm.
- Check that the selector lever cannot be moved out of P or N.
- If any faults are found check electrical operation of shiftlock solenoid and check for wiring faults to or from transmission control module (TCM).

NOTE —
The solenoid is energized via the TCM, using brake pedal position, engine speed, and road speed inputs.



Shift interlock, checking function

1993 and later models are equipped with shift interlock. The shift interlock uses a bowden-type cable between the ignition switch and the shift lever. The cable mechanically locks the shift lever in the park position when the key is in the off position or removed from the ignition lock. This feature also prevents the key from being removed from the ignition lock until the selector lever is in P.

- Shift selector lever to park (P) position and turn ignition key OFF.
- Remove ignition key. Check that selector lever cannot be shifted out of (P) position.

NOTE —

- *It must only be possible to remove ignition key with selector lever in (P) position.*
- *Shift interlock cable must not be kinked.*

- Turn ignition key on and depress brake pedal. Check that selector lever can be moved freely from gear to gear.
- With selector lever in a gear position other than P, attempt to move key to off position. Key should not go into the off position.

If any faults are found check cable and cable attachment points for damage or faults.



260 Driveshaft

GENERAL 260-1

TROUBLESHOOTING 260-1
Driveshaft Noise and Vibration 260-2

DRIVESHAFT SERVICE 260-4
Driveshaft, aligning 260-4
Driveshaft, removing and installing 260-5
Flex disc, replacing 260-8
Center bearing, replacing 260-9
Front centering guide, replacing 260-10
Driveshaft constant velocity (CV) joint, replacing 260-11

TABLES
a. Driveshaft Troubleshooting 260-3

GENERAL

The two-piece driveshaft is joined in the center by a sliding splined coupling. This coupling compensates for slight front-and-back movement of the engine and transmission. The front of the driveshaft is connected to the transmission by either a flexible rubber coupling (flex disc) or a universal joint drive.
The rear of the driveshaft is connected to the final drive through a constant velocity (CV) joint. The driveshaft is supported in the center by a center bearing. The bearing is rubber mounted to isolate vibration.

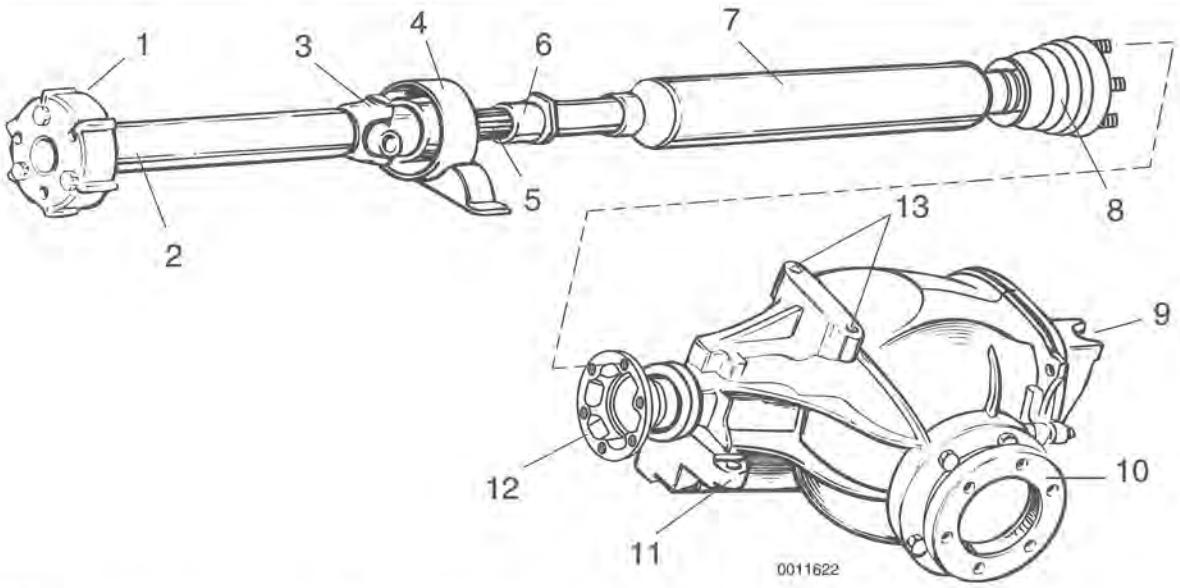
NOTE—
For information about the rear axle (final drive) and rear drive axles, see **331 Final Drive**.

TROUBLESHOOTING

The source of driveline vibrations and noise can be difficult to pinpoint. Engine, transmission, rear axle, or wheel vibrations can be transmitted through the driveshaft to the car body. Noises from the rear of the car may be caused by final drive problems, or by faulty wheel bearings or drive axles. Check that the tires are correctly inflated and are not excessively worn.

Smooth operation of the driveshaft and final drive depends on the condition of the rubber isolation components, center bearing, end joints, the lubricant level and type in the final drive, and properly tightened fasteners. Any symptom of vibration or noise may be caused by worn or damaged components.

Aside from inspecting for worn or broken parts, troubleshooting should also consider the installed angles of the driveshaft. Also check the splined coupling for free movement.



1. Flex disc
2. Front section of driveshaft
3. Universal joint
4. Center bearing
5. Splined shaft
6. Clamping sleeve
7. Rear section of driveshaft
8. CV joint
9. Rear mounting point
10. Output flange
11. Side mounting point
12. Input shaft flange
13. Upper mounting points

Driveshaft Noise and Vibration

When troubleshooting driveshaft problems, begin with a close visual inspection. Check the driveshaft for broken or missing balance weights. The weights are welded to the driveshaft. Check the torque of the fasteners at the flange connections, check the rubber of the flex disc and center bearing for deterioration or tearing, and check for preload at the center bearing. See **Driveshaft center bearing, replacing** for preload specifications.

Check the end joints for play. With the driveshaft installed, pull and twist the driveshaft while watching the joint. The BMW specification for play is very small, so almost any noticeable play could indicate a problem.

Further inspection requires removal of the driveshaft. Check the front centering guide for correct installation as described in **Driveshaft centering guide, replacing**. Also check runout at the transmission output flange and output shaft, and at the final drive input flange. Check the bolt hole bores in the flange for wear.

Driveshaft flange runout (max. allowable)

- Transmission output flange
  axial play . . . . . 0.10 mm (0.004 in.)
  radial play. . . . . 0.07 mm (0.003 in.)
- Final drive input flange
  radial play (measured at
  driveshaft centering lip) . . . . . 0.07 mm (0.003 in.)

NOTE—

- *If inspection reveals nothing wrong with the driveshaft, it may need to be rebalanced. This can be done by any repair shop with the right equipment. Also, check the alignment of the driveshaft as described below.*
- *Minor driveshaft vibrations can often be corrected simply by disconnecting the driveshaft at the final drive, and repositioning the driveshaft 90 °, 180 ° or 270 ° in relation to the final drive input flange.*

Table a lists symptoms of driveshaft problems and their probable causes. Most of the repair information is contained within this repair group. The bold type refers to repair information contained outside of this repair group.

Table a. Driveshaft Troubleshooting

Symptom	Probable cause	Corrective action
1. Vibration when moving off (forward or reverse)	a. Incorrect preload of center bearing	a. Check preload of center bearing. Readjust if necessary.
	b. Center bearing rubber deteriorated or torn.	b. Inspect center bearing. Replace if necessary.
	c. Flex disc damaged or worn	c. Inspect flex disc. Replace if necessary.
	d. Engine or transmission mounts faulty	d. Inspect engine and transmission mounts. Align or replace, if necessary.
	e. Front centering guide worn, or driveshaft mounting flanges out of round	e. Check front centering guide and replace if necessary. Check runout of driveshaft flanges.
	f. Universal joints worn or seized	f. Check universal joint play and movement. Replace driveshaft if necessary.
	g. Sliding coupling seized	g. Remove driveshaft and check movement of sliding coupling. Clean coupling splines and replace parts as necessary.
	h. Driveshaft misaligned	h. Check driveshaft alignment.
2. Vibration, audible rumble over 35 mph (60 km/h)	a. Front centering guide worn, or driveshaft mounting flanges out of round or damaged	a. Check front centering guide and replace if necessary. Check runout of driveshaft mounting flanges.
	b. Mounting flange bolts loose or holes worn	b. Remove driveshaft and check transmission output flange and final drive input flange. Replace if necessary.
	c. Driveshaft unbalanced	c. Check driveshaft for loose or missing balance plates. Have driveshaft rebalanced or replace if necessary.
	d. Universal joints worn or seized	d. Check universal joint play and movement. Replace driveshaft if necessary.
	e. Center bearing faulty	e. Replace center bearing.
	f. Final drive rubber mount faulty	f. Inspect final drive rubber mount and replace if necessary.
3. Noise during on/off throttle or when engaging clutch	a. Final drive components worn or damaged (excessive pinion-to-ring-gear clearance)	a. Remove final drive and repair.
	b. Drive axle or CV joint faulty	b. Inspect drive axles and CV joints. Repair or replace as necessary. See **331 Final Drive**
	c. Sliding coupling seized	c. Remove driveshaft and check movement of sliding coupling. Clean coupling splines and replace parts as necessary.

DRIVESHAFT SERVICE

Most components of the driveshaft are easily replaced once the driveshaft is removed from the car. Repair kits for the universal joints are not available, and it is not common practice to repair the universal joints on BMW driveshafts. Worn or damaged universal joints usually require replacement of that section of the driveshaft.

The front of the driveshaft is aligned with the transmission by a centering guide. The guide is recessed into the front of the driveshaft. It engages the end of the transmission output shaft when the driveshaft is installed.

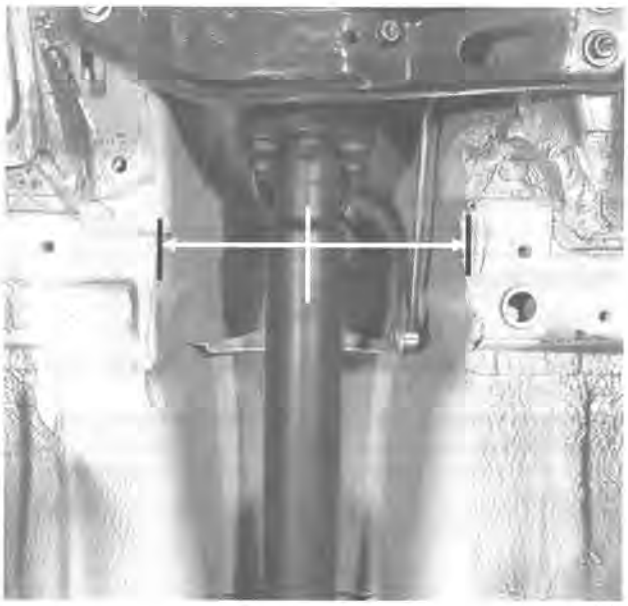
The driveshaft is balanced to close tolerances. Whenever it is to be removed or disassembled, the mounting flanges and driveshaft sections should be marked with paint or a punch before proceeding with work. This will ensure that the driveshaft can be reassembled or installed in exactly the same orientation.

Universal joint play

- Maximum allowable . . . . . 0.15 mm (0.006 in.)

Driveshaft, aligning

The alignment of the driveshaft does not normally need to be checked unless the engine/transmission or the final drive have been removed and installed. If, however, all other parts of the driveshaft have been inspected and found to be okay, but there is still noise or vibration, driveshaft alignment should be checked.



5326

There are two important driveshaft alignment checks. The first is to make sure that the driveshaft runs straight from the transmission to the final drive, without any variation from side-to-side caused by misalignment of the engine/transmission in its mounts. Make a basic check by sighting along the driveshaft from back to front. Any misalignment should be apparent from the center bearing forward. To adjust the side-to-side alignment, loosen the transmission or engine mounts to reposition them, then retighten the mounts.

The second important driveshaft alignment check is more complicated. It checks the amount the driveshaft is angled vertically at the joints. This angle is known as driveshaft deflection.

In general, there should be little deflection in the driveshaft between the engine, the center bearing, and the final drive. Precise checks require the use of a large protractor or some other means of measuring the angle of the engine and the final drive and comparing these angles to the angle of the driveshaft sections.

To change the deflection angle, shims can be placed between the center bearing and the body or between the transmission and its rear support. When using shims to change a deflection angle, keep in mind that the angle of adjacent joints will also change. Deflection angles should be as small as possible.

CAUTION—
The maximum allowable change in height of the center bearing or transmission support using shims is 3 mm (0.12 in.).

Driveshaft, removing and installing

WARNING—
- *Removal of the driveshaft will disconnect the transmission from the final drive. Do not rely on engagement of the transmission to prevent the car from rolling. Chock all wheels. Use caution when working beneath the car and lowering the driveshaft. Firmly set the parking brake.*
- *The driveshaft is mounted to the transmission and final drive with self-locking nuts. These nuts are designed to be used only once and should be replaced.*



5338

– Remove exhaust system and heat shields. See **180 Exhaust System**.

Loosen driveshaft sliding coupling clamping sleeve (**arrow**) several turns.

NOTE—
BMW special tool 26 1 040 can be used to loosen the clamping sleeve.

– Using paint or a punch, make matching marks on driveshaft and attaching flanges.



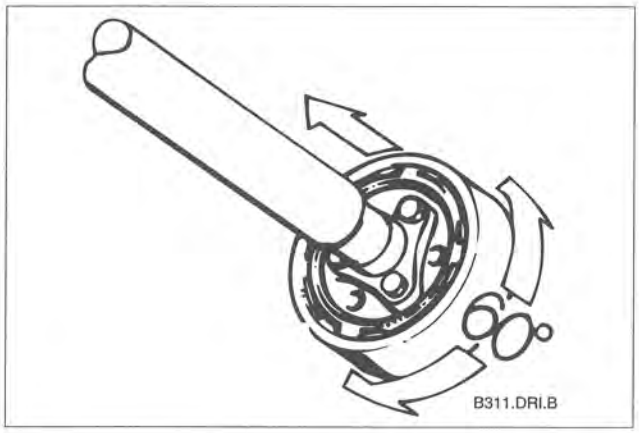
5267

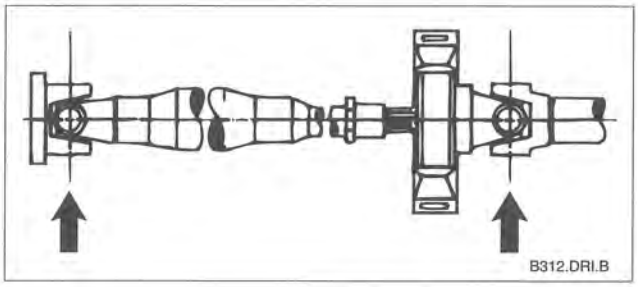
Remove nuts and bolts holding flex disc or end joint to transmission flange. Do not pull driveshaft off flange at this time. Note open-end wrench used to counterhold bolt.

NOTE—
Removal of the bolts may be made easier by placing a large hose clamp around the flex disc and tightening the clamp slightly to compress the coupling.



5330





➢ Remove bolts from driveshaft at final drive flange.

– Support driveshaft and remove center bearing mounting bolts.

> ***WARNING—***
> *Do not let the rear section rest on the fuel tank connection line.*

– Remove driveshaft.

- Bend driveshaft down at center bearing, and then pull it off at front. If necessary, slide driveshaft together at splined coupling.

NOTE—

- *Do not pull driveshaft sections apart.*

➢ On models with a vibration damper, the damper can be removed from the transmission flange by turning it about 60° and pulling it over the flange.

If the splined coupling is to be cleaned or if the rubber bushing behind the clamping sleeve is being replaced, mark the two sections of the driveshaft before separating. Lubricate the splines with molybdenum disulfide grease (Molykote Longterm 2® or equivalent) before reassembly. Inspect the flange bolt mounting holes and replace any worn components.

➢ Assemble driveshaft with U-joints on same plane.

- If the two sections are pulled apart without the driveshaft being marked, reassemble the two halves so that the universal joints are on the same plane. There is still the possibility of the driveshaft being reassembled wrong by 180° and causing vibration. In this case remove the driveshaft and turn one section 180°, and reassemble.

– Prior to installation, lightly lubricate centering guide in flex disc with molybdenum disulfide grease (Molykote Longterm 2® or equivalent).



5331

➢ Preload center bearing toward front 4–6 mm (**arrow**).

– Reinstall driveshaft by first positioning it against final drive flange and then sliding it onto transmission flange. Align any marks made during removal. Position center bearing up against the body and loosely install the mount bolts. Use new self-locking nuts. Torque driveshaft nuts while holding the bolts. Preload bearing mount toward front of car, then tighten mounting bolts. The remainder of installation is reverse of removal.

Center bearing mount

- Preload
  (towards front of car). . . . . 4 to 6 mm (5/32 to 1/4 in.)

Tightening Torques

- Driveshaft center mount to body. . . . . 21 Nm (16 ft-lb)
- Driveshaft clamping sleeve . . . . . .10 Nm (89 in-lb)
- Driveshaft to final drive flange (with CV joint)
  M8 ribbed nut . . . . . .43 Nm (32 ft-lb)
  M8 compression nut . . . . . .32 Nm (23 ft-lb)
  M10 ribbed nut . . . . . .90 Nm (66 ft-lb)
  M10 compression nut . . . . . .64 Nm (47 ft-lb)
- Driveshaft to final drive flange (with U-joint)
  M10 ribbed nut . . . . . .90 Nm (66 ft-lb)
  M10 compression nut . . . . . .64 Nm (47 ft-lb)
- Driveshaft to transmission or final drive flange
  M10/8.8 grade. . . . . .48 Nm (36 ft-lb)
  M10/10.9 grade. . . . . .64 Nm (47 ft-lb)
  M12. . . . . .100 Nm (74 ft-lb)
- Rear transmission bracket to transmission/body
  M8. . . . . .23 Nm (17 ft-lb)
  M10. . . . . 42 Nm (31 ft-lb)

WARNING—

- *Do not reuse self-locking nuts. These nuts are designed to be used only once.*
- *Avoid stressing the flex disc when torquing the bolts. Do this by holding the bolts steady and turning the nuts on the flange side.*

NOTE—

Bolt grade is marked on the bolt head. When replacing bolts, only use bolts of the same strength and hardness as the originals installed.

Flex disc, replacing

The flex disc between the front section of the driveshaft should be checked for cracks, tears, missing pieces, or distortion. Check for worn bolt hole bores in the flange. When replacing the flex disc, use new self-locking nuts.

– Remove driveshaft. See **Driveshaft, removing and installing**.

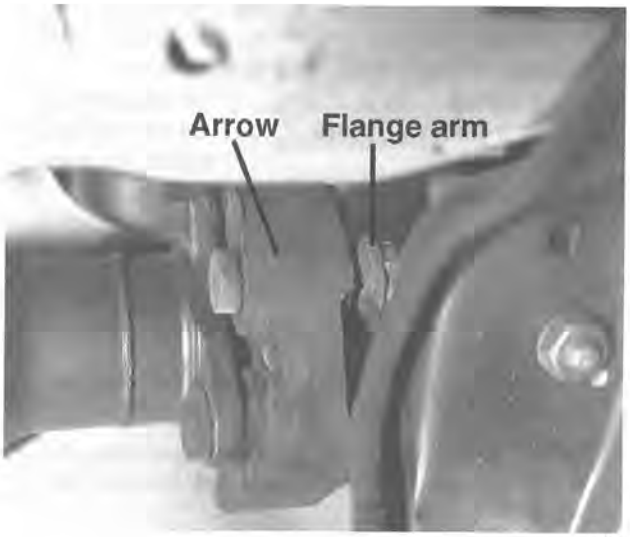
NOTE—

- *It is possible to only partially remove the driveshaft, leaving it connected to the final drive. The driveshaft can be tilted down in the center and slid off the transmission flange once the center bearing bracket is unbolted from the body.*
- *Use care when using this method. Suspend the driveshaft using stiff wire in as close to the installed position as possible. If the driveshaft hangs unsupported, the rear universal joint may be damaged.*

– Unbolt flex disc from driveshaft.

NOTE—

Removal and installation of the bolts may be made easier by placing a large hose clamp around the flex disc, and tightening the clamp slightly to compress the coupling.



5332

➤ Install new flex disc using new self-locking nuts. Molded arrows on coupling should face flange arms.

NOTE—

Torque only the nuts while holding the bolt heads stationary. This will prevent damaging the rubber disc.

NOTE—

- *Remove the hose clamp if one was used during installation or if the flex disc came supplied with one.*
- *The bolt grade is marked on the head. When replacing bolts, only use bolts of the same strength and hardness as the originals installed.*

– Reinstall driveshaft.

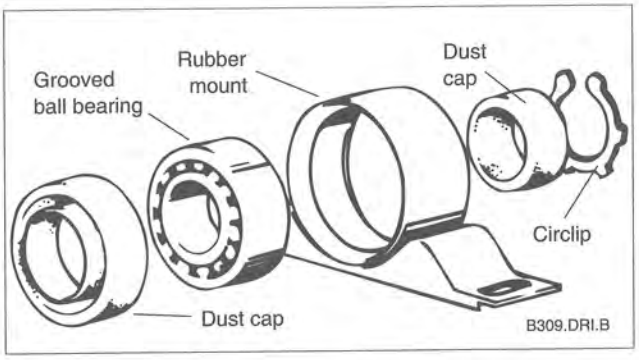
Tightening Torques

- Flex disc to driveshaft or transmission flange
  - M10 8.8 grade . . . . . 48 Nm (35 ft-lb)
  - M10 10.9 grade . . . . . 64 Nm (47 ft-lb)
  - M12 . . . . . 100 Nm (74 ft-lb)

WARNING—

Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

Center bearing, replacing



To replace the center bearing, the driveshaft must be removed from the car. The bearing assembly is pressed onto the front section of the driveshaft and secured by a circlip or a bolt. The center bearing consists of a ball bearing assembly press-fit in a rubber mount.

– Remove driveshaft. See **Driveshaft, removing and installing**.



5333

➢ Make matching marks (**arrows**) on front and rear driveshaft sections.

– Unscrew clamping sleeve fully and pull driveshaft sections apart. Remove rubber bushing, washer, and clamping sleeve from front section.

– Inspect condition of rubber bushing for splined coupling. Replace worn or damaged parts.



5334

➢ Remove center bearing circlip (**arrow**) and dust guard, if applicable. Remove bearing from driveshaft using puller.

– Make sure dust guard is on driveshaft, and then press center mount onto driveshaft flush with dust guard.

– Place clamping sleeve, washer, and rubber bushing on front driveshaft section. Lubricate splines with molybdenum disulfide grease (Molykote Longterm 2® or equivalent) and then reassemble driveshaft. Make sure matching marks align. Do not retighten clamping sleeve until driveshaft is installed.

– Reinstall driveshaft.

– Tighten clamping sleeve.

– Install driveshaft. See **Driveshaft, removing and installing**.

Tightening Torque

- Clamping sleeve . . . . . 10 Nm (7.5 ft-lb)

Front centering guide, replacing

The front centering guide centers the driveshaft to the transmission. The guide is press-fit into a cavity in the front of the driveshaft and slides onto the transmission output shaft.

A worn centering guide can cause driveshaft wobble and vibration. It is necessary to remove the driveshaft to inspect and replace the centering guide. No specifications are given for wear of the guide, but generally the guide should fit snugly on the transmission output shaft.

NOTE—
Some driveshafts have a dust cap installed on the end of the driveshaft over the centering guide. The dust cap may become bent or distorted when the driveshaft is removed or installed. Damage to the dust cap should not affect the centering guide and should not be mistaken for guide wear.

– Remove driveshaft. See **Driveshaft, removing and installing.**

– Pack cavity behind centering guide with heavy grease until grease is flush with bottom edge of guide.

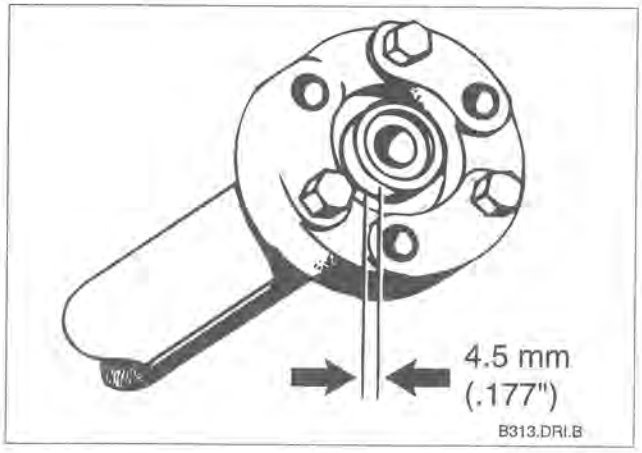
– Insert 14 mm (approximately 1/2 in.) diameter mandrel or metal rod into guide. Strike guide with hammer. Centering guide is forced out.

NOTE—
The mandrel needs to fit snugly in the centering guide so that the grease cannot escape around the sides of the mandrel.

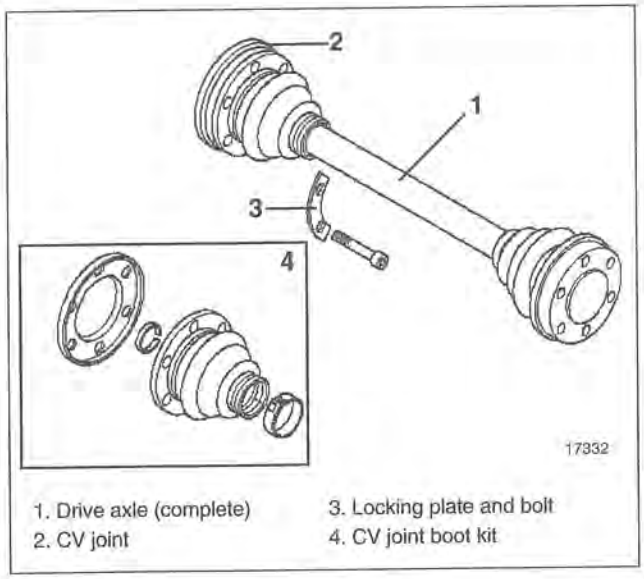
– Remove old grease from driveshaft, lubricate new centering guide with molybdenum disulfide grease (Molykote Longterm 2® or equivalent) and drive it into the driveshaft.

◀ The sealing lip of the guide should face outward and the guide should be driven into the driveshaft to a specified depth.

– Reinstall driveshaft. See **Driveshaft, removing and installing**.



Driveshaft constant velocity (CV) joint, replacing



1. Drive axle (complete)
2. CV joint
3. Locking plate and bolt
4. CV joint boot kit

The constant velocity (CV) joint on the rear of the driveshaft bolts directly to the final drive output flange. The CV joint can be replaced after removing the driveshaft. Always replace clamps, circlips, boots, gaskets, and covers. Have these items on hand before starting the job.

– Remove driveshaft. See **Driveshaft, removing and installing**.

– Remove boot clamp at back of CV joint.

– At front of joint, remove circlip securing joint to shaft. Pull joint off driveshaft using a suitable puller. Remove bolts from joint.

NOTE—
The CV joint is cemented (Loctite®) to driveshaft and will require a puller to break free. The CV joint mounting bolt shoulders are knurled and need to be driven out of joint.

– Pack the new joint with CV joint grease, working the grease down into the cage. Install a new gasket and dust cover.

Driveshaft CV Joint Lubricant Capacity (approx.)

• CV joint grease	80 grams

NOTE—
Do not swivel the CV joint inner race when packing it with grease. The balls can fall out of the cage.

– Tap bolts and retainers through joint holes. Clean splines on driveshaft and apply a small amount of bolt cement to splines.

– Place joint boot on shaft. Install joint onto driveshaft and tap it on (use wooden dowel).

– Install new circlip on shaft. Install new boot clamp.

– Reinstall driveshaft.

Tightening Torque

• Driveshaft to final drive flange (with CV joint)	
M8 ribbed nut	43 Nm (32 ft-lb)
M8 compression nut	32 Nm (23 ft-lb)
M10 ribbed nut	70 Nm (52 ft-lb)
M10 compression nut	64 Nm (47 ft-lb)



300 Suspension, Steering and Brakes–General

GENERAL 300-1
Front Suspension 300-2
Rear Suspension 300-2
Steering 300-3
Brakes 300-4

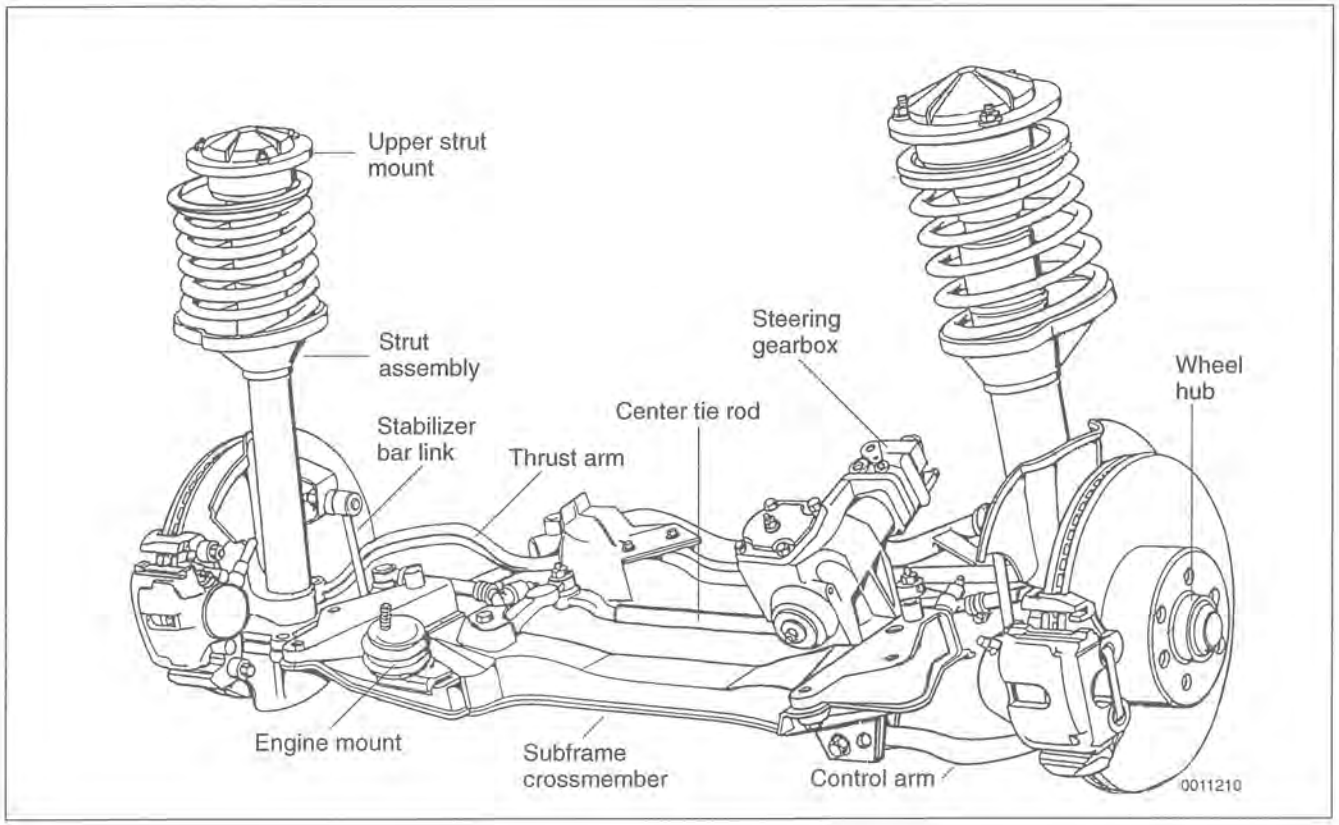
INTEGRATED SYSTEMS 300-4
Antilock Brake System (ABS) 300-5
Automatic Stability Control (ASC/ASC+T) 300-5
Self Levelling Rear Suspension (LAD) 300-6
Electronic Damping Control (EDC III) 300-7

SUSPENSION AND STEERING TROUBLESHOOTING 300-7

TABLE
a. Suspension and Steering Troubleshooting 300-7

GENERAL

The **Suspension, Steering and Brakes** repair groups cover front and rear suspension, braking systems and steering system, including wheel alignment. Also covered here are the integrated suspension systems including traction control (ASC/ASC+T), electronic damping control (EDC III), and self levelling suspension (LAD).



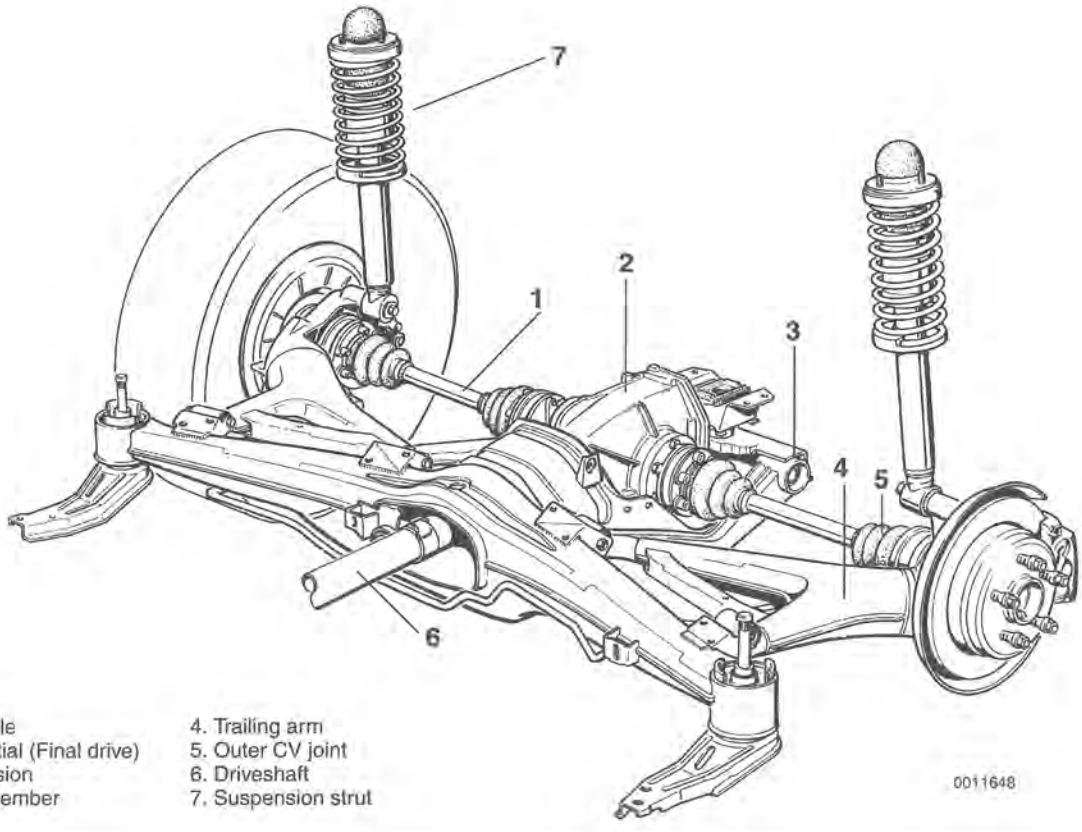
Front Suspension

The double-pivot independent front suspension uses two main structural members as rigid mounting points for the suspension components. The control and thrust arms control front-to-back and side-to-side movement. The arms are connected to the crossmembers through rubber bushings and to the bottom of the suspension struts through ball joints. A stabilizer bar distributes suspension loads during cornering.

Each front suspension strut assembly includes a shock absorber cartridge inside a tubular strut housing and a coil spring. The upper strut mounts allow the struts to turn with the wheels. The lower end of each strut housing includes the stub axle for the front wheel bearings and integral wheel hubs.

Rear Suspension

The rear suspension uses a rear axle subframe as the main mounting point for the differential (also called final drive housing) and the rear suspension components. The differential is mounted through rubber mounts and bushings to help isolate drivetrain noise and vibration.



1. Drive axle
2. Differential (Final drive)
3. Suspension cross member
4. Trailing arm
5. Outer CV joint
6. Driveshaft
7. Suspension strut

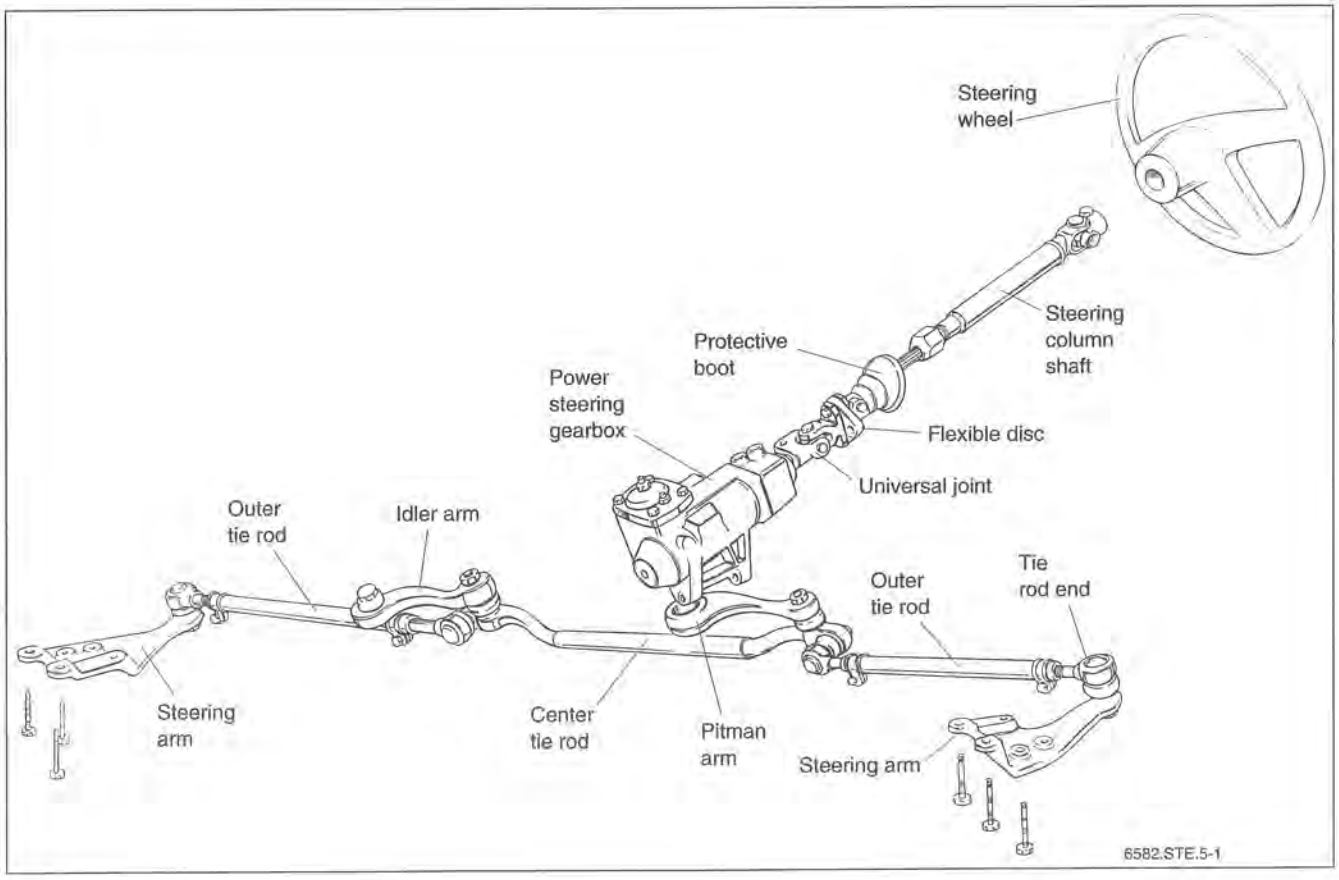
Trailing arms locate the rear wheels and anchor the spring struts and the stabilizer bar. Drive axles with constant-velocity (CV) joints at both ends transfer power from the differential to the road wheels.

Steering

The BMW Servotronic power steering system consists of an engine-driven hydraulic pump, a ball-and-nut type electro-hydraulic steering gearbox, and connecting linkage to the road wheels.

The Servotronic system varies assist electronically according to road speed. An electronic/hydraulic valve on the steering gearbox controls power assist via the Servotronic electronic control module.

The steering linkage connects to the steering gearbox through a pitman arm to the wheels. An idler arm maintains correct toe angle and the tie rod allow the wheels to pivot and react to suspension travel.



Brakes

The E32 7 Series is equipped with power disc brakes with an integral Antilock Brake System (ABS or ABS/ASC). The parking brake is a dual-drum system integrated with the rear brake discs.

Two types of brake assist systems are used depending on model and model year.

Early 735i/iL (up to 3/1988 build date) and all 750iL models are equipped with a hydraulic brake booster unit. This system is hydraulically boosted using the fluid from the power steering pump.

Most 735i/iL (from 3/1988 build date) and all 740i/iL models provide brake assist by a vacuum booster. The vacuum booster uses engine vacuum to help actuate the master cylinder and reduce pedal effort when the engine is running. A heavy duty dual booster is used in 740i/iL models.

The dual-chamber master cylinder pressurizes two separate hydraulic circuits. The front circuit actuates the left front and right rear brakes. The rear circuit actuates the right front and left rear brakes. If one circuit fails, the remaining circuit can still provide a portion of the braking force.

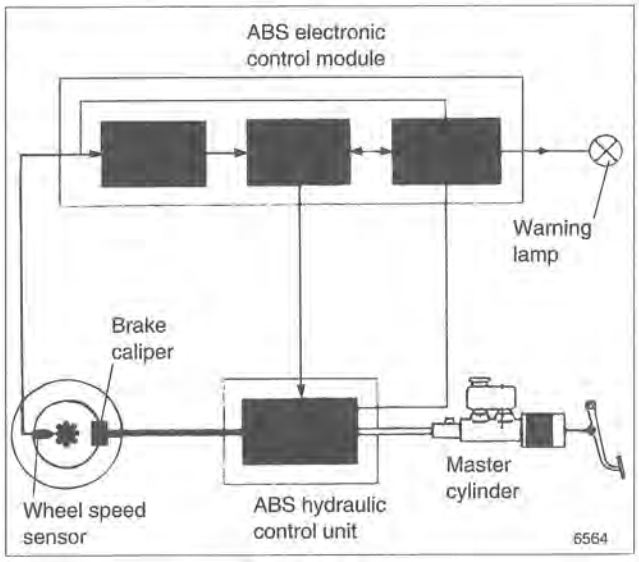
Each disc brake uses a caliper with a single hydraulic cylinder. Front and rear rotors are mounted to the wheel hubs. Disc brakes automatically adjust for brake pad and rotor wear. Brake pads in the left front and right rear brakes contain wear sensors. When the pads need replacement, the sensors illuminate a light on the dashboard. See **340 Brakes** for repair information.

INTEGRATED SYSTEMS

BMW E32 cars include several advanced systems that integrate with other systems to enhance driveability, safety and performance. Anti-lock braking (ABS) is standard on all E32 cars. Other integrated systems include traction control (ASC or ASC+T), self levelling suspension (LAD) and electronic damping control (EDC III). These systems were not installed on all cars. Some systems were standard on some models and installed as optional equipment on others. See **370 Integrated Suspension Systems** for repair information.

Antilock Brake System (ABS)

The electronically-controlled ABS maintains vehicle stability and control during emergency braking by preventing wheel lock-up. ABS provides optimum deceleration and stability during emergency braking. It automatically adjusts the hydraulic pressure at each wheel to prevent wheel lock.



The main ABS system components are the wheel speed (pulse) sensors, the ABS control module, and the hydraulic control unit. The wheel speed sensors continuously send wheel speed signals to the ABS electronic control module. The control module compares these signals to determine, in fractions of a second, whether any of the wheels are about to lock. If any wheel is nearing a lock-up condition, the control module signals the hydraulic unit to maintain or reduce hydraulic pressure at the appropriate wheel(s). Pressure is modulated by electrically-operated solenoid valves in the hydraulic control unit.

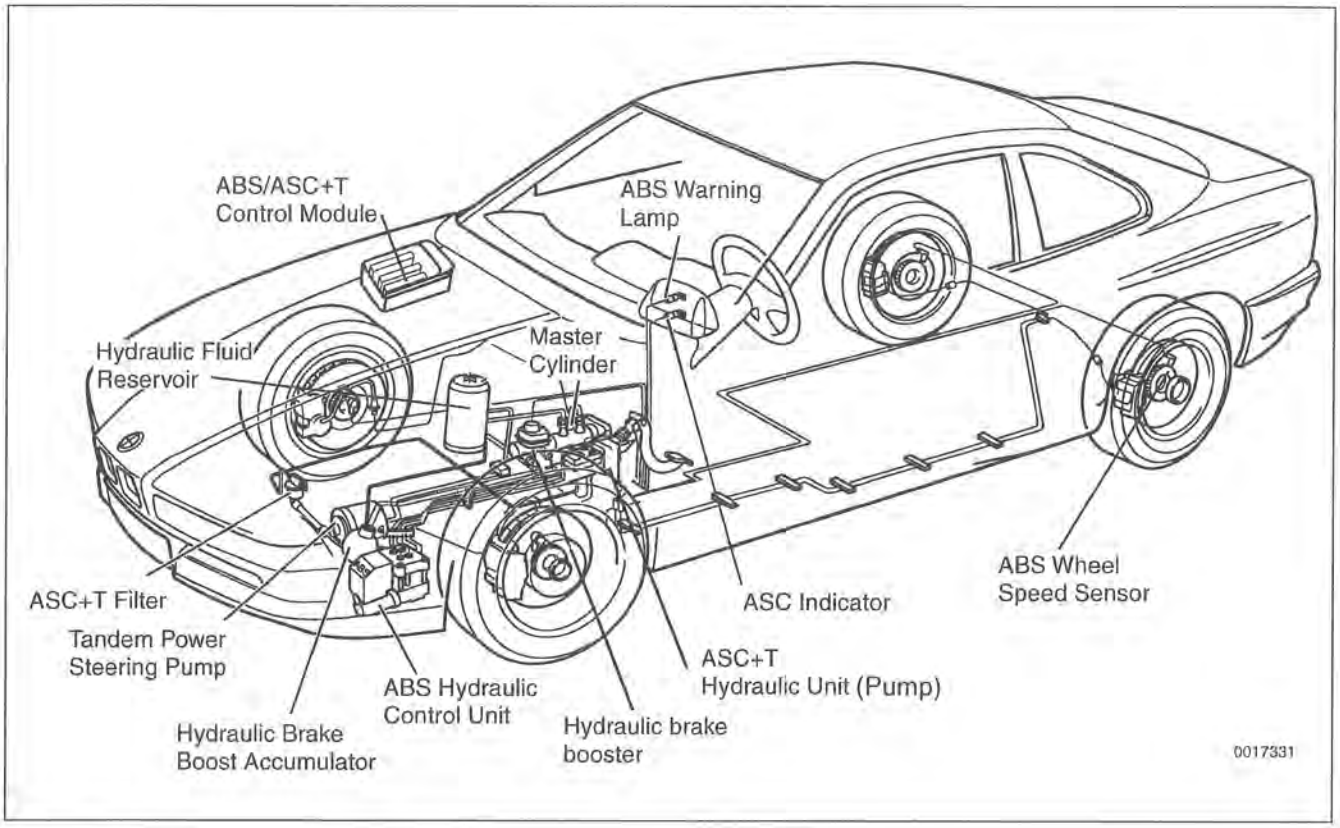
Automatic Stability Control (ASC/ASC+T)

The traction control system, known by different names depending on model and model year, works in conjunction with the ABS and the DME engine management system to enhance vehicle control. In addition to the normal ABS function, the traction control system also controls engine throttle and engine timing to reduce engine torque to help maintain vehicle stability. On later cars with ASC+T, (T=traction), the application of the rear brakes are controlled by the system.

NOTE—

ASC+T is a further development of the earlier ASC system. The ASC+T system integrates an additional hydraulic pump to actuate/apply the rear brakes when the rear drive wheels are spinning at a faster rate than the front wheels.

Repair and troubleshooting of the ASC and ASC+T systems requires special test equipment and knowledge and should be performed only by an authorized BMW dealer.



Self levelling Rear Suspension (LAD)

The self levelling rear suspension system, called LAD (Load Absorption Damping), uses mechanical and hydraulic components to monitor and adjust the rear suspension ride height based on load and driving conditions. The LAD system uses hydraulic pressure (supplied by an additional pump integrated with the power steering pump, sometimes known as the "tandem" pump) to adjust the height of the rear shock absorbers under varying load and driving conditions.

A camber warning switch is used to monitor suspension loading via the instrument cluster and check control. If the rear axle is loaded beyond the regulating limit of the LAD system (i.e. excessive wheel camber), the check control warning **SUSPN LEVELLING** will be displayed. The camber warning switch is mounted on the rear axle subframe. For additional information on LAD see **370 Integrated Suspension Systems**.

Electronic Damping Control (EDC III)

Some late model E32 7 Series cars are equipped with a fully automatic electronic damping system (EDC III). This system allows the driver the choice of two settings for ride control: Comfort or Sport (K or S on the console mounted switch).

NOTE—
Cars with EDC III can be quickly identified by inspecting the front strut assemblies. Cars with EDC III will have electrical wires coming from a set of switching solenoids at the lower section of each strut.

The EDC III electronic control module uses input from three accelerometers, a steering angle sensor and the speedometer to determine road and driving conditions. The module then controls solenoid valve operation (shock valving) at each shock absorber based on the switch position selected by the driver.

Component testing and replacement information on EDC III can be found in **370 Integrated Suspension Systems**.

SUSPENSION AND STEERING TROUBLESHOOTING

Stable handling and ride comfort both depend on the integrity of the suspension and steering components. Any symptom of instability or imprecise road feel may be caused by worn or damaged suspension components.

In addition to inspecting for worn parts, troubleshooting must also consider the condition of tires, wheels and alignment. Tire wear and incorrect inflation pressures can dramatically affect handling. Subtle irregularities in wheel alignment angles also affect stability. Mixing different types or sizes of tires, particularly on the same end of the car, can affect alignment and may unbalance a car's handling.

Table a. Suspension and Steering Troubleshooting

Symptom	Probable cause	Corrective action
1. Car pulls to one side, wanders	a. Incorrect tire pressure b. Incorrect wheel alignment c. Faulty brakes (pulls only when braking)	a. Check and correct tire pressures. b. Check and adjust wheel alignment. c. Check for sticking/damaged front caliper.
2. Steering heavy, poor return-to-center	a. Worn upper strut bearing(s) b. Incorrect tire pressure c. Power steering system faulty	a. Replace strut bearings. b. Check and correct tire pressures. c. Check power steering fluid level. Test system pressure.
3. Front-end or rear-end vibration or shimmy	a. Worn strut shock absorber cartridges b. Worn suspension bushings (control arm, thrust arm, trailing arm, crossmember) c. Worn front suspension ball joints (control arm, thrust arm, steering tie-rod end) d. Unbalanced or bent wheels/tires e. Loose wheel lug bolts	a. Replace struts. b. Replace worn bushings. c. Replace worn ball joints. d. Balance tires. Check tires for uneven wear patterns. Check wheels for damage. e. Tighten lug bolts to proper torque.
4. Poor stability, repeated bouncing after bumps, suspension bottoms out easily	a. Worn struts	a. Replace struts.
5. Suspension noise (especially over bumps)	a. Worn front upper strut bearings(s) b. Worn suspension bushings (control arm, thrust arm, trailing arm, crossmember) c. Worn stabilizer bar rubber mounts d. Loose front suspension crossmember	a. Replace upper strut bearings. b. Replace worn bushings. c. Replace stabilizer bar rubber mounts. d. Check crossmember for damage. Tighten mounting bolts.
6. Uneven ride height	a. Incorrect coil springs b. Bent or damaged suspension components c. Sagging coil springs d. Faulty Self levelling (LAD) system (where applicable).	a. Measure ride height and replace springs as required. b. Inspect and repair/replace as necessary. c. Check and adjust ride height. Test LAD system. d. Test LAD system. Check and adjust ride height.
7. Wheel noise, continuous growling, may be more noticeable when turning	a. Worn wheel bearing	a. Replace wheel bearing.
8. Steering loose, imprecise	a. Incorrect tire pressure b. Loose steering gearbox mounting bolt(s) c. Worn tie rod end(s) d. Faulty front wheel bearing e. Worn or damaged steering gearbox	a. Check and correct tire pressures. b. Inspect and tighten bolts. c. Replace tie rod(s) and align wheels. d. Replace wheel bearing. e. Adjust or replace steering gearbox.

310 Front Suspension

GENERAL 310-1

SHOCK ABSORBERS AND SPRINGS . 310-2
Strut assembly, removing and installing (except on cars with EDC III) 310-3
Strut, disassembling and assembling 310-4
Strut assembly, removing and installing (cars with EDC III) 310-6
Ride Height 310-7

CONTROL ARMS 310-8
Control arm, removing and installing 310-8
Control arm bushings, replacing (steel control arms only) 310-10

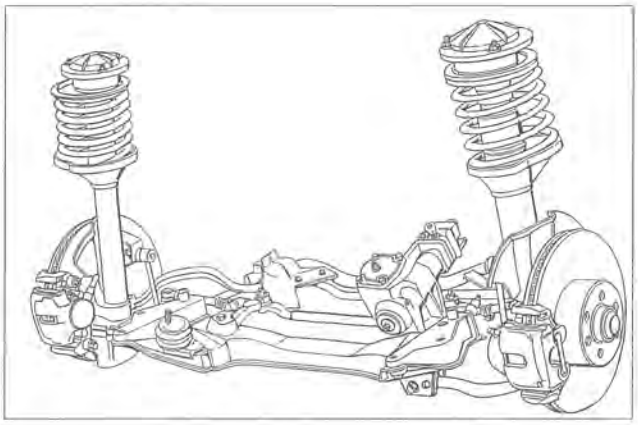
FRONT WHEEL BEARINGS 310-10
Wheel bearing, replacing 310-11

STABILIZER BAR 310-13
Stabilizer bar, removing and installing 310-13

THRUST ARMS 310-14
Thrust arm, removing and installing 310-14
Thrust arm bushings, replacing 310-15

SUBFRAME CROSSMEMBER 310-16
Subframe crossmember, removing 310-16
Subframe crossmember, installing 310-18

TABLE
a. Front Ride Height Specifications 310-8



GENERAL

For a general description of the front suspension and components, see **300 Suspension, Steering and Brakes–General**.

Special service tools are required for most of the work described in this repair group. Read the procedures through before beginning any job.

WARNING—

- *Physical safety will be impaired if procedures described here are undertaken without the proper service tools and equipment. Be sure to have the right tools on hand before beginning any job.*
- *Do not reuse self locking nuts or bolts. They are designed to be used only once and may fail if reused. Always replace self locking fasteners any time they are loosened or removed.*
- *Do not install bolts and nuts coated with undercoating wax, as the correct tightening torque cannot be assured. Always clean the threads with solvent before installation, or install new parts.*
- *Do not attempt to weld or straighten any suspension components. Replace damaged parts.*

SHOCK ABSORBERS AND SPRINGS

Electronic damping control (EDC III) is installed as an option in some E32 cars. EDC III cars do not have conventional struts. A separate replacement procedure is given below for these struts. For further information on EDC III, see **370 Integrated Suspension Systems**.

NOTE—

- *Most assembly components are available as replacement parts, although the most commonly replaced parts are the strut cartridges, the upper strut mounts and the coil springs.*
- *Shock absorber cartridges and springs should always be replaced in pairs.*

Strut assembly, removing and installing (except on cars with EDC III)

NOTE—
For EDC III strut removal procedures, see **Strut assembly, removing and installing (cars with EDC III)** *later in this group.*

– Raise car and remove front wheel.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

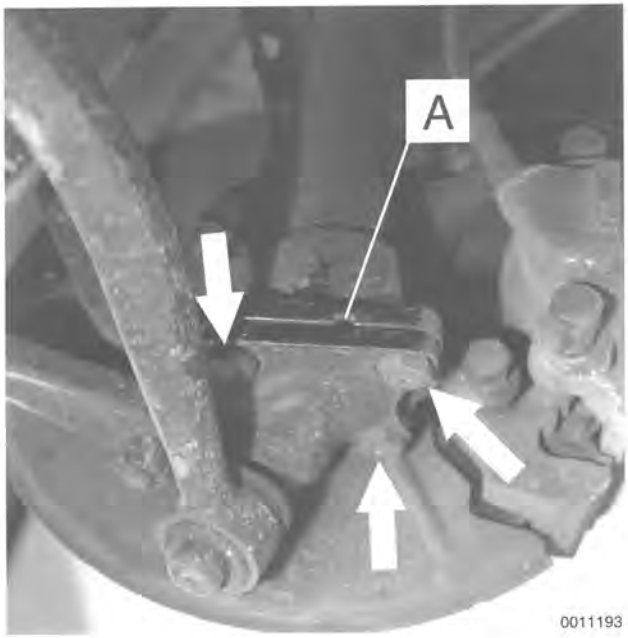


– Unbolt brake caliper assembly, keeping brake hose connected. Secure brake caliper with wire and do not let it hang from brake hose. See **340 Brakes**.

➢ Remove ABS pulse sensor mounting bolt (**arrow**) and pull sensor from housing.

– Disconnect brake fluid line, ABS sensor wire harness, and brake pad wear sensor wire harness from strut housing.

– Disconnect stabilizer bar link from strut assembly.



➢ Remove strut-to-steering arm mounting bolts (**arrows**). Disconnect steering arm from strut assembly.

– Support strut assembly from below and then remove strut mounting nuts on strut tower. Remove strut assembly from car.

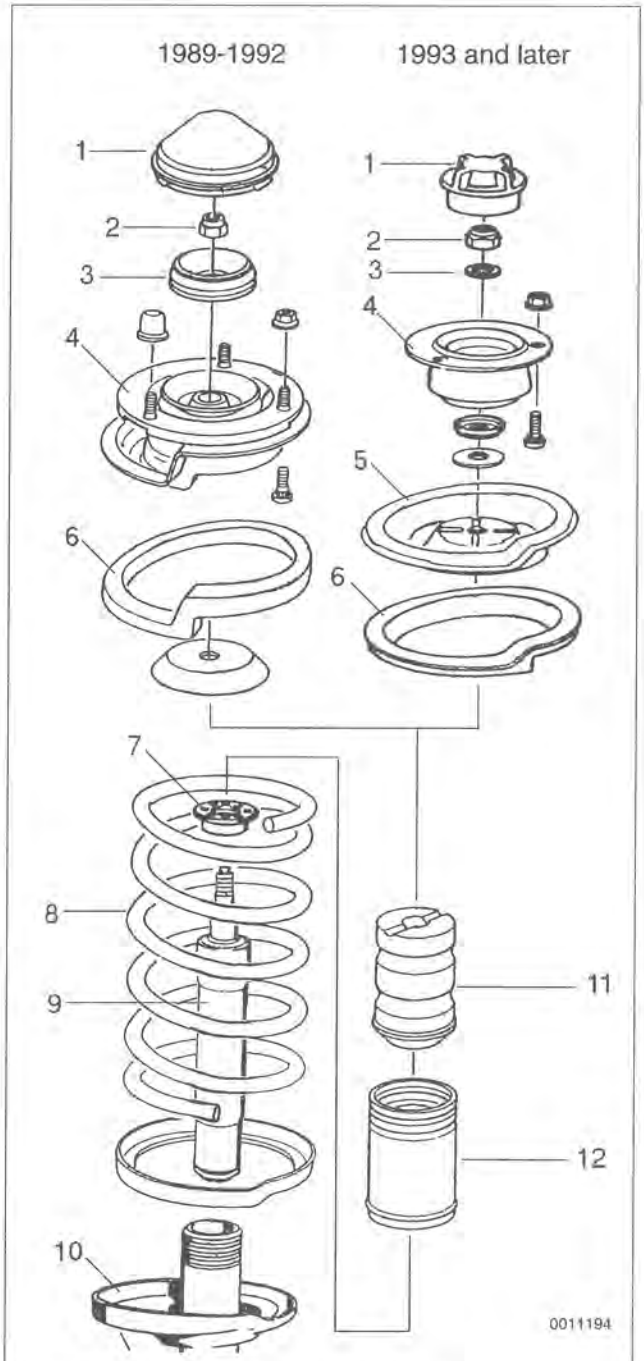
NOTE—
Store removed strut assembly upright. Do not allow it to lie horizontally or upside-down for any length of time. If incorrect storage has occurred, place the strut assembly upright with rod fully extended for at least 24 hours.

– Make sure all thread bores, bolts, nuts and mating surfaces are clean.

– Install strut assembly to strut tower using new self locking nuts.

Tightening Torques
- Strut assembly to body (self locking nuts) . . . . . 22 Nm (16 ft-lb)

– Install steering arm to strut assembly, making sure mating notches are aligned.



1. Protective cap
2. Top nut (self locking)
3. Washer
4. Upper strut mount
5. Upper spring seat
6. Rubber spring pad
7. Strut cartridge retaining collar
8. Spring
9. Strut cartridge
10. Strut housing
11. Bump stop
12. Protective tube

Tightening Torques

- Steering arm to strut housing (use Loctite 270® or equivalent. . . . . 110 Nm (81 ft-lb)

– The remainder of installation is reverse of removal.

Tightening Torques

- Brake caliper to strut housing . . . . . 110 Nm (81 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)
- Stabilizer link to strut housing . . . . . 59 Nm (43 ft-lb)

Strut, disassembling and assembling

Replacing the upper strut mount, spring and strut cartridge requires that the strut first be disassembled. This procedure requires a spring compressor specifically designed for the purpose.

WARNING—
Do not attempt to disassemble the struts without a spring compressor designed specifically for this job.

Springs and strut cartridges should always be replaced in pairs.

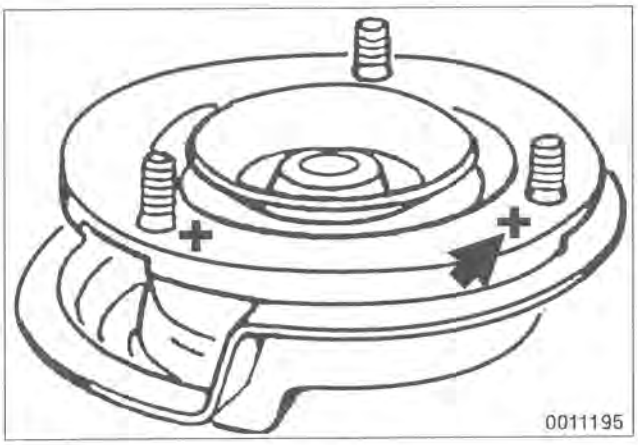
– Remove strut assembly from car as described above.

– Using a spring compressor, compress spring until spring force on upper mount is relieved.

WARNING—
Make sure the spring compressor grabs the spring evenly and securely before compressing it.

– Pry protective cap off top of strut assembly. Then remove top (center) nut and washer while holding strut shaft stationary.

– Remove upper strut mount and related components.



- Inspect strut mounts to determine if they are special camber correcting type mounts. These special mounts are marked with a "+" or "–" near a mounting stud. When replacing mount, be sure to replace it with same type of mount to maintain front wheel alignment settings.
- Release spring compressor carefully and evenly, allowing spring to slowly expand.
- Remove rubber stop and protective tube from strut cartridge shaft.
- Loosen strut cartridge retaining collar and remove cartridge from housing.
- If there is oil in housing pour it out. Clean out housing.

NOTE—

- *Hydraulic-type strut cartridges are installed in the strut housing with a small amount of oil for cooling. Gas-pressure strut cartridges do not require oil.*
- *Store the removed strut assembly/shock absorber standing upright. Do not allow it to lie horizontally or upside-down for any length of time. If incorrect storage has occurred, place the strut assembly upright with the rod fully extended for at least twenty four hours.*

- Assembly is reverse of disassembly. If installing hydraulic-type strut cartridges, pour 30 ml (1 fl. oz.) of motor oil into housing before installing new cartridge. Be sure to use a new self locking top (center) nut.

WARNING—
Make sure the self locking top nut is fully tightened before releasing the spring compressor. Always use a new nut.

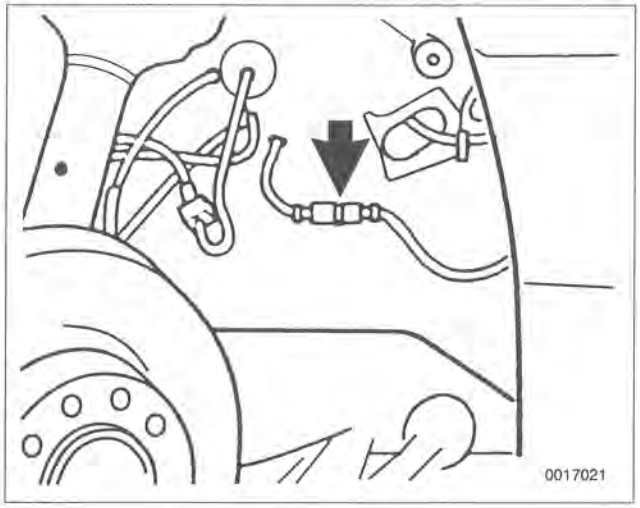
Tightening torques

- Shock cartridge retaining collar to strut housing . . . . . 130 Nm (96 ft-lb)
- Stabilizer to strut . . . . . 59 Nm (44 ft-lb)
- Upper strut mount to strut cartridge shaft (self locking nut - always replace)
  shaft with external hexagon . . . . . 65 Nm (48 ft-lb)
  shaft with internal hexagon . . . . . 45 Nm (33 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

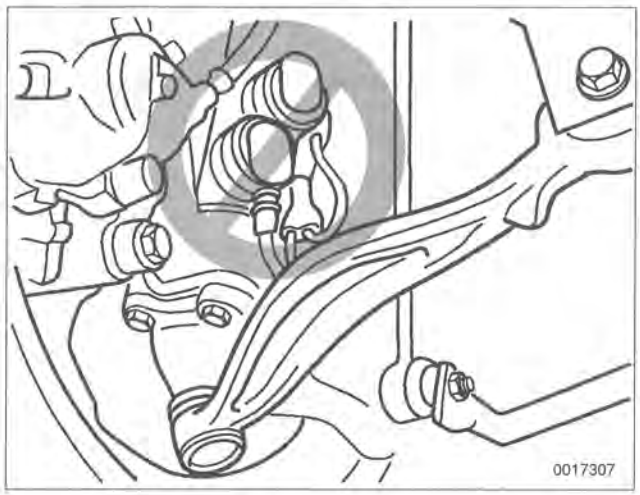
Strut assembly, removing and installing (cars with EDC III)

– Raise car and remove front wheel.

WARNING—
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.



➢ Disconnect EDC harness connector (**arrow**) in front wheel well.



➢ EDC III solenoids on front strut housing–***Do not remove***.

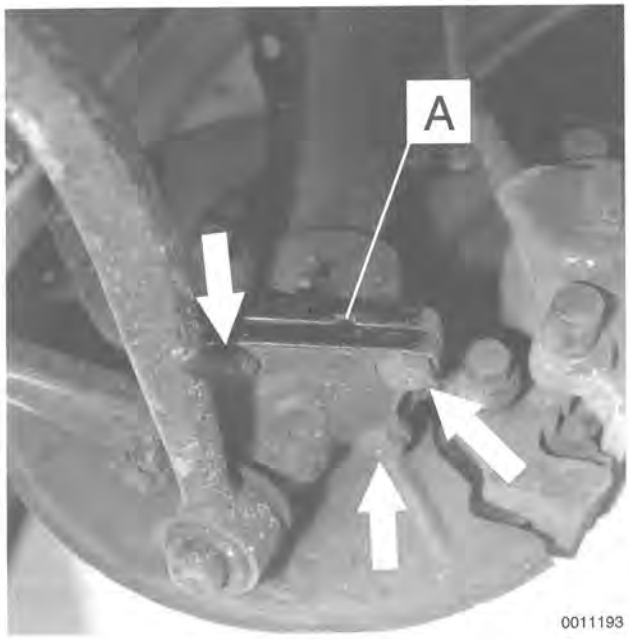
CAUTION—
Do not remove sealing covers from EDC III solenoid valves on strut housing. The strut will be permanently damaged.

– Disconnect brake pad wear sensor wiring harness connector on strut housing.

– Remove caliper bolts and hang caliper to one side. Remove brake rotor and hub assembly. See **340 Brakes**.

NOTE—
It is not necessary to disconnect brake hydraulic line from caliper.

– Detach stabilizer bar link from strut.



➢ Remove strut-to-steering arm mounting bolts (**arrows**) and separate steering arm from strut.

NOTE—
*Note mating notch (**A**) when installing steering arm to strut assembly.*

– Working at top of strut tower in engine compartment, remove strut bearing cap. Then detach electrical harness connector from top of strut.

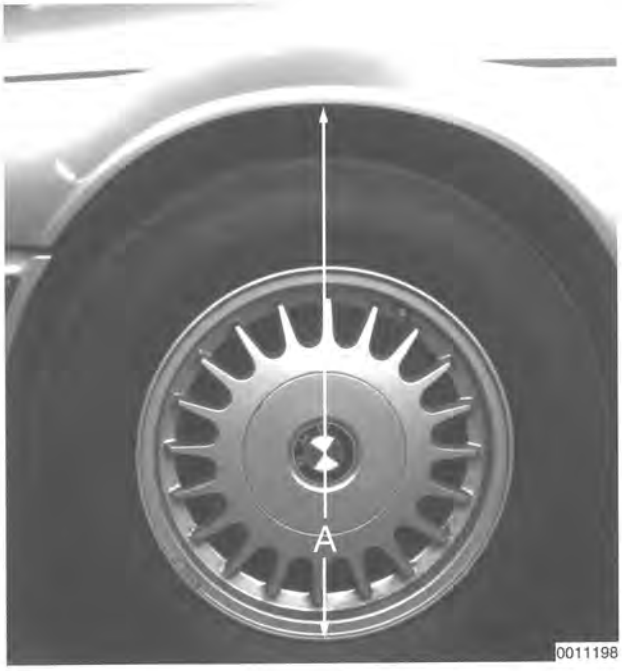
– While supporting strut housing, remove three strut mount nuts at top and slide strut out.

CAUTION—
- *Always store struts in the upright position.*
- *Be very careful not to damage the EDC III solenoid valves or their connections on the strut housing.*

– Installation is reverse of removal.

Tightening Torques
- Brake caliper to strut housing . . . . . 110 Nm (81 ft-lb)
- Brake rotor to hub . . . . . 16 Nm (12 ft-lb)
- Hub collar nut to stub axle . . . . . 290 Nm (214 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)
- Stabilizer bar link to strut housing . . . . 59 Nm (43 ft-lb)
- Steering arm to strut housing (use Loctite®270 or equivalent) . . . . 110 Nm (81 ft-lb)
- Strut assembly to body . . . . . 22 Nm (16 ft-lb)

Ride Height



➢ Ride height measurement (**A**) is taken from center of wheel arch to bottom of wheel rim. Measure ride height with car in normal loaded position on the ground.

If ride height is outside specification listed, new springs should be installed.

Table a lists front suspension ride height specifications for the cars covered by this manual. These specifications apply to a car in a normally loaded position. When checking ride height or installing suspension components that require the car to be "normally loaded," load the car as follows:

Normal loaded position
- Each front seat . . . . . .68 kg (150 lb)
- Center of rear seat . . . . . .68 kg (150 lb)
- Trunk . . . . . .21 kg (46 lb)
- Fuel tank . . . . . full

Table a. Front Ride Height Specifications

Wheel (rim) installed	Ride Height
15 in. standard suspension	588 mm (23 1/8 in.)
TRX 390 standard suspension	592 mm (23¼ in.)
TRX 415 standard suspension	602 mm (23¾ in.)

CONTROL ARMS

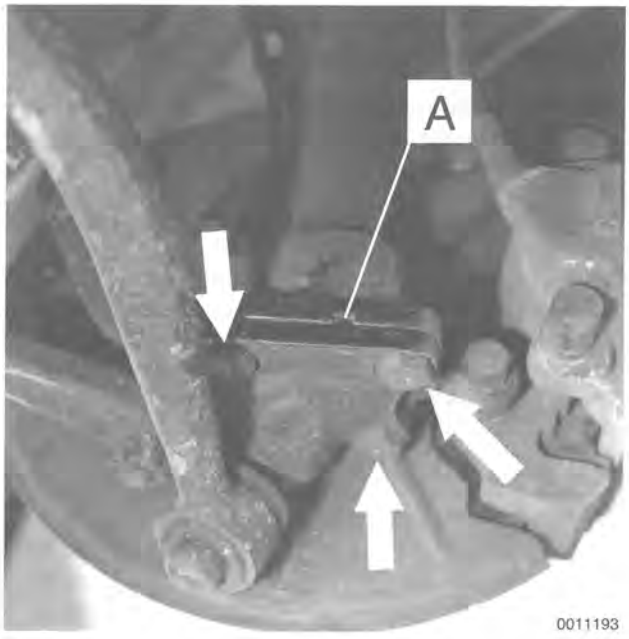
The control arms are attached to the front crossmember through rubber bushings and to the steering arm by ball joints. If worn, the control arm ball joint can only be replaced as part of an entire control arm assembly.

Some special tools may be required to remove the control arms and to replace the control arm bushings. Read the procedure through before beginning the job.

Control arm, removing and installing

– Raise car and remove wheel.

WARNING—
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.



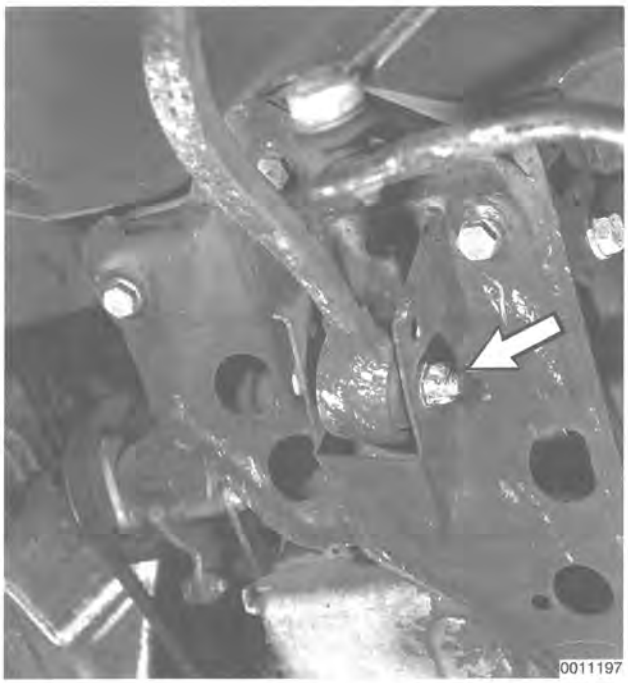
0011193

➤ Remove strut-to-steering arm mounting bolts (**arrows**) and separate steering arm from strut.

NOTE—
*Note mating notch (**A**) when installing steering arm to strut assembly.*

– Working at removed steering arm, remove ball joint nut from inside of steering arm. Lightly tap ball joint from steering arm.

CAUTION—
Take care not to damage the ball joint threads if the control arm is to be reused. If necessary, press the ball joint out using BMW special tool no. 31 1 110 or an equivalent press.



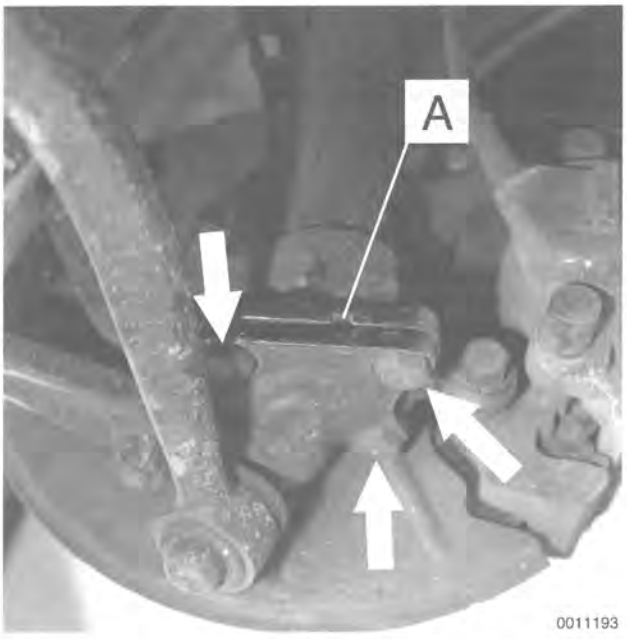
➢ Working at other end of control arm, remove through-bolt attaching control arm to crossmember.

– When installing control arm, make sure all thread bores, bolts, nuts and mating surfaces are clean.

– Install bushing-end of control arm to crossmember, using washers on both sides of bolt and a new self locking nut. Do not tighten nut at this time.

– Install control arm ball joint to steering arm using a new self locking nut and tighten fully.

Tightening Torques
- Control arm ball joint to steering arm . . . . . 93 Nm (68 ft-lb)



➢ Install steering arm to strut, making sure mating notch (**A**) is aligned.

Tightening Torques
- Strut housing to steering arm (use Loctite 270® or equivalent. . . . . 110 Nm (81 ft-lb)

– Install wheel and lower car.

– Load car to normal loaded position as described earlier under **Ride Height**. Jounce suspension a few times.

– With car on ground and loaded, tighten control arm bushing through-bolt.

Tightening Torques
- Control arm to crossmember (car in normal loaded position) . . . . . 78 Nm (57 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

Control arm bushings, replacing (steel control arms only)

Control arm bushings should always be replaced in pairs.

NOTE—
Two types of control arms are installed on the E32 cars; aluminum construction and steel construction. On cars with aluminum control arms, the entire control arm must be replaced if the bushing is worn.

- Raise car and remove wheel.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

- Remove control arm from car as described earlier.

NOTE—
The control arm bushings can be replaced with the control arm installed in the car if BMW special press tools 31 1 051 and 33 3 141/142/144 are available.

- Using a service press and appropriate press tools, press bushing out of control arm.
- Clean bushing bore and install new bushing from chamfered side of bushing bore in arm.
- Install control arm as described earlier.

> ***CAUTION—***
> *Tighten the control arm bushing through-bolt to its final torque only with car on the ground and the suspension normally loaded as described earlier.*

FRONT WHEEL BEARINGS

The front wheel bearings are permanently sealed and require no maintenance. The bearing is integral with the wheel hub and pressed onto the strut assembly stub axle.

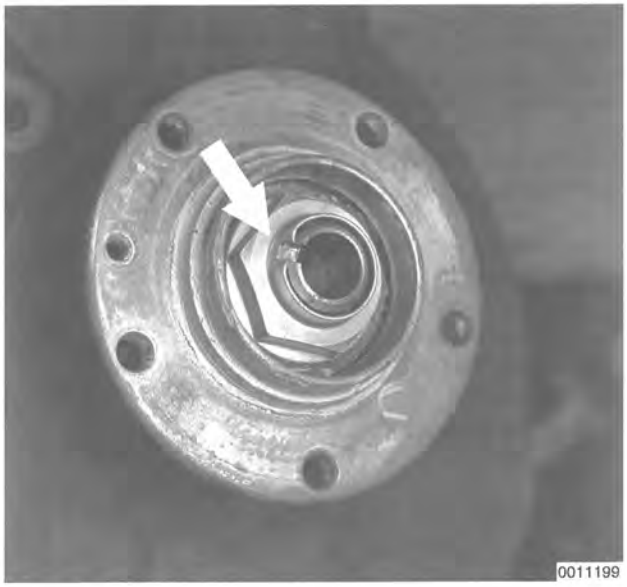
Special press tools are required to replace the front wheel bearings. Read the procedure through before beginning the job.

Wheel bearing, replacing

– Raise car and remove wheel.

WARNING—
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

– Pry off grease cap from center of wheel hub.



➢ Bend back staked part of wheel hub collar nut (**arrow**).

– Remount wheel and lower car to ground to gain leverage in loosening collar nut.

– Loosen collar nut. Do not remove nut completely.

NOTE—
The wheel hub collar nut is tightened to a torque of 290 Nm (214 ft-lb). Make sure the car is firmly on the ground and use heavy-duty tools when loosening the nut.

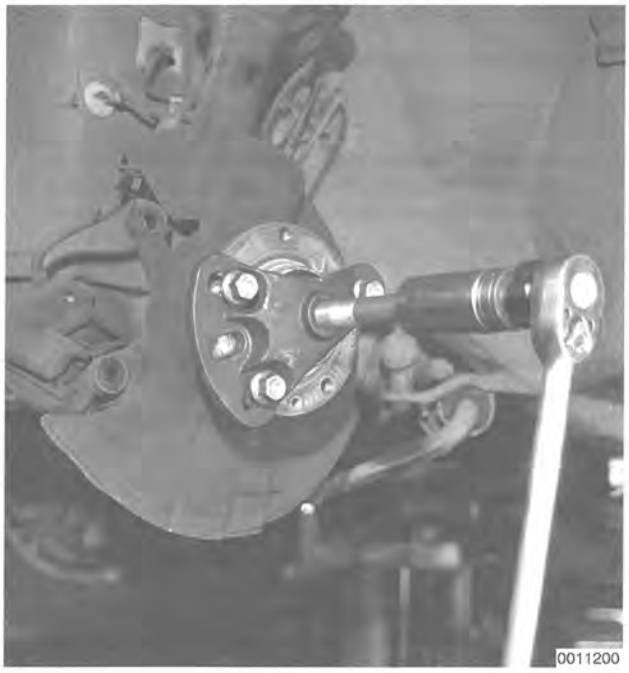
– Raise car and remove wheel.



➢ Remove ABS pulse sensor mounting bolt (**arrow**) and pull sensor from housing.

– Remove wheel hub collar nut.

– Unbolt brake caliper assembly and rotor as described in **340 Brakes**. Leave brake hose connected to caliper. Suspend caliper assembly from chassis with strong wire.


0011200

➢ Remove wheel hub with integral wheel bearing from stub axle using a puller (BMW special tool nos. 31 2 102/105/106 or equivalents).

NOTE—
If bearing inner race stays on stub axle, remove splash guard and use a two-jaw puller (BMW special tool no. 31 2 102 or equivalent) to remove race.

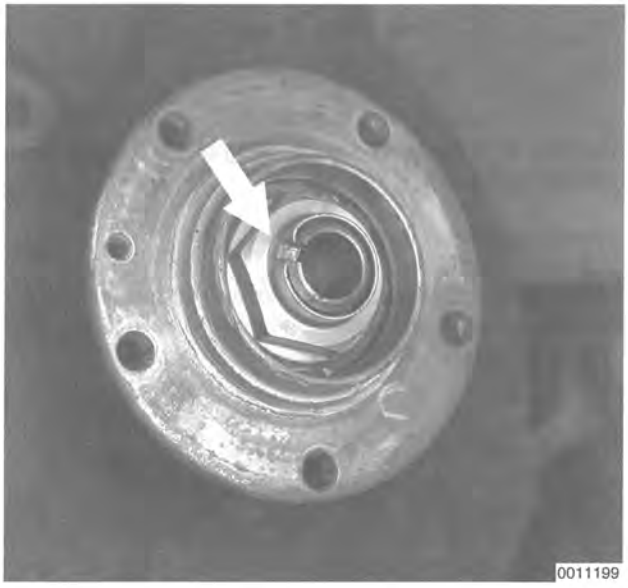
– Install splash guard and a new dust shield behind bearing. Press new wheel hub/bearing assembly on using BMW special tool no. 31 2 110 or an equivalent pressing tool.

NOTE—
When pressing wheel hub/bearing on, apply force only to the bearing inner race.

– Install a new collar nut. Do not tighten nut to its final torque at this time.

– Install brake rotor and mount wheel and lug nuts. Lower car to ground to gain leverage.

Tightening Torque
- Brake rotor to wheel bearing/hub assembly . . . . . 16 Nm (12 ft-lb)


0011199

➢ Tighten collar nut and then stake nut to axle (**arrow**).

Tightening Torque
- Collar nut to stub axle . . . . . 290 Nm (214 ft-lb)

– Raise car and remove wheel.

– Install brake caliper as described in **340 Brakes**.

Tightening Torque
- Brake caliper to strut housing . . . . . 110 Nm (81 ft-lb)

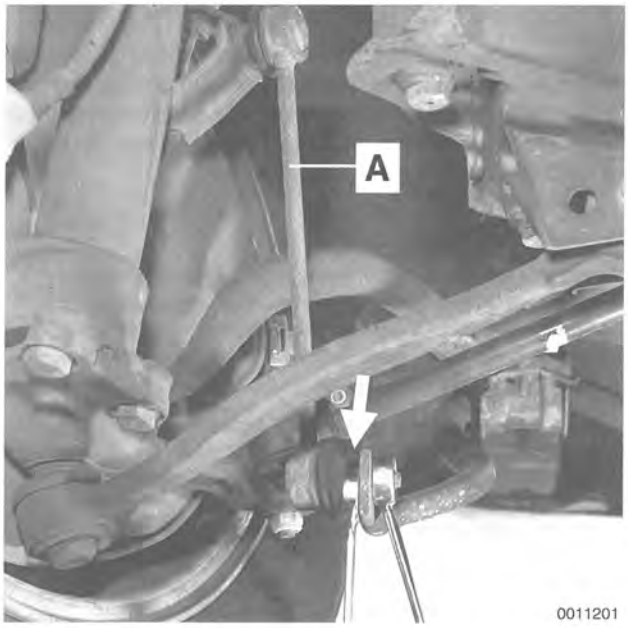
– Install a new grease cap, using Loctite®638 sealant or equivalent.

– Install wheel and lower car.

Tightening Torque
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

STABILIZER BAR

Stabilizer bar, removing and installing



0011201

– Raise car and remove both wheels.

> ***WARNING —***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

➢ Disconnect stabilizer bar connecting link (**A**) from stabilizer bar on left and right sides.

- Counterhold link (**arrow**) when removing nut. Remove lower connecting link nuts and tap links out of stabilizer bar.


0011202

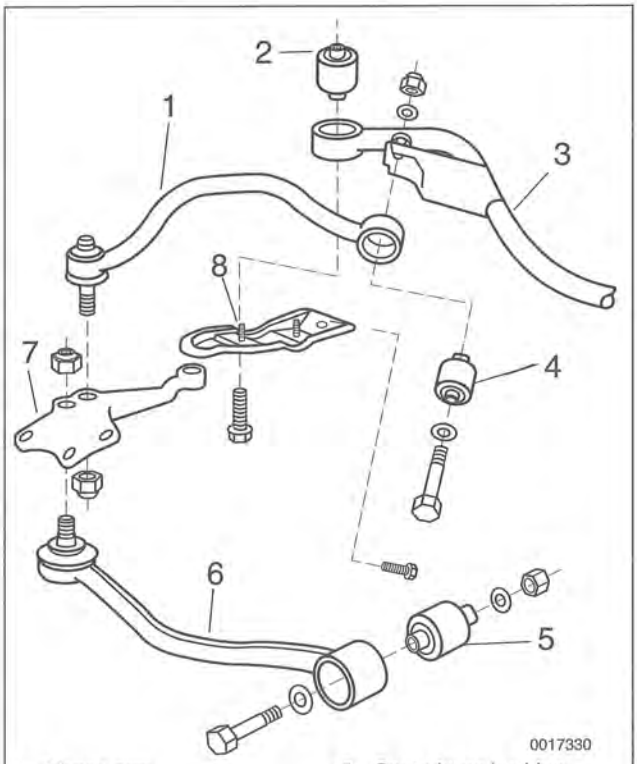
➢ Unbolt left and right stabilizer bar bushing brackets and remove bar.

– Installation is reverse of removal. Use new self locking nuts on connecting links.

NOTE —
Installation of the stabilizer bar is easiest with the car level (front wheels at the same height), and as near to normal ride height as possible.

Tightening Torques

- Connecting link to strut housing/stabilizer bar (counterhold when tightening) . . . 59 Nm (43 ft-lb)
- Stabilizer bar mounting brackets to subframe . . . . . 22 Nm (16 ft-lb)



1. Thrust arm
2. Subframe bushing
3. Subframe
4. Thrust arm bushing
5. Control arm bushing
6. Control arm
7. Steering arm
8. Support bracket



THRUST ARMS

The thrust arms are attached to the connecting subframe crossmember through hydraulic bushings and to the steering arms by ball joints.

Inspect the ball joints for wear and looseness. Inspect the bushings for fluid leaks. The ball joint can only be replaced as part of an entire thrust arm assembly. The hydraulic bushings are available as individual replacement parts and should always be replaced in pairs.

NOTE—

- *Steering wheel vibration during braking (usually at road speeds of 50 to 60 m.p.h.) can often be caused by faulty thrust arm bushings and not out-of-true brake rotors. Be sure to inspect the bushings for leaking fluid and replace them if any fluid leaks are present.*
- *Some very early 1988 cars may be equipped with the old-style rubber bushings. These rubber bushings should have been removed and replaced with the newer hydraulic bushings during the new car pre-delivery inspection or during the first service visit. The hydraulic bushings can be identified by plastic clips on either side of the bushing. If the old-style rubber bushings are still installed, they should be replaced with the later-style hydraulic bushings.*

Thrust arm, removing and installing

– Raise car and remove wheel.

WARNING—
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

Unscrew ball joint nut from steering arm. Lightly tap ball joint out of steering arm.

CAUTION—
Take care not to damage the ball joint threads if the thrust arm is to be reused. If necessary, press the ball joint out using BMW special tool no. 31 2 140 or an equivalent press.


0011204

- Remove through-bolt (**arrow**) attaching thrust arm to connecting crossmember.
  - When installing thrust arm, make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Install bushing-end of thrust arm to crossmember using washers on both sides of bolt and a new self locking nut. Do not tighten nut at this time.
- Install thrust arm ball joint to steering arm using a new self locking nut.

Tightening Torques
- Thrust arm ball joint to steering arm . . . . . 93 Nm (68 ft-lb)

- Install wheel and lower car.
  - Load car to normal loaded position as described earlier under **Ride Height**. Jounce suspension a few times.
  - With car on ground and loaded, tighten thrust arm bushing through-bolt.

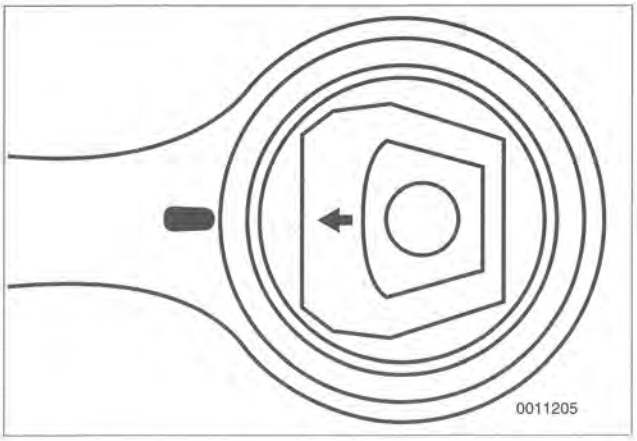
Tightening Torques
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)
- Thrust arm to connecting crossmember (car in normal loaded position) . . . . . 127 Nm (94 ft-lb)

Thrust arm bushings, replacing

Thrust arm bushings should always be replaced in pairs.

- Raise car and remove wheel.

WARNING —
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.


0011205

- Remove thrust arm from car as described earlier.
- Using a service press and appropriate press tools (BMW special tool no.s 31 1 052/053 or equivalent), press bushing out of thrust arm.
- Clean bushing bore and press in new bushing while aligning arrow on bushing with mark on thrust arm. Press bushing in so it protrudes equally from both sides of thrust arm.

CAUTION —
To avoid damaging the new hydraulic bushing, press only on the outer steel sleeve during installation.

– Install thrust arm as described earlier.

> ***CAUTION—***
> *Tighten the thrust arm bushing through-bolt to its final torque only with car on the ground and the suspension normally loaded as described earlier.*

SUBFRAME CROSSMEMBER

The subframe crossmember provides rigid mounting points for the engine, suspension and steering components.

Removing the subframe crossmember requires engine lifting equipment to support the weight of the engine so that the subframe can be removed from below.

> ***WARNING—***
> *Removal or replacement of the subframe crossmember may affect suspension and steering geometry, including front wheel alignment. Make appropriate matching marks during removal and be sure to have the front end professionally aligned after installation.*

Subframe crossmember, removing

– Using an engine hoist (BMW special tool no. 00 0 200 and 11 0 020), slightly raise engine just until weight of engine is supported. See **110 Engine Removal and Installation**.

– Working in engine compartment, remove top nut from right engine mount.

– Raise car and remove front wheels.

> ***WARNING—***
> *Make sure that the car and the engine are firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*



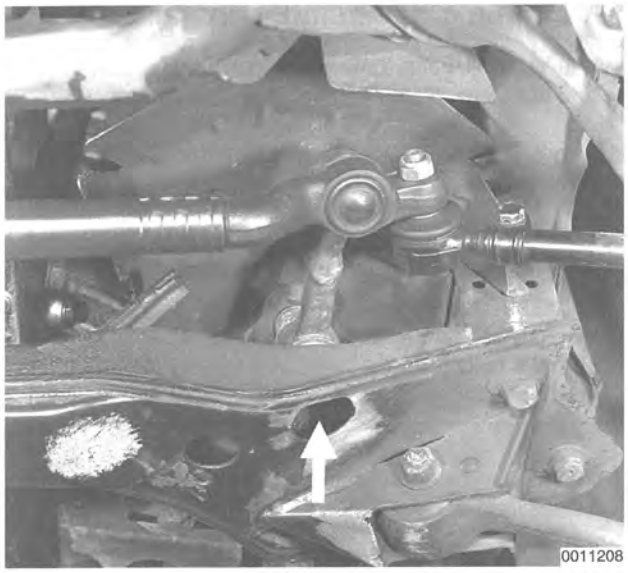
SUBFRAME CROSSMEMBER

– Working beneath car, remove lower nuts from the left (**arrow**) and right engine mounts.

– Unbolt left and right control arm through-bolts. Remove bolts and support control arm from chassis using stiff wire.

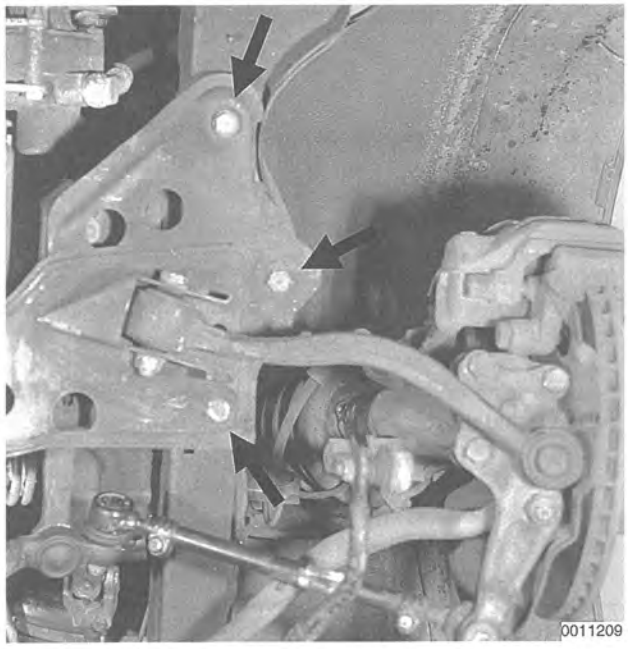
> ***WARNING—***
> *Do not allow the control arm to hang from the ball joint. This can damage the ball joint.*

– Unbolt steering gearbox from subframe. See **320 Steering**. Suspend gearbox from body using stiff wire.



➢ Unbolt steering idler arm from crossmember (**arrow**).

– Using an appropriate jack, support crossmember from below.



➢ Unbolt crossmember from chassis on left and right sides.

– Slowly lower crossmember, making sure all electrical leads and suspension components are clear during removal.

Subframe crossmember, installing

– Make sure all bolts, bolt holes, and mating surfaces are clean to ensure proper tightening and alignment.

– Using a jack, raise crossmember into position and install mounting bolts.

Tightening Torques

- Subframe crossmember to chassis
  M10-8.8 bolts . . . . . 42 Nm (31 ft-lb)
  M10-9.8 bolts . . . . . 47 Nm (35 ft-lb)
  M12 bolts . . . . . 77 Nm (57 ft-lb)

– Install idler arm and steering gearbox to crossmember using new self locking nuts.

Tightening Torques

- Idler arm to subframe crossmember (self locking nut)
  M10 bolt . . . . . 42 Nm (32 ft-lb)
  M12 bolt . . . . . 85 Nm (63 ft-lb)
- Steering gear box to subframe crossmember (self-locking nuts)
  M10-10.9 bolts . . . . . 42 Nm (31 ft-lb)
  M12 bolts . . . . . 80 Nm (59 ft-lb)

– Install control arms to crossmember. Do not tighten control arm through-bolts and new self locking nuts to their final torque at this time.

– Lower engine onto engine mounts, allowing it to settle fully before tightening engine mount bolts.

Tightening Torque

- Engine mounts to engine bracket or main crossmember . . . . . 45 Nm (33 ft-lb)

– Install wheels and lower car to ground. Load car to normal loaded position as described earlier under **Ride Height** and tighten control arm through-bolts.

Tightening Torque

- Control arm throughbolts to main crossmember (car in normal loaded position) . . . . . 78 Nm (57 ft-lb)

– Remainder of installation is reverse of removal. When job is completed have wheels professionally aligned.



SUBFRAME CROSSMEMBER

320 Steering and Wheel Alignment

GENERAL 320-1
Servotronic Steering System 320-2

STEERING WHEEL 320-2
Steering wheel, removing and installing 320-3

POWER STEERING 320-4
Power steering pump, pressure testing 320-4
Power steering pump, removing and installing 320-5
Power steering system, filling and bleeding . . 320-7

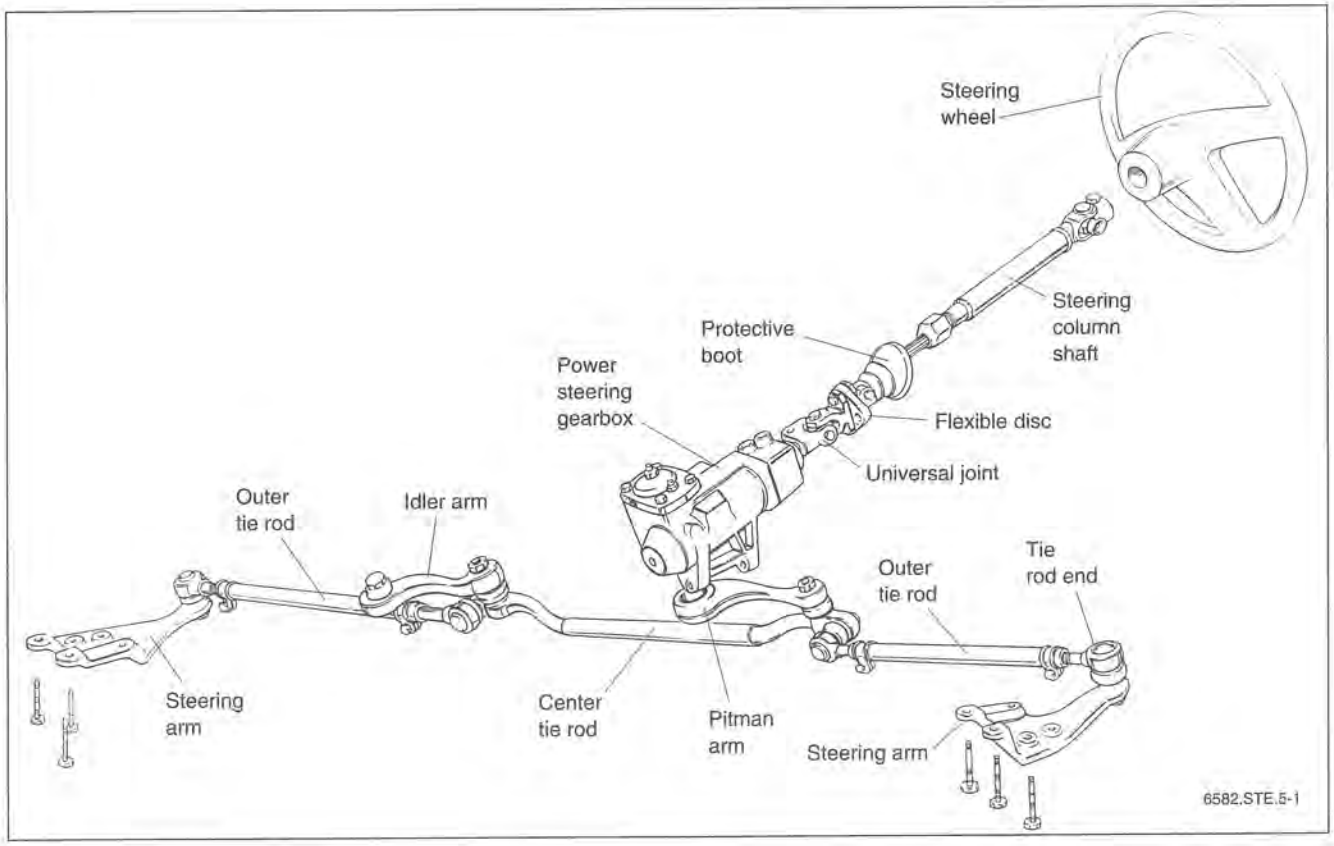
STEERING GEAR AND LINKAGE 320-8
Steering gearbox, removing and installing . . . 320-8
Steering idler arm, removing and installing . . 320-11
Outer tie rod, removing and installing 320-11
Tie rod end, replacing 320-12
Center tie rod, replacing. 320-13

WHEEL ALIGNMENT 320-13
Camber 320-13
Caster 320-14
Front Toe-in and Toe Difference Angle 320-14
Rear Toe-in 320-14
Wheel Alignment Specifications. 320-14

TABLES
a. Front Wheel Alignment Specifications 320-15
b. Rear Wheel Alignment Specifications 320-15

GENERAL

This repair group covers servicing of the mechanical and hydraulic components of the steering system, including wheel alignment information.



NOTE—
For information on steering column switches and the ignition lock see **612 Switches and Electrical Accessories.**

WARNING—
- *Do not reuse self locking nuts. They are designed to be used only once and may fail if reused. Always replace them with new locking nuts.*
- *Do not install bolts and nuts coated with undercoating wax, as correct tightening torque cannot be assured. Always clean the threads with solvent before installation, or install new parts.*
- *Do not attempt to weld or straighten any steering components. Always replace damaged parts.*

Servotronic Steering System

The BMW 7 Series cars are equipped with Servotronic steering system which provides variable boost to the steering effort based on road speed.

At low speeds, maximum power assist is provided to ease parking and city driving. At high speeds, assist is reduced to ensure stability. The speedometer sends a speed signal to the Servotronic control module (located in the left kick-panel). The control module converts this signal to a regulating current which is sent to the electro-hydraulic valve at the steering gearbox.

If the electronics in the system fail, the electro-hydraulic valve opens and the steering reverts to conventional power assist.

STEERING WHEEL

All E32 cars are fitted with a driver side SRS airbag mounted to the front of the steering wheel. Special precautions must be observed when removing the steering wheel or servicing components in and around the steering column.

WARNING—
The BMW Supplemental Restraint System (SRS) is complex and special precautions must be observed when servicing. Serious injury may result if SRS system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures. BMW specifies that all inspection and service should be performed by an authorized BMW dealer.

Steering wheel, removing and installing

Use caution when removing the airbag unit from the steering wheel and be sure to follow the airbag removal and installation procedure outlined in **721 Airbag System (SRS)**.

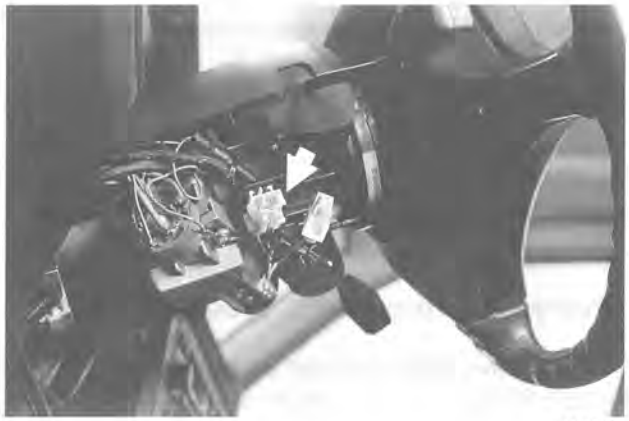
– Make sure front wheels are pointed straight ahead. Center steering wheel.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Carefully remove airbag from front of steering wheel. See **721 Airbag System (SRS).** Store airbag unit in a safe place.

> ***WARNING—***
> *Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*



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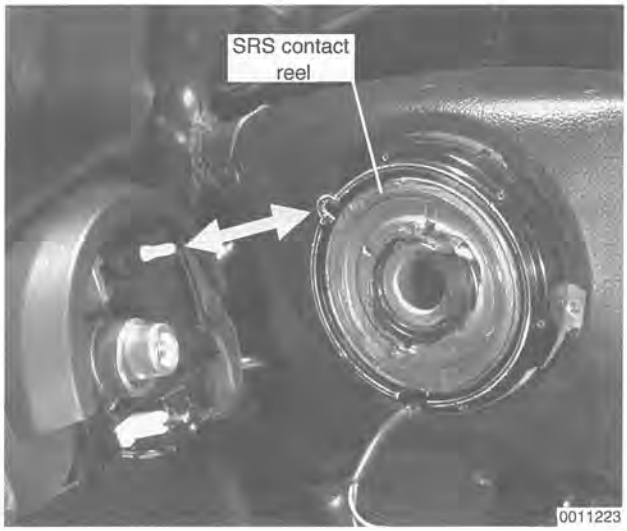
– Remove lower left dash panel as described in **513 Interior Trim**.

– Remove lower steering column trim.

◁ Remove orange SRS connector (**arrow**) below steering wheel from its holder and carefully separate connector.

– Remove steering wheel center nut (or bolt) and washer. Lightly punch mark or scribe position of steering wheel to steering column shaft.

– Unlock steering wheel by turning ignition key on. Remove steering wheel.



0011223

> ***WARNING—***
> *The SRS contact reel is mounted to the rear of the steering wheel hub. The contact reel is a wound coil of wire that ensures continuous electrical contact for the airbag unit. Once the steering wheel mounting nut or bolt is removed the contact reel is locked in the center position and its position must not be altered.*

◁ Locking pin in column aligns with cutout in contact reel (**arrow**).

- Install steering wheel while aligning matching marks. Make sure locking pin engages cutout in contact reel.

> ***CAUTION—***
> *Use a new self locking nut on steering wheel. The nut is designed to be used only once.*

Tightening Torques

- Steering wheel to steering column spindle
  Self locking nut . . . . . 80 Nm (59 ft-lb)
  Bolt . . . . . 63 Nm (46 ft-lb)

– Install airbag unit. See **721 Airbag System (SRS).**

– Reconnect negative (–) battery cable.

WARNING—
Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the SRS warning light goes out. If the warning light stays on, the SRS system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.

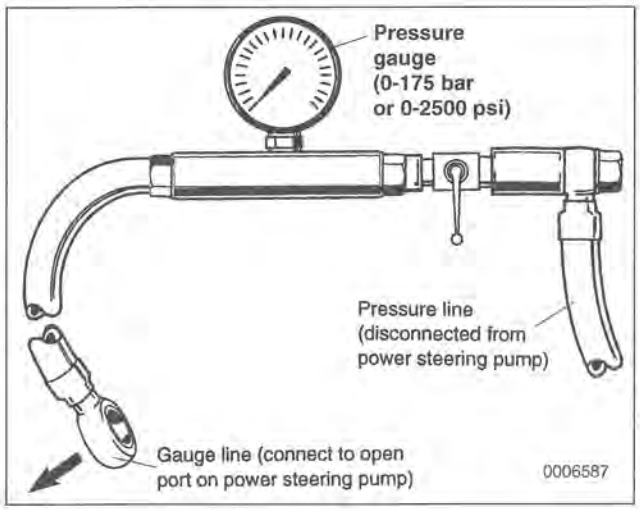
POWER STEERING

Power assist is provided by a belt-driven pump at the lower left front of the engine. The power steering fluid reservoir is located at the left side of the engine compartment.

NOTE—
Cars equipped with the self levelling rear suspension system (called LAD) use a tandem pump to provide hydraulic pressure to the steering system and the rear shock absorbers. See **370 Integrated Suspension Systems** *for additional information.*

Power steering pump, pressure testing

Testing power steering system pressure requires a 0–175 bar (0–2500 psi) pressure gauge with a shut-off valve and the correct fittings. Make sure the steering pump drive belt is in good condition and properly adjusted before making the test.



➤ Connect pressure gauge in high pressure line between pump and gearbox.

NOTE—
On cars equipped with the LAD, be sure to connect the gauge to the power steering part of the pump. The power steering output line should lead directly to the steering gearbox.

– Center steering wheel with front wheels pointing straight ahead.

– Start engine and let it idle.

WARNING—
Only run the car in a well-ventilated area. Exhaust fumes can be fatal.

– Close gauge valve for no more than ten seconds, note pump output pressure, then reopen valve. If pressure gauge reading is not within range listed below, pump should be replaced.

> ***CAUTION—***
> *Do not close the pressure valve for more than 10 seconds. High pressure could damage the seals in the pump or steering gearbox.*

Steering System Pressure

- Pressure gauge valve closed . . . . . 150 ± 15 bar (2130 ± 213 psi)
- Pressure gauge valve open. . . . . 15 bar (210 psi)

– Working beneath car, insert a piece of wood at idler arm to block steering from reaching full lock (about ½ turn before full lock).

– Start car and have a helper turn steering wheel to right until idler arm contacts block. Hold wheel against stop for about 5 seconds. Record pressure.

– Repeat two previous steps for left side.

At each wheel lock position, the system pressure should be within the range specified above. Low pressure indicates internal leaks in the steering gearbox. High pressure indicates a faulty power steering pump.

When finished testing, remove the pressure gauge and install the fluid hose to the pump using a new sealing washer. Take care not to overtorque the banjo bolt. Fill and bleed power steering system as described below.

Tightening Torques

- Hydraulic hose to power steering pump
  M14 banjo bolt . . . . . 35 Nm (26 ft-lb)
  M16 banjo bolt . . . . . 40 Nm (30 ft-lb)

Power steering pump, removing and installing

– Empty power steering fluid reservoir using a clean syringe. Do not reuse fluid.

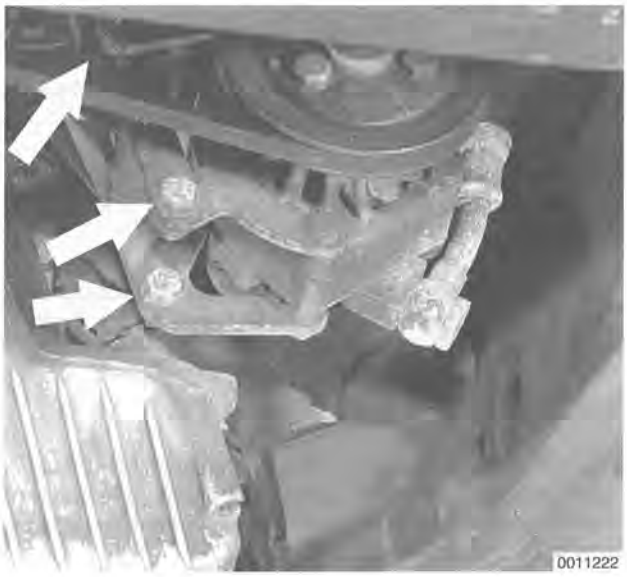
– Raise front of car.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

– Remove fluid hoses from pump. Plug openings in pump and in hose ends.

NOTE—
On cars equipped with the self levelling suspension system (called LAD), the power steering/LAD tandem pump is mounted with some additional brackets, spacers, and fluid lines. Note the installed position of these components during removal.

– Remove power steering pump drive belt. See **020 Maintenance**.


0011222

➢ Remove pump mounting bolts (**arrows**) and remove pump. (M30 engine shown, other pump mountings similar.)

– When installing pump make sure all thread bores, bolts, nuts, fluid couplings and mating surfaces are clean.

– Mount pump using new self locking nuts.

Tightening Torque
- Power steering pump to bracket (self locking nuts) . . . . . 22 Nm (16 ft-lb)

– On engine with standard V-belt, tension belt as follows:
- Loosen pump mounting bolts.
- Use torque wrench on toothed adjuster and adjust belt so wrench reads 8 Nm (71 in-lb).
- Tighten pump mounting bolts.

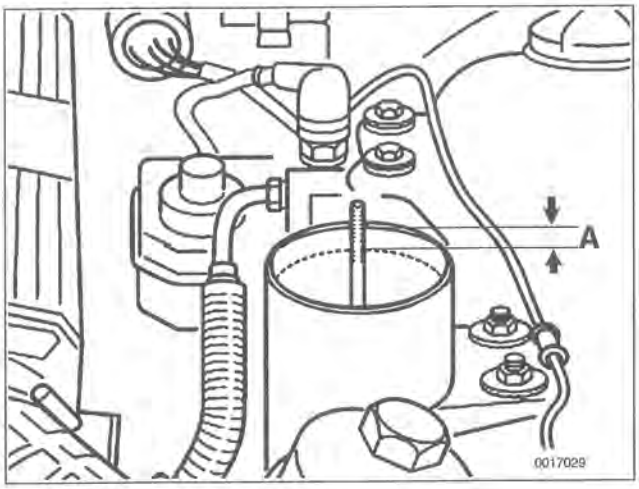
– On engines with multi-ribbed belt, install belt to pulleys and release tensioner. See **020 Maintenance**.

Tightening Torque
- Power steering pump bracket to engine block or oil pan (self locking nuts) . . . . 22 Nm (16 ft-lb)

– Install power steering fluid hoses to pump.
- Make sure hoses have adequate clearance from chassis.
- Do not overtorque banjo bolts. Use new sealing washers.

Tightening Torques
- Hydraulic hoses to power steering pump
  M14 banjo bolts . . . . . 35 Nm (26 ft-lb)
  M16 banjo bolts . . . . . 40 Nm (30 ft-lb)

– The remainder of installation is reverse of removal. Fill and bleed power steering system as described below.



Power steering system, filling and bleeding

– With engine off, fill power steering fluid reservoir with clean fluid.

- **Reservoir with dipstick:** fill level to "MAX" mark on dipstick.

Reservoir without dipstick (cars with LAD):

- Fill level **A**: 25 mm (1 in.) below reservoir rim.

> ***CAUTION—***
> *The power steering systems uses one of three types of fluid; Dexron III® automatic transmission fluid (ATF), Pentosin® CHF 7.1 hydraulic fluid, or Pentosin® CHF 11. Check the power steering system reservoir for a label identifying the type of fluid used. Do not mix the various kinds of fluid.*

Power Steering System Capacity

- Without self levelling rear suspension (LAD) . . . . . 1.2 ltr (1.3 qt)
- With self levelling rear suspension (LAD) . . . . . 1.8 ltr (1.9 qt)

– Start engine. Slowly turn steering wheel from lock to lock two times.

– Turn engine off and check fluid level, adding fluid if necessary.

– On cars with self levelling rear suspension (LAD), raise rear of car until drive wheels are off ground. Wait two minutes and check fluid level. The level should be no more than 25 mm (1.0 in.) below reservoir rim. Correct level as necessary.

NOTE—
To identify cars with LAD, see **370 Integrated Suspension Systems.**

STEERING GEAR AND LINKAGE

The steering gear and linkage require no maintenance other than alignment and a periodic inspection for worn components.

Steering gearbox, removing/installing

Engine lifting equipment is required to raise the engine to gain sufficient clearance to remove the steering gear from below.

- On cars with self levelling rear suspension (LAD), pump brake pedal 20 times to discharge system pressure on cars with LAD.
- Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

- Remove airbag unit from steering wheel. See **721 Airbag System (SRS)**.

> ***WARNING—***
> *Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*

- Drain and remove power steering system reservoir.
- Raise front of car.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

- Remove heat shield from left engine mount. Tilt shield toward engine to remove.
- Remove heat shield protecting left control arm.
- Remove center tie rod to Pitman arm nut (**arrow**). Discard self locking nut. Disconnect tie rod from Pitman arm.



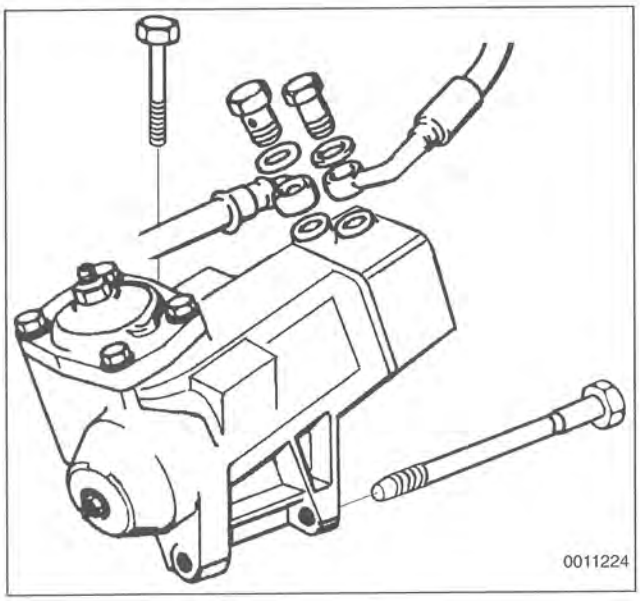
STEERING GEAR AND LINKAGE



➢ Remove lower steering column universal joint clamping bolt (**arrow**) and slide universal joint up off steering gearbox shaft.

NOTE—
It may be necessary to remove the air filter housing or other components to gain access to the steering gearbox.

– Disconnect harness connector for electro-hydraulic regulator at bottom of steering gearbox.



➢ Working in engine compartment, remove fluid hoses from top of steering gearbox. Immediately plug all fluid openings.

– Using engine lifting equipment, raise engine slightly.

– Remove left side engine mount.

– Turn wheels fully to left.

– Remove steering gearbox bolts. Then remove steering gearbox by sliding it forward and down.

– Make sure all thread bores, bolts, nuts, splines and mating surfaces are clean.

Tightening Torques
- Steering gearbox to subframe crossmember
  M10 bolt (class 10.9 bolt only) . . . . . 42 Nm (32 ft-lb)
  M12 bolt . . . . . 85 Nm (63 ft-lb)

– Install steering column universal joint to steering gearbox shaft.

– Install steering gearbox to subframe crossmember using new self locking nuts.



➢ Center steering column to gearbox by aligning universal joint split with mark on steering gearbox (**A**). Install clamping bolt and new self locking nut.

NOTE—
Make sure the clamping bolt fits into the machined groove in the steering gearbox shaft when mating the universal joint to the shaft.

Tightening Torque
- Steering column universal joint to steering gearbox shaft (self locking nut) . . . . . 22 Nm (16 ft-lb)

– Install center tie rod to Pitman arm using a new self locking nut.

Tightening Torque
- Center tie rod to Pitman arm. . . . . 59 Nm (44 ft-lb)

– Connect harness connector for Servotronic electro-hydraulic regulator.

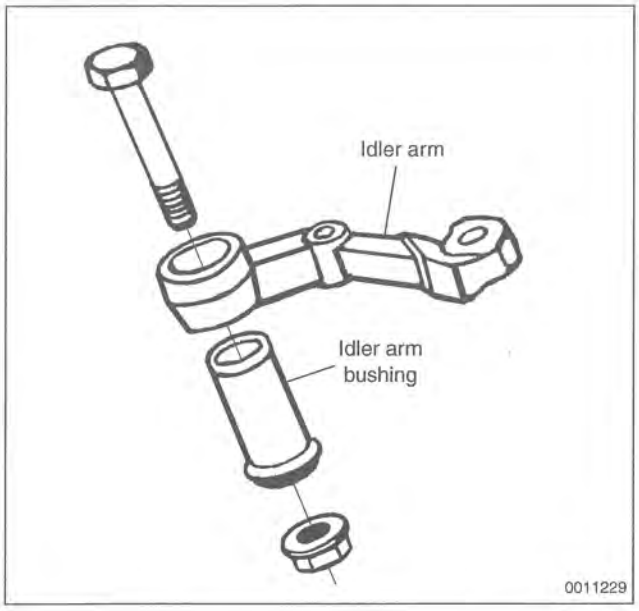
– Connect fluid hoses to steering gearbox. Use new sealing washers at couplings and make sure not to overtorque banjo bolts.

Tightening Torques
- Hydraulic fluid hoses to steering gearbox
  M14 banjo bolt . . . . . 35 Nm (26 ft-lb)
  M16 banjo bolt . . . . . 40 Nm (30 ft-lb)

– Reconnect negative (–) battery cable.

– Install airbag unit. See **721 Airbag System (SRS)**.

– Fill and bleed power steering system as described above.



Steering idler arm, removing and installing

The idler arm is bolted to the subframe crossmember through a bushing. The bushing is subject to wear and is available as a replacement part.

– Raise front of car.

WARNING—
Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.



➢ Remove center tie rod self locking nut (**1**) at idler arm. Remove center tie rod end from idler arm using an appropriate press.

– Remove idler arm mounting bolt through opening in subframe and remove idler arm from car.

– If replacing idler arm bushing, press bushing out using a press (use BMW special tool nos. 32 1 050 and 32 2 032 or equivalent press fittings). Press bushing in correct direction.

– Installation is reverse of removal.

- Make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Use new self locking nuts to mount idler arm to subframe crossmember and center tie rod to idler arm.
- Have car professionally aligned.

Tightening Torques

- Center tie rod to idler arm . . . . . 37 Nm (28 ft-lb)
- Idler arm to subframe crossmember
  M10 bolt . . . . . 42 Nm (32 ft-lb)
  M12 bolt . . . . . 85 Nm (63 ft-lb)

Outer tie rod, removing and installing

– Raise front of car.

WARNING—
Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

– Measure and record overall length of complete installed tie rod assembly.

NOTE—
Accurate measurement of tie rod assembly will help to approximate correct wheel alignment when new parts are installed.

– Remove tie rod end ball joint nuts and press tie rod ends off using a press (BMW special tool no. 32 2 050 or equivalent).

– Installation is reverse of removal.
- Make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Use new self locking nuts on both tie rod end ball joints.
- Have car professionally aligned.

Tightening Torque
- Tie rod end to steering arm or center tie rod . . . . . 37 Nm (28 ft-lb)

Tie rod end, replacing

– Raise car and press off tie rod end ball joint as described above.

– Make a reference measurement of tie rod end to tie rod. Record measurement.

NOTE—
Accurate measurement of tie rod assembly will help to approximate correct wheel alignment when new parts are installed.

– Loosen tie rod end clamping bolt and thread tie rod end out of the rod. Count number of turns as end is removed.

– Installation is reverse of removal.
- Install tie rod end to tie rod in as close to original position as is possible.
- Make sure all threaded parts are clean.
- Use new self locking nuts on tie rod end and tie rod clamping bolt.
- Have car professionally aligned.

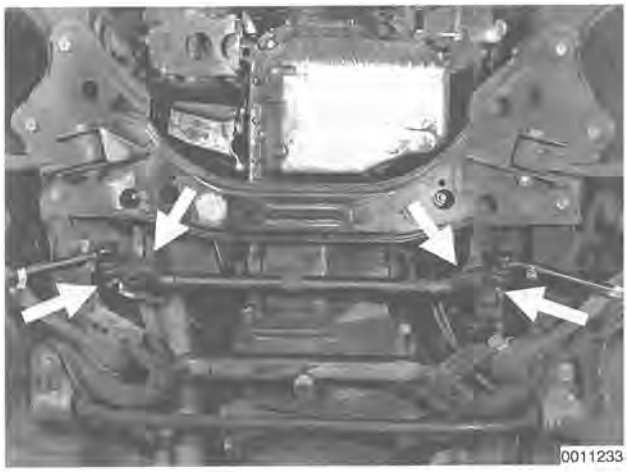
CAUTION—
Always use new self locking nuts. They are designed to be used only once and may fail if reused.

Tightening Torques
- Tie rod end clamping bolt . . . . . 14 Nm (10 ft-lb)
- Tie rod end to steering arm or center tie rod. . . . . 37 Nm (28 ft-lb)

Center tie rod, replacing

– Raise front of car.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*


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➢ Remove self locking nuts connecting center tie rod to outer tie rods, Pitman arm, and idler arm (**arrows**).

– Press outer tie rod ends off center tie rod using a press (BMW special tool no. 32 2 050 or equivalent).

– Press center tie rod off Pitman arm and idler arm using a press (BMW special tool no. 32 2 040 or equivalent).

– Installation is reverse of removal.

- Make sure all threaded parts are clean.
- Replace all self locking nuts.
- Check tie rod end ball joints and idler arm bushing for wear.
- Have car professionally aligned.

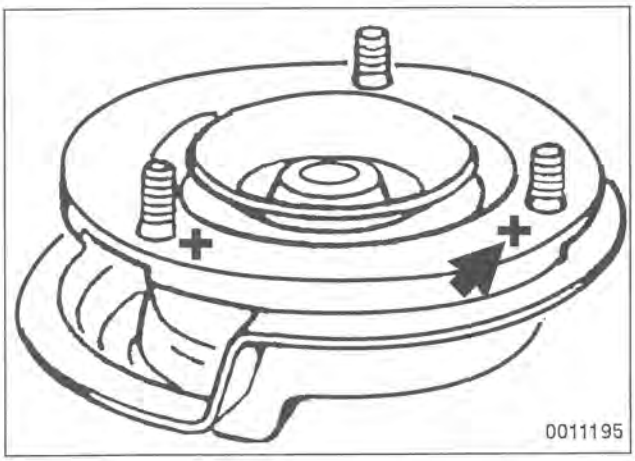
Tightening Torques

- Center tie rod to outer tie rod ends . . . 37 Nm (28 ft-lb)
- Center tie rod to Pitman arm. . . . . 59 Nm (44 ft-lb)
- Center tie rod to idler arm. . . . . 37 Nm (28 ft-lb)

WHEEL ALIGNMENT

Proper handling, stability and driving ease depend upon the correct alignment of all four wheels. The front axle is aligned in relation to the rear axle, then the front wheels are aligned in relation to one another.

BMW E32 cars use a sophisticated multi-link suspension at the front and rear of the car. Proper alignment requires computerized alignment equipment.


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Camber

➢ Special camber correcting strut mounts are identified by a "+" or "–" mark (**arrow**).

- Front and rear camber are fixed by the design of the car, but some front camber adjustments can be made by replacing the upper strut mounts with special offset mounts available from BMW. Offset strut mounts can correct camber up to ± 30'.

NOTE—
Front upper strut mount replacement is covered in **310 Front Suspension**.

Caster

Front and rear caster is fixed by the design of the car and deviations are usually the result of worn or damaged suspension or body parts.

Check the control arms and thrust arms (including bushings) for wear, damage and deformation if front caster problems are present. Check the trailing arms, rear axle subframe and thrust arms if rear caster problems are present.

Front Toe-in and Toe Difference Angle

Toe-in is the difference in the distance between the front of the front wheels and the rear of the front wheels. It is adjusted by altering the length of the outer tie rods.

Toe-in adjustments should only be made on specialized alignment equipment and only with the car in normal loaded position as described below under **Wheel Alignment Specifications**.

Toe difference angle determines the progressively different paths taken by the front wheels as the car is turning. It is fixed by the idler arm, but depends on accurate setting of the toe-in.

Rear Toe-in

There is no provision for routine rear wheel toe-in adjustment. Some correction is possible where rear wheel toe-in falls outside of the allowable limits by removing the trailing arm and replacing the outer trailing arm pivot bushing with an eccentric version. The eccentric bushing repositions the trailing arm slightly, resulting in a toe-in change.

The eccentric bushings are marked indicating increments of change and can be installed in any position to produce a specific amount of toe correction.

NOTE—
Trailing arm bushing replacement is covered in **330 Rear Suspension**.

Before replacing trailing arm with corrective bushings, inspect the rear springs and other bushings and flexible mounts in the rear suspension and replace as necessary. This may correct the problem.

Wheel Alignment Specifications

Alignment specifications for all models covered by this manual are listed in **Table a** and **Table b**. The specifications only apply under the following conditions:

- Correct wheels and tires in good condition, at the correct inflation pressures.

- Wheel bearings in good condition.
- Ride height in accordance with specifications. See **310 Front Suspension** and **330 Rear Suspension**.
- Car in normal loaded position.

Normal loaded position

- Each front seat . . . . . 68 kg (150 lb.)
- Center of rear seat . . . . . 68 kg (150 lb.)
- Trunk . . . . . 21 kg (46 lb.)
- Fuel tank . . . . . full

Table a. Front Wheel Alignment Specifications

Toe angle (total)	0° 18' ± 5'
Toe difference angle (inside wheel @ 20° lock)	–1° 50' ± 30'
Camber	–11' ± 30'
Caster	
@10° wheel lock	7° 59' ± 30'
@20° wheel lock	8° 14' ± 30'
Maximum permissible difference between sides	30'
Front Wheel Displacement	0° ± 15'
Full lock	
Inside wheel (approximate)	43°
Outside wheel (approximate)	33°
Turning circle diameter	11.6 m (38.1 ft.)

Table b. Rear Wheel Alignment Specifications

Toe angle (total)	0° 18' ± 7'
Axis deviation (allowable range)	0 ± 15'
Camber	–2° 20' ± 30'
Maximum allowable deviation between sides	30'



330 Rear Suspension

GENERAL 330-1

SHOCK ABSORBERS AND SPRINGS . 330-2
Rear strut assembly, removing and installing (except cars with EDC III) 330-2
Rear strut assembly, removing and installing (cars with EDC III) 330-4
Rear strut, disassembling and assembling . . . 330-6

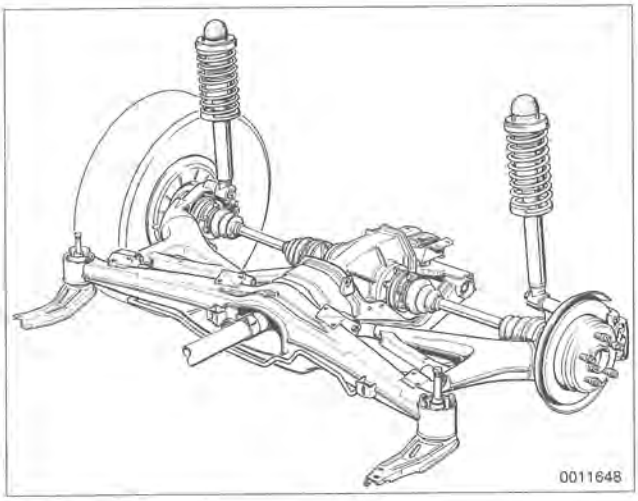
RIDE HEIGHT 330-7

REAR WHEEL BEARINGS 330-8
Rear wheel bearing, replacing 330-8

DRIVE AXLES 330-11
Drive axle, removing and installing 330-11
CV joint and boot, replacing 330-12

TRAILING ARMS 330-13
Trailing arm, removing and installing 330-14
Trailing arm bushings, replacing 330-16

TABLES
a. Rear Ride Height Specifications 330-8



GENERAL

For a general description of the rear suspension, see **300 Suspension, Steering and Brakes–General.**

Rear suspension assembly.

Special service tools are required for most of the work described in this repair group. Read the procedures through before beginning any job.

NOTE—

- *Service and repair information on the final drive unit can be found in* **331 Final Drive.**
- *General suspension and steering troubleshooting can be found in* **300 Suspension, Steering, and Brakes–General.**

Long wheelbase (iL) models are equipped with a self levelling rear suspension system called LAD (Load Absorption Damping). The hydro-mechanical LAD system uses the power steering system to automatically adjust the rear suspension ride height based on load and driving conditions. The system is in operation whenever the engine is running. For more information on the LAD system see **370 Integrated Suspension Systems**.

WARNING —

- *Personal injury may result if procedures described in this repair group are undertaken without the proper service tools and equipment. Be sure to have the right tools on hand before beginning the job.*
- *Do not install bolts and nuts coated with undercoating wax, as correct tightening torque cannot be assured. Always clean the threads with solvent before installation, or install new parts.*
- *Do not attempt to weld or straighten any suspension components. Replace damaged parts.*
- *Do not reuse self-locking nuts. They are designed to be used only once and may fail if reused. Always replace them with new self-locking nuts.*

SHOCK ABSORBERS AND SPRINGS

Most strut assembly components are available as replacement parts, although the most commonly replaced parts are the strut cartridges and the coil springs.

NOTE —

- *Electronic damping control (EDC III) is installed as an option on some late E32 cars. EDC III cars do not have conventional struts. A separate replacement procedure is given below for these struts. For further information on EDC III, see* **370 Integrated Suspension Systems.**
- *Shock absorber cartridges and springs should always be replaced in pairs.*

Rear strut assembly, removing and installing (except cars with EDC III)

Various types of rear strut assemblies are fitted on the cars covered by this manual based on the suspension system installed: Conventional struts, Self levelling LAD struts, and EDC III struts. When replacing the strut assemblies, be sure to identify the suspension system installed.

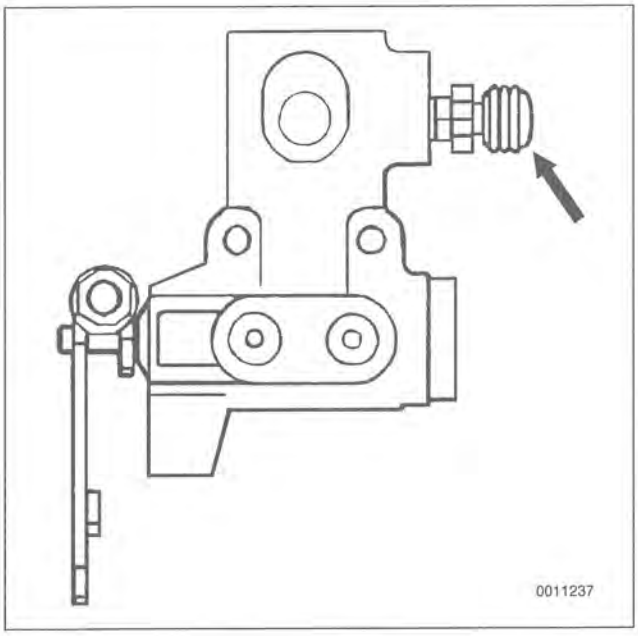
NOTE —

- *Most long wheel base models are fitted with LAD struts. This system uses special hydraulic shocks. These struts can be identified by the hydraulic line to the lower section of the strut housing.*
- *Some late models cars covered by this manual are fitted with an electronic damping control system (EDC III). This suspension system uses special electro-hydraulic shocks at all four corners. These struts can be identified by the wiring leads to the switching solenoids.*

– Raise car and remove rear wheel.

WARNING —

Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.



➢ On LAD-equipped car: Place drain pan beneath pressure regulating valve on driver's side of axle subframe. Loosen bleeder screw (**arrow**) and allow hydraulic pressure to discharge.

> ***CAUTION—***
> *Clean the area around the bleeder screw and the hydraulic fittings on the struts before opening the LAD system.*

– On LAD-equipped car: Place drain pan beneath strut and remove hydraulic line from lower section of strut.

– Support trailing arm from below.

– Remove rear seat cushion and backrest. See **520 Seats**.


0017260

➢ Peel back rubber strut top cap and remove strut upper mounting nuts (**arrows**).

– Working underneath car, remove lower strut mounting bolt and remove strut assembly.

> ***NOTE—***
> *Store the removed strut assembly upright. Do not allow it to lie horizontally or upside-down for any length of time. If incorrect storage has occurred, place the strut assembly upright with the rod fully extended for at least 24 hours.*

– When installing rear strut, make sure all thread bores, bolts, nuts and mating surfaces are clean.

– Install strut assembly into strut tower using a new upper mounting gasket and new self-locking nuts.

Tightening torques

- Strut assembly to strut tower (self-locking nuts) . . . . . 22 Nm (16 ft-lb)

– Install strut assembly to trailing arm but do not tighten to final torque.

– On LAD-equipped car: Install hydraulic fluid line to strut. Make sure bleeder screw on regulator valve is tightened.

Tightening Torque–with LAD Struts

- Hydraulic fluid line to strut assembly. . . . . 14 Nm (10 ft-lb)

– Install road wheel and lower car. Load car to normal loaded position as described later in **Ride Height.** Tighten lower strut mounting bolt.

Tightening Torques

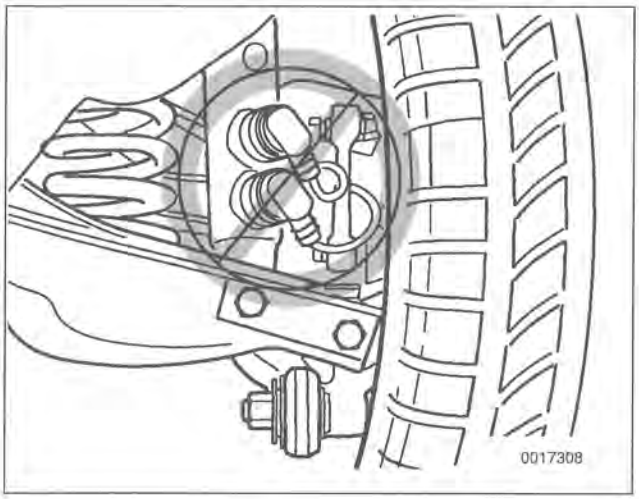
- Strut assembly to trailing arm (car in normal loaded position) . . . . . 127 Nm (94 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

– On LAD-equipped cars: Fill and bleed LAD system as described in **370 Integrated Suspension Systems**.

– The remainder of installation is reverse of removal.

Rear strut assembly, removing and installing (cars with EDC III)

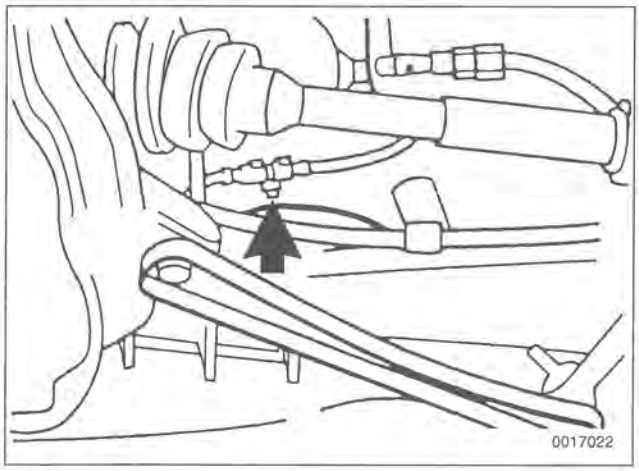
Electronic damping control (EDC III) cars are fitted with special electro-hydraulic shocks. Use care when removing and installing strut assemblies to prevent damaging the solenoid covers on the strut housings.



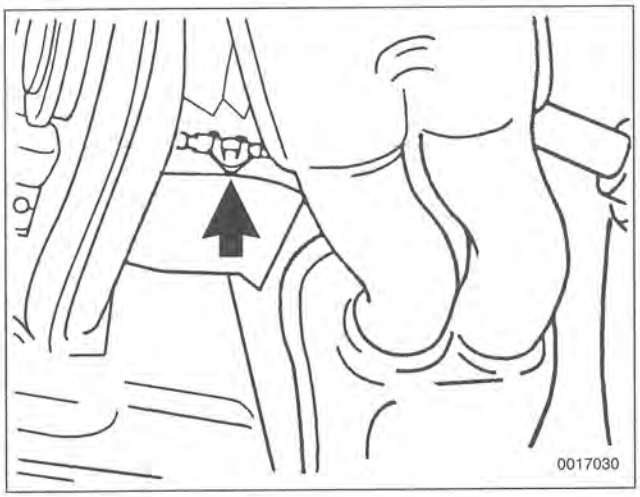
➢ Do not remove covers from EDC III solenoid valves on strut housing. If the covers are removed, the struts will be permanently damaged.

Raise car and remove rear wheel.

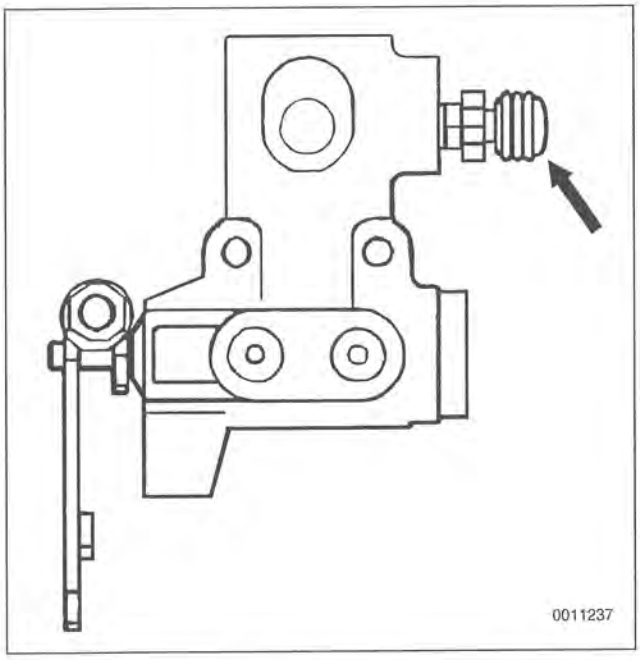
WARNING —
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.



➢ Right side: Working underneath right rear of car, detach EDC harness connector (**arrow**).



➢ Left side: Working underneath left rear of car, detach EDC harness connector (**arrow**) in front of fuel tank.



➢ On LAD-equipped car: Place drain pan beneath pressure regulating valve on driver's side of axle subframe. Loosen bleeder screw (**arrow**) and allow hydraulic pressure to discharge.

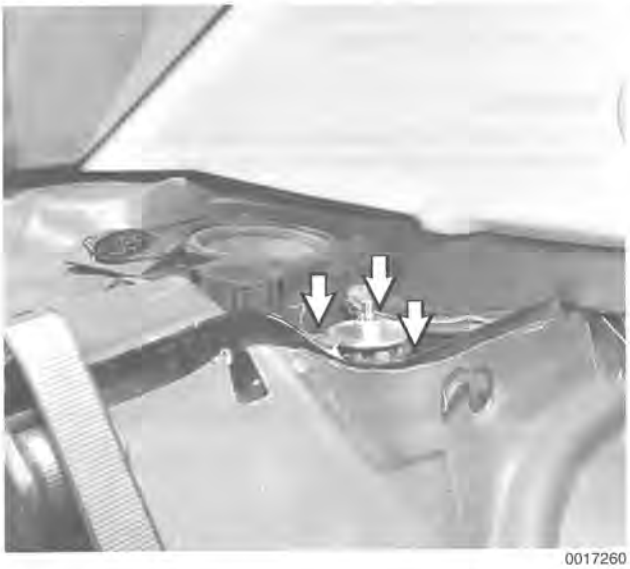
CAUTION—
Clean the area around the bleeder screw and the hydraulic fittings on the struts before opening the LAD system.

– On LAD-equipped car: Place drain pan beneath strut and remove hydraulic line from lower section of strut.

– Support trailing arm from below.

– Remove rear seat cushion and backrest. See **520 Seats**.

– Remove rear parcel shelf. See **513 Interior Trim**.



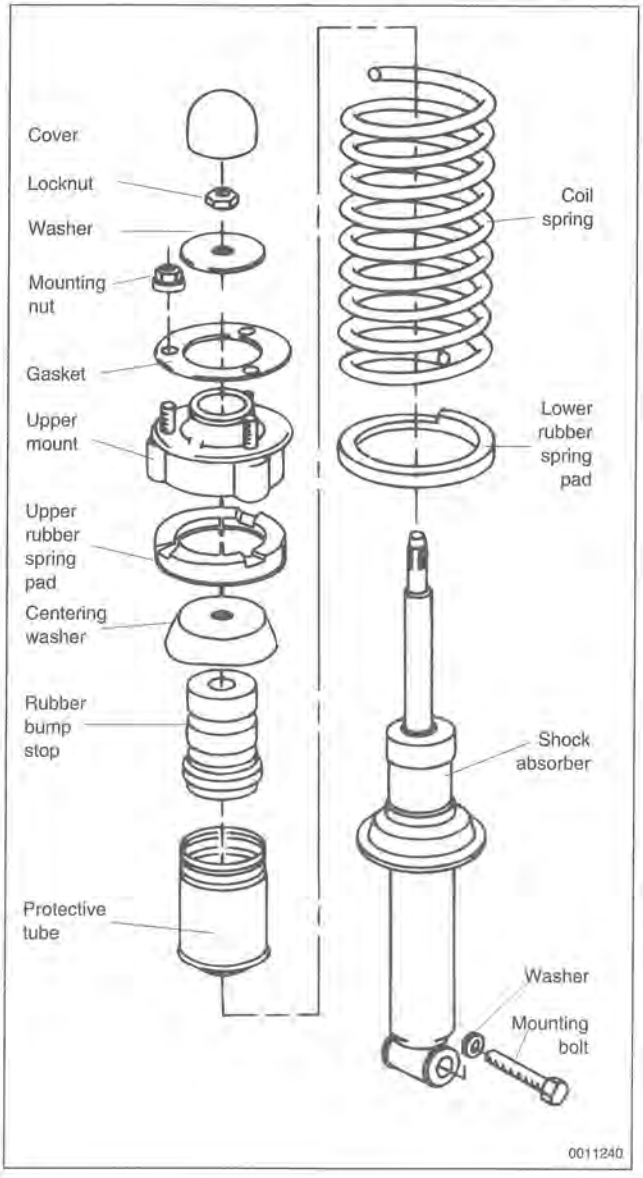
➢ Peel back rubber strut top cap and remove strut upper mounting nuts (**arrows**).

– Working underneath car, remove lower strut mounting bolt and remove strut assembly.

NOTE—
Store the removed strut assembly upright. Do not allow it to lie horizontally or upside-down for any length of time. If incorrect storage has occurred, place the strut assembly upright with the rod fully extended for at least 24 hours.

– When installing strut, make sure all thread bores, bolts, nuts and mating surfaces are clean.

– Install strut assembly into strut tower using a new upper mounting gasket and new self-locking nuts.



Tightening torques

- Strut assembly to strut tower (self-locking nuts) . . . . . 22 Nm (16 ft-lb)

– Install strut assembly to trailing arm but do not tighten to final torque.

– On LAD-equipped car: Install hydraulic fluid line to strut.

Tightening Torque

- Hydraulic fluid line to strut assembly. . . . . 14 Nm (10 ft-lb)

– Install road wheel and lower car. Load car to normal loaded position as described later in **Ride Height.** Tighten lower strut mounting bolt.

Tightening Torques

- Strut assembly to trailing arm (car in normal loaded position) . . . . . 127 Nm (94 ft-lb)
- Road wheel to hub . . . . . 100±10 Nm (74±7 ft-lb)

– On LAD-equipped car: Fill and bleed LAD system as described in **370 Integrated Suspension Systems**.

– The remainder of installation is reverse of removal.

Rear strut, disassembling and assembling

Rear strut assembly. (Conventional shock shown, self levelling and EDC III shocks are similar).

- Replacing the upper strut mount, spring and strut cartridge requires that the strut first be disassembled. This procedure requires a spring compressor specifically designed for the purpose.

> ***WARNING—***
> *Do not attempt to disassemble the struts without a spring compressor designed specifically for this job*

– Remove strut assembly from car as described earlier.

– Using a spring compressor, compress spring until spring force on upper mount is relieved.

> ***WARNING—***
> *Make sure the spring compressor grabs the spring properly before compressing it.*

– Pry protective cap off top of strut assembly, then remove top (center) nut and washer.

– Release spring compressor carefully and evenly, allowing spring to expand slowly.

– Remove spring from shock absorber.

NOTE—
Store the removed shock absorber upright. Do not allow it to lie horizontally or upside-down for any length of time. If incorrect storage has occurred, place the shock absorber upright with the rod fully extended for at least 24 hours.

– Compress spring and install it and related components to shock absorber. Use a new self-locking top (center) nut.

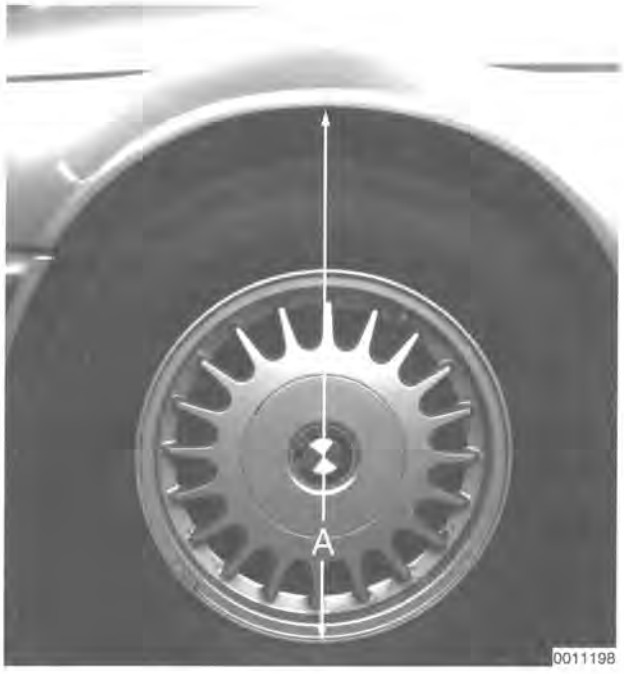
WARNING—
Make sure the self-locking top nut is fully tightened before releasing the spring compressor.

Tightening Torque

- Upper strut mount to shock absorber shaft (self-locking nut) . . . . . 25 Nm (18 ft-lb)

– Release spring compressor slowly, positioning spring ends in shoulders of spring seats. Install strut assembly as described above.

RIDE HEIGHT



Rear ride height measurement (**A**) is taken from center of wheel arch to bottom of wheel rim. Measure ride height with car in normal loaded position on the ground.

NOTE—
On cars with self levelling rear suspension (iL models), rear ride height is controlled by the LAD level height control system. For information on adjusting rear ride height on LAD-equipped cars, see **370 Integrated Suspension Systems**.

Table a lists rear suspension ride height specifications. These specifications apply to a car in a normally loaded position, simulating a load of passengers, luggage and fuel. When checking ride height or installing suspension components that require the car to be "normally loaded," load the car as follows:

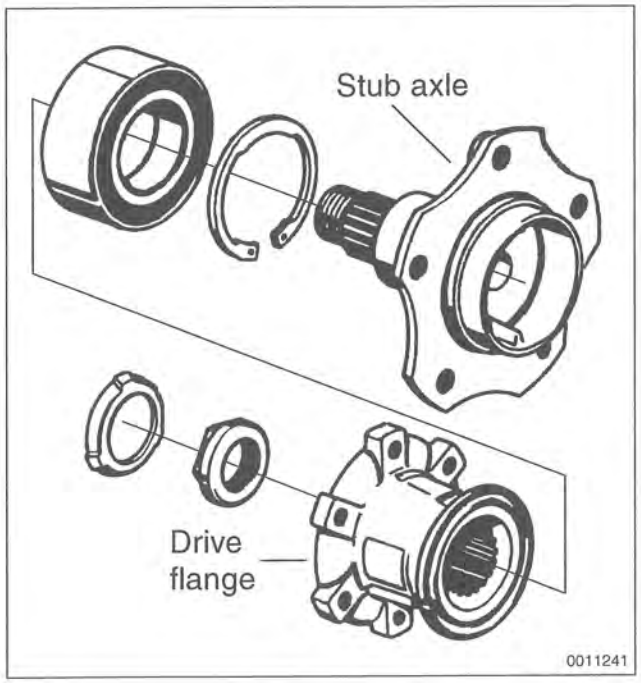
Normal loaded position

- Each front seat . . . . . .68 kg (150 lb)
- Center of rear seat . . . . . .68 kg (150 lb)
- Trunk . . . . . .21 kg (46 lb)
- Fuel tank . . . . . full

Table a. Rear Ride Height Specifications

Wheel installed	Rear ride height (A)
15 in. rims	522 ± 10 mm (20.55 ± 0.4 in.)
17 in. rims	550 ± 10 mm (21.65 ± 0.4 in.)
TRX 415 rims	536 ± 10 mm (21.10 ± 0.4 in.)

REAR WHEEL BEARINGS



Rear wheel bearing assembly.

- The wheel bearing is pressed into the trailing arm and secured with a large circlip. The stub axle is pressed into the bearing and held in place by the drive flange collar nut.

Special press tools are required to replace the wheel bearings. Read the procedure through before beginning the job.

Rear wheel bearing, replacing

– Raise rear of car.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

– Remove drive axle outer CV joint from wheel drive flange as described below under **Drive Axles.** Support drive axle from chassis with wire.

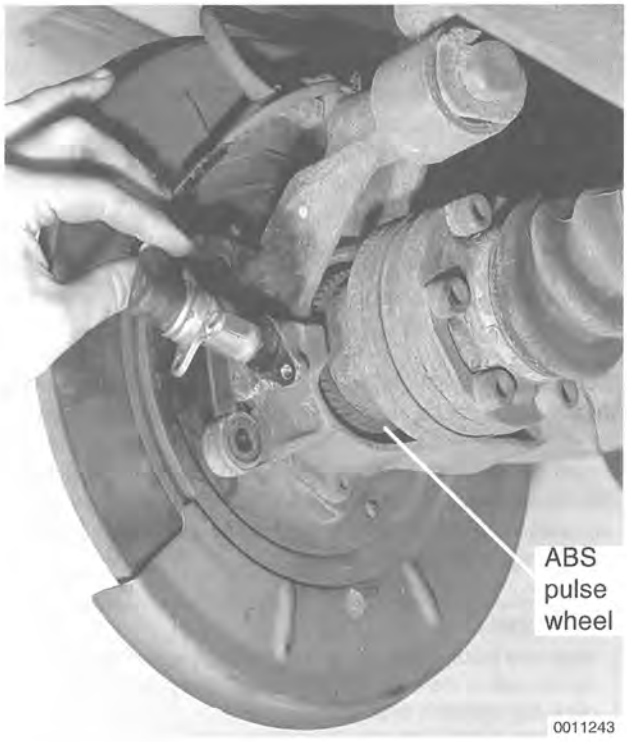


Pry lockplate off drive flange collar nut.

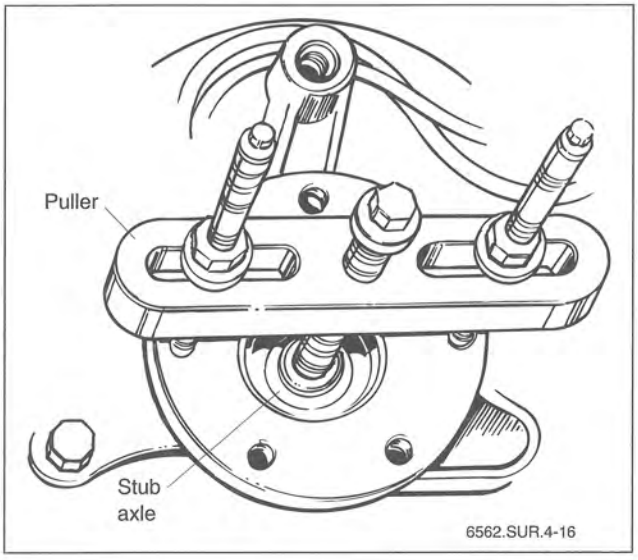
– Lower car to ground. Apply parking brake to prevent wheel from turning. Loosen, but do not remove drive flange collar nut.

– Raise car and remove wheel.

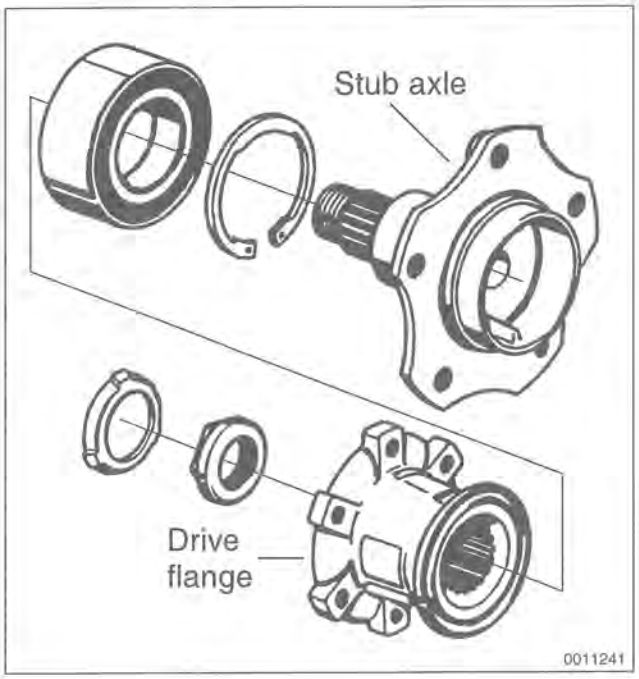
– Remove brake caliper assembly and rotor as described in **340 Brakes**. Leave brake hose connected to caliper. Suspend caliper assembly from chassis with wire.



➢ Remove ABS pulse sensor from trailer arm.



➢ Remove drive flange collar nut and remove flange using a puller if necessary.



- Remove large circlip from trailing arm bearing housing.
- With drive flange removed, thread drive flange collar nut back onto stub axle until it is flush with end of axle. Using a soft-faced hammer, tap stub axle out of bearing.
- If necessary, use a puller to remove bearing inner race from stub axle.
- Remove bearing from trailing arm using a puller. (BMW special tool nos. 33 4 031, 33 4 033, and 33 4 038 or equivalents).
- Clean trailing arm bearing housing thoroughly. Make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Install new wheel bearing into trailing arm using a press (BMW special tool nos. 33 4 030, 33 4 036, and 33 4 037 or equivalents). Apply force only to outer race when pressing in bearing. Install a new circlip.

CAUTION—
Make sure that the bearing is pressed in far enough to contact the shoulder at the back side of the housing and that the circlip is fully seated in its groove.

- Draw stub axle into bearing using a puller (BMW special tool nos. 33 4 080, and 33 4 020 or equivalents). Support bearing inner race when installing stub axle.

NOTE—
BMW specifies special tools to pull the stub axle through the wheel bearing into position. If using alternative tools to install the axle, be sure to support the bearing inner race when pressing or pulling the axle into place.

- Reinstall drive flange.
- Lightly oil the bearing surface of drive flange collar nut and install it to drive flange. Tighten collar nut firmly, but do not fully tighten it at this time.

WARNING—
For safety reasons, the axle collar nut should only be tightened to its final torque with the wheel installed and the car lowered to the ground. However, loading the bearing without the nut tightened sufficiently may damage the bearing.

- Install brake rotor and caliper as described in **340 Brakes**. Install ABS sensor. Install road wheel.

Tightening Torques
- Brake rotor to drive flange . . . . . 16 Nm (12 ft-lb)
- Brake caliper to trailing arm . . . . . 67 Nm (50 ft-lb)

– Lower car to ground. Apply parking brake to prevent wheel from turning. Tighten drive flange collar nut to its final torque.

Tightening Torque

- Drive flange collar nut to wheel hub axle . . . . . 250 Nm (184 ft-lb)

– Install a new lock plate over drive flange collar nut.

– Install drive axle as described later.

DRIVE AXLES

The drive axles use constant-velocity (CV) joints on both ends. The CV joints and associated components are the same on both ends of the drive axle. To replace a CV joint or dust boot, the drive axle must be removed from the car.

Drive axle, removing and installing

– Raise rear of car.

WARNING —
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.


0011245

➢ Remove drive axle CV joint bolts from both ends of drive axle and remove drive axle from car.

– Installation is reverse of removal. Make sure all thread bores, bolts and mating surfaces are clean. Make sure lockplate is reinstalled.

Tightening Torque

- Drive axle to differential and drive flange
  Standard M10 bolt . . . . . 83 Nm (61 ft-lb)
  Lock-tooth M10 bolt . . . . . 100 Nm (74 ft-lb)

CV joint and boot, replacing

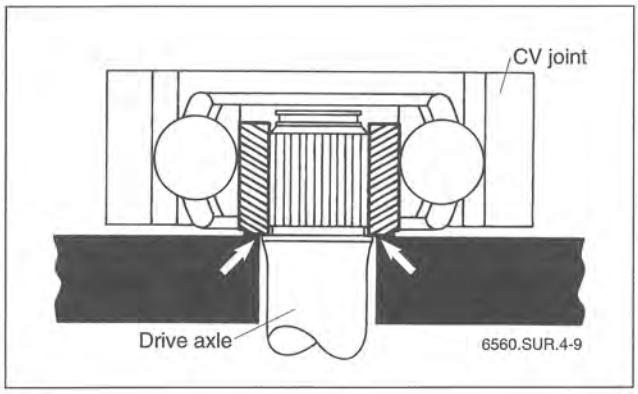
– Remove drive axle from car as described above.

– Remove boot clamping bands and cut old boot off joint and shaft.

➢ Lift off outer dust cover from joint and remove circlip (**arrow**) retaining joint inner hub to shaft.



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➢ While supporting inner hub (**arrows**) press drive out of joint.

– Clean all old lubricant off shaft splines and joint's inner splines.

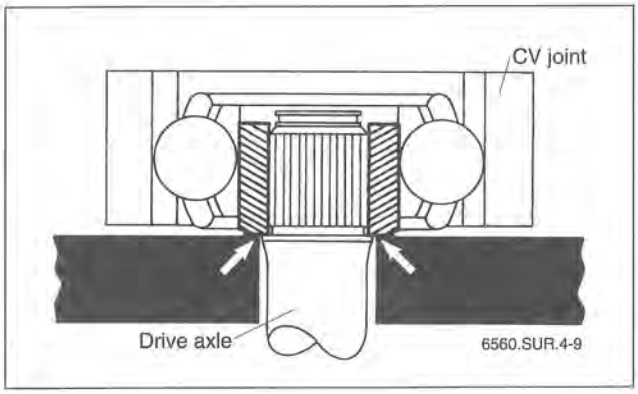
NOTE—

To inspect a CV joint, clean away the grease and look for galling, pitting and other signs of wear or damage. Polished interior surfaces or visible ball tracks alone are not necessarily cause for replacement. Discoloration due to overheating indicates lack of lubrication. A joint that is otherwise in good condition may be reinstalled if thoroughly cleaned and repacked with new grease. Before reinstalling the joint to the shaft, inspect the drive axle and the splines for wear or damage.

– Place small clamping band, boot and inner joint cover over drive axle.

NOTE—

When replacing the CV joint boot, use a complete CV joint boot repair kit. The kit will include a new boot, clamps, special lubricant, and a new inner CV joint circlip. The kit is available from an authorized BMW dealer parts department.



➢ Apply Loctite®270 or an equivalent heavy-duty locking compound to drive axle splines. Position new CV joint on shaft so that hub with raised or taller side (**arrows**) is facing shaft.

WARNING—
Do not let the locking compound contact the balls in the joint. Apply only a thin coat to cover the splines.

– Press shaft into joint while supporting inner hub of joint. Install new circlip.

NOTE—
Do not let the ball hub pivot more than 20° in the outer ring of the joint. The balls will fall out if the hub is pivoted too far.

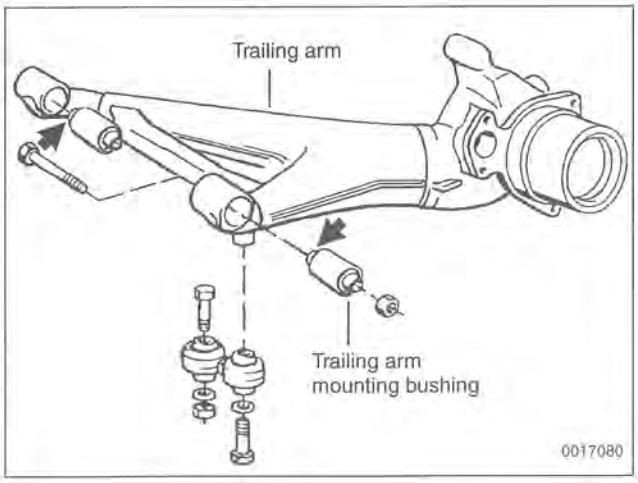
– Pack each CV joint and rubber boot with specified amount of lubricant supplied in boot kit. Apply adhesive to large end of boot and mount it on joint. Secure boot with clamps. Then apply sealer to joint end cover(s) and install them.

NOTE—
BMW recommends Bostik®1513 or Epple®4851 adhesive, and Epple®39 or Curil®T sealer.

CV Joint Lubricant Capacity

• Each joint . . . . . 80 gm (2.8 oz.)

TRAILING ARMS



➢ The trailing arms and their mounting bushings control the position of the rear wheels. A damaged trailing arm or worn bushings will change the rear wheel alignment and may adversely affect handling and stability.

WARNING—
Do not attempt to straighten a damaged trailing arm. Bending or heating may weaken the original part.

The rear brake lines must be disconnected to remove a trailing arm. This means the complete brake system must be bled as part of the installation procedure.

NOTE—
- *When installing trailing arm bushings, make sure longer section of inner sleeve (**arrows**) faces center of car.*
- *On cars with Automatic Stability Control+Traction (ASC+T), a special procedure is needed to properly bleed the brakes. See* **340 Brakes** *for additional information before opening the brake hydraulic system.*





Trailing arm, removing and installing

– Raise rear of car and remove wheel.

> ***WARNING —***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

– Remove outer CV joint from drive flange as described above.

➢ Disconnect rear brake line at union (**arrow**) on top of trailing arm. Drain brake fluid or plug line.

– Remove brake caliper and brake rotor. See **340 Brakes**. Disconnect parking brake cable from parking brake actuator. Unclip parking brake cable from trailing arm.

– Remove ABS pulse sensor from brake caliper and unclip sensor's wiring from trailing arm.

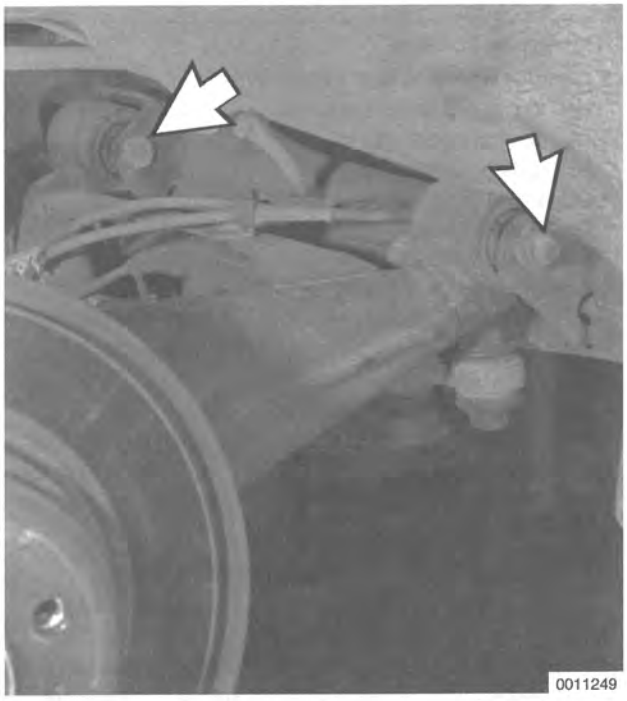
– If removing right trailing arm, separate brake pad wear sensor connector.

– Disconnect stabilizer bar link from trailing arm.

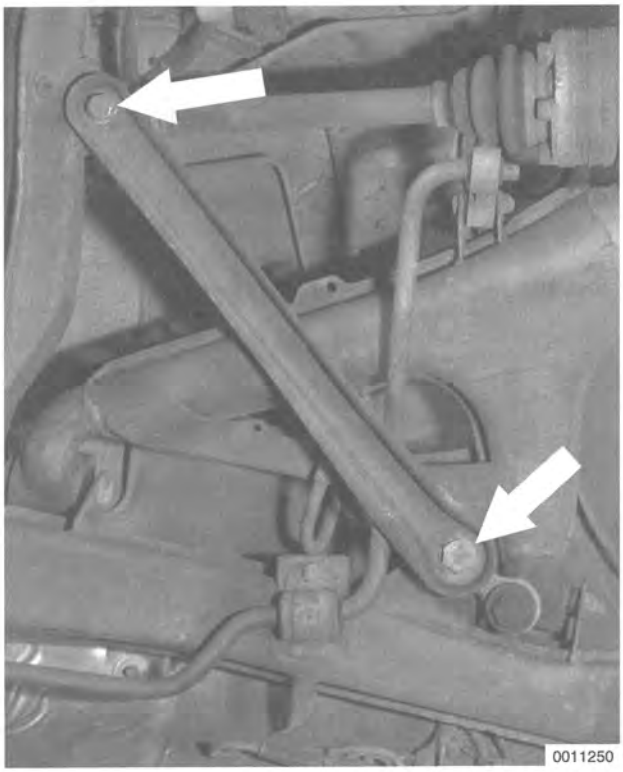
➢ Trailing arm connecting link (**arrow**).

• Remove connecting link mounting bolt from trailing arm.

– Disconnect rear strut lower mounting bolt. Pull strut away from trailing arm.



➢ Remove two trailing arm through-bolts (**arrows**) and nuts and remove trailing arm from car.



➢ If removing right side trailing arm, unbolt diagonal support arm from connecting link (**arrows**), then loosen other end of arm and swing it aside.

– Installation is reverse of removal.

- Always use new self-locking nuts.
- When installing trailing arm mounting bolts, install inner bolt first. Tighten mounting bolts to final tightening torque with car on ground and loaded as specified under **Ride Height.**
- Bleed brake system as described in **340 Brakes**.
- If trailing arm is being replaced, transfer attached brake system components to new arm as described in **340 Brakes** and install a new wheel bearing as described earlier under **Rear Wheel Bearings**.

NOTE—

BMW-supplied replacement trailing arms come with the bushings installed. A new wheel bearing will have to be installed.

Tightening Torques

- Connecting link to rear axle subframe (car in normal loaded position) . . . . . 127 Nm (94 ft-lb)
- Diagonal support arm to rear axle subframe . . . . . 110 Nm (81 ft-lb)
- Drive axle to wheel drive flange
  Standard M10 bolt . . . . . 83 Nm (61 ft-lb)
  Lock-tooth M10 bolt . . . . . 100 Nm (74 ft-lb)
- Rear strut to trailing arm (car in normal loaded position) . . . . . 127 Nm (94 ft-lb)
- Road wheel to wheel hub . . . 100±10 Nm (74±7 ft-lb)
- Trailing arm to rear axle subframe (car in normal loaded position)
  M12 bolts (except 10.9) . . . . . 67 Nm (50 ft-lb)
  10.9 bolts . . . . . 77 Nm (57 ft-lb)

Trailing arm bushings, replacing

NOTE—

Special offset (eccentric) trailing arm bushings are available from BMW to correct for slight out-of-tolerance rear toe-in settings. See an authorized BMW dealer for additional parts information.

– Remove trailing arm as described earlier.

– Note installed position of bushings, then press them out of trailing arm.

– Press new bushings in so that longer end of inner sleeve faces center of car (when trailing arm is installed).

– Install trailing arm as described above.



331 Final Drive

GENERAL 331-1

FINAL DRIVE SERVICE 331-1
Final drive oil, draining and filling 331-1
Final drive, removing and installing. 331-2
Final drive rubber mounts (final drive unit removed) 331-3
Final drive oil seals 331-4
Final drive flange oil seal, replacing. 331-4
Final drive, input shaft oil seal, replacing 331-5

GENERAL

This repair group covers basic service to the final drive, including removal and installation of the complete unit. Internal repairs and final drive disassembly are not covered in this manual.

The final drive is mounted to the rear suspension crossmember and is easily removed using ordinary hand tools. There are three oil seals in the final drive housing that can be replaced with unit installed in the car. Replacement of the final drive rubber mounts requires removal of the unit.

FINAL DRIVE SERVICE

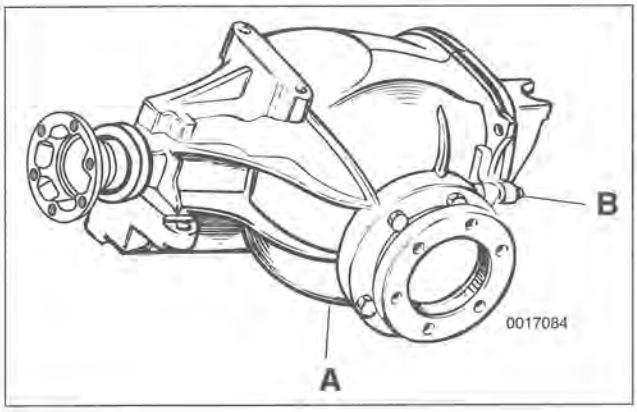
Final drive service requires some method of raising the car and supporting it securely while the work is performed. Jack stands and a floor jack can easily be used, but use extreme caution when working beneath the car and lowering the final drive.

Final drive oil, draining and filling

– Drive car to warm final drive fluid.

– Raise rear of car.

WARNING—
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.



NOTE—
The car should be level when draining final drive oil.

Place a drain pail below final drive and remove drain plug (**A**) and fill plug (**B**) from final drive.

NOTE—
Use a 14 mm allen bit socket to remove the drain plug. Alternatively, cut approximately 30 mm (1.2 in.) from an allen key and use an open end wrench on the key stub.

– Reinstall and tighten drain plug.

Tightening torque

- Final drive oil drain plug to final drive housing . . . . . 70 Nm (52 ft-lb)

– Fill final drive with appropriate type and quantity of lubricant. Install and tighten fill plug. The final drive fluid level is correct when the fluid begins to spill from the fill plug.

Tightening torque

- Final drive oil fill plug to final drive housing . . . . . 70 Nm (52 ft-lb)

Final Drive Drain and Fill

- Oil specifications
  w/o limited slip . . . . . Castrol SAF-XO
  with limited slip . . . . . BMW Synthetic Final Drive Oil
- Final drive oil capacity . . . . . 1.9 liters (2.0 qt.)

NOTE—

To identify the type of differential (limited slip vs. open), locate the sheet metal data tag on the left-hand rear side of the final drive unit. This tag identifies the type and final drive ratio. For example S 3,10 means that it is a limited slip differential (S) with a 3.10 final ratio.

Final drive, removing and installing

The final drive unit is supported at three points on the suspension crossmember through rubber bushings. New self-locking nuts should always be used when re-attaching the driveshaft to the final drive.

– Raise rear of car.

WARNING—

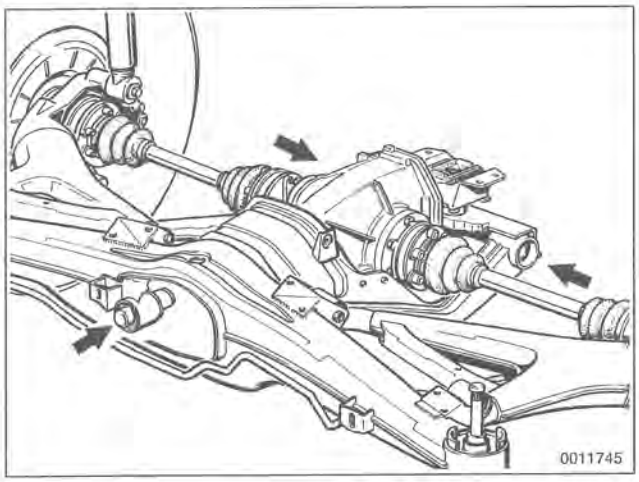
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

– Drain oil from final drive unit, as described earlier.

– Make matching marks on driveshaft and final drive input flange. Remove bolts and nuts that hold driveshaft to final drive. Push driveshaft forward slightly and suspend from body with stiff wire.

CAUTION—

Do not let the driveshaft or drive axles hang unsupported. Damage to the driveshaft center bearing or drive axle outer CV joint could result.



- Disconnect drive axles from final drive and suspend from body with stiff wire. See **330 Rear Suspension**.
- Place jack beneath final drive unit and support weight of unit.
- Disconnect wires for vehicle speed sender and remove wiring harness and connector from final drive housing.
- Remove final drive mounting bolts (**arrows**). Lower final drive.
- Installation is reverse of removal.
  - Position final drive in place against its mounts and loosely install front mounting bolt to locate unit. Then install left and right rear bolts.
  - Use new self-locking nuts when reconnecting driveshaft and align marks made during removal.
  - Torque nuts, while holding bolts.
  - Check final drive oil level and add or fill as necessary.

CAUTION—
Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

NOTE—
When installing a new or BMW remanufactured final drive unit, special break-in procedures apply. During the first 1,000 Km (620 miles), the car should be driven at different engine and road speeds, but never exceeding $^2/_3$ of the maximum speed.

Tightening Torques

- Drive axle to final drive
  M10 . . . . . 83 Nm (61 ft-lb)
  M10 with locking teeth (always replace bolts and washers) . . . . . 96 Nm (70 ft-lb)
- Driveshaft to final drive flange . . . . . See **260 Driveshaft**
- Final drive to rubber mounts . . . . . 77 Nm (57 ft-lb)
- Final drive to subframe . . . . . 123 Nm (91 ft-lb)
- Oil drain and fill plug . . . . . 70 Nm (52 ft-lb)
- Vehicle speed sender to final drive . . . 10 Nm (89 in-lb)

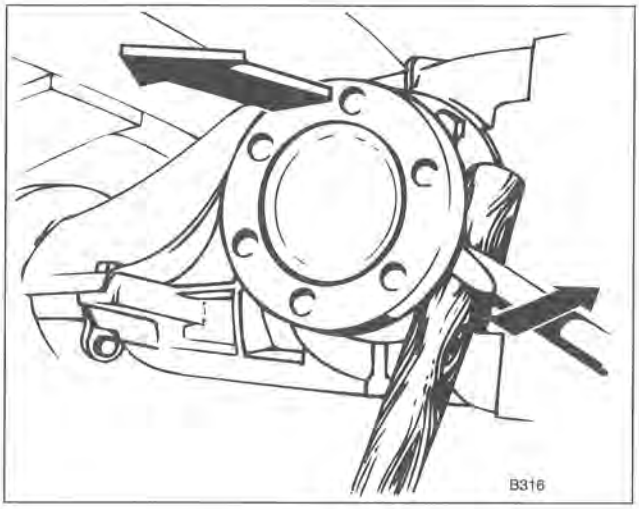
Final drive rubber mounts (final drive unit removed)

Replacement of the rubber bushings for the final drive requires special bushing press tools. The three bushings (front, left and right rear) are accessible after removing the final drive unit from the car. Note the installation direction of the bushings before removing them.

Final drive oil seals

Low oil level caused by a faulty final drive oil seal may be the cause of noisy operation or limited-slip chatter. The drive flange (side) oil seals can be replaced while the final drive is installed. The input shaft (front) oil seal can only be replaced once the final drive unit is removed.

NOTE—
Do not mistake leaking CV joints for flange seal leaks. It may be helpful to degrease the final drive to pinpoint the source of the leak prior to replacing seals.

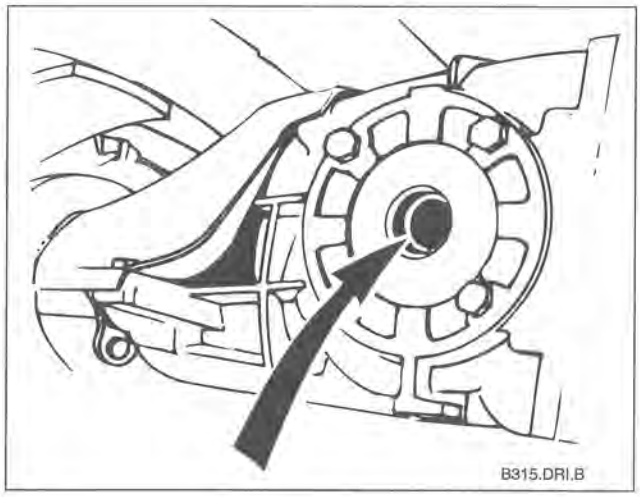

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Final drive flange oil seal, replacing

- Detach drive axle(s) from final drive. See **330 Rear Suspension**.

CAUTION—
Suspend the detached drive axle from the car body with a stiff wire hook to prevent damage to the outer CV joint.

- Pry drive flange from final drive using a wooden dowel and pry bar.


B315.DRI.B

- Remove snap ring from final drive opening (**arrow**).

NOTE—
Inspect flange at the point where the oil seals rides on the shaft. Replace the flange assembly if there is a groove worn in the shaft.

- Pry old oil seal from its recess using a hooked seal removal tool, or a large screwdriver.

CAUTION—
Be careful not to mar the final drive housing when removing the seal.

- Dip new seal in final drive lubricant and drive seal into place until fully seated.

NOTE—
Before driving new seal into place, check drive flange shaft for a wear groove where the old seal contacted on the shaft. If any wear is present, try to install the seal at a slightly different depth so that the new seal does not ride on the wear groove.

- Install new snap ring in groove of final drive housing. Make sure both ends of ring are fully seated in groove.

- Install drive flange by pressing it in by hand until snap ring engages. It may be necessary to turn drive flange slightly while pushing.

– Attach drive axle and tighten bolts.

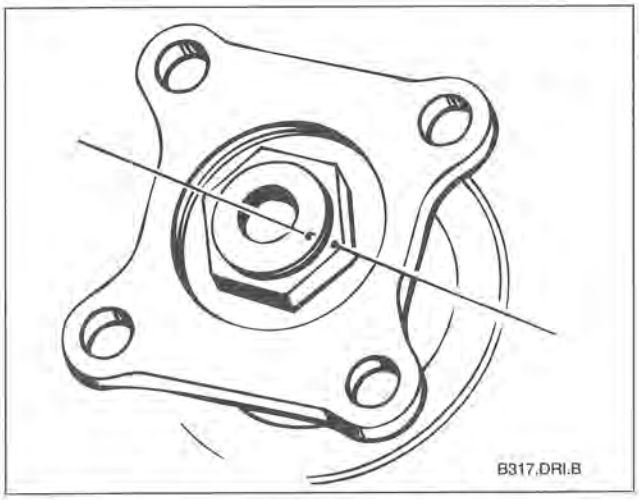
Tightening Torque

- Drive axle to final drive
  M10 . . . . . 83 Nm (61 ft-lb)
  M10 with locking teeth (always replace bolts and washers) . . . . . 96 Nm (70 ft-lb)

Final drive input shaft oil seal, replacing

– Drain oil and remove final drive as described earlier.

– Drain oil from final drive.



– Make matching marks on input shaft and input shaft collar nut.

– Pry lockplate from nut and then hold input flange and remove collar nut. If necessary, use a puller to remove input flange.

– Pry faulty seal from its recess using a hooked seal removal tool or a large screwdriver. Dip new seal in final drive lubricant and drive seal into position.

CAUTION—
Be careful not to mar the housing when removing the seal.

NOTE—
Before driving new seal into place, check drive flange shaft for a wear groove where the old seal contacted on the shaft. If any wear is present, try to install the seal at a slightly different depth so that the new seal does not ride on the wear groove.

– Lightly lubricate input shaft and press input flange back on. Install collar nut and slowly tighten until matching marks line up, coming as close as possible to specified torque.

NOTE—
If the input flange nut torque is exceeded, the crushable collar sleeve behind the flange will need to be replaced. This operation requires disassembly of the final drive unit.

Tightening Torques

- Final drive input shaft flange to pinion
  20 pinion thread diameter . . . . . 85 Nm (137 ft-lb)
  (or until matching marks line up)

– Install a new lockplate. Install final drive unit and driveshaft.



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GENERAL

All BMW E32 models are equipped with power-assisted four-wheel disc brakes with integral anti-lock brakes (ABS). A brake booster power-assists a dual-circuit master cylinder. Some models uses a hydraulic brake boost while others models use a vacuum boost system. Boost system varies depending on model and model year, as identified later in the text.

Single-piston calipers act on vented front rotors and solid or vented rear rotors. A brake pad wear sensor for each axle indicates when pads need replacement. The dual-drum parking brake is integrated with the rear brake rotors.

NOTE—
On 1990 and later cars, ASC or ASC+T is integrated with the ABS. To identify cars with traction control, check for an ASC switch mounted in the center console.

WARNING—
- *Brake friction materials such as brake linings or pads contain abrasive fibers which can lead to illnesses. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing any brake friction fibers or dust.*
- *Brake fluid is poisonous, highly corrosive and dangerous to the environment. Wear safety glasses and rubber gloves when working with brake fluid. Do not siphon brake fluid with your mouth. Immediately clean away any fluid spilled on painted surfaces and wash with water. Dispose of brake fluid properly.*
- *Do not reuse self-locking nuts, bolts or fasteners. They are designed to be used only once and may fail if reused. Always replace them with new self-locking nuts.*

TROUBLESHOOTING

Brake performance is mainly affected by three things: the level and condition of the brake fluid, the brake system's ability to create and maintain hydraulic pressure, and the condition of the friction components.

Air in the brake fluid will make the brake pedal feel spongy during braking or will increase the brake pedal force required to stop. Fluid contaminated by moisture or dirt can corrode the system. Inspect the brake fluid inside the reservoir. If it is dirty or murky, or is over a year old, the fluid should be replaced.

Visually check the hydraulic system starting at the master cylinder. Check all brake fluid lines and couplings for leaks, kinks, chafing and corrosion.

On a car with vacuum brake booster, check the brake booster by pumping the brake pedal approximately 10 times with the engine off. Then hold the pedal down and start the engine. The pedal should fall slightly. If not, check for any visible faults before suspecting a faulty brake booster. Check for strong vacuum at the vacuum hose fitting at the booster, and check the non-return valve for one-way flow.

Worn or contaminated brake pads will cause poor braking performance. Oil-contaminated or glazed pads cannot produce as much friction, and stopping distances will increase. Inspect the rotors for glazing, discoloration, scoring or oil contamination.

Steering wheel vibration while braking at speed is often caused by warped rotors, but can also be caused by faulty thrust arm bushings. See **310 Front Suspension** for more information on thrust arm bushings.

Table a lists symptoms of brake problems, their probable causes and suggested corrective actions.

Table a. Brake System Troubleshooting

Symptom	Probable cause	Corrective action
Brake squeak or squeal	1. Incorrectly installed brake pads or parking brake shoes	1. Check component installation.
	2. Brake pad carriers dirty or corroded	2. Remove brake pads and clean calipers.
	3. Brake pad anti-rattle springs faulty or missing	3. Install/replace anti-rattle springs.
	4. Brake pads heat-glazed or oil-soaked	4. Replace brake pads. Clean rotors. Replace leaking calipers as required.
	5. Wheel bearings worn (noise most pronounced when turning)	5. Replace worn bearings. See **310 Front Suspension** or **330 Rear Suspension**.
Pedal goes to floor when braking	1. Brake fluid level low due to system leaks	1. Check fluid level and inspect hydraulic system for signs of leakage. Fill and bleed system.
	2. Master cylinder faulty	2. Replace master cylinder.
Low pedal even after system bleeding	1. Master cylinder faulty	1. Replace master cylinder.
Pedal feels spongy or brakes work only after pedal is pumped	1. Air in brake fluid	1. Bleed system.
	2. Master cylinder faulty (internal return spring weak)	2. Replace master cylinder.
	3. Leaking line or hose unions	3. Repair or replace lines and hoses. Bleed system.
Excessive braking effort	1. Brake pads wet	1. Use light pedal pressure to dry pads while driving.
	2. Brake pads heat-glazed or oil-soaked	2. Replace brake pads. Clean rotors. Replace leaking calipers.
	3. Vacuum booster or vacuum hose connections to booster faulty (where applicable)	3. Inspect vacuum lines. Test vacuum booster and replace as required. Test vacuum non-return valve for one-way air flow.
	4. Hydraulic booster system out of fluid or malfunctioning (where applicable)	4. Test hydraulic booster pump and components.
Brakes pulsate, chatter, or grab	1. Warped brake rotors	1. Resurface or replace rotors.
	2. Brake pads worn	2. Recondition brakes.
	3. Brake pads heat-glazed or oil-soaked	3. Replace brake pads. Clean rotors. Replace leaking calipers.
Uneven braking, car pulls to one side, rear brakes lock	1. Incorrect tire pressures or worn tires	1. Inspect tire condition. Check and correct tire pressures.
	2. Brake pads on one side of car heat-glazed or oil-soaked	2. Replace brake pads. Clean rotors. Replace leaking calipers.
	3. Caliper or brake pads binding	3. Clean and recondition brakes.
	4. Worn suspension components	4. Inspect for worn or damaged suspension components. See **310 Front Suspension** or **330 Rear Suspension**.
Brakes drag, bind, or overheat	1. Brake caliper or brake pads binding	1. Clean or replace caliper.
	2. Master cylinder faulty	2. Replace master cylinder.

NOTE—

Tires and wheels are important parts of the braking system. Check tires for wear and proper inflation. Check wheels for flat spots and trueness.

BLEEDING BRAKES

When preparing to bleed the brakes, be sure to read the following warnings and cautions.

WARNING—
When working underneath the car, make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

CAUTION—
- *Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.*
- *When adding or replacing brake fluid always add new brake fluid from an unopened container.*
- *It is important to bleed the entire brake system whenever any part of the brake hydraulic system has been opened.*

NOTE—
Bleeding the ASC+T hydraulic pump, which is part of the ASC+T system is covered later under **Bleeding hydraulic system (ASC+T)**.

Brake bleeding is usually done for one of two reasons; either to replace old brake fluid as part of routine maintenance or to expel trapped air in the system that resulted from opening the brake hydraulic system during repairs.

Brake system bleeding can be done with a pressure bleeder, a vacuum bleeder, or manually. Pressure bleeding is recommended as the most efficient method.

When bleeding the brakes, start at the wheel farthest from the master cylinder and progress in the following order:

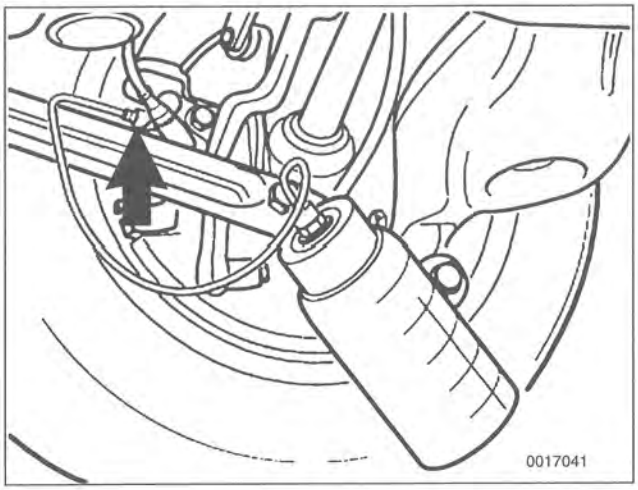
- Right rear brake
- Left rear brake
- Right front brake
- Left front brake.

CAUTION—
On cars with Automatic Stability Control with Traction (ASC+T), special procedures are required to properly bleed the front and rear brakes.

Pressure bleeding brakes (except cars with ASC+T)

– Using clean syringe, remove old brake fluid from reservoir. Clean out reservoir with a lint-free cloth.

– Top off brake fluid and connect pressure bleeder to reservoir.



➢ Connect bleeder hose and waste bottle to right rear bleeder screw (**arrow**).

– Pressurize system to approximately 1 bar (14.5 psi).

> ***CAUTION—***
> *Do not exceed a pressure of 2 bar (29 psi) when pressure bleeding the brake system. Excessive pressure will damage the brake fluid reservoir.*

– Have helper hold brake pedal down.



➢ Open bleeder screw (**arrow**). Have helper slowly pump brakes *at least 12 times* with bleeder screw open, holding pedal down on last pump. Close bleeder screw and release brake pedal.

– Refill brake fluid reservoir and proceed to next wheel in order given above.

Tightening Torques

- Bleeder screw (7 mm). . . . . .5 Nm (44 in-lb)
- Bleeder screw (9 mm). . . . . 12-16 Nm (9-12 ft-lb)

Vacuum bleeding brakes (except cars with ASC+T)

- Using clean syringe, remove old brake fluid from reservoir. Clean out reservoir with a lint-free cloth.
- Top off brake fluid and replace reservoir cap.
- Connect vacuum pump to right rear brake bleeder screw. Route discharge hose into waste bottle.

> ***CAUTION—***
> *Vacuum bleeding requires an air-tight seal between the pump and the bleeder screw. Any leakage will result in faulty bleeding.*

- Open bleeder screw and withdraw brake fluid until it is clean and without air bubbles.

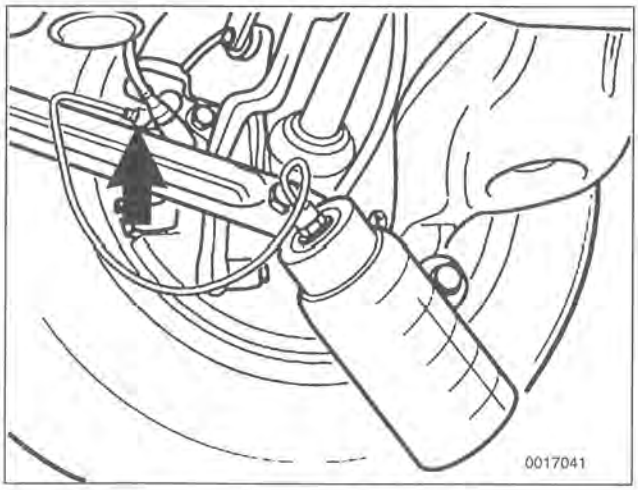
NOTE—
Fill the brake fluid reservoir level frequently to prevent it from emptying during brake bleeding.

- Close bleeder screw. Refill brake fluid reservoir and proceed to next wheel in order given above.

Tightening Torques
- Bleeder screw (7 mm) . . . . . 5 Nm (44 in-lb)
- Bleeder screw (9 mm) . . . . . 12-16 Nm (9-12 ft-lb)

Manually bleeding brakes (except cars with ASC+T)

- Using clean syringe, remove old brake fluid from reservoir. Clean out reservoir with a lint-free cloth. Top off brake fluid and replace reservoir cap.



- Connect bleeder hose and waste bottle to right rear bleeder screw (**arrow**).
- Have helper pump brakes several times. Then hold pedal down firmly on last pump.
- Open right rear caliper bleeder screw and allow fluid to expel. Close bleeder screw.
- Repeat previous two steps at least 12 times, or until discharged brake fluid is clean and without air bubbles.

NOTE—
Fill the brake fluid reservoir level frequently to prevent it from emptying during brake bleeding.

- Refill brake fluid reservoir and proceed to next wheel in order given above and repeat procedure.

Tightening Torques

- Bleeder screw (7 mm). . . . . .5 Nm (44 in-lb)
- Bleeder screw (9 mm). . . . . .12-16 Nm (9-12 ft-lb)

Bleeding brakes (cars with ASC+T)

Whenever repairs or replacement of components such as brake master cylinder or ASC+T hydraulic unit are performed a revised bleeding procedure must be followed. If repairs are downstream of the ASC+T hydraulic unit (i.e., caliper replacement) normal pressure bleeding procedures for ABS equipped cars must be followed.

Bleeding brakes in ASC+T equipped cars requires a pressure bleeder and is a multi-step procedure. Bleeding the front brakes differs significantly from bleeding the rear brakes. Be sure to read the complete procedure before starting work on the car.

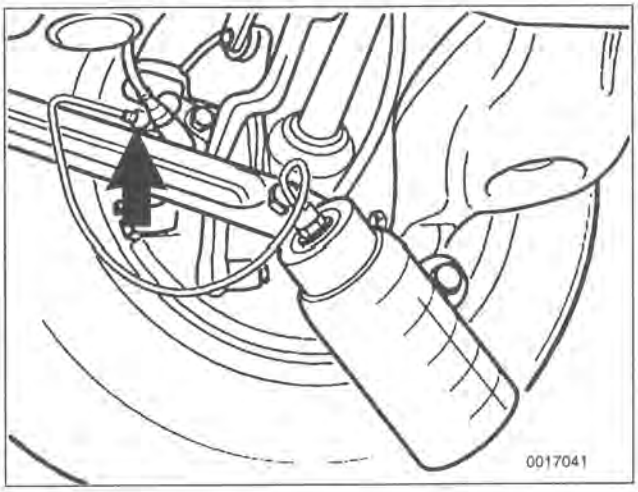
NOTE—
Bleed ASC+T hydraulic system first, as described later in this repair group.

– Using clean syringe, remove old brake fluid from reservoir. Clean out reservoir with a lint-free cloth and top off brake fluid.

– Connect pressure bleeder to reservoir.

CAUTION—
Do not exceed 2 bar (30 psi) of pressure in brake bleeder.

Rear brakes



➤ Connect bleeder hose and brake fluid waste bottle to right rear bleeder screw (**arrow**).

- Open bleeder and flush brake fluid for 2-4 minutes, (approximately 100cc).

– Connect bleeder hose and brake fluid waste bottle to left rear bleeder screw.

- Open bleeder and flush brake fluid for 2-4 minutes, (approximately 100cc).

– Connect bleeder hose and brake fluid waste bottle to right rear bleeder screw.

- Open bleeder and pump brake pedal 20 times or until fluid is clean and free of air bubbles.

– Connect bleeder hose and brake fluid waste bottle to left rear bleeder screw.

- Open bleeder and pump brake pedal 20 times or until fluid is clean and free of air bubbles.

– Raise rear of car and place jack stand under each rear trailing arm. Lower car with trailing arms resting on jack stands until drive axles are in horizontal position.

NOTE—
This will prevent damage to the C/V joints during bleeding.

– Connect bleeder hose and brake fluid waste bottle to right rear bleeder screw.

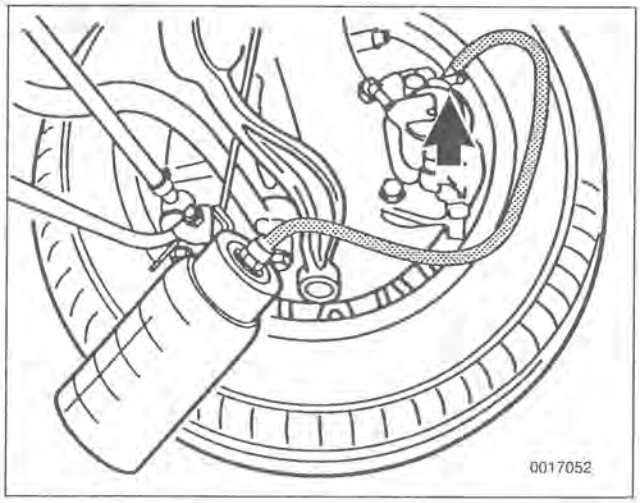
- Open bleeder screw.
- Start engine and select low gear. Run engine slowly up to 3,500 rpm and hold engine speed.
- Operate ASC switch (on center console) about every 2 seconds for a period of one minute.
- Close bleeder.
- Move shift lever to neutral and stop engine.

– Repeat on left rear brake caliper.

NOTE—
Bleeding operation will use approximately 1.5 liters of brake fluid.

Front brakes

– Connect pressure bleeder to brake fluid reservoir.



– Connect bleeder hose and waste bottle to right front bleeder screw (**arrow**).

- Pump brake pedal 12 time or until fluid is clean and free of air bubbles.
- Hold brake pedal down while tightening bleeder valve.

– Repeat on left front caliper.

– Top-off fluid in both hydraulic and brake reservoirs and replace caps.

Tightening Torques
- Bleeder screw (7 mm). . . . . 5 Nm (44 in-lb)
- Bleeder screw (9 mm). . . . . 12-16 Nm (9-12 ft-lb)

BRAKE PADS, CALIPERS AND ROTORS

Brake pads can be replaced without disconnecting the brake fluid hose from the caliper or having to bleed the brakes. The rotors can be replaced without disassembling the wheel hub and bearing. Always machine or replace rotors in pairs. Replace pads in sets (one set = one axle.)

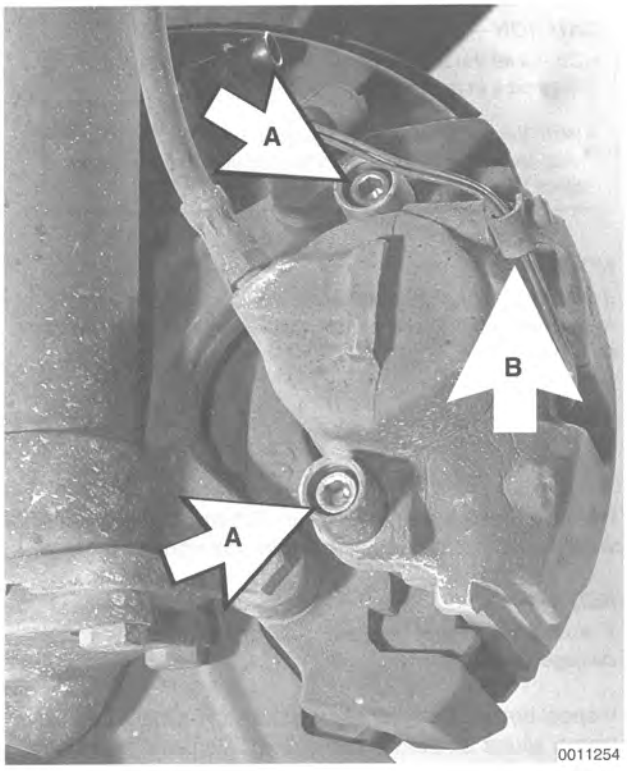
WARNING—
Brake friction materials such as brake linings or pads contain abrasive fibers which can lead to illnesses. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing any brake friction fibers or dust.

Brake pads, replacing

This procedure is applicable to both front and rear brake pads.

– Raise car and remove wheels.

> ***WARNING —***
> *Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*



➢ Remove plastic caps from guide bolt bushings and then remove guide bolts (**A**). Disconnect brake pad sensor wire from holder (**B**).



➢ Unhook brake pad anti-rattle clip from caliper using screwdriver (**arrow**).



0011264

➢ Pull caliper straight off rotor.

> ***CAUTION—***
> - *Do not let the brake caliper hang from the brake hose. Support it from the chassis with strong wire.*
> - *With the pads removed, residual hydraulic pressure may cause the caliper piston to slide out. Use a wooden block to hold the piston in place.*

NOTE—
If there is a ridge on the rotor edge, the caliper piston will have to be pushed into the caliper slightly before the caliper can be removed.



0011256

➢ Remove brake pads from caliper. Where applicable pry pad wear sensor from pad using a thin screwdriver.

NOTE—
If reusing the sensor, use care when removing as it is easily damaged during removal.

– Inspect brake caliper for signs of leakage. Check that caliper piston slides smoothly into caliper. Replace caliper if any faults are found.

– Clean guide bolts thoroughly and carefully inspect them for damage. Faulty guide bolts could cause brake failure.

– Insert brake pad wear sensor into cutout in new pad where applicable.

NOTE—
If the brake lining indicator light came on prior to brake pad replacement, the wear sensor should be replaced.



0011257

➢ Slowly press piston back into caliper. Use a rag to protect caliper piston and seals.

NOTE—
- *To protect hydraulic components from old contaminated brake fluid, open caliper bleeder screw when pressing piston back into caliper. This will also reduce the effort required to push the piston in. Catch expelled fluid in appropriate container.*
- *Open the bleeder screw only when applying force to the piston. Do not allow air to be drawn in through the bleeder screw.*
- *Pressing the caliper piston in with bleeder screw closed may cause the brake fluid reservoir to overflow. To prevent this, use a clean syringe to first remove some fluid from the reservoir.*

– Lightly coat contact points of new pads with Plastilube® or equivalent.

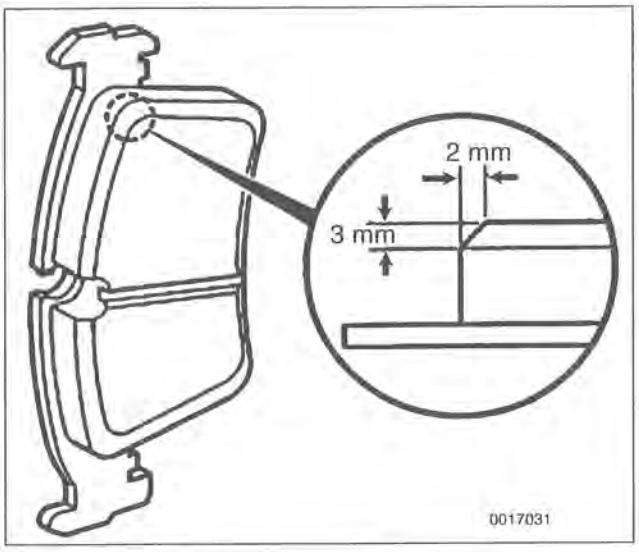
- Place outer brake pad onto caliper.
- Place inner brake pad with its locating spring onto brake caliper piston.
- Route pad wear sensor wiring through caliper opening and bleeder dust cap.

– Installation is reverse of removal.

- Do not lubricate guide bolts.
- Once brake assembly is installed depress brake pedal several times to seat pads.

Tightening Torques

- Caliper guide bolt to pad carrier . . . . . 30 Nm (22 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)



➤ In case of persistent squealing or grinding noises from the brakes, make sure that pads and rotors are free of dirt, rust or scoring. Free up all moving parts. Chamfer all edges of brake pads.

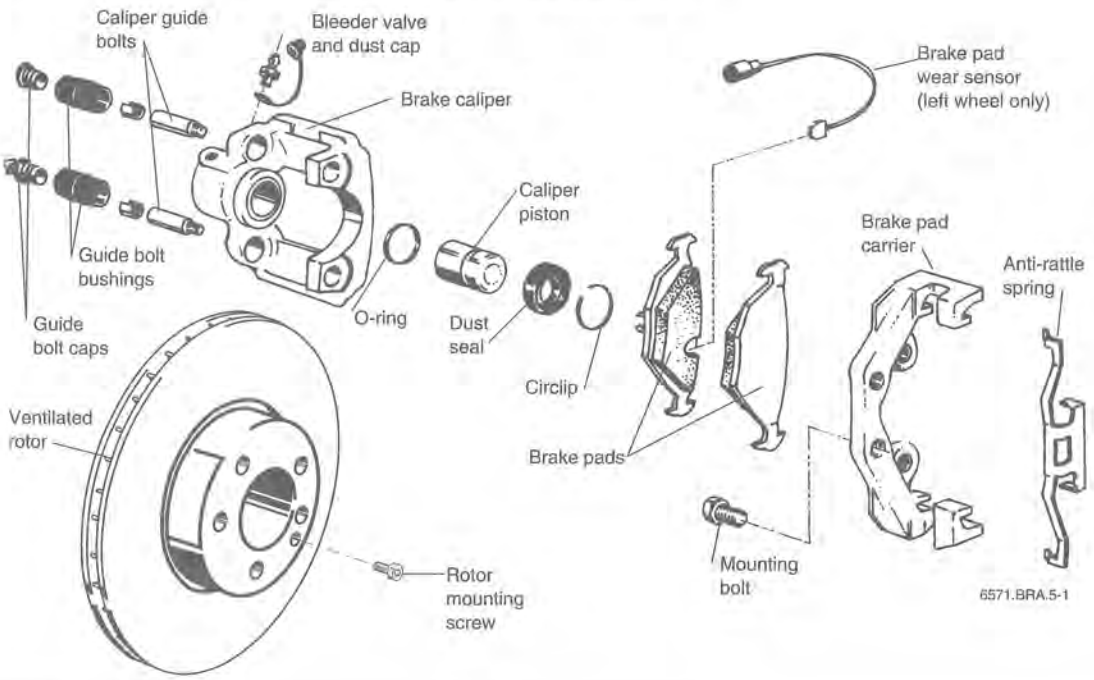
Brake caliper, removing and installing

This procedure is applicable to both front and rear calipers. Front and rear brake assemblies are shown in the illustrations.

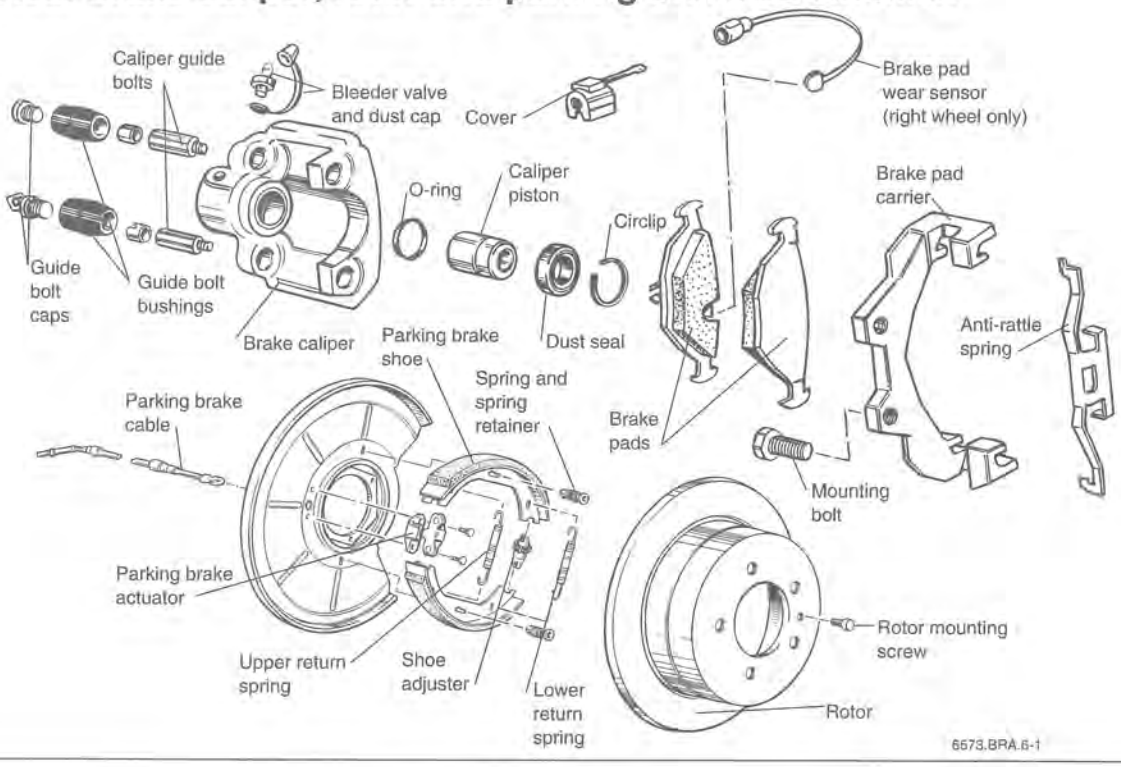
– Raise car and remove wheel.

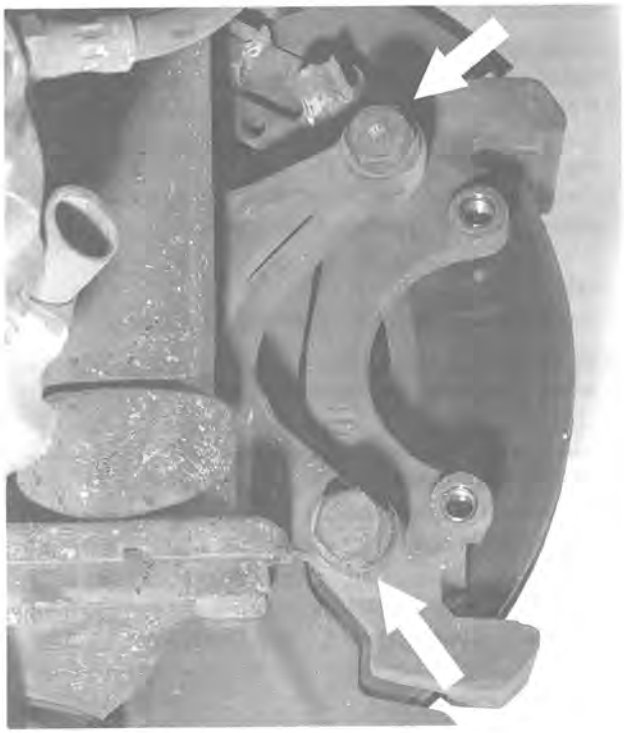
WARNING —
Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

Front brake caliper and rotor assembly



Rear brake caliper, rotor and parking brake assemblies





➢ Remove brake pad carrier mounting bolts (**arrows**) from strut assembly (front caliper) or from trailing arm (rear caliper).

– Loosen brake hose fitting at caliper and spin caliper assembly off hose.

– Inspect brake caliper for any signs of leakage. Check that caliper piston slides smoothly into caliper. Replace caliper if any faults are found.

– Installation is reverse of removal. Bleed entire brake system before driving car. See **Bleeding Brakes**.

Tightening Torques

- Brake fluid hose to caliper. . . . . 17-19 Nm (13-15 ft-lb)
- Caliper guide bolt to pad carrier . . . . . 30 Nm (22 ft-lb)
- Front brake caliper to strut assembly . 110 Nm (81 ft-lb)
- Rear brake caliper to trailing arm . . . . 67 Nm (50 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

Brake rotor, removing and installing

Always replace rotors in pairs.

– Without disconnecting brake line at caliper, remove brake caliper as described earlier.



➢ Remove brake rotor mounting screw (**arrow**) from face of rotor.

– Inspect rotor for excessive grooving, cracks and warping. Check rotor thickness. See **Table b**.

NOTE—

The minimum allowable thickness should be stamped on the rotor hub. Measure the rotor braking surface with a micrometer at eight to ten different points and use the smallest measurement recorded.

Table b. Rotor Reconditioning Specifications

	Front	Rear
Wear limit (min. thickness)		
735i/iL	26.4 mm (1.039 in.)	10.4 mm (0.409 in.)
740i/iL, 750iL	26.4 mm (1.039 in.)	18.4 mm (0.724 in.)
Axial runout (max.)		
Rotor removed	0.09 mm (0.004 in.)	0.04 mm (0.002 in.)
Rotor installed	0.20 mm (0.008 in.)	0.20 mm (0.008 in.)

– Installation is reverse of removal.

- Clean rotor with brake cleaner before installing.
- Clean wheel hub with wire brush before installing rotor.
- If brake fluid hose was removed or loosened, entire brake system must be bled as described under **Bleeding Brakes**.
- Once brake assembly is installed depress brake pedal several times to seat caliper and pads.

NOTE—

- *Brake rotor and wheel hub must be free of grease.*
- *When installing new rear brake rotors, the parking brake should be adjusted. See* **Parking Brake**.

Tightening Torques

- Brake rotor to wheel hub . . . . . 16 Nm (12 ft-lb)
- Caliper guide bolt to pad carrier . . . . . 30 Nm (22 ft-lb)
- Front brake caliper to strut assembly . .110 Nm (81 ft-lb)
- Rear brake caliper to trailing arm . . . . 67 Nm (50 ft-lb)
- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

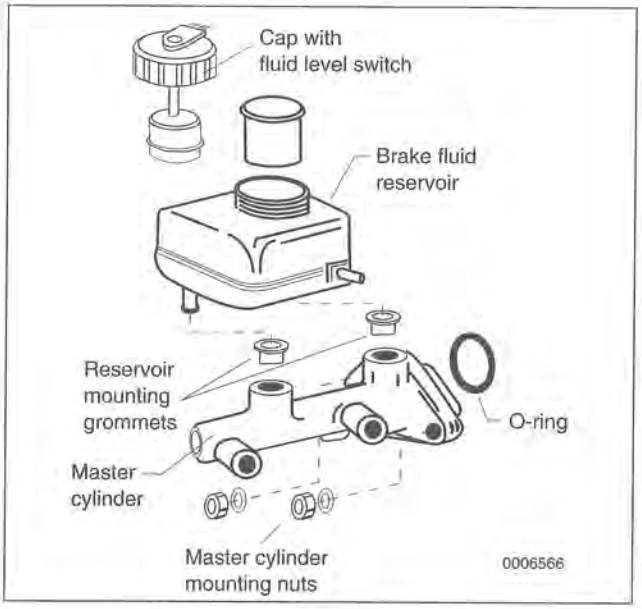
MASTER CYLINDER

On cars with M30 and M70 engines: The brake master cylinder is mounted to the front of the brake booster on the driver side bulkhead.

– On cars with M60 engine: The brake master cylinder is mounted in the front left of the engine compartment, behind the headlight.

NOTE—

Two types of brake power assist systems are used. Early 735i/iL models (built up to 3/1988) and all 750iL models use a hydraulic boost system. 735i/iL built from 3/1988 and all 740i/iL cars use a vacuum boost system.



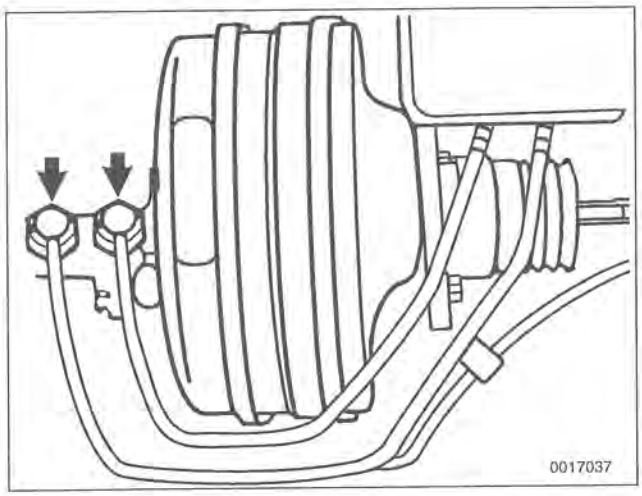
Master cylinder, removing and installing

– Using clean syringe, empty brake fluid reservoir.

CAUTION—

Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.

– Disconnect brake fluid level sender connector from fluid reservoir cap.



– Carefully remove reservoir from master cylinder by pulling straight up.

➢ On 740i/iL: Remove brake fluid supply hoses (**arrows**) from top of master cylinder.

– On cars with manual transmission: Remove clutch master cylinder supply hose from side of fluid reservoir.

– Disconnect brake fluid lines from master cylinder. Plug openings and brake lines.

– Unscrew mounting hardware and remove master cylinder from brake booster.

NOTE—
It may be necessary to move aside the engine main power connector, the diagnostic connector or the hydraulic oil reservoir for better access to the master cylinder fittings.

– Make sure all nuts, fluid couplings, thread bores and mating surfaces are clean.

– If the fluid reservoir was removed, install it carefully using new sealing grommets.

– Mount master cylinder to the brake booster using new O-ring and new self-locking nuts.

CAUTION—
- *On cars with hydraulic brake booster, always replace master cylinder mounting bolts.*
- *Use care not to over-torque the master cylinder mounting nuts. This could damage the brake booster and prevent proper vacuum build-up.*

Tightening Torques

- Brake master cylinder to brake booster
  Hydraulic booster . . . . . 28 Nm (20 ft-lb)
  Vacuum booster . . . . . 21 Nm (16 ft-lb)

– Connect all brake fluid lines and bleed entire brake system as described under **Bleeding Brakes**.

Tightening Torque

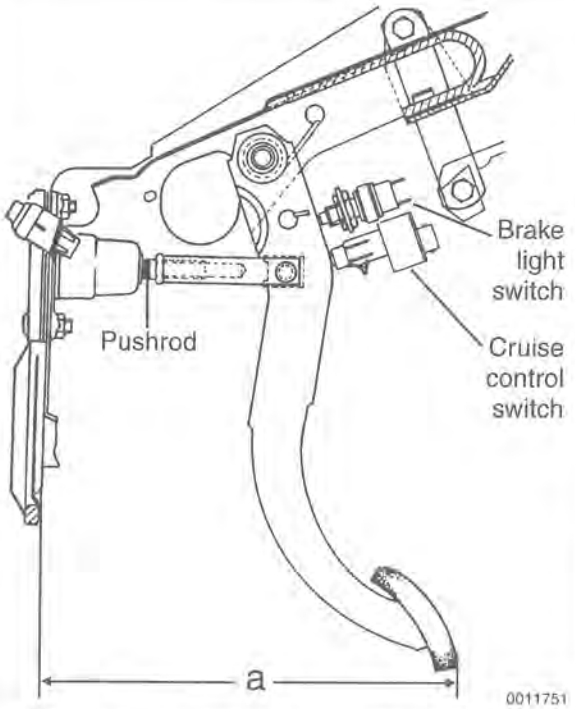
- Brake fluid line to master cylinder
  M10 coupling . . . . . 19 Nm (15 ft-lb)
  M12 coupling . . . . . 17 Nm (13 ft-lb)

Brake pedal height, adjusting (except cars with M60 engine)

Brake pedal height and brake light switch adjustment should be checked any time the master cylinder or the brake booster are removed or replaced.

To adjust pedal height, gain access to the top of the pedal cluster by removing the pedal cluster trim panel, as described in **513 Interior Trim**. Once the trim panel is removed, loosen the lock-nut on the pushrod clevis and slowly turn the pushrod until the correct dimension is obtained. Adjust pedal height to dimension **a**.

For brake light switch adjustment, remove the electrical connectors from the switch, loosen the locknut, and thread the switch in and out until the switch plunger is about ¾ depressed with the pedal in the rest position. Be sure to retighten the locknut on the pushrod clevis and locknut on the brake light switch.



• **Dimension a** = 245–255 mm (9.65–10.00in.)

BRAKE BOOSTER

Two different brake booster systems have been installed in E32 cars. See **Table c**.

Table c. Brake Booster Systems

735i/iL	740i/iL	750iL
Hydraulic brake boost system (to 3/88)	Vacuum brake boost system	Hydraulic brake boost system
Vacuum brake boost system (from 3/88)		

Intake manifold vacuum acts on a large diaphragm in the vacuum booster to help reduce pedal effort. The booster used in 740i/iL cars is a compact dual diaphragm unit which produces increased boost.

In cars with the hydraulic brake booster system, power steering fluid pressure is used to provide boost pressure for the brakes.

Vacuum brake booster, removing and installing (735i/iL)

On 735i/iL cars with vacuum brake booster, the booster is mounted to the rear bulkhead on the driver side of the engine compartment, directly behind the brake master cylinder.

– Using clean syringe, empty brake fluid reservoir.

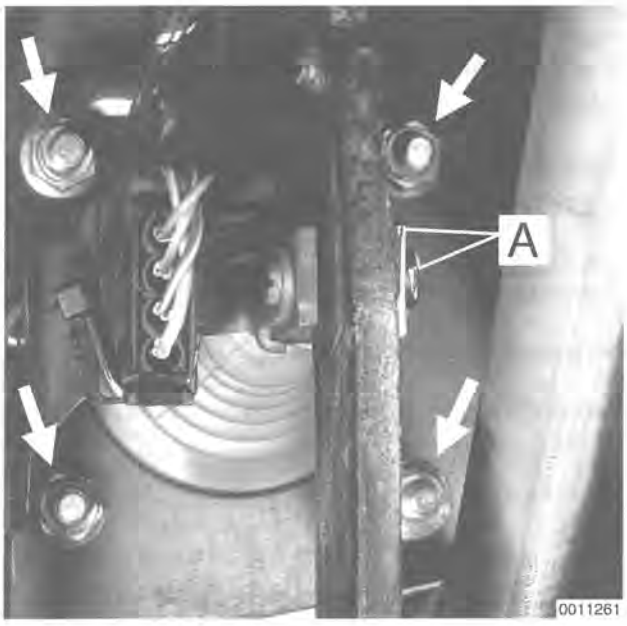
> ***CAUTION—***
> *Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.*

– Remove brake fluid level sender connector from reservoir cap. On cars with manual transmission, remove clutch master cylinder supply hose from side of reservoir.

– Disconnect brake fluid lines from master cylinder.

– Disconnect vacuum hose to brake booster.

– Working inside car, remove dashboard panel(s) from beneath steering column to access pedal assembly. See **513 Interior Trim**.



➢ Remove clip and clevis pin (**A**) from brake booster pushrod and disconnect it from brake pedal lever.

• Remove brake booster mounting nuts (**arrows**).

– Working in engine compartment, remove brake booster together with master cylinder.

– If vacuum booster or master cylinder O-ring is being replaced, disconnect booster from master cylinder.

– During installation make sure all nuts, fluid couplings, thread bores and mating surfaces are clean.

– Mount master cylinder to vacuum booster using new O-ring and new self-locking nuts.

> ***CAUTION—***
> • *On cars with hydraulic brake booster, always replace master cylinder mounting bolts.*
>
> • *Use care not to over-torque the master cylinder mounting nuts. This could damage the brake booster and prevent proper vacuum build-up.*

Tightening Torque

• Brake master cylinder to vacuum brake booster . . . . . 21 Nm (16 ft-lb)

– Mount brake booster/master cylinder assembly to bulkhead using new self-locking nuts.

Tightening Torque

- Brake booster to bulkhead . . . . . 22 Nm (16 ft-lb)

– Connect brake pedal lever to booster pushrod. Make sure clevis pin retaining clip is correctly installed.

– Connect all brake fluid lines and bleed entire brake system as described in **Bleeding Brakes**.

– Connect large vacuum line to vacuum booster.

Tightening Torques

- Brake fluid line to master cylinder17-19 Nm (13-15 ft-lb)

NOTE—

When replacing the brake booster non-return valve or the vacuum hose, install the valve so that the molded arrow on the valve is pointing towards the intake manifold. Use new hose clamps.

– Adjust brake pedal height as described earlier.

– Start engine and check that SRS light functions correctly and that brake lights work properly. Re-check brake pedal height.

Vacuum brake booster, removing and installing (740i/iL)

On 740i/iL cars, the vacuum brake booster is directly behind the brake master cylinder in back of the left headlight.

– Remove brake master cylinder as described earlier.

– Using clean syringe detach brake fluid reservoir and lay aside.

– Disconnect vacuum hose from booster.

➢ Pull retaining clip and clevis pin (**A**) off booster push rod.

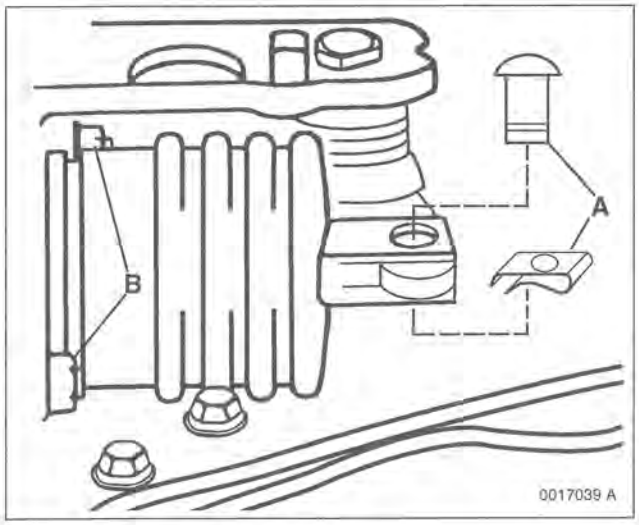
- Remove booster mounting nuts (**B**) and lift out booster.

– Installation is reverse of removal.

- Connect all brake fluid lines and bleed entire brake system as described in **Bleeding Brakes**.
- Connect vacuum line to vacuum booster.

Tightening Torques

- Brake booster to bracket. . . . . 22 Nm (16 ft-lb)
- Brake booster to master cylinder . . . . 21 Nm (20 ft-lb)
- Brake fluid line to master cylinder17-19 Nm (13-15 ft-lb)



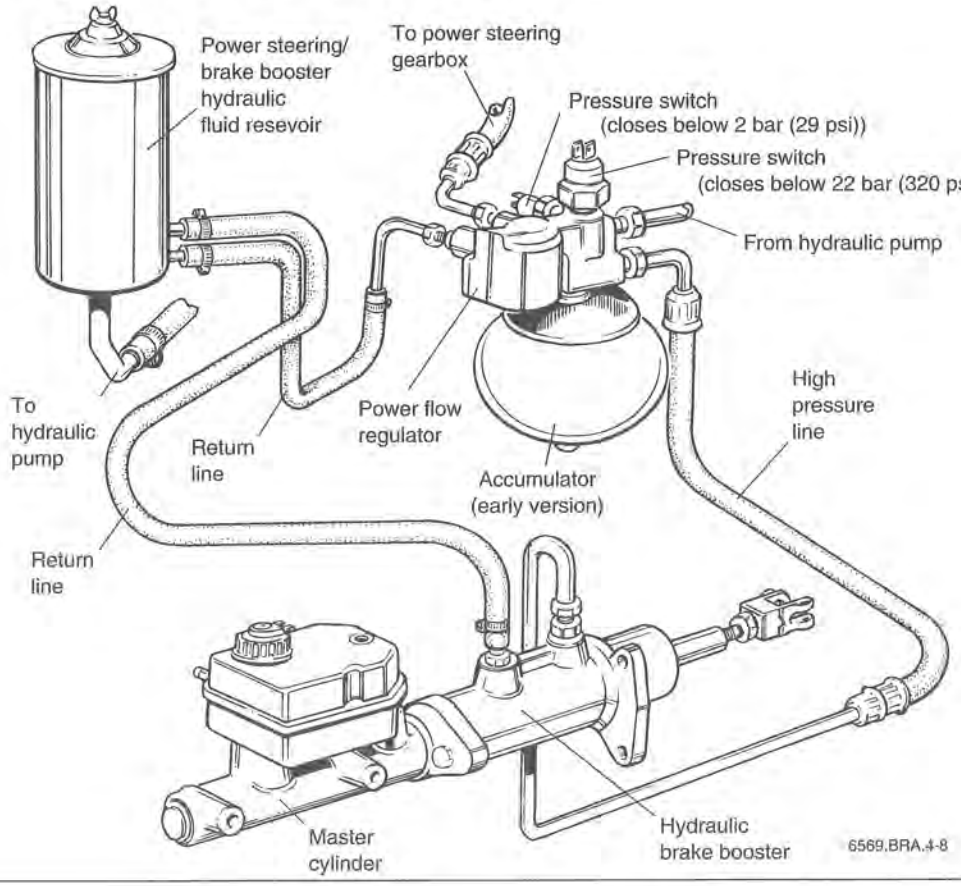
BRAKE BOOSTER

Hydraulic brake booster system

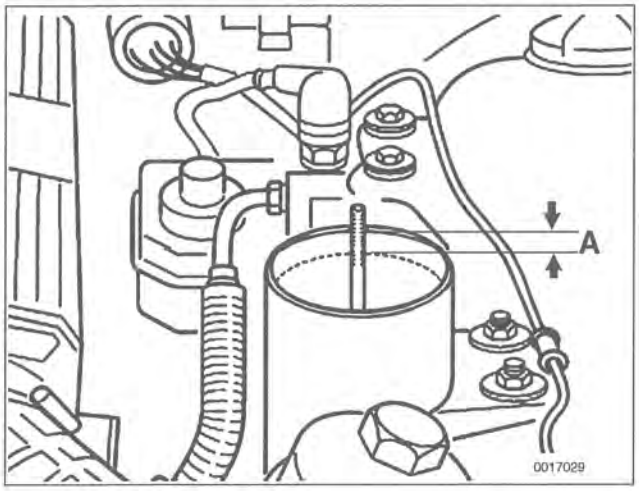
When the engine is running, the power steering pump supplies hydraulic fluid under pressure to the power flow regulator and accumulator. The regulator and accumulator assembly stores and regulates the pressure to the brake booster. When the brake pedal is depressed, the pressure in the brake booster helps actuate the master cylinder to reduce pedal effort.

NOTE —
The hydraulic booster system is sometimes referred to as the H31 system.

Hydraulic brake booster system



The pedal pushrod is connected to the brake booster, which is connected directly to the master cylinder, so failure of the booster does not normally result in total brake failure. The hydraulic brake booster is not repairable, and if faulty must be replaced. Special high-pressure measuring equipment is needed to test the system.



➢ Before testing system, check fluid level in power steering/brake booster reservoir.

- With engine off, remove cover from reservoir.
- Depress brake pedal until fluid level stops rising (approximately 20 times).
- Add fluid if level (**A**) is lower than 25 mm (1 inch) from top rim of reservoir.

NOTE—

- *The hydraulic system on early E32 cars (up to September 1991) uses Pentosin® CHF 7.1 hydraulic fluid.*
- *Beginning with cars produced in September 1991, Pentosin® CHF 11 S is used in the hydraulic system.*

CAUTION—
Check the hydraulic reservoir for a label identifying the type of fluid used. Do not mix the various kinds of fluid.

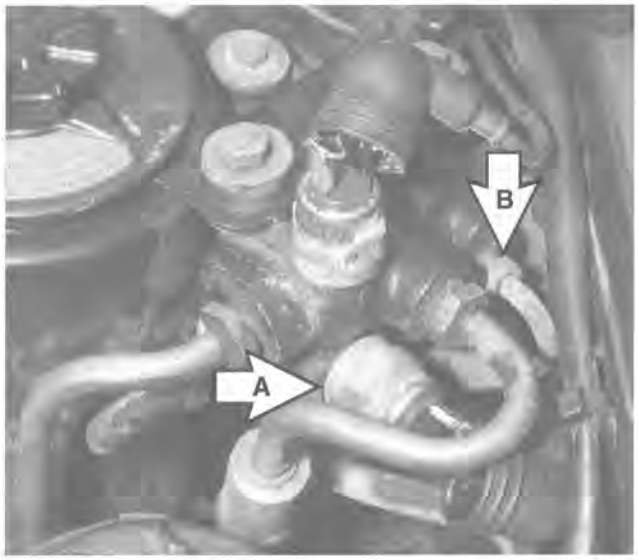
Hydraulic brake booster system, testing

Testing the hydraulic brake booster system is done in three stages:

- Pressure test
- Fluid leak test
- Hydraulic accumulator test

– Discharge hydraulic accumulator pressure by operating brake pedal at least 20 times with engine stopped.

Pressure test



➢ Thoroughly clean area around hydraulic pressure switch on side of power flow regulator and remove pressure switch (**A**).

WARNING—
Extreme cleanliness is essential when working on the hydraulic brake booster system. Even a small piece of dirt could damage the brake booster system or the power steering system.

– Connect pressure gauge in place of pressure switch.

NOTE—
The gauge should have a range of 0 to 60 bar (0 to 1000 psi).

– Start engine and check for leaks. With engine running, pressure should be at upper switching specification listed in **Table d**.

Table d. Hydraulic Brake Booster Test Specifications

Upper switching pressure	52 to 57 bar (754 to 827 psi)
Lower switching pressure	36 to 41 bar (522 to 595 psi)
Maximum allowable pressure drop after 5 minutes	5 bar (73 psi)

– Apply brake pedal until pressure drops to lower switching specification. Check that pressure quickly returns to upper switching specification.

NOTE—
If any faults are found up to this point, the power flow regulator is faulty and should be replaced.

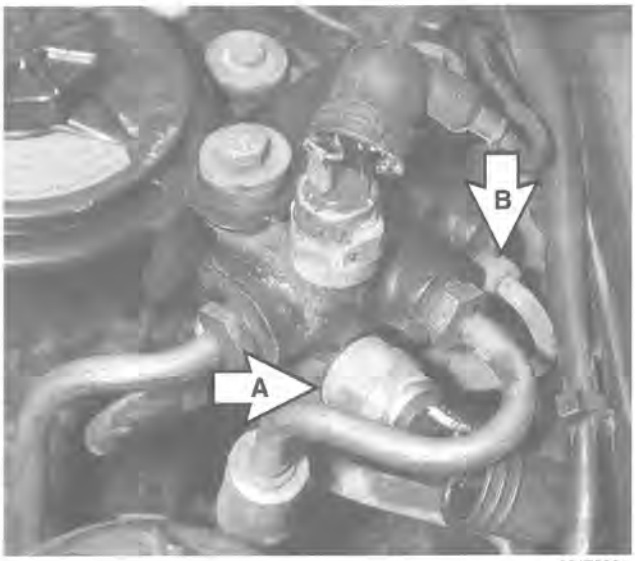
– Turn engine off. After five minutes, pressure drop should be no greater than specification listed in **Table d**.

NOTE—
If the pressure drop exceeds the limits, proceed with fluid leak test below. If the pressure drop is within limits, proceed with hydraulic accumulator test below.

Tightening Torque
- Pressure switch to power flow regulator . . . . . 18 Nm (13 ft-lb)

Fluid leak test

NOTE—
Perform this test if the system did not hold the specified pressure during the pressure test given earlier.



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➢ Remove reservoir return line (**B**) from power flow regulator to check for leaking fluid.

NOTE—
If fluid comes out of the power flow regulator, the regulator is faulty and should be replaced. If no fluid comes out, the brake booster is leaking internally and should be replaced.

– Install return line.

Tightening Torque
- Return line to power flow regulator . . . . . 16 Nm (12 ft-lb)

Hydraulic accumulator test

– Discharge hydraulic accumulator by pumping brake pedal at least 20 times. Start engine. If pressure does not immediately rise to specifications listed in **Table e,** hydraulic accumulator is faulty and should be replaced.

Table e. Hydraulic Accumulator Pressure Specifications

50°F (10°C)	141 to 363 psi (9.75 to 25.0 bar)
68°F (20°C)	145 to 377 psi (10.0 to 26.0 bar)
86°F (30°C)	149 to 402 psi (10.25 to 27.75 bar)

– Remove test equipment and install and tighten return line and pressure switch.

Tightening torque

- Pressure switch to power flow regulator . . . . . 18 Nm (13 ft-lb)

Hydraulic brake booster, replacing

– Discharge hydraulic accumulator by operating brake pedal at least 20 times with the engine stopped.

– Remove master cylinder as described earlier.

➢ Clean supply and return line fittings on brake booster. Remove hydraulic lines from booster.

WARNING—
Extreme cleanliness is essential when working on the hydraulic brake booster system. Even a small piece of dirt could damage the brake booster system or the power steering system.

– Working inside car, remove lower left trim panels above brake pedal. See **513 Interior Trim**.

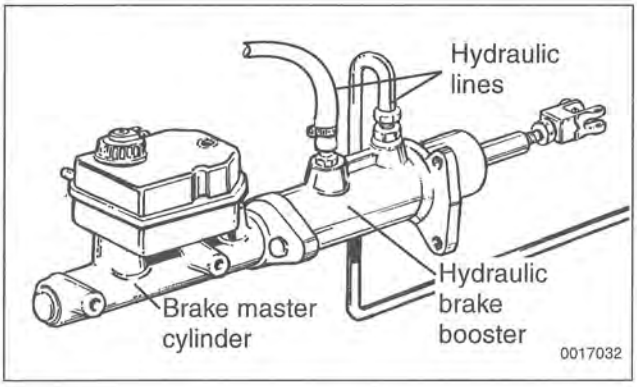
➢ Remove clip and clevis pin (**A**) from brake booster pushrod and disconnect it from brake pedal lever.Remove four mounting nuts. Working from engine compartment side, pull brake booster from pedal base.

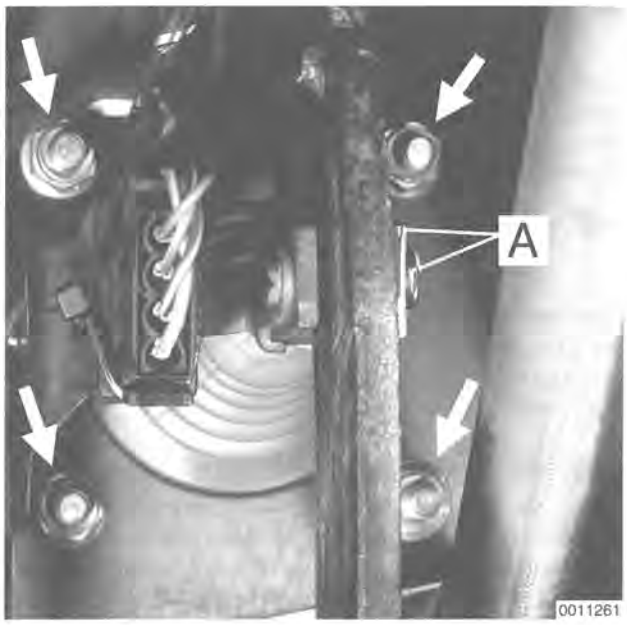
– Installation of brake booster is reverse of removal.

- Tighten all fittings to specified torque.
- Adjust brake pedal travel and brake light switch as described under **Brake pedal height, adjusting.**

Tightening torque

- Brake booster to bulkhead . . . . . 22 Nm (16 ft-lb)
- Hydraulic lines to brake booster 31 Nm (23 ft-lb)
- Master cylinder to hydraulic brake booster . . . . . 28 Nm (20 ft-lb)





BRAKE BOOSTER

CAUTION—

- *On cars with hydraulic brake booster, always replace master cylinder mounting bolts.*
- *Use care not to over-torque the master cylinder mounting nuts. This could damage the brake booster and prevent proper vacuum build-up.*
- *Hydraulic fittings should be installed using a crowfoot flare-nut wrench and an accurate torque wrench. Failure to tighten the fittings to the specified torque with the correct wrench could result in damage to the component or the fitting. Damaged fittings or components will result in leaks, which will affect system operation.*

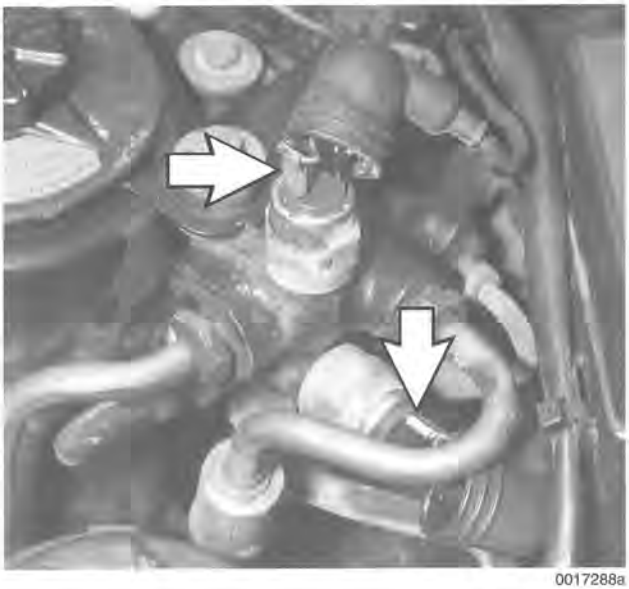
Power flow regulator, replacing

– Discharge hydraulic brake accumulator by operating brake pedal at least 20 times with engine stopped.

– Thoroughly clean power flow regulator and its fittings.

WARNING—

Extreme cleanliness is essential when working on the hydraulic brake booster system. Even a small piece of dirt could damage the brake booster system or the power steering system.



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➢ Remove and label electrical wires from two pressure switches on regulator (**arrows**).

– Remove hydraulic lines from power flow regulator.

– Remove regulator by removing two mounting bolts.

– Installation of power flow regulator is reverse of removal.

- If power flow regulator is being replaced, install old switches to new regulator.
- On early cars (to 12/90): Remove accumulator from regulator by clamping regulator in a soft-jaw vise and threading accumulator off. Reinstall in new regulator.
- Tighten all fittings to specified torque.
- Adjust brake pedal height as described earlier.
- When installation is complete, bleed power steering system as described in **320 Steering and Wheel Alignment**.

WARNING—

Hydraulic fittings should be installed using a crowfoot flare-nut wrench and an accurate torque wrench. Failure to tighten the fittings to the specified torque with the correct wrench could result in damage to the component or the fitting. Damaged fittings or components will result in leaks, which will affect system operation.

NOTE—

If the accumulator is difficult to remove from the regulator, use a strap wrench or a large oil filter wrench on the accumulator while the regulator is in the vise.

Tightening Torques

- Accumulator to power flow regulator . . . . . 50 Nm (36 ft-lb)
- Line from power flow regulator to steering gearbox . . . . . 50 Nm (36 ft-lb)
- Line from power flow regulator to power steering pump . . . . . 40 Nm (30 ft-lb)
- Line from power flow regulator to brake booster . . . . . 31 Nm (23 ft-lb)
- Pressure switches to power flow regulator . . . . . 18 Nm (13 ft-lb)
- Return pipe from power flow regulator to fluid reservoir . . . . . 16 Nm (12 ft-lb)

Hydraulic brake accumulator, removing and installing

The hydraulic accumulator, or "bomb," in early models (up to 12/90) is installed to the underside of the power flow regulator. In later models (from 12/90) it is installed behind the front left foglight.

Early version (up to 12/90)

– Remove power flow regulator as described earlier.

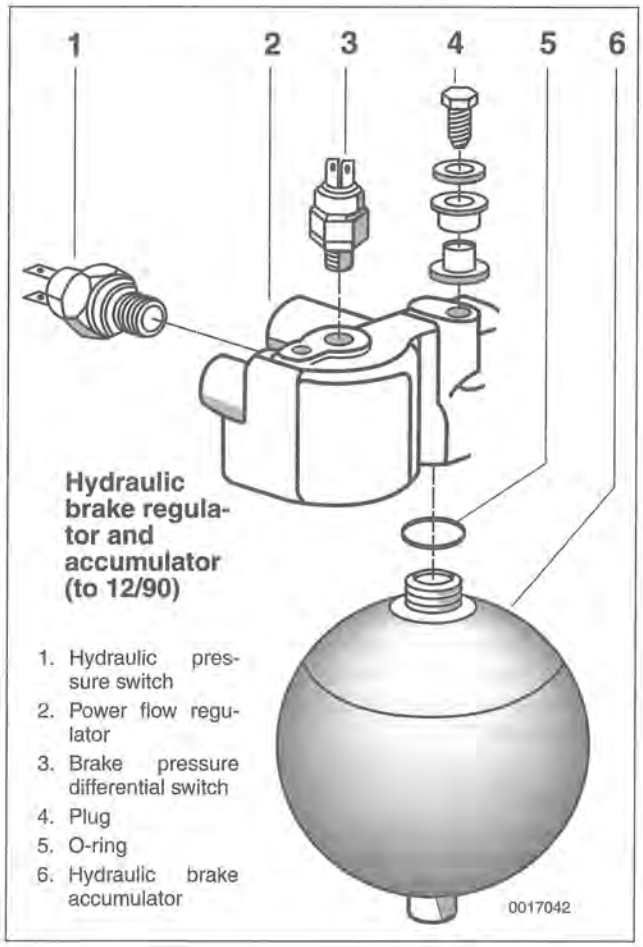
➢ Remove accumulator from regulator by clamping regulator in a soft-jaw vise and threading accumulator off.

– Reinstall in new regulator.

– Reinstall regulator as described earlier.

– Run engine and operate brake pedal.

– Check hydraulic fluid level.



Hydraulic brake regulator and accumulator (to 12/90)

1. Hydraulic pressure switch
2. Power flow regulator
3. Brake pressure differential switch
4. Plug
5. O-ring
6. Hydraulic brake accumulator

Tightening Torques

- Accumulator to power flow regulator . . . . . 50 Nm (36 ft-lb)
- Line from power flow regulator to steering gearbox . . . . . 50 Nm (36 ft-lb)
- Line from power flow regulator to power steering pump . . . . . 40 Nm (30 ft-lb)
- Line from power flow regulator to brake booster . . . . . 25 to 35 Nm (18 to 25 ft-lb)
- Return pipe from power flow regulator to fluid reservoir . . . . . 16 Nm (12 ft-lb)

Late version (from 12/90)

– Discharge hydraulic brake accumulator by operating brake pedal at least 20 times with engine stopped.

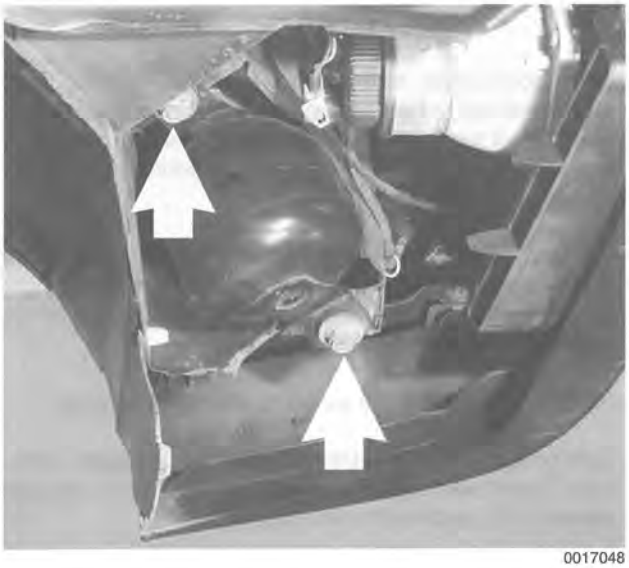


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- Raise car on lift.

> ***WARNING—***
> *Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

- Remove two bolts (**arrows**) in left front wheel housing holding alternator fresh air intake duct in place and remove duct.



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- Remove accumulator mounting nuts (**arrows**) from brackets.
- Disconnect hydraulic lines from accumulator.

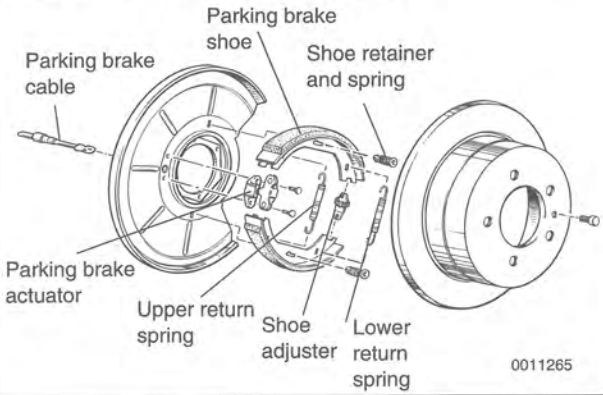
NOTE—
Have shop towel ready to catch any fluid that escapes.

- Installation is reverse of removal.
  - Run engine and operate brake pedal.
  - Check hydraulic fluid level.

Tightening Torques

- Accumulator to bracket (M8) . . . . . 22 Nm (16 ft-lb)
- Line to hydraulic power booster . . . . . 40 Nm (30 ft-lb)
- Return pipe from power flow regulator to fluid reservoir . . . . . 16 Nm (12 ft-lb)

Parking brake assembly



PARKING BRAKE

The parking brake is a dual drum system integrated into the rear wheel brake rotors.

Parking brake shoe replacement is not normally required, but periodic adjustment of the shoes may be necessary from time to time to compensate for wear. The parking brake should also be adjusted any time the cable, the rear brake rotor or the parking brake shoes are replaced.

Parking brake, adjusting

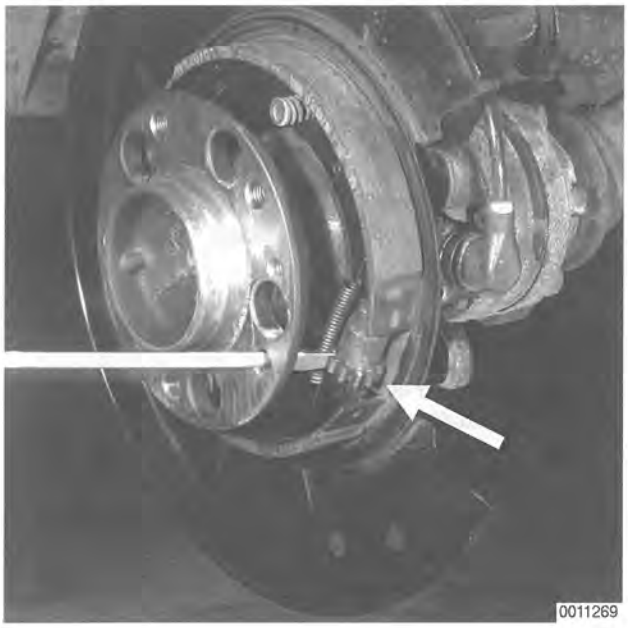


The parking brake can be adjusted with the wheels installed, although the rear of the car will need to be lifted slightly to spin the rear wheels.

- Lift parking brake lever boot out of console. While holding cables stationary, loosen parking brake cable nuts (**arrows**) until they are completely slack.
- Raise rear of car.

> ***WARNING —***
> *Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

- Remove one lug bolt from each rear wheel.
- Turn road wheel until lug bolt hole lines up with parking brake adjuster.



- Using screwdriver, turn adjuster (**arrow**) to expand brake shoes until road wheel can no longer turn, then back adjuster off about eight (8) notches. (Rear wheel and brake rotor shown removed in photo.) Repeat procedure on other rear wheel.
- Working inside car, set parking brake several times to seat cable. Then pull parking brake lever up four notches. Tighten cable adjusting nuts until it is just possible to turn rear wheels with slight resistance.
- Release lever and make sure rear wheels turn freely.
- Turn on ignition. With parking brake lever released, instrument panel warning light should be off. Check that light comes on as soon as lever is pulled up.
- Install parking brake lever boot. Install road wheel lug bolts.

Tightening Torque

- Road wheel to hub . . . . . 100 ± 10 Nm (74 ± 7 ft-lb)

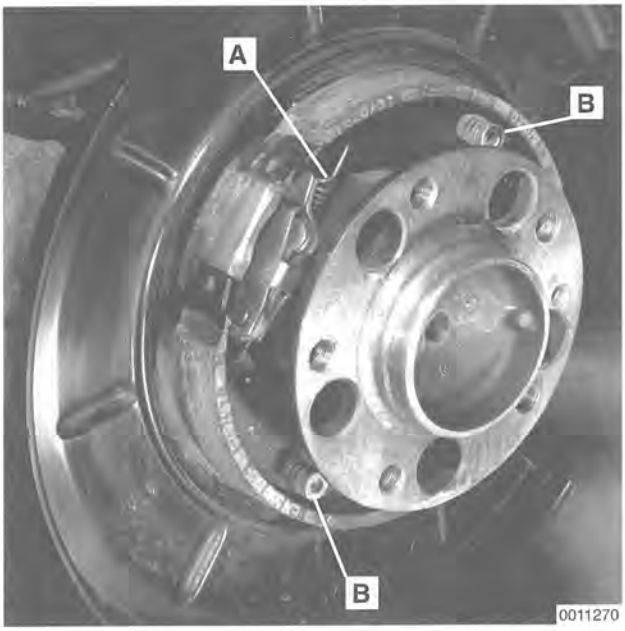
Parking brake shoes, removing and installing

– Raise rear of car.

> ***WARNING—***
> *Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

– Without disconnecting brake fluid hose, remove rear brake calipers from trailing arms. Remove rear brake rotors. See **Brake Pads, Calipers and Rotors**.

> ***CAUTION—***
> *Do not let the brake caliper assembly hang from the brake hose. Support it from the chassis with strong wire.*



➤ Unhook upper return spring (**A**) from brake shoes. Remove shoe retainers (**B**) by pushing them and rotating 90°.

– Spread shoes apart at top and remove them from below.

> ***NOTE—***
> *When removing the brake shoes the shoe expander pivot pin may fall out.*

– Inspect shoe expander to make sure it functions properly. Apply thin coat of grease to sliding parts and pins.

– Installation is reverse of removal. Be sure to adjust parking brake cables as described earlier.

Parking brake cable, replacing



– Remove rear brake caliper and rotor. See **Brake Pads, Calipers, and Rotors**.

– Remove parking brake shoes as described above.

– Remove parking brake cable from cable holder on trailing arm.

➤ Working inside car, lift parking brake lever boot out of console. Remove cable adjusting nut (**arrow**).

– Slide cable out of housing from below car and install new cable.

– Installation is reverse of removal. Adjust parking brake as described above.

ANTILOCK BRAKE SYSTEM (ABS)/ TRACTION CONTROL (ASC/ASC+T)

Automatic stability control (ASC) uses ABS wheel sensor input to the DME to improve vehicle stability by controlling power to the rear wheels.

ABS/ASC+T system in 750iL *(other models similar)*

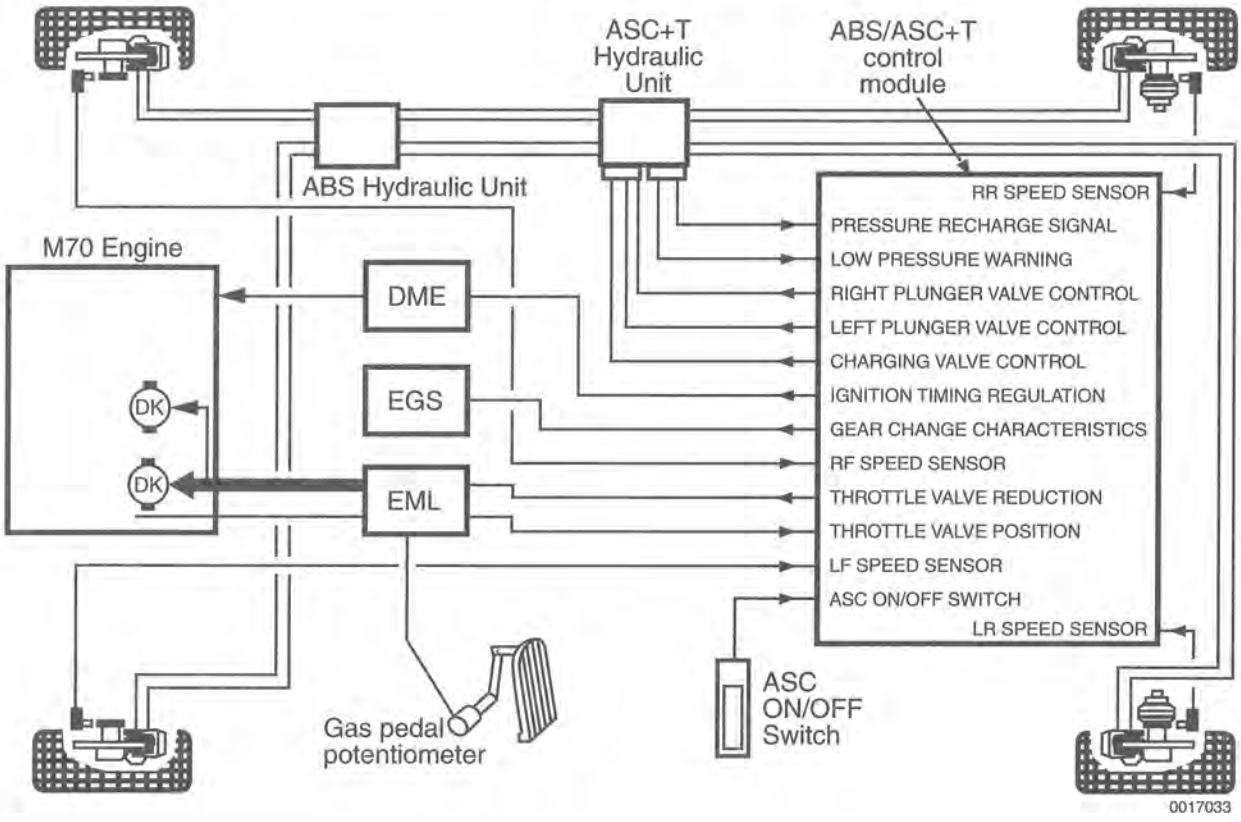
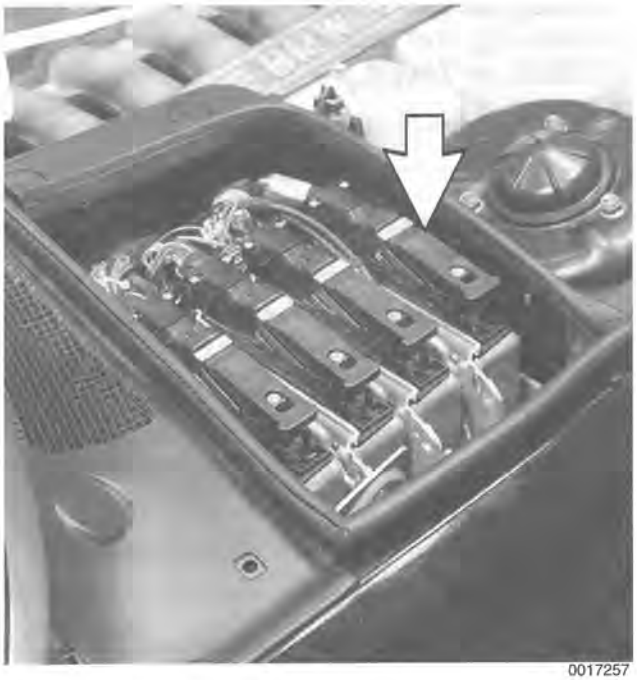


Table f. ABS and Traction Control Application in E32 Cars

Model	ABS	ASC	ASC+T
735i/iL	Yes	Yes (from 1991)	No
740i/iL	Yes	No	Yes
750iL	Yes	Yes (1990)	Yes (from 1991)

Automatic stability control with traction control (ASC+T) uses individual wheel brakes as well as engine management to control wheel lock up or spin.

The traction control system is integrated with the ABS system. The two systems share the same control module and receive wheel speed information from the wheel speed sensors. However, the two systems operate independently from each other. Each is capable of functioning in the event of fail-


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ure by the other, unless shared electrical components such as power supply also fail.

The ABS/traction control module works in conjunction with the DME/EML (735i/iL or 750iL) or DME/ADS (740i/iL) and EGS (transmission control) modules.

The ABS/traction control system is designed to be maintenance free. There are no adjustments that can be made to the system. Repair and troubleshooting of the major ABS/traction control system components require special test equipment and knowledge and should be done by an authorized BMW dealer.

The ABS/traction control electronic control module (**arrow**) is located in the electronics box (E-box) in the right rear of the engine compartment. (E-box on 750iL shown, other models are similar.)

ABS system inspection

ABS self-tests each time the car is started. Once the test is complete, the ABS dashboard light turns off. If the ABS dashboard light remains lit or comes on at any time during driving, a system fault has occurred and the ABS system is electronically disabled. The conventional braking system remains fully functioning.

A visual inspection of the ABS system may help to locate system faults. If no visual faults can be found and the ABS light remains on, have the system diagnosed by an authorized BMW dealer.

Carefully inspect the entire ABS wiring harness, particularly the pulse sensor harnesses and connectors near each wheel. Look for chafing or damage due to incorrectly routed wires.

Remove the pulse sensors and clean the sensor tips. Inspect the toothed ABS pulse wheels for missing teeth or other damage. Check the pulse wheels for dirt, brake pad dust accumulation, or heavy rust deposits that could alter the clearance between the sensor tip and the wheel.

NOTE—
If a front pulse wheel is damaged, the entire wheel hub with integral wheel bearing must be replaced. In the rear the pulse wheel is integral with the drive axle flange. See **310 Front Suspension** *or* **330 Rear Suspension**.

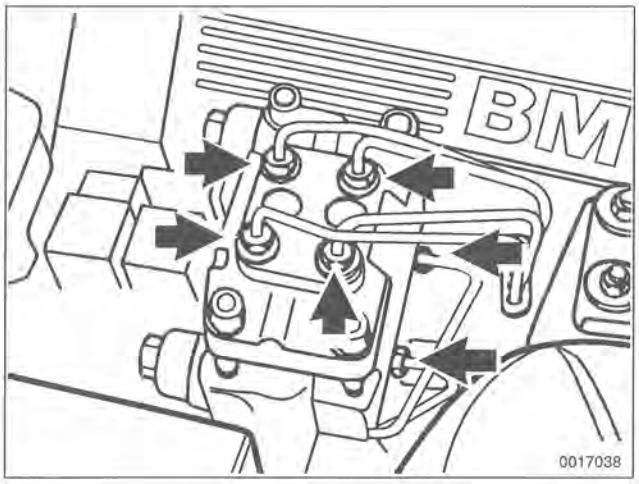
ABS hydraulic control unit, removing and installing (735i/iL or 740i/iL)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Using a clean syringe drain brake fluid from reservoir.

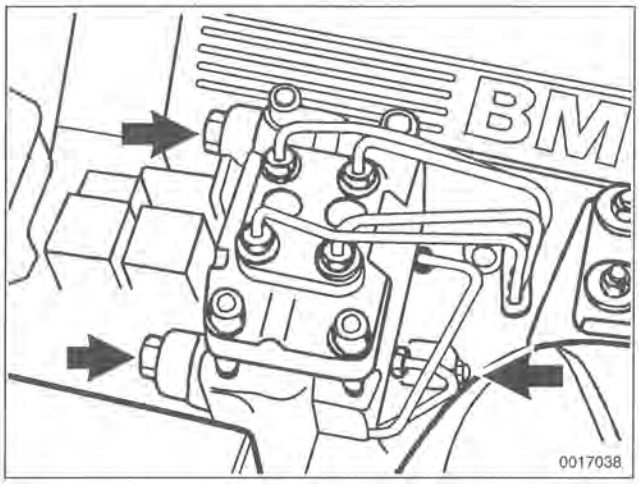
– Remove plastic cover on ABS hydraulic control unit. Disconnect electrical harness connector and ground cable.



➢ Loosen but do not remove ABS control unit hydraulic lines (**arrows**).

– Remove hydraulic lines and insert plugs in openings.

> ***CAUTION—***
> • *Be very sure top of ABS unit is clean and free of any dirt before removing hydraulic lines.*
>
> • *Mark all hydraulic lines before removing them. Lines must go back in the same locations as they were removed from.*



➢ Loosen ABS unit mounting bolts (**arrows**) and slide unit up and out of its mounts.

– Installation is reverse of removal. Bleed complete brake system.

Tightening Torques

• Brake lines to ABS unit . . . . . 17-19 Nm (13-15 ft-lb)

ABS hydraulic control unit, removing and installing (750iL)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*


0017044

– Remove upper and lower left side air filter housing.

➢ Loosen but do not remove ABS control unit hydraulic lines (**arrows**).

NOTE—
- *Have shop towel ready to catch any fluid that escapes.*
- *Left headlight may need to be removed for better access to brake lines.*

– Remove plastic cover on ABS hydraulic control unit. Disconnect electrical harness connector and ground cable.

– Remove hydraulic lines and insert plugs in openings.

CAUTION—
- *Be very sure top of ABS unit is clean and free of any dirt before removing hydraulic lines.*
- *Mark all hydraulic lines before removing them. Lines must go back in the same locations as they were removed from.*

– Loosen ABS unit mounting bolts and slide unit up and out of its mounts.

– Installation is reverse of removal. Bleed complete brake system.

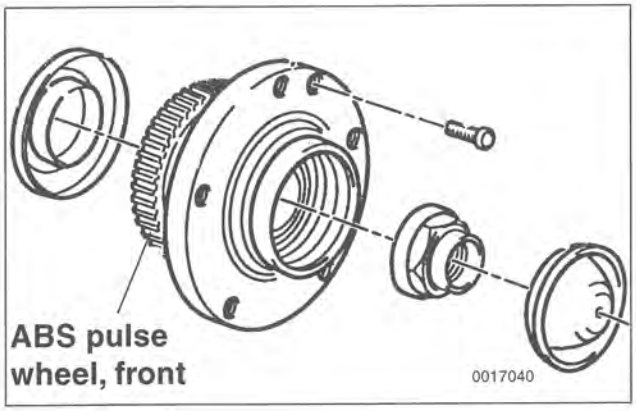
Tightening Torques

- Brake lines to ABS unit
  M10 coupling . . . . . 19 Nm (15 ft-lb)
  M12 coupling . . . . . 17 Nm (13 ft-lb)

ABS pulse wheel

Dirt or rust accumulation on the toothed pulse wheels, which can send false signals to the ABS/traction control module, must be cleaned off. If any teeth are damaged or broken, the wheel must be replaced.

The rear wheel pulse wheel is part of the outer drive axle flange. See **330 Rear Suspension** for drive axle and flange removal.

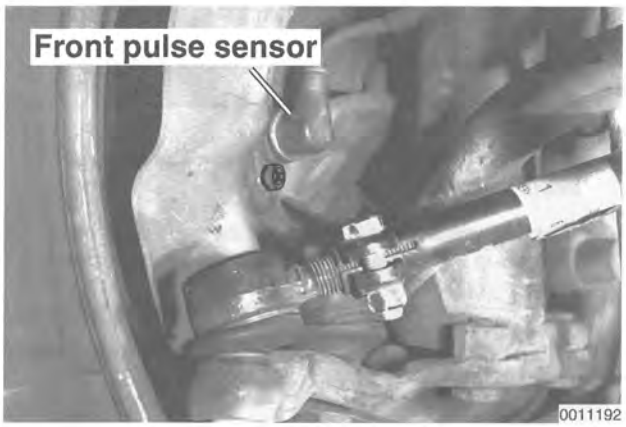

ABS pulse wheel, front
0017040

➢ The front wheel pulse wheel is integral with the wheel hub and wheel bearing. See **310 Front Suspension** for front wheel hub removal.

ABS pulse sensor, replacing

– Raise car and locate pulse sensor.

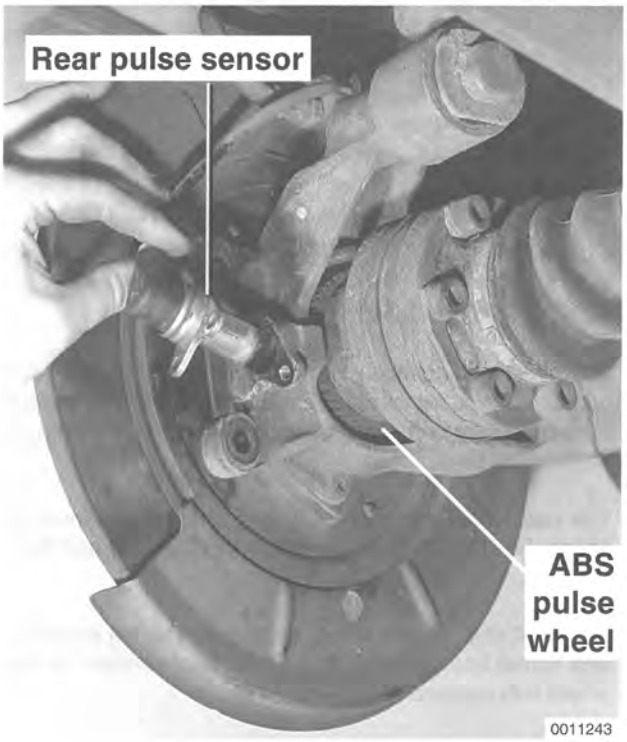
> ***WARNING—***
> *Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*



Front sensor

➢ Unscrew pulse sensor mounting bolt.

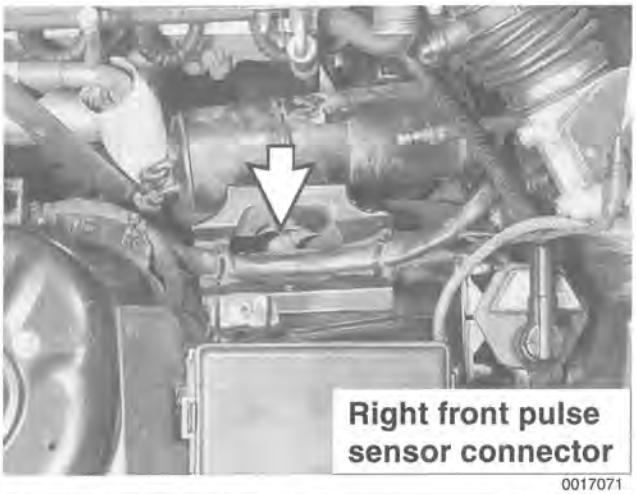
- Remove sensor from its housing.
- Remove harness from any retaining mounts.



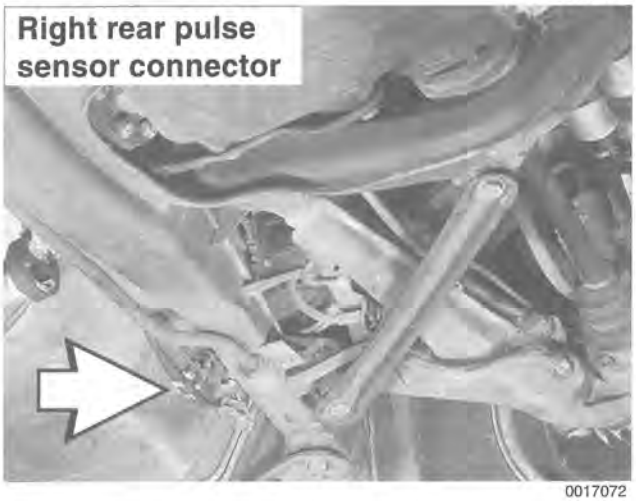
Rear sensor

➢ Remove rear wheel and brake caliper as described earlier.

- Unscrew pulse sensor mounting bolt.
- Remove sensor from housing.



0017071



0017072

➢ Working in engine compartment (front wheel sensors) or under rear of car (rear wheel sensors), disconnect pulse sensor connector and remove sensor from car.

NOTE—

- *To gain access to the left front sensor connector, detach and move aside oil filter housing or hydraulic fluid reservoir, as needed.*
- *To gain access to the right front sensor connector, detach and move aside the windshield washer reservoir and the fuel tank purge canister, as needed.*
- *To gain access to the left rear sensor connector, lift the left rear seat cushion as described in* **520 Seats**.

– Apply thin coat of Molykote® Longterm 2 or equivalent grease to pulse sensor and housing. Installation is reverse of removal.

Table g. ABS Pulse Sensor to Pulse Wheel Gap

Wheel	Gap
Front	0.18 - 0.71 mm (0.007 - 0.028 in)
Rear	0.15 - 0.88 mm (0.006 - 0.035 in)

ASC+T System

NOTE—

To determine whether an E32 car is equipped with ASC+T, look for the ASC+T hydraulic control unit. It is installed next to the left front strut tower in the engine compartment. Most 1991 and later 740i/iL and 750iL cars are equipped with ASC+T.

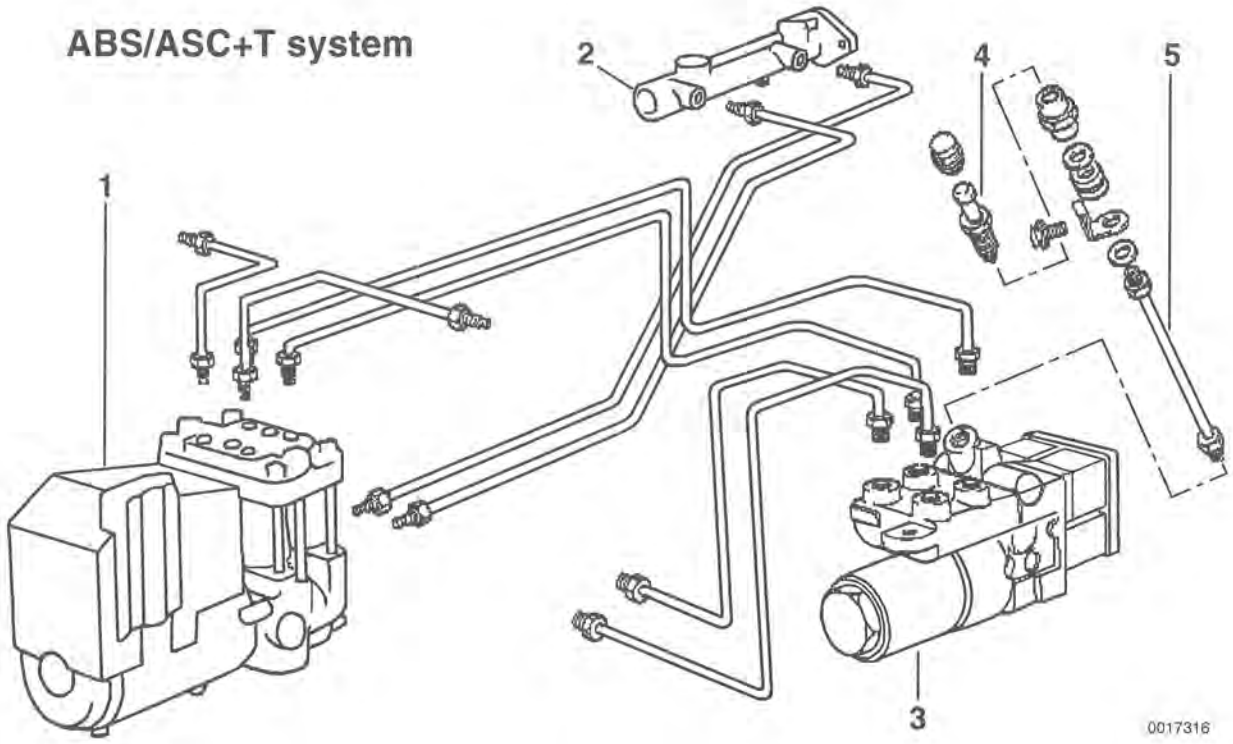
The ABS wheel speed sensors supply the traction control system with wheel speed input. The ASC system uses this input to control throttle and timing, thereby reducing the potential for spin at the rear wheels.

The ASC+T system adds the potential for braking control at the rear wheels, depending on the degree of wheel slip and road speed. In addition, by braking the spinning wheel and directing torque to the wheel with better traction, the need for a limited slip differential is eliminated.

NOTE—

For optimum propulsion in deep snow, or if the car needs to be rocked by rapidly changing between forward and reverse, the traction control system can be switched off using the ASC switch on the center console.

ABS/ASC+T system



1. ABS hydraulic control unit
2. Brake master cylinder
3. ASC+T hydraulic control unit
4. ASC+T bleeder screw (750iL model)
5. ASC+T bleeder extender (740i/iL model)

CAUTION—

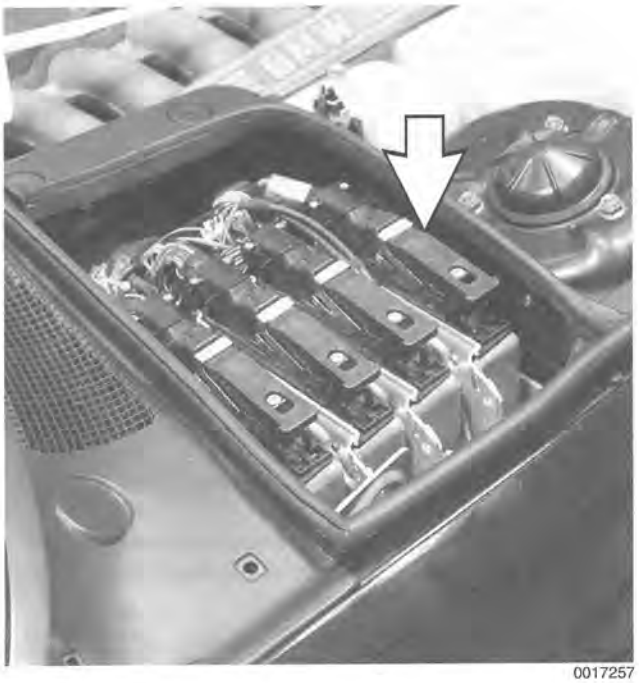
- *ASC+T may be unnecessarily activated if tires are unequal in size, traction or inflation.*
- *Switch the system off if fitting snow-chains.*

The driver is informed of the status of the ASC+T system by an indicator lamp on the instrument cluster.

Whenever the ignition system is switched on, the ASC+T system is in operation. The indicator lamp goes off when the engine is started. If a wheel speed sensor indicates wheel slip due to excessive acceleration for the given road conditions, the ASC lamp flashes to alert the driver. At the same time, the system acts through the DME and the ABS systems to reduce power to the wheel(s). If the ASC+T system fails or is switched off, the ASC lamp stays on.

In addition, the EGS (automatic transmission) control module modifies gear shift points in response to signals from the ASC+T control module.

Bleeding hydraulic system (ASC+T)


0017257

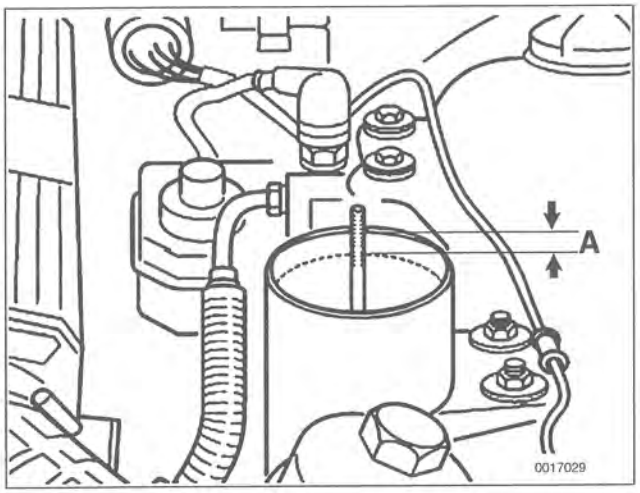
NOTE—

- *Before bleeding the hydraulic system, be sure the brake system is filled with brake fluid.*
- *The hydraulic system on early E32 cars uses Pentosin® CHF 7.1 hydraulic fluid.*
- *Beginning with cars produced in September 1991, Pentosin® CHF 11 S is used in the hydraulic system.*

> ***CAUTION—***
> *Check the hydraulic reservoir for a label identifying the type of fluid used. Do not mix the various kinds of fluid.*

– With ignition switch in off position remove cover from E-Box located in the right rear of engine compartment.

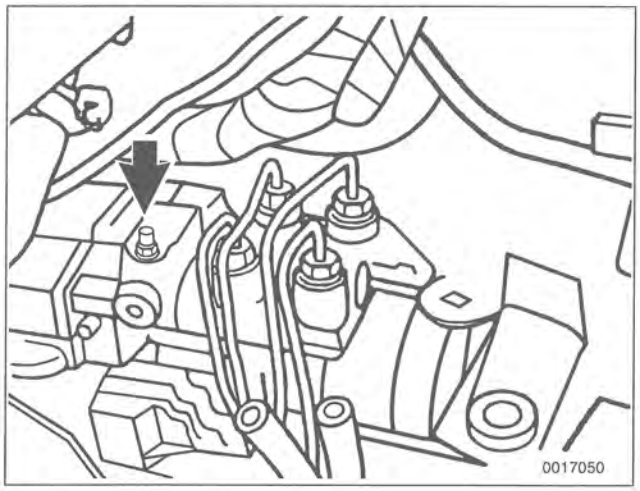
➤ Disconnect harness connector from ABS/ASC+T control unit (**arrow**).



➤ Fill hydraulic oil reservoir to **A** = 25 mm (1 inch) from top.

– Reconnect control unit harness connector.

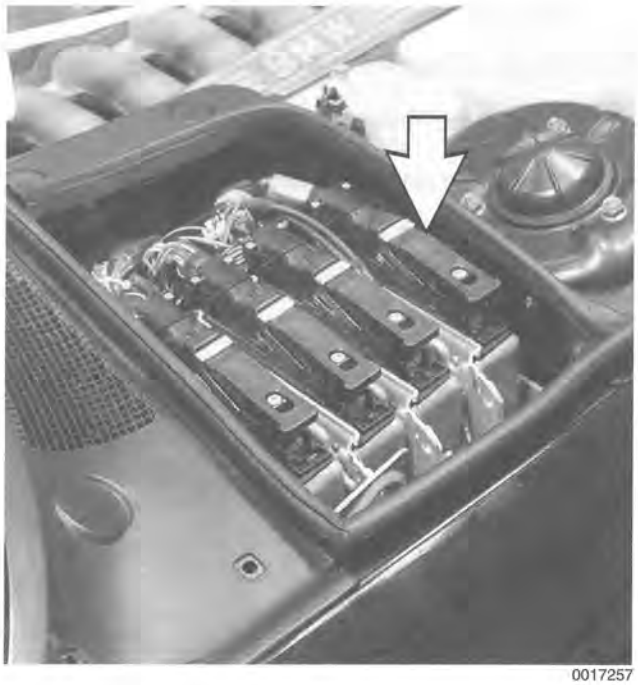
– Start engine and run for at least 30 seconds.



- Install bleeder hose on ASC+T hydraulic control unit bleeder valve (**arrow**) and place other end of hose in waste bottle.
- Open bleeder valve and flush system until oil is free of air bubbles.
- Close bleeder valve.
- Shut engine off.
- Check and if necessary top up hydraulic fluid level.

Reinitializing ABS/ASC+T control module

The ABS/ASC+T system must be reinitialized if any of the following components has been disconnected or replaced.
– ABS/ASC+T hydraulic control unit
– Throttle-valve assembly
– Throttle potentiometer



- Disconnect ABS/ASC+T control module harness connector (**arrow**) located in E-box at right rear corner of engine compartment.
- Run engine for one minute, then shut off.
- Reattach ABS/ASC+T control module.

ASC+T hydraulic control unit, replacing (740i/iL)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

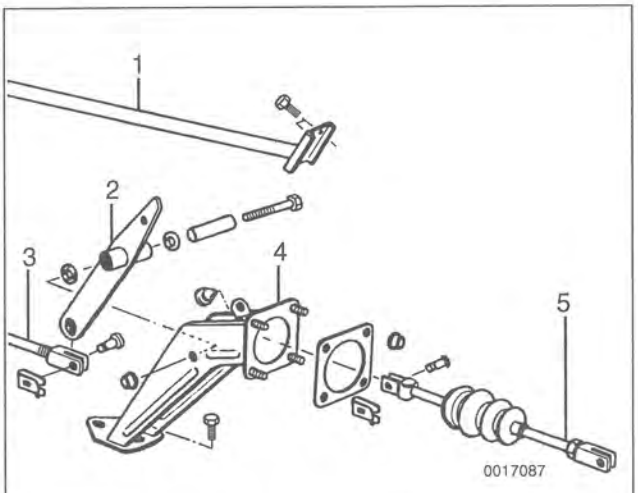
– Using a clean syringe drain hydraulic fluid reservoir. Remove reservoir.

– Remove oil filter housing supply line support bracket.

– Remove dashboard panel(s) from beneath steering column to access pedal assembly. See **513 Interior Trim**.



➤ Working inside car, remove rear pedal console mounting nuts (**arrows**).

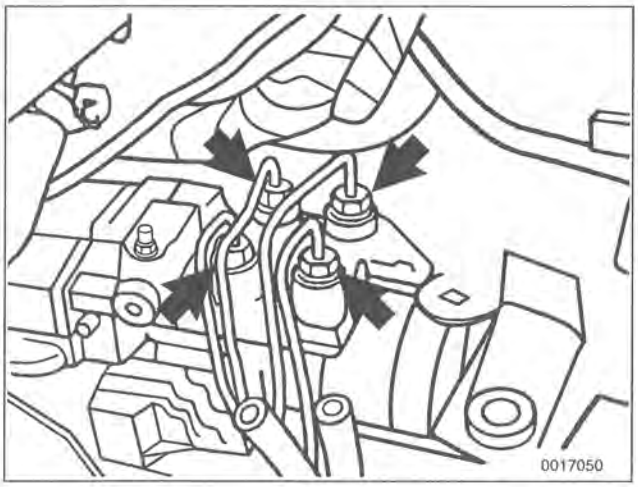


1. Pedal console support tube
2. Reversing lever
3. Brake booster pullrod
4. Pedal console, rear
5. Brake pedal pushrod

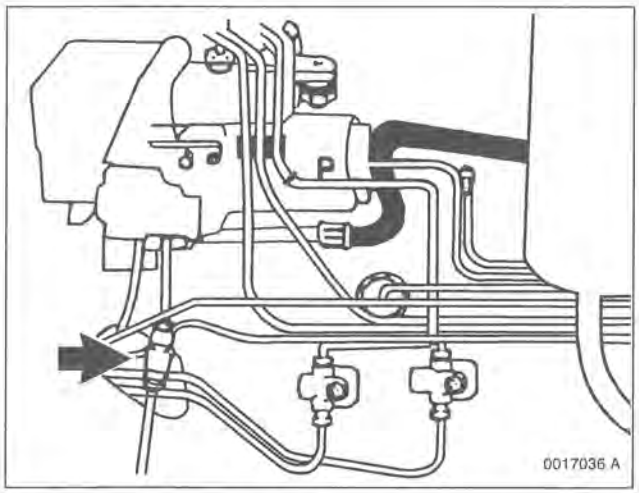
➤ Working in engine compartment close to rear bulkhead, remove rear pedal console assembly.

– Loosen ASC+T hydraulic unit bleeder valve to release hydraulic pressure.

NOTE—
Have shop towel ready to catch escaping oil.



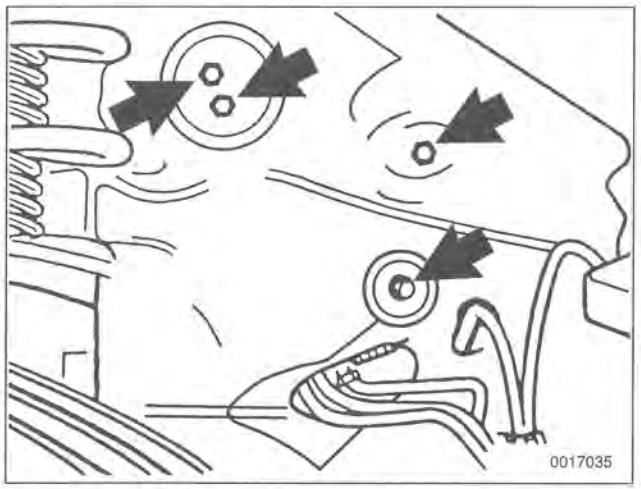
➢ Disconnect four brake lines (**arrows**) at top of hydraulic unit. Also remove brake lines to ABS hydraulic control unit, as necessary.



– Raise front of car and remove left front wheel.

WARNING—
Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

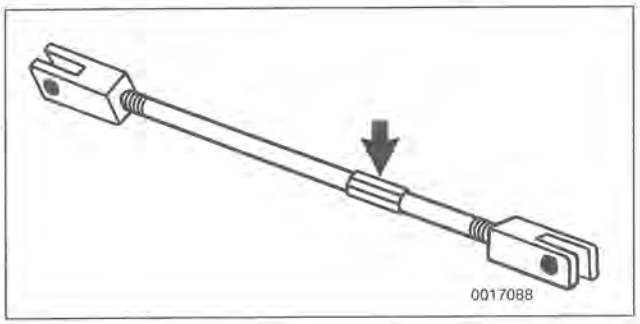
➢ Remove engine splash pan if necessary. Disconnect hydraulic fluid line from adapter fitting (**arrow**) from below.



– Remove left front wheel housing splash shield.

➢ Remove four hydraulic unit mounting bolts (**arrows**) in back of splash shield.

– Lift ASC+T hydraulic unit out through opening made by removing pedal console assembly.



When reinstalling brake pullrod, make sure flattened section of rod (**arrow**) is installed toward engine compartment rear bulkhead.

– Remainder of installation is reverse of removal.
  - Bleed brake system as described under **Bleeding brakes (cars with ASC+T)**.
  - Reinitialize ASC+T system as described earlier.

Tightening Torques
- Brake lines to hydraulic unit . . . 17-19 Nm (13-15 ft-lb)
- Rear pedal console to bulkhead . . . . . 22 Nm (16 ft-lb)

ASC+T hydraulic control unit, replacing (750iL)

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

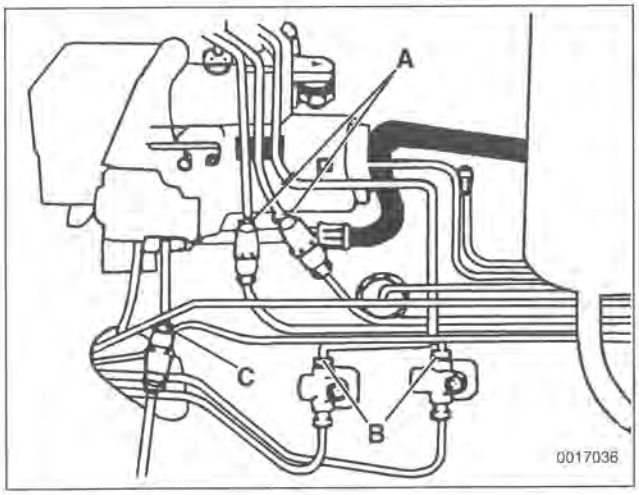
– Remove brake booster and master cylinder as described earlier.

– Loosen hydraulic unit bleeder valve to release hydraulic pressure.

NOTE—
Have shop towel ready to catch escaping oil.

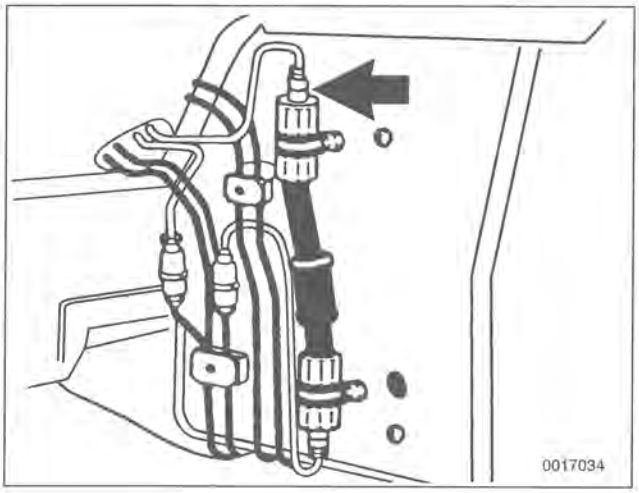
– Raise front of car and remove left front wheel.

> ***WARNING—***
> *Make sure the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

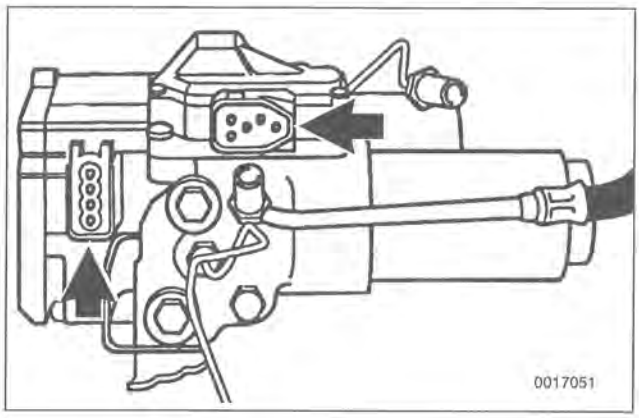


– Remove engine splash pan if necessary.

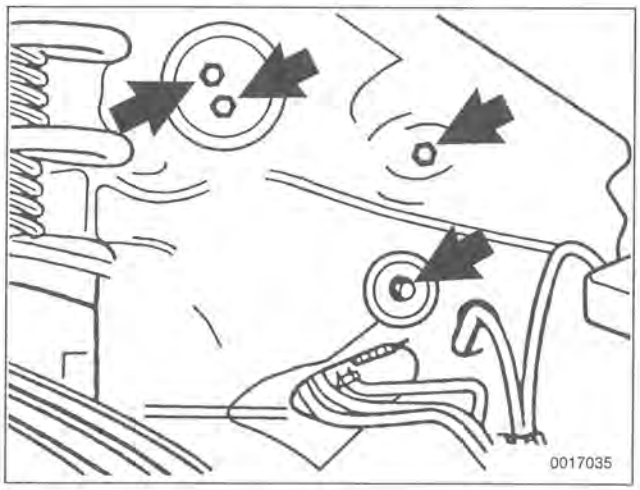
Disconnect brake lines at junctions **A** and **B** from below.
  - Disconnect hydraulic fluid line at adapter fitting **C** from below.



- Loosen and remove self levelling (LAD) control pressure fitting from adapter (**arrow**).



- Disconnect electrical harness connectors (**arrows**) from hydraulic unit.



- Remove left front wheel housing splash shield.
- Remove four hydraulic unit mounting bolts (**arrows**) in back of left wheel housing splash shield.
- Remove hydraulic unit by pulling it up though opening made by removing brake booster.
- Installation is reverse of removal.
  - Bleed brake system as described under **Bleeding brakes (cars with ASC+T)**.
  - Bleed hydraulic boost system as described earlier.
  - Reinitialize ASC+T system as described earlier.

Tightening Torques

- Brake lines to hydraulic unit . . . 17-19 Nm (13-15 ft-lb)
- Brake booster to bulkhead . . . . . 22 Nm (16 ft-lb)
- Brake master cylinder to hydraulic booster . . . . . 28 Nm (20 ft-lb)



370 Integrated Suspension Systems

GENERAL 370-1

SELF LEVELLING SUSPENSION (LAD) 370-2
- Pressure testing LAD system 370-3
- Ride height, adjusting 370-4
- Filling and bleeding LAD system 370-6
- LAD regulator valve, replacing 370-6
- Wheel camber warning switch, replacing 370-7
- LAD hydraulic fluid accumulators, replacing 370-8
- Converting LAD rear struts to standard rear struts 370-9
- Troubleshooting LAD 370-11

ELECTRONIC DAMPING CONTROL (EDC III) 370-12
- EDC III electronic control module and power relay 370-15
- Steering angle sensor, removing and installing 370-16
- Front vertical acceleration sensor, removing and installing 370-17
- Rear vertical acceleration sensor, removing and installing 370-17
- Longitudinal acceleration sensor, removing and installing 370-18
- Monitoring and Troubleshooting EDC III 370-19

TABLES

a. Rear Ride Height Specifications (LAD cars only) 370-5
b. Parts List for Converting LAD Rear Suspension to Conventional Suspension 370-9
c. Troubleshooting LAD 370-10
d. EDC III Damper Solenoid Settings 370-14
e. EDC III Control Module Pinout (26 pin connector) 370-15
f. EDC III Control Module Pinout (10 pin connector) 370-16
g. Troubleshooting EDC III 370-19

GENERAL

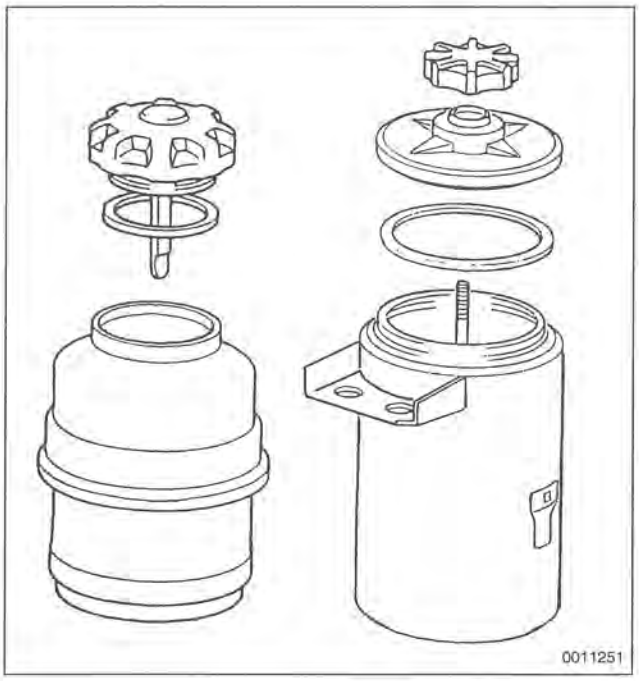
Most E32 cars with the long chassis (iL models) were equipped with a self levelling rear suspension which adjusts to load. This system is known as LAD.

Repairs to the LAD system are covered in this group. Also included is a description of parts and procedures for replacing the load-levelling suspension with a conventional rear strut system.

NOTE—

- *The high system pressure in the self levelling suspension system can cause hydraulic oil to seep past the rear strut piston seals. This seepage is normal. Only the formation of distinct oil drops on the strut body is evidence of a serious leak.*
- *When the vehicle is raised on a lift with the wheels hanging free, there is a potential for some oil overflow from the hydraulic oil reservoir due to the large amount of oil being returned. This is also normal.*

Beginning with E32 vehicles produced in September 1990, electronic damping control (known as EDC III) was offered as an option.



Electronic faults in EDC III should be diagnosed by qualified personnel at an authorized BMW dealer.

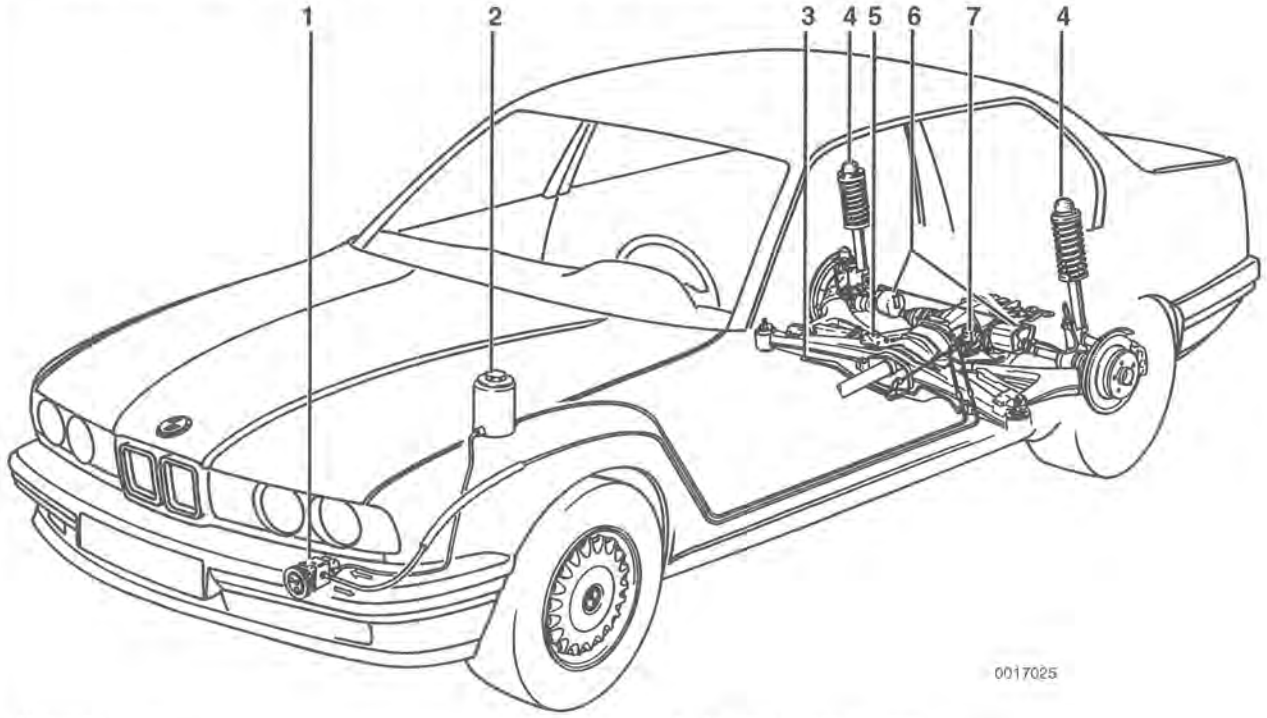
SELF LEVELLING SUSPENSION (LAD)

The self levelling rear suspension system, called LAD (Load Absorption Damping), uses mechanical and hydraulic components to monitor and adjust the rear suspension ride height based on load and driving conditions. The system is in operation whenever the engine is running.

On cars without LAD or EDC III, the plastic power steering reservoir has a cap with an integral dipstick. On cars with LAD (right), the metal reservoir has a removable cover held in place with a retaining nut and no dipstick.

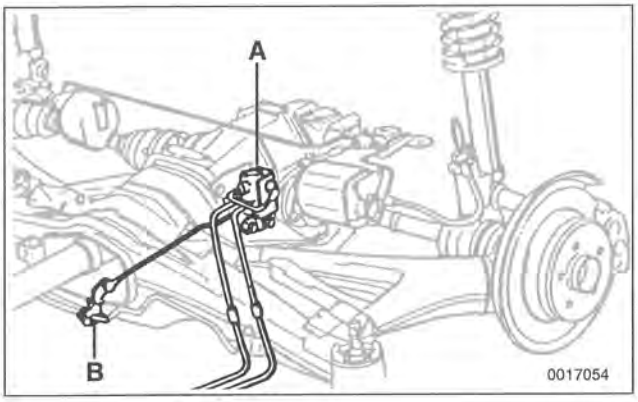
The main components of LAD are the load-sensitive rear strut system, a mechanical regulating valve, fluid accumulators, and a tandem power steering pump. Except for the electric camber warning switch, the system is completely hydro-mechanical.

Self levelling suspension (LAD) components



1. Hydraulic pump
2. Hydraulic reservoir
3. Rear stabilizer bar
4. Rear self levelling struts
5. Camber warning switch
6. LAD Hydraulic fluid accumulator
7. LAD regulator valve (with linkage to rear stabilizer)

The camber warning switch is used to monitor suspension loading via the instrument cluster and Check Control. If the rear axle is loaded beyond the regulating limit of the LAD system (i.e. excessive wheel camber), the Check Control warning **SUSPN LEVELLING** will be displayed. The camber warning switch is mounted on the rear axle subframe.



The LAD regulating valve (**A**) is mechanically connected to the rear anti-roll bar via a connecting link and a lever (**B**). When the suspension is loaded or unloaded, the anti-roll bar twists and the lever on the regulating valve is repositioned to either direct hydraulic pressure to the spring struts (raising the car) or back to the power steering fluid reservoir (lowering the car).

The LAD hydraulic system uses an additional pump integrated into the power steering pump. For information on removing and installing the power steering/LAD pump, see **320 Steering and Wheel Alignment**.

Pressure testing LAD system

Testing the LAD hydraulic pump pressure requires a 0–150 bar (0–2000 psi) pressure gauge and the correct fittings to install the gauge in-line with the LAD hydraulic system. Make sure the power steering/LAD pump drive belt is in good condition and properly tensioned.

– Raise rear of car.

> ***WARNING—***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*


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– Connect gauge between pump and pump output fitting. Use new sealing washers when connecting gauge.

> ***NOTE—***
> *Be sure to connect the gauge to the LAD hydraulic system and not the power steering system. The LAD hydraulic output line is routed to the rear of the car.*

Working beneath rear of car, disconnect control link from regulator valve lever (**arrow**). With transmission in neutral and parking brake applied, start engine.

> ***WARNING—***
> *Only run the car in a well-ventilated area. Exhaust fumes can be fatal.*

– Working beneath rear of car, operate LAD regulator lever to three positions as specified below. Have an assistant note pressure gauge readings at each position and compare them with specifications listed.

Pump Pressure

- Lever in center position
  (car at normal position) . . . . . 20–30 bar (290–435 psi)
- Lever in forward position
  (car raised) . . . . . more than 120 bar (1740 psi)
- Lever in rear position
  (car lowered) . . . . . 20-30 bar (290-435 psi)

– When finished testing, remove pressure gauge and install fluid hose to pump. Take care not to over-torque banjo bolt. Fill and bleed system as described later.

Tightening Torque

- Control link to LAD regulator valve lever
  (self locking nut) . . . . . 9 Nm (80 in-lb)
- Hydraulic hose to LAD pump . . . . . 31 Nm (22 ft-lb)

– Adjust rear ride height as described below. Install control link to regulator valve lever using a new self locking nut.

Ride height, adjusting

Adjusting the ride height on LAD-equipped cars requires that the car be placed over a pit or on a full platform lift with the rear wheels on moveable plates. This allows the rear wheel camber to adjust as the rear of the car is raised and lowered.

– Put car in neutral gear and release parking brake.

– Load luggage compartment with weight specified below.

LAD Ride Height Load Requirement

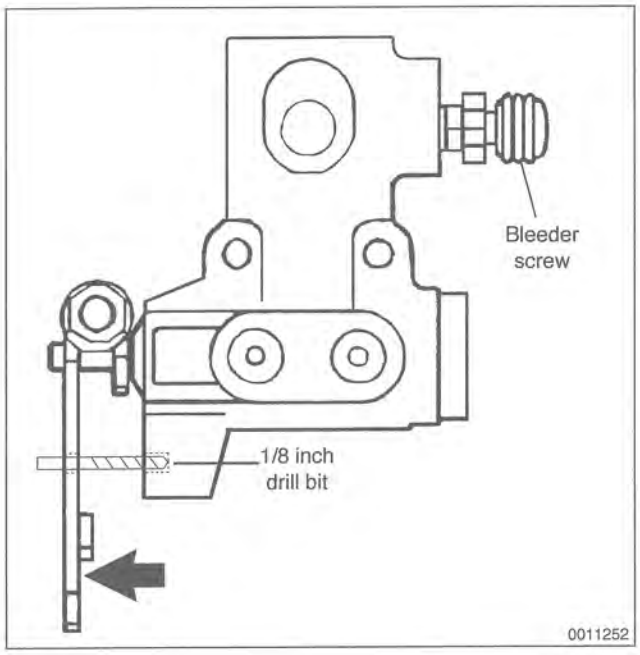
- Weight placed over rear axle to
  check or adjust ride level height . . . . . 200 kg (440 lb.)



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➢ Working beneath rear of car, disconnect control link from regulator valve lever (**arrow**). Start engine.

> ***WARNING —***
> *Only run the car in a well-ventilated area. Carbon monoxide fumes can be fatal.*



➢ LAD regulator valve and lever (**arrow**).

- Using ride height specifications given in **Table a,** move LAD regulator valve lever forward or rearward until height is correct. Then lock lever in center position by inserting a 3 mm ($^1/_8$ in.) drill bit through lever and into valve body.

> ***CAUTION—***
> *If the lever is pushed rearward past the center position once the correct level is reached, repeat the adjusting procedures.*

NOTE—
Moving the lever forward raises the car. Moving the lever rearward lowers the car. When the lever is in the center position, the ride height is maintained.

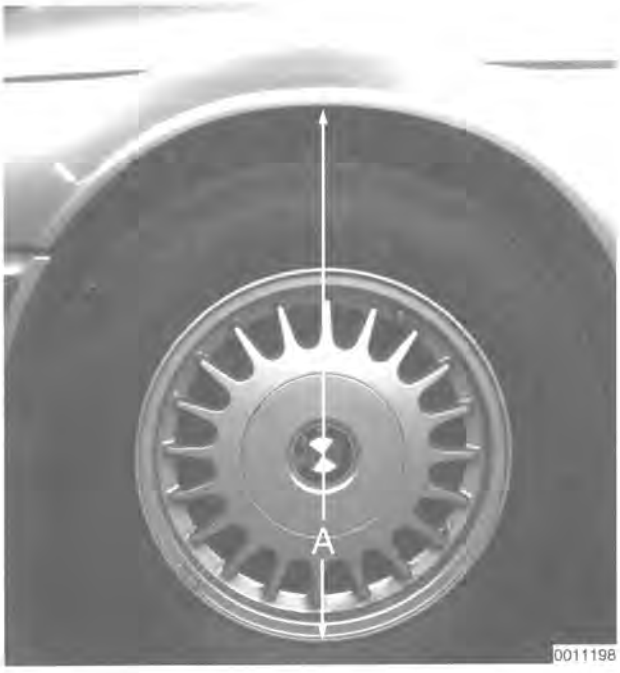
– If necessary, loosen locknuts and adjust control link length so that link end fits correctly into lever. Tighten lock nuts.

– Using a new self locking nut, install link and then remove drill bit.

Tightening Torque

- Control link to LAD regulator valve lever (self locking nut) . . . . . .9 Nm (80 in-lb)

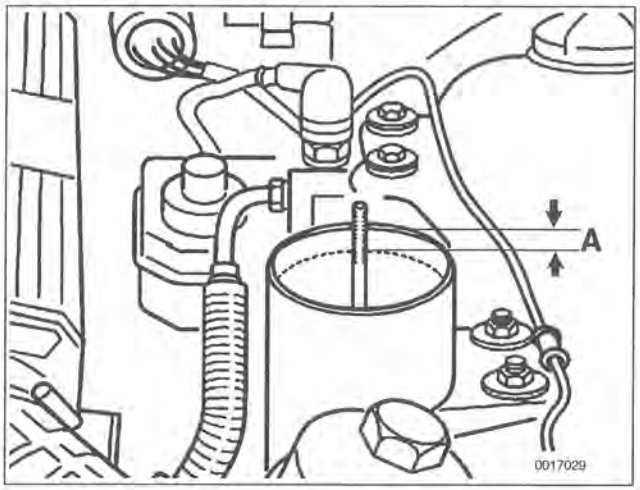
– Remove load from luggage compartment and allow system to self adjust ride height. Reload car, wait a few minutes, and then check that ride height is correct.



➢ Ride height (**A**) is measured from the lower edge of the wheel arch to the bottom edge of the wheel rim.

Table a. Rear Ride Height Specifications (LAD cars only)

Wheel installed	Rear ride height
15 in.	522 ± 3 mm (20.55 ± 0.4 in.)
16 in.	529 ± 3 mm (20.83 ± 0.1 in.)
17 in.	545 ± 3 mm (21.46 ± 0.1 in.)
TD 390	Not available
TRX 415	Not available



Filling and bleeding LAD system

With engine off, fill power steering/LAD fluid reservoir until fluid level (**A**) is approximately 25 mm (1 in.) below reservoir rim.

NOTE—

- *The hydraulic system on early E32 cars uses Pentosin® CHF 7.1 hydraulic fluid.*
- *Beginning with cars produced in September 1991, Pentosin® CHF 11 S is used in the hydraulic system.*

> ***CAUTION—***
> *Check the hydraulic reservoir for a label identifying the type of fluid used. Do not mix fluids.*

– Load car with 150 kg (332 lbs.) placed in the luggage compartment.

– Start engine. Turn steering wheel from lock to lock three times. Turn engine off.

> ***WARNING—***
> *Only run the car in a well-ventilated area. Exhaust fumes can be fatal.*

– Raise rear of car until drive wheels are off ground. Wait about two minutes and check fluid level. Fluid level should be no more than 25 mm (1 in.) above the base of the reservoir screen. Correct the fluid level as necessary.

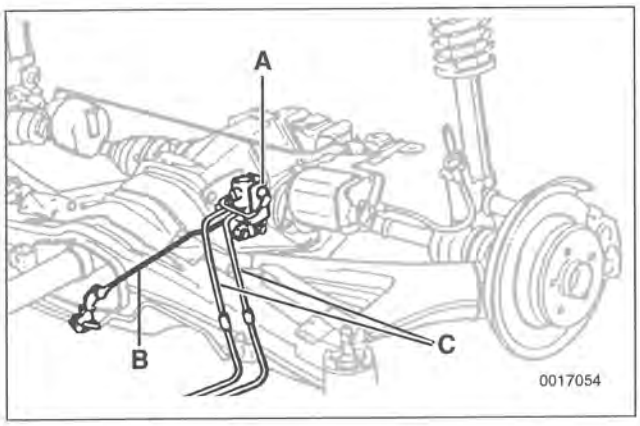
LAD regulator valve, replacing

The LAD regulator valve is mounted to the left of the final drive carrier, above the center of the rear subframe, with a linkage arm connecting it to the stabilizer bar.

– Raise rear of car.

> ***WARNING—***
> *Make sure that car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

– Remove rear exhaust pipe and muffler as described in **180 Exhaust System**.



➤ LAD regulator valve bleeder screw (**A**), stabilizer bar control link (**B**), and hydraulic fluid feed and return lines (**C**).

- Place a drain pan beneath LAD regulator valve and loosen bleeder screw to relieve system pressure.

NOTE—
Have shop towels ready to clean up any fluid spillage.

- Working beneath rear of car, disconnect control link from LAD regulator valve lever.
- Remove all hydraulic fluid lines and hoses, noting their correct installed positions. Plug open lines and fittings.

– Remove regulator valve with its mounting bracket. If replacing regulator valve, remove it from its mounting bracket.

– Make sure all fluid fittings and thread bores are clean.

– Mount regulator valve assembly to rear axle subframe. Connect control link and all fluid lines to valve. Use new self locking nuts.

Tightening torque

- LAD control link to regulator valve (self locking nut) . . . . . 9 Nm (80 in-lb)
- LAD hydraulic fluid lines/hoses to regulator valve . . . . . 20 Nm (15 ft-lb)
- LAD regulator valve to mounting bracket (self locking nuts) . . . . . 9 Nm (80 in-lb)
- LAD regulator valve with mounting bracket to rear axle subframe
  M6 bolts . . . . . 9 Nm (80 in-lb)
  M8 bolts . . . . . 22 Nm (16 ft-lb)

– Fill and bleed hydraulic system as described earlier.

– Adjust LAD system ride height as described earlier.

Wheel camber warning switch, replacing

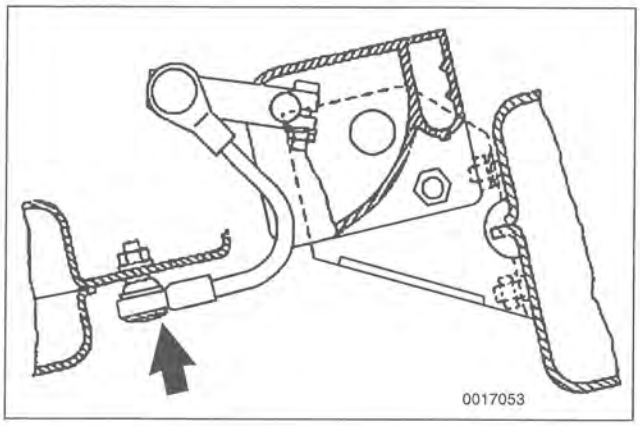
The wheel camber warning switch is mounted to the right of the rear subframe.

– Raise rear of car.

WARNING—
Make sure that car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.


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➤ Disconnect electrical harness connector (**arrow**) from camber switch.



➤ Camber switch linkage attachment to rear trailing arm (**arrow**).

• Remove linkage from trailing arm.

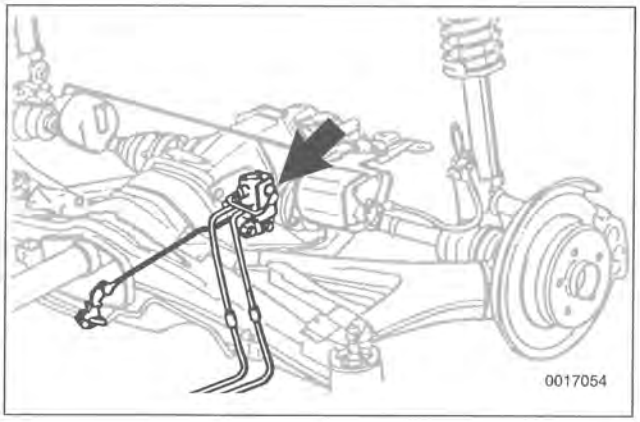
– Loosen and remove two mounting bolts and remove switch.

– Installation is reverse of removal.

– Adjust LAD system ride height as described earlier.

LAD hydraulic fluid accumulators, replacing

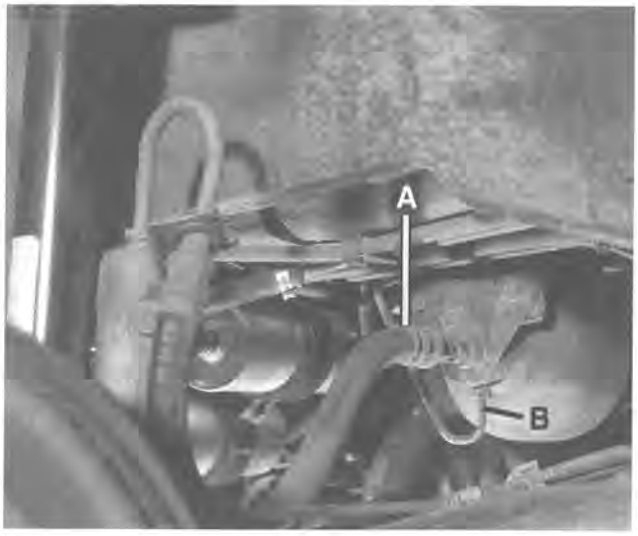
The LAD hydraulic fluid accumulators are mounted next to the rear trailing arm mounts on each side of the rear suspension.



– Raise rear of car.

> ***WARNING —***
> *Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

– Left side: Remove rear exhaust pipe and muffler as described in **180 Exhaust System**.



➤ Place a drain pan beneath LAD regulator valve and loosen bleeder screw (**arrow**) to relieve system pressure.

➤ Place pan beneath accumulator and remove hydraulic line (**B**) and hose (**A**) from accumulator.

– Remove accumulator and bracket from subframe.

– Remove accumulator from bracket.

– Make sure all fluid fittings and thread bores are clean.

– Mount accumulator to its bracket and to rear axle subframe using new self locking nuts.

Tightening Torque

• Hydraulic fluid accumulator with mounting bracket to rear axle subframe (self locking nuts) . . . . . .9 Nm (80 in-lb)

– Connect hydraulic fluid lines to accumulator.

– Fill and bleed hydraulic system as described earlier.

– Adjust LAD system ride height as described earlier.

Converting LAD rear struts to standard rear struts

The parts needed when changing from self levelling rear struts to standard gas-filled struts are listed in **Table b**.

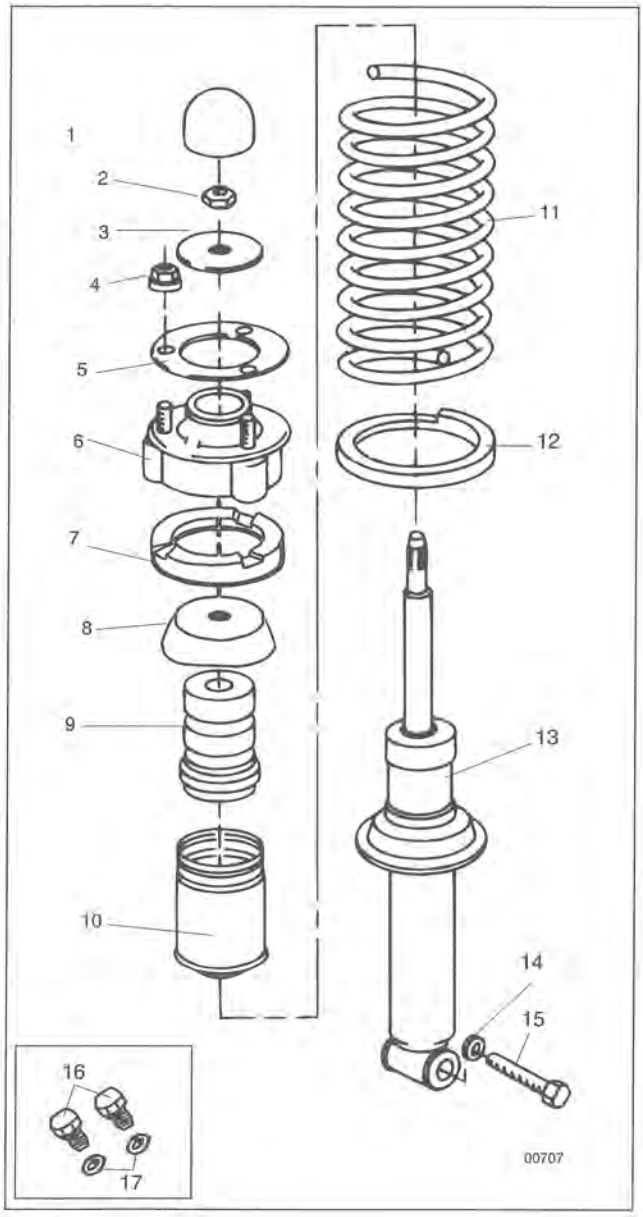
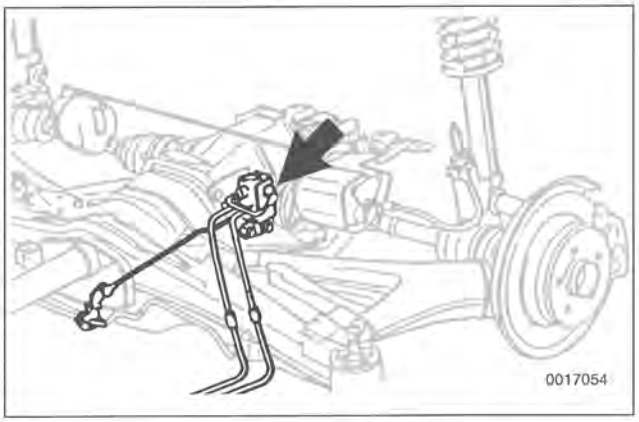


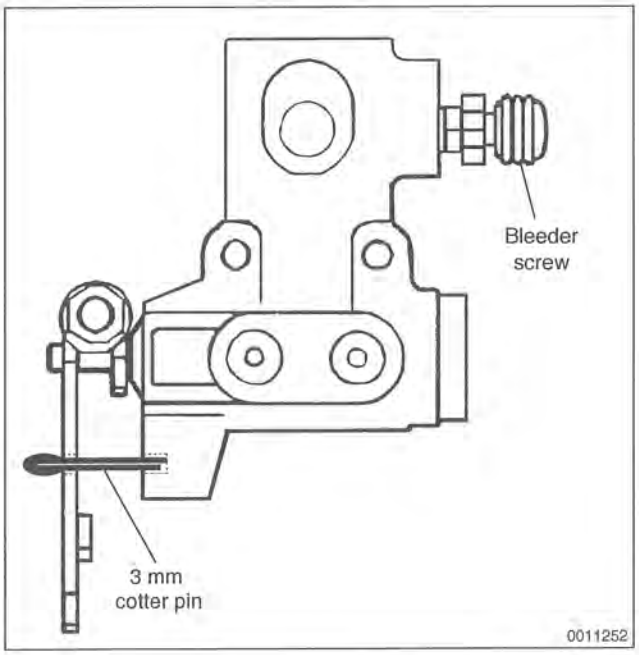
Table b. Parts List for Converting LAD Rear Suspension to Conventional Suspension

	New part required	Description	Qty.	BMW Part No.
1	No	Strut cap	2	33 52 1 132 854
2	Yes	Self locking nut	2	07 12 9 922 436
3	Yes	Plate	2	33 52 1 129 565
4	Yes	Collar nut	6	31 33 1 092 887
5	No	Plate	2	33 52 1 129 567
6	Yes	Upper mount	2	33 52 1 132 088
7	No	Spring pad	2	33 53 1 133 048
8	Yes	Shaft support	2	33 52 1 136 063
9	Yes	Rubber stop	2	33 53 1 135 624
10	Yes	Protective tube	2	33 53 1 134 314
11	Yes	Spring	2	33 53 1 131 805
12	No	Spring pad	2	33 52 1 131 523
13	Yes	Strut	2	Consult BMW parts dept.
14	No	Flat washer	2	33 52 1 125 260
15	No	Bolt (14X1.5X85)	2	07 11 9 914 829
16	Yes	Plug (M14X1.5)	2	07 11 9 919 228
17	Yes	Sealing ring	2	07 11 9 963 201

– Raise car and remove both rear wheels.

WARNING—
Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.





- Place a drain pan beneath LAD regulator valve and loosen bleeder screw (**arrow**) to relieve system pressure.
- Disconnect hydraulic line from left and right struts. Be sure to place a drain pan beneath each strut before loosening fluid line.
- Support trailing arms from below using jack stands.
- Remove rear LAD struts. This part of procedure is identical to removing conventional rear struts as described in **330 Rear Suspension**.
- Detach hydraulic lines from LAD hydraulic fluid accumulators. Plug opening in accumulators using M14 x 1.5 plugs and sealing rings (BMW part numbers 07 11 9 919 228 and 07 11 9 963 201).
- Center arm on regulator valve and install 3 mm ($^1/_8$ in.) cotter pin through lever and into valve body. This will lock regulator valve in closed position.
- See **330 Rear Suspension** to assemble and reinstall struts.

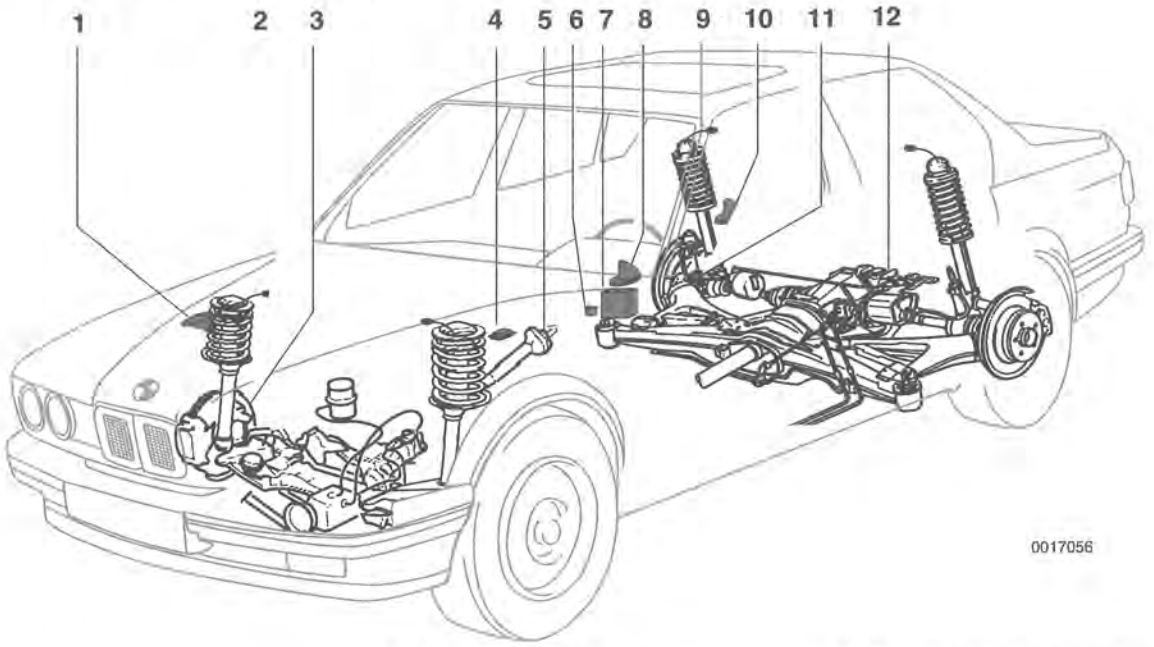
Troubleshooting LAD

The LAD system is completely hydraulic-mechanical, with the exception of the electrical rear wheel camber sensor. **Table c** lists some common LAD problems.

Table c. Troubleshooting LAD

Symptom	Probable cause	Repairs
Ride height too high or too low	1. Ride height maladjusted 2. Regulator rod not mounted correctly	1. Adjust ride height. 2. Check regulator rod installation, correct if necessary.
Rear end of car drops below nominal ride height with payload and engine running	1. Car overloaded 2. Hydraulic oil level too low 3. Regulator rod not mounted correctly 4. Hydraulic fluid feed pipe damaged 5. Pump pressure insufficient 6. Ride control valve faulty 7. Strut assembly faulty	1. Reduce load to maximum permissible. 2. Check and correct hydraulic oil level. 3. Check regulator rod installation, correct ride height if necessary. 4. Check feed pipe, repair or replace as necessary. 5. Check pump, replace if necessary. 6. Check ride control valve, check charging pressure. 7. Check struts/springs, replace if necessary.
Rear end of car does not lift/drop to nominal ride height after unloading car	1. Regulator linkage not mounted correctly 2. Hydraulic fluid feed/return pipe damaged 3. Ride level height regulator valve faulty. 4. Struts faulty 5. Pump pressure too low	1. Check and repair regulator linkage installation and adjust ride height. 2. Check and repair/replace feed or return pipes. 3. Check ride level height regulator valve and replace if necessary. 4. Replace struts if necessary. 5. Check pump
Continuous wheel camber warning light displayed in instrument cluster	1. Car overloaded 2. Hydraulic fluid level too low 3. Regulator linkage not mounted correctly 4. Hydraulic fluid feed/return pipe damaged 5. Pump pressure to low 6. Ride level height regulating valve faulty 7. Adjustment/installation of wheel camber warning switch incorrect 8. Fuse number 29 faulty 9. Wheel camber warning switch faulty	1. Reduce load to maximum permissible. 2. Check and correct fluid level. 3. Check and repair regulator linkage installation and adjust ride height. 4. Check and repair/replace feed or return pipes. 5. Check pump. 6. Check ride height regulating valve. 7. Check adjustment of camber warning switch. 8. Check circuit and replace fuse. 9. Check camber switch.
Insufficient damping, rattling noise in rear axle area	Struts faulty	Check and replace struts.

Electronic damping control (EDC III) components



1. Front acceleration sensor
2. Front strut harness connector
3. Front strut solenoid valves
4. Console mounted program switch
5. Steering angle sensor
6. EDC III power relay
7. EDC III control module
8. Rear longitudinal acceleration sensor
9. Rear strut harness connector
10. Rear vertical acceleration sensor
11. Rear strut solenoid valves
12. Vehicle speed sensor

ELECTRONIC DAMPING CONTROL (EDC III)

Electronic damping control (EDC III) is a fully automatic suspension damper (shock absorber) control system. It allows the driver the choice of two damping programs, Comfort (K) or Sport (S).

NOTE—
Front shocks are covered in **310 Front Suspension**.

Conventional non-adjustable suspension systems provide an acceptable damping action over as wide a range of speeds and loads as possible. This means a compromise between comfortable softness and sporty hardness. EDC III, using electronic controls, resolves this trade-off with variable damping.

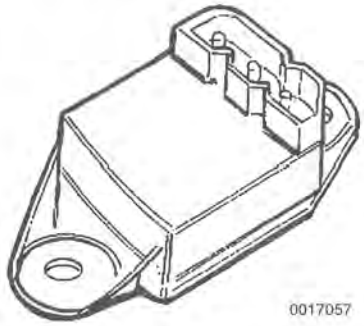
EDC III uses various input parameters directly relating to road condition, load on the car and driving style to select one of three damping characteristics: soft, medium or firm. The results are optimum damping over a wide range of speeds and loads and gains in both ride comfort and safety. This is achieved by continuously matching the damping force to road conditions, vehicle and driving style.

System Operation

The following inputs are used to detect dynamic forces acting on the vehicle:

- Vertical acceleration ("bounce")
- Fore and aft acceleration
- Steering angle
- Vehicle road speed
- Condition of road surface

Acceleration sensor



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There are three acceleration sensors: one each for the front and rear axles (vertical motion), and one for longitudinal motion. All three sensors are made from solid state piezo ceramic elements. Vehicle movement is converted into electric signals by the sensors. The control module uses these inputs to detect road surface condition, vehicle loading and degree of motion.

The road speed input comes from the vehicle speed sensor in the final drive.

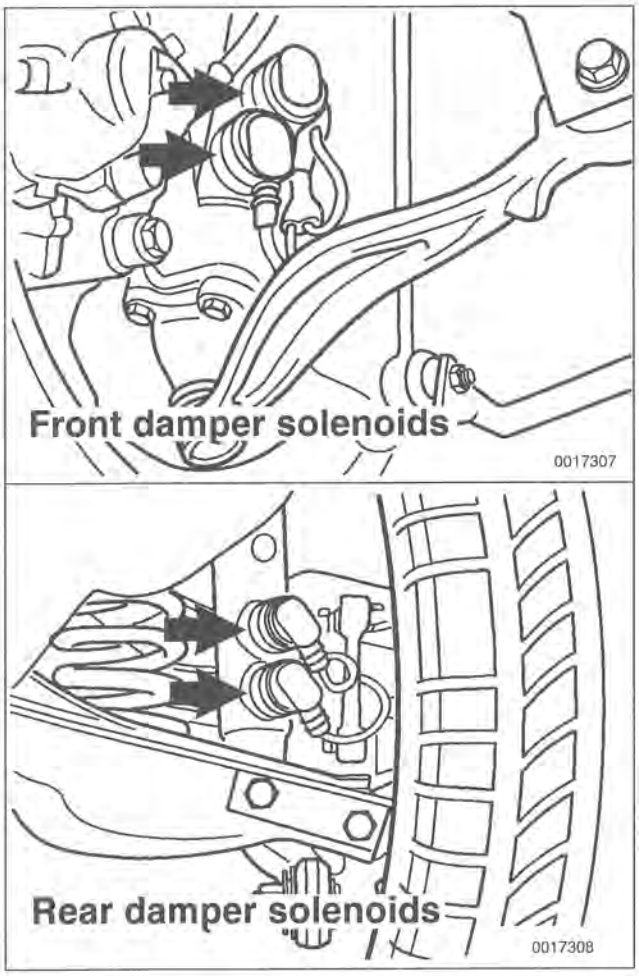
Steering angle sensor



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The steering angle sensor contains a potentiometer with two wipers which signal the control module how far and how fast the steering is turned.

The signals received from the sensors are processed by the electronic control module, which sends signals to solenoids on the front and rear shock absorbers. The system response can be varied by selecting the Sport (S) or the Comfort (K) position on the center console mounted program switch.



Electronic Shock Absorber Operation

The shock absorbers used on the EDC III system are similar to conventional twin tube dampers, but have two solenoid valves (**arrows**) each. These valves are held closed by spring pressure. This represents the firm setting with oil flowing through the piston and base valves. One of the damping valves is energized to open for the soft setting and the second valve is energized for the medium setting.

> ***CAUTION—***
> *The damper solenoid valves can be easily damaged. Use care when removing and storing the EDC III strut assemblies.*

NOTE—

- *Removal and installation of EDC III struts is covered in* **310 Front Suspension** *or* **330 Rear Suspension**, *as applicable.*
- *The two valves on each damper are never energized simultaneously.*
- *Damping can be varied front to rear, but not from side to side.*

EDC III solenoid construction is identical for the soft and medium solenoids, though the soft solenoid has a larger orifice so more oil can pass through it. **Table d** shows the various settings and operation modes of the solenoids.

Table d. EDC III Damper Solenoid Settings

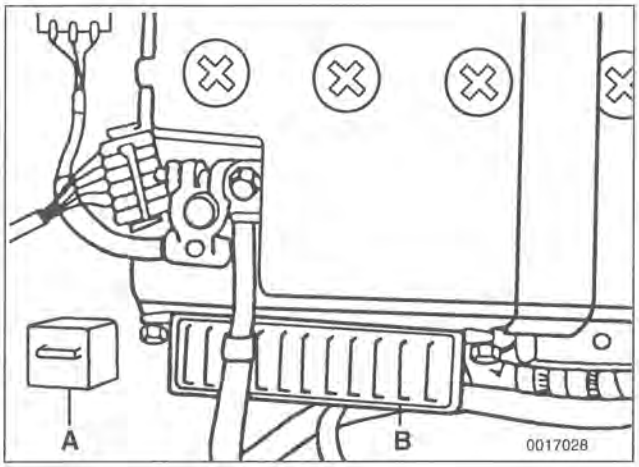
Setting	Solenoid energized	Result
Soft	Soft solenoid	Maximum oil transfer
Medium	Medium solenoid	Moderate oil transfer
Firm	No solenoids	No oil transfer

Program Selection

The two position console mounted program switch enables the driver to choose between Comfort (K) and Sport (S) settings.

When the Comfort setting is selected, the priority is soft damping. Any changes to dynamic movement detected by the sensors will allow the system to switch to either medium or firm depending on how severe the dynamic changes are. The system will automatically switch back to soft setting when conditions warrant. This results in an ideal combination of maximum comfort and optimum driving responsiveness.

When the Sport setting is selected, only the medium and firm damping settings are used. The control module selects the medium setting until dynamic changes require a higher damping force to maintain stability. The Sport program characteristics allow the firm setting to be selected sooner and held longer than the Comfort program.



EDC III electronic control module and power relay

The EDC III power relay (**A**) and electronic control module (**B**) are mounted next to the battery beneath the right rear seat cushion. For access to either, see **520 Seats**.

Table e and **Table f** list EDC III electronic control module pinouts and normal output readings.

NOTE—

If power is lost at the control module, or if a fault in the system trips the safety circuit integrated into the software of the control module, the ride will be set in the firm position.

Table e. EDC III Control Module Pinout (26 pin connector)

Connector #	Component/function	Output
1	Acceleration sensor	0 - 5 volts
2	Sport indicator lamp	12 volts
3	Not used	
4	Not used	
5	Not used	
6	Program switch	Ground
7	Program switch	Ground
8	Not used	
9	Not used	
10	Head light switch	12 volts
11	Fuse 12	12 volts
12	Diagnostic connector	
13	Speed signal	Square-wave signal
14	Steering angle sensor	0 - 5 volts
15	Steering angle sensor	0 - 5 volts
16	Acceleration sensor	0 - 5 volts
17	Comfort indicator lamp	12 volts
18	Not used	
19	Diagnostic connector	
20	Analog ground	
21	Not used	
22	Not used	
23	EDC power relay	12 volts
24	Acceleration sensor	0 - 5 volts
25	Steering angle sensor	5 volts
26	Fuse 45	12 volts

Table f. EDC III Control Module Pinout (10 pin connector)

Connector #	Component/function	Output
1	Front control, Comfort	Approx. 4.5 volts
2	Front control, Sport	Approx. 4.5 volts
3	Rear control, Comfort	Approx. 4.5 volts
4	Terminal 15	
5	Rear control, Sport	Approx 4.5 volts
6	Ground connection	Body ground
7	Not used	
8	Rear valve coil supply	Approx 2 amps
9	Front valve coil supply	Approx 2 amps
10	Not used	

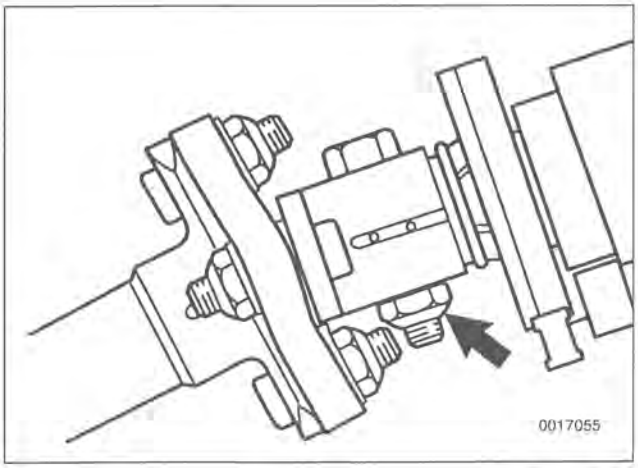
Steering angle sensor, removing and installing

The steering angle sensor is located at the lower end of the steering shaft.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

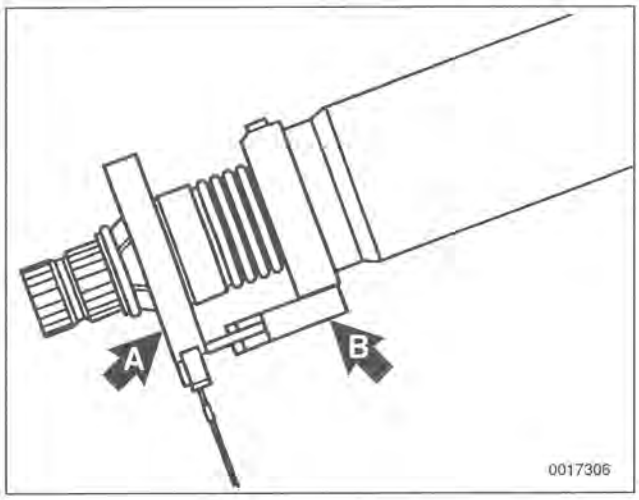
CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove lower trim panel under left side of dash. See **513 Interior Trim**.



➢ Remove steering shaft universal joint locking bolt (**arrow**) and slide universal joint off steering shaft.

NOTE—
Mark both the steering shaft and universal joint so they can be reinstalled in the same positions.



➢ Steering angle sensor (**A**) and operating pin (**B**).
- Slide steering angle sensor off end of steering shaft.

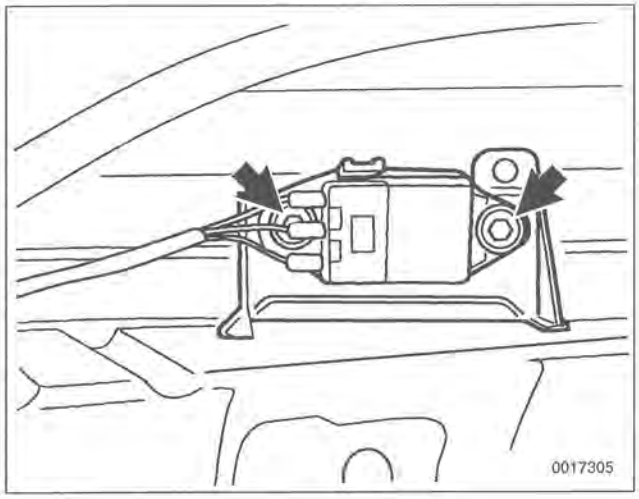
NOTE—
During reinstallation, operating pin must fit in steering angle sensor.

– Reinstallation is reverse of removal.
- Install universal joint so that clamping bolt slides into locking groove in steering shaft.

– Use new self locking nut.

Tightening Torque
- Steering universal joint clamping bolt. . . . . 22 Nm (16 ft-lb)

Front vertical acceleration sensor, removing and installing



➢ The front acceleration sensor is located in the right front wheel housing under a cover. Mounting screws are at **A**.

– With ignition switch in off position, remove sensor cover.

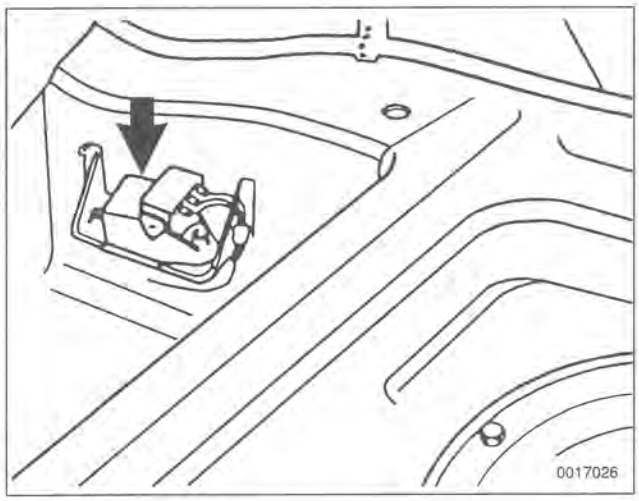
– Disconnect electrical harness connector.

– Remove two mounting screws and remove sensor.

– Installation is reverse of removal.

Tightening Torque
- Front vertical acceleration sensor to wheel housing. . . . . 6.5 Nm (58 in lb)

Rear vertical acceleration sensor, removing and installing



➢ The rear vertical acceleration sensor (**arrow**) is located in the right front of the luggage compartment, next to the strut tower.

– Turn ignition switch to off position.

– Open luggage compartment and remove floor mat.

– Disconnect sensor electrical harness connector.

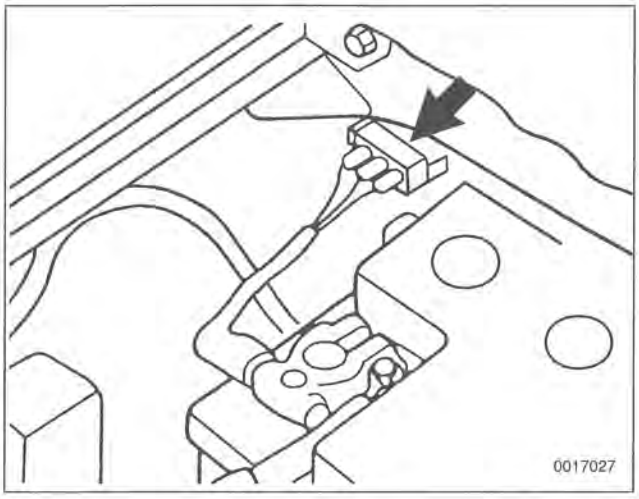
– Remove two mounting screws and remove sensor.

– Installation is reverse of removal.

Tightening Torque

- Rear vertical acceleration sensor to wheel housing . . . . . 6.5 Nm (58 in lb)

Longitudinal acceleration sensor, removing and installing



The longitudinal acceleration sensor (**arrow**) is located under the right rear seat cushion, next to the battery.

– Turn ignition switch to off position.

– Remove right rear seat cushion. See **520 Seats**.

– Disconnect sensor electrical harness connector.

– Remove two mounting screws and remove sensor.

– Installation is reverse of removal.

Tightening Torque

- Longitudinal acceleration sensor to floor . . . . . 6.5 Nm (58 in lb)

Monitoring and Troubleshooting EDC III

- All EDC III cycles and sensor inputs are checked by the EDC III electronic control module for plausibility and function. Faults that are detected are stored in memory according to their priority.

- The EDC III control module is connected to the vehicle diagnostic plug. Thus, troubleshooting can be carried out by plugging the system into the BMW diagnostic tester and reading fault codes. **Table g** lists some common faults in the EDC III system.

NOTE—
In case of some kinds of failure, the EDC III system goes into a firm setting. There is no visual warning to the driver of a problem. The only indication is that the ride is firm at all times.

Table g. Troubleshooting EDC III

Problem/defect	Possible causes/repairs
System stuck in "medium"	
Defective steering angle sensor signal	Loose contact Contact corrosion Steering angle sensor defective Short in sensor power supply wire (5 volts) Broken locating pin in steering angle sensor Bent wiper contact in steering sensor
Defective road speed sensor signal	Wire from vehicle speed sensor to instrument cluster damaged. Wire from instrument cluster to EDC III control module damaged.
Defective front axle acceleration sensor signal	Remove sensor, apply 12 volts to terminal 15 and ground negative terminal. The output should be 2.5 volts.
Defective rear axle acceleration sensor signal	Apply 12 volts to terminal 15 and ground negative terminal. The output should be 2.5 volts.
Defective longitudinal acceleration sensor signal	Remove sensor, apply 12 volts to terminal 15 and ground negative terminal. the output should be 2.5 volts.
Defective soft solenoid valve signal	Check wiring to each solenoid valve on each strut.
System stuck in "firm"	
Defective medium solenoid valve signal	Check wiring to each solenoid valve on each strut.
Defective EDC control module	Replace control module.



400 Body–General

GENERAL 400-1
BODY ASSEMBLY 400-1
PERFORMANCE AND CONVENIENCE . 400-2
INTERIOR EQUIPMENT 400-3

GENERAL

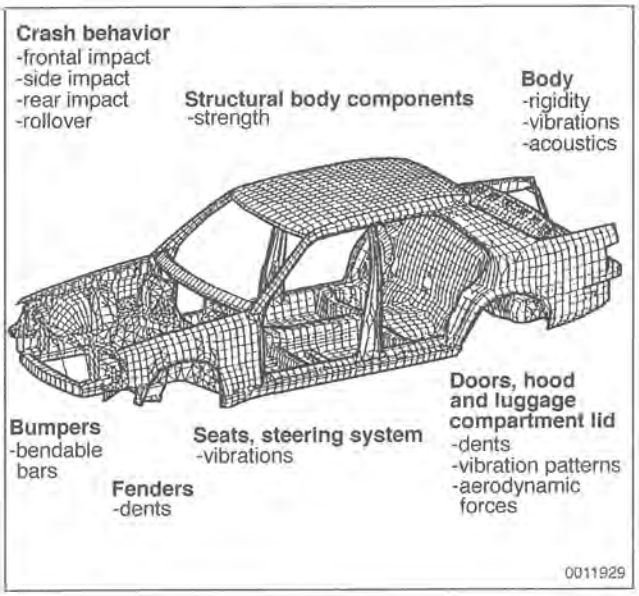
This general information group covers basic body information and system descriptions for the repair groups found in **4 Body** and **5 Body Equipment**.

When working or servicing cars equipped with SRS, the following precautions must be observed to prevent injury.

WARNING—

- *The airbag(s) are inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous. Special precautions must be observed prior to any work at or near the steering wheel or steering column, including the pedal assembly.*
- *Always disconnect the battery and cover the negative (–) battery terminal with an insulator before starting diagnostic, troubleshooting or service work on cars fitted with SRS, and before doing any welding on the car.*

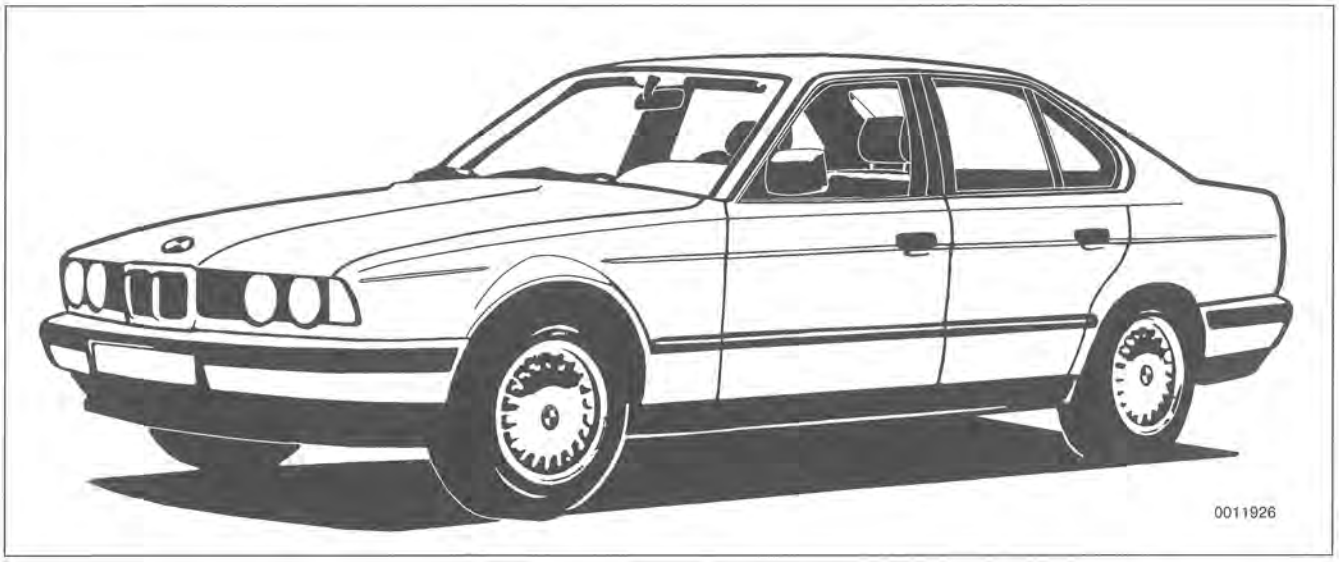
BODY ASSEMBLY



The E32 chassis was introduced in North America early in 1987 as a 1988 model. The aerodynamically efficient 7 Series with a low coefficient of drag (0.31 in standard models, 0.32 in stretched models) achieves unprecedented levels of performance and handling for a car of its size.

The E32 chassis was developed using advanced computer modeling to calculate static, dynamic, and acoustic body characteristics. Through these advanced computer simulation models, a high level of body rigidity, functionality and safety was achieved without the addition of extra weight. This allows the suspension to work more accurately from a firmer platform.

Many of the body sections have been combined into single large stampings, resulting in improved production and quality standards. The side frame members are constructed of one piece. Optimized high-technology joining techniques help to reduce the total number of welded and brazed joints.



The hood is front-hinged and prevented from sliding back in an accident by retaining hooks. The hood, trunk, front doors and rear doors open to extremely wide angles. Bolt-on components, including the front fenders, are easily replaced.

The unitized body forms a very rigid passenger compartment with large crumple zones in the front and rear for energy absorption during a collision. Passive safety has been increased by providing body deformation and strength characteristics. The bumpers are fully self-regenerating up to an impact speed of approximately 2.5 m.p.h. Generous body side member cross-sections improve resistance to side swiping impacts.

PERFORMANCE AND CONVENIENCE

The E32 model line included a stretched body version known as the iL series (735iL/740iL/750iL). Cars with this body style feature:

- 4.5 in. longer body.
- Complete leather upholstery (optional on the "i" models).
- Heated power rear seats. (See **520 Seats**.)
- High pressure headlight/foglight washers. (See **611 Wipers and Washers**.)
- Self levelling suspension (LAD). (See **370 Integrated Suspension Systems**.)
- 1991 and later options: Electronic damping control (EDC III). (See **370 Integrated Suspension Systems**.)

INTERIOR EQUIPMENT

The E32 interior is designed with a high standard of driving ergonomics. The car's overall dimensions provide ample interior space and freedom of movement, particularly for rear seat passengers.

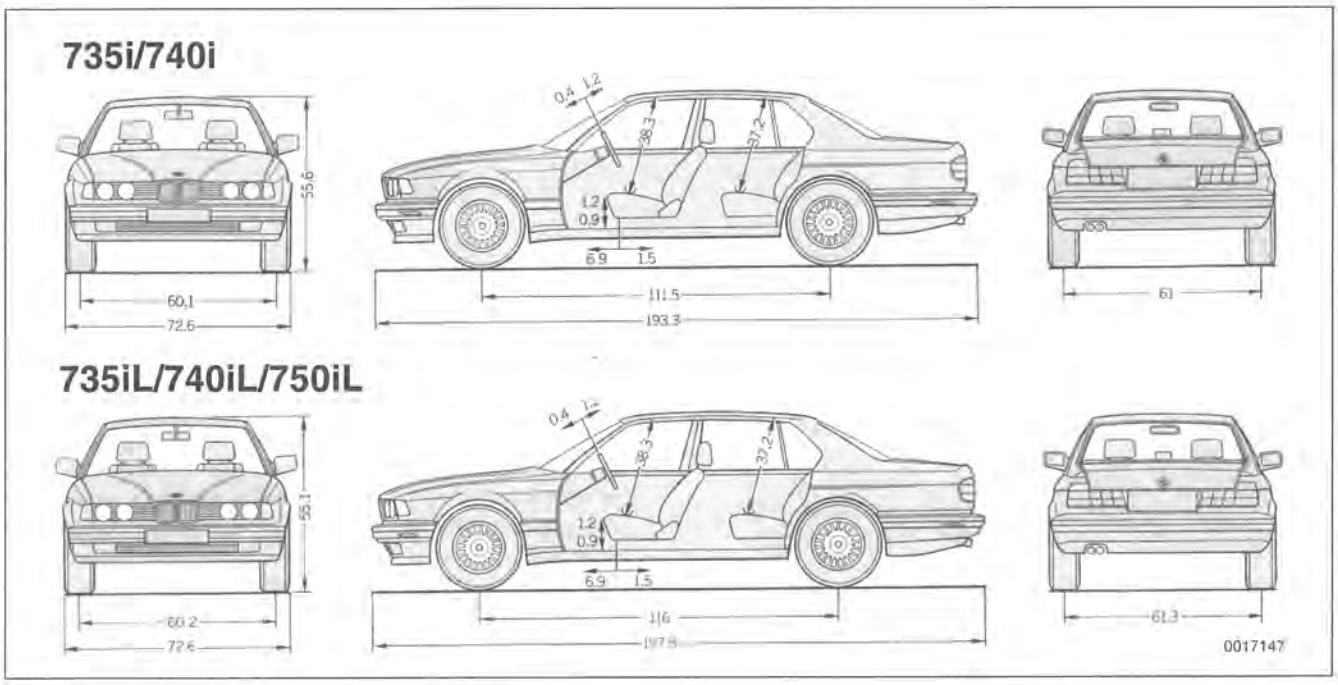
Large, bonded, flush windshield and rear window and green-tinted heat-insulating glass is standard on all models. All-around vision from the driver's seat ensures full awareness of surrounding conditions and enhanced driving safety.

All interior switches are illuminated and switch functions are clearly marked with identification symbols. Trim panels and surfaces have soft finishes which are pleasant to the touch. Ample storage space for odds and ends is provided. The articulating glove compartment is lockable using the car's one-key system.

The one-piece molded roof lining is constructed from a sound-absorbing material. Interior roof mounted grab handles can be hinged down as necessary. All trim pieces have been optimized for minimum noise levels and function as part of a harmonious overall design theme.

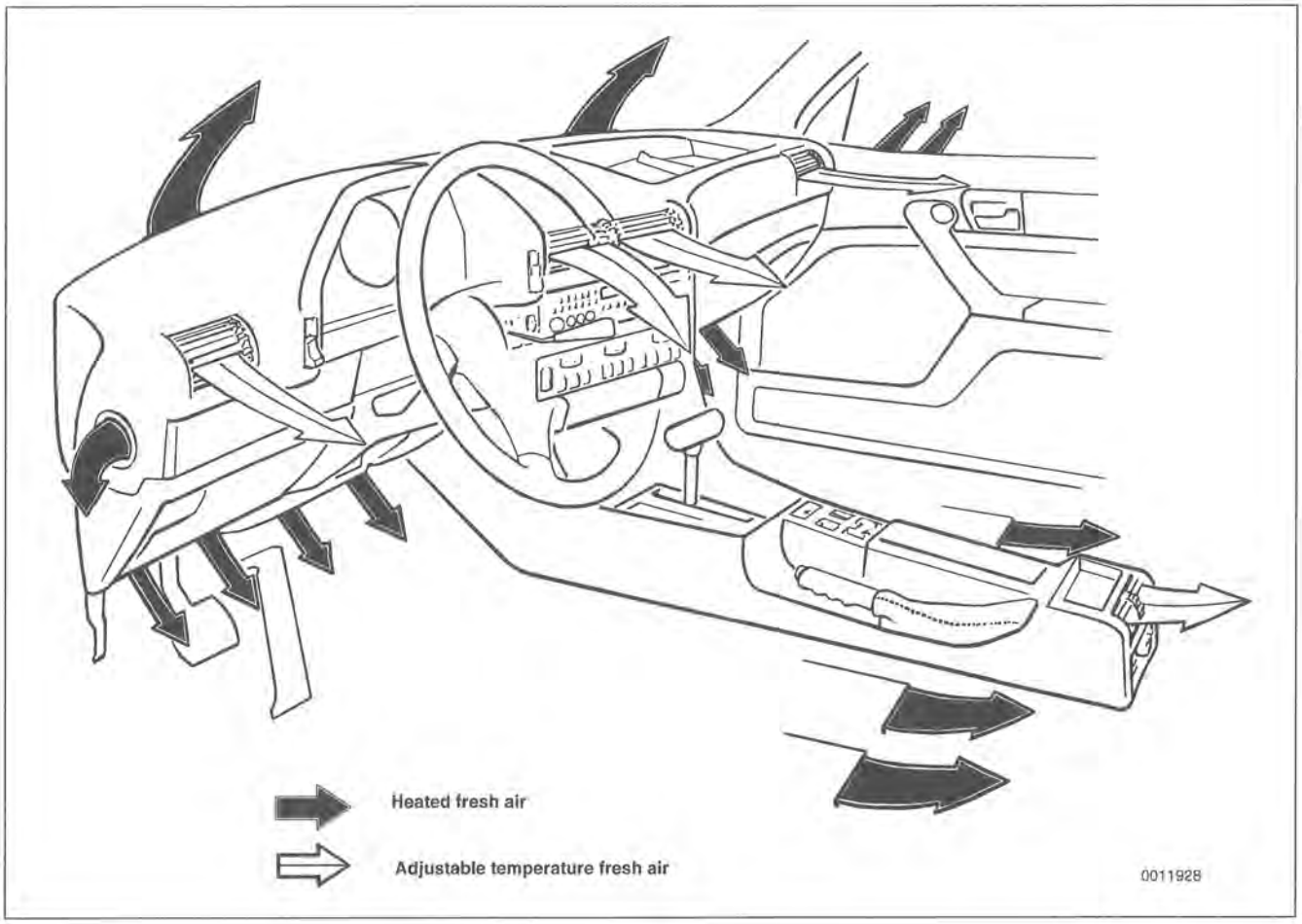
Anatomically-correct seats are constructed from polyurethane foam, with zones of different firmness. The front seat bases have additional steel springs for added support and strength. The 10-way power seats are provided with conveniently located switches along the outside edge of the seat.

The upper seat belt anchors on the B-pillar adjust automatically in height when the front seats are moved forward and back. An ergonomically positioned rear seat-belt system has the latches on the outside for a much improved, safer belt position for the rear seat occupants.



The padded dashboard houses the instrument cluster and the ventilation and heating system. The instrument cluster is removable as a unit without removing the dashboard. All electrical repairs to the instrument cluster are covered in **620 Instruments**.

The electronically controlled heating and air conditioning system (IHKA) provides separate controls for the driver and front passenger. An extra large, infinitely variable radial blower motor provides perfect distribution of air. Fresh air enters through the grille below the engine hood and into the passenger compartment via the dashboard and front and rear footwell vents. The interior air is extracted through vents located in the rear of the vehicle, behind the bumper covers.



Convenience is an integral part of the 7 Series. For ease and safety when entering the car at night, the interior lights are switched on by pulling up on the driver's door handle, which also activates a heating element for lock de-icing. The interior light is switched on every time the engine is turned off if the exterior lights were previously turned on. The interior lights will stay on for 20 seconds after closing the doors and will automatically turn themselves off if left on for more than 15 minutes.



410 Fenders, Engine Hood

GENERAL 410-1

FRONT FENDERS 410-1
Front fender, removing and installing 410-1

ENGINE HOOD 410-3
Engine hood, removing and installing 410-3
Engine hood, aligning 410-4
Hood hinge, replacing 410-5
Hood lock cable, replacing 410-5
Hood gas-pressure strut, replacing 410-6

GENERAL

This repair group covers replacement of the front fenders and removal and installation of the engine hood. Note that the body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. To prevent corrosion, exposed metal should be painted.

FRONT FENDERS

Front fender, removing and installing

– Remove front bumper and bumper side brackets. See **510 Exterior Trim, Bumpers**.

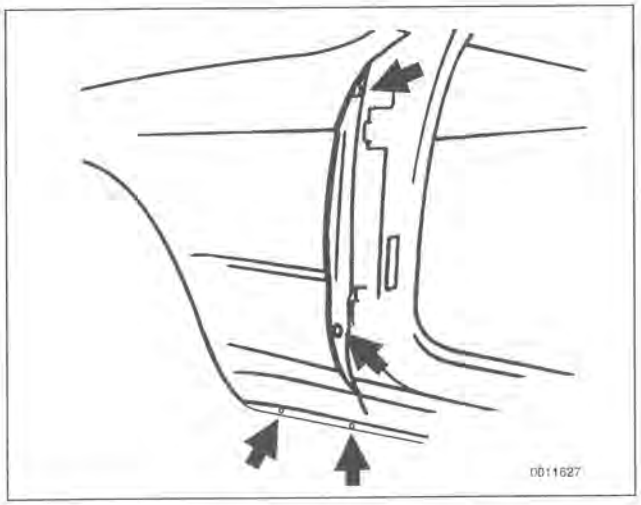
– If replacing left fender, remove both windshield wiper arms. See **611 Wipers and Washers**.

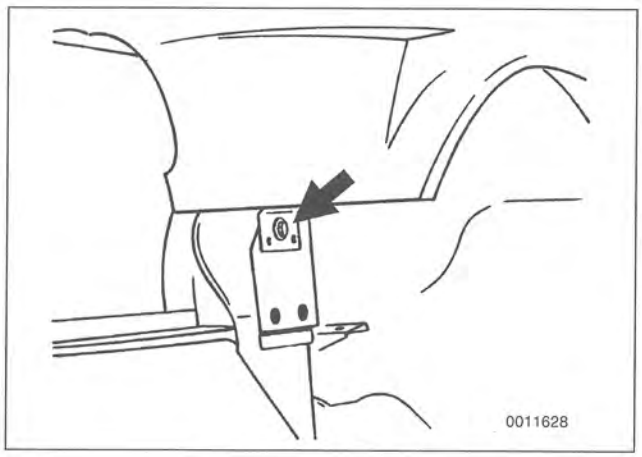
– Remove ventilation grille(s) at base of windshield. See **611 Wipers and Washers.**

– Peel up rubber strip at top of fender.

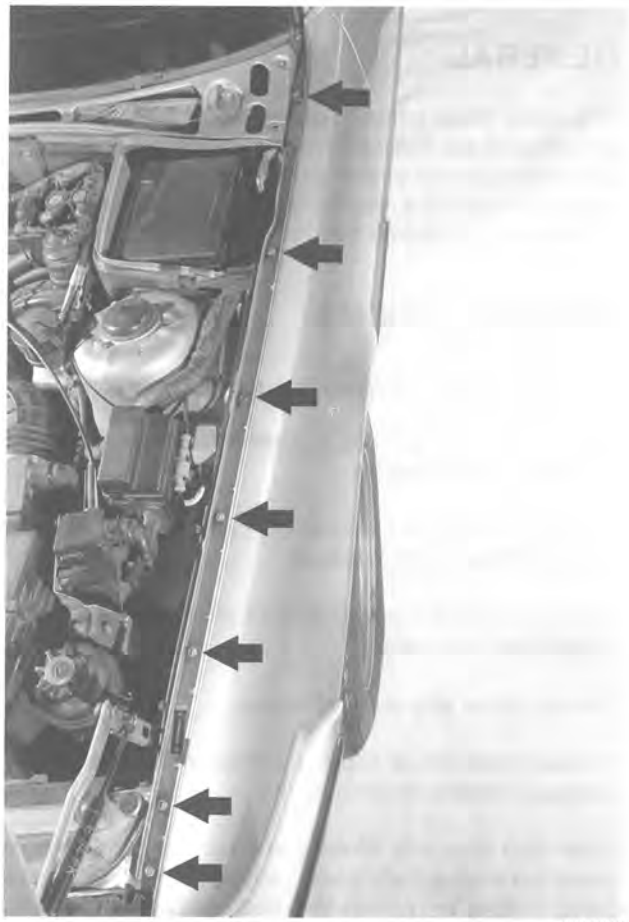
– Working inside wheel housing, remove wheel housing trim and seal between fender and trim.

◀ Open front door fully. Working at leading edge of door, remove two screws from fender (**arrows**). Working at rocker panel, remove two screws from bottom of fender (**arrows**).





➢ Remove front lower fender mounting bolt (**arrow**) (behind bumper skirt).



➢ Remove fender mounting bolts, top edge (**arrows**).

– Carefully remove fender from body.

– Clean any old sealant and protective coating from body mounting surfaces.

– When installing new fender, position fender in place and loosely install all mounting bolts. Align fender correctly with door and windshield pillar (A-pillar), then tighten bolts.

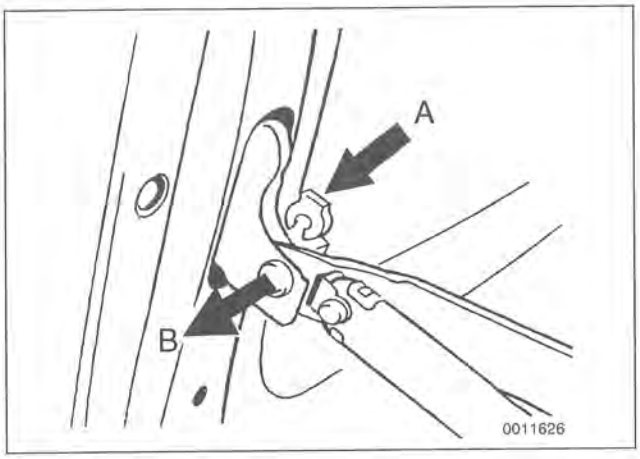
– Remainder of installation is reverse of removal. Repair any paint damage and paint any exposed metal.

ENGINE HOOD

Engine hood, removing and installing

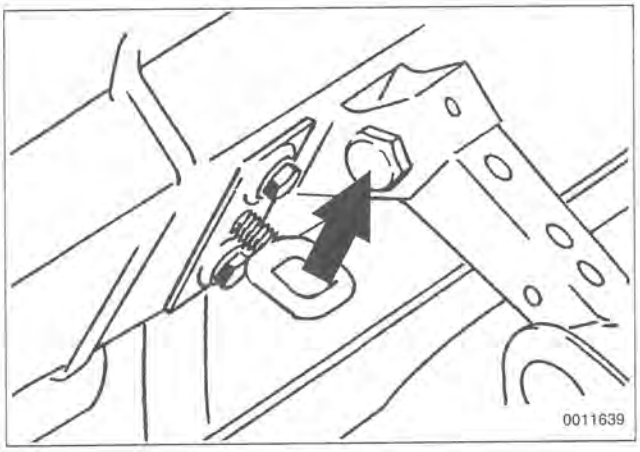
– Raise hood. Remove under-hood insulation.

– Unclip washer nozzle hoses and wiring from hood and set aside. Remove ground wire from hood, if applicable.



➢ Remove retaining clip (**A**) and slide pin out (**B**).

CAUTION—
Do not let the hood fall forward when the supports are disconnected.

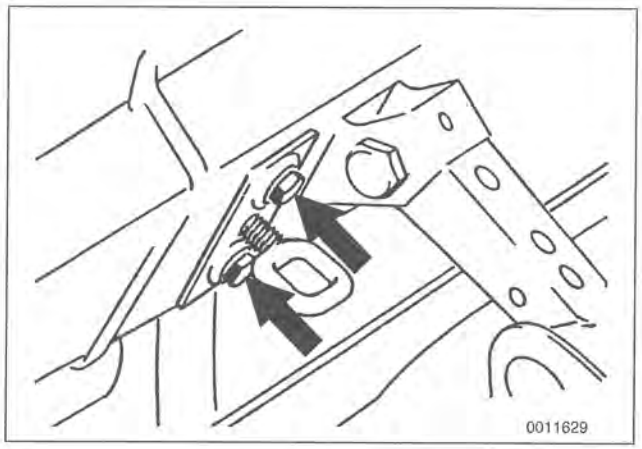


➢ While supporting hood (with aid of helper), remove left and right hinge pivot bolts (**arrow**) and carefully remove hood.

– Hood installation is reverse of removal.

Tightening Torque
- Hood hinge pivot bolt to bracket . . . . . 5 Nm (44 in-lb)

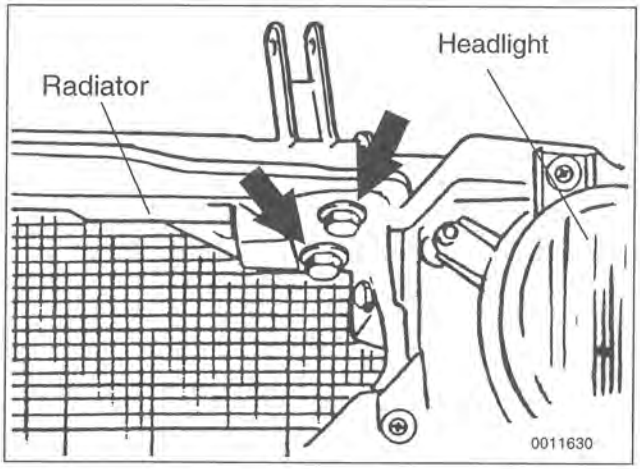
Engine hood, aligning



- Open hood and loosen bolts (**arrows**) on hood lock bracket.

NOTE —
Tighten the bolts on the lock bracket finger tight. The lock will be aligned in the forward direction when the hood is lowered. Tighten screws after opening the hood.

- Remove center, left and right radiator grilles to gain access to underside of hood hinges. See **510 Exterior Trim, Bumpers.**



- Working through grille opening, loosen bolts on left and right hood hinges (**arrows**).
- Working at front corners of radiator support, screw in fully rubber stops on left and right sides.
- Close hood and align with left and right fenders. Tighten hood hinge bolts when gap is equal on both sides.
- Adjust hood height at front by screwing hood lock eye in or out until hood is approximately 1mm (0.04 in.) below top of fenders. Close hood to check adjustment.
- Unscrew rubber stops at front until hood lightly touches stops and is flush with top of fenders.

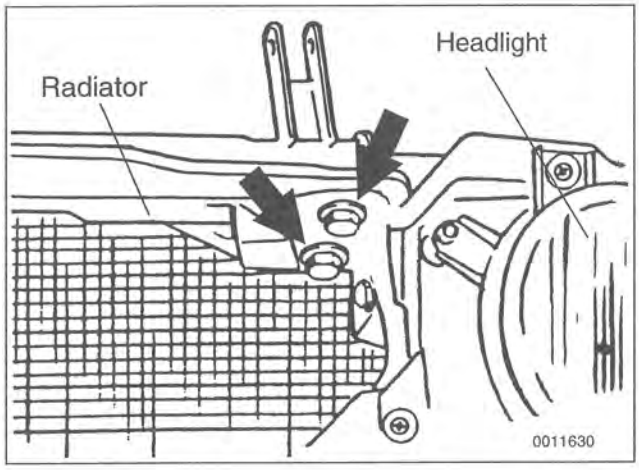


- Loosen bolts (**arrows**) to reposition rear catch.
  - Adjust rear catch so that top surface of hood aligns with top surface of fender.

NOTE —
If the rear guide roller on the hood does not slide into the catch smoothly, loosen the roller mounting bracket bolts and reposition the roller left or right until it slides into the catch correctly.

Hood hinge, replacing

- Remove engine hood as described earlier.
- Remove center, left, and right radiator grilles to gain access to underside of hood hinges. See **510 Exterior Trim, Bumpers**.



- Working through grille openings, remove bolts (**arrows**) from left and right hood hinges and remove hinges.

Hood lock cable, replacing

- Remove center, left, and right radiator grilles. See **510 Exterior Trim, Bumpers**.


0011644

- Working through grille opening, remove horn mounting bolt and move horn aside. Then remove hood lock mounting bolt (**arrow**).
- Open hood and remove hood lock from above, unhooking cable clips along body. Disconnect cable from hood lock.
- Working within passenger compartment, remove lower left dashboard trim panel and knee bolster. See **513 Interior Trim**.
- Remove bolt from hood lock latch and detach cable from latch.
- Pull cable out from engine compartment.
- Installation is reverse of removal.



0011645

Hood gas-pressure strut, replacing

– Open hood fully.

➢ Pry up end of retaining clip on strut and pull strut end from mounting stud. Repeat procedure on opposite end of strut and remove.

– Installation is reverse of removal.



411 Doors

GENERAL 411-1

DOORS 411-1
Front or rear door, removing and installing . . . 411-1
Door hinge bearing sleeve, replacing 411-3
Front door panel, removing and installing 411-4
Rear door panel, removing and installing 411-5
Front outside door handle with door lock cylinder, removing and installing 411-6
Rear outside door handle, removing and installing 411-7
Front door lock, removing and installing 411-7
Rear door lock, removing and installing 411-8
Door check, replacing 411-9
Door striker, replacing 411-9

GENERAL

This repair group covers front and rear door mechanical repair information, including removal and installation of the interior door panels.

NOTE—

- *For information on the power door windows and door glass replacement, see* **512 Door Windows**.
- *For information on the power door locking system, see* **515 Central Locking**.

DOORS

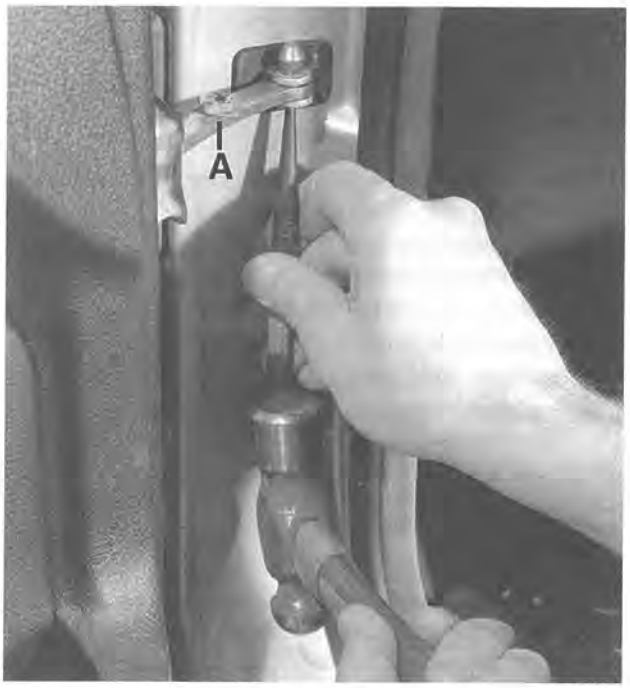
Front or rear door, removing and installing



0011650

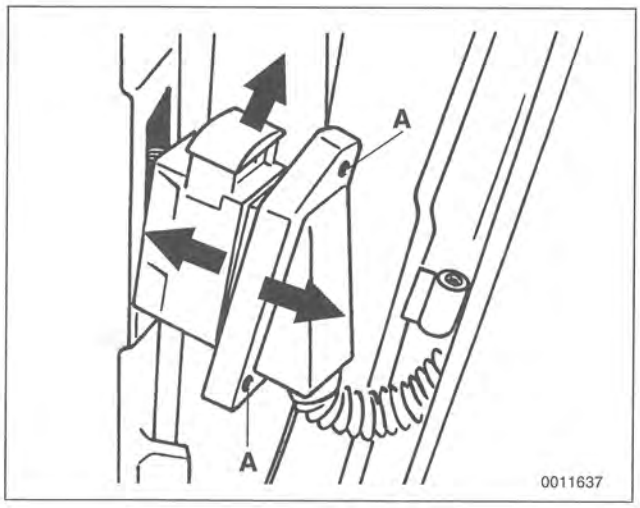
Door hinge pin bolt (**arrow**).

- With door fully open, remove pin bolts from top and bottom door hinges.



0011651

➢ Remove retainer clip (**A**) from door check pin on body pillar. Drive out door check pin.



0011637

➢ Remove main harness connector retaining screws (**A**) at body A-pillar and unlock and separate connector (**arrows**).

– Remove door by lifting up off lower hinge halves.

> ***CAUTION—***
> *Be careful not to damage door or other painted body surfaces. Make sure no load is placed on wiring harness.*

– Installation is reverse of removal.

- Check door hinge bearing sleeves as described later and replace any that are worn.
- Align door so that panel gaps are equal on either side.
- Adjust door striker so that trailing edge of front door is slightly higher (1mm) than leading edge of rear door.

Door Adjustment

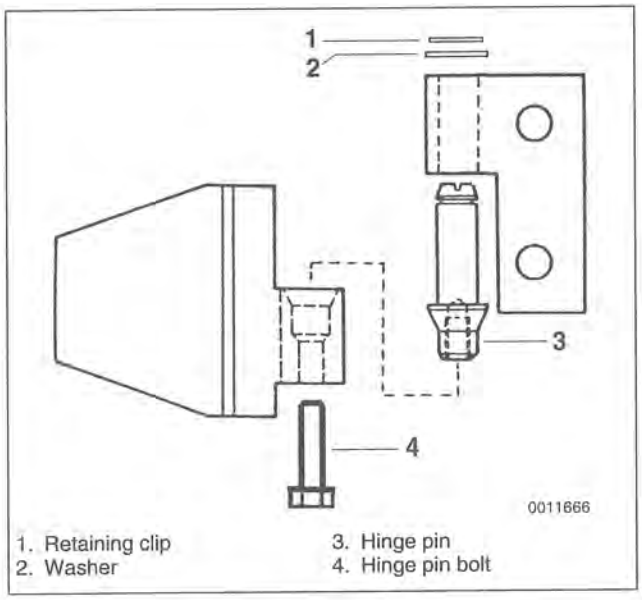
- Door gap to fender or rear door . . . . . 5.5 ± 0.5 mm (0.216 ± 0.020 in.)
- Deviation from parallel . . . . . 1 mm (0.040 in.)

Door hinge bearing sleeve, replacing

Check the door bearing sleeves with the door installed. Open the door fully and lift up on the door end (nearest the outside handle) to check for worn hinge bearing sleeves. If any play is detected, the bearing sleeves are most likely worn.

– Remove door as described earlier.

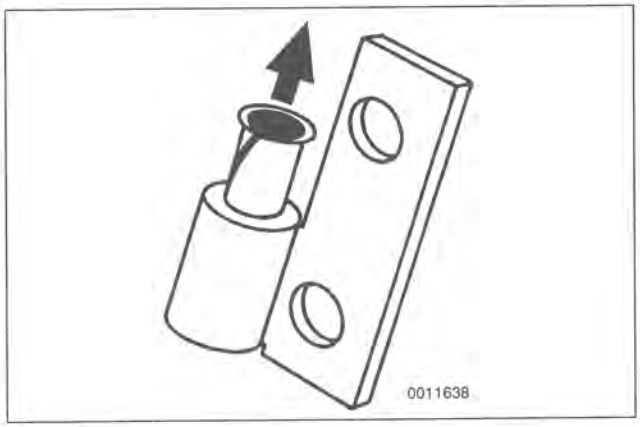
NOTE—
If replacing the upper bearing sleeve, first unbolt the hinge half from the door. Mark the position of the hinge before removing. On the lower hinge, the hinge half with the sleeve is on the body.



1. Retaining clip
2. Washer
3. Hinge pin
4. Hinge pin bolt

➢ Door hinge assembly.

• Remove hinge pin from hinge half.



➢ Drift old bearing sleeve from hinge half. **Arrow** indicates bearing removal direction.

– Install new bearing sleeve.

– Remainder of installation is reverse of removal. Lubricate bearing surfaces before installing door.

NOTE—
A special BMW service tool (BMW tool no. 41 5 010) is used to install the bearing sleeve into the bearing half. The tool is used to peen and flatten the end of the bearing sleeve to the hinge. An appropriate size mandrel can be used as an alternative.

Front door panel, removing and installing


0017282

– Carefully pry out mirror adjustment switch and disconnect harness connector from switch (if applicable).

– Carefully pry out and remove door wood trim.

➢ Remove door panel retaining screws (**arrows**) behind and ahead of top armrest anchor.

– Unscrew door locking knob.


0011653

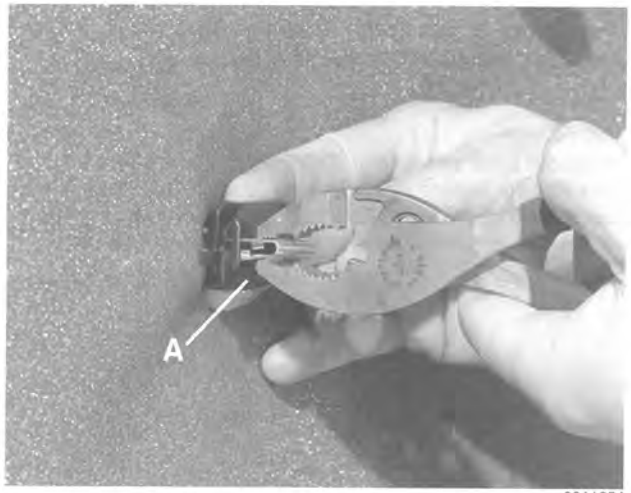
➢ Unclip trim panel from door perimeter, one clip at a time.

– Pull top of door panel (unclip) from inside weather strip. Lift trim panel up and off door. Disconnect door handle release cable from handle.

NOTE—

A retaining clip behind the center of the door panel retains the center of the panel to the door. Be sure to lift the panel straight up and off the retaining clip when removing.

– Installation is reverse of removal.



0011654

➢ Remove door panel retaining piece (**A**) from metal clip in center of door.

- Squeeze metal clip while sliding plastic piece off. Note installation direction before removing.
- Install plastic piece to cutout in door panel, noting installation direction.
- Replace any damaged plastic parts/clips.
- Check that rubber seal and vapor barrier are correctly positioned and not damaged.

Rear door panel, removing and installing

– Remove ash tray.

– Carefully pry out and remove door wood trim.



0017283

➢ Remove door panel retaining screws (**arrows**) behind and ahead of top armrest anchor.

– Unscrew door locking knob.



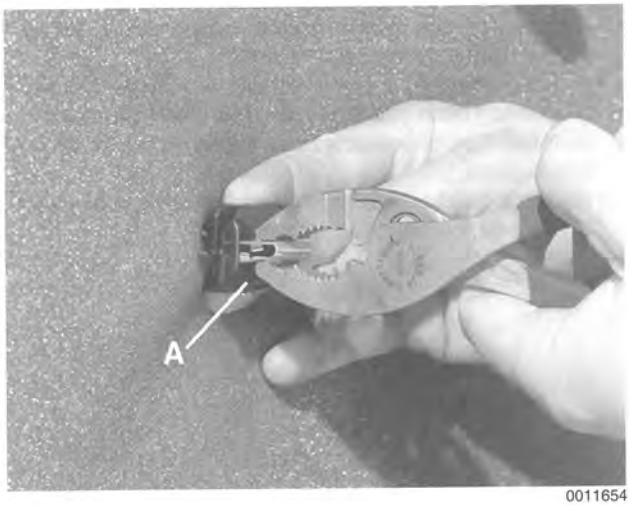
0011653

➢ Unclip trim panel from door perimeter, one clip at a time.

– Pull top of door panel (unclip) from inside weather strip. Lift trim panel up and off door. Detach power window switch harness connector from switch. Disconnect door handle release cable from handle.

NOTE—

A retaining clip behind the center of the door panel retains the panel to the door. Be sure to lift the panel up and off the retaining clip when removing.



0011654

– Installation is reverse of removal, noting the following:

➢ Remove door panel retaining piece (**A**) from metal clip in center of door.

- Squeeze metal clip while sliding plastic piece off. Note installation direction before removing.
- Install plastic piece to cutout in door panel, noting installation direction.
- Replace any damaged plastic clips.
- Check that rubber seal and vapor barrier are correctly positioned and not damaged.

Front outside door handle with door lock cylinder, removing and installing



0011681

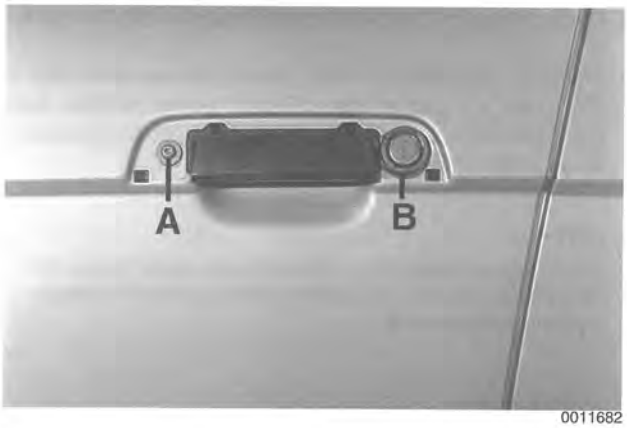
– Remove front door panel as described earlier.

– Close front window completely. Disconnect harness connector from window motor to prevent accidental operation.

➢ Pry out access plug in end of door. Insert screwdriver into access hole and push locking plate forward to unlock and release exterior trim piece.

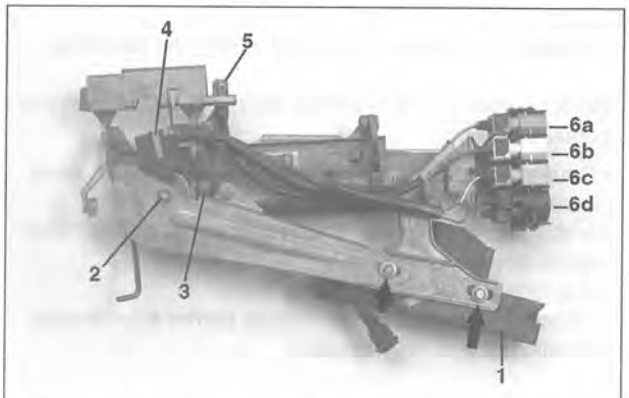
– Remove door handle exterior trim piece by carefully lifting off from top.

– Working inside door, disconnect locking linkage from door lock.



0011682

➢ Remove handle screw (**A**) and locking (**B**) nut while supporting handle. Remove handle from inside door. Disconnect harness connectors.



1. Central locking drive, basic setting: bolts centered in elongated holes (**arrows**)
2. Lock cylinder
3. Lock heater
4. Microswitch: door lock contacts
5. Microswitch: door lock heater
6. Harness connectors
   a. Door lock heater microswitch
   b. Door lock heater
   c. Locking contact microswitch
   d. Terminal 30/vehicle alarm

0011683

➢ Remove door handle assembly from inside door. Disconnect harness connectors.

– Installation is reverse of removal.

- Make sure rubber seal for handle is correctly positioned before tightening mounting fasteners.
- Install exterior trim piece and then use a hooked tool to pull locking plate into the locked position. Make sure door handle trim contacts body evenly before locking trim in place.
- Reconnect all harness connectors (including power window motor) before installing door panel.

Rear outside door handle, removing and installing



0011681

- Remove rear door panel as described earlier.
- Close window completely. Disconnect harness connector from window motor to prevent accidental operation.
- Pry out access plug in end of door. Insert screwdriver into access hole and push locking plate forward to unlock and release outside handle trim.
- Remove door handle exterior turn piece by carefully lifting off from top.
- Working inside door, disconnect locking linkage from door lock.



0011684

- Remove door handle trim piece from door handle. Remove door handle screws (**arrows**) while supporting handle.
- Remove door handle assembly from inside door.
- Installation is reverse of removal.
  - Make sure rubber seal for handle is correctly positioned before tightening mounting fasteners.
  - Install exterior trim piece and then use a hooked tool to pull locking plate into locked position.
  - Make sure door handle trim contacts body evenly before locking trim in place.
  - Reconnect all harness connectors (including power window motor) before installing door panel.

Front door lock, removing and installing



0011685

- Remove front door panel as described earlier.
- Close door window completely. Disconnect harness connector from window motor to prevent accidental operation.
- Working inside door, peel back rubber window guide from guide rail. Using T30 Torx driver, remove guide rail mounting bolt. Remove lower rail from door.

NOTE—
The top of the lower guide rail is "hooked" to the door.

- Disconnect locking linkage from door lock.



0011686

➢ Remove door lock screw (**arrows**). Pull back door seal as necessary. Remove lock from inside door.

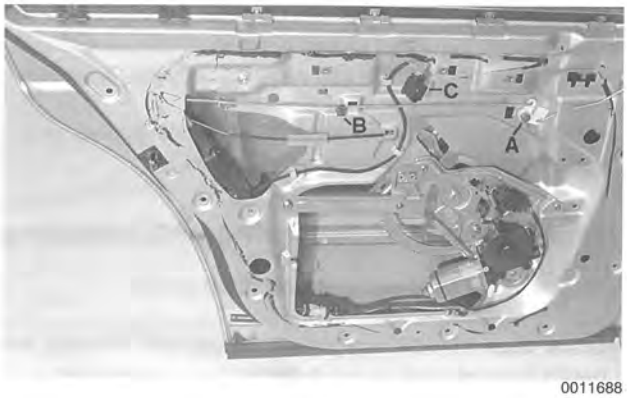
– Installation is reverse of removal, noting the following:

- Before installing door lock into door, position lock and rotary latch in "locked" position.
- Reconnect power window motor harness connector before installing door panel.

Rear door lock, removing and installing

– Remove rear door panel as described earlier.

– Close door window completely. Disconnect harness connector from window motor to prevent accidental operation.



0011688

➢ Working inside door, remove bolt from linkage rod retainer (**A**), lift rod out of retaining clip (**B**), and disconnect harness connector (**C**).



0011687

➢ Remove door lock screws (**arrows**). Pull back door seal as necessary. Remove lock from inside door.

– Installation is reverse of removal.

- Before installing door lock into door, position lock and rotary latch in "locked" position.
- Reconnect power window motor harness connector before installing door panel.

Door check, replacing

- Remove interior door panel as described earlier.
- Close door window completely. Disconnect harness connector from window motor to prevent accidental operation.
- Remove locking clip and washer from door check pivot pin. Drive pin from bracket.
- Remove bolts from door check lockplate on door.
- Remove rubber cover from door check on door.
- Remove screws and remove door check from inside door.
- Installation is reverse of removal. Lubricate door check before installing.



0011651

Door striker, replacing

The door striker contains an electrical contact switch to signal the general module and the check control module when the door is open. If the switch is faulty, the complete striker must be replaced.

To remove the striker, remove the mounting screws using the appropriate Torx driver and remove the striker. Disconnect the harness connector from the striker during removal. Installation is reverse of removal. Adjust striker position before tighten screws fully.

NOTE—
If the striker backup plate falls into the body cavity, the plate can be reached after removing the inside trim from the B-pillar.



412 Trunk Lid

GENERAL 412-1

TRUNK LID 412-1
Trunk lid, removing and installing 412-1
Trunk lid, aligning 412-2
Trunk lid support strut, removing and installing 412-2

GENERAL

This repair group covers trunk lid removal and installation. Also included here are replacement procedures for the gas-charged struts that hold the trunk lid in the up position.

NOTE—
The body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. Paint all exposed metal once the work is complete.

TRUNK LID

Trunk lid, removing and installing

– Raise trunk lid.

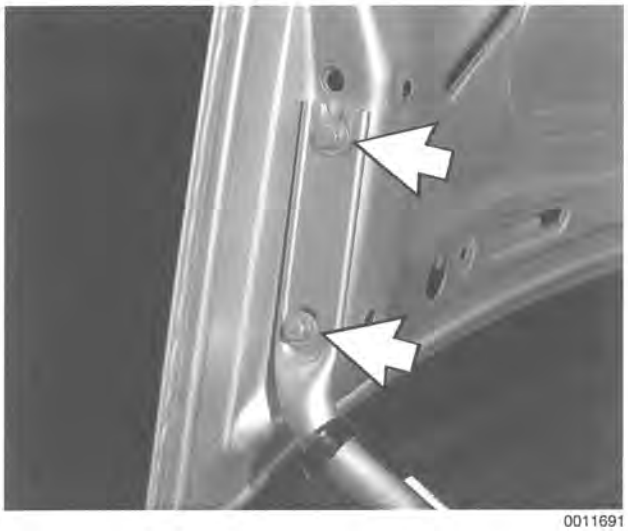
– Remove vehicle tool kit from trunk lid by removing 4 screws and large plastic retainer.

– Remove insulating liner from underside of trunk lid by pulling off each clip carefully.

– Disconnect wiring from electrical components and remove complete wiring harness from trunk lid.

– Remove plastic covers from hinge arms.

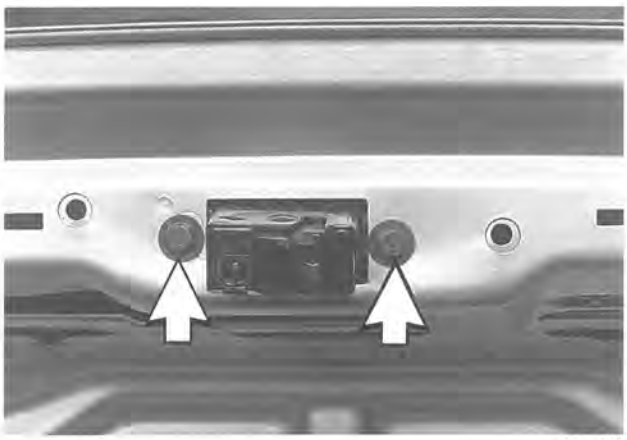
➢ While supporting trunk lid, loosen top hinge bolts and remove lower bolts (**arrows**). Remove trunk lid with aid of helper.



0011691

NOTE—
Before loosening hinge bolts, mark hinge and hinge bolt locations for installation.

– Installation is reverse of removal. If necessary, align trunk lid to body as described next.



0011692

Trunk lid, aligning

– Raise trunk lid.

➢ Remove plastic cover over trunk lid lock. Loosen lock bolts (**arrows**).

– Loosen bolts at left and right trunk hinges.

– Working at lower corners of trunk lid, screw in fully rubber stops on left and right sides.

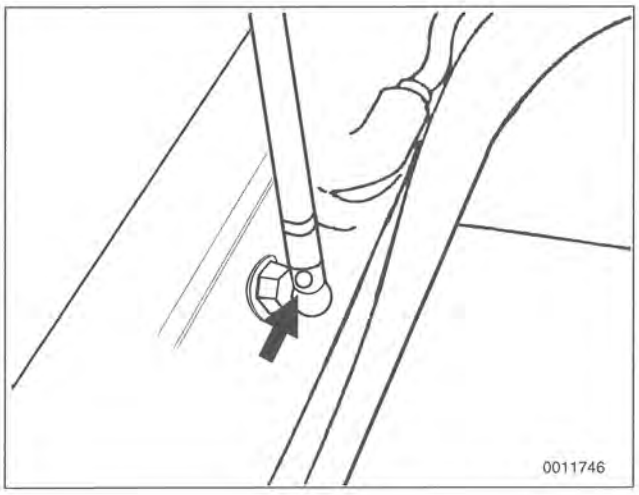
– Close trunk lid and align to body at rear and front. Open lid and tighten hinge bolts.

– Adjust lock so that closed trunk lid is approximately 1mm (0.04 in.) below top of rear fenders.

– Open trunk lid and screw out rubber stops so that closed trunk lid is flush with top of rear fenders.

Trunk lid support strut, removing and installing

WARNING—
Make sure to support trunk lid before removing strut.



0011746

➢ Open trunk lid. Remove spring clip (**arrow**) from support strut and remove strut from body end.

– Remove strut from trunk lid.

– Installation is reverse of removal. Replace any trim retaining clips damaged during removal.



510 Exterior Trim, Bumpers

GENERAL 510-1

EXTERIOR TRIM 510-1
BMW emblem, removing and installing. 510-1
Door molding, replacing 510-2
Fender molding, replacing 510-2
Outside mirror, removing and installing 510-3
Mirror glass, replacing 510-4
Radiator grille, removing and installing 510-4
Headlight grille, removing and installing 510-5

BUMPERS 510-5
Front or rear bumper, removing and installing 510-7

GENERAL

This repair group covers bumper removal and installation, as well as replacement of some of the exterior trim.

EXTERIOR TRIM

Much of the exterior trim is retained to the body by plastic clips and fasteners that may be damaged during trim removal. Be sure to have the necessary fasteners on hand when removing exterior trim pieces.

BMW emblem, removing and installing

The procedure given below applies to both front and rear emblems.

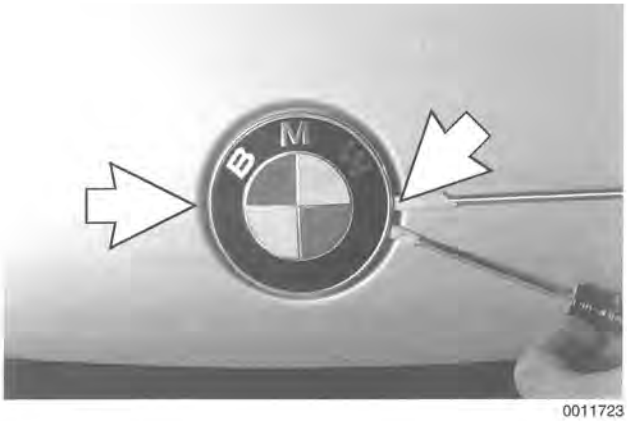
– Wrap end of screwdriver with tape.

➢ Pry up emblem carefully on either side (**arrows**). Note tape on screwdriver tips.

> ***CAUTION—***
> *Use care to protect painted surfaces.*

– Installation is reverse of removal.

- Replace plastic inserts in body if damaged.
- If emblem fits loosely into inserts, use a small piece of body side molding tape or adhesive on rear of emblem before installing.



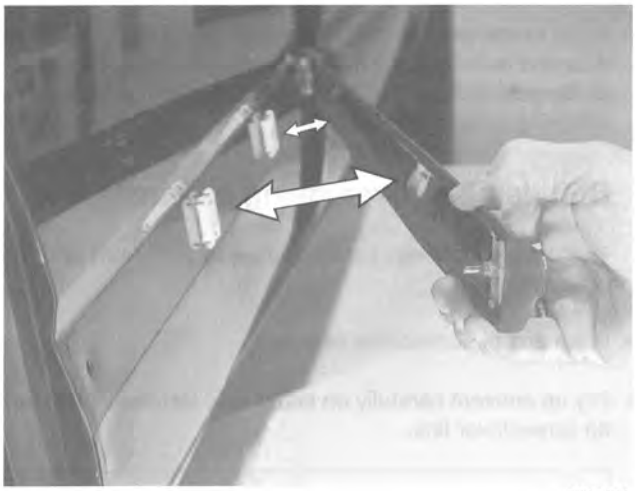
0011723

Door molding, replacing



0017264

➢ Open door. Remove plastic nut (**arrow**) from door edge.



0017262

➢ Door molding plastic clips and retainers (**arrows**).

- Pull molding off plastic retainers gently, sliding it off the last one.

– Installation is reverse of removal. Replace any clips damaged during removal.

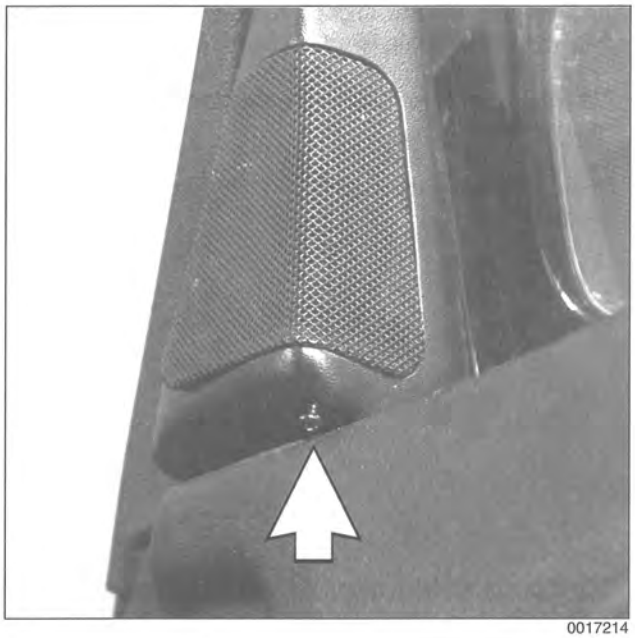
Fender molding, replacing

– Front fender: Remove plastic nut on inside lip of fender. Then slide molding forward off plastic retainer.

– Rear fender: Remove rear wheel well splash shield. Remove plastic nut on inside lip of fender and remove molding.

– Installation is reverse of removal.

Outside mirror, removing and installing



0017214

➢ Door speaker trim cover mounting screw (**arrow**).

- Open door and remove loudspeaker from window frame.

– Remove insulation from behind speaker (if so equipped).

– Remove speaker trim cover mounting screw. Remove cover.



0017213

➢ Remove mirror mounting screws (**1** and **2**). Lift mirror off door and disconnect plug.

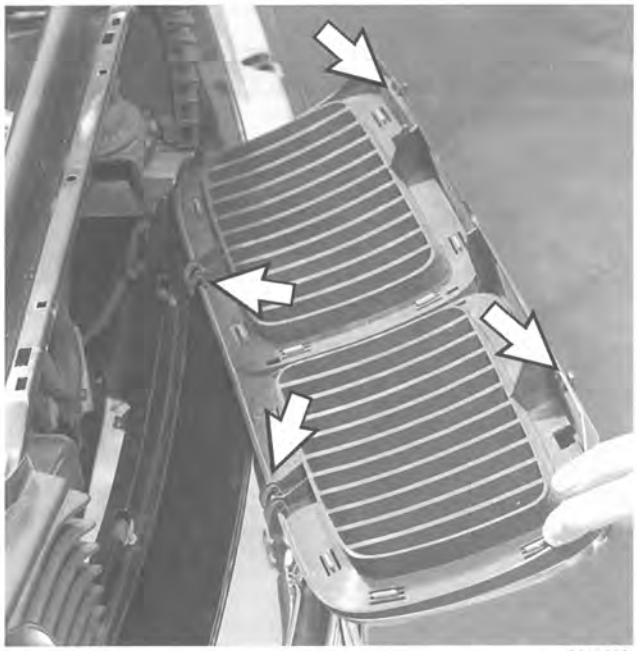
– Installation is reverse of removal. Check mirror function before installing covering parts.



0011728

Mirror glass, replacing

- Insert screwdriver to engage tab on mirror glass locking ring. Turn locking ring to unlock mirror glass.
- Lift glass from mirror assembly and disconnect wiring from heating element.
- Install new glass into position. Turn locking ring to lock mirror glass.

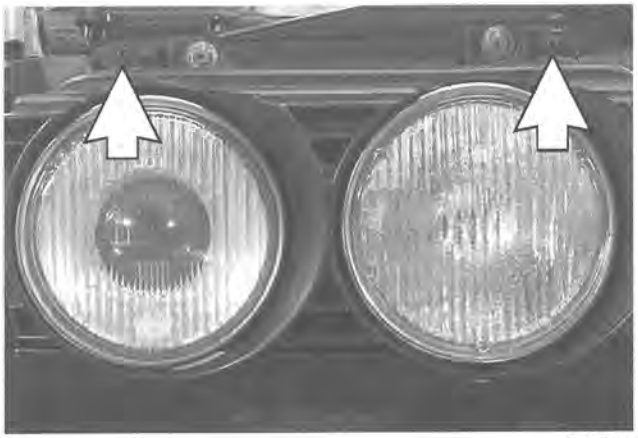


0017289

Radiator grille, removing and installing

- Open engine hood.
- Working from engine side of hood, pry grille retaining tabs (**arrows**) off top radiator support and gently push grille out.
- Push hood closed without latching at front. Pivot grille forward and unhook bottom plastic hooks off front panel.
- Installation is reverse of removal.

Headlight grille, removing and installing

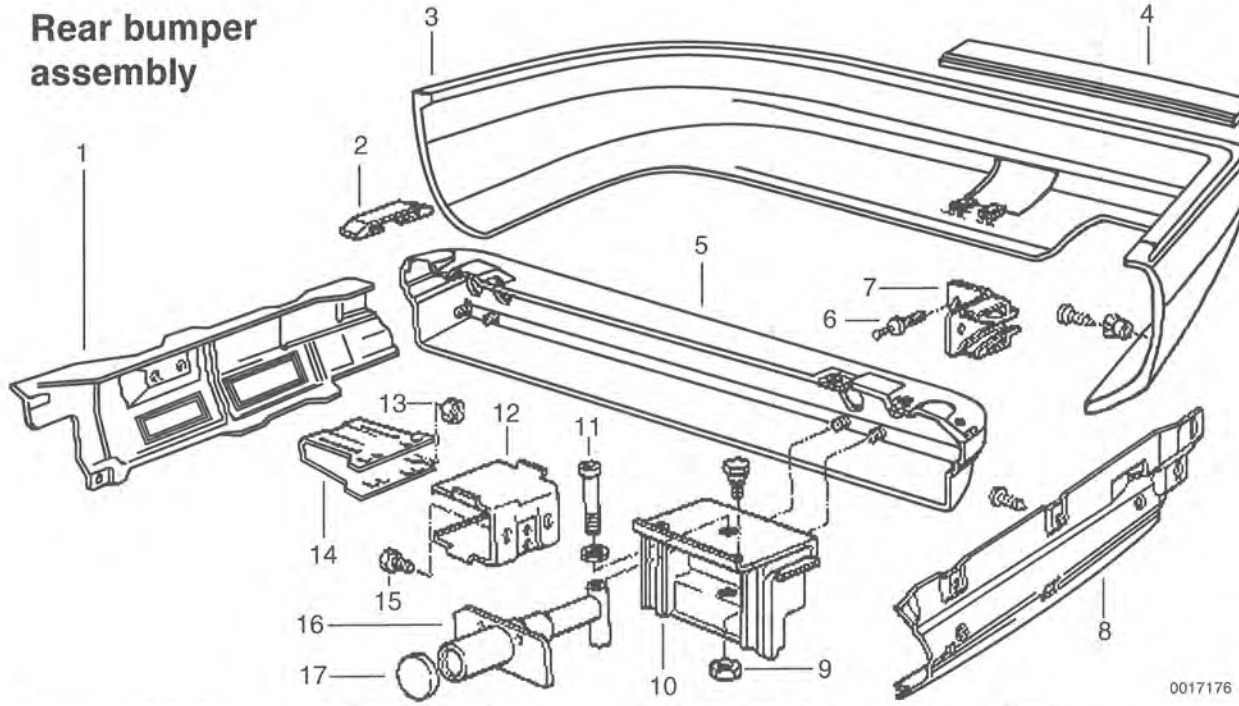


0017208

- Remove expanding rivets (**arrows**).
- Tilt grille forward past headlight assembly.
- Installation is reverse of removal.

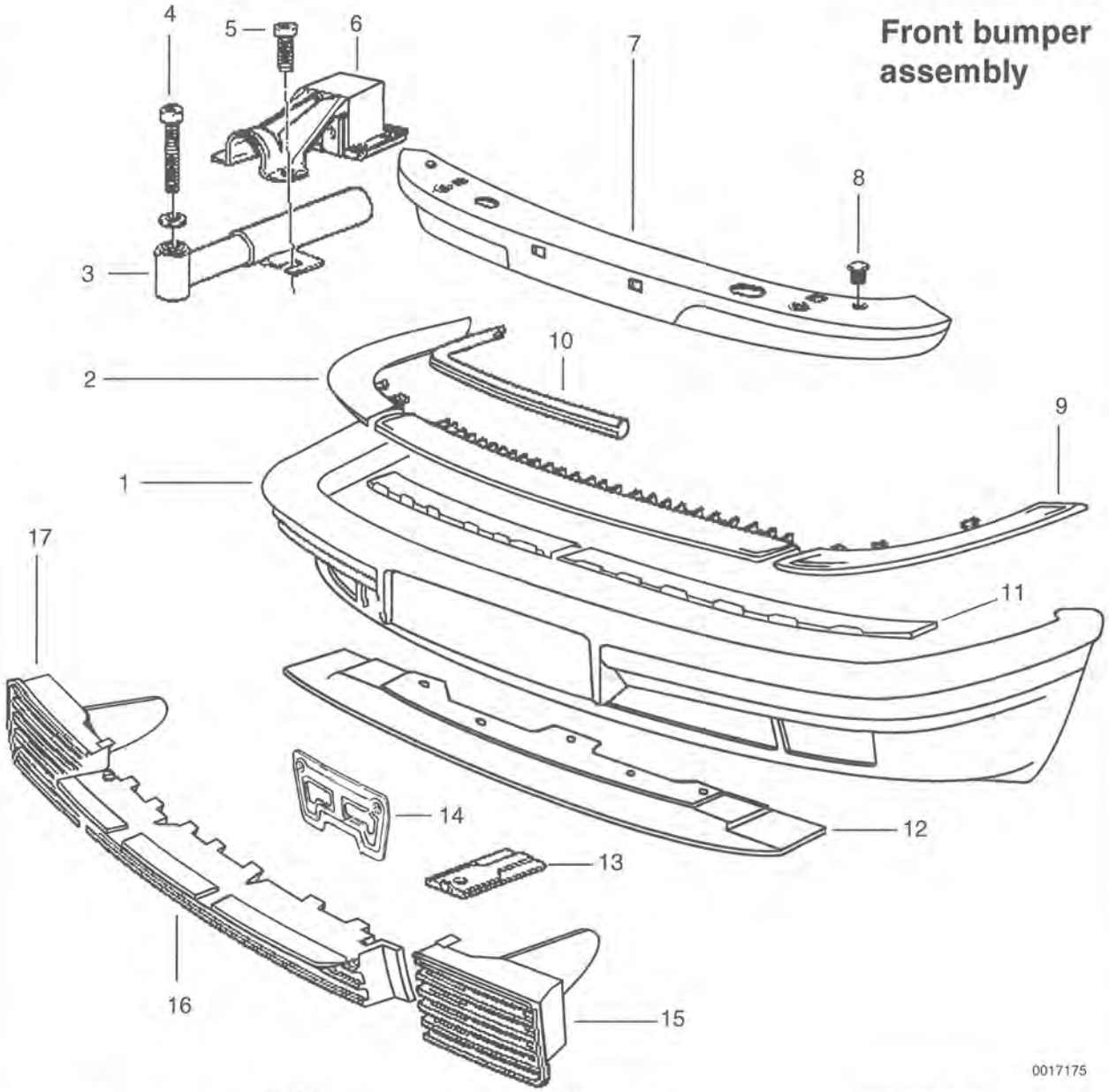
BUMPERS

Rear bumper assembly



0017176

1. Reinforcement, right
2. Sliding piece
3. Bumper cover
4. Spacer, left
5. Bumper
6. Expanding rivet
7. Guide
8. Heat shield
9. Nut
10. Bracket
11. Allen head bolt
    • tighten to 42 Nm (32 ft-lb)
12. Bracket
13. Nut
14. Bracket
15. Bolt
16. Impact absorber
17. Cap



1. Bumper cover
2. Covering, right
3. Impact absorber
4. Allen head bolt
   • tighten to 42Nm (32 ft-lb)
5. Bolt
6. Bracket
7. Bumper
8. Mounting bolt
9. Covering, left
10. Gasket
11. Spacer, left
12. Sealing, lower
13. Bracket
14. License plate bracket
15. Cover, left
16. Cover, center
17. Cover, tow hook, right

Front or rear bumper, removing and installing



0017177

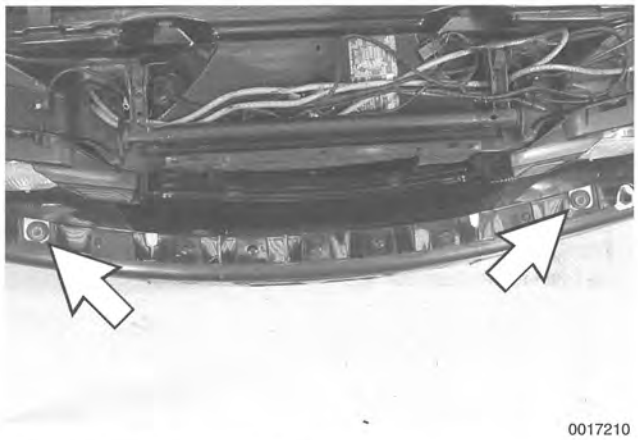
➢ Front bumper: Remove headlight pressure washer nozzle covers. Then remove nozzle mounting screws (**1**) and 19 mm plastic nuts (**2**), pushing nozzles down through opening in bumper.

– Front bumper: Detach high pressure headlight washer hoses from lower bumper lip.



0017209

➢ Using a screwdriver, press release tabs on bumper top chrome strip and carefully remove strip.



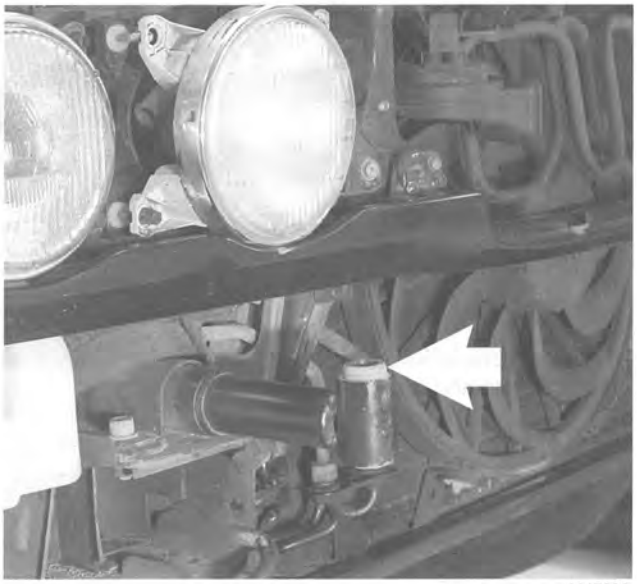
0017210

➢ Remove bumper mounting bolts (**arrows**).

– Pull bumper off body slowly.

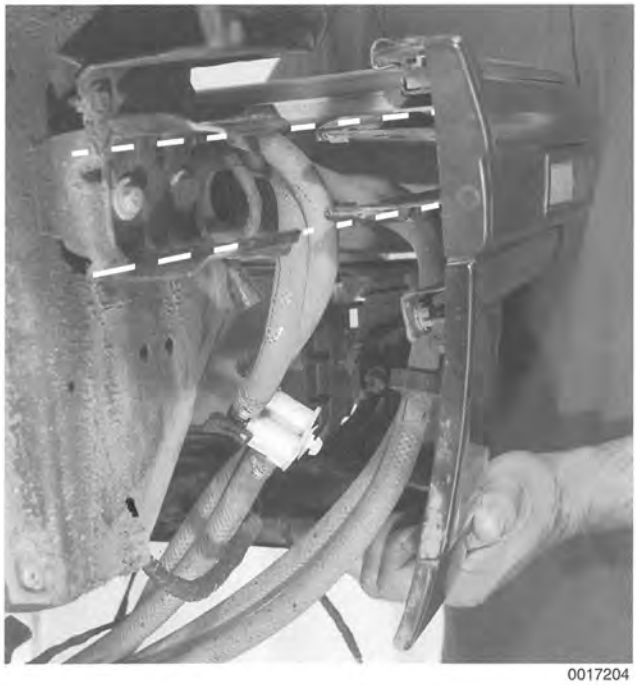
NOTE—

Detach electrical harness connectors to foglight assemblies and temperature sensor, as needed, when removing the front bumper.



0017206

➢ Before installing bumper use BMW Special tool 51 10 40 (14 mm Allen socket) to turn bumper height adjuster sleeves (**arrows**) counterclockwise a few turns.



0017204

➢ With an assistant, slip bumper onto body, carefully aligning side brackets.

– Turn bumper height adjusting sleeves until bumper height is correct and clearance with fenders is even on both sides. Install and tighten bumper mounting bolts and install trim piece.

Tightening Torque

- Bumper to impact absorber . . . . . 42 Nm (30 ft-lb)



512 Door Windows

GENERAL 512-1

WINDOW SERVICE 512-1

Front door window, removing/installing. 512-1

Rear door window, removing/installing 512-3

Door window regulator and window motor, removing and installing. 512-5

Door windows, adjusting 512-6

GENERAL

This heading covers replacement of the front and rear door glass. Also covered here is the replacement of the power window regulator and power window motor. For removal and installation of the doors and door panels, see **411 Doors**.

WARNING—

- *Always wear hand and eye protection when working with broken glass.*
- *If the window is broken, all of the glass bits should be vacuumed out of the door cavity. Use a blunt screwdriver to clean out any remaining glass pieces from the window guide rails.*

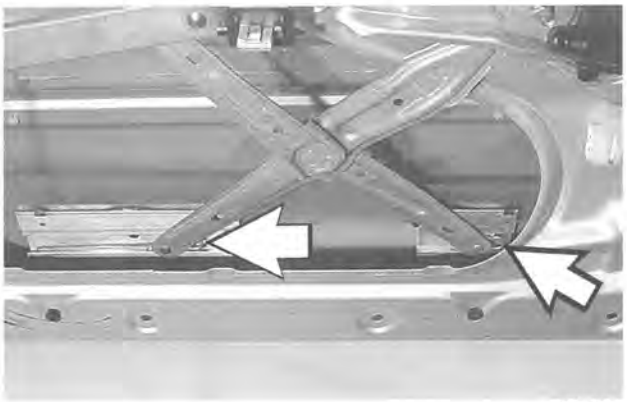
WINDOW SERVICE

Front door window, removing/installing

– Remove outside mirror from door. See **510 Exterior Trim, Bumpers**.

– Remove interior door panel. See **411 Doors**.

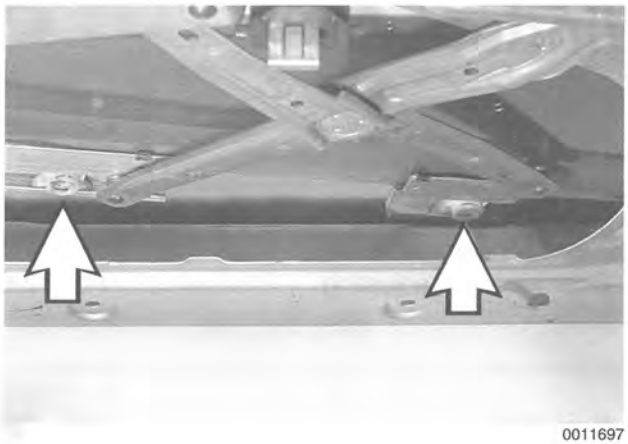
Lower front window. Remove retaining clips (**arrows**) from window slides.



0011696

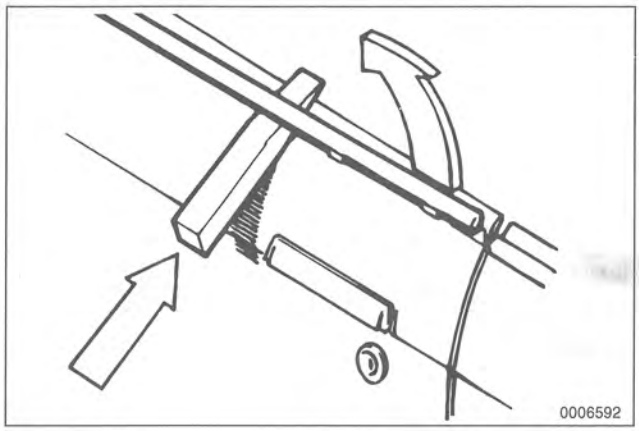
NOTE—

Once window is lowered, disconnect harness connector from power window motor to prevent accidental operation of window.



0011697

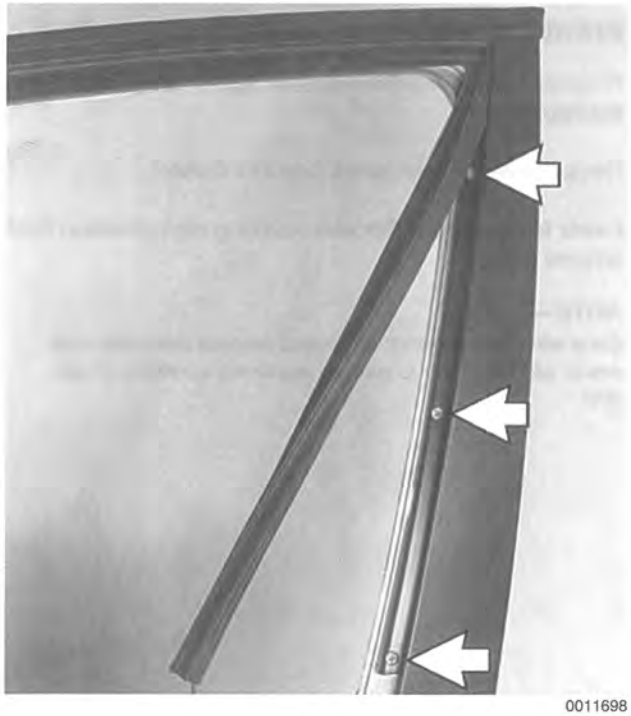
➢ Pry window lifting arms from slides (**arrows**).



0006592

➢ Using wooden wedge carefully pry off outer window trim from top of door. Lift off remaining inner seal.

– Remove plastic trim from door frame perimeter. Pull rubber window channel out of door frame.



0011698

➢ Remove window screws (**arrows**) from trim cover and remove trim cover by sliding down and off.

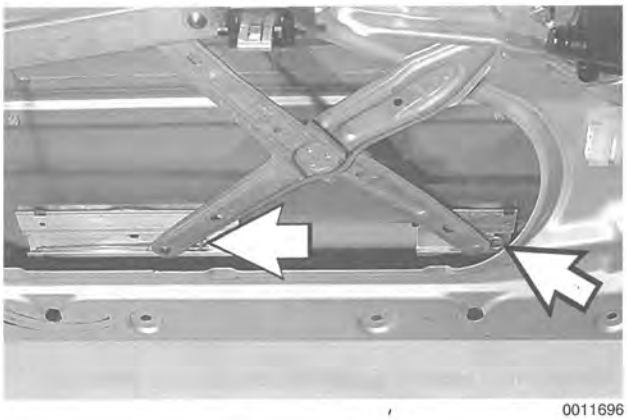
– Remove window glass from above.

– Installation is reverse of removal.

- When inserting window into door, be sure glass aligns with left and right guides as it is lowered into the door.
- If necessary, adjust door window as described later.

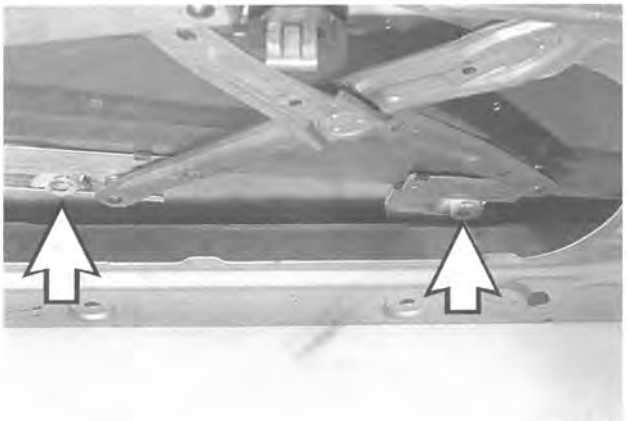
Rear door window, removing/installing

– Remove interior door trim panel. See **411 Doors**.

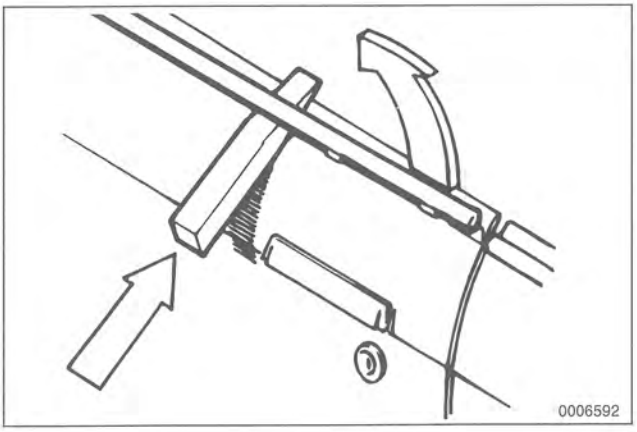

0011696

➢ Lower window. Remove retaining clips from window slides (**arrows**).

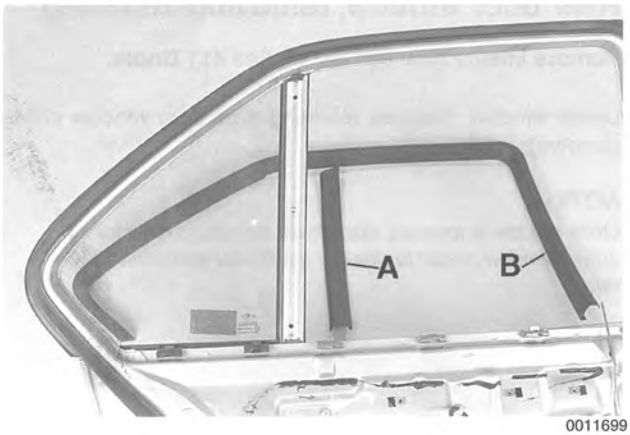
NOTE—
Once window is lowered, disconnect harness connector from power window motor to prevent accidental operation of window.


0011697

➢ Pry window lifting arms from slides (**arrows**).

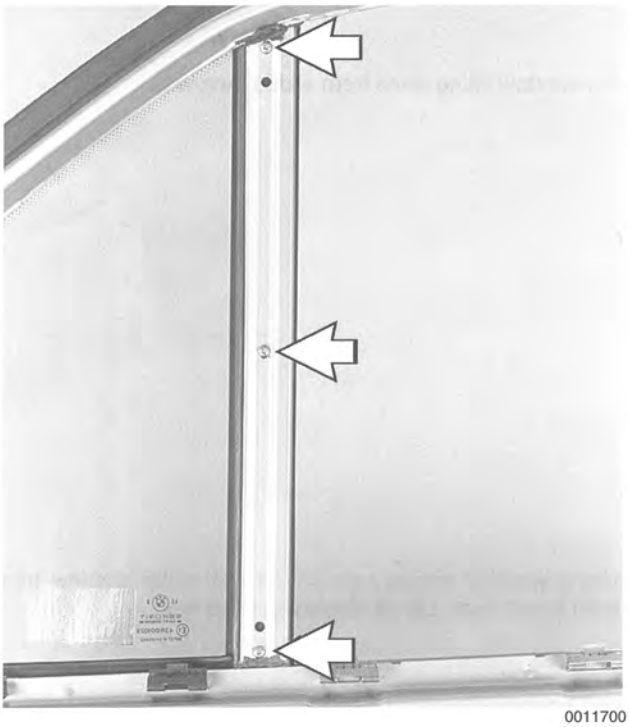

0006592

➢ Using wooden wedge carefully pry off outer window trim from top of door. Lift off remaining inner seal.



0011699

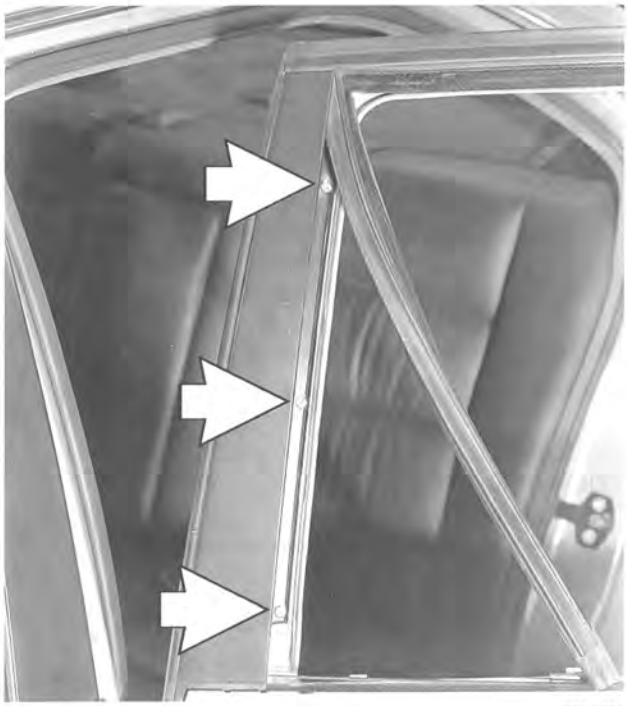
➢ Remove inside window trim pieces (**A** and **B**) by prying/pulling off door.



0011700

➢ Remove rear window guide mounting screws (**arrows**).

– Pull off exterior trim cover from rear window guide. Pull rubber window channel from door frame.



0011701

➢ Remove outside trim cover mounting screws (**arrows**) and remove trim cover by sliding up and off window guide.

– Remove window glass from above.

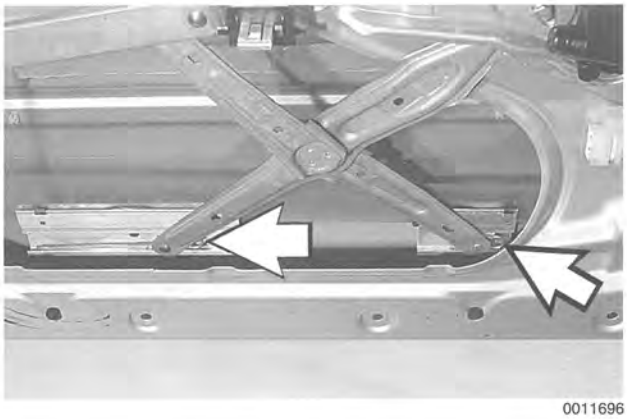
– Installation is reverse of removal.

- When inserting window into door, be sure glass aligns with left and right guides as it is lowered into the door.
- If necessary, adjust door window as described below.

Door window regulator and window motor, removing and installing

– Lower window. Remove power window switch and disconnect plug from switch. See **Center console, removing and installing** in **513 Interior Trim**.

– Remove interior door panel. See **411 Doors**.

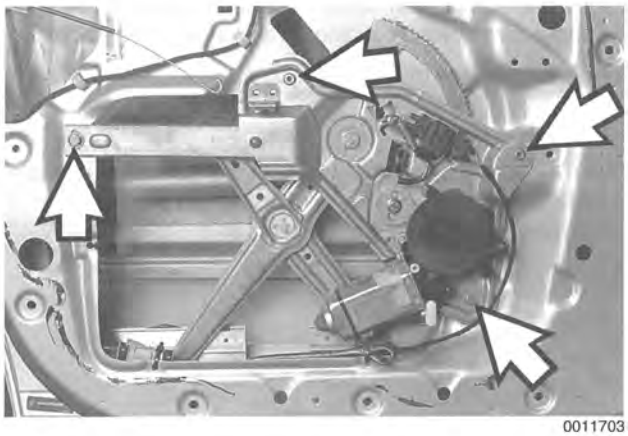


0011696

➢ Remove retaining clips for window slides (**arrows**).

– Pry window lifting arms out of left and right slides.

– Detach electrical harness connector from window regulator motor.



0011703

➢ Remove window regulator mounting bolts or rivets (**arrows**).

NOTE—
The regulator may be mounted to the door with rivets. If necessary, drill out rivets and replace with hex head bolts (M6 x 10) and nuts.

– Remove regulator assembly from door.

– Unbolt power window motor from rear of regulator.

– Installation is reverse of removal.
  • If necessary, adjust door window as described later.

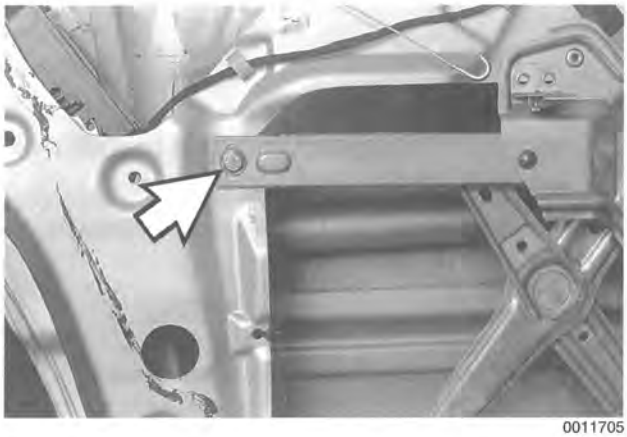
Tightening Torque
• Window regulator to door . . . . . .9 Nm (80 in-lb)

Door windows, adjusting

This procedure applies to both front and rear windows.

Whenever the window regulator is removed, the window adjustment should be checked. The glass should contact the top of the window squarely and should seat against the window seal uniformly.

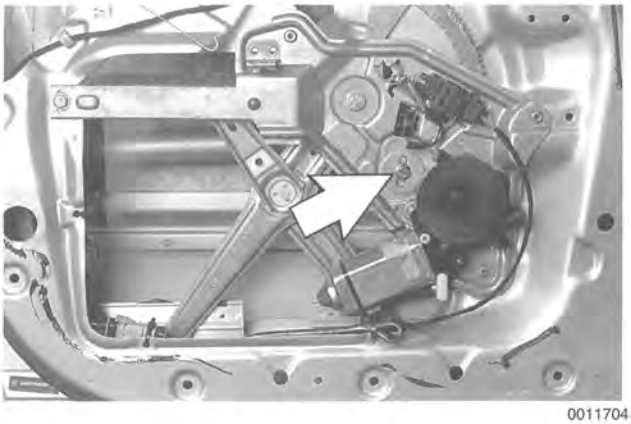
NOTE—
If the window seal does not contact the door glass uniformly, wind noise will result.



0011705

– Remove interior door panel. See **411 Doors**.

➢ Adjust window to door frame by loosening bolt (**arrow**) and repositioning bracket.



0011704

➢ Adjust window bottom stop by loosening bolt (**arrow**) and repositioning stop plate.



513 Interior Trim

GENERAL 513-1

CENTER CONSOLE 513-1
Center console, removing and installing 513-1

DASHBOARD 513-3
Dashboard, removing and installing 513-3

GLOVE COMPARTMENT 513-6
Glove compartment, removing and installing . 513-6

OTHER INTERIOR TRIM 513-7
Lower left dash panel, removing and installing 513-7
Pedal cluster trim panel, removing and installing 513-8
Rear parcel shelf, removing and installing 513-8
Rear window power sunshade, servicing 513-9

GENERAL

This repair group covers basic interior trim removal and installation. For removal and installation of interior switches, including interior lighting, see **612 Switches and Electrical Accessories**.

> ***WARNING—***
> *Cars covered by this manual are equipped with a Supplemental Restraint System (SRS) that automatically deploys an airbag(s). The airbag unit(s) uses a pyrotechnic device to electrically ignite a powerful gas. Before performing any work involving the steering wheel or interior trim in the vicinity of the airbag(s), disconnect the negative (–) battery cable and the orange SRS connector as described in* **721 Airbag System (SRS)**. *Performing repairs without disconnecting the SRS orange connector may cause serious personal injury or death.*

CENTER CONSOLE

Center console, removing and installing

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Disconnect orange SRS connector on steering column as described in **721 Airbag System (SRS)**.

– Remove lower left dash panel from below steering column as described later.



0017226

➤ Working in rear seat, remove ashtray/cigarette lighter cover, disconnect wiring harness and remove rear console mounting screws (**arrows**).

– Remove cassette tape box or phone console. Disconnect harness connectors, if applicable.

NOTE—
The phone console may be retained with hidden or difficult to see screws.

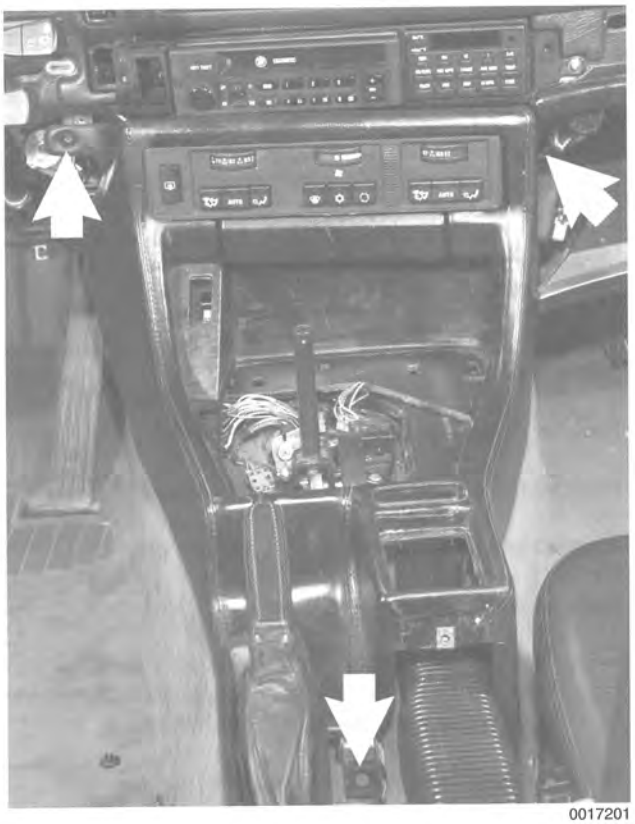


0017224

➤ Unclip and peel back dust boot at parking brake lever. Remove console mounting screw and remove rear center console section.

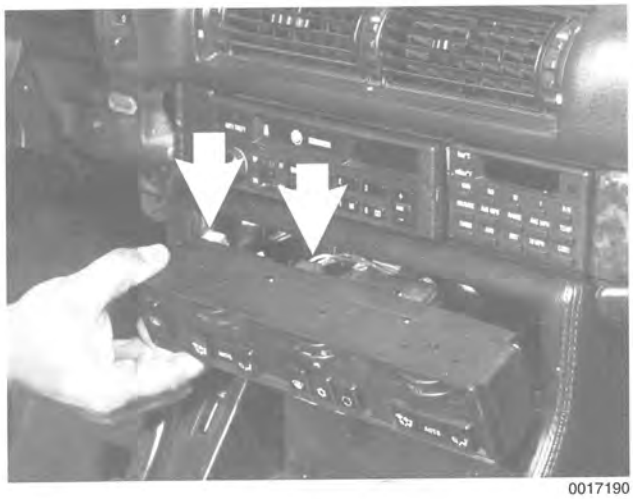
– Remove transmission shift lever knob. Lift out shift lever cover from top of center console. See **250 Gearshift Linkage**.

– Pry out emergency flasher switch, window switch assembly and ASC switch (where applicable) from center console. Disconnect harness connectors from switches.



0017201

➢ Open glove compartment. Remove center console side mounting screws (**arrows**).



0017190

➢ Carefully pry out heater/A/C control head from center console and detach electrical harness connectors (**arrows**).

– Lift center console off, twisting the rear end to right to clear parking brake handle.

– Installation is reverse of removal.

DASHBOARD

Dashboard, removing and installing

Label wires and connectors during the removal procedure as an aid for installation.

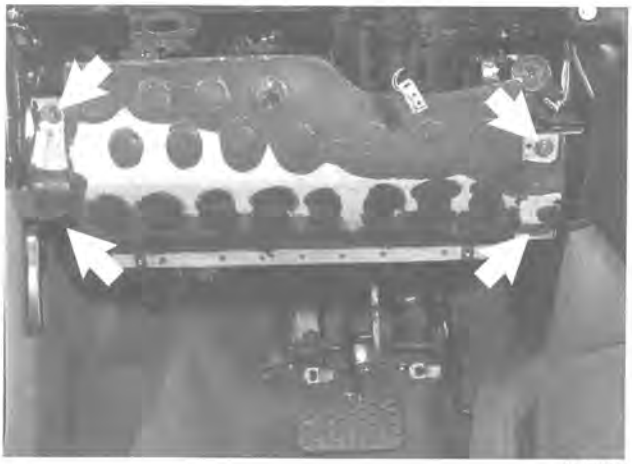
– Disconnect negative (–) battery cable. See **020 Maintenance**.

– Disconnect orange SRS connector on steering column as described in **721 Airbag System (SRS)**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

WARNING—
SRS is complex and dangerous. Special precautions must be observed when servicing cars equipped with SRS. Serious injury may result if system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures.

- Remove steering wheel. See **320 Steering and Wheel Alignment**.
- Remove center console as described earlier.
- Remove glove compartment as described later.
- Remove panel from above glove compartment.
- Remove radio. See **650 Radio**.
- Remove instrument cluster and On-board Computer. Remove radio/On-board Computer bezel and detach harness connector inside bezel. See **620 Instruments**.
- Remove trim panel above pedal cluster.
- Remove carpeted panels from left and right sides of center console in footwells. Screw retains panel at forward end.



0017225

- Knee bolster mounting bolts (**arrows**).
  - Remove knee bolster (reinforcement) panel from lower left side of dashboard.
- Remove screws from center air grille in top of dashboard. Lift out grille.



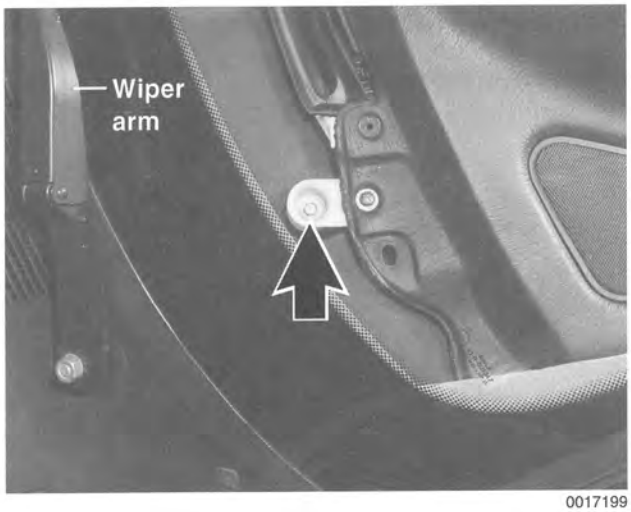
0011714

- Remove dashboard mounting screws (**arrows**).
- Remove passenger airbag, if applicable.
- Lift off front dashboard trim at base of windshield.



0011715

- Peel back door seals on left and right sides in area of windshield pillar (A-pillar). Carefully lift off A-pillar trim panels from left and right sides.



0017199

- Remove front dashboard mounting screws from center, left and right sides. Left side shown (**arrow**).



0017198

➢ Remove mounting bolts (**A**, **B**) at lower left side of dashboard.

NOTE—
Wire ties will need to be cut and main harnesses moved out of the way to access the lower dashboard mounting bolts on the left side.

– Disconnect connectors for dash mounted loudspeakers.

– Slowly lift dashboard up and out, disconnecting harness connectors and air circulation hoses and cutting wire ties as necessary.

– Installation is reverse of removal.
- Use new wire ties to keep under-dash harnesses in place. Do not overtighten wire ties when installing.
- Check that fresh air flap is not obstructed when lowering panel into position.

GLOVE COMPARTMENT

Glove compartment, removing and installing

– Open glove compartment and swing backward.

– Detach support strap from right side.



0017281

➢ Remove glove compartment retaining clips (**arrows**), right side pivot (**A**) and support strap (**B**) shown. Left side pivot and support strut are similar.

– Pry off spring loaded front pivots and lower glove compartment, detaching electrical harness connector, if applicable.

– Installation is reverse of removal.

OTHER INTERIOR TRIM

Lower left dash panel, removing and installing

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Disconnect orange SRS connector on steering column as described in **721 Airbag System (SRS)**.

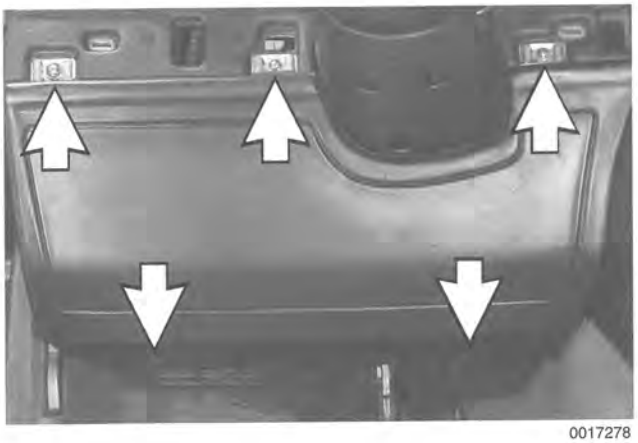
> ***WARNING—***
> *SRS is complex and dangerous. Special precautions must be observed when servicing cars equipped with SRS. Serious injury may result if system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures.*



0017279

➢ Carefully pry wood trim out of clip (**A**), then slide trim toward left. Disconnect harness connector (**B**) from instrument illumination dimmer and remove dimmer from trim before reinstalling.

– Carefully remove wood trim covers from left and right side of steering column.


0017278

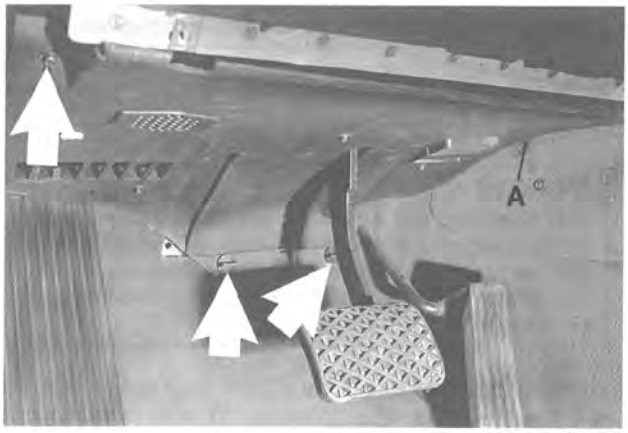
➢ Remove left dash panel mounting screws (**arrows**) and remove panel.

– Installation is reverse of removal.

Pedal cluster trim panel, removing and installing

The pedal cluster trim panel is mounted above the pedal cluster and behind the lower left dash panel.

– Remove carpeted trim panel from driver side of center console. A screw retains the panel at forward end of each panel.



0011852

➢ Remove pedal cluster trim panel retaining clips and mounting screw (**arrows**) turn retainers 90° to release.

– Partially pull trim panel down and disconnect harness connectors from chime module.

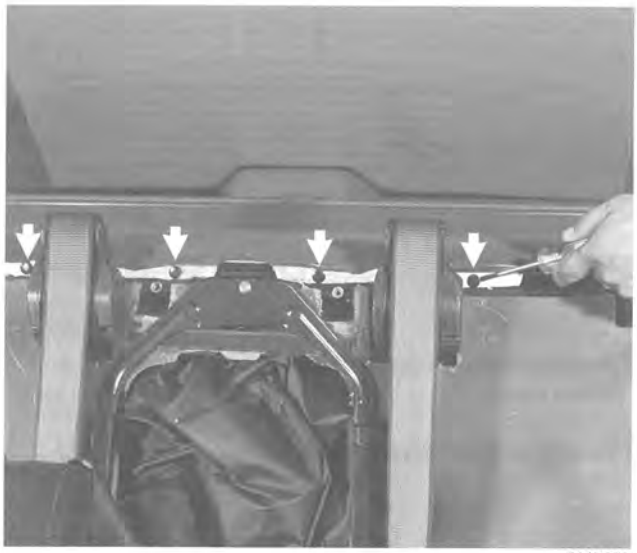
– Unhook trim panel from center console at right side and remove.

– Installation is reverse of removal.

- Make sure ventilation duct work is properly connected when installing panel into position.

Rear parcel shelf, removing and installing

– Remove rear seat(s). See **520 Seats**.



0017266

➢ Remove clips (**arrows**) from front of parcel shelf.

– Pull parcel shelf forward and off.

– Installation is reverse of removal.

Rear window power sunshade, servicing

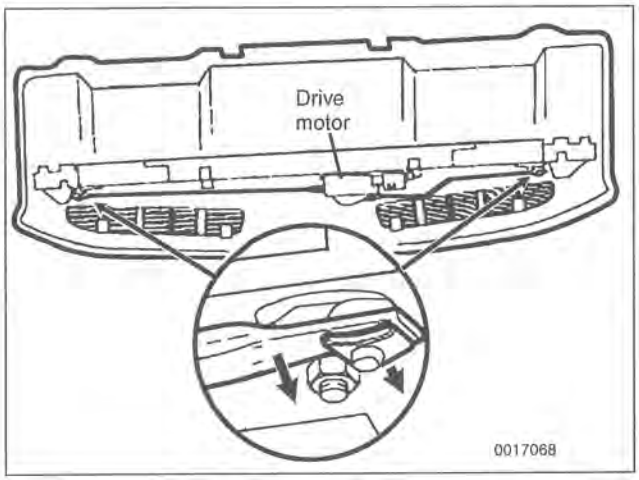
Beginning with model year 1993, an optional electrically operated rear window sunshade was available with E32 cars. The sunshade up/down switch is installed in the rear of the center console where it is accessible to rear seat passengers.

CAUTION—
Do not operate sunshade up/down switch unless drive mechanism is completely connected to sunshade.

– Remove rear parcel shelf as described earlier.

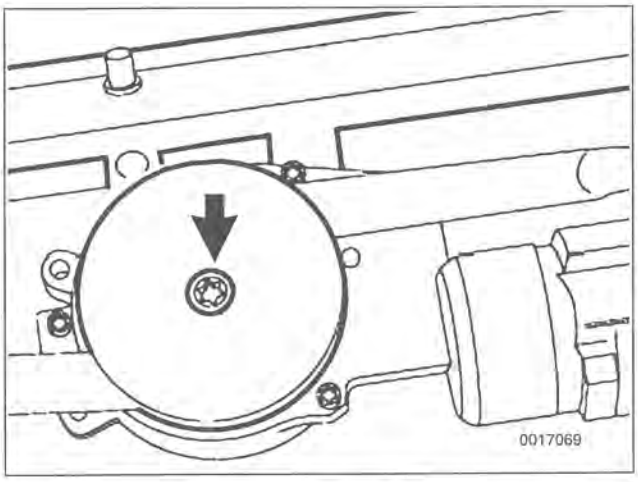
– If sunshade is up, linkage is under spring pressure. Carefully pry out linkage and allow sunshade to roll down slowly.

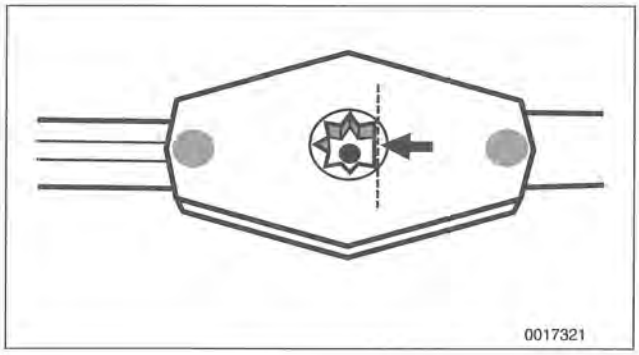
➢ Remove retaining clips and pry out left and right linkage rods (**inset**).



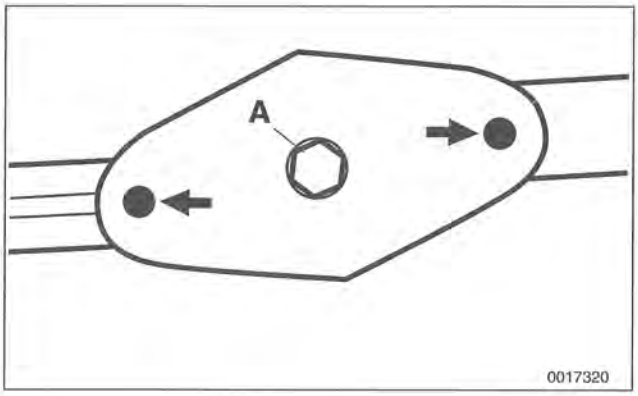
– Remove screws and clips holding drive motor. Pry out motor.

➢ Remove retaining screw (**arrow**) from center of linkage drive arm and remove arm with linkage rods.



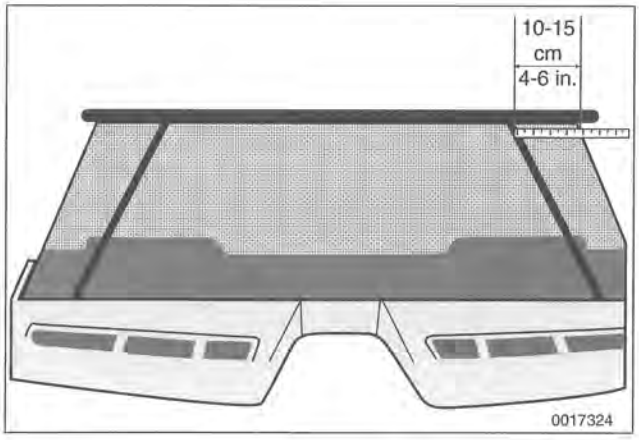


- Position drive arm on new motor by aligning flat side of drive arm with flat side on motor shaft (**arrow**). Reinstall retaining screw.



- If drive arm has a hexagonal guide hole (**A**), it will not fit the redesigned motor shaft and must be replaced.
  - Drill out both linkage rod rivets (**arrows**) and remove linkage rods from arm.
  - Reinstall using new pins and lock clips in place of rivets.

- Reinstall drive motor loosely.
- Roll out sunshade until both left and right linkages are suspended. Reinstall retaining clips.
- Supply electrical power to sunshade motor. Extend and retract sunshade one complete cycle.



- Extend sunshade until linkage has a clearance of 10 - 15 cm (4 - 6 in).
  - With sunshade extended, clearance should be roughly equal for right and left linkage arms.
  - To adjust clearance, slide motor from side to side, then tighten retaining screws.
- Reinstall rear shelf with sunshade.



515 Central Locking

GENERAL 515-1
Central locking function, checking 515-2
Emergency locking and unlocking doors 515-2
Synchronizing central locking system 515-3
Front door locking actuator, replacing 515-3
Front door locking actuator, adjusting 515-3
Rear door locking actuator, replacing 515-4
Rear door locking actuator, adjusting 515-5
Trunk lid locking actuator, replacing 515-5
Trunk lid locking actuator, adjusting 515-6

GENERAL

The central locking system uses electrical locking actuators at all four doors, the gas filler door and the trunk lid. The locking system can be actuated by either front door lock or by the trunk lid lock. When the key is in the lock position, a microswitch engages the central locking system via the general module. The general module is mounted beneath the rear seat.

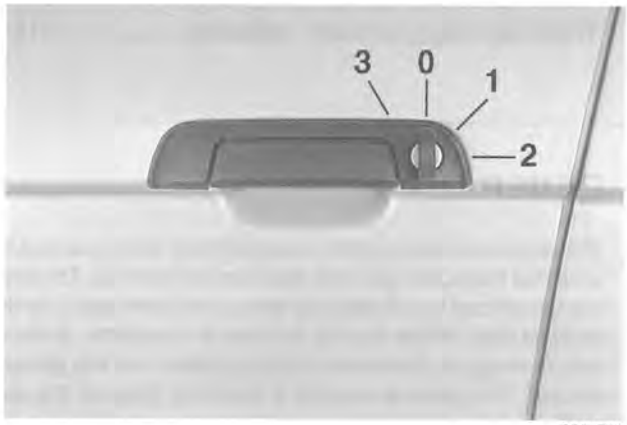
Microswitches are operated via the door lock cylinder at both front doors. Turning the key approximately 45° operates the door locking microswitch. Turning the key approximately 90° actuates the double locking microswitch. Turning the key approximately 45° in the opposite direction from position "0" actuates the unlocking microswitch and deactivates the alarm system.

The door lock microswitches are integrated in the front door handle/door lock assembly. See **411 Doors** for removal and replacement of the front door handle.

NOTE—
If just one of the central locking actuators does not operate, the locking linkage could be frozen or stiff enough to prevent actuation of the actuator. Remove the interior door panel and lubricate the locking linkage.

Central locking function, checking

- Turn ignition on.
- Lower all windows.
- Open sunroof fully.
- Turn ignition off.



0011762

➢ Turn door lock to position 3 to double lock doors, trunk lid and fuel filler flap. (A loud click will be heard twice.)

NOTE—
Check that door catch buttons cannot be pulled up manually and that the alarm system is armed.

- Check that fuel filler flap and trunk lid are locked.
- Using ignition key, unlock all doors.
- Lock doors and wait at least 35 seconds.
- Lift door handle and hold for at least 5 seconds.
- Check heating of lock with your finger on the keyhole.

NOTE—
Door locks will be heated for 40 seconds. The heater can be switched on again afterwards by lifting the door handle. The heating function can only be activated three times within 40 minutes. Door lock heating can only be activated from the driver's door lock.

Emergency locking and unlocking doors

In the event of a power failure (discharged battery), the vehicle can be manually locked and unlocked at the front right (passenger) door.

NOTE—
On cars built before July 1990, the driver's door can also be manually unlocked using this method.


0011763

➢ To manually unlock passenger door, place ignition key in lock cylinder and lift door handle while turning key fully in clockwise direction.

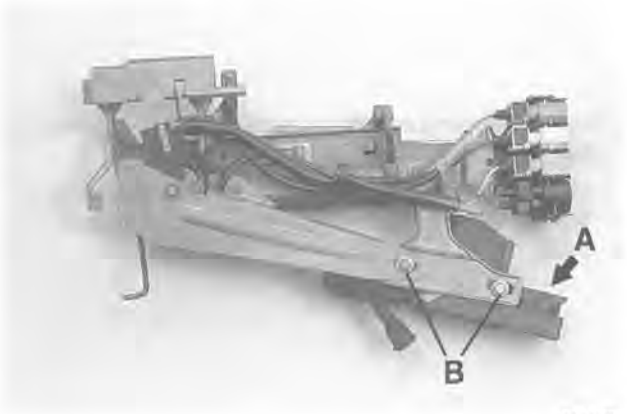
- To lock the door manually, turn key fully in the counter-clockwise direction.

Synchronizing central locking system

Under certain circumstances, the door locks may become unsynchronized. To synchronize the locks, close all doors and trunk lid. Lock the passenger door by turning the key clockwise into the emergency locking position (approximately 110° from position 0). Unlock the driver's door. If any of the locks do not operate, repeat the locking procedure until the locking system is synchronized.

NOTE —
Unsynchronization might happen if a door which is not completely closed is locked or a door handle is lifted before the interior lock button is raised.

Front door locking actuator, replacing



0011764

- Remove interior door panel. See **411 Doors**.
- Disconnect harness connector from locking actuator by pushing back sliding lock on connector.
- Locking activator harness connection (**A**). Remove front door lock actuator mounting screws (**B**) and lift out locking actuator.
- Installation is reverse of removal. Check fit of actuator in linkage and locking operation before installing door panel.

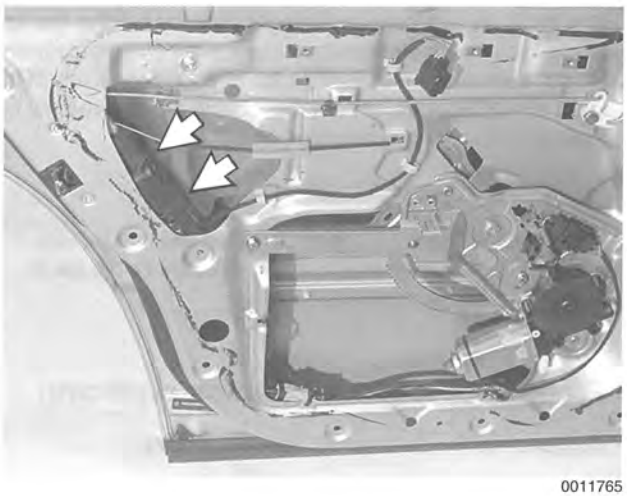
Front door locking actuator, adjusting

- Attach linkage rod to locking actuator and install locking actuator so that mounting screws are centered in elongated mounting holes.
- Connect actuator harness connector to locking actuator.
- Mount actuator on outside door handle and attach screws loosely.
- Push locking actuator into locked position.
- Push back locking actuator as far as possible. Compress central lock actuator by hand to relieve pressure from locking pawl.
- Tighten screws.

Tightening Torque
- Central lock actuator to lock assembly .2 Nm (18 in-lb)

Rear door locking actuator, replacing

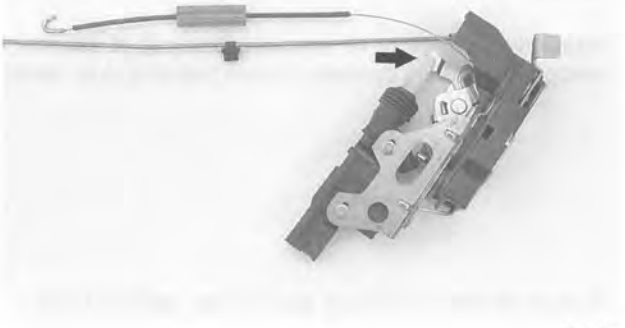
– Remove interior door panel. See **411 Doors**.



0011765

➢ Remove locking actuator mounting screws (**arrows**) and undo wire connectors to enable actuator to be tilted upward.

– Lift out locking actuator and disconnect harness connector.



0011766

➢ Rear door locking actuator correctly engaged to linkage (**arrow**).

- Installation is reverse of removal. Check fit of actuator in linkage and locking operation before installing door panel.

Rear door locking actuator, adjusting

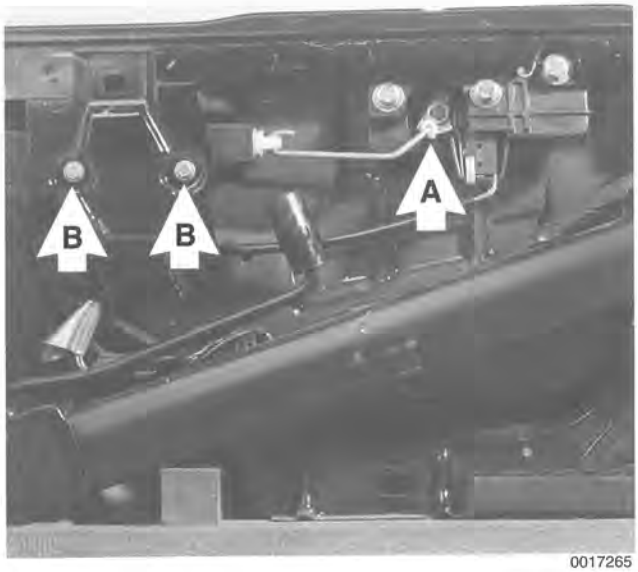
- Attach linkage rod to locking actuator and install locking actuator so that mounting screws are centered in elongated mounting holes.
- Connect actuator harness connector to locking actuator.
- Mount actuator to door and attach screws loosely.
- Push locking actuator into locked position.
- Push back locking actuator as far as possible. Compress the central lock actuator by hand to relieve pressure from the locking pawl.
- Tighten screws.

Tightening Torque

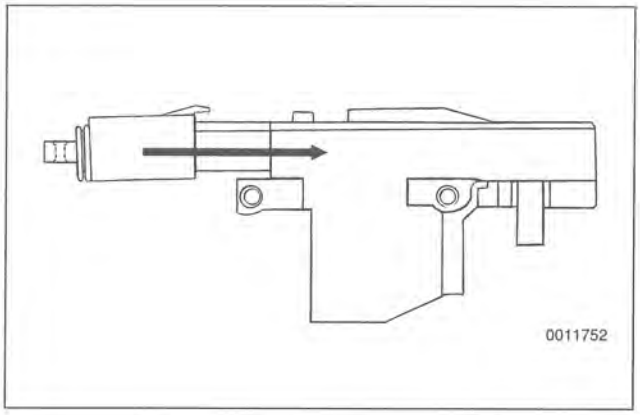
- Central lock actuator to door. . . . . .2 Nm (18 in-lb)

Trunk lid locking actuator, replacing

- Remove trunk rear trim panel from around lock area.
- Disconnect locking linkage at lock cylinder (**A**). Unscrew locking actuator mounting screws (**B**) and remove actuator.
- Installation is reverse of removal. Adjust linkage as described below.



0017265



Trunk lid locking actuator, adjusting

– Place lock in unlocked position.

– Connect actuator and linkage.

– Loosely tighten bolts.

➢ Push actuator into locked position (**arrow**) prior to adjusting and pull locking actuator body slightly to left and tighten screws.

– Check function.

Tightening Torque

- Central lock actuator to door. . . . . .2 Nm (18 in-lb)



520 Seats

GENERAL 520-1

FRONT SEATS 520-1
- Front seat, removing and installing 520-1
- Front seat armrest, removing and installing . . 520-2
- Front seat, disassembling 520-3

REAR SEATS 520-7
- Rear seat cushion and backrest, removing and installing (non-power seats) . . 520-7
- Rear seat cushion, removing and installing (power seats) 520-8
- Rear seat backrest, removing and installing (power seats) 520-9

GENERAL

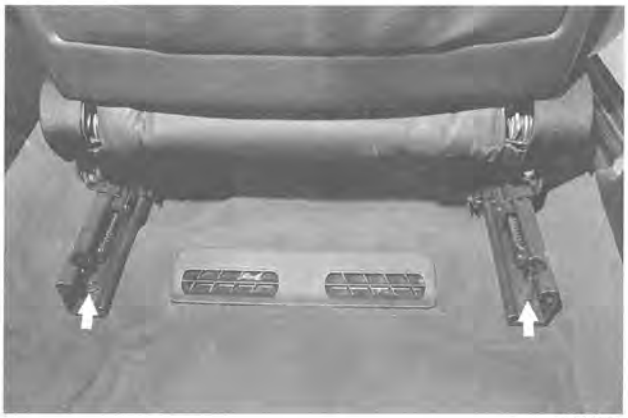
This repair group covers removal and installation of the front and rear seats. It also includes complete disassembly of the electrically operated front seat.

FRONT SEATS

Front seat, removing and installing

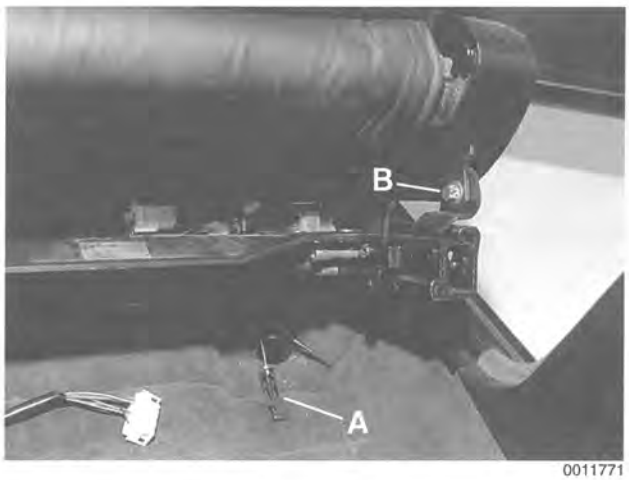
– Remove headrest from seat by pulling up.

NOTE—
Some effort may be required to remove the headrest. Pull quickly on the headrest to disengage it from its retainers.



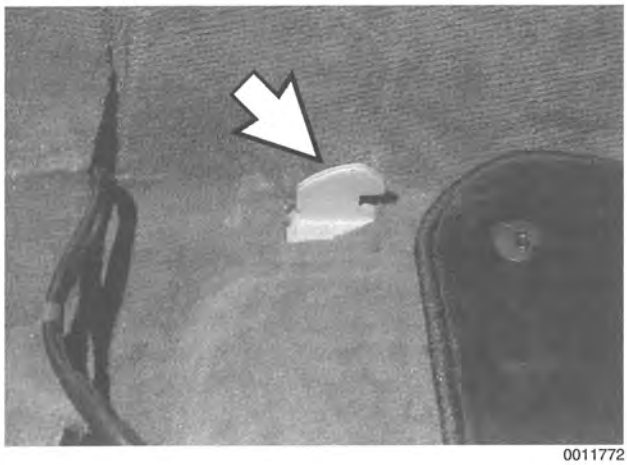
0011770

➢ Move seat to full forward position. Remove two bolts at rear of seat rails (**arrows**).



0011771

➢ Move seat back to rear position and highest level at front and rear. Unplug harness connector(s) from under side of seat. Disconnect height adjustment cable (**A**) from underside of seat. Unbolt seat belt from seat frame (**B**).



0011772

➢ Remove seat by tilting forward and sliding forward off front brackets (retaining hooks).

– Installation is reverse of removal.

Front seat armrest, removing and installing

– Push back panel of front seat up, unhook from lower back of seat and pull off.

NOTE—

On some models the backrest trim panel may be retained by screws on either side.



0011773

➢ Unscrew front seat armrest mounting nuts (**arrows**) and remove armrest.

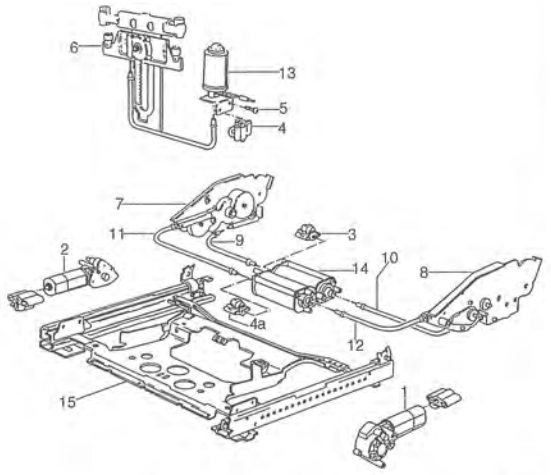
Front seat, disassembling

NOTE—
Drive cable replacement is possible once the seat is disassembled and the drive motor is removed.

– Remove seat as described earlier.

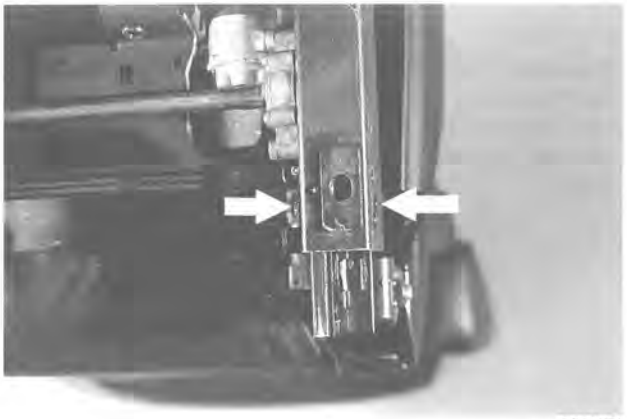
➢ Seat frame and frame motor assembly.

– On cars with memory seats, remove seat memory control unit from seat underside. Disconnect harness connectors on seat bottom.



0011754

1. Angular seat drive regulator
2. Forward/backward seat drive regulator
3. Backrest drive regulator
4. Headrest and up/down seat drive regulator
5. Oval head screw
6. Headrest gearbox
7. Intermediate muffler
8. Gearbox
9. Gearbox
10. Backrest drive shaft, left
11. Up/down seat drive shaft, right
12. Up/down seat drive shaft, left
13. Drive
14. Up/down seat drive
15. Seat rails with drives



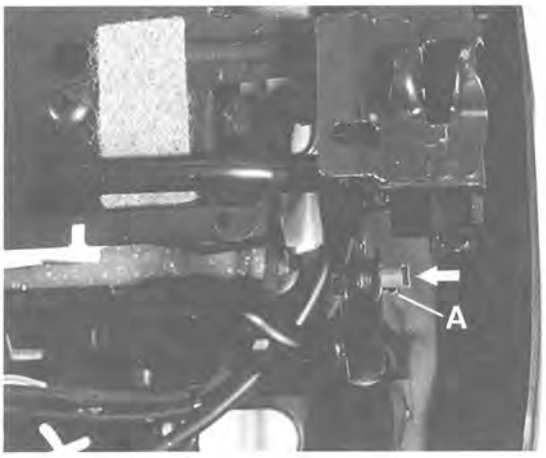
0011774

➢ Align rear seat rail mounting pins with holes in outer seat rail (**arrows**).



0011775

- Seat rail motor drive (**arrow**) for moving seat forward/backward.
  - In order to move seat rail, the seat can be temporarily connected to the harness connector in car or it can be moved manually by turning the drive in the end of the motor.
- Pull off power seat operating knobs from seat switch.
- Remove trim panels from left and right sides of seat cushion.



0011776

- Depress tab (**A**) and remove front and rear seat rail mounting pins (**arrow**). Remove seat rail assembly from seat, disconnecting harness connectors as necessary.

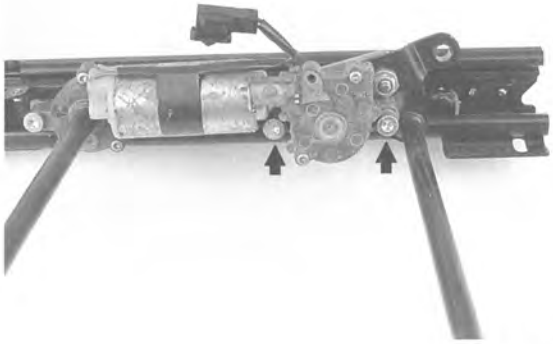
NOTE—

- *BMW Special tool 52 1 100 can be used to remove the seat rail mounting pins.*
- *Always use new seat mounting pins. These pins should not be reused.*



0011777

- If replacing motors on seat rail assembly, it may be necessary to remove the support plate from the seat rail assembly. Remove the plate by drilling out the rivets (**black arrows**) and removing the screw (**white arrow**) from the plate.



0011778

➢ Remove seat forward/back motor mounting bolts (**arrows**) and remove motor.

– Remove backrest trim panel by sliding up and off seat back.

NOTE—
On some models the backrest trim panel may be retained by screws on either side.



0011779

➢ Disconnect harness connector from inside rear seat back. Press down on seat back locking levers using pliers and remove backrest from seat bottom.



0011780

➢ With headrest off, remove screw from headrest adjustment gearbox, moving seat cover aside if necessary.

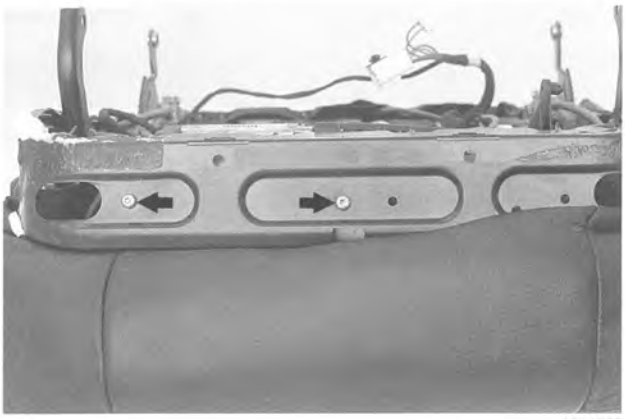


0011781

➢ Remove screws (**arrows**) from headrest adjustment motor, moving seat cover aside if necessary.

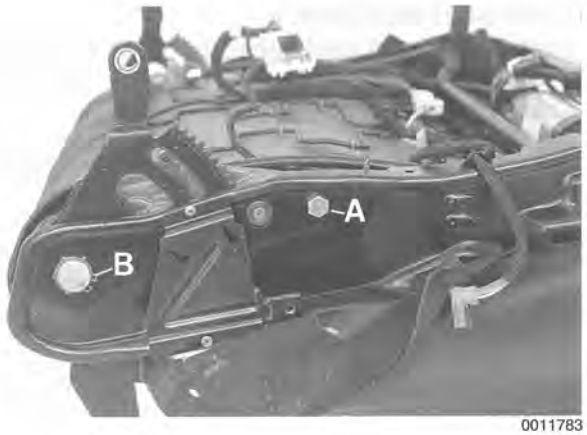
– On seats with memory, unscrew potentiometer from motor.

– Partially loosen seat cover from seat bottom.



0011782

➢ Remove screws (**arrows**) from backrest/seat height adjustment motor bracket. Pull drive cables out of both sides of both motors and remove motor assembly from seat.



0011783

➤ Remove backrest gearbox mounting bolt (**A**) and backrest bracket circlip (**B**) from backrest support bracket fittings.

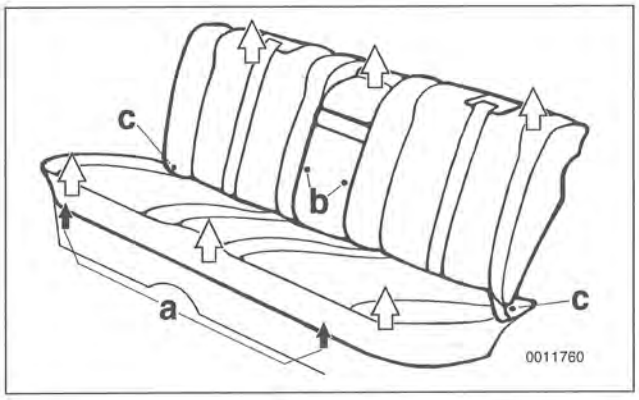
NOTE—
Backrest adjustment motor uses black plug. Seat height adjustment uses white plug.

– Installation is reverse of removal.
- All harness connectors are color coded.
- Replace mounting pins, and seat mounting frame rivets.
- Lightly lubricate gears with grease.

REAR SEATS

Rear seat cushion and backrest, removing and installing (non-power seats)

– Pull front of cushion up and out of clips.



➤ To remove rear seat, pull seat bottom up and out of clips (**a**). Remove bolts behind center armrest (**b**) and at seat back corners (**c**). Slide seat back up off holders.

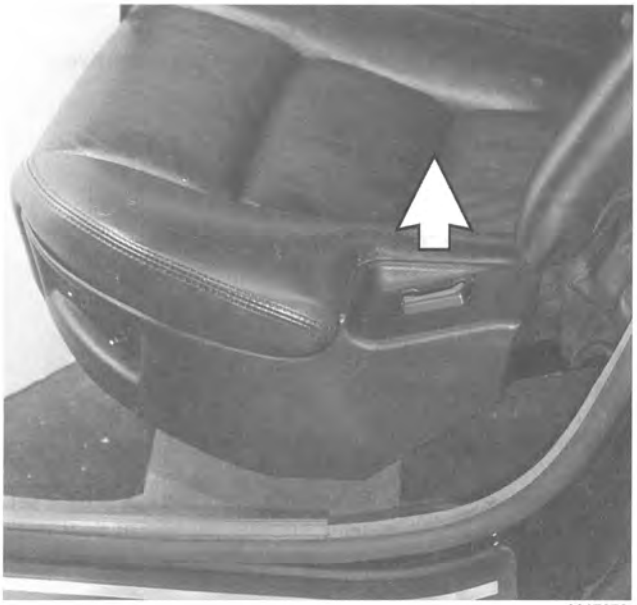
– Slide backrest off holders. Unclip seat belts with covers from seat.

Rear seat cushion, removing and installing (power seats)

– Pull front of cushion up and out of clip.

– Remove seat control knobs and remove trim screws behind them.

➢ Pull up seat belt lock trim and remove from seat belt lock.



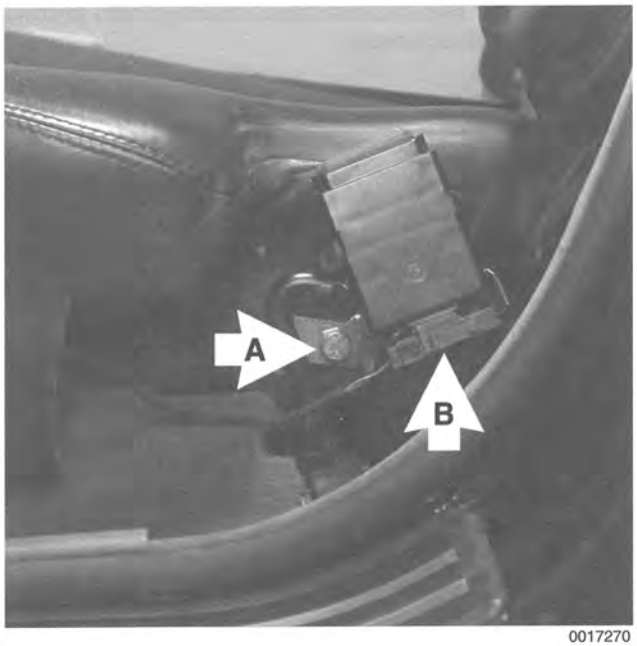
0017273

➢ Rear door edge trim retaining clip (**arrow**).

- Pull off door seal at bottom rear corner of door. Tilt door edge trim outward and remove.



0017271

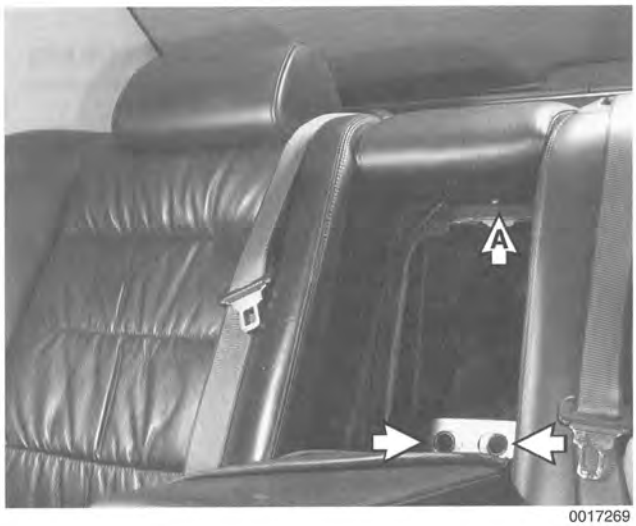


0017270

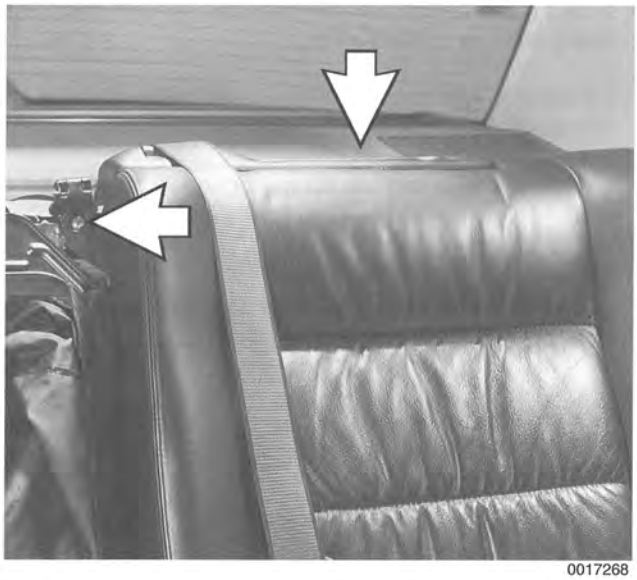
- Unbolt rear seat belt lock mounting bolt (**A**) and disconnect wiring harness connector (**B**).
- Lift front of seat cushion, sliding seat tracks off body anchors and unhooking locating rods from backrest.
- Detach electrical harness connector and lift cushion out of car.
- Installation is reverse of removal.
  - Guide seat cushion locating rods into backrest holes.
  - Guide seat tracks into body anchors on floor.

Rear seat backrest, removing and installing (power seats)

- Remove seat cushion as described earlier.
- Pull up on headrest and remove.
- Fold down armrest. Unlock spring-loaded retainer, squeeze in direction of **arrows** and remove armrest. Remove center backrest upper section by removing fastener (**A**).
- Remove seat belt anchor bolt below backrest.

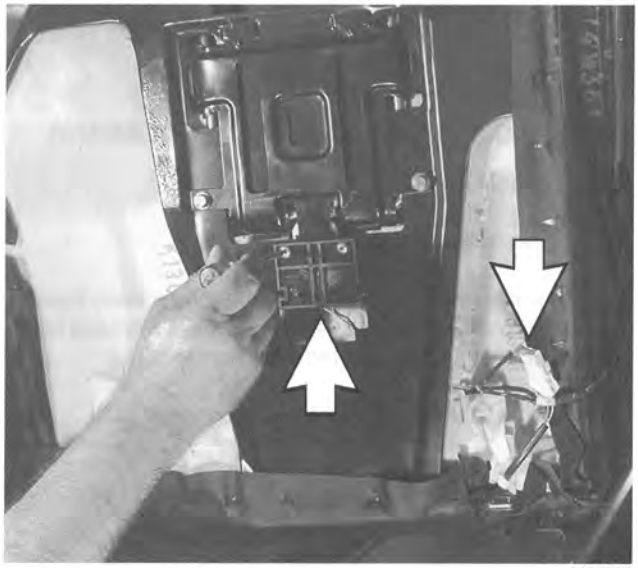


0017269



0017268

- Remove rear seat backrest upper mounting bolts (**arrows**) and pull backrest forward.
- Remove screws from backrest upper plastic trim and pull trim off, releasing seat belt from backrest.



0017267

- Electrical harness connectors in back of rear seat backrest.
  - Working in back of backrest, remove screws from headrest electrical harness connector (**arrows**). Loosen connector and feed out past upholstered material. Detach harness connector at base of backrest (**arrows**). Backrest can now be lifted out.
- Installation is reverse of removal.

Tightening Torques

- Seat belt anchor to floor . . . . . 48 Nm (36 ft-lb)

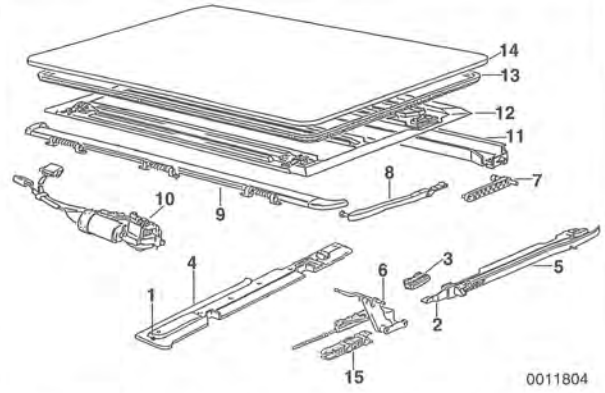


540 Sunroof

GENERAL 540-1

SUNROOF 540-1
Sunroof panel, emergency closing 540-1
Sunroof panel, adjusting 540-2
Sunroof panel, removing and installing 540-3
Sunroof drive cables, replacing 540-4
Sunroof motor, removing and installing 540-6

GENERAL



1. Rubber pad
2. Retainer
3. Slide
4. Cover rail
5. Cable
6. Gate
7. Linkage for drain
8. Linkage for wind deflector
9. Wind deflector
10. Motor
11. Drain
12. Liner frame
13. Seal
14. Sunroof panel

The electrically operated sunroof is controlled by a set of cables that move the sunroof panel along guide rails when the motor is operated. The sunroof panel can be adjusted without removing it from the car. Replacement of the sunroof liner or components such as the cable assembly require that the sunroof panel be removed.

➤ Sunroof assembly.

NOTE —
Be sure to check the drains in the front corners of the sunroof carrier if water is entering the car through the headliner.

SUNROOF

Sunroof panel, emergency closing



➤ Remove access panel from below sunroof motor.



0011817

➤ Insert hex key into drive in sunroof motor and turn hex key counterclockwise to close panel.

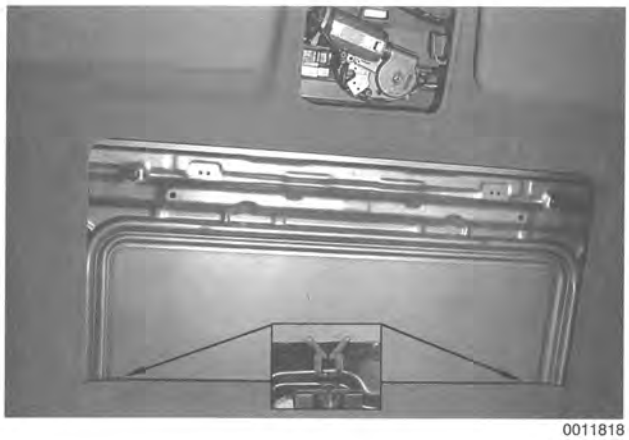
NOTE—

The hex key for manually (emergency) closing the sunroof can be found in the tool kit located in the trunk lid.

Sunroof panel, adjusting

The sunroof panel should be adjusted whenever the top of the closed sunroof becomes misaligned with the roof of the car, if it does not close squarely, if there are wind noises at speed, if there are water leaks, or if the sunroof has been removed.

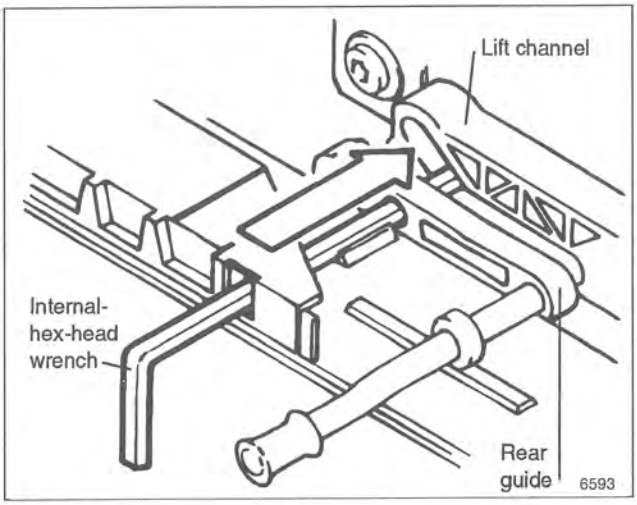
– Open sunroof approximately 4 inches (100 mm).



0011818

➤ Sunroof headliner slid back into roof cavity. Headliner is clipped to pins (**arrows**) on sunroof panel. Inset shows clip detail as viewed from above.

- Pry open clips on left and right sides of headliner and slide headliner back into roof cavity.



◁ Hex key wrench inserted through rear guide to lock guide and panel in "closed" position.

- Lock sunroof guides in "closed" position on left and right sides. This will ensure that sunroof panel is squarely positioned in opening.



0011820

◁ Sunroof panel mounting screws (**arrows**). Sunroof panel shown in tilt position for screw clarity.

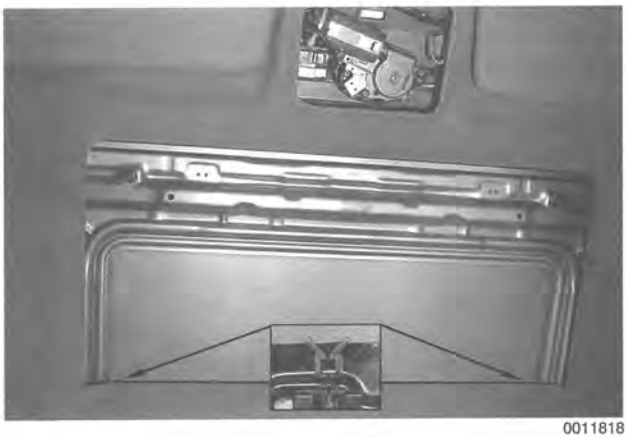
- Loosen screws on left and right sides and adjust lid position.
- Adjust sunroof panel by tilting it as necessary until front edge is lower than roof by 1 mm (0.04 in.), and rear edge is higher than roof by 1 mm (0.04 in).
- When adjustment is correct, tighten sunroof mounting screws.

Tightening Torque

- Sunroof panel to sunroof drive gate . 3.5 Nm (31 in-lb)

Sunroof panel, removing and installing

– Open sunroof approximately 4 inches (100 mm).

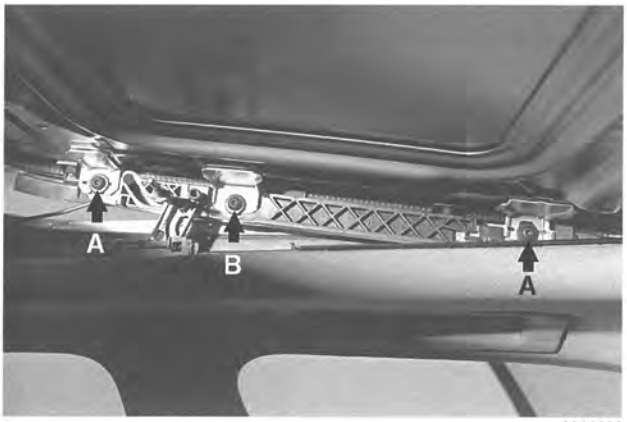


0011818

◁ Sunroof headliner slid back into roof cavity. Headliner is clipped to pins (**arrows**) on sunroof panel. Inset shows clip detail as viewed from above.

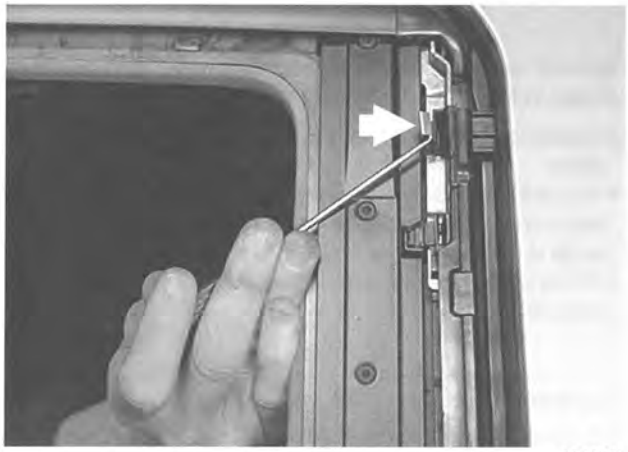
- Pry open clips on left and right sides of headliner and slide headliner frame back into roof cavity.

– Close sunroof fully.



0011820

➢ Loosen sunroof panel outer screws (**A**) and remove center screw (**B**) on left and right sides of sunroof panel. Sunroof panel shown in tilt position for screw clarity.



0011821

➢ Pry back clips (**arrow**) at left and right corners of sunroof panel and carefully push sunroof panel out from below. Sunroof panel shown removed.

Tightening Torque

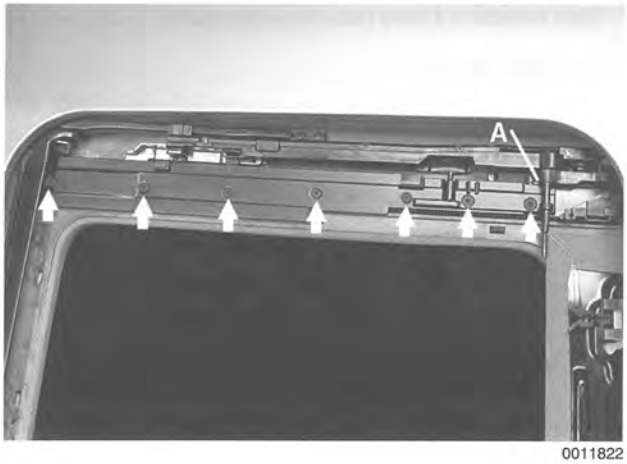
- Sunroof panel to sunroof drive gate . 3.5 Nm (31 in-lb)

Sunroof drive cables, replacing

– Remove sunroof panel. See **Sunroof panel, removing and installing**.

– Remove sunroof motor. See **Sunroof motor, removing and installing**.

– Working from above, push left and right drive cable ends back towards roof cavity.



0011822

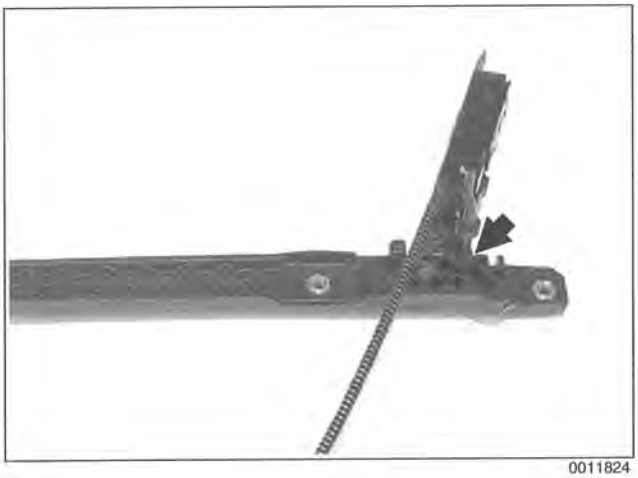
➢ Remove screws (**arrows**) from guide rail covers on left and right sides and remove covers. Drive cable shown pushed back (**A**).



0011823

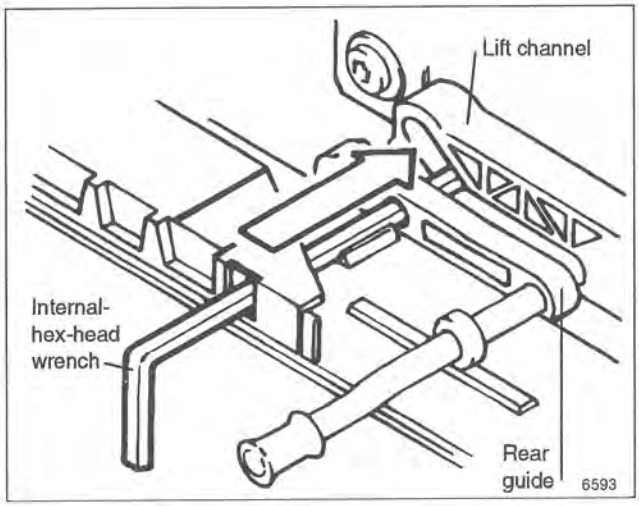
➢ Press drive cable end (**arrow**) after removing drive cable from tube. Disconnect linkage from gate.

– Pull drive cable forward and off track. Pull cable assembly out of guide tubes.



0011824

➢ Position drive cable pin in center position of drive gate (**arrow**) and then pull cable from gate.



➢ Hex key wrench inserted through rear guide to lock guide and panel in "closed" position.

- Installation is reverse of removal. New screws should be used when installing the guide rail covers. Before installing sunroof motor, pull left and right drive cables forward and lock drive cables and sunroof guides in "closed" position to ensure that drive cables are synchronized.

NOTE—

- *The flocked sunroof cables should not be lubricated.*
- *Drive cable ends are marked left (L) and right (R)*

Tightening Torque

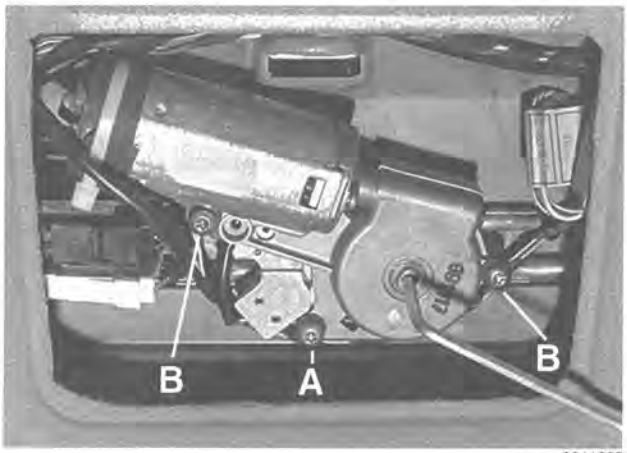
- Sunroof motor to motor carrier . . . . . 2.8 Nm (25 in-lb)
- Sunroof guide rail cover to carrier
  M4 screw. . . . . 1.8 Nm (17 in-lb)
  M5 screw2.8 Nm (25 in-lb) Sunroof motor, removing and installing

The sunroof should be in the closed position before removing or installing the sunroof motor. If necessary, manually

close the sunroof panel as described under **Sunroof panel, emergency closing**.

Sunroof motor, removing and installing

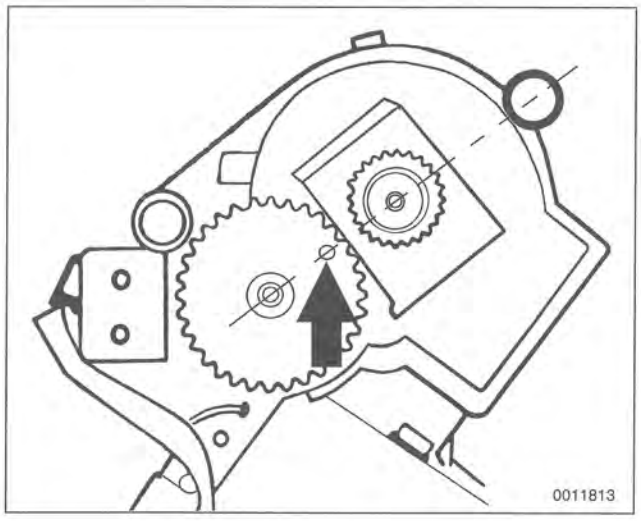
The sunroof should be in the closed position before removing or installing the sunroof motor. If necessary, manually close the sunroof panel as described under **Sunroof panel, emergency closing**.



0011825

➢ Remove sunroof motor mounting screws (**A** and **B**). Screw at **A** is longer than screws at **B**.

– Disconnect harness connector from motor and remove motor.


0011813

➢ Sunroof motor in "closed" position. Hole (**arrow**) in large gear aligns with shafts on both gears.

- Installation is reverse of removal. Be sure the motor is in the "closed" position before installing it to the sunroof carrier.

Tightening Torque

- Sunroof motor to motor carrier . . . . . 2.8 Nm (25 in-lb)



600 Electrical System–General

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GENERAL

A brief description of the principal parts of the electrical system is presented here. Also covered here are basic electrical system troubleshooting tips.

Voltage and Polarity

The vehicle electrical system is a 12-volt direct current (DC) negative-ground system. A voltage regulator controls system voltage at 12.6-14.5 volts. All circuits are grounded by direct or indirect connection to the negative (–) terminal of the battery. A number of ground connections throughout the car connect the wiring harness to chassis ground. These circuits are completed by the battery cable or ground strap between the body and the battery negative (–) terminal.

Wiring, Fuses and Relays

Nearly all parts of the wiring harness connect to components of the electrical system with keyed, push-on connectors that lock into place. Notable exceptions are the heavy battery cables and the starter wiring. The wiring is color-coded for circuit identification.

With the exception of the battery charging system, most electrical power is routed from the ignition switch or the battery through the main fuse/relay panel, located in the left rear corner of the engine compartment. Fuses are color coded to indicate current capacities.

The relays and control units/modules are mounted in various places throughout the vehicle. See **610 Electrical Component Locations**.

Electrical System Safety Precautions

Please read the following warnings and cautions before doing any work on your electrical system.

WARNING—

- *The cars covered by this manual are equipped with a Supplemental Restraint System (SRS) that automatically deploys one or more airbags. Each airbag unit houses an explosive powerful charge. Any work involving the SRS system should only be performed by an authorized BMW dealer. Making repairs without the proper knowledge and special test equipment may cause serious personal injury. See* **721 Airbag System (SRS)**.
- *The ignition system of the car operates at lethal voltages. People with pacemakers or weak hearts should not expose themselves to the ignition system. Extra caution must be taken when working on the ignition system or when servicing the engine while it is running or the key is on. See* **120 Ignition System** *for additional ignition system warnings and cautions.*
- *Before operating the starter without starting the engine (as when making a compression test), disable the ignition system as described in* **120 Ignition System**.
- *Keep hands, clothing and other objects clear of the electric radiator cooling fan when working on a warm engine. The fan may start at any time, even when the ignition is switched off.*

CAUTION—

- *Always turn off the engine and disconnect the negative (–) cable from the battery before removing any electrical components. Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*
- *Connect and disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is off.*
- *Do not disconnect the battery with engine running.*
- *Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.*
- *Do not use a test lamp that has a normal incandescent bulb to test circuits containing electronic components. The high electrical consumption of these test lamps may damage the components.*
- *Do not use an analog meter. Use only a digital multimeter.*
- *Many of the solid-state modules are static sensitive. Static discharge will permanently damage them. Always handle the modules using proper static prevention equipment and techniques.*
- *To avoid damaging harness connectors or relay panel sockets, use jumper wires with flat-blade connectors that are the same size as the connector or relay terminals.*
- *Always switch a digital multimeter to the appropriate function and range before making test connections.*
- *Do not try to start the engine of a car which has been heated above 176°F (80°C), (for example, in a paint drying booth). Allow it to cool to normal temperature.*
- *Disconnect the battery before doing any electric welding on the car.*
- *Do not wash the engine while it is running or anytime the ignition is switched on.*

Electrical Test Equipment

Many of the electrical tests described in this manual call for measuring voltage, current or resistance using a digital multimeter (DMM). Digital meters are preferred for precise measurements and for electronics work because they are generally more accurate than analog meters. The numerical display is also less likely to be misread, since there is no needle position to be misinterpreted by reading at an angle.

An LED test light is a safe, inexpensive tool that can be used to perform many simple electrical tests that would otherwise require a digital multimeter. The LED indicates when voltage is present between any two test-points in a circuit.

CAUTION—

- *Choose test equipment carefully. Use a digital multimeter with at least 10 megaohm input impedance, or an LED test light. An analog meter (swing-needle) or a test light with a normal incandescent bulb may draw enough current to damage sensitive electronic components.*
- *An ohmmeter must not be used to measure resistance on solid state components such as control units or time delay relays.*
- *Always disconnect the battery before making resistance (ohm) measurements on the circuit.*

WIRING DIAGRAMS

The wiring diagrams shown in **Electrical Wiring Diagrams** have been specially designed to enable quick and efficient diagnosis and troubleshooting of electrical malfunctions.

Wiring Codes and Abbreviations

A lot of information is included in each wiring diagram if you know how to read them. Wire colors in the diagrams are abbreviated. Combined color codes indicate a multi-colored wire. For example the code BLU/RED indicates a blue wire with a red stripe. See **Table a**.

Many electrical components, connectors, fuses, and ground locations are identified using a unique number. Each of these numbers corresponds to a particular part in the circuit commonly found in **Electrical Wiring Diagrams.**

NOTE—

Sometimes the color of an installed wire may be different than the one on the wiring diagram. Do not be concerned. Just be sure to confirm that the wire connects to the proper terminals.

Table a. Wire Color Codes

BLU	Blue
BRN	Brown
YEL	Yellow
GRN	Green
GRY	Gray
ORG	Orange
RED	Red
BLK	Black
VIO	Violet
WHT	White

Most terminals are identified by numbers on the components and harness connectors. The terminal numbers for major electrical connections are shown in the diagrams. Though many terminal numbers appear only once, several other numbers appear in numerous places throughout the electrical system and identify certain types of circuits. Some of the most common circuit numbers are listed below in **Table b**.

Table b. Terminal and Circuit Numbers

Number	Circuit description
1	Low voltage switched terminal of coil
4	High voltage center terminal of coil
+X	Originates at ignition switch. Supplies power when the ignition switch is in the PARK, RUN or START position
15	Originates at ignition switch. Supplies power when ignition switch is in RUN or START position
30	Battery positive (+) voltage. Supplies power whenever battery is connected. (Not dependent on ignition switch position, unfused)
31	Ground, battery negative (–) terminal
50	Supplies power from battery to starter solenoid when ignition switch is in START position only
+54	Originates at ignition switch. Supplies power when ignition switch is in the RUN position only
85	Ground side (–) of relay coil
86	Power-in side (+) of relay coil
87	Relay actuated contact
D	Alternator warning light and field energizing circuit

Additional abbreviations shown in the wiring diagrams are given below.

Abbreviations

- ABS. . . . . antilock brakes
- A/C . . . . . air conditioning
- ADS . . . . . auxiliary throttle valve system
- ASC/ASC+T . . . . automatic stability control/ + traction
- DME . . . . . digital motor electronics
- DWA . . . . . anti-theft system
- ECM . . . . . electronic control module
- EDC . . . . . electronic damping control
- EML . . . . . electronic throttle control
- IHKA . . . . . automatic heating/A/C control
- LAD. . . . . load absorption damping
- SRS . . . . . supplemental restraint system-airbag
- TCM . . . . . transmission control module
- ZKE . . . . . central body electronics

ELECTRICAL TROUBLESHOOTING

Four things are required for current to flow in any electrical circuit: a voltage source, wires or connections to transport the voltage, a load or device that uses the electricity and a connection to ground. Most problems can be found using a digital multimeter (volt/ohm/amp meter) to check for voltage supply, for breaks in the wiring (infinite resistance/no continuity), or for a path to ground that completes the circuit.

Electric current is logical in its flow, always moving from the voltage source toward ground. Electrical faults can usually be located through a process of elimination. When troubleshooting a complex circuit, separate the circuit into smaller parts. The general tests outlined below may be helpful in finding electrical problems. The information is most helpful when used with the wiring diagrams.

Be sure to analyze the problem. Use the wiring diagrams to determine the most likely cause. Get an understanding of how the circuit works by following the circuit from ground back to the power source.

When making test connections at connectors and components, use care to avoid spreading or damaging the connectors or terminals. Some tests may require jumper wires to bypass components or connections in the wiring harness. When connecting jumper wires, use blade connectors at the wire ends that match the size of the terminal being tested. The small internal contacts are easily spread apart, and this can cause intermittent or faulty connections that can lead to more problems.

Voltage and Voltage Drops

The wires, connectors, and switches that carry current are designed with very low resistance so that current flows with a minimum loss of voltage. A voltage drop is caused by higher than normal resistance in a circuit. This additional resis-

tance actually decreases or stops the flow of current. A voltage drop can be noticed by problems ranging from dim headlights to sluggish wipers. Some common sources of voltage drops are corroded or dirty switches, dirty or corroded connections or contacts and loose or corroded ground wires and ground connections.

A voltage drop test is a good test to make if current is flowing through the circuit, but the circuit is not operating correctly. A voltage drop test will help to pinpoint a corroded ground strap or a faulty switch. Normally, there should be less than 1 volt drop across most wires or closed switches. A voltage drop across a connector or short cable should not exceed 0.5 volts.

NOTE—

- *A voltage drop test is generally more accurate than a simple resistance check because the resistances involved are often too small to measure with most ohmmeters. For example, a resistance as small as 0.02 ohms would results in a 3 volt drop in a typical 150 amp starter circuit. (150 amps x 0.02 ohms =3 volts).*
- *Keep in mind that voltage with the key on and voltage with the engine running are not the same. With the ignition on and the engine off (battery voltage), voltage should be approximately 12.6 volts. With the engine running (charging voltage), voltage should be approximately 14.0 volts. Measure voltage at the battery with the ignition on and then with the engine running to get exact measurements.*

Voltage, measuring

– Connect digital multimeter negative lead to a reliable ground point on car.

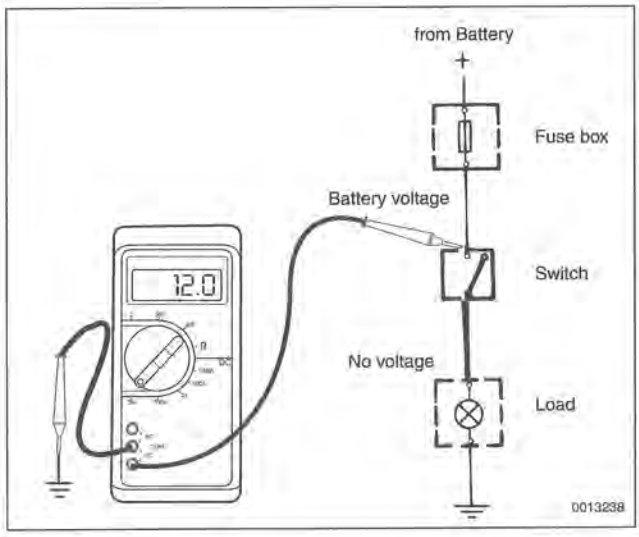
NOTE—

The negative (–) battery terminal is always a good ground point.

➢ Connect digital multimeter positive lead to point in circuit you wish to measure. If a reading is obtained, current is flowing through circuit.

NOTE—

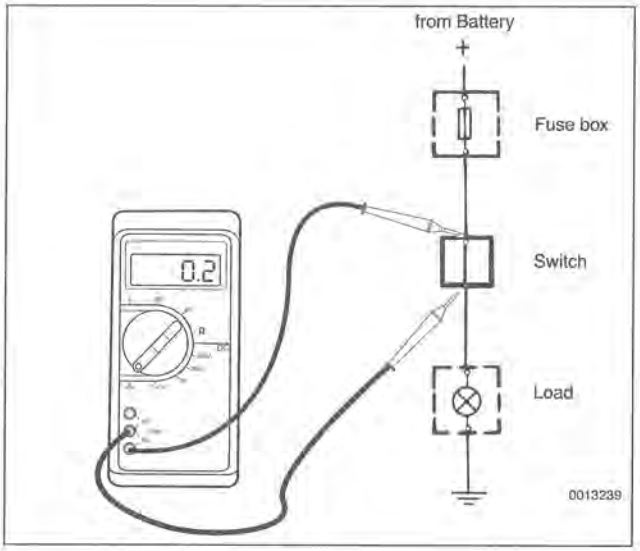
The voltage reading should not deviate more than 1 volt from the voltage at the battery. If the voltage drop is more than this, check for a corroded connector or loose ground wire.



Voltage drop, testing

Voltage drop can only be checked when current is running through the circuit, such as by operating the starter motor or turning on the headlights. A digital multimeter should be used to ensure accurate readings.

– Connect digital multimeter positive lead to positive end of cable or switch being tested.



➤ Connect digital multimeter negative lead to other end of cable or switch being tested.

– With power on and circuit working, meter shows voltage drop (difference between two points). This value should not exceed 1 volt.

NOTE—

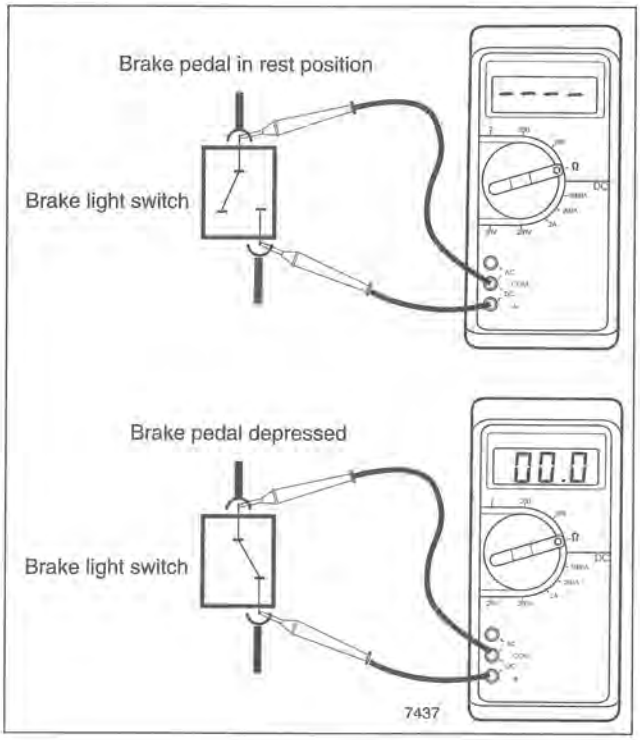
The maximum voltage drop in an automotive circuit, as recommended by the Society of Automotive Engineers (SAE), is as follows: 0 volts for small wire connections; 0.1 Volts for high current connections; 0.2 volts for high current cables; and 0.3 volts for switch or solenoid contacts. On longer wires or cables, the drop may be slightly higher. In any case, a voltage drop of more than 1.0 volt usually indicates a problem.

Continuity, checking

The continuity test can be used to check a circuit or switch. Because most automotive circuits are designed to have little or no resistance, a circuit or part of a circuit can be easily checked for faults using an ohmmeter. An open circuit or a circuit with high resistance will not allow current to flow. A circuit with little or no resistance allows current to flow easily.

CAUTION—

Use only a high quality digital ohmmeter having high input impedance when checking electronic components. The internal power source used in most analog (swing-needle) meters can damage solid state components.



➤ Brake light switch being tested for continuity.

- With brake pedal in rest position (switch open) there is no continuity (infinite ohms). With pedal depressed (switch closed) there is continuity (zero ohms).
- When checking continuity, the ignition should be off. On circuits that are powered at all times, the battery should be disconnected. Using the appropriate wiring diagram, a circuit can be easily tested for faulty connections, wires, switches, relays, and engine sensors by checking for continuity.

Short Circuits

A short circuit is exactly what the name implies. The circuit takes a shorter path than it was designed to take. The most common short that causes problems is a short to ground where the insulation on a positive (+) wire wears away and the metal wire is exposed. When the wire rubs against a metal part of the car or other ground source, the circuit is shorted to ground. If the exposed wire is live (positive battery voltage), a fuse will blow and the circuit may be damaged.

Shorts to ground can be located with a digital mu6ltimeter. Short circuits are often difficult to locate and may vary in nature. Short circuits can be found using a logical approach based on the current path.

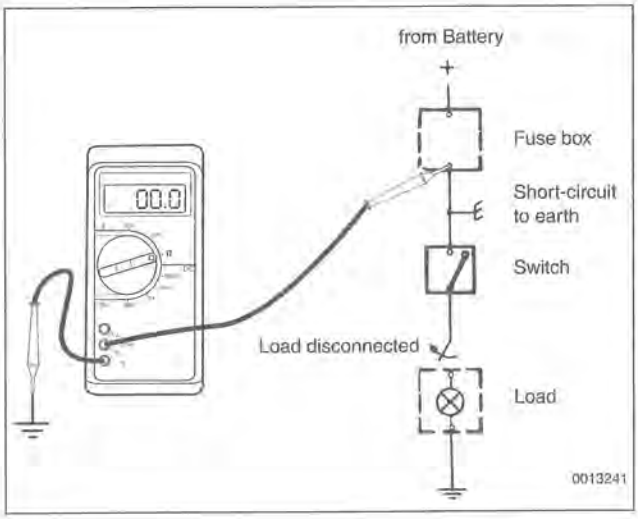
CAUTION—

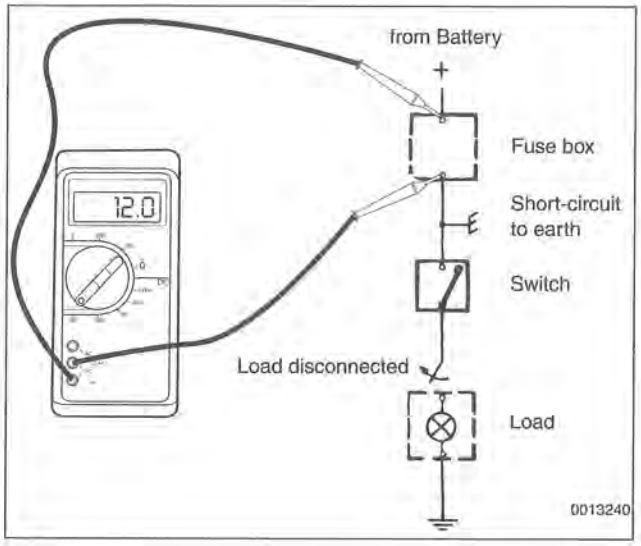
- *On circuits protected with high rating fuses (25 amp and greater), the wires or circuit components may be damaged before the fuse blows. Always check for damage before replacing fuses of this rating.*
- *When replacing blown fuses, use only fuses having the correct rating. Always confirm the correct fuse rating printed on the fuse/relay panel cover.*

Short circuit, testing with ohmmeter

- Remove blown fuse from circuit and disconnect cables from battery.
- Disconnect harness connector from circuit's load or component.
- Using an ohmmeter, connect one test lead to load side of fuse terminal (terminal leading to circuit) and the other test lead to ground.
- If there is continuity to ground, there is a short to ground.
- If there is no continuity, work from wire harness nearest to fuse/relay panel and move or wiggle wires while observing meter. Continue to move down harness until meter displays a reading. This is the location of short to ground.

  Visually inspect the wire harness at this point for any faults. If no faults are visible, carefully slice open the harness cover or the wire insulation for further inspection. Repair any faults found.





Short circuit, testing with voltmeter

– Remove blown fuse from circuit.

– Disconnect harness connector from circuit's load or component.

NOTE—
Most fuses power more than one component. Be sure all components are disconnected when checking for a short circuit.

➢ Using a digital multimeter, connect test leads across fuse terminals. Make sure power is present in circuit. If necessary turn key on.

– If voltage is present at voltmeter, there is a short to ground.

– If voltage is not present, work from wire harness nearest to fuse/relay panel and move or wiggle wires while observing meter. Continue to move down harness until meter displays a reading. This is the location of short to ground.

– Visually inspect wire harness at this point for any faults. If no faults are visible, carefully slice open harness cover or wire insulation for further inspection. Repair any faults found.



610 Electrical Component Locations

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GENERAL

This repair group covers fuse, relay and control module location information. Electrical equipment and accessories installed varies depending on model and model year. To confirm that the proper electrical component has been identified, refer to **Electrical Wiring Diagrams**.

WARNING —

Airbag units are explosive devices and must be handled with extreme care. Before starting any work on electrical systems, refer to the warnings and cautions in **721 Airbag System (SRS)**.

CAUTION —

- *Relay and fuse positions are subject to change and may vary from car to car. If questions arise, an authorized BMW dealer is the best source for the most accurate and up-to-date information.*
- *A good way to verify a relay position is to compare the wiring colors at the relay socket to the colors indicated on the wiring diagrams located at the rear of this manual.*
- *Always switch the ignition off and remove the negative (–) battery cable before removing any electrical components.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*
- *Connect and disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is switched off.*
- *Only use a digital multimeter for electrical tests.*

FUSES, RELAYS AND CONTROL MODULES

The fuses, relays and control modules are located in four main locations throughout the vehicle (five locations in the 750iL); the front power distribution box, the rear power distribution box, the auxiliary relay panel(s) and the electronics box (E-box). Refer to the component location photos and tables in this repair group for electrical component locations.

Fuse Positions

> ***CAUTION—***
> - *Replace fuses with those of the same rating. Installing a fuse with higher rating can lead to circuit failure and may also start a fire.*
> - *Relay/fuse positions vary by model and equipment.*

Fuses no. 1-29 and no. 60-63 are mounted in the front power distribution box. Additional fuse locations include the rear power distribution box (Fuses 30-33, 40-43, and 48-51), and in auxiliary relay panel I (Fuses 34-37).

Comprehensive lists of fuse positions for all years and models are given in **Table c** through **Table i**.

Relays and Control Modules

For a quick reference to the location of the relays and control modules, refer to **Table a**.

A comprehensive list of electrical components and their positions is given in **Table b**.

The last column of either table refers to photos or line art in this section which illustrates the component.

Table a. E32 Relays and Control Modules (Quick Reference)

Component	Model Year	Location	Reference Figure
A/C Compressor Clutch Relay	1988-1991	Left footwell	61-25
A/C Compressor Clutch Relay	1992 - 1994	Front power distribution box	610-1
A/C Control Relay	1988 - 1994	Auxiliary relay panel I	610-8
ABS Electronic Control Unit	1988 - 1994	E-box	610-6, 610-7
ABS Overvoltage Protection Relay	1988 - 1994	Front power distribution box	610-1
ABS/Traction Control Unit	1988 - 1994	E-box	610-6, 610-7
Anti-Theft Control Module (DWA)	1988 - 1994	Ahead of rear power distribution box, mounted to the seat support by 2 screws	
Blower Motor Relay	1988 - 1994	Front power distribution box	610-1
Check Control Module	1988 -1994	Front power distribution box	610-1
Chime Control Module	1988 - 1994	Mounted to lower left dash panel	

Table a. E32 Relays and Control Modules (Quick Reference)

Component	Model Year	Location	Reference Figure
Crash Control Module	1988 - 1994	Front power distribution box	610-1
Defogger/Auxiliary Coolant Pump Relay	1988 - 1994	Front power distribution box	610-1
Electric Power Protection Relay	1988 - 1994	Rear power distribution box	610-2, 610-3, 610-4, 610-5
Electronic Transmission Control Module (AEGS)	1988 - 1994	Behind right kick panel	
EML Control Module	1988 - 1994	E-box	610-7
Engine Control Module(s) (DME)	1988 - 1994	E-box	610-6, 610-7
Flasher Relay	1988 - 1994	Front power distribution box	610-1
Fuel Pump Relay	1988 - 1994	735 i / iL / 740 i / iL - E-box	610-6
Fuel Pump Relays	1988 - 1994	750 iL - auxiliary relay panel II	610-9
General Module (ZKE)	1988 - 1994	Rear power distribution box	610-2, 610-3, 610-4, 610-5
Headlight/Foglight Washer Control Module (SRA)	1988 - 1994	Auxiliary relay panel I	610-8
High Speed Fan Relay	1988 - 1994	Auxiliary relay panel I	610-8
Horn Relay	1988 - 1994	Front power distribution box	610-1
Infrared Locking Control Unit	1988 - 1994	Rear power distribution box	610-3 610-4
Lamp Control Module	1988 - 1994	Front power distribution box	610-1
Left Rear Seat Heating/Position Relay	1988 - 1994	Rear power distribution box	610-3, 610-4, 610-5
Main DME Relay	1988 - 1994	735 i / iL / 740 i / iL - E-box	610-6
Main DME Relays	1988 - 1994	750 iL - auxiliary relay panel II	610-9
Normal Speed Fan Relay	1988 - 1994	Auxiliary relay panel I	610-8
Parking Light Relay	1988 - 1991	Front power distribution box	610-1
Rear Defogger Relay	1988 - 1994	Rear power distribution box	610-2, 610-3, 610-4, 610-5
Rear Headrest Control Module	1988 - 1994	Rear power distribution box	610-3, 610-4, 610-5
Relay Module	1988 - 1994	Rear power distribution box	610-2, 610-3, 610-4, 610-5
Right Rear Seat Heating/Position Relay	1988 - 1994	Rear power distribution box	610-3, 610-4, 610-5
Starter Relay	1988 - 1994	Front power distribution box	610-1
Luggage Compartment Lid Relay	1988 - 1994	In luggage compartment lid, near lock assembly	
Unloader Relay, KL15	1988 - 1994	Front power distribution box	610-1
Unloader Relay, KL61	1988 - 1994	Front power distribution box	610-1
Unloader Relay, KLR	1988 - 1994	Front power distribution box	610-1
Windshield Washer Pump Relay	1988 - 1994	Front power distribution box	610-1

Front Power Distribution Box

The front power distribution box is mounted in the left rear corner of the engine compartment.



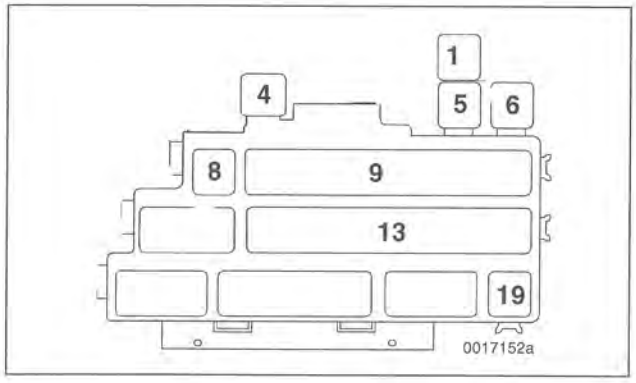
610-1 Front power distribution box

1. Fuses (#1-29)
2. Unloader relay (terminal 61)
3. Unloader relay (terminal 15)
4. Blower motor relay
5. Front defogger/auxiliary coolant pump relay
6. Unloader relay (terminal R)
7. Parking light relay (1988-1991)
   A/C compressor clutch relay (1992-1994)
8. OBC horn relay (1988-1990)
   Starter relay (late)
9. ABS overvoltage protection relay (750iL)
10. Starter relay-A/T (early)
    Fuses #60-63 (late)
11. Windshield washer pump relay (1988-1990)
    OBC horn relay (1991-1994)
12. Crash control module
13. Lamp control module
14. Flasher relay
15. Check control module

Rear Power Distribution Box

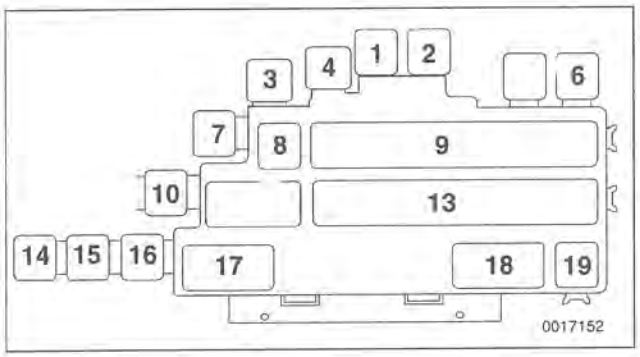
The rear power distribution box is located beneath the left rear seat cushion and houses auxiliary fuses, relays, and control modules.

To access the components in the rear power distribution box, remove the rear seat cushion as described in **520 Seats**. Then remove three retaining screws from the power distribution box top cover and unclip the cover.



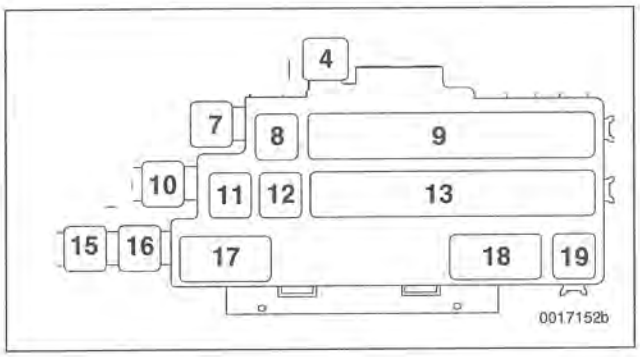
610-2 Rear power distribution box to 3/1988

1. Electric power protection relay
4. Windshield wiper relay
5. Rear defogger relay
6. Wiper pressure control module (ADV)
8. Fuses (#44-37)
9. Relay module
13. General module (ZKE)
19. Fuses (#40-43)



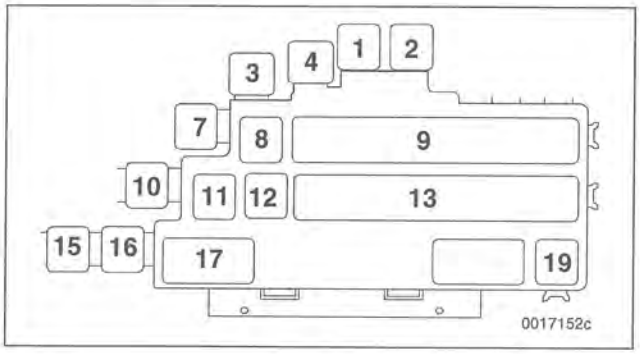
610-3 Rear power distribution box 3/1988-1990

1. Left rear seat heating/position relay (iL models)
2. Right rear seat heating/position relay (iL models)
3. open
4. Fuses (#48-51) (1989-1990)
5. Not used
6. Wiper pressure control module (ADV) (1988-1989)
7. Fuses (#30-33)
8. Fuses (#44-47)
9. Relay module
10. Rear defogger relay (1988-1989)
11. Not used
12. Not used
13. General module (ZKE)
14. Rear seat heating relay (1988)
15. Windshield wiper relay
16. Electric power protection relay
17. Rear headrest control unit (iL models only)
18. Infrared locking control module
19. Fuses (#40-43)



610-4 Rear power distribution box 1991

1. Not used
2. Not used
3. Not used
4. Fuses (#48-51)
5. Not used
6. Not used
7. Fuses (#30-33)
8. Fuses (#44-47)
9. Relay module
10. Fuses (#40-43)
11. Windshield wiper relay
12. Electric power protection relay
13. General module (ZKE)
14. Not used
15. Left rear seat heating/position relay (iL models)
16. Right rear seat heating/position relay (iL models)
    Rear seat heating relay (w/o rear power seats)
17. Rear headrest control unit (iL models only)
18. Infrared locking module
19. Rear defogger relay

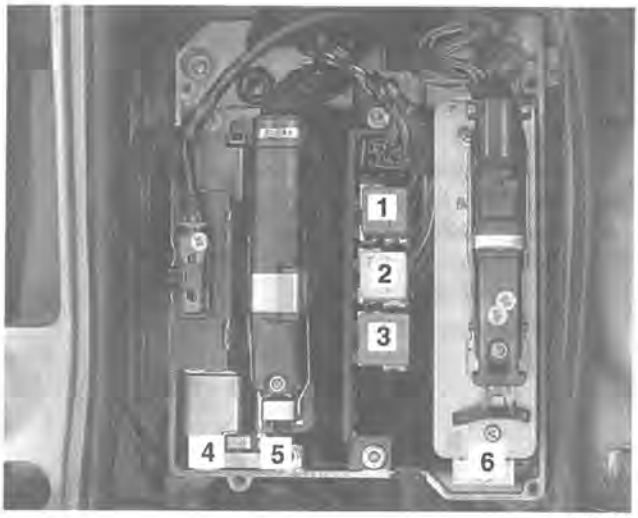


610-5 Rear power distribution box 1992-1994

1. Left rear seat heating/position relay (1992)
   Rear seat heating relay (w/o rear power seat) (1993-1994)
2. Right rear seat heating/position relay (1992)
3. Fuses (#56-59)
4. Fuses (#48-51)
5. Not used
6. Not used
7. Fuses (#44-47)
8. Fuses (#40-43)
9. Relay module
10. Fuses (#30-33)
11. Windshield wiper relay
12. Electric power protection relay
13. General module (ZKE)
14. Not used
15. Right rear seat heating/position relay (1993-1994)
    Rear seat heating relay (1992 w/o rear power seats)
16. Left rear seat heating/position relay (1993-1994)
17. Rear headrest control module
18. Not used
19. Rear defogger relay

Electronics Box (E-box)

The electronics box (E-box) is located in the right rear corner of the engine compartment. The cover is held is place with captive screws. The E-box is cooled by a two-speed electric fan. The fan runs on low speed when the engine is running. If the temperature in the box exceeds 44°C (111°F), the fan will run on high speed.



610-6 E-box 735i/iL and 740i/iL

1. Main DME relay
2. Fuel pump relay
3. Oxygen sensor heater relay (not used on all models)
4. Cruise control module (exc.models with EML)
5. DME control module
6. ABS/traction control module

CAUTION—

- *Relay positions are subject to change and may vary from car to car. If questions arise, an authorized BMW dealer is the best source for the most accurate and up-to-date information.*
- *A good way to verify a relay position is to compare the wiring colors at the relay socket to the colors indicated on the applicable wiring diagram.*



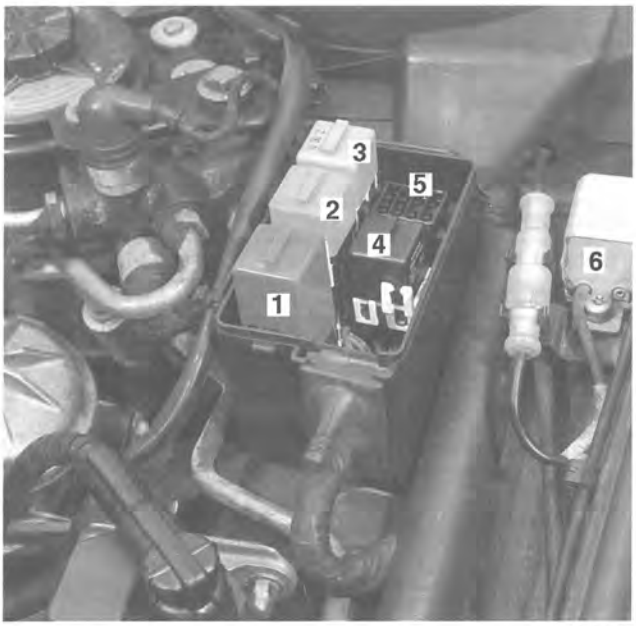
0017257

610-7 E-box 750iL

1. ABS/traction control module
2. DME control module II
3. EML control module
4. DME control module I
5. Hood microswitch

Auxiliary Relay Panels I and II

The auxiliary relay panel I is mounted on the left side of the engine compartment ahead of the left strut tower. It houses various relays and, on later models, a limited number of fuses.

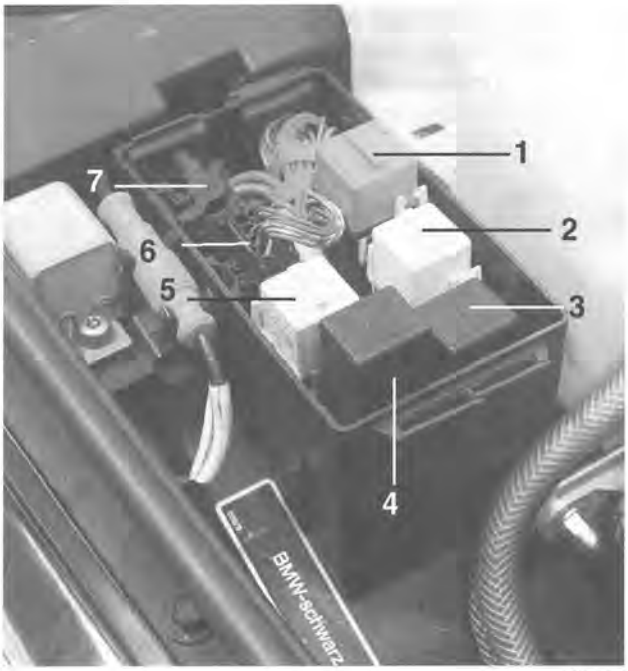


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610-8 Auxiliary relay panel I

1. Headlight/foglight cleaning system module
2. High speed fan relay
3. Normal speed fan relay
4. A/C control relay
5. Fuses (#34-37)
6. SRS crash sensor, left

Auxiliary relay panel II (used only on the 750iL) is mounted on the right side of the engine compartment just ahead of the right strut tower.



0017259

610-9 Auxiliary relay panel II, 750iL only

1. Oxygen sensor heater relay
2. Main DME relay I (cyl. 1-6)
3. Fuel pump relay I (cyl. 1-6)
4. Fuel pump relay II (cyl. 7-12)
5. Main DME relay II (cyl. 7-12)
6. Harness connector (8 pin)
7. Positive jumper post (B+)

COMPONENT LOCATIONS

Table b lists electrical components and their locations on E32 cars. Numbers in the **Reference figure** column refer to photos or illustrations in this group.

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
A/C Compressor Clutch	1988 - 1994	All - front of A/C compressor	
A/C Compressor Clutch Relay	1988 - 1991	All - by driver's footrest, behind speaker	610-25
A/C Compressor Clutch Relay	1992 - 1994	All - in front power distribution box	610-1
A/C Evaporator Temperature Sensor	1998 - 1994	All - left side of dash, on lower left side of heater box	
A/C High Pressure Switch	1988 - 1994	All - behind and below right headlight	
A/C Low Pressure Switch	1988 - 1994	All - lower right front, beside radiator	
A/C Medium Pressure Switch	1988 - 1994	All - lower right front, beside radiator	
A/C Relay	1992 - 1994	All - auxiliary relay panel I	610-8
ABS Hydraulic Unit	1988 - 1994	735 i / iL / 740 i / iL - next to left front strut tower	
ABS Hydraulic Unit	1988 - 1994	750 iL - below left headlight	
ABS Overvoltage Protection Relay	1988 - 1994	740 i / iL / 750 iL - front power distribution box	610-1
ABS Pulse Sensor, Front Wheel	1988 - 1994	All - front steering arm	
ABS Pulse Sensor, Rear Wheel	1988 - 1994	All - rear trailing arm	610-30
ABS/Traction Control Module	1988 - 1994	All - in E-box	610-6, 610-7

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Acceleration Sensor (EDC III), Front	1990 - 1994	All - right front wheel well under a cover	
Acceleration Sensor (EDC III), Longitudinal	1990 - 1994	All - next to battery, under right rear seat	
Acceleration Sensor (EDC III), Rear	1990 - 1994	All - right side of luggage compartment near wheel well	
ADS Throttle Housing	1993 - 1994	740 i / iL- front center of engine	
ADS Throttle Position Actuator	1993 - 1994	740 i / iL - front left of engine compartment, below brake vacuum booster	
ADS Throttle Switch	1993 - 1994	740 i / iL - front center of engine, on ADS throttle housing	
AEGS	1988 - 1994	See electronic transmission control module (AEGS)	
Air Circulation Flap Motor	1988 - 1994	See fresh air distribution motor	
Air Flow Meter	1988 - 1992	735 i / iL - see volume air flow sensor	
Air Mass Meter	1988 - 1994	740 i / iL / 750 iL - see mass air flow sensor	
Airbag Contact Slip Ring	1988 - 1994	All - rear of steering wheel	
Airbag Control Module (SRS)	1988 - 1994	All - under left side of dash	610-26
Airbag Crash Sensor	1988 - 1994	All - on right/left front strut towers	
Airbag, Driver's	1988 - 1994	All - center of steering wheel	
Airbag, Passenger	1988 - 1994	All - right front of dash above glove compartment	
Alternator	1988 - 1994	All - lower left front of engine	
Amplifier, Radio	1988 - 1994	All - luggage compartment under rear window shelf on right side	610-28
Antenna Amplifier AM/FM	1988 - 1994	All - left C pillar	
Antenna Diversity	1988 - 1994	All - left C pillar	
Anti-Slip Control Module	1988 - 1994	See ABS/traction control module	
Anti-Theft Control Module (DWA)	1988 - 1994	All - below left side of rear seat, ahead of rear power distribution box, mounted to seat bulkhead with two screws	
Anti-Theft Horn (DWA)	1988 - 1994	All - below right fresh air cowl	
ASC Switch	1988 - 1994	All - center of dash, near shifter	
ASC+T Hydraulic Control Unit	1983 - 1994	740 i / iL - at left rear of engine compartment at rear bulkhead	
ASC+T Hydraulic Control Unit	1988 - 1994	750 iL - below hydraulic brake booster at engine compartment rear bulkhead	
ASC/ASC+T Control Module	1988 - 1994	See ABS/traction control module	
Audible Turn Signal Relay	1988 - 1990	All - under right side of steering column	
Automatic Air Recirculation Control Module	1993-1994	All - behind driver's footwell panel, behind speaker	
Automatic Air Recirculation Sensor	1993 - 1994	In center console	
Automatic Heating and Air Conditioning (IHKA) Control Module	1988 - 1994	All - between front footwells, ahead of heater box	610-24
Automatic Transmission Back-up Light Switch	1988 - 1994	See back-up light switch, automatic transmission	
Automatic Transmission Control Module	1988 - 1994	See electronic transmission control module (AEGS)	
Automatic Transmission Range Switch	1988 - 1994	All - see gear position/start disable switch	
Auxiliary Coolant Pump Relay	1988 - 1994	All - in front power distribution box	610-1
Auxiliary Cooling Fan Motor	1988 - 1994	All - center front of engine compartment, behind bumper	610-27
Auxiliary Relay Panel I	1988 - 1994	All - left side of engine compartment, ahead of strut tower	610-8
Auxiliary Relay Panel II	1988 - 1994	750 iL - right side of engine compartment, ahead of strut tower	610-9
Auxiliary Throttle Position Motor (ADS)	1993 - 1994	See ADS throttle position actuator	
B+ Jumper Post	1988 - 1994	See jumper post (B+)	

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Back-up Light Switch, Automatic Transmission	1988 - 1994	All - on gear position/start disable switch	
Back-up Light Switch, Manual Transmission	1988 - 1992	735 i / iL - top right side of transmission	
Battery	1988 - 1994	All - under right rear seat cushion	
Blinker Relay	1988 - 1944	See flasher relay	
Blower Final Stage Unit ("Sword")	1988 - 1994	All - left side of right footwell in heater box	
Blower Motor	1988 - 1994	All - below center of cowl, behind coolant expansion tank	
Blower Motor Relay	1988 - 1994	All - front power distribution box	610-1
Booster/Amplifier	1988 - 1994	All - upper right corner of luggage compartment	610-28
Brake Fluid Level Sensor	1988 - 1994	735 i / iL /750 iL - left rear of engine compartment, on top of brake fluid reservoir	610-11
Brake Fluid Level Sensor	1993 - 1994	740 i / iL - left front of engine compartment. on top of brake fluid reservoir	610-17, 610-18
Brake Hydraulic Boost Regulating Switches	1988 - 1994	735 i / iL / 750 iL - left side of engine compartment, right of strut tower, on hydraulic power flow regulator	
Brake Light Switch	1988 - 1994	All - under left side of dash, on brake pedal	610-26
Brake Pad Sensor, Left Front Wheel	1988 - 1994	All - left front wheel on inside brake pad	
Brake Pad Sensor, Right Rear Wheel	1988 - 1994	All - right rear wheel on inside brake pad	610-30
Camshaft Position Sensor	1988 - 1994	740 i / iL / 750 iL - right front of engine	
CD Changer	1991 - 1994	All - luggage compartment	610-28
Central Body Electronics	1988 - 1994	See general module (ZKE)	
Central Locking Module	1988 - 1994	See general module (ZKE)	
Charging Plug	1988 - 1994	All - on left side of glove compartment	
Check Control Module	1988 - 1994	All - front power distribution box	610-1
Chime Module	1988 - 1994	All - behind left side of dashboard, mounted in sound insulation panel	
Clutch Pedal Switch	1988 - 1991	All - under left side of dash, left of brake pedal	
Coding Plug (Odometer)	1988 Early	735 i / iL- connector at rear of instrument cluster	
Combination Switch	1991 - 1994	All - top of steering column	
Compressor Clutch Control Relay	1988 - 1991	See A/C compressor clutch relay	
Compressor Clutch, A/C	1988 - 1994	All - right front of engine	
Compressor, A/C	1988 - 1994	All - right front of engine	
Contact Ring (SRS)	1988 - 1994	All - on steering wheel base, in front of airbag	
Coolant Level Sensor	1988 - 1994	All - top of coolant reservoir	610-21, 610-17
Coolant Temperature Sensor	1988 - 1992	735 i / iL - on coolant inlet, near valve cover (DME & temperature gauge)	610-10
Coolant Temperature Sensor	1993 - 1994	740 i / iL - right rear of engine, in coolant manifold	
Coolant Temperature Sensor	1988 - 1994	750 iL - right rear of engine, in coolant manifold	
Cooling Fan Dual Switch	1988 - 1994	All - right side of radiator	
Cooling Fan Motor	1988 - 1994	All - behind front grill	
Cooling Fan Relays	1988 - 1944	All - in auxiliary relay panel I	610-8
Crankshaft Position/RPM Sensor	1988 - 1994	735 i / iL / 740 i / iL - front of engine at vibration damper	
Crankshaft Position/RPM Sensor 1 - 6	1988 - 1994	750 iL- lower left center front of engine	

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Crankshaft Position/RPM Sensor 7 - 12	1988 - 1994	750 iL - center front of engine near top radiator hose inlet	
Crash Control Module	1988 - 1994	All - front power distribution box	610-1
Crash Sensor, Left Front	1988 - 1994	All - ahead of left front strut tower	610-19
Crash Sensor, Right Front	1988 - 1994	All - ahead of right front strut tower	610-20
Cruise Control Module (Tempomat)	1993 - 1994	All - behind footwell side panel, behind speaker	
Cylinder Identification Sensor	1988 - 1992	735 i / iL - right front of engine, on #1 spark plug wire	
Cylinder Identification Sensor I	1988 - 1994	750 iL - on spark plug wire # 6, under right distributor cover	
Cylinder Identification Sensor II	1988 - 1994	750 iL - on spark plug wire # 12, under left distributor cover	
Data Link Connector	1988 - 1992	735 i / iL - left rear of engine compartment	610-12
Data Link Connector	1993 - 1994	740 i / iL - right rear of engine compartment	610-13
Data Link Connector	1992 - 1994	750 iL - left rear of engine compartment	610-23
Defogger Coupler	1988 - 1994	All - right C pillar	
Defogger Relay, Rear	1988 - 1994	See rear window defogger relay	
Defroster Air Distribution Motor	1988 - 1994	All - below left side of dash, on lower left side of heater box	
Diagnostic Connector	1988 - 1992	See data link connector	
Diagnostic Module (SRS)	1988 - 1994	See airbag control module (SRS)	
Directional Relay	1988 - 1944	See flasher relay	
Diversity, Antenna	1991 - 1994	All - left C pillar	
DME control module	1988 - 1994	See engine control module(s) (DME)	
DME Main Relay(s)	1988 - 1994	See main DME relay	
Door Lock Actuator	1988 - 1994	All - top of door behind door lock	
Door Lock Heater	1988 - 1994	All - door, at key lock assembly	
Door Lock Switch	1988 - 1992	All - behind door lock	
Driver's Airbag Generator	1988 - 1994	All - center of steering wheel	
Driver's Daylight Coding Diode	1988 - 1994	All - front of dash, near light switch	
Driver's Door Handle Switch	1988 - 1994	All - behind driver's door handle	
E-Box	1988 - 1994	All - right side of engine, behind right front strut tower	610-6, 610-7
E-Box Fan	1988 - 1994	All - E-box, below modules	
EDC III Acceleration Sensor, Front	1990 - 1994	All - right front wheel well behind a cover	
EDC III Acceleration Sensor, Longitudinal	1990 - 1994	All - next to battery, under right rear seat	
EDC III Acceleration Sensor, Rear	1990 - 1994	All - right side of luggage compartment near wheel well	
EDC III Electronic Control Module	1990 - 1994	All - under right side of rear seat, near battery	
EDC III Strut Solenoid	1990 - 1994	All - on suspension strut housing	
EDC III Switch	1990 - 1994	All - on center console	
EGS	1988 - 1994	See electronic transmission control module (AEGS	
Electric Power Protection Relay	1988 - 1994	All - in rear power distribution box	610-2, 610-3, 610-4, 610-5
Electro-Hydraulic Converter (Servotronic)	1988 - 1994	All - below left front of car, behind left front wheel	
Electrochromic Mirror	1991 - 1994	All - above center of windshield	
Electronic Damper Control Module	1990 - 1994	See EDC III electronic control module	
Electronic Damper Control Switch	1990 - 1994	See EDC III switch	

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Electronic Heater Control Module (IHKA)	1988 - 1990	See automatic heating and air-conditioning (IHKA) control module	
Electronic Shock Absorber Control Module (EDC III)	1990 - 1994	See EDC III electronic control module	
Electronic Throttle Control Module	1988 - 1994	See EML control module	
Electronic Transmission Control Module (AEGS)	1988 - 1994	All - behind right kick panel	
EML Control Module	1991 - 1992	735 i / iL - E-box	
EML Control Module	1988 - 1994	750 iL - E-box	610-7
Engine Control Module(s) (DME)	1988 - 1994	All - in E-box	610-6, 610-7
Engine Coolant Temperature Sensor	1988 - 1994	See coolant temperature sensor	
Engine Hood Microswitch	1991 - 1994	See hood microswitch	
Engine Hood Switch	1988 - 1994	All - LF on radiator support	
Engine Intake Air Temperature Sensor	1988 - 1994	See intake air temperature sensor	
Engine Speed Sensor	1988 - 1994	735 i / iL / 740 i / iL - see crankshaft position/RPM sensor	
Evaporative Purge Valve	1988 - 1992	735 i / iL - left side of engine, right of oil filter	
Evaporative Purge Valve	1993 - 1994	740 i / iL- front of left cylinder head	
Evaporative Purge Valve (Cyl. 1-6)	1988 - 1994	750 iL - left front of engine compartment	
Evaporative Purge Valve (Cyl. 7-12)	1988 - 1994	750 iL - right front of engine compartment	
Evaporator Temperature Sensor	1998 - 1994	See A/C evaporator temperature sensor	
Final Stage Unit ("Sword")	1988 - 1994	See blower final stage unit ("sword")	
Flasher Relay	1988 - 1994	All - front power distribution box (brown relay)	610-1
FM Amplifier HLO	1991 - 1994	All - left C pillar	
Fog Light Washer Pump	1988 - 1992	735 i / iL - left front of engine compartment, on washer fluid reservoir	
Fog Light Washer Pump	1988 - 1992	740 i / iL / 750 iL - right front of engine compartment, on washer fluid reservoir	
Footwell Air Distribution Motor, Left	1988 - 1994	All - below left side of dash, on left side of heater box	
Footwell Air Distribution Motor, Right	1988 - 1994	All - below right side of dash, on right side of heater box	
Fresh Air Distribution Motor	1988 - 1994	All - below left side of dash, on left side of heater box	
Front Brake Pad Sensor	1988 - 1994	See brake pad sensor, left front wheel	
Front Defogger	1988 - 1990	All - lower part of windshield	
Front Defogger/Auxiliary Coolant Pump Relay	1988 - 1994	All - in front power distribution box	610-1
Front Power Distribution Box	1988 - 1994	All - left rear of engine compartment	610-1
Front Speed Sensor	1988 - 1994	See ABS pulse sensor, front wheel	
Fuel Injectors	1988 - 1994	All - top of engine, on intake manifold	
Fuel Level Sensor	1988 - 1994	All - in fuel tank, below luggage compartment, through right access panel, right of spare tire	
Fuel Pump Relay	1988 - 1994	735 i / iL / 740 i / iL - in E-box	610-6
Fuel Pump Relays	1988 - 1994	750 iL - in auxiliary relay panel II	610-8
Fuel Pump(s)	1988 - 1992	All - in fuel tank, below luggage compartment, through right access panel, right of spare tire	610-29
Fuel Tank Sensor	1988 - 1994	See fuel level sensor	

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Fusible Link 50 A	1988 - 1994	All - below right side of rear seat, right of battery	
Fusible Link 80 A	1988 - 1994	All - below rear seat	
Gas Filler Lock Actuator	1992 - 1994	All - luggage compartment, behind right wheel well	
General Module (ZKE)	1988 - 1994	All - in rear power distribution box	610-2, 610-3, 610-4, 610-5
Glove Compartment Light	1991 - 1994	All - right side of dash, above glove compartment	610-24
Grounds:			
G 100	1988 - 1994	All - left front of engine compartment	
G 101	1988 - 1994	All - right front of engine compartment	
G 103	1988 - 1994	All - below left rear seat	
G 105	1988 - 1994	All - below left rear seat	
G 110	1988 - 1994	All - below left side of dash	
G 117	1988 - 1994	All - right rear of engine compartment	
G 119	1988 - 1994	All - right rear of engine compartment	
G 202	1988 - 1994	All - below left side of dash	
G 204	1988 - 1994	All - below left rear seat	
G 303	1988 - 1994	All - below right rear seat	
G 304	1988 -1994	All - below left rear seat	
Hazard Flasher Relay	1988 - 1994	See flasher relay	
Headlight Switch	1988 - 1994	All - left of instrument cluster	
Headlight Washer Pump	1988 - 1992	735 i / iL - left front of engine compartment, on washer fluid reservoir	
Headlight Washer Pump	1988 - 1994	740 i / iL / 750 iL - right front of engine compartment, on washer fluid reservoir	
Headlight/Foglight Washer Module (SRA)	1988 - 1994	All - auxiliary relay panel I (red relay)	610-8
Headrest Motor, Front Seat	1988 - 1994	All - top right corner of front seatback	
Headrest Potentiometer	1988 - 1994	All - on driver's headrest motor	
Headrest Switch, Left Rear	1988 - 1994	All - left side of seat cushion	
Headrest Switch, Right Rear	1988 - 1994	All - right side of seat cushion	
Heat Exchanger Temperature Sensor	1988 - 1994	See heater core temperature sensor, right/left	
Heater Core Temperature Sensor, Left	1988 - 1994	All - left side of heater box	
Heater Core Temperature Sensor, Right	1988 - 1991	All - right side of heater box	
Heater Core Temperature Sensor, Right/Left	1988 - 1994	All - below right/left side of dash in heater box	
Heater Valve	1988 - 1994	All - left rear of engine compartment at bulkhead	610-23
HiFi Amplifier	1988 - 1994	All - luggage compartment mounted to bottom of back window shelf	610-28
High Pressure Switch (A/C)	1988 - 1994	See A/C high pressure switch	
High Speed Cooling Fan Relay	1988 - 1994	See cooling fan relays	
Hood Microswitch	1988-1994	All - at base of right-hand hood guide rail at rear bulkhead	
Horn	1988 - 1994	All - front of car, behind grill	610-27
Horn Switch	1988 - 1994	All - top of steering column, in steering wheel	
Hot Wire Air Mass Meter	1991 - 1994	See mass air flow sensor	
Hydraulic Fluid Level Sensor	1988 - 1992	All - left front of engine, on hydraulic fluid level container	

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Idle Speed Control (Stabilizer) Valve	1988 - 1992	735 i / iL - between throttle housing and volume air flow sensor	610-12
Idle Speed Control (Stabilizer) Valve	1993 - 1994	740 i / iL - right front of intake manifold	610-14
Igniting Coil I (Cyl. 1-6)	1988 - 1994	750 iL - right front of engine compartment	610-20
Ignition Coil	1988 - 1992	735 i / iL - right side of engine compartment, at strut tower	610-12
Ignition Coil	1993 - 1994	740 i / iL - at top of each cylinder, above spark plug	
Ignition Coil II (Cyl. 7-12)	1988 - 1994	750 iL - left front of engine compartment	610-19
Ignition Switch	1988 - 1994	All - top right of steering column	610-26
IHKA Blend Door Motor	1988 - 1994	All - in heater box, right/left of radio	
Inertia Switch	1988 - 1994	All - under center of rear seat, right of rear power distribution box	
Infrared Locking Control Module	1988 - 1994	All - rear power distribution box	610-3, 610-4
Infrared Receiver	1988 - 1994	All - above center of windshield, near rear view mirror	
Intake Air Temperature Sensor	1988 - 1992	735 i / iL- intake manifold behind throttle housing	
Intake Air Temperature Sensor	1993 - 1994	740 i / iL - right front of intake manifold	
Intake Air Temperature Sensors	1988 - 1994	750 iL - rear of intake manifold runners	610-22, 610-21
Intensive Washer Pump	1988 - 1994	All - right rear of engine compartment, on washer fluid reservoir	610-22
Intermediate Pressure Switch (A/C)	1988 - 1992	See A/C medium pressure switch	
Jumper Post (B+)	1988 - 1992	735 i / iL - right side of front power distribution box	610-12
Jumper Post (B+)	1993 - 1994	740 i / iL - right rear of engine compartment	610-13
Jumper Post (B+)	1988 - 1994	750 iL - right side of front power distribution box	610-23
Kick Down Prevent Relay	1988 - 1990	All - behind right kick panel	
Knock Sensor Connectors, Cyl. 1 - 4	1993 - 1994	740 i / iL - right side of engine, on injector wiring harness duct	610-15
Knock Sensor Connectors, Cyl. 5 - 8	1993 - 1994	740 i / iL - left side of engine, on injector wiring harness duct	
LAD Regulator Valve	1988 - 1990	All - below rear of car, right of final drive housing	
Lamp Control Module	1988 - 1994	All - front power distribution box	610-1
Level Regulator Valve	1988 - 1990	See LAD regulator valve	
Lock Sensor Control Module	1988 - 1994	All - behind left kick panel	
Longitudinal Acceleration Sensor	1992 - 1994	See acceleration sensor (EDC III), longitudinal	
Low Pressure Switch (A/C)	1988 - 1994	See A/C low pressure switch	
Luggage Compartment Lock Motor	1998 - 1994	All - luggage compartment, right of lid lock assembly	
Luggage Compartment Lid Mircoswitch	1988 - 1992	All - luggage compartment lid, near luggage compartment lock	
Luggage Compartment Light Switch	1993 - 1991	All - center rear of luggage compartment	
Luggage Compartment Lock Switch	1988 - 1994	All - center of rear panel, below luggage compartment latch	
Lumbar Support Motor, Front Seat	1988 - 1994	All - front seat back	
Main DME Relay	1988 - 1994	735 i / iL / 740i / iL - E-box	610-6
Main DME Relays	1988 - 1994	750 iL - auxiliary relay panel II (white relays)	610-7
Main Fuse and Relay Box	1988 - 1992	See front power distribution box	610-1
Manual Transmission Back-up Light Switch	1988 - 1992	See back-up light switch, manual transmission	
Mass Air Flow Sensor (cylinders 1 - 6)	1988 - 1994	750 iL- left front of engine compartment	610-19
Mass Air Flow Sensor (cylinders 7 - 12)	1988 - 1994	750 iL- right front of engine compartment	610-20

Table b. E32 Component Locations

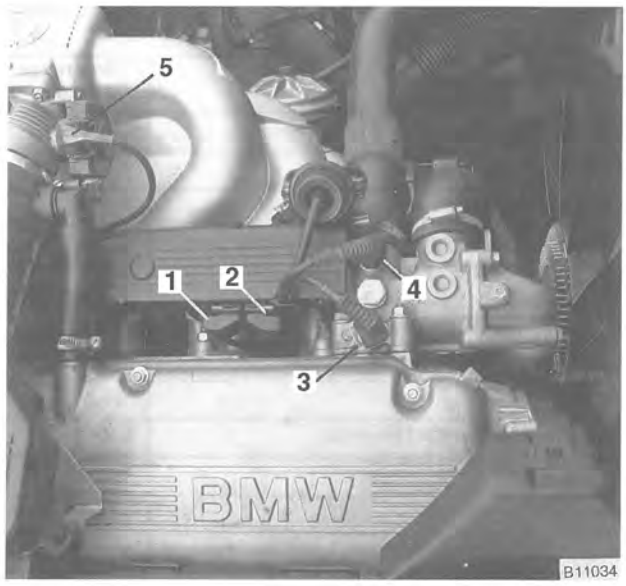
Component	Model Year	Location	Reference Figure
Mass Air Flow Sensor (Hot Film)	1993 - 1994	740 i / iL - top of engine	610-16
Memory Seat/Mirrors Control Module	1988 - 1994	All - under driver's seat	
Mixing Flap Actuator	1988 - 1994	See IHKA blend door motor	
Motronic Control Module DME	1988 - 1994	See engine control module(s) (DME)	
Normal Speed Fan Relay	1988 - 1994	See cooling fan relays	
Odometer	1988 - 1994	All - connector at rear of instrument cluster	
Oil Level Sensor	1988 - 1994	All - on bottom of oil pan	
Oil Pressure Switch	1988 - 1992	735 i / iL - top rear of engine, rear of cylinder head	
Oil Pressure Switch	1993 - 1994	740 i / iL - lower left front of engine	
Oil Pressure Switch	1988 - 1994	750 iL - at bottom of oil filter housing	
On-Board Computer	1988 - 1994	All - center of dash, right of radio	
On-Board Computer Temperature Sensor	1988 - 1994	All - under front bumper, right side	
Outside Temperature Sensor	1988 - 1994	All - behind coolant expansion tank support panel, right of blower motor	
Oxygen Sensor	1988 - 1992	735 i / iL - top of catalyst, near rear of transmission	
Oxygen Sensor Heater Relay	1988 - 1992	735 i / iL / 740 i / iL - E-box	610-6
Oxygen Sensor Heater Relay	1988 - 1994	750 iL - auxiliary relay panel II	610-9
Oxygen Sensor, Left/Right	1988 - 1994	740 i / iL / 750 i / iL - exhaust pipe, ahead of catalytic converter	
Parking Brake Switch	1988 - 1994	All - under console, on rear of park brake lever	
Parking Light Monitor Relay	1988 - 1991	All - front power distribution box	610-1
Pedal Position Sensor	1991-1992	735 with ASC, under left side of dash, behind steering column	
Pedal Position Sensor	1988 - 1994	750 iL - under left side of dash, behind steering column	
Phone Interface Box	1991 - 1994	All - below center console	
Phone Transceiver	1991 - 1994	All - right front of luggage compartment	
Power Steering Fluid Level Sensor	1992 - 1994	All - left front of engine compartment, on power steering fluid reservoir	
Pulse Sensor (ABS)	1988 - 1994	See ABS pulse sensor	
Radio Antitheft Switch (DWA)	1988 - 1994	All - in dashboard behind radio	
Rear Brake Pad Sensor	1988 - 1994	See brake pad sensor, right rear wheel	
Rear Defogger Relay	1988 - 1994	See rear window defogger relay	
Rear Heater Vent Distribution Motor	1988 - 1994	All - front of console, on lower rear of heater box	
Rear Power Distribution Box	1988 - 1994	All - below left side of rear seat	610-2, 610-3, 610-4, 610-5
Rear Seat Belt Contact, Right/Left	1992 - 1994	All - right/left rear of rear seat	
Rear Seat Heater Relay	1988 - 1990	All - rear power distribution box	610-3, 610-4, 610-5
Rear Seat Heater/Position Relay	1988 - 1994	All - rear power distribution box	610-3, 610-4, 610-5
Rear Seat Motor	1988 - 1994	All - under rear seat	
Rear Speed Sensor	1988 - 1992	See ABS pulse sensor, rear wheel	
Rear Vent Flap Switch	1988 - 1990	All - rear of console, on rear vent flap	
Rear Window Defogger Relay	1988 - 1992	All - rear power distribution box	610-2, 610-3, 610-4, 610-5
Right Front Airbag Generator	1992 - 1994	All - behind right side of dashboard	

Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Seat Belt Switch, Front	1988 - 1994	All - front seat belt buckle	
Seat Cushion Movement Potentiometer	1988 - 1994	All - on driver's seat movement motor	
Seat Cushion Rear Height Potentiometer	1988 - 1994	All - on driver's seat cushion tilt motor	
Seat Cushion Tilt Motor, Front	1988 - 1994	All - under front seat	
Seat Headrest Motor, Front	1988 - 1994	See headrest motor, front seat	
Seat Heater	1988 - 1994	All - in seat	
Seat Heater/Position Relay, Rear	1988 - 1994	All - rear power distribution box	610-3, 610-4, 610-5
Seat Height Motor, Front	1988 - 1994	All - under front seat	
Seat Height Potentiometer	1988 - 1994	All - on driver's seat height motor	
Seat Movement Motor, Front	1988 - 1994	All - under front seat	
Seat Movement Motor, Rear	1988 - 1994	All - under rear seat	
Seatback Heater	1988 - 1994	All - on seatback	
Seatback Potentiometer	1988 -1994	All - on driver's seat recliner motor	
Seatback Recliner Motor, Front	1988 - 1994	All - under front seat	
Servotronic Control Module	1988 - 1992	All - behind driver's footwell panel, behind speaker	610-25
Shift Lock	1991 - 1994	All - below center of console, near gear selector	
Slip Control Module (ABS/ASC+T)	1991 - 1994	See ABS/traction control module	
Speed Sensor	1988 - 1994	See ABS pulse sensor	
Starter	1988 - 1992	735 i / iL - left side of engine, below intake manifold	
Starter	1993 - 1994	740 i / iL - right side of engine, right side of oil pan	
Starter	1988 - 1994	750 iL - right side of engine, right side of oil pan	
Starter Relay	1988 - 1994	All - front power distribution box	610-1
Steering Angle Sensor	1992 - 1994	All - on steering column	
Steering Column Adjustment Motor	1991 - 1994	All - left side of dash	
Steering Column Adjustment Potentiometer	1991 - 1994	All - top right side of steering column	
Sunroof Motor	1988 - 1992	All - above center of windshield, near rear view mirror	
Sunroof Position Switch	1988 - 1994	All - above center of windshield, near rear view mirror	
Temperature Distribution Potentiometer	1988 - 1994	All - above radio, in dash center IHKA outlets	
Throttle Position Actuator I (EML) Cyl. 1 - 6	1988 - 1994	750 iL - top left front of engine, on throttle housing	610-21
Throttle Position Actuator II (EML) Cyl 7 - 12	1988 - 1994	750 iL - top right front of engine, on throttle housing	610-20
Throttle Position Switch	1988 - 1992	735 i / iL - top of engine, at intake manifold	610-10, 610-12
Throttle Valve Heater	1988 - 1992	735 i / iL - top of engine, on throttle housing	
Throttle Valve Switch (ADS)	1988 - 1994	740 i / iL - top of engine, on throttle housing	610-14
Traction Control Module	1988 - 1994	See ABS/traction control module	
Transmission Control Module	1988 - 1994	See electronic transmission control module (AEGS)	
Transmission Kickdown Switch	1991 - 1994	All - under accelerator pedal	
Under Hood Light Switch	1988 - 1994	All - left front of hood	
Unloader Relay, KI 15	1988 - 1994	All - front power distribution box	610-1
Unloader Relay, KL61	1990 - 1994	All - front power distribution box	610-1

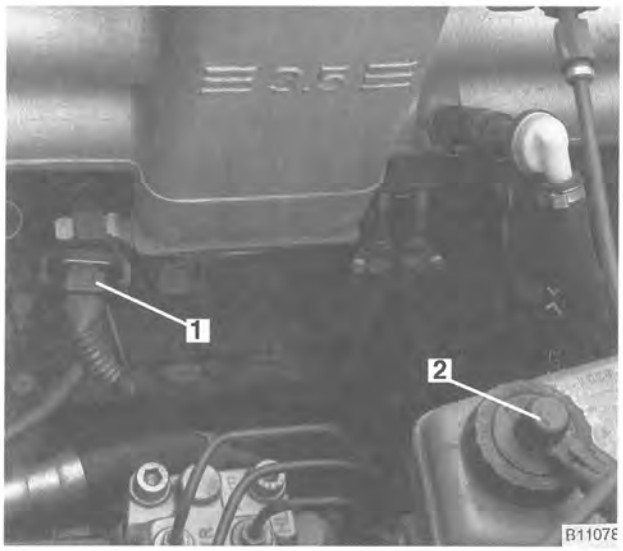
Table b. E32 Component Locations

Component	Model Year	Location	Reference Figure
Unloader Relay, KLR	1988 - 1994	All - front power distribution box	610-1
Vehicle Speed Sensor	1988 - 1994	All - rear of car, on differential	
Ventilation Distribution Motor	1988 - 1994	All - left side of dash, on left side of heater box	
Volume Air Flow Sensor	1988 - 1994	735 i / iL - intake tube between throttle housing and air filter	610-12
Water Valve Assembly	1988 - 1994	See heater valve	
Wheel Camber Warning Switch	1998 - 1994	All - below car at right rear trailing arm	
Window Limit Switch	1988 - 1994	All - center front of door	
Window Motor, Door	1988 - 1994	All - lower front of door	
Windshield Washer Fluid Level Sensor	1988 - 1994	All - side of windshield washer fluid reservoir	610-20
Windshield Washer Jet	1988 - 1994	All - on hood	
Windshield Washer Jet Heater	1988 - 1994	All - under cover on engine hood	
Windshield Washer Pump	1988 - 1994	All - in windshield washer fluid reservoir	610-20
Windshield Washer Pump Relay	1988 - 1991	All - front power distribution box (blue relay)	610-1
Windshield Wiper Motor	1988 - 1994	All - inside left fresh air cowl behind rear engine compartment bulkhead	
Windshield Wiper Pressure Control Motor (ADV)	1988 - 1994	All - below left side of fresh air cowl	
Windshield Wiper Pressure Control Relay (ADV)	1988 - 1994	All - in rear power distribution box	610-2, 610-3
Windshield Wiper Relay	1988 - 1994	All - in rear power distribution box	610-2, 610-3, 610-4, 610-5



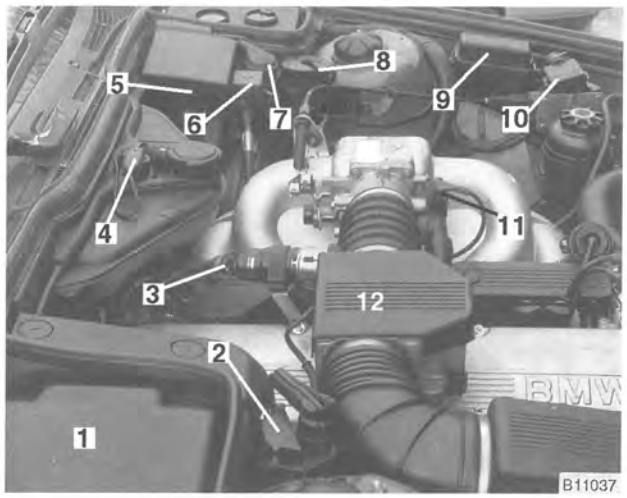
610-10 Engine compartment, front, 735i/iL

1. Harness connector, reference sensor, DME
2. Harness connector, engine speed sensor, DME
3. Coolant temperature sensor (temperature gauge)
4. Coolant temperature sensor (DME)
5. Throttle position switch



610-11 Engine compartment, left rear, 735i/iL

1. Evaporative purge control valve
2. Brake fluid level sensor



610-12 Engine compartment, 735i/iL

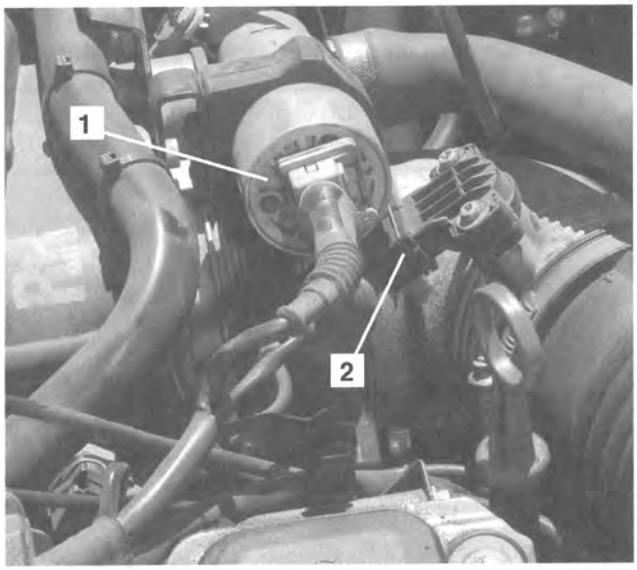
1. E-box
2. Ignition coil
3. Idle speed control (stabilizer) valve
4. Coolant level sensor
5. Heater control valve
6. Positive jumper post (B+)
7. Engine harness connector
8. Data link (diagnostic) connector
9. Auxiliary relay panel I
10. Cruise control actuator
11. Throttle position switch
12. Volume air flow sensor



0017310

610-13 Engine compartment, right rear, 740i/iL

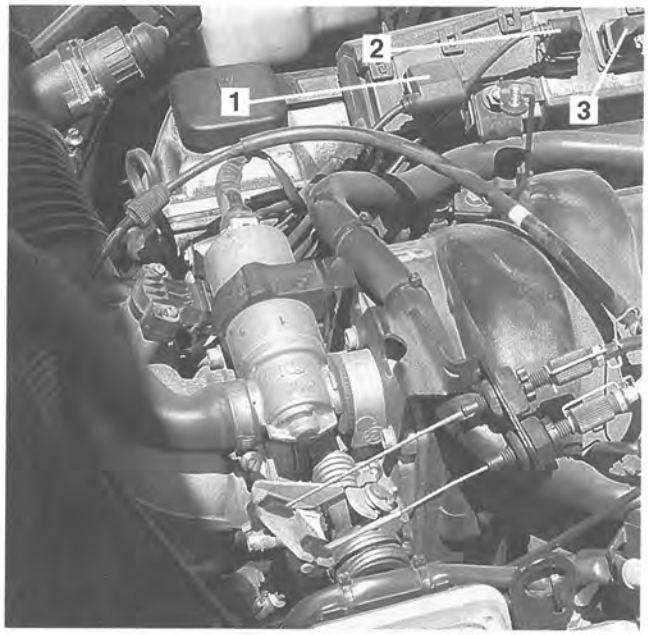
1. Positive jumper post (B+)
2. Coolant level sensor
3. Data link (diagnostic) connector



0017311

610-14 Engine compartment, right front, 740i/iL

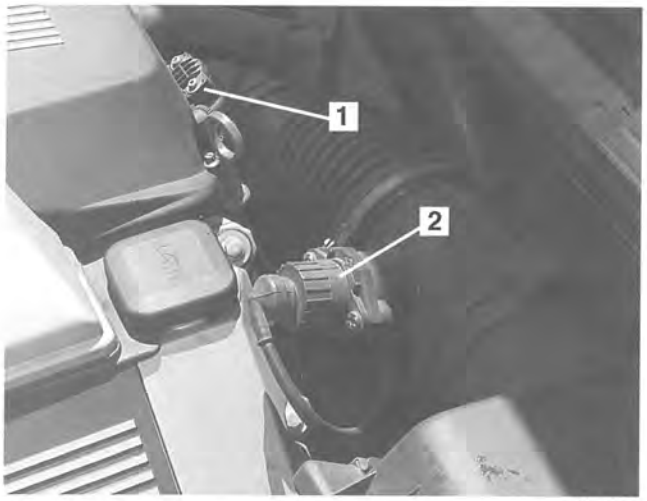
1. Idle control (stabilizer) valve
2. Throttle valve switch (ASC+T only)



0017312

610-15 Engine compartment, front (top engine cover removed), 740i/iL

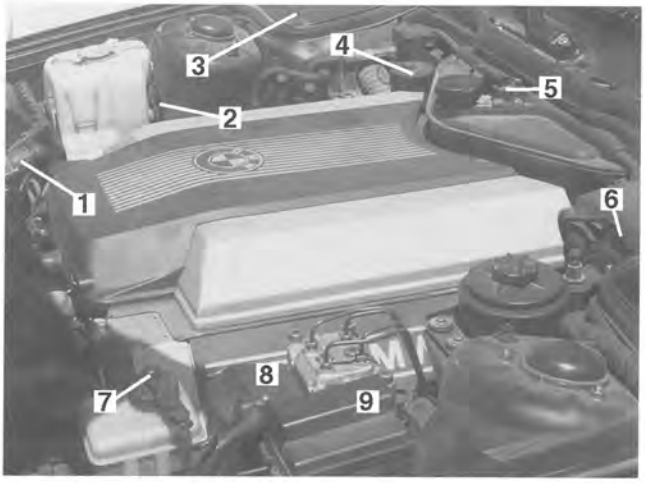
1. Camshaft position sensor
2. Knock sensor connector (cyl. 1, 2)
3. Knock sensor connector (cyl. 3, 4)



0017313

610-16 Engine compartment, right rear, 740i/iL

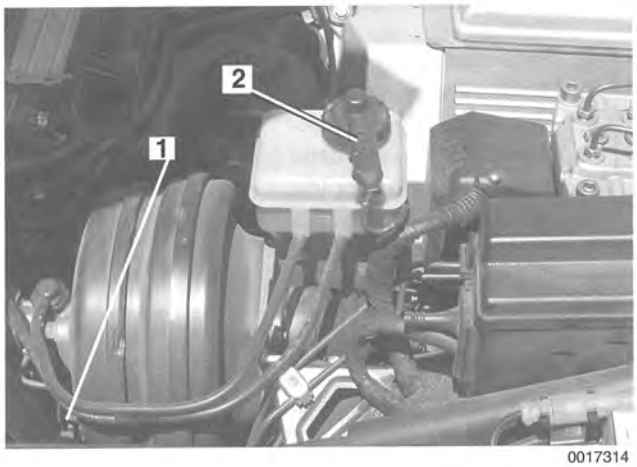
1. Throttle valve switch (ASC+T only)
2. Mass air flow sensor (hot film)



0017314

610-17 Engine compartment, 740i/iL

1. Air filter housing
2. Windshield washer fluid level sensor
3. E-box
4. Data link (diagnostic) connector
5. Coolant level sensor
6. Heater core control valve (below cover)
7. Brake fluid level sensor
8. ABS hydraulic control unit
9. Auxiliary relay panel



0017314

610-18 Engine compartment, left front, 740i/iL

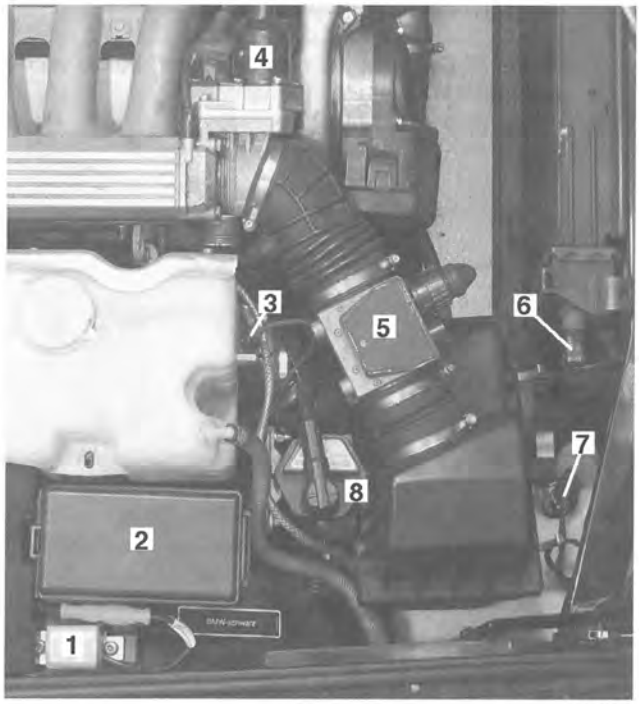
1. ADS (ASC+T) throttle position motor, below vacuum brake booster
2. Brake fluid level sensor



0017236

610-19 Engine compartment, left front, 750iL

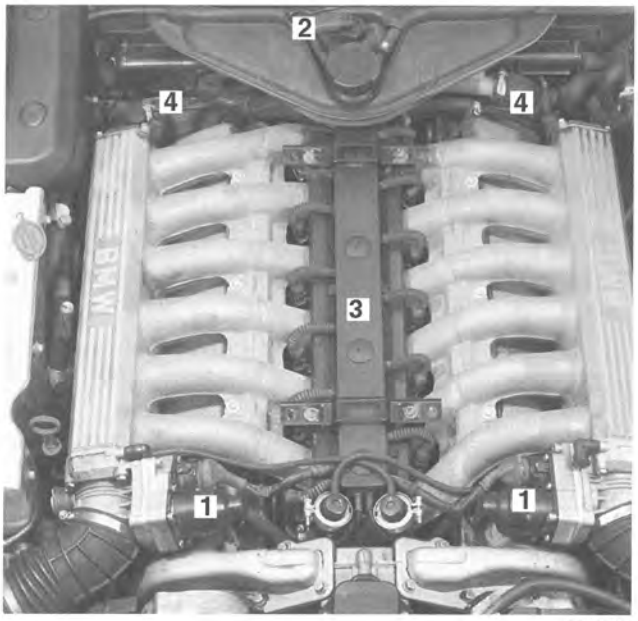
1. SRS crash sensor, left
2. Auxiliary relay panel I
3. Ignition coil (cyl. 7 - 12)
4. Mass air flow sensor (cyl. 1 - 6)
5. Hydraulic boost pressure switch
6. Hydraulic boost pressure switch



0017237

610-20 Engine compartment, right front, 750iL

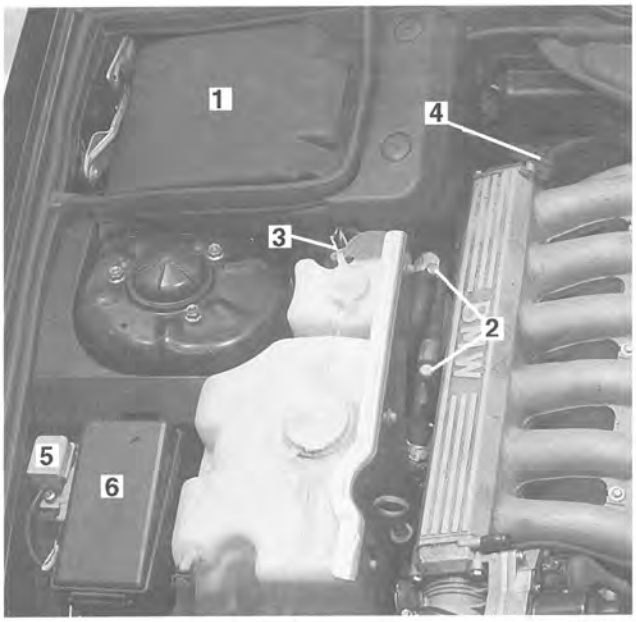
1. SRS crash sensor, right
2. Auxiliary relay panel II
3. Washer fluid level sensor
4. Throttle position actuator (EML) (cyl. 7 - 12)
5. Mass air flow sensor (cyl. 7 - 12)
6. Auxiliary cooling fan dual switch
7. Windshield washer pump
8. Ignition coil (cyl. 1 - 6)



0017240

610-21 Center of engine compartment, 750iL.

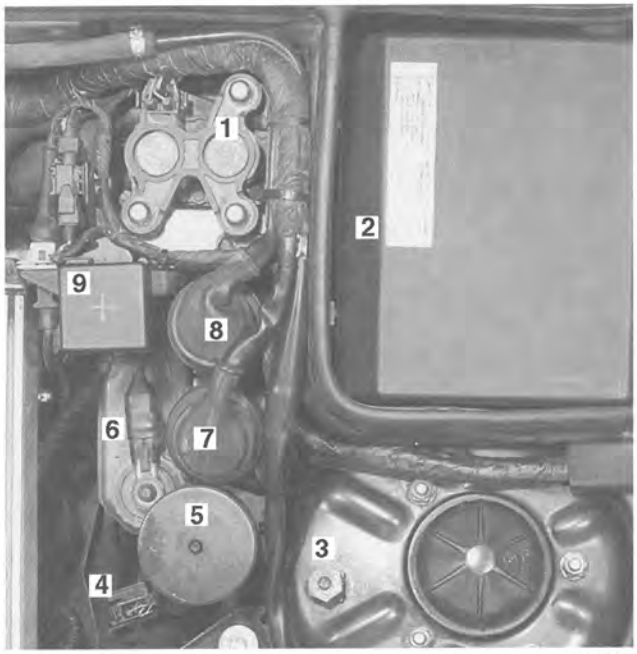
1. Throttle position actuator (EML), right and left
2. Coolant reservoir level sensor
3. Fuel injector wiring duct
4. Intake air temperature sensors



0017235

610-22 Engine compartment, right rear, 750iL

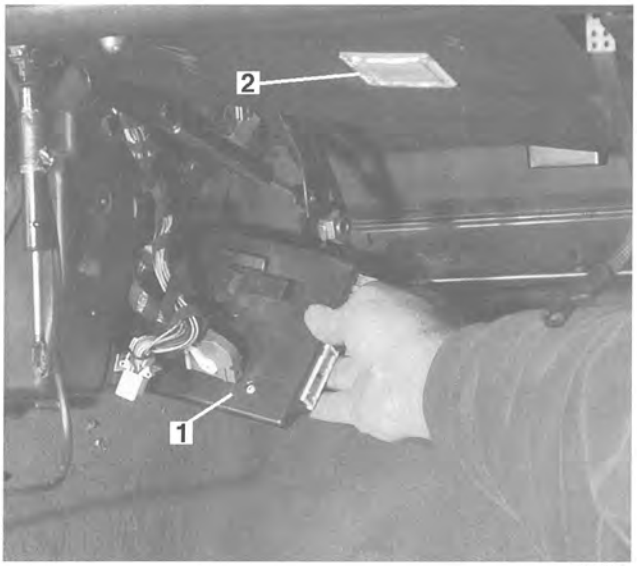
1. E-Box
2. A/C service connectors
3. Intensive washer pump
4. Intake air temperature sensor (cyl. 7 - 12)
5. SRS crash sensor (right)
6. Auxiliary relay panel II



0017229

610-23 Engine compartment, left rear, 750iL

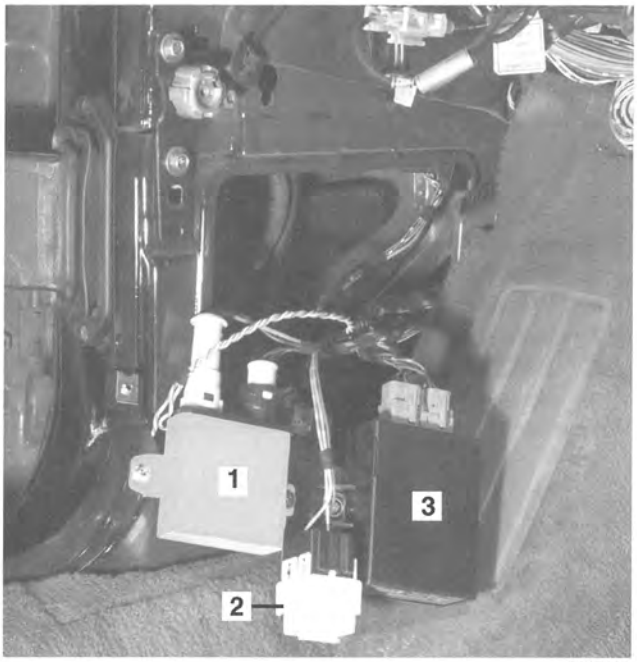
1. Heater control valve (cover removed)
2. Front power distribution box
3. Negative jumper post (–)
4. Oil level sensor connector
5. Data link (diagnostic) connector
6. Brake fluid level sensor
7. Main engine harness connector
8. EML harness connector
9. Positive jumper post (B+)



0017192

610-24 Right footwell

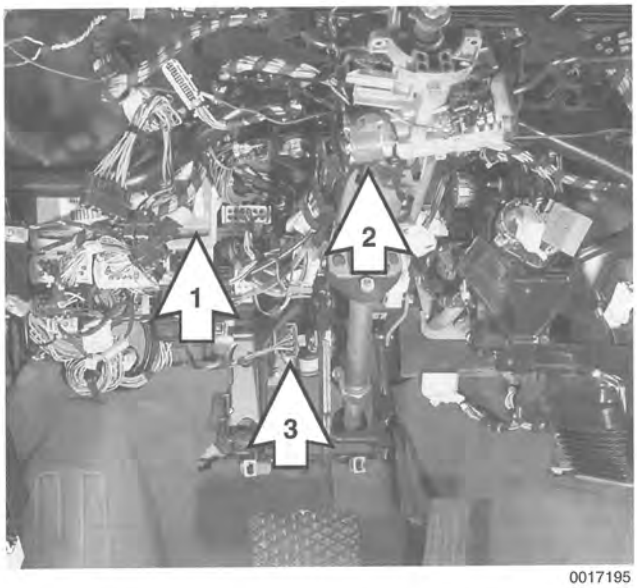
1. IHKA control module
2. Glove compartment light



0017191

610-25 Left footwell, behind speaker trim panel

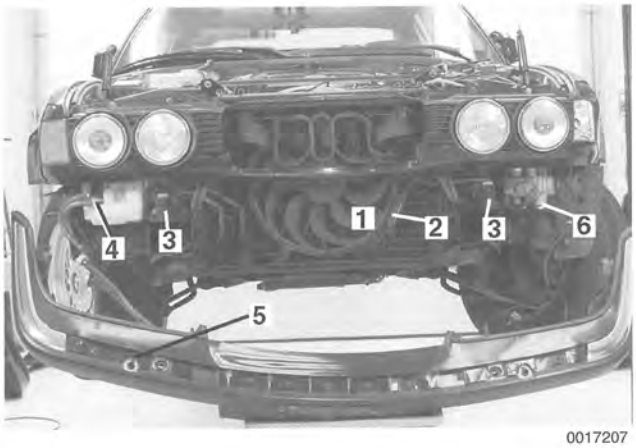
1. Servotronic control module
2. A/C clutch control relay (1988-1991)
3. Lock sensor control module



0017195

610-26 Steering column area

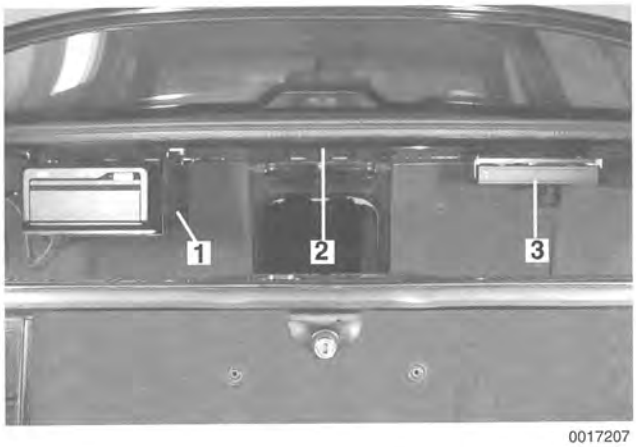
1. Air bag (SRS) control unit
2. Ignition switch
3. Brake light switch



0017207

610-27 Nose of car, bumper removed

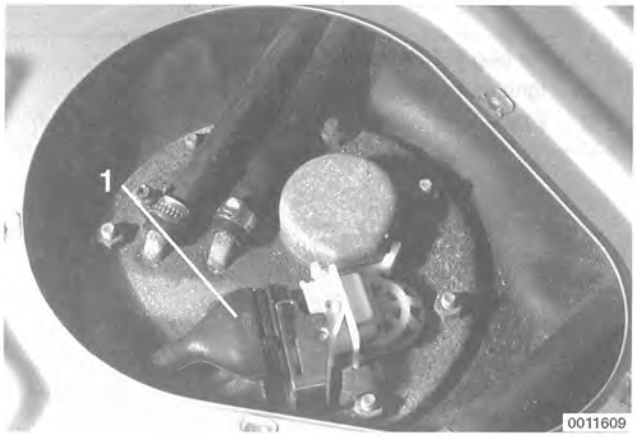
1. Auxiliary cooling fan
2. Auxiliary cooling fan resistor
3. Horns
4. Headlight/foglight washer pump
5. OBC outside air temperature sensor
6. ABS hydraulic control unit



0017207

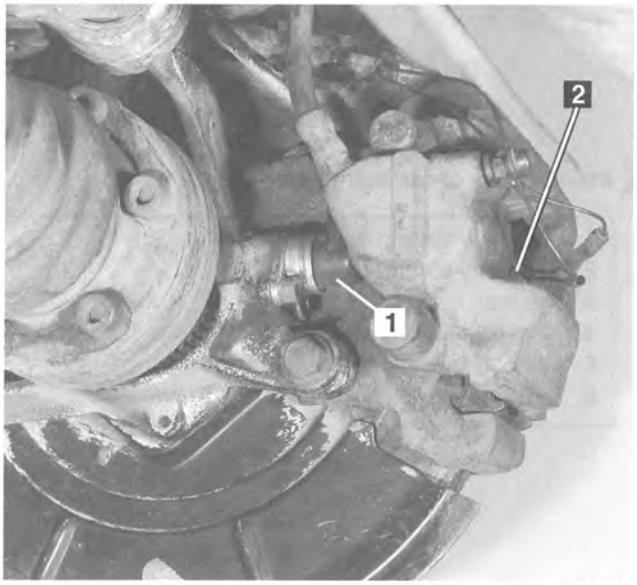
610-28 Inside luggage compartment, below rear parcel shelf

1. CD changer
2. Center brake light bulb
3. Radio amplifier



610-29 Luggage compartment floor, right side beneath access panel

1. Fuel pumps/sending unit harness connector



610-30 Rear wheel housing, right rear

1. Wheel speed sensor
2. Brake pad sensor

FUSE POSITION TABLES

Table c through **Table i** list fuse positions in the front power distribution box, the rear power distribution box and the auxiliary relay panel I. Refer to the beginning of this repair group for locations of these panels.

Table c. 1988 735i/735iL Fuse Positions (to 3/88)

Fuse	Rating	Protected Circuit
1	7.5 A	Brake pad warning (see also Fuses 17, 20) Instrument cluster check control (see also Fuses 12, 17, 20, 21) On-board computer (see also Fuses 17, 20) Windshield washer Windshield wiper
2	7.5 A	Headlights/foglights (see also Fuses 3, 5, 7, 10, 11, 13, 14) Lamp monitor (see also Fuses 3, 4, 5, 7, 15)
3	7.5 A	Headlights/foglights (see also Fuses 2, 5, 7, 10, 11, 13, 14) Lamp monitor (see also Fuses 2, 4, 5, 7, 15) Turn signal/hazard lights (see also Fuse 6)
4	7.5 A	Lamp monitor (see also Fuses 2, 4, 5, 7, 15) Park/tail/marker/underhood lights (see also Fuses 5, 15, 20)
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 21, 26) Headlights/foglights (see also Fuses 2, 3, 7, 10, 11, 13, 14) Lamp monitor (see also Fuses 2, 3, 4, 7, 15) License/luggage compartment lights (see also Fuse 21) Park/tail/marker/underhood lights (see also Fuses 4, 15, 20)
6	7.5 A	Turn signal/hazard lights (see also Fuse 3)
7	15 A	Headlights/foglights (see also Fuses 2, 3, 5, 10, 11, 13, 14) Lamp monitor (see also Fuses 2, 3, 4, 5, 15)
8	7.5 A	Not used
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21, 29, 33)
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 11, 13, 14)
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14)
12	15 A	Back up lights Instrument cluster check control (see also Fuses 1, 17, 20, 21) Memory mirrors (see also Fuses 16, 17, 18, 30, 42, 44) Windshield washer jet heaters
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 13)

Table c. 1988 735i/735iL Fuse Positions (to 3/88)

Fuse	Rating	Protected Circuit
15	7.5 A	Antilock brake system (ABS) (see also Fuses 17, 29) Brake lights Cruise control (see also Fuse 17) Lamp monitor (see also Fuses 2, 3, 4, 5, 7, 8) Park/tail/marker/underhood lights (see also Fuses 4, 5, 20)
16	30 A	Memory mirrors (see also Fuses 12, 17, 18, 30, 42, 44) Memory seat (see also Fuses 17, 18, 30, 42, 44)
17	7.5 A	Antilock brake system (ABS) (see also Fuses 15, 29) Anti-theft system (DWA) (see also Fuses 18, 20, 31) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Cruise control (see also Fuse 15) Door lock heating (ZKE) (see also Fuse 30) Electronic transmission control (AEGS) Injection electronics (DME) (see also Fuse 23) Instrument cluster check control (see also Fuses 1, 12, 20, 21) Interior lights (ZKE) (see also Fuses 21, 30, 34) On-board computer (see also Fuses 1, 20) Memory mirrors (see also Fuses 12, 16, 18, 30, 42, 44) Memory seat (see also Fuses 16, 18, 30, 42, 44) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)
18	15 A	Anti-theft system (DWA) (see also Fuses 17, 20, 31) Memory mirrors (see also Fuses 12, 16, 17, 30, 42, 44) Memory seat (see also Fuses 16, 17, 30, 42, 44) Radio (see also Fuses 21, 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 9, 20, 21, 29, 33)
20	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 31) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29, 33) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Instrument cluster check control (see also Fuses 1, 12, 17, 21) On board computer (see also Fuses 1, 17) Park/tail/marker/underhood lights (see also Fuses 4, 5, 15) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)

Table c. 1988 735i/735iL Fuse Positions (to 3/88)

Fuse	Rating	Protected Circuit
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29, 33) Glove compartment/cigar lighter/ashtray light/charging plug (see also Fuses 5, 26) Instrument cluster check control (see also Fuses 1, 12, 17, 20) Interior lights (ZKE) (see also Fuses 17, 30, 44) License/luggage compartment lights (see also Fuse 5) Radio (see also Fuses 18, 41)
22	30 A	Windshield wiper pressure control (ADV) (see also Fuse 44)
23	7.5 A	Injection electronics (DME) (see also Fuse 17)
24	7.5 A	Not used
25	30 A	Auxiliary cooling fan (see also Fuse 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 5, 21)
27	30A	Not used
28	15 A	Power assist steering (Servotronic)
29	7.5 A	Antilock brake system (ABS) (see also Fuses 15, 17) Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 21, 33) Auxiliary cooling fan (see also Fuse 25) Rear window defogger (see also Fuses 33, 46)
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 17, 21, 44) Memory mirrors (see also Fuses 12, 16, 17, 18, 42, 44) Memory seat (see also Fuses 16, 17, 18, 42, 44) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 17, 20, 31, 44)
31	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 20) Central locking system (ZKE) (see also Fuses 30) Power windows (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Not used
33	7.5 A	Automatic climate control (IHKA) (also see Fuses 9, 19, 20, 21, 29) Rear window defogger (see also Fuses 29, 46)
40	30 A	Not used
41	30 A	Radio (see also Fuses 18, 21)

Table c. 1988 735i/735iL Fuse Positions (to 3/88)

Fuse	Rating	Protected Circuit
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 44) Memory seat (see also Fuses 16, 17, 18, 30, 44)
43	30 A	Power seats
44	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 47) Interior lights (ZKE) (see also Fuses 17, 21, 30) Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 42) Memory seat (see also Fuses 16, 17, 18, 30, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield wiper pressure control (ADV) (see also Fuse 22)
45	30 A	Not used
46	30 A	Rear window defogger (see also Fuses 29, 33)
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)
51	15 A	Not used
52	7.5 A	Not used
53	10 A	Not used

CAUTION—

Fuse designations and locations are subject to change and may vary from car to car, depending on options. If questions arise, an authorized BMW dealer is the best source for the most accurate and up-to-date information.

Table d. 1988 735i/735iL/750iL Fuse Positions (from 3/88)

Fuse	Rating	Protected Circuit
1	15 A	Antilock brake system (ABS) (see also Fuses 17, 29) Brake lights Brake pad warning (see also Fuses 17, 20) Cruise control (see also Fuse 15 [early production]), 17 Cruise control (EML) Electronic throttle control (EML 1.2) (see also Fuses 17, 20) Instrument cluster check control (see also Fuses 12, 15, 17, 20, 29, 33) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13, 14) Park/tail/marker/under hood lights (see also Fuses 4, 5, 20)
2	7.5 A	Headlights/foglights (see also Fuses 3, 4, 5, 7, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 3, 4, 5, 7, 10, 11, 13, 14) Turn signal/hazard lights (see also Fuses 3, 6, 13, 14)
3	7.5 A	Headlights/foglights (see also Fuses 2, 4, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 5, 17, 22, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 4, 5, 7, 10, 11, 13, 14) Turn signal/hazard lights (see also Fuse 2, 6, 13, 14)
4	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 5, 7, 10, 11, 13, 14) Park/tail/marker/underhood lights (see also Fuses 1, 15, 20)
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 26, 33) Headlights/foglights (see also Fuses 2, 3, 4, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 17, 22, 44) Heated seats (see also Fuses 16, 27, 29, 40) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 7, 15) License/luggage compartment lights (see also Fuse 33) Lumbar support (see also Fuse 16) Park/tail/marker/underhood lights (see also Fuses 1, 4, 20)
6	7.5 A	Turn signal/hazard lights (see also Fuse 2, 3, 13, 14)
7	15 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 10, 11, 13, 14)
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21, 29) Horn

Table d. 1988 735i/735iL/750iL Fuse Positions (from 3/88)

Fuse	Rating	Protected Circuit
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 10, 11, 13, 14)
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 13, 14)
12	15 A	Back up lights Instrument cluster check control (see also Fuses 1, 15, 17, 20, 29, 33) Memory mirrors (see also Fuses 16, 17, 18, 30, 42, 44) Windshield washer jet heaters
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 14) Turn signal/hazard lights (see also Fuse 2, 3, 6, 14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 13) Turn signal/hazard lights (see also Fuses 2, 3, 6, 13)
15	7.5 A	Cruise control (see also Fuse 1, 17 [early production]) Instrument cluster check control (see also Fuses 1, 12, 17, 20, 29, 33) On board computer (see also Fuses 17, 20) Windshield washer (ZKE) (see also Fuse 44) Windshield wipers (ZKE) (see also Fuse 44)
16	30 A	Heated seats (see also Fuses 5, 27, 29, 40) Lumbar support (see also Fuse 5) Memory mirrors (see also Fuses 12, 17, 18, 30, 42, 44) Memory seat (see also Fuses 17, 18, 30, 42, 44)

Table d. 1988 735i/735iL/750iL Fuse Positions (from 3/88)

Fuse	Rating	Protected Circuit
17	7.5 A	Antilock brake system (ABS) (see also Fuses 1, 29) Anti-theft system (DWA) (see also Fuses 18, 20, 31) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Charging Cruise control (see also Fuse 1, 15 early production) Door lock heating (ZKE) (see also Fuse 30) E-box fan (see also Fuse 28) Electronic throttle control (EML 1.2) (see also Fuses 1, 20) Electronic transmission control (AEGS) Electronic transmission control (AEGS/EML) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 22, 44) Infrared locking system (IRS) (see also Fuses 18, 31) Injection electronics (DME/EML 1.2) (see also Fuse 23, 24, 28) Instrument cluster check control (see also Fuses 1, 12, 15, 20, 29, 33) Interior lights (ZKE) (see also Fuses 30, 33, 34) Memory mirrors (see also Fuses 12, 16, 18, 30, 42, 44) Memory seat (see also Fuses 16, 18, 30, 42, 44) On-board computer (see also Fuses 15, 20) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)
18	15 A	Anti-theft system (DWA) (see also Fuses 17, 20, 31) Cellular telephone (see also Fuses 31, 34 [early production]) Infrared locking system (IRS) (see also Fuses 17, 31) Memory mirrors (see also Fuses 12, 16, 17, 30, 42, 44) Memory seat (see also Fuses 16, 17, 30, 42, 44) Radio/CD player (see also Fuse 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 20, 21, 29)

Table d. 1988 735i/735iL/750iL Fuse Positions (from 3/88)

Fuse	Rating	Protected Circuit
20	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 31) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 29, 33) On board computer (see also Fuses 15, 17) Park ventilation Park/tail/marker/underhood lights (see also Fuses 1, 4, 5) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29) Rear window defogger (see also Fuses 29, 46)
22	30 A	Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 44) Windshield wiper pressure control (ADV) (see also Fuse 44)
23	7.5 A	Injection electronics (DME/EML 1.2) (see also Fuses 17, 24, 28)
24	7.5 A	Injection electronics (DME/EML 1.2) (see also Fuses 17, 23, 28)
25	30 A	Auxiliary cooling fan (see also Fuse 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 5, 33)
27	30A	Rear headrest (see also Fuses 29, 40) Heated seats (see also Fuses 5, 16, 29, 40) Power seats (see also Fuses 29, 40, 43)
28	15 A	E-box fan (see also Fuse 17) Injection electronics (DME/EML 1.2) (see also Fuses 17, 23, 24) Power assist steering (Servotronic)
29	7.5 A	Antilock brake system (ABS) (see also Fuses 1, 17) Automatic climate control (IHKA) (see also Fuses 8, 9, 19, 20, 21) Auxiliary cooling fan (see also Fuse 25) Heated seats (see also Fuses 5, 16, 27, 40) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 33) Power seats (see also Fuses 27, 40, 43) Rear headrest (see also Fuses 27, 40) Rear window defogger (see also Fuses 21, 46)

Table d. 1988 735i/735iL/750iL Fuse Positions (from 3/88)

Fuse	Rating	Protected Circuit
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 5, 17, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 18, 42, 44) Memory seat (see also Fuses 16, 17, 18, 42, 44) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 17, 20, 31, 44)
31	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 20) Cellular telephone (see also Fuses 18, 34 early production) Central locking system (ZKE) (see also Fuses 20, 30) Infrared locking system (IRS) (see also Fuses 17, 18) Power windows (ZKE) (see also Fuses 17, 20, 30, 44) Sunroof (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Not used
33	15 A	Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 29) License/luggage compartment lights (see also Fuses 4, 5) Interior lights (ZKE) (see also Fuses 5, 17, 30, 44) Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 4, 5, 26)
40	30 A	Heated seats (see also Fuses 5, 16, 27, 29) Power seats (see also Fuses 27, 29, 43)
41	30 A	Radio (see also Fuse 18)
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 44) Memory seat (see also Fuses 16, 17, 18, 30, 44) Power seats (see also Fuses 27, 29, 40, 43)
43	30 A	Power seats (see also Fuses 27, 29, 40)

Table d. 1988 735i/735iL/750iL Fuse Positions (from 3/88)

Fuse	Rating	Protected Circuit
44	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 47) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22) Interior lights (ZKE) (see also Fuses 17, 30, 33) Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 42) Memory seat (see also Fuses 16, 17, 18, 30, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield wipers (ZKE) (see also Fuse 15) Windshield wiper pressure control (ADV) (see also Fuse 22)
45	30 A	Accessory connector (not used)
46	30 A	Rear window defogger (see also Fuses 21, 29)
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)

CAUTION—

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Table e. 1989 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
1	15 A	Antilock brake system (ABS) (see also Fuse 17) Brake lights Brake pad warning (see also Fuses 17, 20) Cruise control (see also Fuse 17) Cruise control (EML) Electronic throttle control (EML 1.2) (see also Fuses 17, 20) Instrument cluster check control (see also Fuses 12, 15, 17, 20, 29, 33) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13, 14) Park/tail/marker/under hood lights (see also Fuses 4, 5, 20)
2	7.5 A	Headlights/foglights (see also Fuses 3, 5, 7, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 3, 4, 5, 7, 10, 11, 13, 14) Turn signal/hazard lights (see also Fuses 3, 6, 13, 14)
3	7.5 A	Headlights/foglights (see also Fuses 2, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 5, 17, 22, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 4, 5, 7, 10, 11, 13, 14) Turn signal/hazard lights (see also Fuses 2, 6, 13, 14)
4	7.5 A	Lamp monitor (LKM) (see also Fuses 1, 2, 3, 5, 7, 10, 11, 13, 14) Park/tail/marker/underhood lights (see also Fuses 1, 5, 20)
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 4, 26, 33) Headlights/foglights (see also Fuses 2, 3, 7, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 17, 22, 44) Heated seats (see also Fuse 16) Lamp monitor (LKM) (see also Fuses 1,2, 3, 4, 7, 10, 11, 13, 14) License/luggage compartment lights (see also Fuse 33) Lumbar support (see also Fuse 16) Park/tail/marker/underhood lights (see also Fuses 1, 4, 20)
6	7.5 A	Turn signal/hazard lights (see also Fuse 2, 3, 13, 14)
7	15 A	Headlights/foglights (see also Fuses 2, 3, 5, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 10, 11, 13, 14)
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21, 29) Auxiliary cooling fan (see also Fuses 25, 29) Cellular telephone (see also Fuses 18, 31) Horn
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 11, 13, 14)

Table e. 1989 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 13, 14)
12	15 A	Back up lights Instrument cluster check control (see also Fuses 1, 15, 17, 20, 29, 33) Memory mirrors (see also Fuses 16, 17, 18, 30, 42, 44)
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 14) Turn signal/hazard lights (see also Fuses 2, 3, 6, 14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 13) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 13) Turn signal/hazard lights (see also Fuses 2, 3, 6, 13)
15	7.5 A	Instrument cluster check control (see also Fuses 1, 12, 17, 20, 29, 33) On board computer (see also Fuses 17, 20) Windshield washer (ZKE) (see also Fuse 44) Windshield wipers (ZKE) (see also Fuse 44)
16	30 A	Heated seats (see also Fuse 5) Lumbar support (see also Fuse 5) Memory mirrors (see also Fuses 12, 17, 18, 30, 42, 44) Memory seat (see also Fuses 17, 18, 30, 42, 44)

Table e. 1989 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
17	7.5 A	Antilock brake system (ABS) (see also Fuse 1) Anti-theft system (DWA) (see also Fuses 18, 20, 31) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Charging (see also Fuse 28) Cruise control (see also Fuse 1) Door lock heating (ZKE) (see also Fuse 30) E-box fan (see also Fuse 28) Electronic throttle control (EML 1.2) (see also Fuses 1, 20) Electronic transmission control (AEGS) Electronic transmission control (AEGS/EML) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 22, 44) Infrared locking system (IRS) (see also Fuses 18, 31) Injection electronics (DME 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.2) (see also Fuse 23, 24) Instrument cluster check control (see also Fuses 1, 12, 15, 20, 29, 33) Interior lights (ZKE) (see also Fuses 18, 30, 33, 34) Memory mirrors (see also Fuses 12, 16, 18, 30, 42, 44) Memory seat (see also Fuses 16, 18, 30, 42, 44) On-board computer (see also Fuses 15, 20) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)
18	15 A	Anti-theft system (DWA) (see also Fuses 17, 20, 31) Cellular telephone (see also Fuses 9, 31) Infrared locking system (IRS) (see also Fuses 17, 31) Interior lights (see also Fuses 17, 30, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 30, 42, 44) Memory seat (see also Fuses 16, 17, 30, 42, 44) Radio/CD player (see also Fuse 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 20, 21, 29) Park ventilation (see also Fuses 20, 21)

Table e. 1989 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
20	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 31) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Electronic throttle control (EML 1.2) (see also Fuses 1, 17) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 29, 33) On board computer (see also Fuses 15, 17) Park ventilation (see also Fuses 19, 21) Park/tail/marker/underhood lights (see also Fuses 1, 4, 5) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29) Park ventilation (see also Fuses 19, 21) Rear window defogger (see also Fuses 28, 46)
22	30 A	Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 44) Windshield wiper pressure control (ADV) (see also Fuse 44)
23	7.5 A	Injection electronics (DME 1.3) (see also Fuse 17) Injection electronics (DME/EML 1.2) (see also Fuses 17, 24, 28)
24	7.5 A	Injection electronics (DME/EML 1.2) (see also Fuses 17, 23, 28)
25	30 A	Auxiliary cooling fan (see also Fuses 9, 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 5, 33)
27	30A	Power seats (see also Fuses 29, 40, 43) Rear headrest (see also Fuses 29, 40)
28	15 A	Charging (see also Fuse 17) E-box fan (see also Fuse 17) Injection electronics (DME/EML 1.2) (see also Fuses 17, 23, 24) Power assist steering (Servotronic) Rear window defogger (see also Fuses 21, 46) Windshield washer jet heaters
29	7.5 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 19, 20, 21) Auxiliary cooling fan (see also Fuses 9, 25) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 33) Power seats (see also Fuses 27, 40, 43) Rear headrest (see also Fuses 27, 40) Rear window defogger (see also Fuses 21, 46)

Table e. 1989 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 17, 18, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 18, 42, 44) Memory seat (see also Fuses 16, 17, 18, 42, 44) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 17, 20, 31, 44)
31	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 20) Cellular telephone (see also Fuses 9, 18) Central locking system (ZKE) (see also Fuses 20, 30) Infrared locking system (IRS) (see also Fuses 17, 18) Power windows (ZKE) (see also Fuses 17, 20, 30, 44) Sunroof (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Not used
33	15 A	Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 29) License/luggage compartment lights (see also Fuses 4, 5) Interior lights (ZKE) (see also Fuses 17, 18, 30, 44) Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 5, 26)
34	15 A	Not used
40	30 A	Power seats (see also Fuses 27, 29, 43) Rear headrest (see also Fuses 27, 29)
41	30 A	Radio (see also Fuse 18)
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 44) Memory seat (see also Fuses 16, 17, 18, 30, 44)
43	30 A	Power seats (see also Fuses 27, 29, 40, 42)

Table e. 1989 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
44	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 47) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22) Interior lights (ZKE) (see also Fuses 17, 18, 30, 33) Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 42) Memory seat (see also Fuses 16, 17, 18, 30, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield washer (ZKE) (see also Fuse 15) Windshield wipers (ZKE) (see also Fuse 15) Windshield wiper pressure control (ADV) (see also Fuse 22)
45	30 A	Accessory connector (not used)
46	30 A	Rear window defogger (see also Fuses 21, 29)
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)
50	30 A	Accessory connector (not used)

CAUTION—

Fuse designations and locations are subject to change and may vary from car to car, depending on options. If questions arise, an authorized BMW dealer is the best source for the most accurate and up-to-date information.

Table f. 1990 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
1	15 A	Antilock brake system (ABS) (see also Fuse 17) Automatic stability control (ASC) (see also Fuses 17, 29) Brake lights Brake pad warning (see also Fuses 17, 20) Cruise control (see also Fuse 17) Cruise control (EML) Electronic throttle control (EML 1.2) (see also Fuses 17, 20) Instrument cluster check control (see also Fuses 12, 15, 17, 20, 29, 33) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13, 14) Park/tail/marker/under hood lights (see also Fuses 4, 5, 20)
2	7.5 A	Headlights/foglights (see also Fuses 3, 5, 7, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 3, 4, 5, 7, 10, 11, 13, 14) Turn signal/hazard lights (see also Fuses 3, 6, 13, 14)
3	7.5 A	Headlights/foglights (see also Fuses 2, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 5, 17, 22, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 4, 5, 7, 10, 11, 13, 14) Turn signal/hazard lights (see also Fuse 2, 6, 13, 14)
4	7.5 A	Lamp monitor (LKM) (see also Fuses 1, 2, 3, 5, 7, 10, 11, 13, 14) Park/tail/marker/underhood lights (see also Fuses 1, 5, 20)
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 4, 26, 33) Headlights/foglights (see also Fuses 2, 3, 7, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 17, 22, 44) Heated seats (see also Fuse 16) Lamp monitor (LKM) (see also Fuses 1,2, 3, 4, 7, 10, 11, 13, 14) License/luggage compartment lights (see also Fuse 33) Lumbar support (see also Fuse 16) Park/tail/marker/underhood lights (see also Fuses 1, 4, 20)
6	15 A	Turn signal/hazard lights (see also Fuse 2, 3, 13, 14)
7	15 A	Headlights/foglights (see also Fuses 2, 3, 5, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 10, 11, 13, 14)
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21, 29) Auxiliary cooling fan (see also Fuses 25, 29) Cellular telephone (see also Fuses 18, 31) Horn

Table f. 1990 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 11, 13, 14)
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 13, 14)
12	15 A	Back up lights (see also Fuse 20) Instrument cluster check control (see also Fuses 1, 15, 17, 20, 29, 33) Memory mirrors (see also Fuses 16, 17, 18, 30, 42, 44)
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 14) Turn signal/hazard lights (see also Fuses 2, 3, 6, 14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 11, 13) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 13) Turn signal/hazard lights (see also Fuses 2, 3, 6, 13)
15	7.5 A	Instrument cluster check control (see also Fuses 1, 12, 17, 20, 29, 33) On board computer (see also Fuses 17, 20) Windshield washer (ZKE) (see also Fuse 44) Windshield wipers (ZKE) (see also Fuse 44)
16	30 A	Heated seats (see also Fuse 5) Lumbar support (see also Fuse 5) Memory mirrors (see also Fuses 12, 17, 18, 30, 42, 44) Memory seat (see also Fuses 17, 18, 30, 42, 44)

Table f. 1990 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
17	7.5 A	Antilock brake system (ABS) (see also Fuse 1) Anti-theft system (DWA) (see also Fuses 20, 51) Automatic stability control (ASC) (see also Fuses 1, 29) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Charging (see also Fuse 28) Cruise control (see also Fuse 1) Door lock heating (ZKE) (see also Fuse 30) E-box fan (see also Fuse 28) Electronic throttle control (EML 1.2) (see also Fuses 1, 20) Electronic transmission control (AEGS) Electronic transmission control (AEGS/EML) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 22, 44) Infrared locking system (IRS) (see also Fuses 31, 51) Injection electronics (DME 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.2) (see also Fuse 23, 24, 28) Instrument cluster check control (see also Fuses 1, 12, 15, 20, 29, 33) Interior lights (ZKE) (see also Fuses 18, 30, 33, 34) Memory mirrors (see also Fuses 12, 16, 18, 30, 42, 44) Memory seat (see also Fuses 16, 18, 30, 42, 44) On-board computer (see also Fuses 15, 20) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)
18	15 A	Anti-theft system (DWA) (see also Fuses 17, 20, 31) Cellular telephone (see also Fuses 9, 31) Interior lights (see also Fuses 17, 30, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 30, 42, 44) Memory seat (see also Fuses 16, 17, 30, 42, 44) Radio/CD player (see also Fuse 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 20, 21, 29) Park ventilation (see also Fuses 20, 21)

Table f. 1990 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
20	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 51) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29) Back up lights (see also Fuse 12) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Electronic throttle control (EML 1.2) (see also Fuses 1, 17) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 29, 33) On board computer (see also Fuses 15, 17) Park ventilation (see also Fuses 19, 21) Park/tail/marker/underhood lights (see also Fuses 1, 4, 5) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29) Park ventilation (see also Fuses 19, 20) Rear window defogger (see also Fuses 28, 46)
22	30 A	Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 44)
23	15 A	Injection electronics (DME 1.3) (see also Fuse 17) Injection electronics (DME/EML 1.2) (see also Fuses 17, 24, 28)
24	15 A	Injection electronics (DME/EML 1.2) (see also Fuses 17, 23, 28)
25	30 A	Auxiliary cooling fan (see also Fuses 9, 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 5, 33)
27	30A	Power seats (see also Fuses 29, 40, 43) Rear headrest (see also Fuses 29, 40)
28	15 A	Charging (see also Fuse 17) E-box fan (see also Fuse 17) Injection electronics (DME/EML 1.2) (see also Fuses 17, 23, 24) Power assist steering (Servotronic) Rear window defogger (see also Fuses 21, 46) Windshield washer jet heaters
29	7.5 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 19, 20, 21) Automatic stability control (ASC) (see also Fuses 1, 17) Auxiliary cooling fan (see also Fuses 9, 25) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 33) Power seats (see also Fuses 27, 40, 43) Rear headrest (see also Fuses 27, 40) Rear window defogger (see also Fuses 21, 46)

Table f. 1990 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 5, 17, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 18, 42, 44) Memory seat (see also Fuses 16, 17, 18, 42, 44) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 17, 20, 31, 44)
31	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 20) Cellular telephone (see also Fuses 9, 18) Central locking system (ZKE) (see also Fuses 20, 30) Infrared locking system (IRS) (see also Fuses 17, 51) Power windows (ZKE) (see also Fuses 17, 20, 30, 44) Sunroof (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Not used
33	15 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 4, 5, 26) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 29) Interior lights (ZKE) (see also Fuses 5, 17, 30, 44) License/luggage compartment lights (see also Fuse 5)
34	15 A	Not used
40	30 A	Power seats (see also Fuses 27, 29, 43) Rear headrest (see also Fuses 27, 29)
41	30 A	Radio (see also Fuse 18)
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 44) Memory seat (see also Fuses 16, 17, 18, 30, 44)
43	30 A	Power seats (see also Fuses 27, 29, 40, 42)

Table f. 1990 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
44	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 47) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22) Interior lights (ZKE) (see also Fuses 17, 18, 30, 33) Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 42) Memory seat (see also Fuses 16, 17, 18, 30, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield washer (ZKE) (see also Fuse 15) Windshield wipers (ZKE) (see also Fuse 15)
45	30 A	Accessory connector (not used)
46	30 A	Rear window defogger/antenna (see also Fuses 21, 29)
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)
50	30 A	Accessory connector (not used)
51	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 20) Infrared locking (IRS) (see also Fuses 17, 31)

CAUTION—

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Table g. 1991 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
1	15 A	Antilock brake system (ABS) (see also Fuse 17) Automatic stability control (ASC) (see also Fuses 17, 29) Automatic stability plus traction (ASC+T) (see also Fuses 17) Brake lights Brake pad warning (see also Fuses 17, 20) Cruise control (see also Fuse 17) Cruise control (EML) Electronic throttle control (EML 1.2) (see also Fuses 17, 20) Electronic transmission control (EGS/EML) (see also Fuse 17) Instrument cluster check control (see also Fuses 12, 17, 20, 29, 33) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13, 14) Park/tail/marker/under hood lights (see also Fuses 4, 5, 20)
2	7.5 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 4, 5, 15, 26) Headlights/foglights (see also Fuses 3, 4, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 4, 5, 17, 22) Interior lights (ZKE) (see also Fuses 4, 5, 17, 18) Lamp monitor (LKM) (see also Fuses 1, 3, 4, 5, 7, 10, 11, 13, 14) Light switch details (see also Fuses 3, 4, 5, 21) Turn signal/hazard lights (see also Fuses 3, 6, 13, 14)
3	7.5 A	Headlights/foglights (see also Fuses 2, 4, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 4, 5, 17, 22, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 4, 5, 7, 10, 11, 13, 14) Light switch details (see also Fuses 2, 4, 5, 21) Turn signal/hazard lights (see also Fuse 2, 6, 13, 14)
4	7.5 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 2, 5, 15, 26) Headlights/foglights (see also Fuses 2, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22, 44) Interior lights (ZKE) (see also Fuses 2, 5, 17, 18, 30, 33, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 5, 7, 10, 11, 13, 14) License/luggage compartment lights (see also Fuse 5) Light switch details (see also Fuses 2, 3, 5, 21) Park/tail/marker/underhood lights (see also Fuses 1, 5, 20)

Table g. 1991 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 2, 4, 15, 26) Headlights/foglights (see also Fuses 2, 3, 4, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 17, 22, 44) Interior lights (ZKE) (see also Fuses 2, 4, 17, 18, 30, 33, 44) Lamp monitor (LKM) (see also Fuses 1,2, 3, 4, 7, 10, 11, 13, 14) License/luggage compartment lights (see also Fuse 4) Light switch details (see also Fuses 2, 3, 4, 21) Park/tail/marker/underhood lights (see also Fuses 1, 4, 20)
6	15 A	Turn signal/hazard lights (see also Fuse 2, 3, 13, 14)
7	15 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 10, 11, 13, 14)
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21) Auxiliary cooling fan (see also Fuses 25, 29) Cellular telephone (see also Fuses 18, 49) Horn
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 11, 13, 14)
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 13, 14)
12	15 A	Back up lights (see also Fuse 20) Instrument cluster check control (see also Fuses 1, 17, 20, 29, 33) Electronic damper control (EDC) (see also Fuse 45) Electronic mirror (see also Fuse 17) Memory mirrors (see also Fuses 16, 17, 18, 30, 42, 44)
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 14) Turn signal/hazard lights (see also Fuses 2, 3, 6, 14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 13) Turn signal/hazard lights (see also Fuses 2, 3, 6, 13)

Table g. 1991 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
15	7.5 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 2, 4, 5, 26) On board computer (see also Fuses 17, 20) Windshield washer (ZKE) (see also Fuse 44) Windshield wipers (ZKE) (see also Fuse 44)
16	30 A	Heated seats (see also Fuse 27, 29, 40) Lumbar support Memory mirrors (see also Fuses 12, 17, 18, 30, 42, 44) Memory seat (see also Fuses 17, 18, 30, 42, 44)
17	7.5 A	Antilock brake system (ABS) (see also Fuse 1) Automatic stability control (ASC) (see also Fuses 1, 29) Automatic stability plus traction (ASC+T) (see also Fuse 1) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Charging (see also Fuse 28) Cruise control (see also Fuse 1) Door lock heating (ZKE) (see also Fuse 30) E-box fan (see also Fuse 28) Electronic throttle control (see also Fuses 1, 20) Electronic transmission control (EGS) Electronic transmission control (EGS/EML) (see also Fuse 1) Headlight/foglight washer (ZKE) (see also Fuses 2, 3, 4, 5, 22, 44) Infrared locking system (IRS) (see also Fuses 31, 51) Injection electronics (DME 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.7) (see also Fuse 23, 24, 28) Instrument cluster check control (see also Fuses 1, 12, 20, 29, 33) Interior lights (ZKE) (see also Fuses 2, 4, 5, 18, 30, 33, 44) Memory mirrors (see also Fuses 12, 16, 18, 30, 42, 44) Memory seat (see also Fuses 16, 18, 30, 42, 44) On-board computer (see also Fuses 15, 20) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)

Table g. 1991 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
18	15 A	Anti-theft system (DWA) (see also Fuses 17, 20, 31) Cellular telephone (see also Fuses 9, 49) Interior lights (see also Fuses 2, 4, 5, 17, 30, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 30, 42, 44) Memory seat (see also Fuses 16, 17, 30, 42, 44) Memory steering column (see also Fuses 16, 42) Radio/CD player (see also Fuse 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 20, 21, 29) Park ventilation (see also Fuses 20, 21)
20	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 51) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29) Back up lights (see also Fuse 12) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Electronic throttle control (EML 1.2) (see also Fuses 1, 17) Instrument cluster check control (see also Fuses 1, 12, 17, 29, 33) On board computer (see also Fuses 15, 17) Park ventilation (see also Fuses 19, 21) Park/tail/marker/underhood lights (see also Fuses 1, 4, 5) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29) Light switch details (see also Fuses 2, 3, 4, 5) Park ventilation (see also Fuses 19, 20) Rear window defogger (see also Fuse 46)
22	30 A	Headlight/foglight washer (ZKE) (see also Fuses 2, 3, 4, 5, 17, 44)
23	15 A	Injection electronics (DME 1.3) (see also Fuse 17) Injection electronics (DME/EML 1.3) (see also Fuses 17, 24, 28) Injection electronics (DME/EML 1.7) (see also Fuse 17, 24, 28)
24	15 A	Injection electronics (DME/EML 1.7) (see also Fuses 17, 23, 28)
25	30 A	Auxiliary cooling fan (see also Fuses 9, 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 2, 4, 5, 33)
27	30A	Power seats (see also Fuses 29, 40, 43) Heated seats (see also Fuses 16, 29)

Table g. 1991 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
28	15 A	Charging (see also Fuse 17) E-box fan (see also Fuse 17) Injection electronics (DME/EML 1.7) (see also Fuses 17, 23, 24) Power assist steering (Servotronic) Windshield washer jet heaters (see also Fuse 29)
29	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20) Automatic stability control (ASC) (see also Fuses 1, 17) Auxiliary cooling fan (see also Fuses 9, 25) Heated seats (see also Fuses 16, 27) Instrument cluster check control (see also Fuses 1, 12, 17, 20, 33) Power seats (see also Fuses 27, 40, 43) Rear headrest (see also Fuse 40) Rear window defogger (see also Fuses 21, 46)
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 5, 17, 33, 44) Memory mirrors (see also Fuses 12, 16, 17, 18, 42, 44) Memory seat (see also Fuses 16, 17, 18, 42, 44) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 17, 20, 31, 44)
31	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 18, 20) Central locking system (ZKE) (see also Fuses 20, 30) Infrared locking system (IRS) (see also Fuses 17, 51) Power windows (ZKE) (see also Fuses 17, 20, 30, 44) Sunroof (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Not used
33	15 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 2, 4, 5, 15, 26) Instrument cluster check control (see also Fuses 1, 12, 17, 20, 29) Interior lights (ZKE) (see also Fuses 5, 17, 30, 44) License/luggage compartment lights (see also Fuse 5)
40	30 A	Heated seats (see also Fuses 16, 27, 29) Power seats (see also Fuses 27, 29, 43) Rear headrest (see also Fuse 29)
41	30 A	Radio/CD player (see also Fuse 18)

Table g. 1991 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 44) Memory seat (see also Fuses 16, 17, 18, 30, 44) Memory steering column (see also Fuses 16, 18)
43	30 A	Power seats (see also Fuses 27, 29, 40, 42)
44	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 47) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22) Interior lights (ZKE) (see also Fuses 17, 18, 30, 33) Memory mirrors (see also Fuses 12, 16, 17, 18, 30, 42) Memory seat (see also Fuses 16, 17, 18, 30, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield washer (ZKE) (see also Fuse 15) Windshield wipers (ZKE) (see also Fuse 15)
45	30 A	Electronic damping control (EDC III) (see also Fuse 12)
46	30 A	Rear window defogger/antenna (see also Fuses 21, 29)
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)
48	15 A	Power steering column adjust
49	10 A	Cellular telephone (see also Fuses 9, 18)
50	30 A	Accessory connector (not used)
51	7.5 A	Anti-theft system (DWA) (see also Fuses 17, 20) Infrared locking (IRS) (see also Fuses 17, 31)

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Table h. 1992 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
1	15 A	Antilock brake system (ABS) (see also Fuse 17) Automatic stability control (ASC) (see also Fuses 17, 29) Automatic stability plus traction (ASC+T) (see also Fuses 17) Brake lights (see also Fuse 44) Brake pad warning (see also Fuses 17, 20) Cruise control (see also Fuse 17) Cruise control (EML) Electronic throttle control (EML 1.2) (see also Fuses 17, 20) Electronic transmission control (EGS/EML) (see also Fuse 17) Instrument cluster check control (see also Fuses 12, 15, 17, 20, 29, 33) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 5, 7, 13, 14) Park/tail/marker/under hood lights (see also Fuses 4, 5, 20)
2	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14) Interior lights (ZKE) (see also Fuses 4, 5, 17, 18, 30, 33) Lamp monitor (LKM) (see also Fuses 1, 3, 4, 5, 7, 13, 14) Light switch details (see also Fuses 3, 4) Turn signal/hazard lights (see also Fuses 3, 6)
3	7.5 A	Headlights/foglights (see also Fuses 2, 5, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 5, 17, 22, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 4, 5, 7, 13, 14) Light switch details (see also Fuses 2, 4) Turn signal/hazard lights (see also Fuse 2, 6)
4	7.5 A	Interior lights (ZKE) (see also Fuses 2, 5, 17, 18, 30, 33) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 5, 7, 13, 14) License/luggage compartment lights (see also Fuse 5) Light switch details (see also Fuses 2, 3) Park/tail/marker/underhood lights (see also Fuses 1, 5, 20)
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 15, 18, 26) Headlights/foglights (see also Fuses 2, 3, 7, 10, 11, 13, 14) Headlight/foglight washer (ZKE) (see also Fuses 3, 17, 22, 44) Interior lights (ZKE) (see also Fuses 2, 4, 17, 18, 30, 33) Lamp monitor (LKM) (see also Fuses 1,2, 3, 4, 7, 13, 14) License/luggage compartment lights (see also Fuse 4) Park/tail/marker/underhood lights (see also Fuses 1, 4, 20)
6	15 A	Turn signal/hazard lights (see also Fuse 2, 3)

Table h. 1992 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
7	15 A	Headlights/foglights (see also Fuses 2, 3, 5, 10, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 13, 14)
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21) Auxiliary cooling fan (see also Fuses 25, 29) Cellular telephone (see also Fuses 18, 49) Horn
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 11, 13, 14)
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14)
12	15 A	Back up lights (see also Fuse 20) Instrument cluster check control (see also Fuses 1, 15, 17, 20, 29, 33) Electronic damper control (EDC) (see also Fuse 45) Electronic mirror (see also Fuse 17) Memory mirrors (see also Fuses 16, 17, 18, 42, 44)
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7,14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 13)
15	7.5 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 5,18, 26) Instrument cluster check control (see also Fuses 1, 12, 17, 20, 29, 33) On board computer (see also Fuses 17, 20) Windshield washer (ZKE) (see also Fuse 44) Windshield wipers (ZKE) (see also Fuse 44)
16	30 A	Heated seats (see also Fuse 27, 29, 40) Lumbar support Memory mirrors (see also Fuses 12, 17, 18, 42, 44) Memory seat (see also Fuses 17, 18, 30, 42, 44)

Table h. 1992 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
17	7.5 A	Antilock brake system (ABS) (see also Fuse 1) Automatic stability control (ASC) (see also Fuses 1, 29) Automatic stability plus traction (ASC+T) (see also Fuse 1) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Charging (see also Fuse 28) Cruise control (see also Fuse 1) Door lock heating (ZKE) (see also Fuse 30) E-box fan (see also Fuse 28) Electronic mirror (see also Fuse 12) Electronic throttle control (see also Fuses 1, 20) Electronic transmission control (EGS) Electronic transmission control (EGS/EML) (see also Fuse 1) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 22, 44) Injection electronics (DME 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.7) (see also Fuse 23, 24, 28) Instrument cluster check control (see also Fuses 1, 12, 15, 20, 29, 33) Interior lights (ZKE) (see also Fuses 2, 4, 5, 18, 30, 33) Memory mirrors (see also Fuses 12, 16, 18, 42, 44) Memory seat (see also Fuses 16, 18, 30, 42, 44) On-board computer (see also Fuses 15, 20) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)
18	15 A	Anti-theft system (Alpine) (see also Fuses 20, 33, 41) Cellular telephone (see also Fuses 9, 49) Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 5, 15, 26) Interior lights (see also Fuses 2, 4, 5, 17, 30, 33) Memory mirrors (see also Fuses 12, 16, 17, 42, 44) Memory seat (see also Fuses 16, 17, 30, 42, 44) Memory steering column (see also Fuses 16, 42) Radio/CD player (see also Fuse 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 20, 21, 29) Park ventilation (see also Fuses 20, 21)

Table h. 1992 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
20	7.5 A	Anti-theft system (Alpine) (see also Fuses 18, 33, 41) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29) Back up lights (see also Fuse 12) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Electronic throttle control (EML 1.2) (see also Fuses 1, 17) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 29, 33) On board computer (see also Fuses 15, 17) Park ventilation (see also Fuses 19, 21) Park/tail/marker/underhood lights (see also Fuses 1, 4, 5) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29) Park ventilation (see also Fuses 19, 20) Rear window defogger (see also Fuse 46)
22	30 A	Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 44)
23	15 A	Injection electronics (DME 1.3) (see also Fuse 17) Injection electronics (DME/EML 1.3) (see also Fuses 17, 24, 28) Injection electronics (DME/EML 1.7) (see also Fuse 17, 24, 28)
24	15 A	Injection electronics (DME/EML 1.7) (see also Fuses 17, 23, 28)
25	30 A	Auxiliary cooling fan (see also Fuses 9, 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 5, 15, 18)
27	30A	Power seats (see also Fuses 29, 40, 43) Heated seats (see also Fuses 16, 29) Rear headrest (see also Fuse 29)
28	15 A	Charging (see also Fuse 17) E-box fan (see also Fuse 17) Injection electronics (DME/EML 1.7) (see also Fuses 17, 23, 24) Power assist steering (Servotronic)
29	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 21) Automatic stability control (ASC) (see also Fuses 1, 17) Auxiliary cooling fan (see also Fuses 9, 25) Heated seats (see also Fuses 16, 27) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 33) Power seats (see also Fuses 27, 40, 43) Rear headrest (see also Fuse 27) Rear window defogger (see also Fuses 21, 46) Windshield washer jet heaters

Table h. 1992 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 5, 17, 33) Memory seat (see also Fuses 16, 17, 18, 42, 44) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 17, 20, 31, 44)
31	7.5 A	Central locking system (ZKE) (see also Fuses 20, 30) Power windows (ZKE) (see also Fuses 17, 20, 30, 44) Sunroof (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Not used
33	15 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 2, 4, 5, 15, 26) Instrument cluster check control (see also Fuses 1, 12, 15, 17, 20, 29) Interior lights (ZKE) (see also Fuses 5, 17, 30) License/luggage compartment lights (see also Fuse 5)
40	30 A	Heated seats (see also Fuses 16, 27, 29) Power seats (see also Fuses 27, 29, 43) Rear headrest (see also Fuse 29)
41	30 A	Radio/CD player (see also Fuse 18)
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 44) Memory seat (see also Fuses 16, 17, 18, 30, 44) Memory steering column (see also Fuses 16, 18)
43	30 A	Power seats (see also Fuses 27, 29, 40, 42)
44	30 A	Brake lights (see also Fuse 1) Central body electronics (ZKE) (see also Fuses 17, 30, 47) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22) Memory mirrors (see also Fuses 12, 16, 17, 18, 42) Memory seat (see also Fuses 16, 17, 18, 30, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield washer (ZKE) (see also Fuse 15) Windshield wipers (ZKE) (see also Fuse 15)
45	30 A	Electronic damping control (EDC III) (see also Fuse 12)
46	30 A	Rear window defogger/antenna (see also Fuses 21, 29)

Table h. 1992 735i/735iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)
48	15 A	Power steering column adjust
49	10 A	Cellular telephone (see also Fuses 9, 18)

CAUTION—

Fuse designations and locations are subject to change and may vary from car to car, depending on options. If questions arise, an authorized BMW dealer is the best source for the most accurate and up-to-date information.

Table i. 1993-94 740i/740iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
1	15 A	Antilock brake system (ABS) (see also Fuse 17) Brake lights Brake pad warning (see also Fuses 17, 20) Cruise control (see also Fuse 17) Cruise control (EML) Electronic throttle control (EML 1.2) (see also Fuses 17, 20) Electronic transmission control (EGS/EML) (see also Fuse 17) Instrument cluster check control (see also Fuses 12, 17, 20, 29, 33) Lamp monitor (LKM) (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13, 14) Park/tail/marker/under hood lights (see also Fuses 4, 5, 20) Slip control (ABS/ASC+T) (see also Fuses 17, 60, 62)
2	7.5 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 4, 15, 18, 26) Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 13, 14, 61, 63) Headlight/foglight washer (ZKE) (see also Fuses 3, 4, 5, 17, 22, 44) Interior lights (ZKE) (see also Fuses 4, 5, 17, 18, 30, 33) Lamp monitor (LKM) (see also Fuses 1, 3, 4, 5, 7, 10, 11, 13, 14) Light switch details (see also Fuses 3, 4) Turn signal/hazard lights (see also Fuses 3, 6, 13, 14)
3	7.5 A	Headlights/foglights (see also Fuses 2, 4, 5, 7, 10, 11, 13, 14, 61, 63) Headlight/foglight washer (ZKE) (see also Fuses 2, 4, 5, 17, 22, 44) Lamp monitor (LKM) (see also Fuses 1, 2, 4, 5, 7, 10, 11, 13, 14) Light switch details (see also Fuses 2, 4, 5) Turn signal/hazard lights (see also Fuse 2, 6, 13, 14)
4	7.5 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 4, 15, 18, 26) Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14, 61, 63) Headlight/foglight washer (ZKE) (see also Fuses 2, 3, 5, 17, 22, 44) Interior lights (ZKE) (see also Fuses 2, 5, 17, 18, 30, 33) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 5, 7, 10, 11, 13, 14) License/luggage compartment lights (see also Fuse 5) Light switch details (see also Fuses 2, 3, 5) Park/tail/marker/underhood lights (see also Fuses 1, 5, 20)

Table i. 1993-94 740i/740iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
5	10 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 2, 4, 15, 18, 26) Headlights/foglights (see also Fuses 2, 3, 4, 7, 10, 11, 13, 14, 61, 63) Headlight/foglight washer (ZKE) (see also Fuses 3, 17, 22, 44) Interior lights (ZKE) (see also Fuses 2, 4, 17, 18, 30, 33) Lamp monitor (LKM) (see also Fuses 1,2, 3, 4, 7, 10, 11, 13, 14) License/luggage compartment lights (see also Fuse 4) Light switch details (see also Fuses 2, 3, 4) Park/tail/marker/underhood lights (see also Fuses 1, 4, 20)
6	15 A	Turn signal/hazard lights (see also Fuse 2, 3)
7	15 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 10, 11, 13, 14, 61, 63) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 10, 11, 13, 14)
9	15 A	Automatic climate control (IHKA) (see also Fuses 19, 20, 21, 25, 29) Cellular telephone (see also Fuses 18, 49) Horn Memory seat (see also Fuses 16, 17, 18, 42, 44)
10	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 11, 13, 14) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 11, 13, 14, 61, 63)
11	7.5 A	Headlights/foglights (see also Fuses 2, 3, 5, 7, 10, 13, 14, 61, 63) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 13, 14)
12	15 A	Back up lights (see also Fuse 20) Electronic mirror (see also Fuse 51) Instrument cluster check control (see also Fuses 1, 17, 20, 29, 33) Lumbar support (see also Fuse 16) Memory mirrors (see also Fuses 16, 17, 18, 42, 44) Electronic damping control (EDC III) (see also Fuse 45)
13	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 14, 61, 63) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 14) Turn signal/hazard lights (see also Fuses 2, 3, 6, 14)
14	7.5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7, 10, 11, 13, 61, 63) Lamp monitor (LKM) (see also Fuses 1, 2, 3, 4, 5, 7, 10, 11, 13) Turn signal/hazard lights (see also Fuses 3, 6, 13)

Table i. 1993-94 740i/740iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
15	7.5 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 2, 4, 5,18, 26) On board computer (see also Fuses 17, 20) Windshield washer (ZKE) (see also Fuse 44) Windshield wipers (ZKE) (see also Fuse 44)
16	30 A	Heated seats (see also Fuse 27, 29, 40) Lumbar support (see also Fuse 12) Memory mirrors (see also Fuses 12, 17, 18, 42, 44) Memory seat (see also Fuses 9, 17, 18, 42, 44) Power steering column adjust (see also Fuse 18)
17	7.5 A	Antilock brake system (ABS) (see also Fuse 1) Brake pad warning (see also Fuses 1, 20) Central body electronics (ZKE) (see also Fuses 30, 44, 47) Charging (see also Fuse 28) Cruise control (see also Fuse 1) Door lock heating (ZKE) (see also Fuse 30) E-box fan (see also Fuse 23) Electronic throttle control (EML 1.3) (see also Fuses 1, 20) Electronic throttle control (EML 1.7) (see also Fuses 1, 20) Electronic transmission control (EGS) Electronic transmission control (EGS/EML) (see also Fuse 1) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 22, 44) Injection electronics (DME 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.3) (see also Fuse 23) Injection electronics (DME/EML 1.7) (see also Fuse 23, 24, 28) Instrument cluster check control (see also Fuses 1, 12, 20, 29, 33) Interior lights (ZKE) (see also Fuses 2, 4, 5, 18, 30, 33) Memory mirrors (see also Fuses 12, 16, 18, 42, 44) Memory seat (see also Fuses 16, 18, 42, 44) On-board computer (see also Fuses 15, 20) Power windows (ZKE) (see also Fuses 20, 30, 31, 44) Slip control (ABS/ASC+T) (see also Fuses 1, 60, 62) Start Sunroof (ZKE) (see also Fuses 20, 30, 31, 44)

Table i. 1993-94 740i/740iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
18	15 A	Anti-theft system (Alpine) (see also Fuses 20, 41) Cellular telephone (see also Fuses 9, 49) Electric sun blind (see also Fuse 32) Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 2, 4, 5, 15, 26) Interior lights (see also Fuses 2, 4, 5, 17, 30, 33) Memory mirrors (see also Fuses 12, 16, 17, 42, 44) Memory seat (see also Fuses 9, 16, 17, 42, 44) Power steering column adjust (see also Fuse 16) Radio/CD player (see also Fuse 41)
19	30 A	Automatic climate control (IHKA) (see also Fuses 8, 9, 20, 21, 29) Park ventilation (see also Fuses 20, 21)
20	7.5 A	Anti-theft system (Alpine) (see also Fuses 18, 41) Automatic climate control (IHKA) (see also Fuses 9, 19, 21, 29) Back up lights (see also Fuse 12) Brake pad warning (see also Fuses 1, 17) Central locking system (ZKE) (see also Fuses 30, 31) Electronic throttle control (EML 1.2) (see also Fuses 1, 17) Instrument cluster check control (see also Fuses 1, 12, 17, 29, 33) On board computer (see also Fuses 15, 17) Park ventilation (see also Fuses 19, 21) Park/tail/marker/underhood lights (see also Fuses 1, 4, 5) Power windows (ZKE) (see also Fuses 17, 30, 31, 44) Sunroof (ZKE) (see also Fuses 17, 30, 31, 44)
21	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 29) Park ventilation (see also Fuses 19, 20) Rear window defogger (see also Fuse 46)
22	30 A	Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 44)
23	15 A	E-box fan (see also Fuse 17) Injection electronics (DME 1.3) (see also Fuse 17) Injection electronics (DME/EML 1.3) (see also Fuses 17, 24, 28) Injection electronics (DME/EML 1.7) (see also Fuse 17, 24, 28)
24	15 A	Injection electronics (DME/EML 1.7) (see also Fuses 17, 23, 28)
25	30 A	Auxiliary cooling fan (see also Fuse 29) Automatic climate control (IHKA) (see also Fuses 19, 20, 21, 29)
26	30 A	Glove compartment light/cigar lighter/ashtray light/charging plug (see also Fuses 2, 4, 5, 15, 18)

Table i. 1993-94 740i/740iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
27	30A	Power seats (see also Fuses 29, 40, 43) Heated seats (see also Fuses 16, 29) Rear headrest (see also Fuse 29)
28	15 A	Charging (see also Fuse 17) Injection electronics (DME/EML 1.7) (see also Fuses 17, 23, 24) Power assist steering (Servotronic)
29	7.5 A	Automatic climate control (IHKA) (see also Fuses 9, 19, 20, 25) Auxiliary cooling fan (see also Fuse 25) Heated seats (see also Fuses 16, 27) Instrument cluster check control (see also Fuses 1, 12, 17, 20, 33) Power seats (see also Fuses 27, 40, 43) Rear headrest (see also Fuse 27) Rear window defogger (see also Fuses 21, 46) Windshield washer jet heaters
30	7.5 A	Central body electronics (ZKE) (see also Fuses 17, 44, 47) Central locking system (ZKE) (see also Fuses 20, 31) Door lock heating (ZKE) (see also Fuse 17) Interior lights (ZKE) (see also Fuses 5, 17, 33) Power windows (ZKE) (see also Fuses 17, 20, 31, 44) Sunroof (ZKE) (see also Fuses 1 7, 20, 31, 44)
31	7.5 A	Central locking system (ZKE) (see also Fuses 20, 30) Power windows (ZKE) (see also Fuses 17, 20, 30, 44) Sunroof (ZKE) (see also Fuses 17, 20, 30, 44)
32	15 A	Electronic sun blind (see also Fuse 18)
33	15 A	Glove compartment/cigar lighter/ashtray light/flashlight charging plug (see also Fuses 2, 4, 5, 15, 26) Instrument cluster check control (see also Fuses 1, 12, 17, 20, 29) Interior lights (ZKE) (see also Fuses 5, 17, 30) License/luggage compartment lights (see also Fuse 5)
40	30 A	Heated seats (see also Fuses 16, 27, 29) Power seats (see also Fuses 27, 29, 43) Rear headrest (see also Fuse 29)
41	30 A	Anti-theft system (Alpine) Radio/CD player (see also Fuse 18)
42	30 A	Memory mirrors (see also Fuses 12, 16, 17, 18, 44) Memory seat (see also Fuses 9, 16, 17, 18, 44) Memory steering column (see also Fuses 16, 18)
43	30 A	Power seats (see also Fuses 27, 29, 40, 42)

Table i. 1993-94 740i/740iL/750iL Fuse Positions

Fuse	Rating	Protected Circuit
44	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 47) Headlight/foglight washer (ZKE) (see also Fuses 3, 5, 17, 22) Memory mirrors (see also Fuses 12, 16, 17, 18, 42) Memory seat (see also Fuses 9, 16, 17, 18, 42) Power windows (ZKE) (see also Fuses 17, 20, 30, 31) Sunroof (ZKE) (see also Fuses 17, 20, 30, 31) Windshield washer (ZKE) (see also Fuse 15) Windshield wipers (ZKE) (see also Fuse 15)
45	30 A	Electronic damping control (EDCIII) (see also Fuse 12)
46	30 A	Rear window defogger/antenna (see also Fuses 21, 29)
47	30 A	Central body electronics (ZKE) (see also Fuses 17, 30, 44)
48	15 A	Power steering column adjust
49	10 A	Airbag (SRS) Cellular telephone (see also Fuses 9, 18)
51	7.5 A	Electronic mirror (see also Fuse 12)
60	30 A	Slip control (ABS/ASC+T) (see also Fuses 1, 17, 62)
61	5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7,10, 11, 13, 14, 63)
62	15 A	Engine control system (DME 3.3) Slip control (ABS/ASC+T) (see also Fuses 62)
63	5 A	Headlights/foglights (see also Fuses 2, 3, 4, 5, 7,10, 11, 13, 14, 61)

CAUTION—

Fuse designations and locations are subject to change and may vary from car to car, depending on options. If questions arise, an authorized BMW dealer is the best source for the most accurate and up-to-date information.



611 Wipers and Washers

GENERAL 611-1

WIPER BLADES 611-1
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GENERAL

This repair group covers windshield wiper and washer system repair information.

Removal and replacement of the windshield wiper/washer stalk switch assembly is covered in **612 Switches and Electrical Accessories**. Electrical wiring diagrams and relays for the wiper/washer system are covered in **Electrical Wiring Diagrams**.

NOTE —

Some E32 7 Series cars are equipped with a mechanism that electronically increases the force on the driver's side wiper blade based on road speed. This wiper contact force system is identified by BMW as "ADV." Some repair procedures vary slightly on cars equipped with ADV, as specified in the text.

WIPER BLADES

Wiper Blade Symptoms and Fixes

Common problems with the windshield wipers include streaking or sheeting, water drops after wiping, and blade chatter.

Streaking is usually caused when wiper blades are coated with road film or car wash wax. Clean the blades using soapy water. If cleaning does not cure the problem, the blades should be replaced. BMW recommends replacing the wipers blades twice a year, before and after the cold season.

Drops that remain behind after wiping are usually caused by oil, road film or diesel exhaust residue on the glass. Use an alcohol or ammonia solution, or a non-abrasive cleanser (Bon-Ami®) to clean the windshield.

Wiper blade chatter may be caused by dirty or worn blades or by wiper arms that are out of alignment. Clean the blades and windshield as described above. Adjust the wiper arm so that there is even pressure along the blade, and so that the blade is perpendicular to the windshield at rest. If the problem persists, the blades and wiper arms should be replaced.

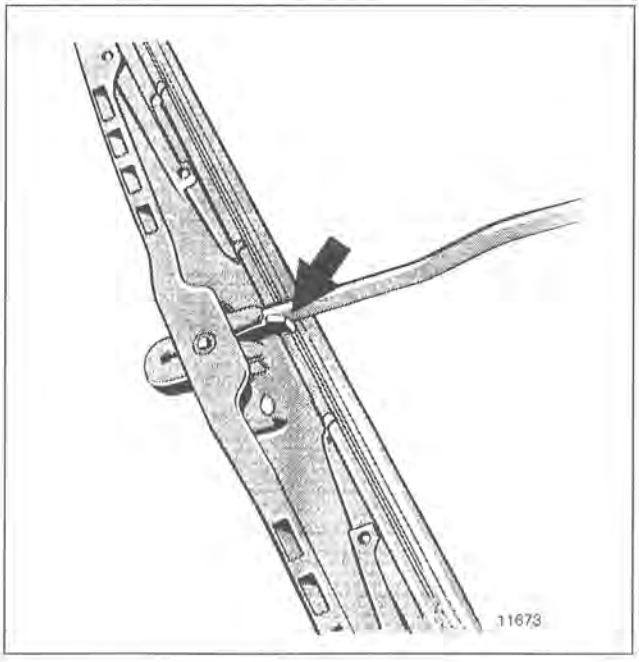
NOTE—
BMW has available a special tool/gauge (BMW special tool no. 00 9 210) to align the angle of the wiper arm to the windshield glass.

The rubber wiper blades can be replaced in one of two ways; either by replacing the complete blade or by replacing just the rubber insert itself.

Insert replacement is the most economical method, although over time the wiper blade itself will become worn. One rule of thumb would be to replace just the inserts every second time.

Wiper blades, replacing

- Pivot wiper arm up off glass.
- Position wiper blade approximately perpendicular to wiper arm.



- Remove wiper blade from wiper arm by depressing retaining tab (**arrow**) and sliding blade out of arm.

NOTE—
Some wiper blade versions may have two retaining tabs.

- Installation is reverse of removal. Install wiper blade to wiper arm until it can be heard to click into position.

Wiper blade inserts, replacing

– Remove wiper blade as described earlier.



0011784

➢ Unhook end of wiper blade insert from wiper arm guides.

NOTE —
If necessary, spread guides slightly using needle nose pliers.

– Pull old insert from wiper arm guides.

– Remove metal support strips from old insert and install into slots in new insert, noting installation direction of cutouts in support strips.

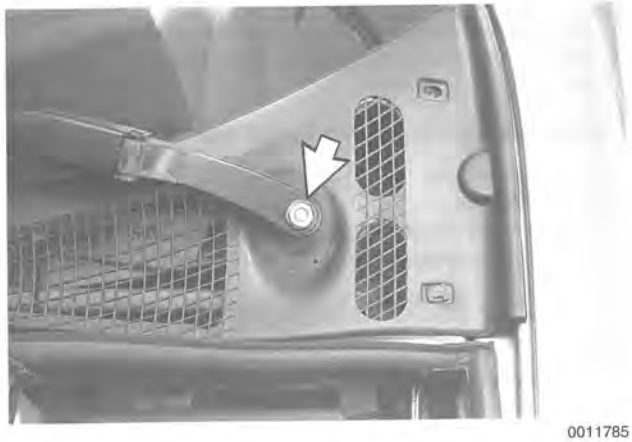
NOTE —
The notched cutouts in the retaining strips should engage the molded tangs in the inserts.

– Slide new insert through wiper blade guides. Lock insert in place at end guides.

Wiper arms, removing and installing

– Swing hinged plastic cover upwards from base of wiper arm.

- Some early models are equipped with a driver's side wiper pressure control system (called ADV). This system electronically regulates the wiper contact force on the windshield. Wiper arm removal varies slightly on cars with ADV.



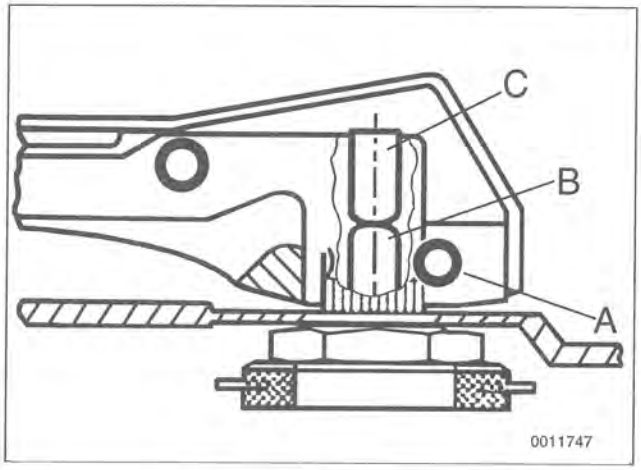
0011785

➢ On cars without ADV, remove wiper arm retaining nut (**arrow**) and remove wiper arm.

NOTE —
Marking the position of the wiper arm on the shaft will aid installation.

– On cars with ADV wiper arm, remove the wiper arm clamping screw and remove the wiper arm.

NOTE —
If necessary, use a screwdriver to spread clamping gap in wiper arm.



➢ Wiper arm on cars with ADV. After installing arm, tighten clamping screw (**A**), then tighten adjusting screw (**C**) until screw contacts ADV pin (**B**).

– Recheck wiper arm tightening torque after waiting 15 minutes.

Tightening Torques

- Wiper arm to wiper shaft
  - Passenger side . . . . . 25 Nm (18 ft-lb)
  - Driver side (with ADV) . . . . . 21 Nm (15 ft-lb)
  - Driver side (w/o ADV) . . . . . 25 Nm (18 ft-lb)

WINDSHIELD WIPER ASSEMBLY

The windshield wiper assembly (linkage and motor) is removed as a single unit. Once the assembly is removed, the wiper motor and other linkage parts can be repaired or replaced.

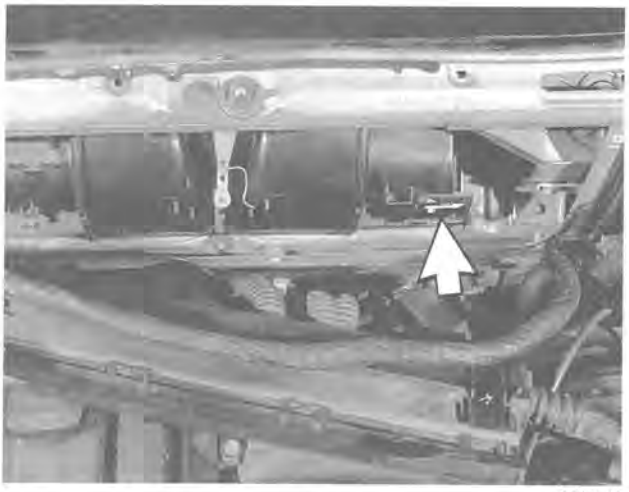
Windshield wiper assembly, removing and installing

NOTE—

- *The wiper arms should be in the parked position before removing the wiper assembly. To avoid damaging the wiper arms and pivots, do not manually slide or force the wiper arm across the windshield.*
- *Before beginning the procedure, set the ventilation flaps in the closed position. If necessary turn the ignition key on and off with the air control/volume lever in the off position to operate the flap motor.*

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***WARNING—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*



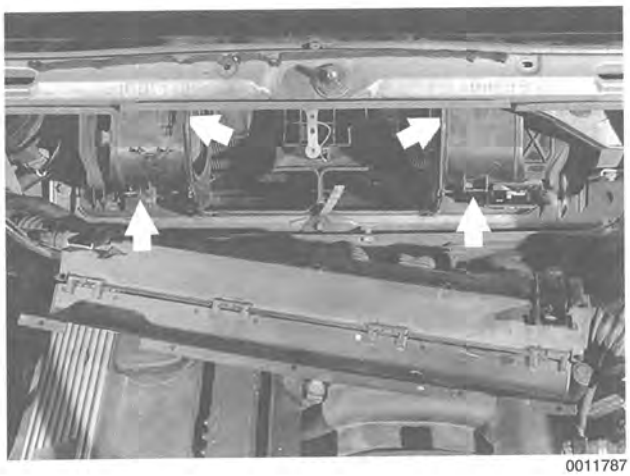
WINDSHIELD WIPER ASSEMBLY

– Remove heater blower motor. See **640 Heating and Air Conditioning**.

➢ Ventilation flap control linkage (**arrow**).

- Remove small cover from left side of blower motor housing. Disconnect linkage rod from beneath cover.

– Remove temperature sensor from top of blower motor housing.



0011787

➢ Blower motor housing spring retainers and spring clips (**arrows**).

- Working inside rear of blower housing, release (pry back) spring retainers on left and right sides of housing. Remove spring clips on front of blower housing.

– While lifting blower housing up slightly, remove inlet cowls on left and right sides. Then remove blower motor housing.

NOTE—
Tilt blower motor housing out from below to remove.

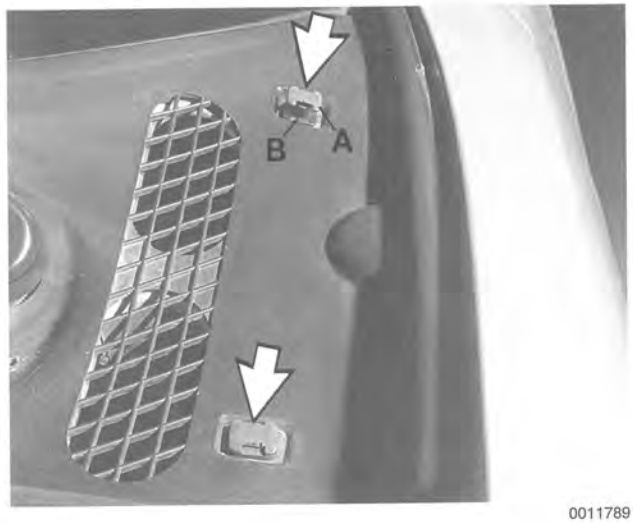


0011788

➢ Remove wiper assembly mounting bolts (**arrows**).

– Remove wiper arms as described earlier.

– Remove left and right molding grilles at base of windshield.



0011789

➢ The grilles at the base of the windshield are retained by two-piece plastic clips (**arrows**). Use thin-bladed screwdriver to remove the center part of the clip (**A**) and then remove the clip outer piece (**B**).

– Remove large nuts and washers from left and right wiper arm shafts.

– Separate harness connector at wiper motor.

– Push wiper arm shafts down into cowl area and maneuver wiper assembly out of cowl.

– Installation is reverse of removal.

Tightening Torques

- Wiper arm to wiper shaft
  Passenger side . . . . . 25 Nm (18 ft-lb)
  Driver side (with ADV) . . . . . 21 Nm (15 ft-lb)
  Driver side (w/o ADV) . . . . . 25 Nm (18 ft-lb)
- Wiper contact pressure motor (ADV) to wiper assembly . . . . . 6.5 Nm (57 in-lb)
- Wiper motor crank to wiper motor (M8 nut) . . . . . 27 Nm (20 ft-lb)
- Wiper shaft nut to body . . . . . 12 Nm (9 ft-lb)

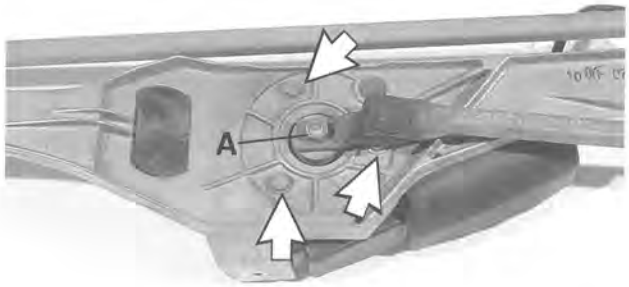
Windshield wiper motor, removing and installing

The procedure given here applies to cars without the wiper force contact system (ADV). Slight differences apply on cars with ADV.

– Remove wiper assembly as described earlier.

– Mark position of wiper linkage crank to wiper motor shaft. Remove linkage crank from motor.

➢ Unbolt wiper motor mounting bolts (**arrows**) and remove motor from linkage. When reinstalling old motor, mark position of crank to wiper shaft after removing nut **A** from crank.



0011790

➢ Attach wiper arm crank to "parked" motor so that crank is in straight line with linkage.



0011791

WASHER SYSTEM

The windshield washer system includes the windshield spray nozzles, the washer fluid pumps and the washer fluid reservoirs. Two separate washer fluid tanks are used, one for "intensive", the other for normal washing. Separate plumbing from each tank feeds the nozzles.

Cars with the headlight/foglight washer system are equipped with an additional fluid reservoir, a fluid pump, hoses and nozzles on the top and bottom of the front bumper.

Washer spray nozzles can be aimed by using a sewing needle or a similar diameter stiff piece of single-core wire.

Windshield spray nozzle, removing and installing



0011792

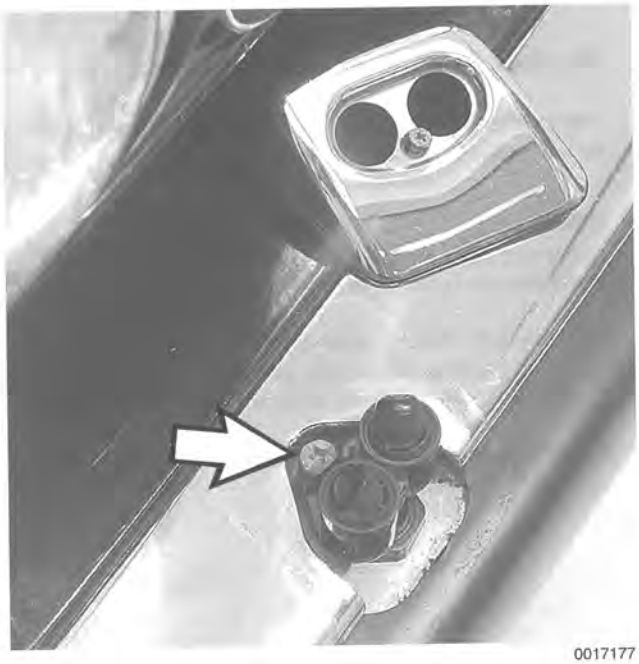
– Open hood and remove hood insulating pad retaining clips until nozzle can be fully accessed from below.

– Carefully disconnect hose from nozzle. Disconnect harness connector for nozzle heater.

➢ Depress nozzle retaining clips and push nozzle up out of hood.

– Installation is reverse of removal.

Headlight spray nozzle, removing and installing



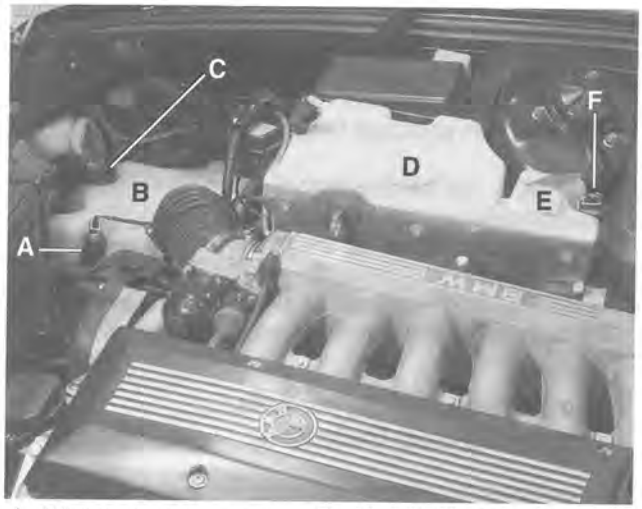
0017177

➢ Remove headlight washer bezel from bumper. Remove washer nozzle retaining screw (**arrow**).

– Twist nozzle assembly gently and pull up to remove.

– Installation is reverse of removal. Adjust spray nozzle as described earlier.

NOTE—
The plumbing to the windshield washer system can best be accessed by removing the front bumper as described in **510 Exterior Trim, Bumpers**.



A Windshield washer pump
B Headlight/foglight washer tank
C Headlight/foglight washer pump
D Windshield washer tank
E Intensive windshield cleaning tank
F Intensive windshield cleaning pump

0017274



0011793

Washer Fluid Pumps

The "intensive" windshield washer fluid pump is mounted in the small washer fluid tank next to the right strut tower.

The regular windshield washer pump in cars without headlight washers is mounted in the large tank forward of the intensive tank.

➤ Windshield and headlight washer tanks and pumps.

In cars with the headlight washer system, the windshield and headlight washer pumps are installed in the lower tank, behind the right headlight assembly.

To replace any of the pumps, open engine hood and drain washer fluid tank as applicable.

Remove tank retaining screw(s). Loosen tank from mount and pull up slightly to access washer pump. Unplug harness connectors for washer fluid level switch (if applicable) and pump.

CAUTION—
Be careful when pulling harness connector off washer fluid pump. The pump can easily pull out of the rubber grommet resulting in spilled washer fluid.

➤ Pull pump out of tank.

NOTE—
Access to the headlight washer pump may be easier after removing the right headlight assembly.

Loosen hose clamp and disconnect hose from pump. Installation is reverse of removal. Check pump sealing grommet for damage.

Washer Fluid Level Sensor

The washer fluid level sensor is mounted in the washer fluid tank near the bottom of the container.

NOTE—
Check wire leads at sensor for worn insulation and corrosion. Check electrical contacts in harness connector for corrosion.

To replace the sensor, drain the fluid tank, detach the sensor electrical harness connector, and pull sensor out of rubber grommet in bottom of tank. If necessary, lift tank slightly.

When installing the sensor, inspect the rubber grommet and replace if necessary.



612 Switches and Electrical Accessories

GENERAL 612-1

INTERIOR SWITCHES 612-1

Steering column stalk switches, removing and installing 612-2
Ignition switch, removing and installing. 612-3
Ignition lock cylinder, removing and installing. 612-4
Light switches, removing and installing. 612-4
Power window switch assembly, removing and installing 612-4
Hazard warning switch, removing and installing. 612-5
Outside mirror switch, removing and installing. 612-5

INTERIOR LIGHTS 612-6

Dome light, map lights, rear lights, trunk lights, door courtesy lights, replacing bulbs 612-6

GENERAL

This section covers replacement of interior switches and accessories.

When working on electrical switches, always disconnect the negative (–) cable from the battery and insulate the cable end to prevent accidental re-connection.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

NOTE—

- *Wiring diagrams can be found in* **Electrical Wiring Diagrams**.
- *Fuse, relay and electrical component locations can be found in* **610 Electrical Component Locations**.
- *Replacement information for the transmission gear position/neutral safety switch is covered in* **250 Gearshift Linkage**.
- *Testing and replacement information for the oil pressure switch is covered in* **119 Lubrication System**.

INTERIOR SWITCHES

Most of the interior switches are removed by carefully prying them from their cavity in the instrument panel or console. Notable exceptions are the steering column stalk switches as well as a few other interior switches. These exceptions are covered in the text below.

NOTE—
To prevent damaging or marring interior trim and interior plastic parts, wrap the tips of screwdrivers and pliers with plastic tape before prying out switches or electrical accessories.

Steering column stalk switches, removing and installing

Removal of the steering column switches requires removal of the steering wheel and the SRS driver's side airbag.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

WARNING—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– On cars with driver's side airbag, remove airbag unit from steering wheel. Store airbag unit in a safe place. Be sure to follow the airbag removal procedure given in **721 Airbag System (SRS)**.

WARNING—
The airbag is an explosive device and should be treated with extreme caution. Improper handling of the airbag could cause serious injury or death. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.

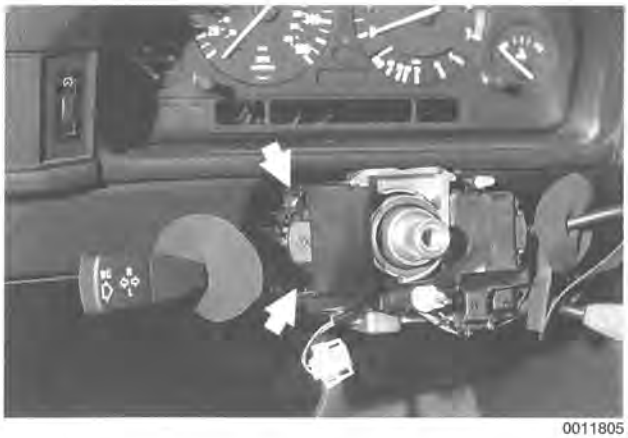

0011803

– With front wheels pointed straight ahead, remove steering wheel. See **320 Steering and Wheel Alignment**.

– Remove trim panel from lower left side of instrument panel. See **513 Interior Trim.**

➢ Remove upper steering column trim cover retaining screw. Some models may have retaining pins instead of screw.

NOTE—
Steering column cover fastener types and locations may vary slightly among models.


0011805

➢ Depress stalk switch retaining hooks (**arrows**) and remove switch. Disconnect harness connector(s).

– Installation is reverse of removal. Install airbag unit as described in **721 Airbag System (SRS)**.

WARNING—
Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the SRS warning light goes out. If the warning light stays on, the SRS system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.

CAUTION—
On steering wheels mounted with a nut, use a new self-locking nut when mounting the steering wheel. The nut is designed to be used only once.

Tightening Torques

- Steering wheel to steering column spindle
  Self-locking nut (always replace) . . . . 80 Nm (59 ft-lb)
  Bolt . . . . . 63 Nm (46 ft-lb)

Ignition switch, removing and installing

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***WARNING —***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*



0011806

– Remove lower left dash panel as described in **513 Interior Trim**.

– Remove screws retaining lower steering column cover and remove cover.

➢ Press ignition switch retaining clips or remove screws (**arrows**) on both sides of ignition switch and disconnect electrical connector.

– Installation is reverse of removal. Before mating ignition switch to ignition lock, check that switch is in correct position relative to ignition lock.



0011807

Ignition lock cylinder, removing and installing

With ignition key in "radio" position (60° from "off"), insert stiff wire into lock opening (**arrow**). Pull lock cylinder out.

Light switches, removing and installing

The procedure given below applies to the light switches in the dashboard next to the instrument panel (headlight and foglight switches).



0017062

Push switch down and insert a thin strip of metal (1.0 mm feeler gauge) to disengage switch locking tab.

- Using a small screwdriver, gently pry switch from instrument panel.
- Disconnect electrical harness connector from back of switch.
- Installation is reverse of removal.

Power window switch assembly, removing and installing



0011810

Power window switch assembly being removed from center console. Pry switch alternately at left and right sides (**arrows**) to remove.

- Disconnect electrical harness connector from switch assembly.
- Installation is reverse of removal. Note installation direction of harness connector.

Hazard warning switch, removing and installing

- Remove power window switch as described earlier.
- Working from underneath center console, push hazard warning switch up out of console.
- Disconnect harness connector from switch.
- Installation is reverse of removal.

Outside mirror switch, removing

- Carefully pry off mirror adjusting knob.

◀ Pry mirror switch from armrest. Disconnect harness connector from switch.



0011811

INTERIOR LIGHTS

Dome light, map lights, rear lights, trunk lights, door courtesy lights, replacing bulbs



0011854

➢ Pry dome light out from left side. Release the locking blade and swing back reflector. Spread apart the contact blades to remove bulb.



0011855

➢ Pry rear light out with small screwdriver, remove reflector and replace bulb.

– Use a screwdriver to carefully pry off trunk light lens and socket. Replace bulb.

– Pull door panel mounted courtesy light socket straight out of door panel. Remove plastic lens cover and replace bulb.

Interior Light Bulb Wattage

- Dome light . . . . . 15 watts
- Map light . . . . . 10 watts
- Rear light . . . . . 10 watts
- Trunk light . . . . . 10 watts
- Door panel courtesy light . . . . . 5 watts



620 Instruments

GENERAL 620-1

INSTRUMENT CLUSTER 620-1
Instrument cluster, self-testing 620-2
Instrument cluster, removing and installing. . . 620-2
Instrument cluster, disassembling and assembling 620-4
Instrument cluster bulbs, replacing 620-5
Odometer coding plug, replacing (cars built up to February 1989). 620-5
Odometer coding plug, replacing (cars built from February 1989) 620-6
Vehicle speed sender, replacing 620-7

ON-BOARD COMPUTER (OBC) 620-8
On-board computer (OBC), removing and installing. 620-8

TABLE
a. Instrument Cluster Self-Test Diagnostics (cars built from February 1989) 620-2

GENERAL

This repair group covers removal and installation of the instrument cluster and the on-board computer (OBC). Bulb replacement information for these units is also included.

NOTE—
A quick check of the temperature gauge and its electrical circuit is given in **170 Radiator and Cooling System**. *Use this procedure to diagnose a faulty temperature gauge*

INSTRUMENT CLUSTER

Two versions of instrument clusters are used on the E32 cars. The two clusters are not interchangeable. On the early cluster, installed in cars built up to February 1989, the odometer coding plug is in the main harness connector in the wiring loom. On the later cluster, the odometer coding plug is integrated within the instrument cluster.

When servicing the instrument cluster, always disconnect the negative (–) cable from the battery and insulate the cable end to prevent accidental re-connection.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

NOTE—

- *If the battery has failed or become disconnected, it may be necessary to reset the language designation of Check Control display to U.S. English Whenever the battery is disconnected, the instrument cluster check control display defaults to U.K. English. To change U.S. English, turn the ignition to the "Radio On" position. Press the Check Control button on the right side of the instrument cluster until the designated language appears. Release the Check Control button and repeat the process until the correct language is displayed.*
- *If there is a difference between MPG Check Control display and the OBC display, the OBC will have to be reset by disconnecting the battery for one minute.*

Instrument cluster, self-testing

It is possible to perform a cluster system test and display system test information. On clusters manufactured from February 1989, the self-test also includes a dynamic test of the instruments.

– With the ignition off, press and hold Check Control button on right side of instrument cluster.

– While holding down Check Control button, turn ignition to the ON position.

– Release Check Control button. Instrument cluster self test information will be displayed. See **Table a.**

Table a. Instrument Cluster Self-Test Diagnostics (cars built from February 1989)

Self-test information	Typical self-test readout (example from 1990 750iL)
Internal BMW no.	1388766
Coding plug no.	13093
K number	7296
Chassis no.	DC78195
Software version	0.83
Internal modification index	14

Instrument cluster, removing and installing

Removal of the instrument cluster requires removal of the steering wheel and the driver side airbag.

– Disconnect negative (–) battery cable. See **020 Maintenance.**

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove airbag unit from steering wheel. See **721 Airbag System (SRS).** Store the airbag unit in a safe place.

> ***WARNING —***
> *The airbag is an explosive device and should be treated with extreme caution. Improper handling of the airbag could cause serious injury or death. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*

– With front wheels pointed straight ahead, remove steering wheel. See **320 Steering and Wheel Alignment**.

➢ Remove two instrument cluster retaining screws.



0011720



0013178

➢ Place towel over steering column. Carefully tilt top of cluster forward out of dash panel. Pull up on locking lever (**arrow**) to release instrument cluster connector. Locking lever must be in up position before installing connector.

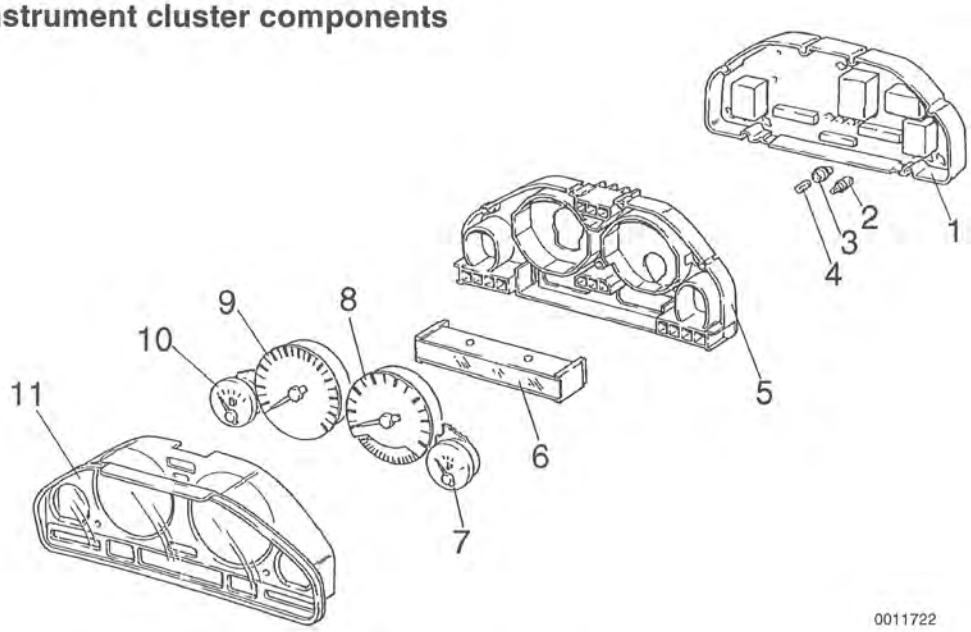
– Installation is reverse of removal.

- Install airbag to steering wheel as described in **721 Airbag System (SRS).**
- Reconnect negative (–) battery cable last, once all harness connectors have been reconnected.

Instrument cluster, disassembling and assembling

Individual instruments, illumination bulbs and the LCD module are available from an authorized BMW dealer as replacement parts.

Instrument cluster components



1. Baseplate
2. Socket lamp
3. Bulb holder
4. Light bulb
5. System carrier
6. LCD module
7. Temperature gauge
8. Tachometer and economy control
9. Speedometer
10. Fuel gauge
11. Instrument carrier

– Remove instrument cluster as described earlier.

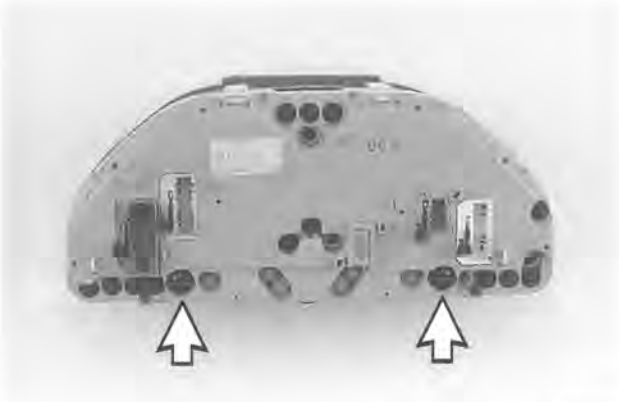
– Pull off odometer reset button and Check Control button from front of instrument cluster.

➢ Instrument cluster base plate toggle locks (**arrows**).

- Turn 90° to unlock/lock.
- Pivot cluster base plate up off instrument carrier.

– Unhook base plate from instrument carrier and disconnect wiring connector (if applicable).

– Remove screws from perimeter of cluster. Carefully lift off cluster cover from instrument carrier.

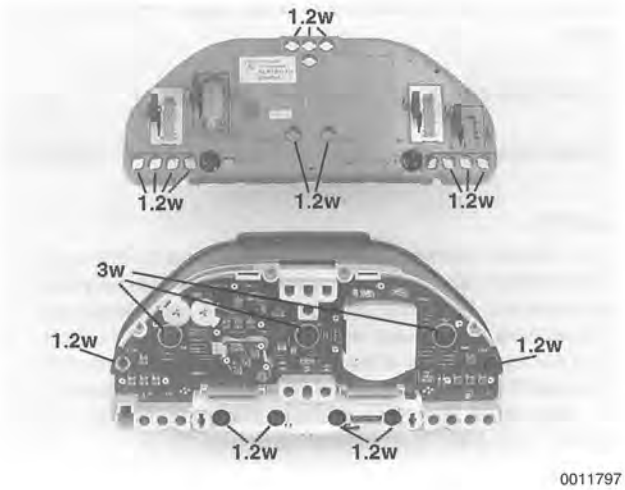


> ***CAUTION—***
> *LCD module can fall out once cluster cover is separated from instrument carrier.*

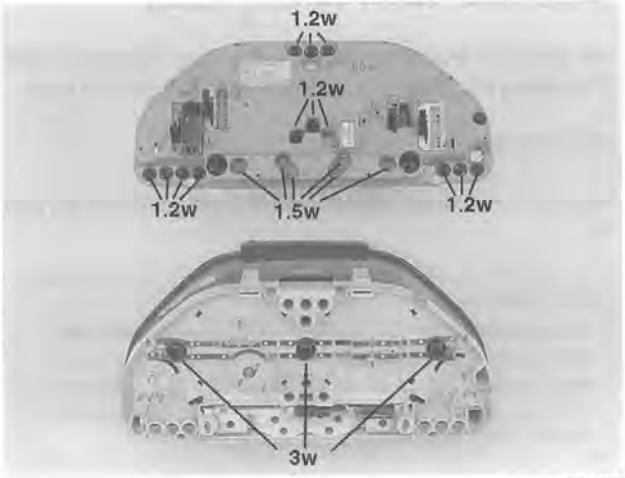
– Remove individual instruments by carefully pulling them straight out of instrument carrier.

– Instrument cluster assembly is reverse of disassembly.

Instrument cluster bulbs, replacing



Instrument cluster bulb arrangement for early production cars (built up to February 1989).



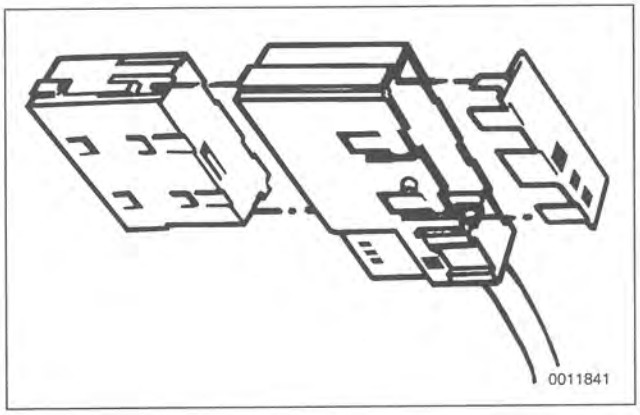
Instrument cluster bulb arrangement for redesigned cluster (cars built from February 1989).

– Remove instrument cluster as described earlier.

– Remove faulty bulb by turning bulb base 90° in its mount. To access bulbs behind base plate, release toggle locks and pivot cluster base plate up off instrument carrier.

Odometer coding plug, replacing (cars built up to February 1989)

On cars with the early instrument cluster (cars built up to February 1989), the vehicle mileage is retained in the coding plug. The coding plug is located in the brown harness connector at the rear of the cluster.



– Remove instrument cluster.

– Record mileage of vehicle.

Coding plug on earlier model (cars built up to February 1989) instrument cluster.

• Remove rear portion of brown connector.

– Insert special removing tool (supplied with replacement coding plug) into backside of plug, releasing coding plug retaining tangs.

– Remove coding plug from front of plug.

– Remove silver identification code label from new coding plug.

– Insert new coding plug from side of connector.

– Install new protective cap onto back of harness connector.

NOTE—
The Federal Odometer Disclosure Requirement 92-513 states that whenever an odometer is replaced, the mileage prior to its replacement along with the date that the replacement occurred must be recorded on the left door frame of the vehicle. It is the responsibility of the person making this replacement to record this information on the vehicle. A "non-removable" label is available from BMW to record this information (part no. 89 89 1 000 500).

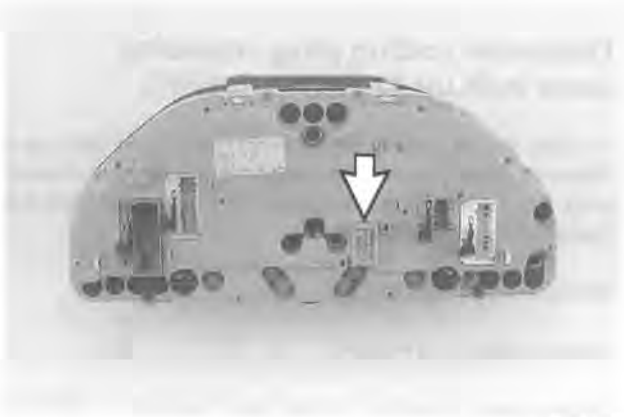
Odometer coding plug, replacing (cars built from February 1989)

On cars with the redesigned cluster (from February 1989), the coding plug has been integrated into the cluster itself.

– Record mileage of vehicle.

– Remove instrument cluster. See procedure described earlier.

CAUTION—
Before removing the coding plug from the instrument cluster, wait at least for one minute after removing the cluster. This will allow residual voltage to be discharged. If this is not done, there is a possibility of data loss or damage to the cluster and/or coding plug.



0011796A

➤ Use a knife to cut out coding plug locking frame (**arrow**) on rear of instrument cluster.

– Remove coding plug by pulling it straight out of printed circuit board.

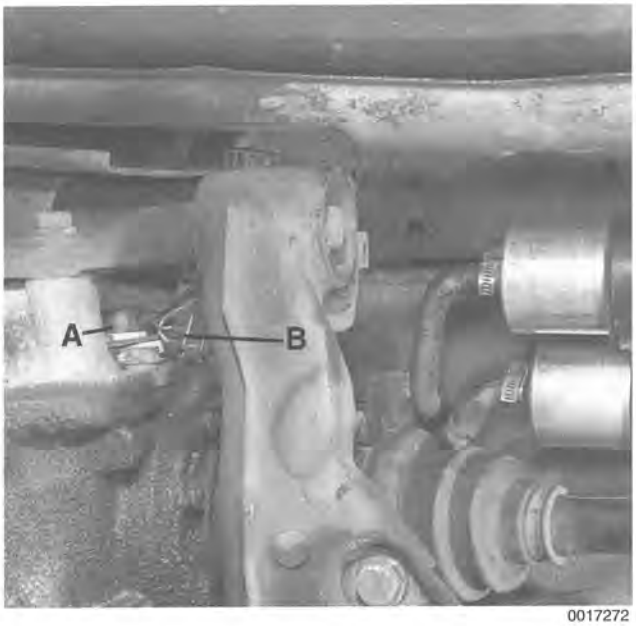
– Install new coding plug and install locking frame.

NOTE—
The coding plug supplies data to the on-board computer (OBC). In order to ensure that the correct data is transferred, the OBC must be disconnected from its multi-pin connector for a least one minute after the replacement of the coding plug.

Vehicle speed sender, replacing

The vehicle speed sender supplies an electronic pulsed speed signal to the speedometer. The sender is mounted beneath the rear of the car, on the differential cover plate.

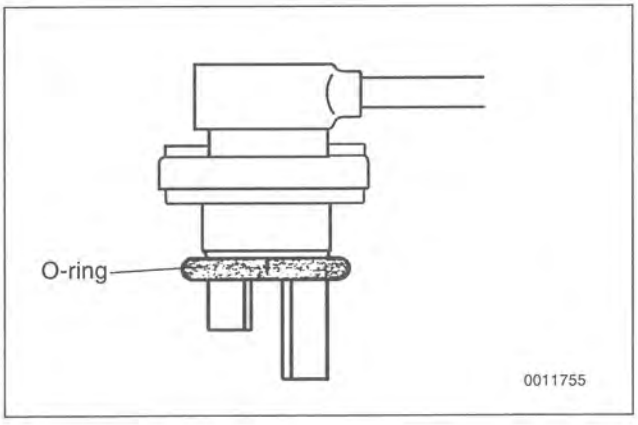
NOTE—
If the speedometer is malfunctioning, check the vehicle speed sender harness connector on the rear differential. Water damage, frayed wires and corrosion of the connector contacts are often the cause of speedometer malfunction.



0017272

➢ Locate vehicle speed sender (**A**) electrical connector at back of differential. Detach electrical harness connector (**B**).

– Remove vehicle speed sender retaining screws and remove sender from differential cover.



0011755

➢ O-ring correctly installed on vehicle speed sender.

- On installation, replace O-ring and coat with oil (90W oil). Install O-ring up to first land on sender. Install sender into differential and tighten mounting bolts evenly in stages until sender is firmly seated.

Tightening Torque

- Vehicle speed sender to differential cover . . . . . 6.6 - 8.4 Nm (53 - 74 in-lb)

ON-BOARD COMPUTER (OBC)

On-board computer (OBC), removing and installing

The on-board computer (OBC) is illuminated by two bulbs. It must be removed to replace the bulbs.

– Remove radio. See **650 Radio**.

➢ Reach inside radio cavity and slide release lever (**arrow**) toward you to release OBC from instrument panel.

– Installation is reverse of removal.





0011802

630 Exterior Lighting

GENERAL 630-1

FRONT LIGHTING 630-2
- Headlight bulb, replacing 630-2
- Headlight assembly, removing and installing 630-2
- Headlight lens unit, removing and installing . . 630-3
- Front foglight assembly, removing and installing 630-3
- Front turn signal assembly, removing and installing 630-4
- Front or rear side marker assembly and bulb, replacing 630-5

REAR LIGHTING 630-5
- Taillight bulb, replacing 630-5
- Taillight assembly, removing and installing . . . 630-6
- Center brake light bulb, replacing 630-6
- License plate light, removing and installing . . 630-6

GENERAL

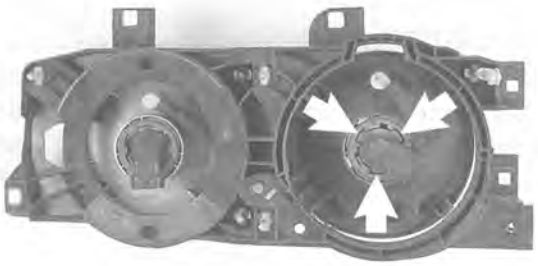
The headlight and foglight assemblies use halogen bulbs. To ensure the longevity of halogen bulbs, the bulb glass should not be handled. Dirt and skin oils may cause a bulb to fail prematurely. If necessary clean bulb using a clean cloth dampened with rubbing alcohol.

NOTE—
Use only original equipment replacement bulbs. Non-original equipment bulbs may cause false failure readings on the Check Control display in the instrument cluster.

CAUTION—
- *When working on electrical systems, detach negative (–) battery cable. See* **020 Maintenance**.
- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

FRONT LIGHTING

Headlight bulb, replacing



0011828

– Open engine hood. If necessary, remove air filter housing from behind headlight assembly.

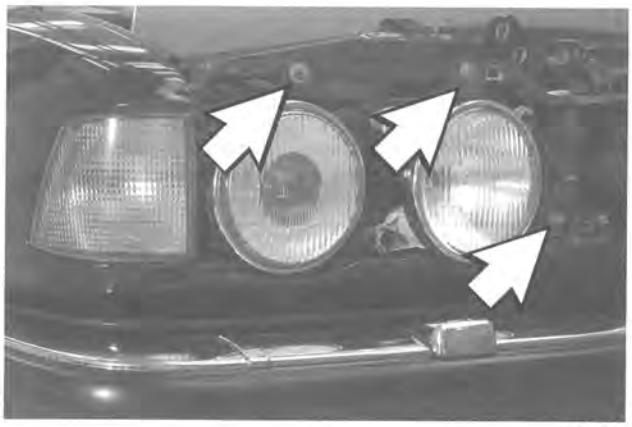
➢ To release bulb from headlight assembly, grasp rear of bulb socket (harness connector) and turn counterclockwise to disengage retaining tabs (**arrows**) and remove.

– Disconnect harness connector from bulb.

– Installation is reverse of removal.

- Align tabs on bulb base to cutouts on rear of lens assembly.
- Secure bulb by rotating clockwise 90°.

Headlight assembly, removing and installing



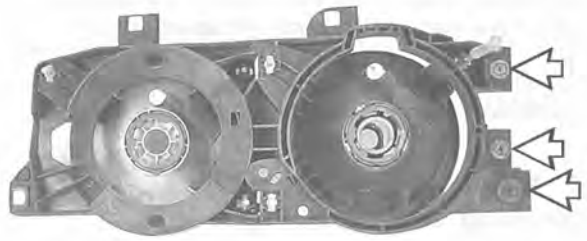
0017275

– Open engine hood. If necessary, remove air filter housing from behind headlight assembly.

– Disconnect harness connectors from headlight bulbs.

– Remove headlight grille. See **510 Exterior Trim, Bumpers**.

➢ Remove screws (**arrows**) from front of headlight assembly.



0011830

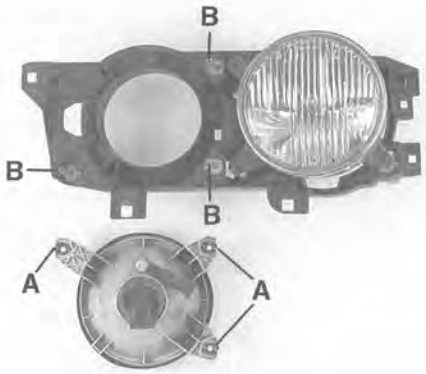
➢ Remove screws from rear of headlight assembly (**arrows**).

– Remove headlight assembly from front.

– Installation is reverse of removal.

Headlight lens unit, removing and installing

– Remove headlight grille. See **510 Exterior Trim, Bumpers**.



0011831

➢ Using a hot air blower, heat plastic sleeves (**A**) on front of lens unit and pry lens unit from ball studs (**B**) on headlight carrier.

– Installation is reverse of removal.

- Remove plastic sleeves from lens unit and install on ball studs before pressing lens unit into carrier.
- Replace any broken plastic retainers.
- Adjust headlight aim.

Front foglight assembly, removing and installing

The following procedure includes foglight lens replacement and foglight bulb replacement.



0011832

NOTE—
There are several different foglights. Procedures may vary slightly.

– Remove towing eye cover from lower bumper valence.

➢ Foglight retaining screw (**A**), towing eye cover locking tab (**B**).

- Lift off towing eye cover.
- Remove screw and remove foglight assembly from valence.

– Remove bulb from rear of foglight assembly. Disconnect electrical harness connector from foglight bulb.

CAUTION—
Do not touch halogen bulbs with your bare hands. Dirt and skin oils may cause premature bulb failure. If necessary clean bulb using a clean cloth dampened with rubbing alcohol.

– Installation is reverse of removal. Check electrical connector for corrosion. Spray with contact cleaner, if necessary.

Front turn signal assembly, removing and installing

The following procedure also includes turn signal bulb replacement.

– Open engine hood. If necessary, remove air filter housing from behind headlight assembly.



0011833

➢ Front turn signal bulb shown removed. Depress locking tabs (**arrows**) and remove. When installing bulb socket, align tab on socket with slot in housing.

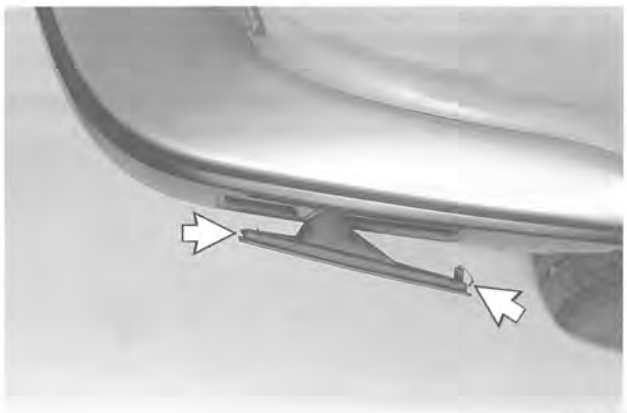
➢ Remove turn signal retaining screws (**arrows**).

– Push turn signal assembly out from behind.



0011834

NOTE—
To remove bulb from bulb socket, push bulb in gently and rotate counterclockwise. Pull bulb from socket.



0011837

Front or rear side marker assembly and bulb, replacing

➢ Side marker lens shown removed from bumper. **Arrows** indicate lens retaining tabs.

- Carefully pry end of side marker away from bumper and remove.

– To remove bulb with socket from side marker housing, turn socket 90° counterclockwise and pull out of lens.

Bulb Specification

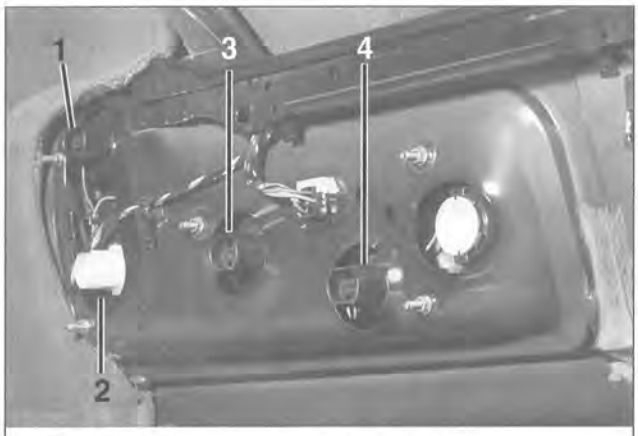
- Side marker bulb. . . . . 5 watt

– Installation is reverse of removal.

REAR LIGHTING

Taillight bulb, replacing

– Open luggage compartment lid and remove compartment rear liner to access taillight sockets.



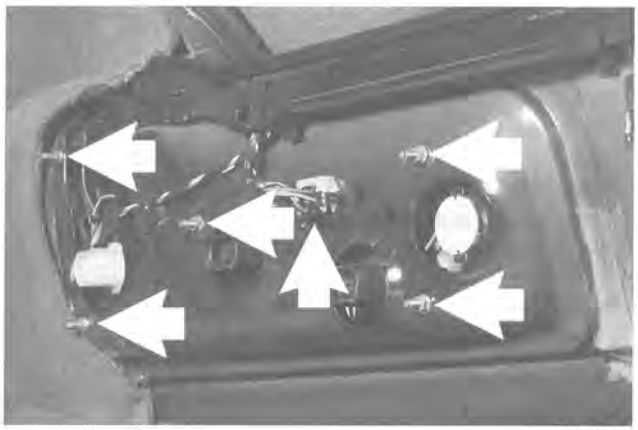
1. Turn signal
2. Taillight
3. Brake light
4. Back up light

0011276

➢ Taillight bulb locations.

- Twist bulb housing 90° and remove bulb socket from taillight lens assembly.

– To remove bulb from bulb socket, push bulb in gently and rotate counterclockwise. Pull bulb from socket.



0017276a

Taillight assembly, removing and installing

– Open luggage compartment lid and remove compartment rear liner to access taillight sockets.

➢ Disconnect harness connector from taillight lens assembly. Remove assembly mounting nuts (**arrows**).

– Installation is reverse of removal.

Center brake light bulb, replacing

– Open luggage compartment lid.

– Locate bulb socket on under side of parcel shelf, below center brake light assembly.

– Turn socket counterclockwise 90° and remove from center brake light assembly. Remove bulb from socket and replace.

– Installation is reverse of removal.

License plate light, removing and installing

– Open luggage compartment lid.

– Gently pry off plastic cover over license plate light assembly.

– Remove screws retaining license plate light assembly.

– Remove bulb and install new bulb.

NOTE—
Inspect bulb contact springs for damage and corrosion. Replace lens assembly if necessary.

– Installation is reverse of removal.



640 Heating and Air Conditioning

GENERAL 640-1

HEATER AND CONTROLS 640-1
Blower motor, removing and installing 640-1
Blower final stage, replacing 640-2
Heater valve, replacing 640-4
Auxiliary coolant pump, replacing 640-4
Heater core, replacing 640-5
Outside temperature sensor, replacing 640-7
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Heater and A/C control head removing and installing 640-9
Sensor fan for interior temperature, replacing 640-9
Air distribution motors, replacing 640-10

AIR CONDITIONING 640-11
A/C system, warnings and cautions 640-12
A/C compressor, replacing (M30 engine) . . . 640-13
A/C compressor, replacing (M60 or M70 engine) 640-14
A/C Compressor Clutch 640-15
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TABLES

a. Blower Motor Test Values 640-2
b. Outside Temperature Sensor Test Values 640-8
c. Heater Core Temperature Sensor Test Values 640-8
d. Evaporative Temperature Sensor Test Values 640-22
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GENERAL

The repair information given under this heading applies to the heating and air conditioning system. Many of the procedures require that the A/C refrigerant charge be evacuated. See **A/C System Warnings and Cautions** later in this repair group.

HEATER AND CONTROLS

Blower motor, removing and installing

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove hoses at coolant expansion tank at engine compartment rear bulkhead and disconnect electrical connector from level sensor in tank. Unbolt expansion tank and move aside.

– Unclip wire harness protective cover on rear bulkhead. Cut wire ties as necessary.

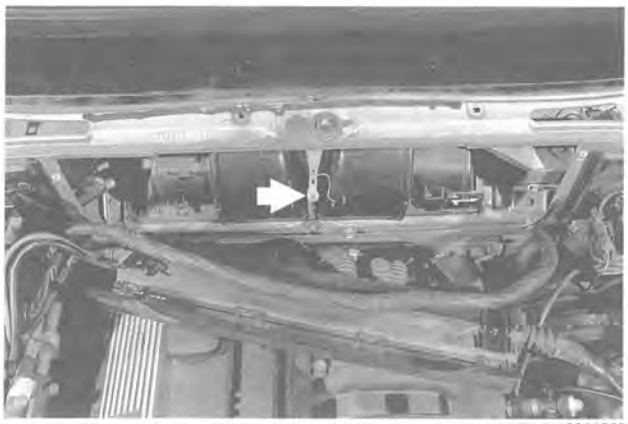
➢ Remove bulkhead splash shield by removing 5 retaining screws (**arrows**).



0011862

➢ Unhook blower motor housing cover retaining strap (**arrow**) and remove cover.

– Disconnect electrical connectors from blower motor.

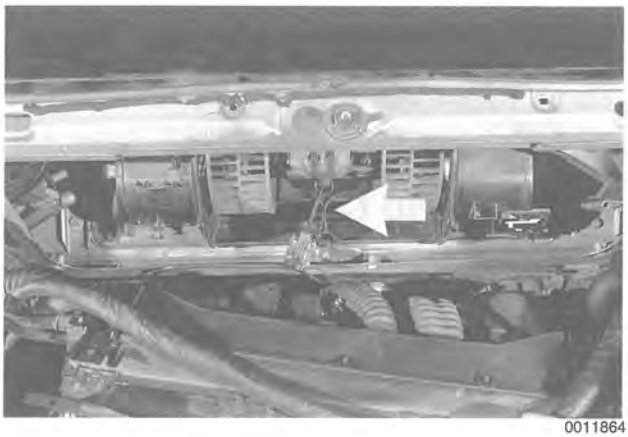


0011863

➢ Disengage blower motor retaining strap. Pry up on strap to release.

– Remove blower motor from cowl opening.

– Installation is reverse of removal. Blower motor test specifications are listed in **Table a**.



0011864

Table a. Blower Motor Test Values

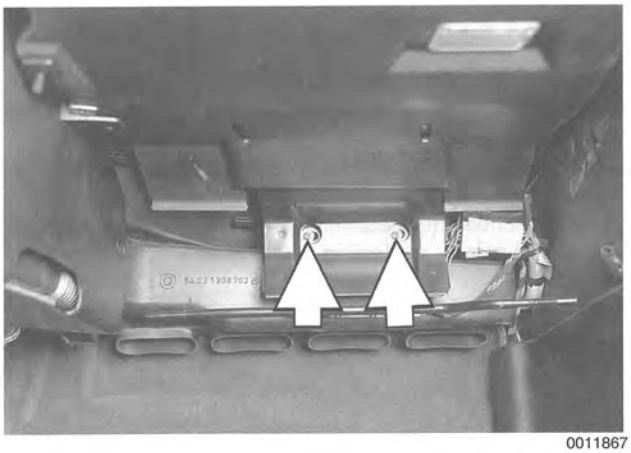
Testing voltage	13 volts DC
Operating voltage	9–15 volts DC
Current consumption (approx.)	12 amps
Maximum speed	3600–4000 rpm
Axial play (max. allowable)	1.0 mm (0.04 in.)

Blower motor final stage, replacing

Blower motor speed is regulated through the blower final stage, often referred to as the "sword".

– Remove glove compartment. See **513 Interior Trim**.

– Remove carpet trim piece from right side of center console. A screw retains trim piece at front end.



0011867

➢ Remove ventilation air duct retaining screws (**arrows**) and clips. Pull air duct down and out.

– Disconnect all plugs on heater/A/C control module and from final stage. Move wire harness aside.



0011868

➢ Remove final stage mounting screws (**arrows**).



0017193

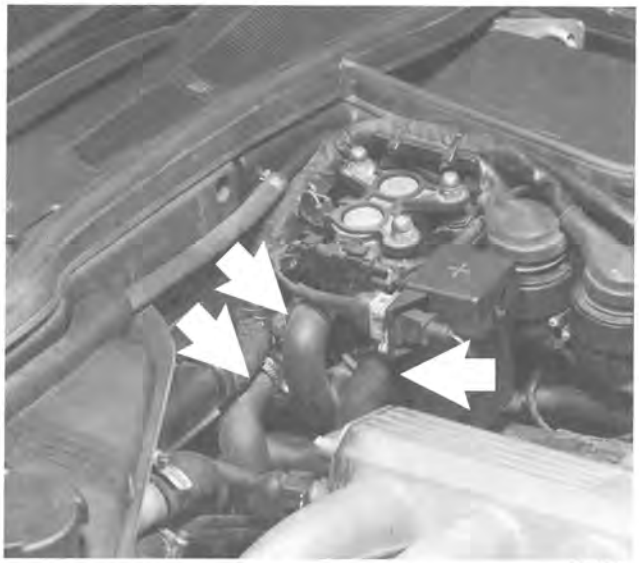
➢ Remove final stage by pulling to right.

– Installation is reverse of removal.

Heater valve, replacing

The heater valve is located in the rear of the engine compartment on the driver's side.

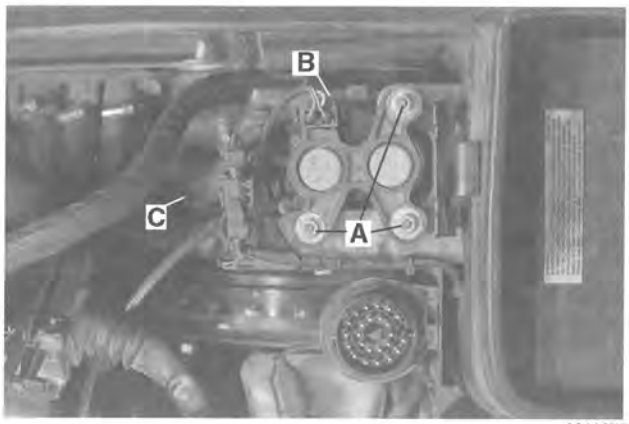
– Drain engine coolant. See **170 Radiator and Cooling System**.



0017189

➢ Disconnect coolant hoses from heater valve (**arrows**).

– Disconnect hose from auxiliary coolant pump. See **Auxiliary coolant pump, replacing**.



0011870

➢ Disconnect harness connector (**B**) and coolant hose (**C**). Remove mounting nuts (**A**) from heater valve. Lift out heater valve together with auxiliary coolant pump.

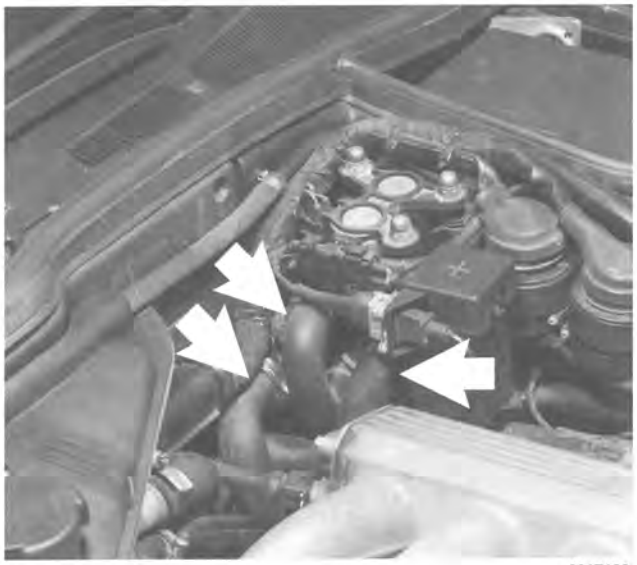
– Separate auxiliary coolant pump from heater valve.

– Installation is reverse of removal. Fill and bleed cooling system. See **170 Radiator and Cooling System**.

Auxiliary coolant pump, replacing

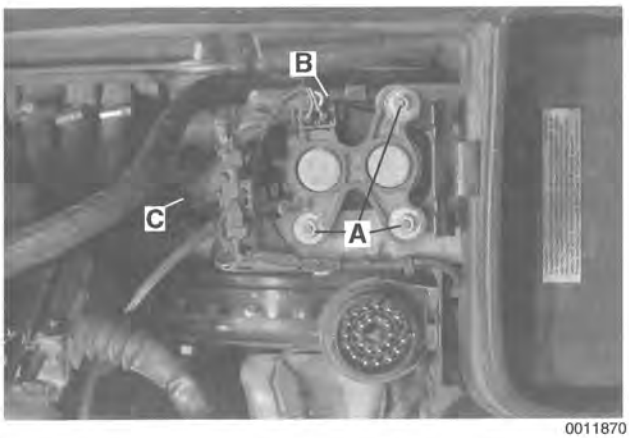
The auxiliary coolant pump is electrically operated and provides additional coolant circulation to the heater core. The pump is located in the rear of the engine compartment directly below the heater valve.

– Drain engine coolant. See **170 Radiator and Cooling System**.



0017189

➢ Disconnect coolant hoses (**arrows**) from rear bulkhead in engine compartment.



0011870

➢ Remove harness connector (**B**) and coolant hose (**C**). Remove mounting nuts from heater valve. Remove heater valve from mount together with auxiliary coolant pump.

– Remove clamp from auxiliary coolant pump and remove pump from heater valve.

– Installation is reverse of removal. Fill and bleed cooling system. See **170 Radiator and Cooling System**.

Heater core, replacing

NOTE—
*Heater core removal requires removal of SRS airbag(s), dash board and center console. See **513 Interior Trim**.*

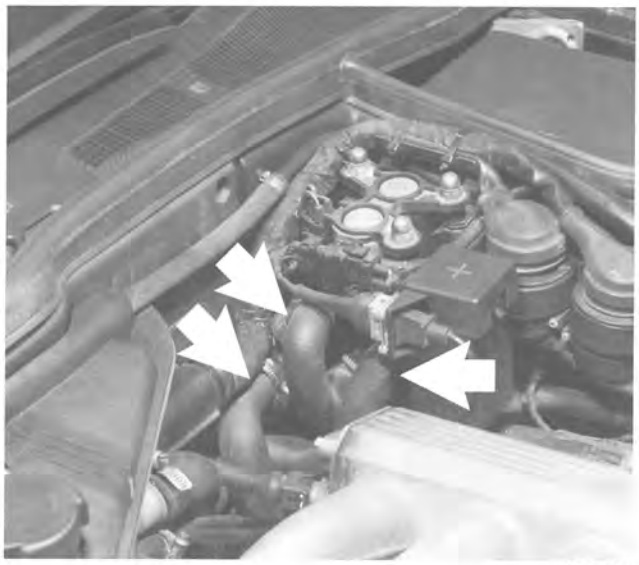
– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Drain engine coolant. See **170 Radiator and Cooling System**.

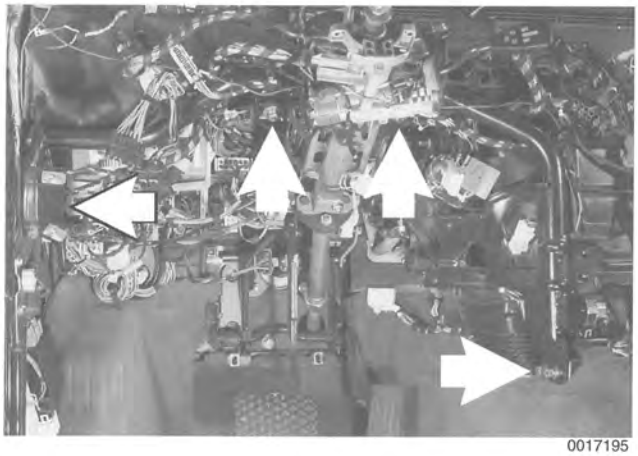
– Remove center console and dashboard. See **513 Interior Trim**.

– Remove rear air distribution tube from top of center tunnel.



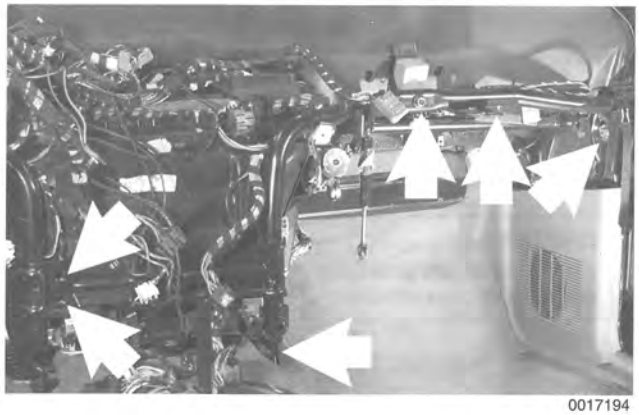
0017189

➢ Disconnect heater hoses (**arrows**) at rear of engine compartment.



0017195

➢ Steering column reinforcement bracket mounting bolts (**arrows**).



0017194

➢ Remove glove compartment support frame mounting bolts (**arrows**).

– Cut wire ties holding wire harness to heater box cover inside car and move harness aside.



0011872

➢ Remove clips (**black arrows**), nuts and screws (**white arrows**) from heater box cover.



0011873

➢ Remove heater pipe mounting bolts (**arrows**) on heater core.

– Remove heater pipes from heater core.

– Remove heater core by lifting out from right side.

– Installation is reverse of removal.

- Use new O-rings when mounting pipes to heater core.
- Use new hose clamps to reattach heater hoses.
- Fill and bleed cooling system. See **170 Radiator and Cooling System**.

Outside temperature sensor, replacing

The outside temperature sensor is mounted in the blower motor housing, behind the engine compartment rear bulkhead splash shield.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove hose from coolant expansion tank and disconnect electrical plug from level sensor at tank. Unbolt expansion tank and move aside.

– Unclip wire harness protective cover on rear bulkhead. Cut wire ties as necessary.



0011862

➢ Remove bulkhead splash shield by removing 5 retaining screws (**arrows**).



0011874

➢ Slide outside temperature sensor (**arrow**) out of blower housing.

– Replace sensor by cutting sensor wiring approximately 30 mm (1.2 in.) from sensor end. Remove approximately 40 mm (1.6 in.) of insulation from sensor harness.

– Install heat shrink tubing on finished wiring splice. Connect wires from new sensor to harness wires and solder in place.

NOTE—
To minimize danger of a short circuit, reconnect and solder the sensor wiring so that wire splices are offset from each other.

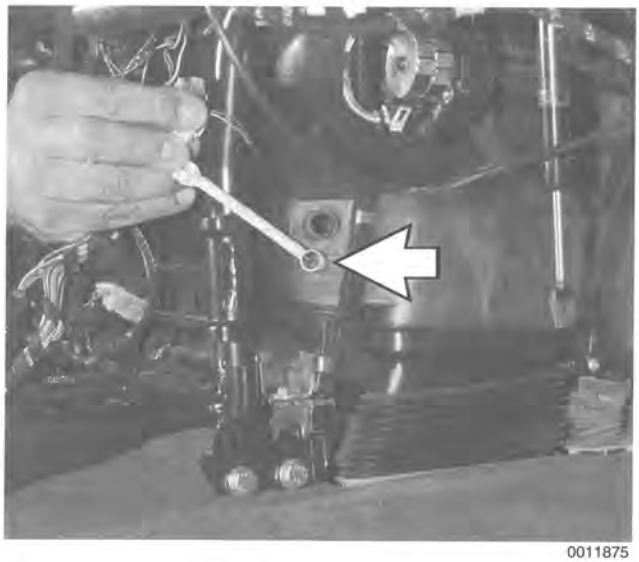
– Installation is reverse of removal. Outside temperature sensor test values are listed in **Table b.**

Table b. Outside Temperature Sensor Test Values

Test temperature	Resistance
0°C (32°F)	2.69 - 3.46 k ohms
10°C (50°F)	1.74 - 2.11 k ohms
20°C (68°F)	1.15 - 1.32 k ohms
25°C (77°F)	0.95 - 1.05 k ohms
30°C (86°F)	0.76 - 0.87 k ohms
40°C (104°F)	0.49 - 0.60 k ohms

Heater core temperature sensor, replacing

– Remove center console. See **513 Interior Trim.**



0011875

➢ Disconnect harness connector from sensor (**arrow**) and carefully pry out sensors from heater core housing. (Right side shown).

– Installation is reverse of removal. Heater core temperature sensor test values are listed in **Table c.**

Table c. Heater Core Temperature Sensor Test Values

Test temperature	Resistance
-20 °C (4°F)	84.39 - 109.61 k ohms
-10°C (14°F)	48.58 - 62.09 k ohms
0°C (32°F)	28.89 - 36.40 k ohms
20°C (68°F)	11.13 - 13.83 k ohms
60°C (140°F)	2.19 - 2.78 k ohms
100°C (212°F)	0.58 - 0.77 k ohms

Heater and A/C control head, removing and installing

E32 models are equipped with an automatic climate control system designated IHKA. The system control head has three groups of three push buttons in the lower part of the panel and three rotary dials in the upper part.

– Working carefully at center console opening, pry out control head.



0017190

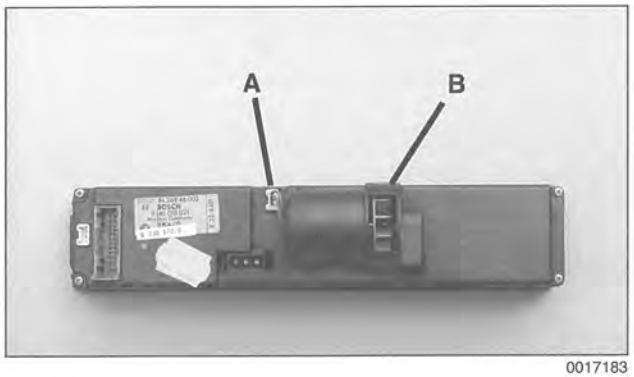
➢ Detach IHKA Heater and A/C control head harness connectors (**arrows**) and remove control head.

– Installation is reverse of removal.

Sensor fan for interior temperature, replacing

A small electric fan, installed in the A/C control head, draws cabin air past the climate control temperature sensor.

– Remove A/C control head as described earlier.



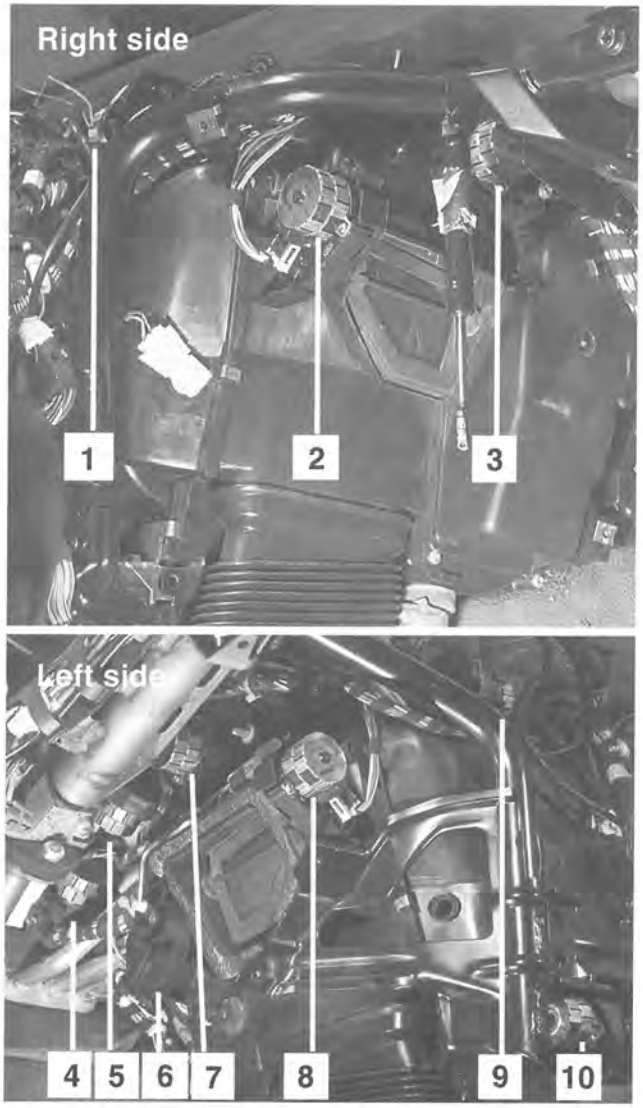
0017183

➢ Disconnect electrical connector (**A**) from top of control head housing. Pry open plastic housing and remove sensor fan (**B**).

– Installation is reverse of removal.

Air distribution motors, replacing

The distribution of air is controlled by a series of flaps that are actuated by stepper motors. There are ten distribution motors located around the heater/AC box area. Replacement of the motors is best accomplished after removing the center console and other dash trim panels as required.



1. Blend door
2. Right footwell
3. Center vent
4. Defroster. temp regulation
5. Fresh air/recirculation
6. Defrost vents
7. Center vent
8. Left footwell
9. Blend doors
10. Rear vents

0017196/0017197

Air distribution motors in IHKA heater box.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove center console, lower dash panels and glove box. See **513 Interior Trim**.

NOTE—
Dashboard removal may be necessary for upper motors on some models.



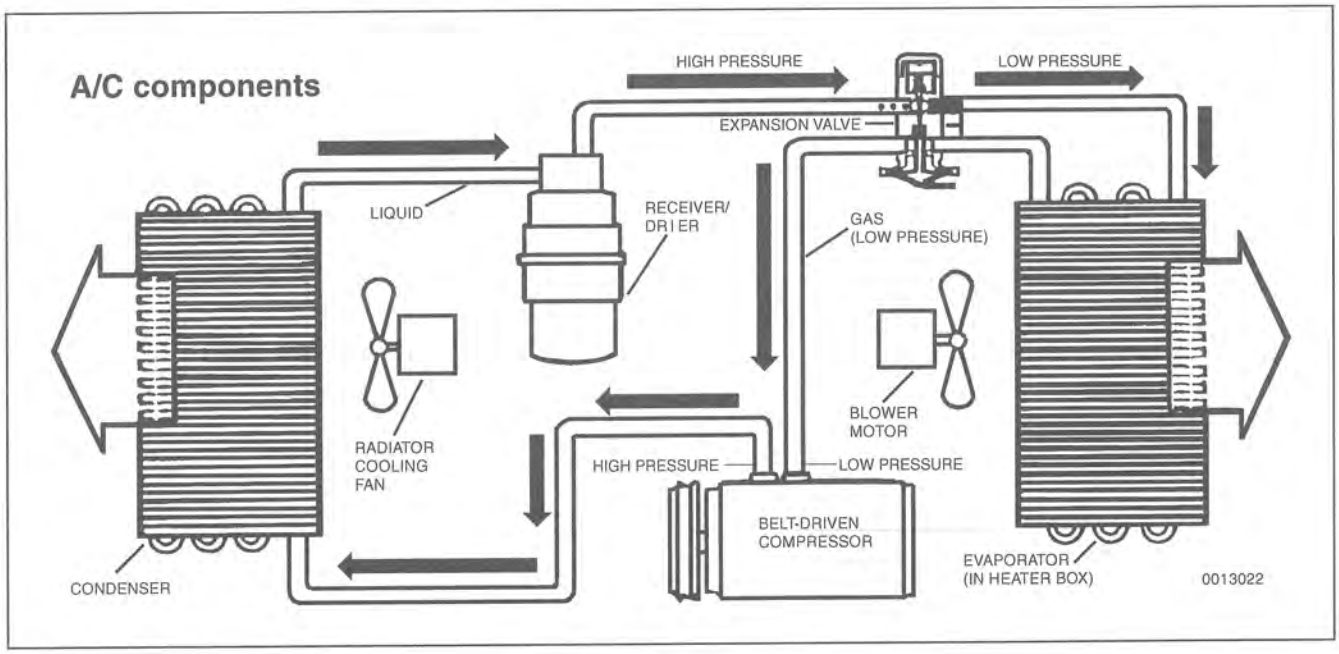
0011877

To remove an air distribution motor, disconnect harness connector and unclip (**arrow**) motor with gearbox from heater box.

AIR CONDITIONING

This section covers removal and installation of air conditioning components. A/C refrigerant discharge, evacuation and recharge are not covered here.

The subassemblies and lines of the air conditioner are filled with either refrigerant R-12 (1989–1992 cars) or R-134a (1993–1994 cars).



A/C system, warnings and cautions

WARNING—

- *Work in a well ventilated area. Avoid breathing refrigerant vapors. Exposure may irritate eyes, nose, and throat. Switch on exhaust/ventilation systems when working on the refrigerant system.*
- *Always be careful that refrigerant does not come in contact with your skin. Always wear hand and eye protection (gloves and goggles) when working around the A/C system. If refrigerant does come in contact with your skin or eyes:*
  -Do not rub skin or eyes
  -Immediately flush skin or eyes with cool water for 15 minutes
  -Rush to a doctor or hospital.
  -Do not attempt to treat yourself.
- *Refrigerant gases are heavier than air, displace oxygen and may cause suffocation in areas of poor circulation, for example under a car.*
- *Do not discharge/charge the A/C system without proper equipment and training. Damage to the vehicle and personal injury may result.*
- *The A/C system is filled with refrigerant gas which is under pressure. Pressurized refrigerant in the presence of oxygen may form a combustible mixture. Never introduce compressed air into any container (full or empty), capped off A/C component, or piece of service equipment.*
- *State and local governments may have additional requirements regarding air conditioning servicing. Always comply with state and local laws.*
- *Do not expose any component of the A/C system to high temperatures (Above 80°C/176°F) or open flames. Excessive heat will cause a pressure increase which could burst the system.*
- *Keep refrigerant away from open flames. Poisonous gas will be produced if it burns. Do not smoke near refrigerant gases for the same reason.*
- *Electric welding near refrigerant hoses causes R-134a to decompose. Discharge system before welding.*

CAUTION—

- *The mixture of refrigerant oil (PAG oil) and refrigerant R-134a attacks some metals and alloys (for example, copper) and breaks down certain hose materials. Use only hoses and lines that are identified with a green stripe or the lettering "R-134a".*
- *Immediately plug open connections on A/C components to prevent dirt and moisture contamination.*
- *R-134a and R-12 systems use different size service fittings. Never use adapters to convert an R-12 fitting to R-134a size.*
- *Do not steam clean condensers or evaporators. Use only cold water or compressed air.*

CAUTION—

- *It is recommended that all service to the A/C system refrigerant components be left to an authorized BMW dealer or other qualified A/C service facility. If any of the refrigerant components are disconnected or removed, special equipment, supplies, and new parts will be needed to remove moisture from the system and recharge the refrigerant before it is closed back up.*
- *As of January 1, 1992 any person who services a motor vehicle air conditioner must, by law, be properly trained and certified, and use approved refrigerant recycling equipment. Technicians must complete an EPA-approved recycling course to be certified*
- *Do not top-off a partially charged refrigerant system. Discharge system, evacuate and then recharge system.*
- *Service equipment for the R-134a and R-12 systems are not compatible. Use proper service equipment. Damage to both vehicle and service equipment will result from R-12 contamination of R-134a.*

A/C compressor, replacing (M30 engine)

– Following manufacturer's instructions, connect an approved refrigerant recovery/recycling/recharging unit to A/C system and discharge system.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove air cleaner assembly from right (passenger side) front corner of engine compartment.

– Remove drive belt from A/C compressor. See **020 Maintenance**.

– Cut tie-wrap retaining A/C compressor electrical harness to refrigerant hose. Disconnect harness connector from compressor.

– Detach A/C pressure and suction hoses (**arrows**) from compressor. Plug hoses and fittings immediately.



0011878

– Raise and support car.

WARNING—

Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Remove engine splash shield from under car.

– Loosen (but do not remove) compressor mounting nuts.

– Swing compressor towards engine and remove drive belt.

– Remove compressor mounting nuts and remove compressor.

– Installation is reverse of removal. Replace O-rings at pressure fittings.

> ***CAUTION—***
> *Do not re-use O-rings when reconnecting refrigerant lines. Always replace O-rings.*

- Be sure there is sufficient oil in compressor.
- Before recharging, evacuate system for at least 30 min.
- Recharge system following equipment manufacturer's instructions.

Tightening Torques (M30 engine)

- A/C compressor to engine block . . . .22 Nm. (17 ft-lb)
- A/C line flange to A/C compressor
  5/8 in. line . . . . . 20 Nm (15 ft-lb)
  3/4 in. line . . . . . 39 Nm (29 ft-lb)
  7/8 in. line . . . . . 42 Nm (31 ft-lb)
  11/16 in. line . . . . . 48 Nm (35 ft-lb)

A/C compressor, replacing (M60 or M70 engine)

– Following manufacturer's instructions, connect an approved refrigerant recovery/recycling/recharging unit to A/C system and discharge system.

> ***WARNING—***
> *Do not discharge/charge the A/C system without proper equipment and training. damage to the vehicle and personal injury may result. Read warnings and cautions given earlier.*

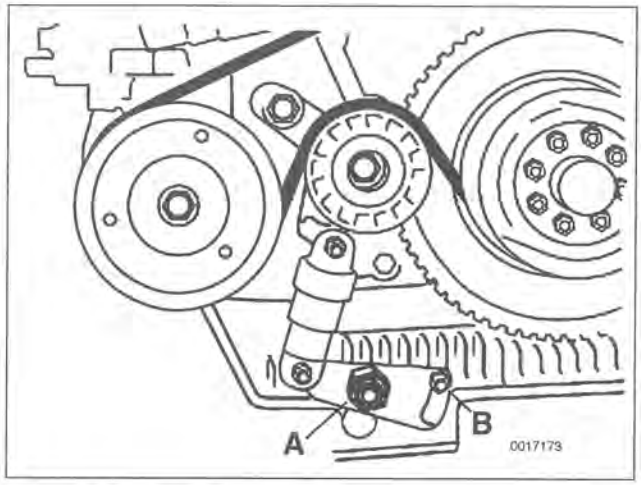
– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Raise and safely support car.

> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

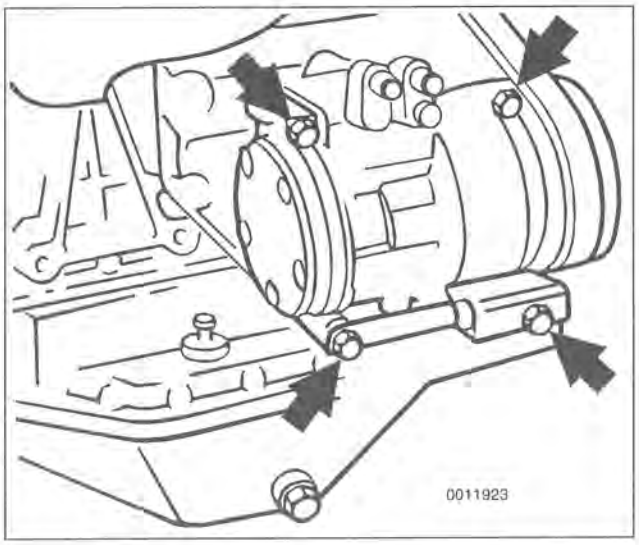
– Remove engine splash shield from under car.



To remove A/C compressor drive-belt, loosen nuts **A** and **B**. Swivel adjuster down and retighten nut **B**.

- Remove A/C compressor drive belt.

– Disconnect suction and pressure hoses from A/C compressor. Plug openings immediately.



➤ Remove A/C compressor mounting bolts (**arrows**) and remove compressor. M60 engine shown. M70 engine is similar.

– Installation is reverse of removal.

> ***CAUTION—***
> *Do not re-use O-rings when reconnecting refrigerant lines. Always replace O-rings.*

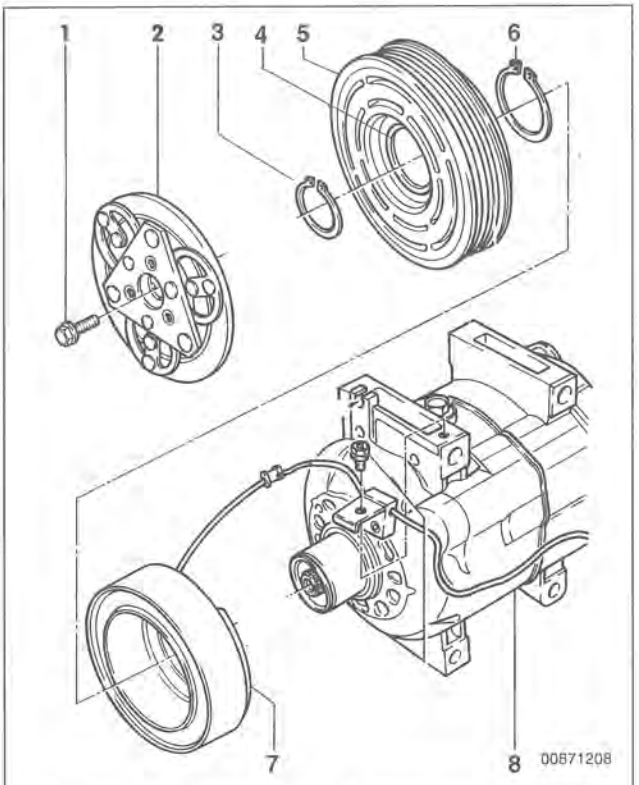
- Be sure there is sufficient oil in compressor.
- Before recharging, evacuate system for at least 30 min.
- Recharge system following equipment manufacturer's instructions.

Tightening Torques (M60/M70 engine)

- A/C compressor to engine block . . . .22 Nm. (17 ft-lb)
- A/C line flange to A/C compressor
  - 5/8 in. line . . . . . 20 Nm (15 ft-lb)
  - 3/4 in. line . . . . . 39 Nm (29 ft-lb)
  - 7/8 in. line . . . . . 42 Nm (31 ft-lb)
  - 11/16 in. line . . . . . 48 Nm (35 ft-lb)

Oil Capacities for A/C Compressors

- R12 drum type . . . . . 300 cm^3
- R12 impeller type . . . . . 200 cm^3
- R134a Nippondenso . . . . . 160-190 cm^3
- R134a Seiko Seiki . . . . . 180-200 cm^3



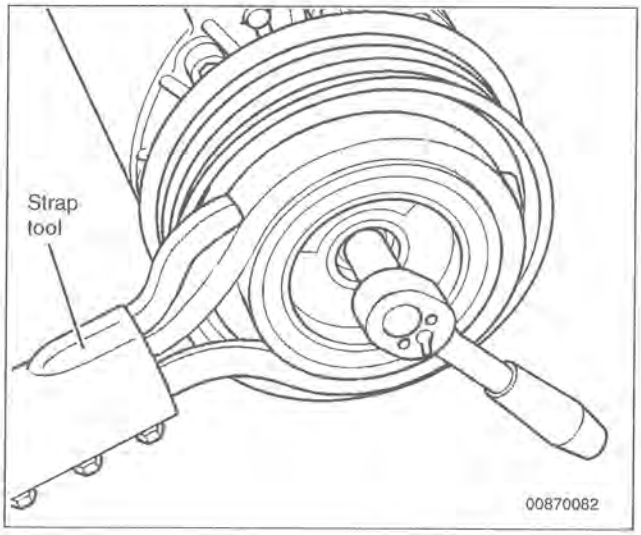
1. Clutch plate retaining bolt
2. Driveplate
3. Pulley retaining circlip
4. Clutch bearing
5. A/C compressor pulley
6. Clutch retaining circlip
7. Clutch (magnetic winding)
8. Compressor

A/C Compressor Clutch

The compressor clutch can be replaced without disturbing the sealed refrigerant system, although clearances may be very tight. Remove splash shield from below engine and detach the compressor from the compressor bracket to gain extra clearance.

➤ A/C compressor and clutch components.

> ***CAUTION—***
> *Do not allow compressor to hang by refrigerant lines. Hang compressor from chassis using stiff wire.*



A/C compressor driveplate must be held stationary with strap tool or equivalent to allow removal of retaining bolt.

- Remove drive plate and pulley to access clutch magnetic winding.

NOTE—

- *BMWs are equipped with compressors from various manufacturers. Special tools may be required to remove driveplate or pulley.*
- *During installation make sure to reinstall all spacer shims. The correct spacing between clutch drive plate and pulley is 0.5 - 0.8 mm (0.020 - 0.031 in).*

Tightening Torque

- Compressor clutch bolt to compressor shaft . . . . . 20 Nm (15 ft-lb)
- Compressor to engine . . . . . 22 Nm (17 ft-lb)

A/C condenser, replacing

– Following manufacturer's instructions, connect an approved refrigerant recovery/recycling/recharging unit to A/C system and discharge system.

WARNING—
Do not discharge/charge the A/C system without proper equipment and training. damage to the vehicle and personal injury may Result. read warnings and cautions given earlier.ult. Read warnings and cautions given under **A/C system, warnings and cautions**.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

– Remove front bumper and center radiator grille. See **510 Exterior Trim, Bumpers**.

– Detach electrical connector from auxiliary cooling fan and remove fan. See **170 Radiator and Cooling System**.

– Detach A/C lines from lower right corner of condenser. Plug lines and fittings immediately.



0011882

➢ Remove A/C condenser mounting bolts (**arrows**) on radiator support.

– Lift up condenser to disengage from lower mounts and remove from below.

– Installation is reverse of removal.

CAUTION—

• Do not re-use O-rings when reconnecting refrigerant lines. Always replace O-rings.

• When installing a new condenser always replace the receiver/drier unit.

- Before recharging, evacuate system for at least 30 min.
- Recharge system following equipment manufacturer's instructions.
- For capacities, see **Table e.**

Tightening Torques (A/C condenser)

- A/C lines to receiver/drier
  5/8 in. line . . . . . 20 Nm (15 ft-lb)
  3/4 in. line . . . . . 39 Nm (29 ft-lb)
  7/8 in. line . . . . . 42 Nm (31 ft-lb)

A/C receiver/drier, replacing

The A/C receiver/drier is mounted in the right side of the engine compartment beneath the windshield washer tank.

CAUTION—

The receiver/drier must be replaced when
–There is dirt in the A/C system
–The compressor has seized or has been replaced for any reason
–The condenser or evaporator are replaced for any reason
–The A/C system is leaking and there is no more refrigerant
–The A/C system was open for 24 hours or more.

NOTE—

There have been two types of receiver/driers installed on E32 cars. Up to 9/1988, three separate switches were used to monitor the receiver/drier. On 9/1989 and later cars, one switch with three functions was used.

– Following manufacturer's instructions, connect an approved refrigerant recovery/recycling/recharging unit to A/C system and discharge system.

WARNING—

Do not discharge/charge the A/C system without proper equipment and training. damage to the vehicle and personal injury may result. Read warnings and cautions given earlier.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove right headlight assembly. See **630 Exterior Lighting**.

– Disconnect harness connectors from windshield washer tanks (upper and lower) and remove both tanks. See **611 Wipers and Washers**.

– Detach refrigerant pressure lines from receiver/drier.



0017182

– Detach A/C receiver/drier harness connector and remove mounting bolts (**arrows**). R12 type receiver/drier.

– Remove receiver/drier complete with safety switch(es).

– Installation is reverse of removal.

> ***CAUTION—***
> *Do not re-use O-rings when reconnecting refrigerant lines. Always replace O-rings.*

- Change switch(es) over to new receiver/drier.
- Before recharging, evacuate system for at least 30 min.
- Recharge system following the equipment manufacturer's instructions.

Tightening Torques (A/C receiver/drier)

- A/C lines to receiver/drier
  - 5/8 in. line . . . . . 20 Nm (15 ft-lb)
  - 3/4 in. line . . . . . 39 Nm (29 ft-lb)
  - 7/8 in. line . . . . . 42 Nm (31 ft-lb)
- Pressure switches
  - High/med . . . . . 25 Nm (18 ft-lb)
  - Low . . . . . 19 Nm (14 ft-lb)
  - 3-way . . . . . 25 Nm (18 ft-lb)

A/C evaporator and expansion valve, removing and installing

– Following manufacturer's instructions, connect an approved refrigerant recovery/recycling/recharging unit to A/C system and discharge system.

> ***WARNING—***
> *Do not discharge/charge the A/C system without proper equipment and training. damage to the vehicle and personal injury may result. Read warnings and cautions given earlier.*

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove hose from coolant expansion tank and disconnect electrical connector from level sensor in tank. Unbolt tank and move aside.

– Unclip wire harness protective cover on engine compartment rear bulkhead. Cut wire ties as necessary.

➢ Remove 5 bulkhead splash shield retaining screws (**arrows**).



0011862

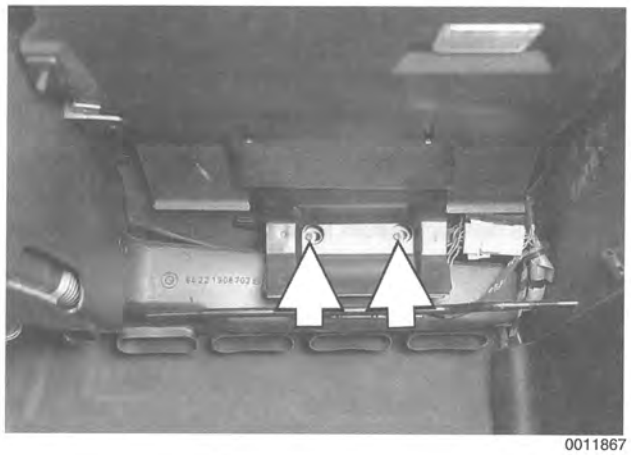


0011886

➢ Working in cowl area remove mounting nut and screws (**arrows**) at refrigerant line fitting.

> ***NOTE—***
> *Nut on refrigerant fitting may be fastened with Loctite®270. Heating with a hot air blower may be necessary to loosen.*

– Remove carpeted trim panel on right side of center console. Remove center console and glove box. Remove glove box support frame. See **513 Interior Trim**.



0011867

➢ Remove screws (**arrows**) retaining ventilation duct and remove duct.

– Cut wire ties holding wire harness to right side of heater housing and disconnect and move wiring to gain access to evaporator cover.



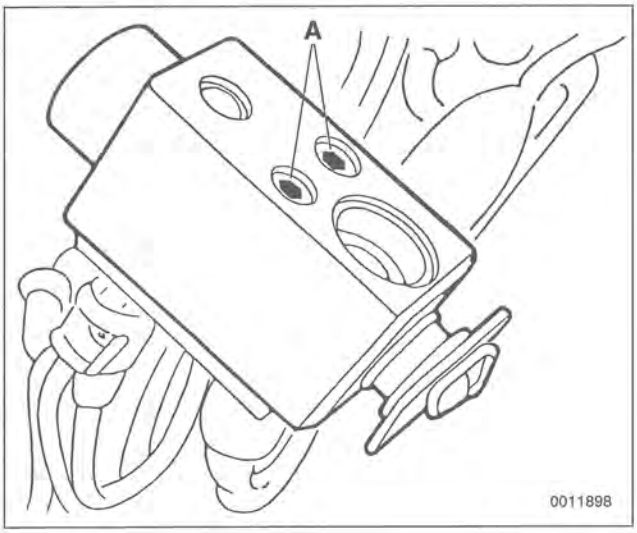
0011888

➢ Remove evaporator cover mounting screws (**arrows**) and remove cover.



0011887

➢ Remove screw (**arrow**) from expansion valve and separate refrigerant line fitting from expansion valve. Discard O-rings.



➢ Remove expansion valve mounting screws (**A**) and remove valve.

– Slide evaporator out of housing.

– Installation is reverse of removal.

> ***CAUTION—***
> *Do not re-use O-rings when reconnecting refrigerant lines. Always replace O-rings.*

- Before recharging, evacuate system for at least 30 min.
- Recharge system following equipment manufacturer's instructions.
- For capacities, see **Table e**.

A/C evaporator temperature sensor, replacing

The evaporator temperature sensor is mounted in the left side of the evaporator housing behind the center console. The sensor can be reached after removing the carpeted trim panel from the left side of the console.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– In left footwell, remove carpeted trim panel from center console.



➢ Disconnect electrical connector from evaporator temperature sensor and pull sensor (**arrow**) straight out of evaporator housing.

– Installation is reverse of removal. **Table d** lists evaporator temperature sensor test values.

Table d. Evaporative Temperature Sensor Test Values

Test Temperature	Resistance
-5°C 23°F)	11.4 - 11.9 k ohms
0°C (32°F)	8.8 - 9.2 k ohms
5°C (41°F)	6.8 - 7.2 k ohms
10°C (50°F)	5.3 - 5.6 k ohms
15°C (59°F)	4.2 - 4.5 k ohms
20°C (68°F)	3.3 - 3.6 k ohms
25°C (77°F)	2.6 - 2.9 k ohms
30°C (86°F)	2.1 - 2.3 k ohms
35°C (95°F)	1.7 - 1.9 k ohms

Microfilter, replacing

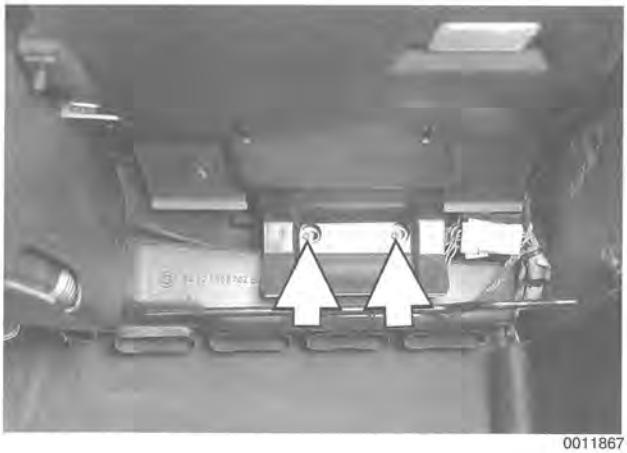
Outside air comes into the car through a filter fitted in the forward portion of the heater box and accessible through the right footwell. Some early E32 cars are not equipped with a pollen microfilter. In general, 1988 through 1990 cars do not have a filter. Some 1991 cars may and may not have a filter.

– From inside car, remove glove box. See **513 Interior Trim**.

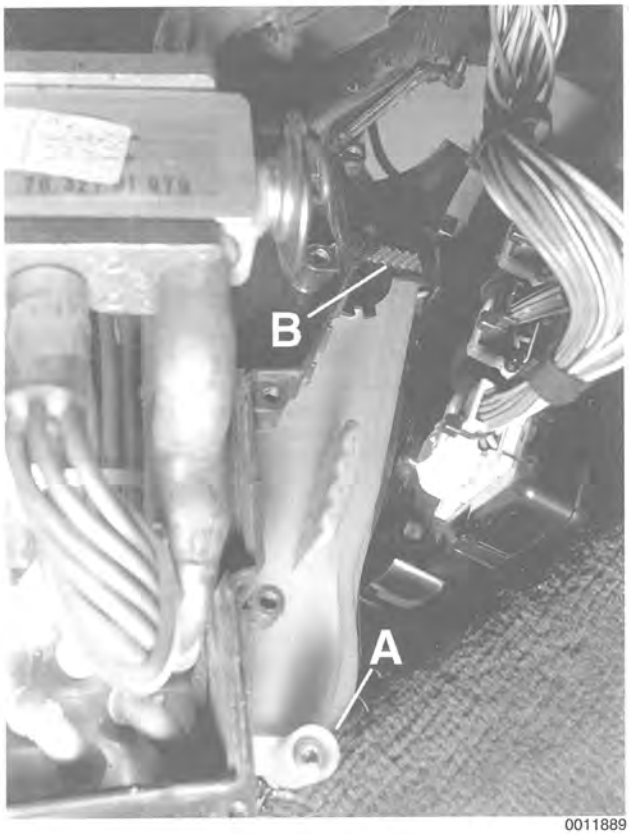
– In right footwell, remove carpeted trim panel from center console.

– Remove trim panel from above glove compartment.

➢ Remove two screws (**arrows**) retaining ventilation duct and remove duct.



0011867



0011889

➢ Remove cover screw (**A**) from microfilter housing and turn locking lever (**B**) to release.

– Pull microfilter out of housing and discard.

– Installation is reverse of removal.

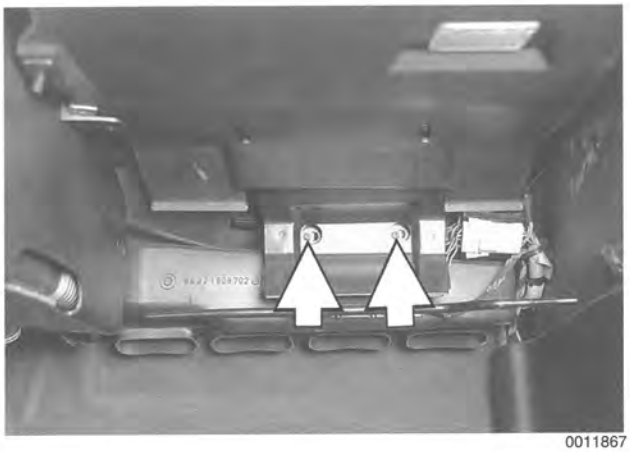
A/C control module, removing and installing

The A/C control module is mounted ahead of the evaporator on top of the transmission tunnel.

– Remove glove compartment. See **513 Interior Trim**.

– Remove center console carpeted side panels at right and left sides.

– Remove screws retaining trim panel above glove box and remove trim panel, disengaging from clip at rear.


0011867

➢ Remove retaining screws (**arrows**) or clips retaining ventilation duct and remove duct.

– Separate electrical connectors from A/C control module on right and left sides. Push aside wiring harness.



0017192

➢ Depress clip (**arrow**) and slide control module out.

Table e. A/C System Refrigerant Capacities

	Quantity
R-12 refrigerant	1925 g ± 25 g (4.24 lbs.± 0.05 lbs.)
R-134a refrigerant	1550 g ± 25 g (3.42 lbs.± 0.05 lbs.)
R-134a oil Nippondenso Seiko Seike	 160 ml + 30 ml 180 ml ± 20 ml
PAG oil SP-10	200 ml ± 20 ml (6.8 oz. ± 0.7 oz.)



650 Radio

GENERAL 650-1

RADIO SERVICE 650-1
Radio, removing and installing 650-1
Front speaker (left footwell), removing and installing 650-2
Front speaker (right footwell), removing and installing 650-2
Rear speaker(s), removing and installing . . . 650-3
Dashboard speaker, removing and installing 650-3
Mirror triangle speaker, removing and installing 650-3
Radio connectors 650-4

TABLE
a. Radio Connector Terminal Designation 1991 and later 650-4

GENERAL

This section covers the BMW factory installed sound system including radio and speaker removal, radio connectors and terminal designations. The antenna is incorporated into the rear window defogger.

RADIO SERVICE

Radio, removing and installing

CAUTION—

- *Before beginning work on the radio or sound system verify that the radio is an original equipment BMW radio and that the wiring harness has not been modified.*
- *Aftermarket radios, amplifiers, speakers, etc. are beyond the scope of this manual. Servicing of aftermarket sound equipment should be referred to an authorized agent of the equipment in question.*
- *Do not remove radio or disconnect the battery without obtaining the anti-theft code.*



0011845

– Swing open small square covers at left and right sides of radio.

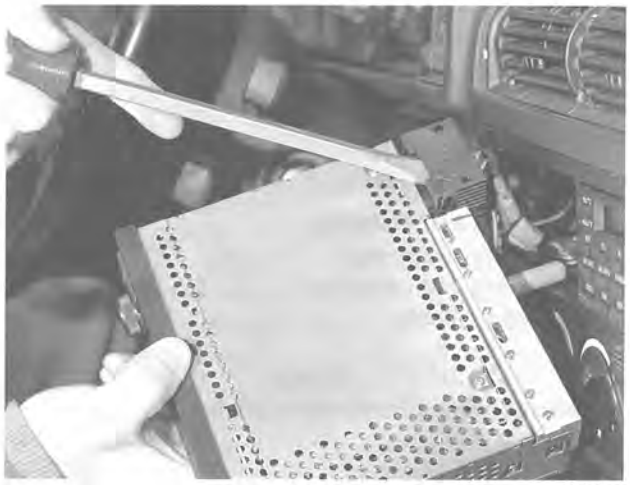
➢ Using hex key, turn screw counterclockwise to loosen.

– Pull radio out of instrument panel opening.

– Remove connector(s) from rear of radio.

– Installation is reverse of removal.

650

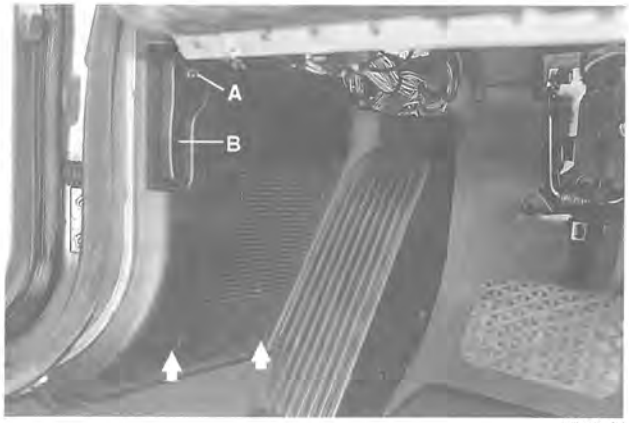


0011846

- On 1991 and later cars, disconnect the large harness connector using a screwdriver. Pry up on connector until it slides up and disconnects from radio.

Front speaker (left footwell), removing and installing

- Remove pedal cluster trim panel and lower left dash panel. See **513 Interior Trim**.
- Pull off door seal from edge of speaker cover.



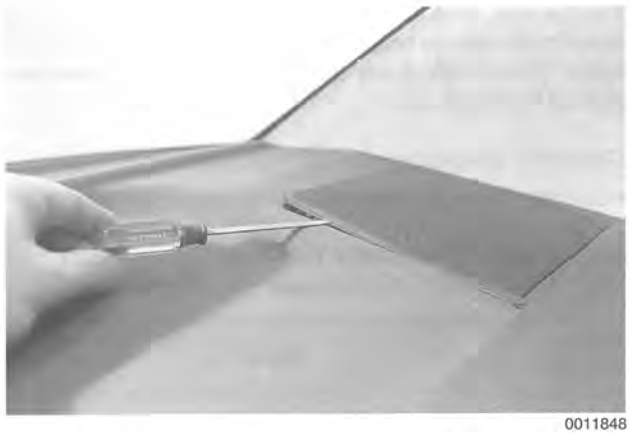
0011847

- Remove hood release latch cover, if applicable, and remove bolt (**A**) from center of hood latch release lever. Remove lever (**B**) and turn retainers 90° (**arrows**).
- Rotate trim panel retainers 90° degrees and pull out. Remove speaker trim panel.
- Disconnect speaker connector and remove nuts holding speaker to cover.
- Installation is reverse of removal.

Front speaker (right footwell), removing and installing

- Remove door seal at edge of speaker cover and turn retainer screws 90°.
- Pull speaker trim panel away from body and then pull panel back towards rear of car. Pull off speaker connector and remove nuts retaining speaker to panel.
- Installation is reverse of removal.

Rear speaker(s), removing and installing



0011848

➢ Remove speaker cover by prying up edge.

NOTE—
Pry up on rear edge of cover first to avoid breaking plastic retainer tabs.

– Remove mounting screws and partially remove speaker(s).

– Disconnect speaker connector(s) and remove speaker(s).

– Installation is reverse of removal.

Dashboard speaker, removing and installing

– Place screwdriver under edge of cover and pry cover off.

– Remove two screws and lift up speaker.

– Disconnect speaker connector and remove loudspeaker.

– Installation is reverse of removal.

Mirror triangle speaker, removing and installing

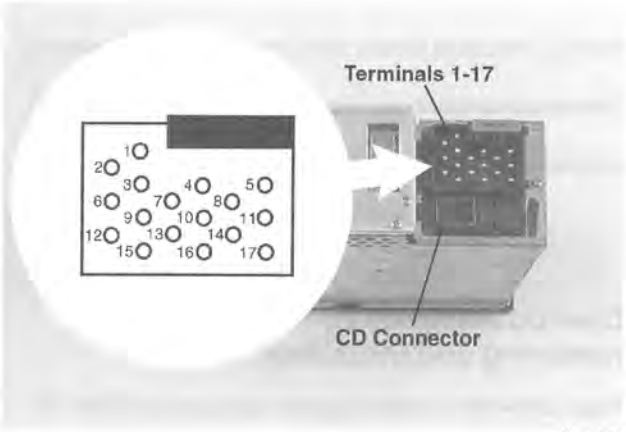


0017214

➢ Remove mirror triangle speaker mounting screw (**arrow**).

– Pull speaker out, disconnect speaker wires and remove speaker.

– Installation is reverse of removal.



0011850

Radio connectors

Table a lists radio connector pinouts for radios installed in later model vehicles covered by this manual. Early model vehicles (1989-1990) have the various terminals identified right on the connector.

Connector designations on 1991 and later radio.

- Use with **Table a** to identify the various terminals.

Table a. Radio Connector Terminal Designation 1991 and later

Connector Terminal	Signal
1	Speaker, left front +
2	Speaker, right front +
3	Speaker, left rear +
4	Telephone mute feature
5	Positive, Terminal R
6	Front speaker, left
7	I-bus connection
8	Speaker, left front
9	Constant positive, Terminal 30
10	Speedometer signal for speed-sensitive volume control
11	Speaker, right front
12	Speaker, left rear
13	Illumination terminal 58G
14	Speaker, right rear
15	Ground Terminal 31
16	Automatic antenna or window antenna amplifier or premium sound system amplifier
17	Not assigned



720 Seat Belts

GENERAL 720-1

FRONT SEAT BELT ASSEMBLY 720-1
Front seat belt height adjuster cable, replacing 720-2
Front seat belt lock tensioner, deactivating . . . 720-3
Front seat belt reel, removing and installing . . . 720-4

REAR SEAT BELT ASSEMBLY 720-5
Rear seat belts, removing and installing 720-5

GENERAL

The E32 cars are equipped with 3-point shoulder belts at four seating positions. A lap belt is used in the center of the rear seat.

Belts that do not retract and/or lock properly should be promptly replaced. The seat belt reels should lock when driving quickly through curves, during severe braking or during a collision. The automatic reel does not require any servicing and should never be opened.

WARNING—

- *For maximum protection from injury, seat belts should be replaced as a set (including all hardware), if they are subject to occupant loading in a collision.*
- *Seat belts should not be modified or repaired. The seat belt anchorage points should not be changed or modified.*
- *Do not install seats belts or seat belt hardware purchased from an auto-recycler or salvage yard. Only BMW original replacement seat belts, hardware and mounting bolts should be used.*
- *Do not bleach or dye seat belt webbing. Webbing that is severely faded, or re-dyed will not meet the strength requirements and must be replaced.*
- *Seat belts should be periodically inspected for webbing defects such as cuts or pulled threads.*

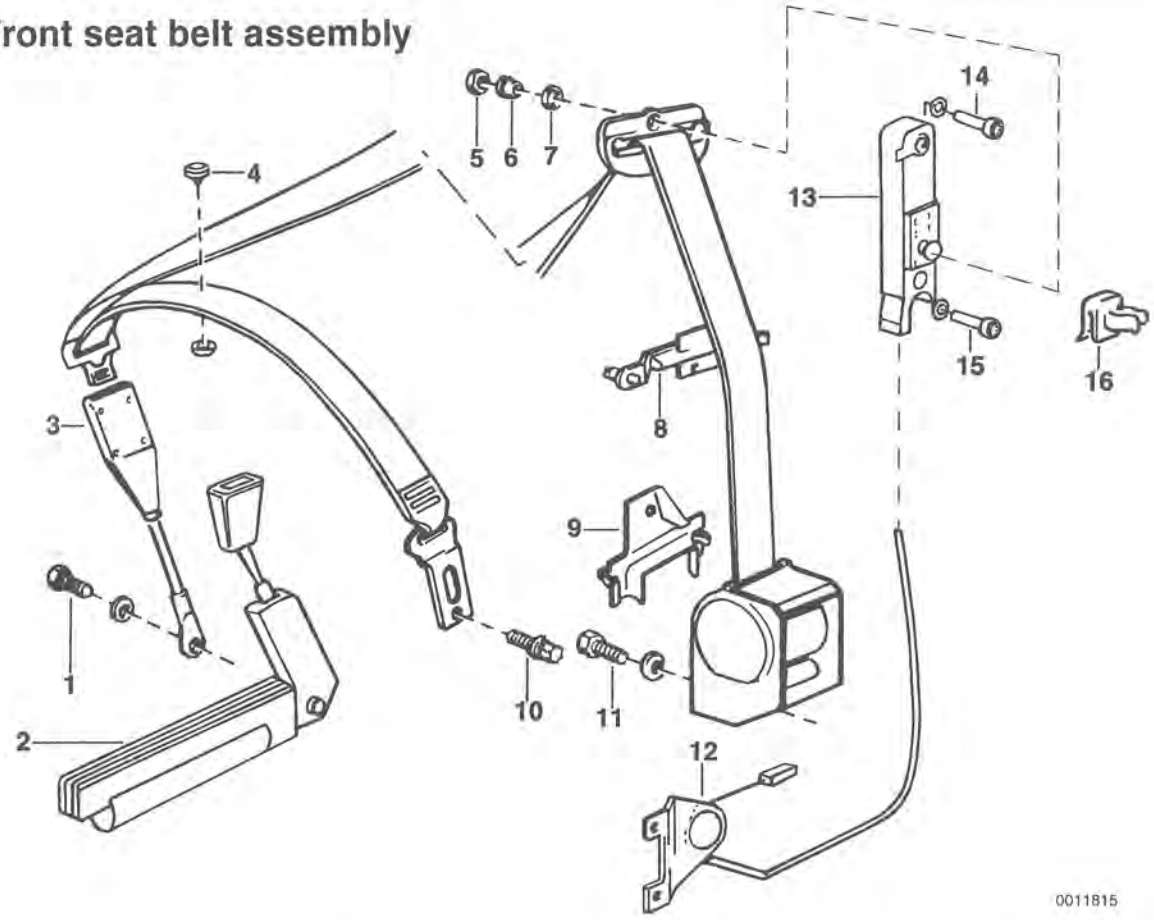
FRONT SEAT BELT ASSEMBLY

The front seat belt lock assembly varies depending on model year.

WARNING—

On late models cars (built from 9-93), an automatic seat belt lock tensioner is used on the front seats. A mechanical impact sensor activates the tensioner in the case of a head-on collision and retracts the seat belt approximately 55 mm (2 in.).This belt lock tensioner must be deactivated before servicing the seat. See **Front seat belt lock tensioner, disabling** *for identifying and disabling the lock tensioner.*

Front seat belt assembly



1. Bolt
2. Belt lock with tensioner (cars from 9-93) - always deactivate
3. Belt lock without tensioner, early cars
4. Button
5. Nut
6. Bushing
7. Thrust washer
8. Sliding piece
9. Bracket
10. Torx bolt
11. Hex bolt
12. Height adjuster cable assembly
13. Seat belt height adjuster
14. Socket head screw
15. Socket head screw
16. Cable holder

Front seat belt height adjuster cable, replacing

A cable-driven front seat belt adjuster is used on the front seat. The upper seat belt anchor on the door pillar (B-pillar) adjusts automatically in height when the front seat is moved forward and back.

– Disconnect height adjusting cable from under seat. Remove seat. See **520 Seats**.

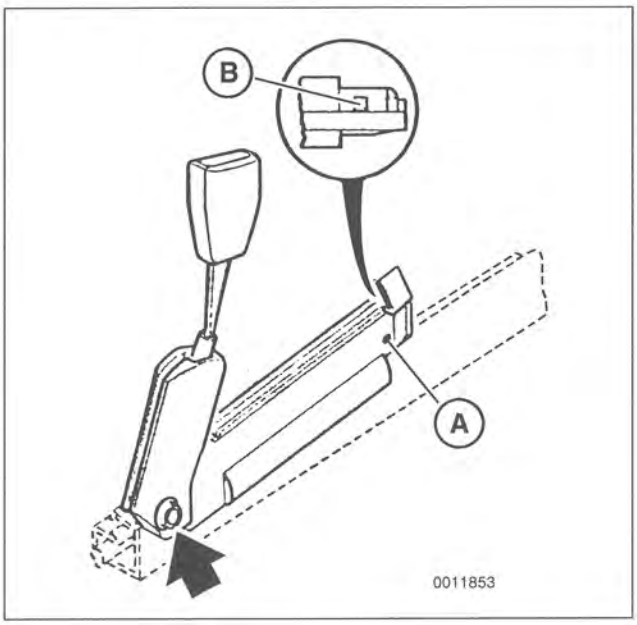
– Carefully pry off cable wheel assembly from floor. Pry up door sill plate and peel back carpet to access cable.



0011857

- Remove trim cover from B-pillar. Trim panel retain clips shown at **arrows**.
- Working at upper guide on B-pillar, press down tongue retaining cable end and remove cable from reversing wheel and guides.
- Installation is reverse of installation. Be sure to reattach all cable retaining clips.

Front seat belt lock tensioner, deactivating



- Working at side of seat, pry up concealing flap on tensioner.
- Front seat belt lock tensioner screw (**A**) and display (**B**). Seat belt lock mounting bolt shown at **arrow**.
  - Turn screw beneath flap clockwise until display changes from green to red.
- To activate lock tensioner, turn screw counterclockwise until green appears in window.

Tightening Torque

- Front seat belt lock mounting bolt . . . . 48 Nm (36 ft-lb)



0011857

Front seat belt reel, removing and installing

- Remove seat belt anchor bolt from beneath front seat.
- Starting at upper corners, peel rubber door seals away from B-pillar trim.
- Remove trim cover from B-pillar. Trim panel retain clips shown at **arrows**.
- Remove door lock/latch mounting screws at B-Pillar and partially remove latch.
- Remove seat belt guide bolt on B-pillar and remove guide. Remove two bolts holding cross bracket to B-pillar.
- Remove seat belt reel mounting bolt. Disconnect harness connector from reel assembly, where applicable. Remove reel with seat belt.
- Installation is reverse of removal.

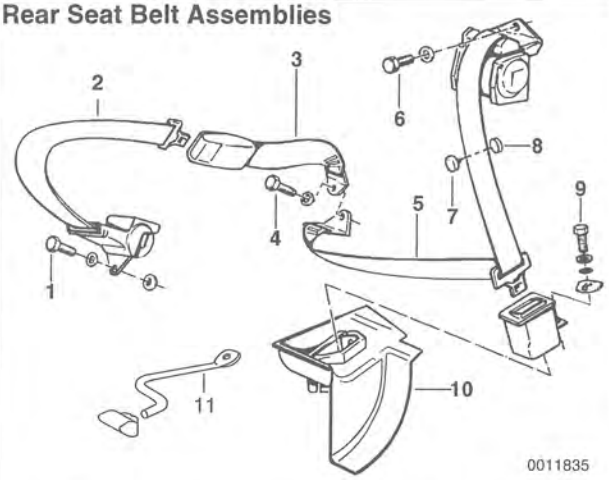
Tightening Torque

- Front seat belt guide bolt . . . . . 48 Nm (36 ft-lb)
- Front seat belt height control bolt . . . . 24 Nm (17 ft-lb)
- Front seat belt on B-pillar . . . . . 31 Nm (23 ft-lb)
- Front seat belt reel mounting bolt . . . . 48 Nm (36 ft-lb)

REAR SEAT BELT ASSEMBLY

Rear seat belts, removing and installing

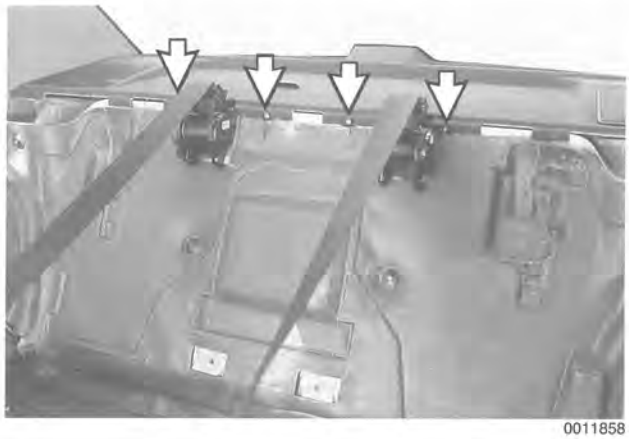
Rear Seat Belt Assemblies



1. Bolt
2. Center seat belt
3. Center seat belt lock
4. Bolt
5. Outside shoulder belt
6. Bolt
7. Button
8. Button
9. Bolt
10. Seat belt lock trim
11. Seat belt lock anchor (power rear seat only)

– Remove rear seat and back rest. See **520 Seats**.

– Remove seat belt anchor bolt from beneath rear seat.



➤ Remove parcel shelf retaining clips (**arrows**) and partially lift up parcel shelf. Bench seat model shown. Model with power rear seat similar.



➤ Remove seat belt reel mounting bolts (**arrows**) and remove seat belt and reel.

– Installation is reverse of removal.

Tightening Torque

- Rear seat belt reel to body . . . . . 48 Nm (36 ft-lb)



721 Airbag System (SRS)

GENERAL 721-1
SRS Warning Light and Fault Display. 721-1
AIRBAGS 721-1
Driver side airbag, removing and installing. . . 721-3
Passenger side airbag, removing and installing 721-4
Airbag contact ring, replacing 721-5
Airbag crash sensor, replacing 721-6

GENERAL

This repair group covers only removal and installation of airbag components. Airbag system repair and fault diagnosis is not covered here. Diagnostics, component testing, and repair should be carried out by properly trained BMW service technicians using specialized test equipment.

NOTE—
Special test equipment is required to retrieve SRS fault codes, diagnose system faults, and reset/turn off the SRS indicator light. The SRS indicator light will remain on until any problem has been corrected and the fault memory has been cleared.

When working on or servicing cars equipped with SRS, the precautions on this page must be observed to prevent injury.

SRS Warning Light and Fault Display

The airbag system utilizes a self-diagnostic control module to detect and store system faults. If a fault is detected, the SRS indicator in the instrument cluster comes on and stays on.

When the ignition key is turned on, the indicator light will illuminate for approximately 4-6 seconds. The light indicates the self-test of the electronic control/monitoring module, the ignitors and sensor circuits, and the system wiring. The airbag system should be inspected by an authorized BMW dealer if the indicator light does not come on, if it does not go out in approximately 4-6 seconds after switching on the ignition, or if the light comes on during driving. If the system has detected a fault, the light will come on and stay on.

AIRBAGS

Airbag system components include an electronic control/monitoring module, an indicator light in the instrument cluster and an inflatable airbag equipped with a gas generator in the steering wheel, and where applicable, an inflatable airbag equipped with a gas generator in the passenger side of the dashboard. In addition to the airbags, the vehicle is equipped with a knee bolster(s) for extra protection.

WARNING—

- *Airbag(s) are inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous. Special precautions must be observed prior to any work at or near the driver side airbag or the passenger side airbag (where applicable).*
- *The airbag is a vehicle safety system. Serious injury may result if system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures. BMW advises that all inspection and service be performed by an authorized BMW dealer.*
- *Always disconnect the battery and cover the negative (–) battery terminal with an insulator before starting diagnostic, troubleshooting or service work not associated with SRS, and before doing any welding on the car.*
- *If an airbag has been activated due to an accident, BMW specifies that SRS components be replaced. For more information on post-collision SRS service, see an authorized BMW dealer.*
- *Do not allow the airbag unit to come in contact with cleaning solutions or grease. Never subject an airbag unit to temperatures above 212°F (100°C). When reconnecting the battery, no person should be inside the vehicle.*
- *Always place an airbag unit that has been removed from its packaging with the padded side facing upward. Do not leave an airbag unit unattended.*
- *If the airbag unit or airbag control module has been dropped from a height of ½ meter (1½ ft.) or more, the airbag unit should not be installed.*

Driver Side Airbag System



1. Driver side airbag unit
2. Airbag control module/diagnosing unit
3. Knee protection
4. SRS indicator in instrument cluster
5. Crash sensors

Driver side airbag, removing and installing

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*



0011893

➢ Working behind steering wheel, remove Torx screws (**arrows**, T30 or T27) while holding airbag in place. Support airbag unit to prevent it from falling out.



0011892

➢ Carefully lift airbag unit off steering wheel and disconnect orange harness connector (**arrow**) from rear of airbag unit. Store airbag in safe place.

> ***WARNING—***
> - *Store the removed airbag unit with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*
> - *Once an airbag is removed, the car must not be driven. The airbag unit should be stored in a safe place with the horn pad facing up.*
> - *Do not connect the battery with the airbag disconnected. A fault code will be stored in the control module, causing the SRS light to illuminate. Special tools are needed to reset the fault memory.*

– Installation is reverse of removal.

- Place airbag unit into position and connect harness connector to rear of airbag unit.
- Tighten right side screw on airbag first (as viewed from the driver's seat), then left side screw.
- Reconnect battery last.

Tightening Torque

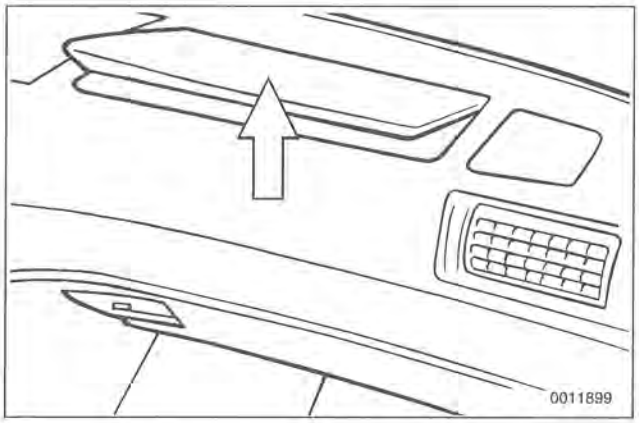
- Airbag unit to steering wheel . . . . . 8 Nm (71 in-lb)

> ***WARNING—***
> *Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the SRS warning light goes out. If the warning light stays on, the SRS system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.*

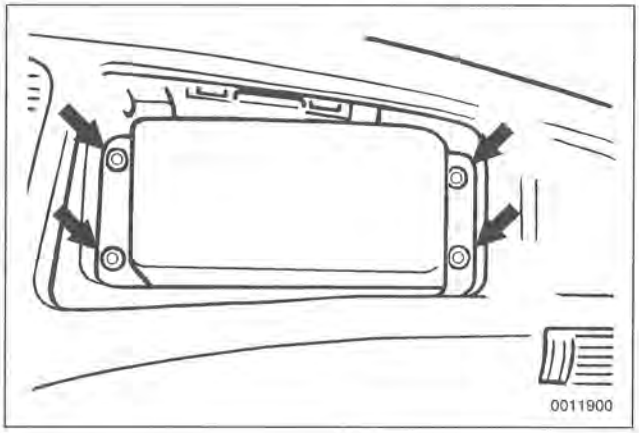
Passenger side airbag, removing and installing

– Disconnect negative (–) battery cable. See **020 Maintenance**.

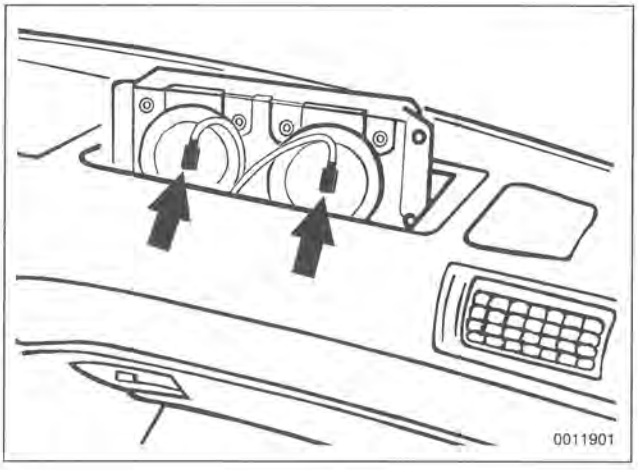
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*



➢ Carefully lift out cover from top of passenger side airbag on dashboard.



➢ Remove passenger side airbag mounting bolts (**arrows**).



➢ Disconnect electrical connectors (**arrows**) from rear of air bag unit and remove airbag.

> ***WARNING—***
> - *Store the removed airbag unit with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*
> - *Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the SRS warning light goes out. If the light stays on, the SRS system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.*

– Installation is reverse of removal. Make sure wiring harness is not pinched when installing airbag unit in dashboard.

Airbag contact ring, replacing

The airbag contact ring is mounted to the rear of the steering wheel and is made up of a wire ribbon that coils and uncoils as the steering wheel is turned. The contact ring assures continuous electrical contact to the driver side airbag unit.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove driver side airbag from steering wheel. See **Driver side airbag, removing and installing**.

– Remove steering wheel. See **320 Steering and Wheel Alignment**.

– Remove contact ring cover (flat plastic ring containing warning text) from steering wheel, if applicable.

➢ Pry out airbag contact ring lock (**arrow**) and remove spring from behind lock.

> ***WARNING—***
> • *The contact ring lock holds the contact ring in the centered position. Once the lock is removed from the steering wheel, the contact ring is free to rotate. Do not allow the contact ring to rotate once the lock is removed.*
>
> • *If the contact ring is accidentally rotated out of its center position, turn the ring either fully clockwise or counterclockwise, then turn it in the opposite direction 3 complete revolutions until the alignment arrow can be seen through the lock opening.*



0011903

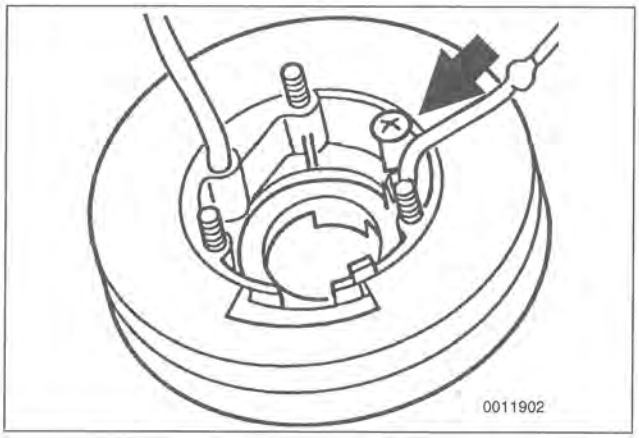
➢ Remove contact ring mounting nuts (**arrows**) nuts or screws. Disconnect wire lead(s) and remove contact ring from rear of steering wheel.



0011904

– Installation is reverse of removal, noting the following:

- Coat horn slip ring (electrical contact ring) with CRC® copper paste before installing steering wheel.
- When installing contact ring lock, make sure lock spring engages pins on lock and lock cover.
- Special instructions apply when installing airbag equipped steering wheel. See **320 Steering and Wheel Alignment**.
- Route wiring lead for horn through square opening in steering wheel.



Airbag contact ring locking screw (**arrow**), as installed on new replacement part from BMW.

- When installing a new contact ring from BMW, remove locking screw after installing the contact ring to steering wheel.
- Lock contact ring mounting nuts in place using lacquer paint or varnish.

Airbag crash sensor, replacing

The airbag system uses two crash sensors mounted in the engine compartment on the left and right wheel arches. The sensors are identified by their orange color.

– Disconnect negative (–) battery cable. See **020 Maintenance**.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*

– Remove lower left dash panel as described in **513 Interior Trim**.

– Remove lower steering column trim. Remove orange SRS connector from its holder and carefully separate connector.

– Remove passenger side airbag harness connectors as described in **Passenger side airbag, removing and installing** earlier in this section.



Working in engine compartment, remove anti-tamper Torx screws (**arrows**) from crash sensor. Remove sensor and disconnect harness connector.

– Installation is reverse of removal. Make sure arrow on sensor faces forward when installing sensor.

> ***WARNING—***
> *Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the SRS warning light goes out. If the warning light stays on, the SRS system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.*

Tightening Torques

- Airbag crash sensor to sensor mounting . . . . . .10 Nm (89 in-lb)



Electrical Wiring Diagrams

GENERAL ELE-1

WIRING DIAGRAMS ELE-2

ABS ELE-140
Air Conditioning and Heating ELE-149
Airbag (Supplemental Restraint System) . . ELE-174
Anti-Theft ELE-176
Charging System ELE-64
Cruise Control ELE-136
Data Link Connector ELE-110
Defogger ELE-196
Electronic Damping Control ELE-134
Engine Cooling ELE-117
Engine Management ELE-70
Exterior Lights ELE-217
Ground Distribution ELE-37
Headlights/Foglights ELE-209
Horns ELE-183
Instrument Panel ELE-199
Interior Lights/Illumination ELE-232
Memory Mirrors ELE-265
Memory Seats ELE-258
Memory Steering Column ELE-272
On-Board Computer ELE-205
Power Distribution ELE-2
Power Door Locks ELE-238
Power Mirrors ELE-248
Power Rear Sunshade ELE-277
Power Seats ELE-249
Power Sunroof ELE-276
Power Windows ELE-244
Radio/Cassette/CD/Speakers ELE-278
Servotronic Steering (Electronic Power Steering) ELE-133
Shift Interlock ELE-130
Soft Close Trunk Lid ELE-275
Starting ELE-58
Steering Column Power Adjustment ELE-273
Transmission Electronics ELE-123
Trunk/Fuel Door Release ELE-274
Warning Systems: Chimes ELE-208
Wiper/Washer ELE-186

ELECTRICAL COMPONENT LOCATIONS

Relay, fuse and control module positions, ground locations . . . . . see **Repair Group 610**

GENERAL

This section contains wiring diagrams for 1988 to 1994 BMW 7 Series vehicles.

WARNING—

On cars equipped with airbags, special precautions apply to any electrical system testing or repair. The airbag unit is an explosive device and must be handled with extreme care. Before starting any work on an airbag equipped car, refer to the warnings and cautions in ***721 Airbag System****.*

NOTE—

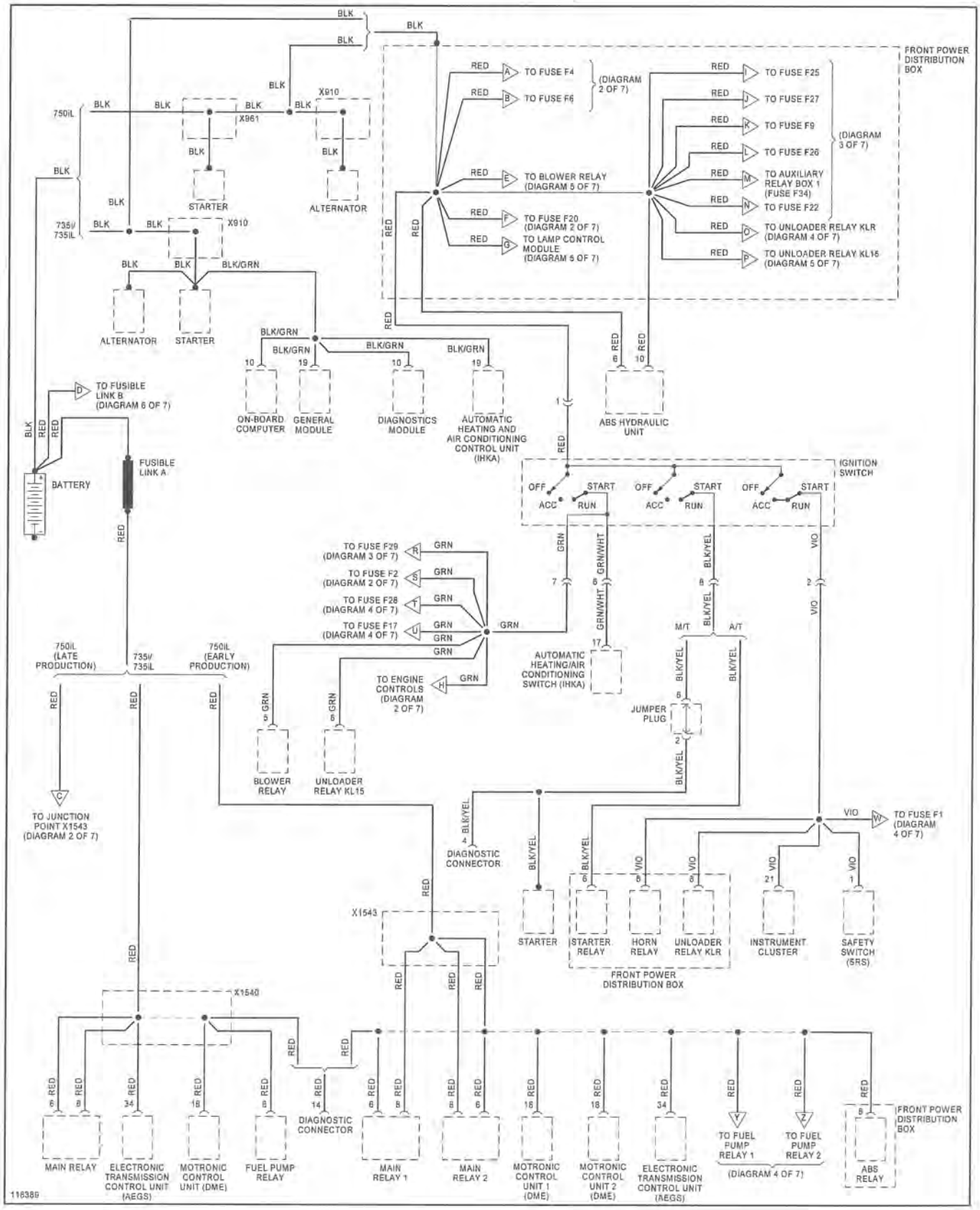
- *The gear position/neutral safety switch is also sometimes referred to as the automatic transmission range switch.*
- *Automatic stability control (ASC) and automatic stability control plus traction (ASC+T), also referred to as traction control, are grouped with anti-lock brakes (ABS).*

CAUTION—

- *Always switch the ignition off and remove the negative (–) battery cable before removing any electrical components. See* **020 Maintenance.**
- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*
- *Connect and disconnect ignition system wires, multiple connectors and ignition test equipment leads only while the ignition is switched off.*
- *Use a digital multimeter for electrical tests. The use of an analog meter may damage electronic components.*
- *Always switch a test meter to the appropriate function and range before making test connections.*

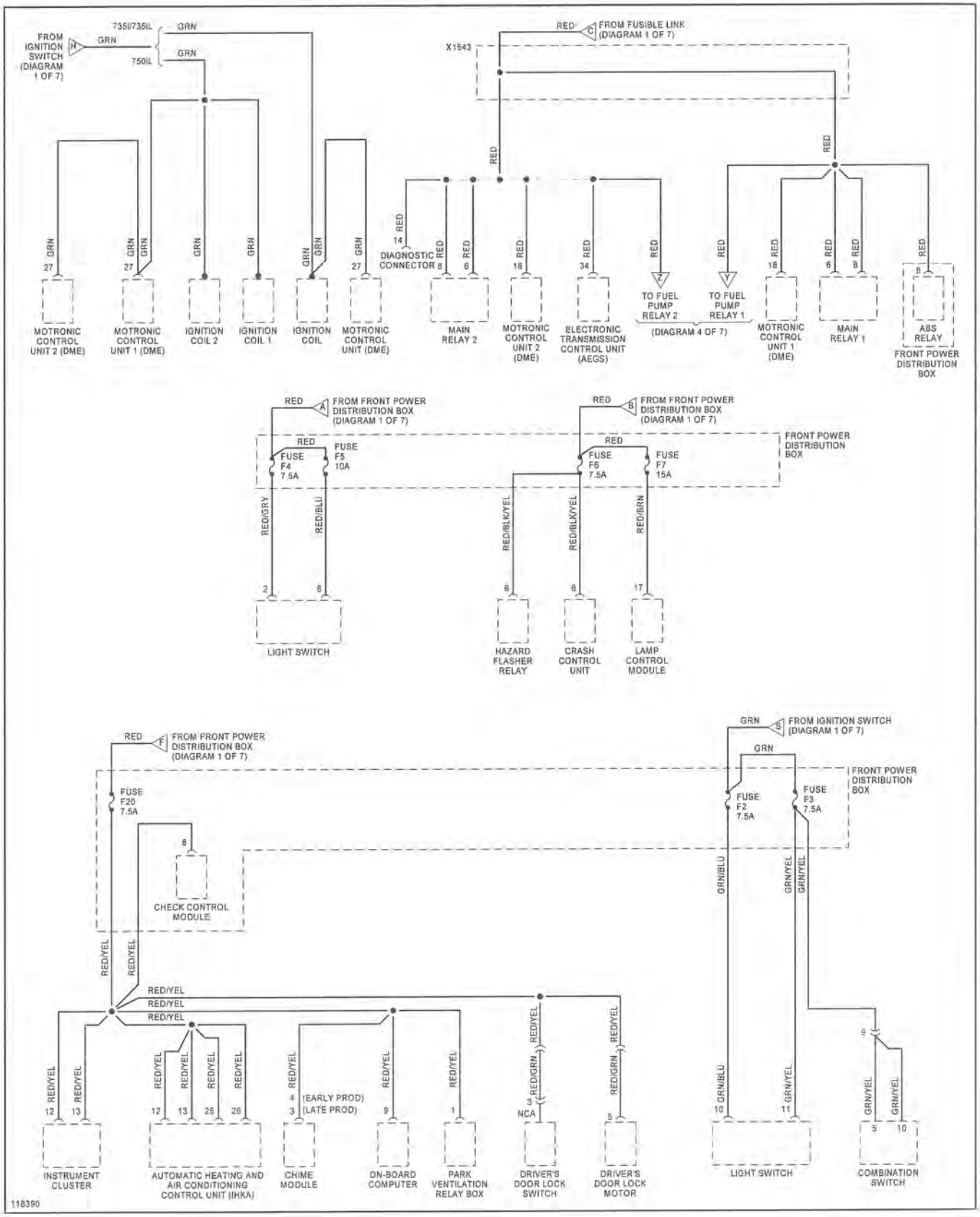
Power Distribution

1988 (1 of 7)

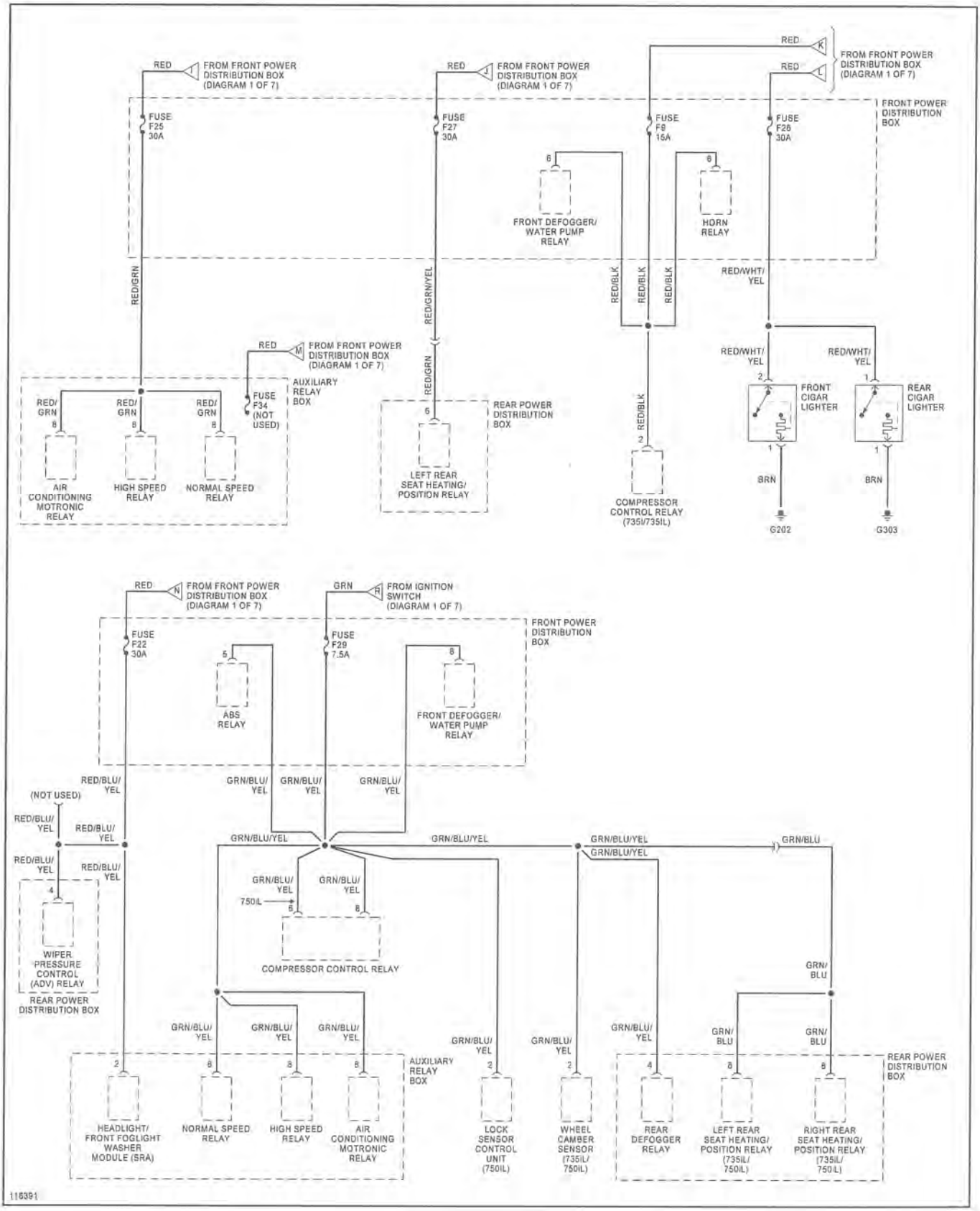


Power Distribution

1988 (2 of 7)

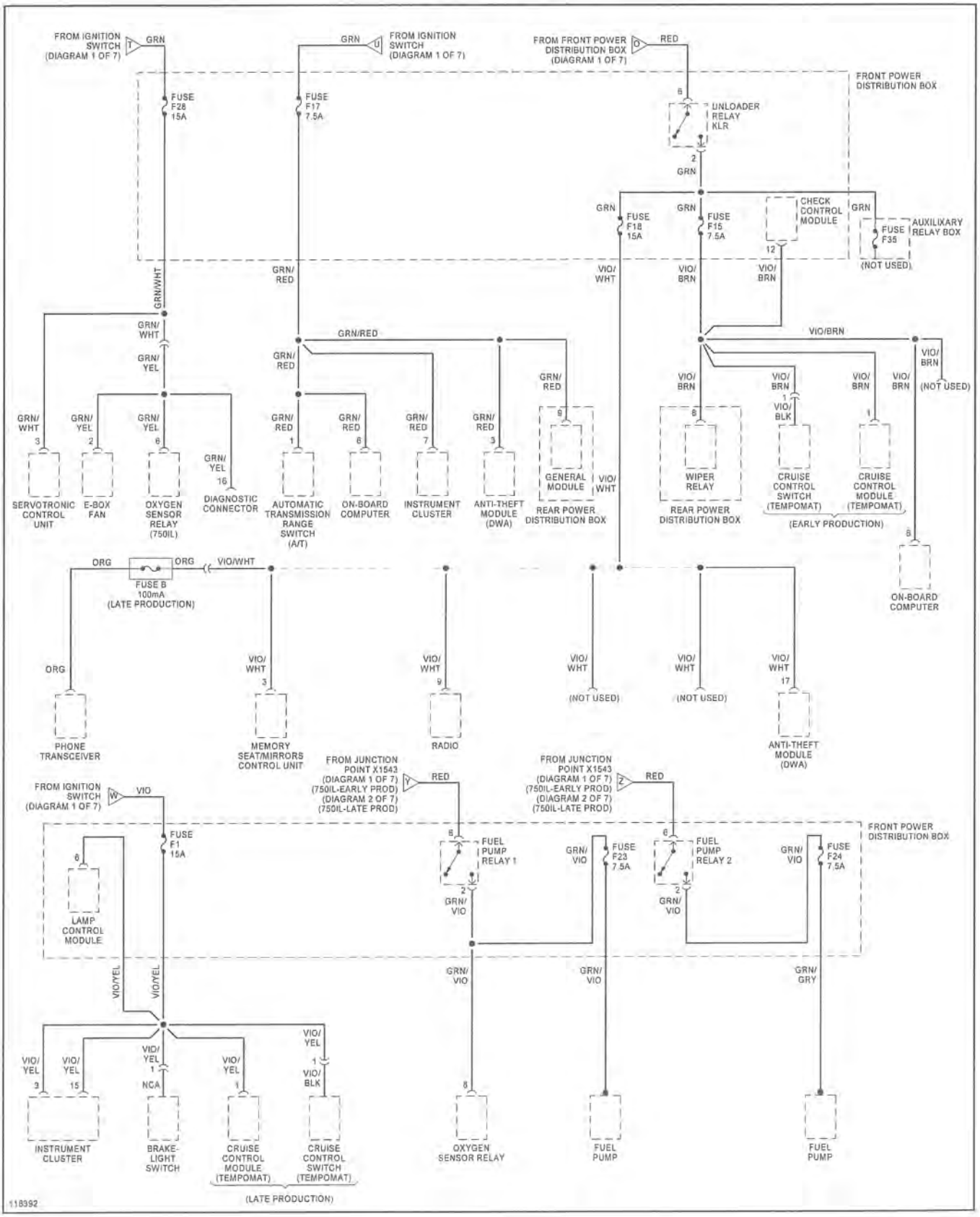


Power Distribution
1988 (3 of 7)



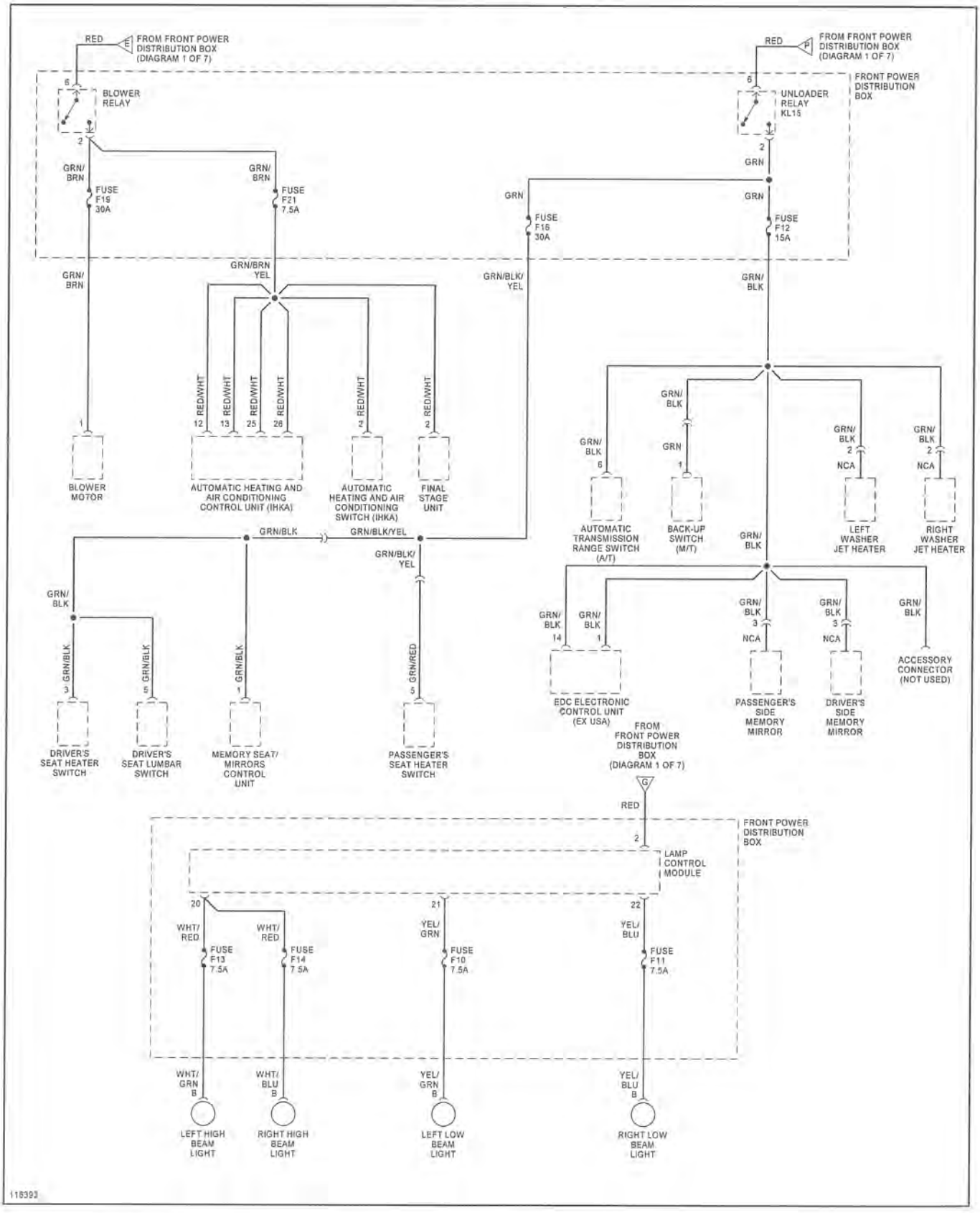
Power Distribution

1988 (4 of 7)



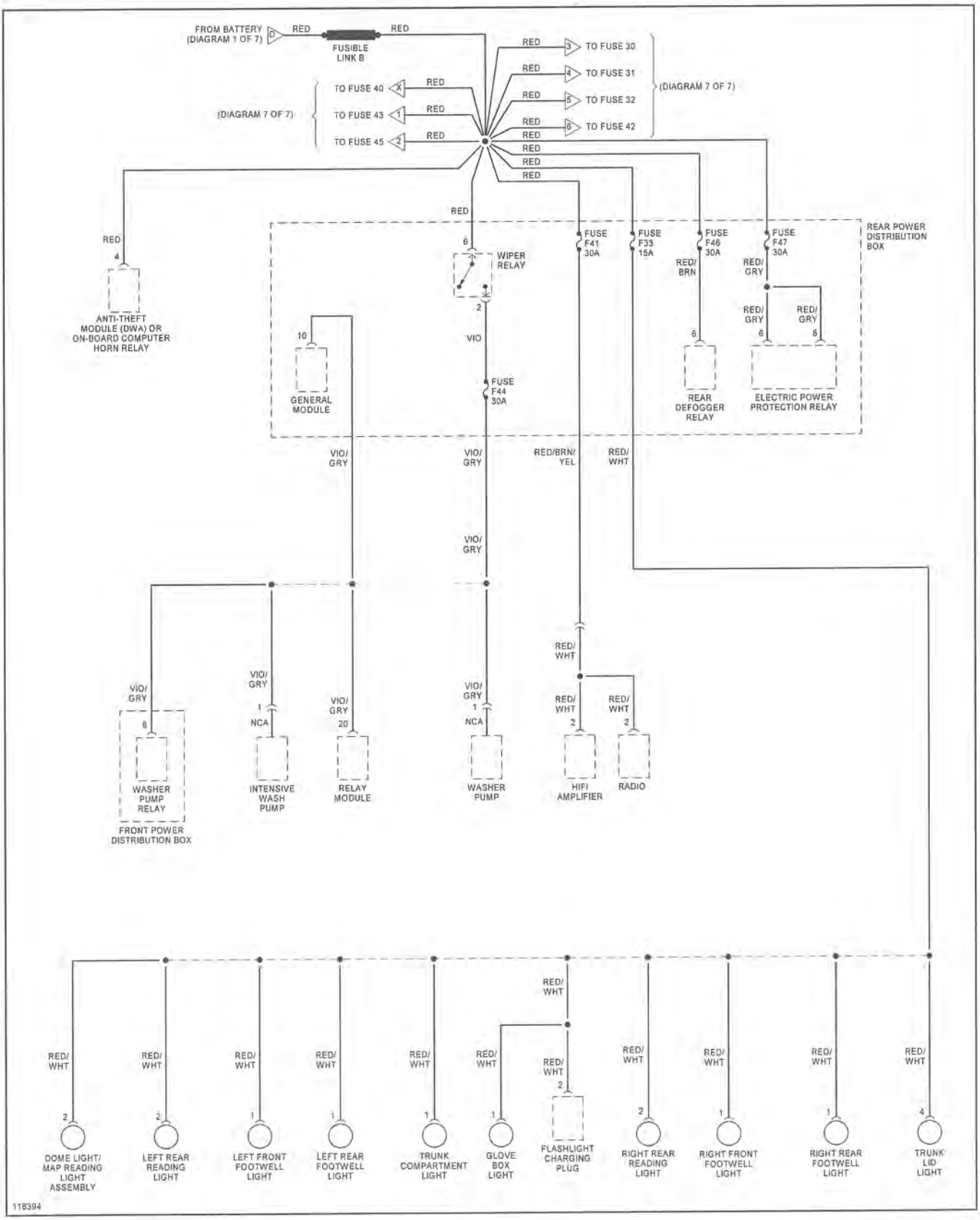
Power Distribution

1988 (5 of 7)

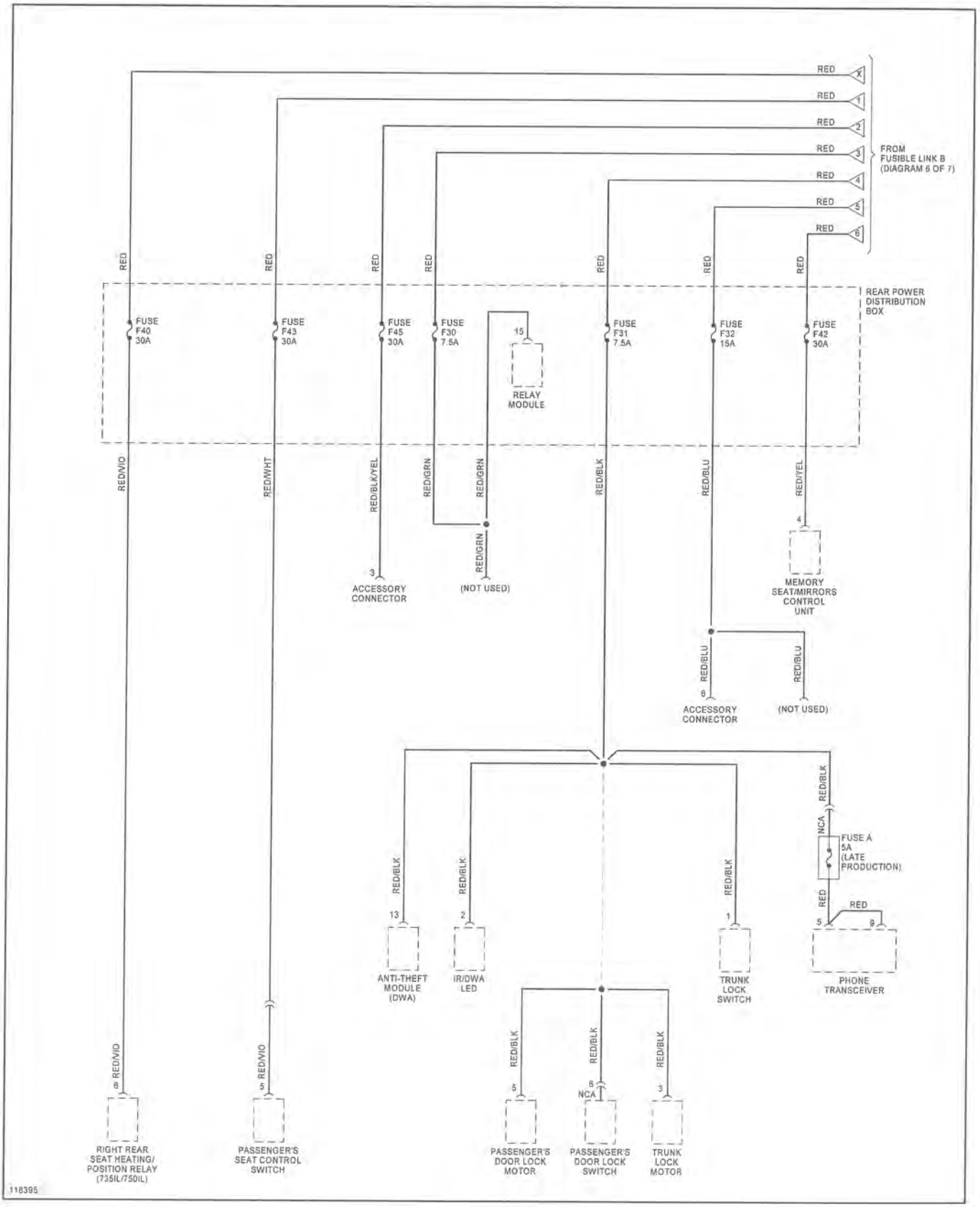


Power Distribution

1988 (6 of 7)

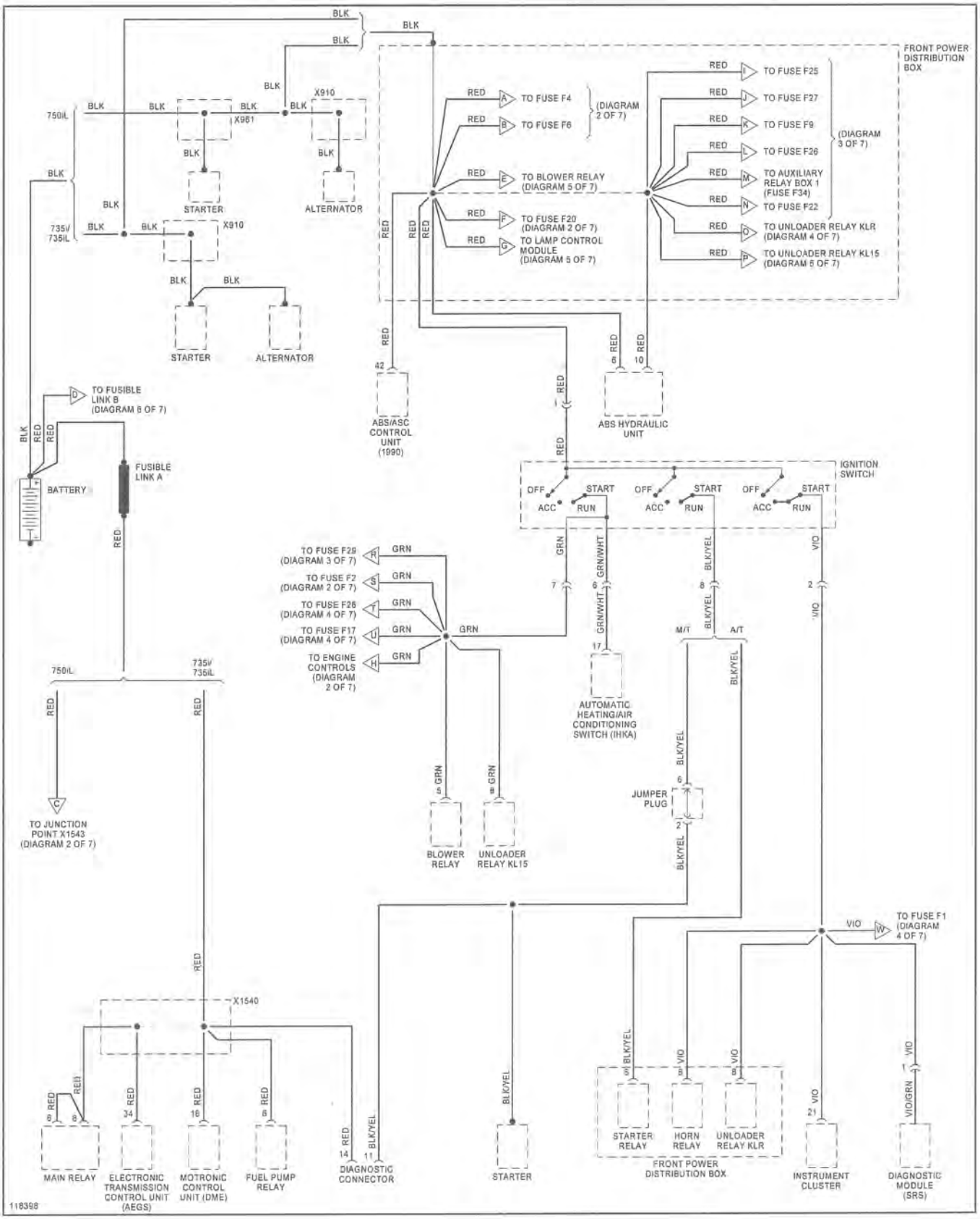


Power Distribution
1988 (7 of 7)



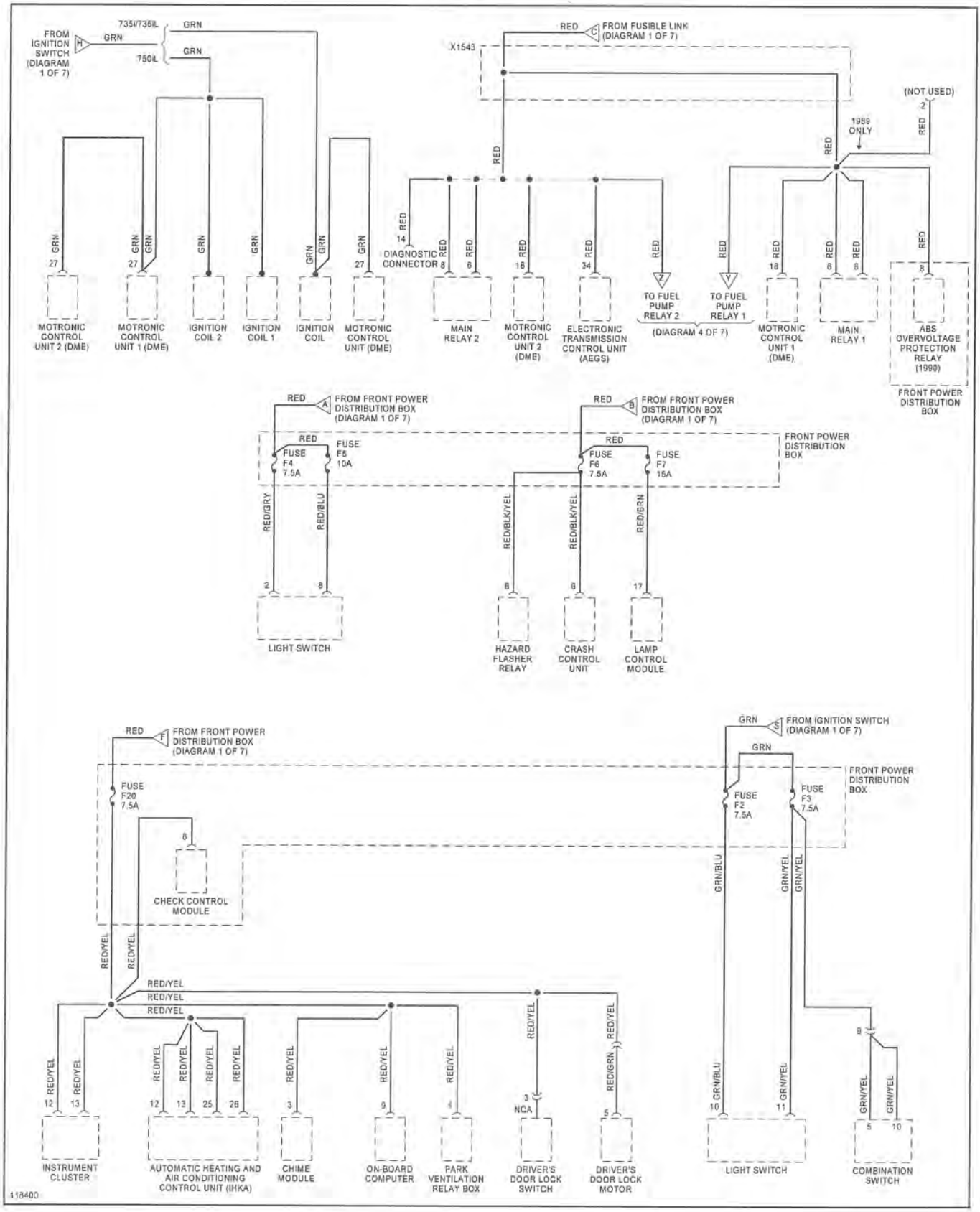
Power Distribution

1989-90 (1 of 7)



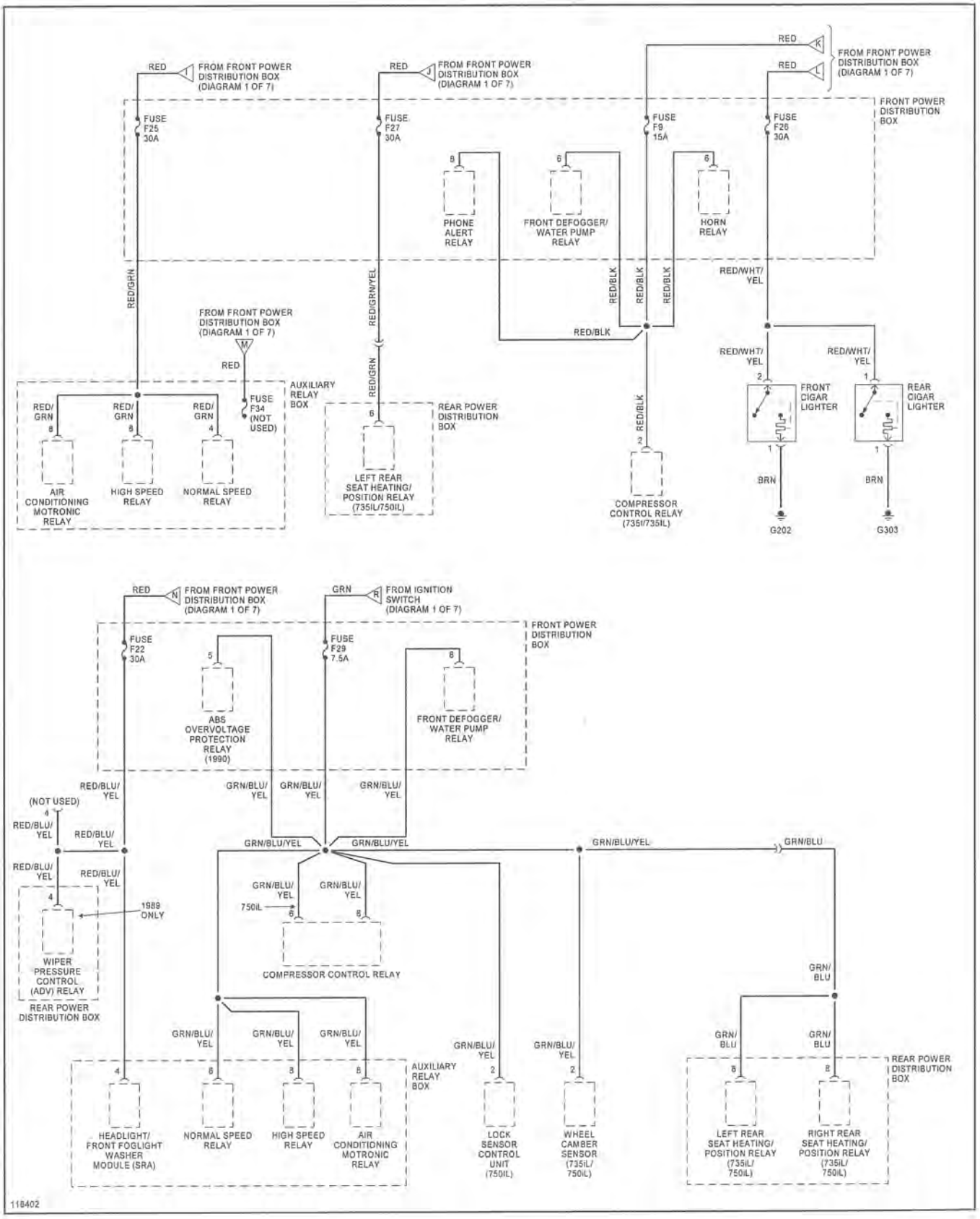
Power Distribution

1989-90 (2 of 7)

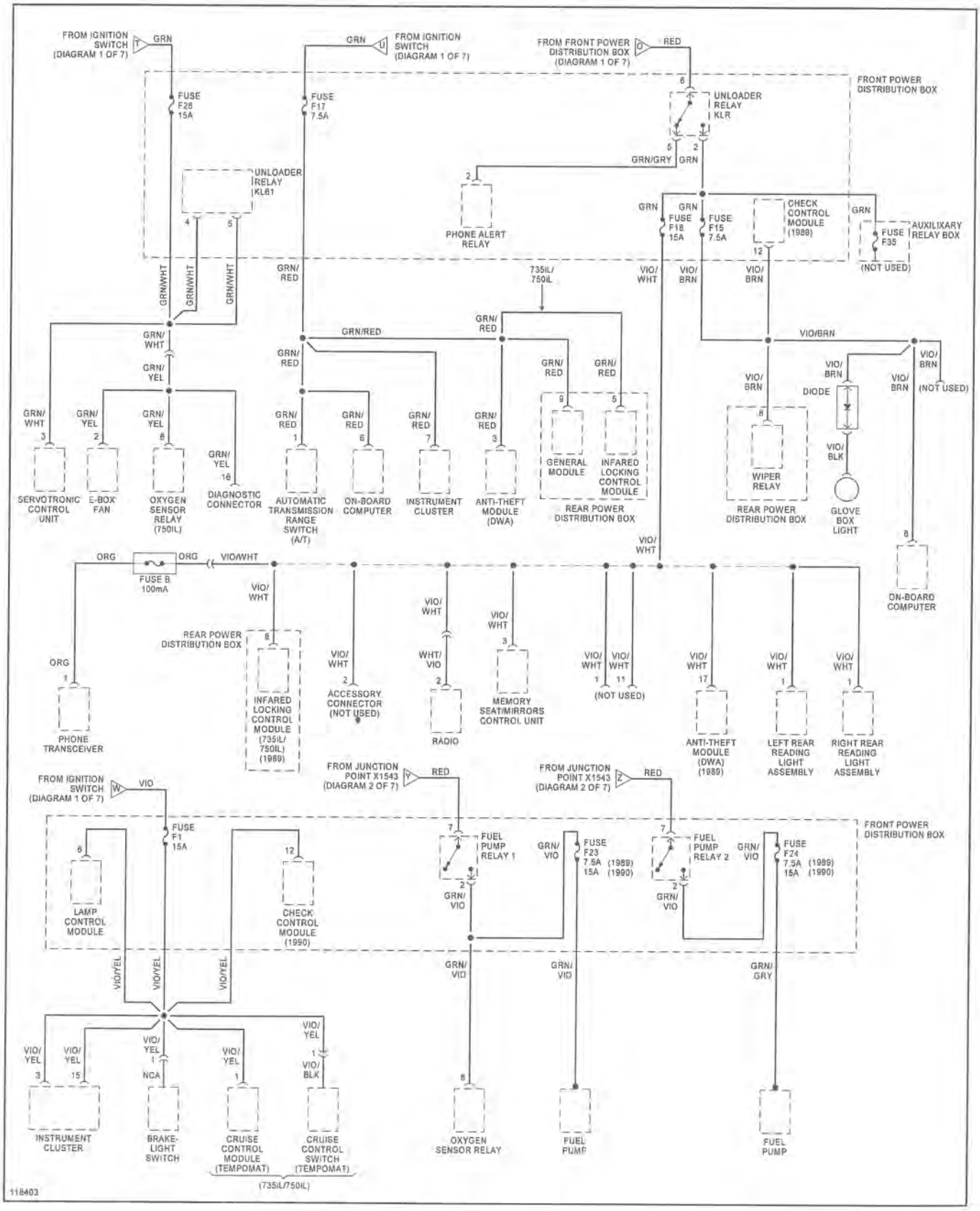


Power Distribution

1989-90 (3 of 7)

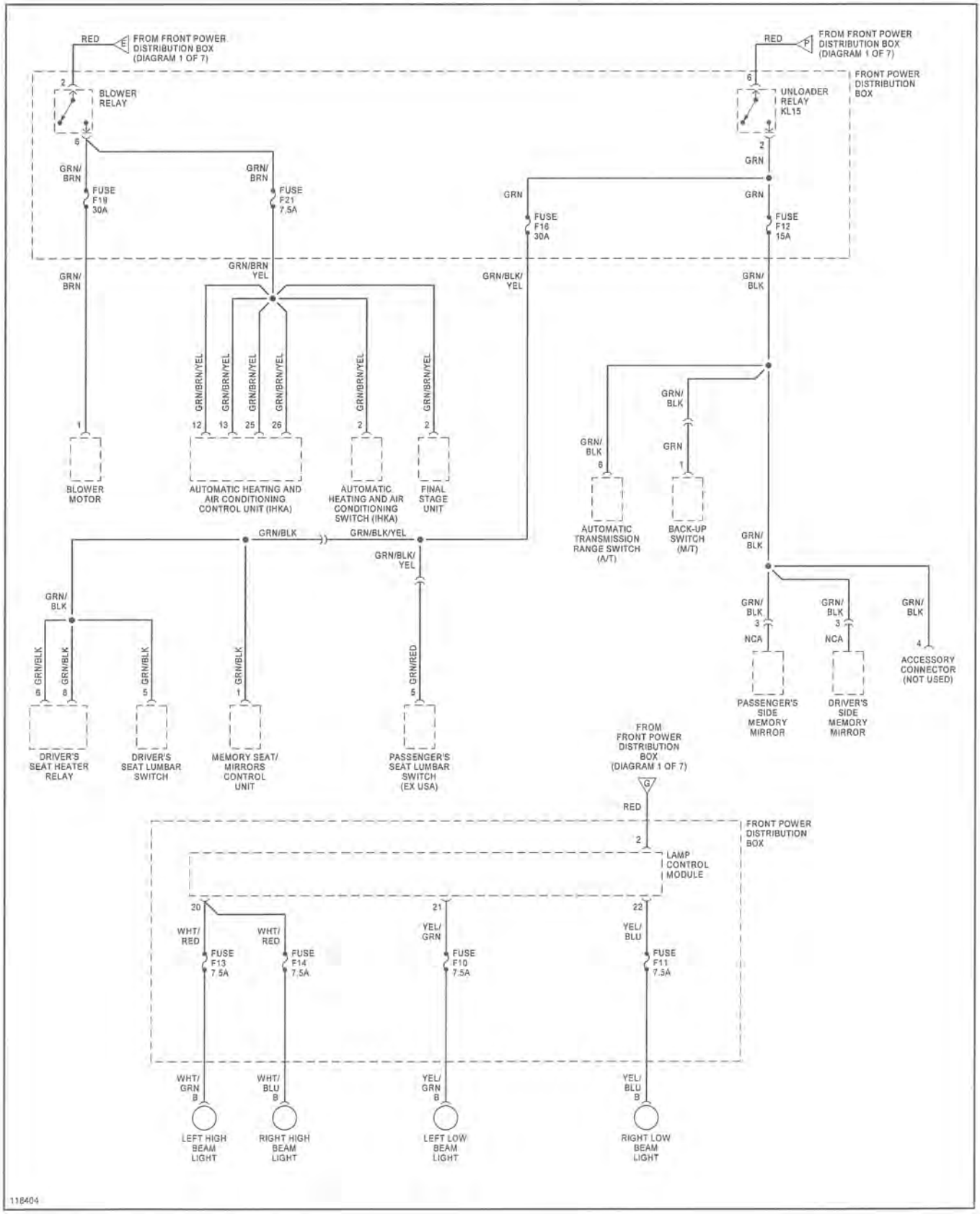


Power Distribution
1989-90 (4 of 7)



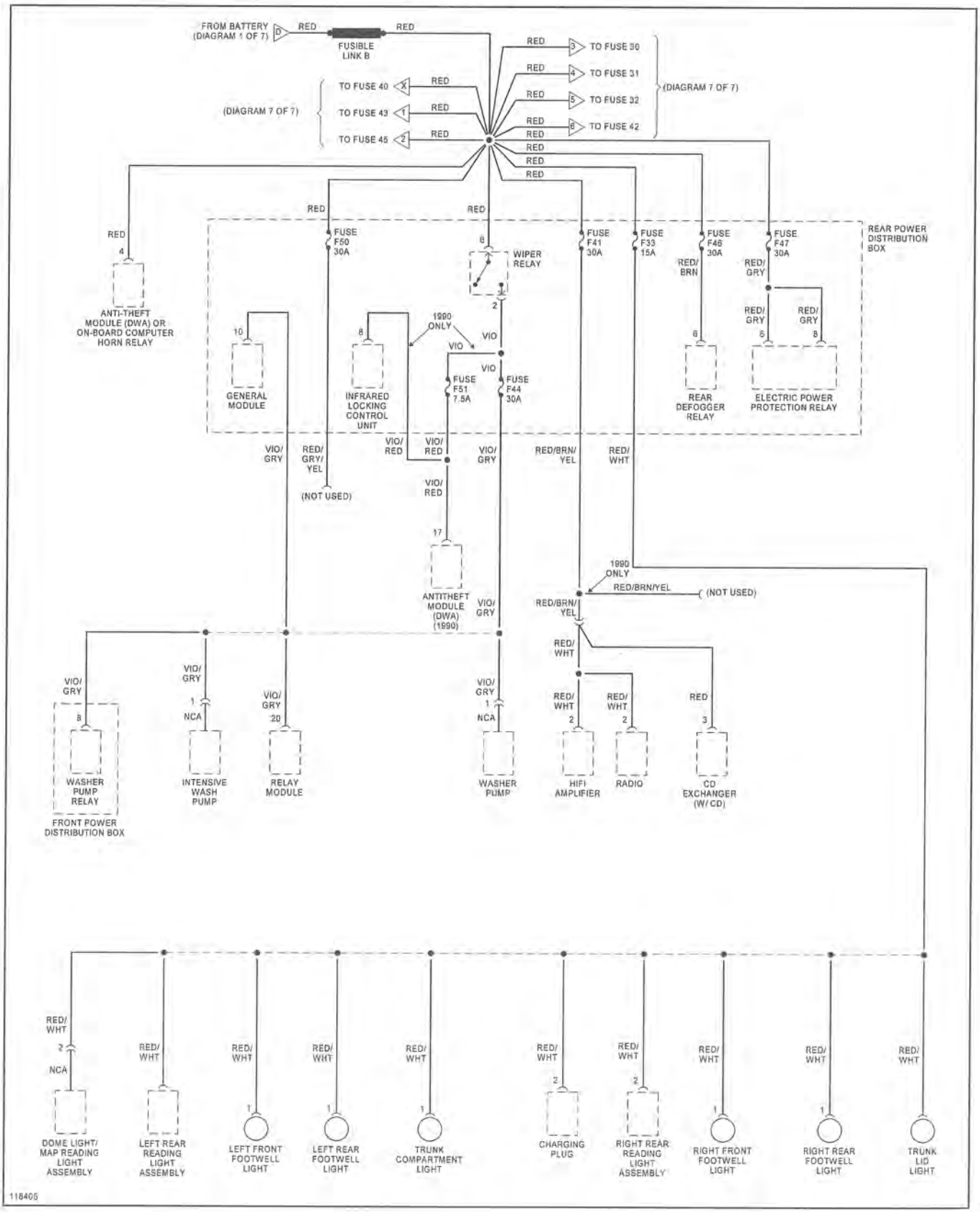
Power Distribution

1989-90 (5 of 7)

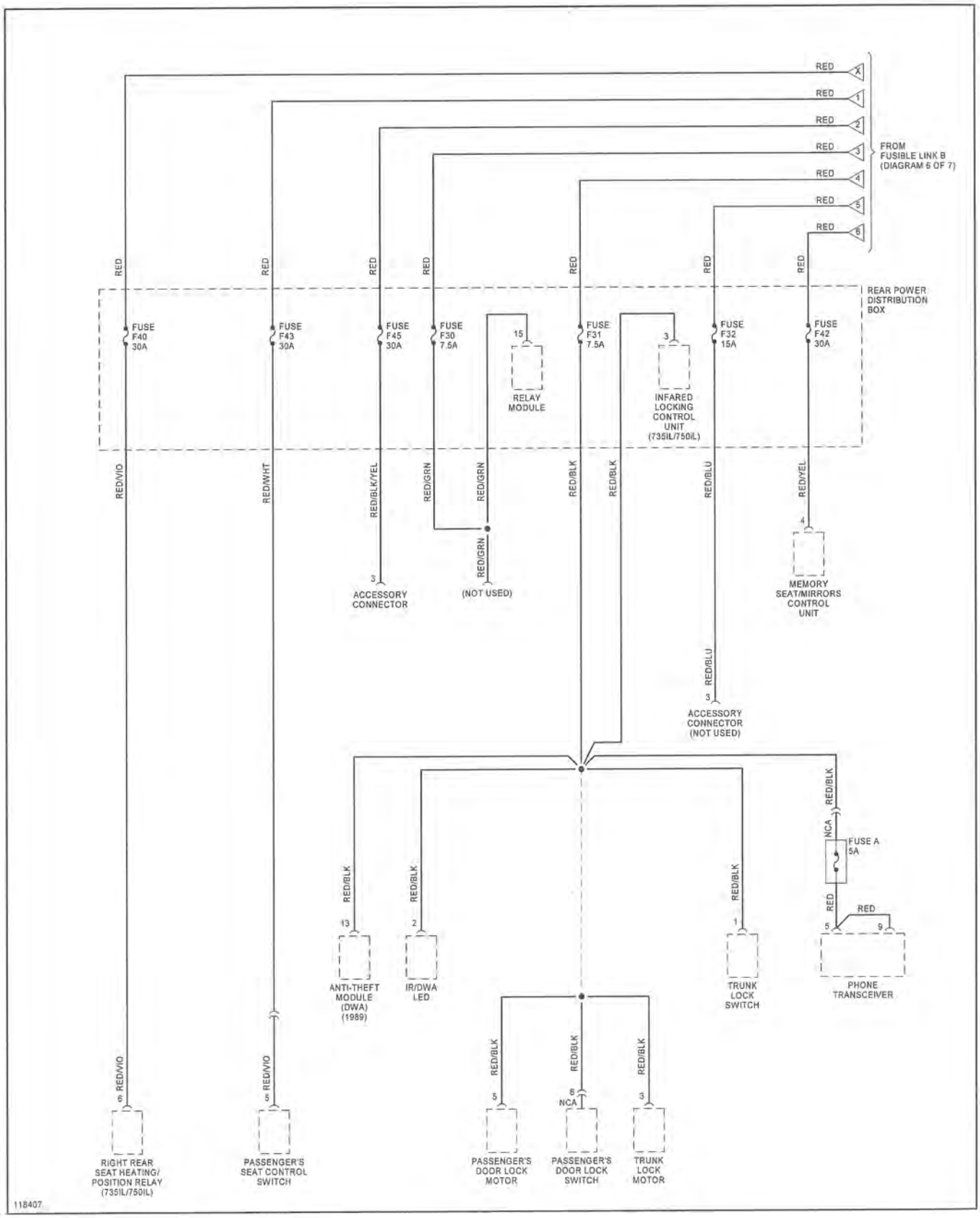


Power Distribution

1989-90 (6 of 7)

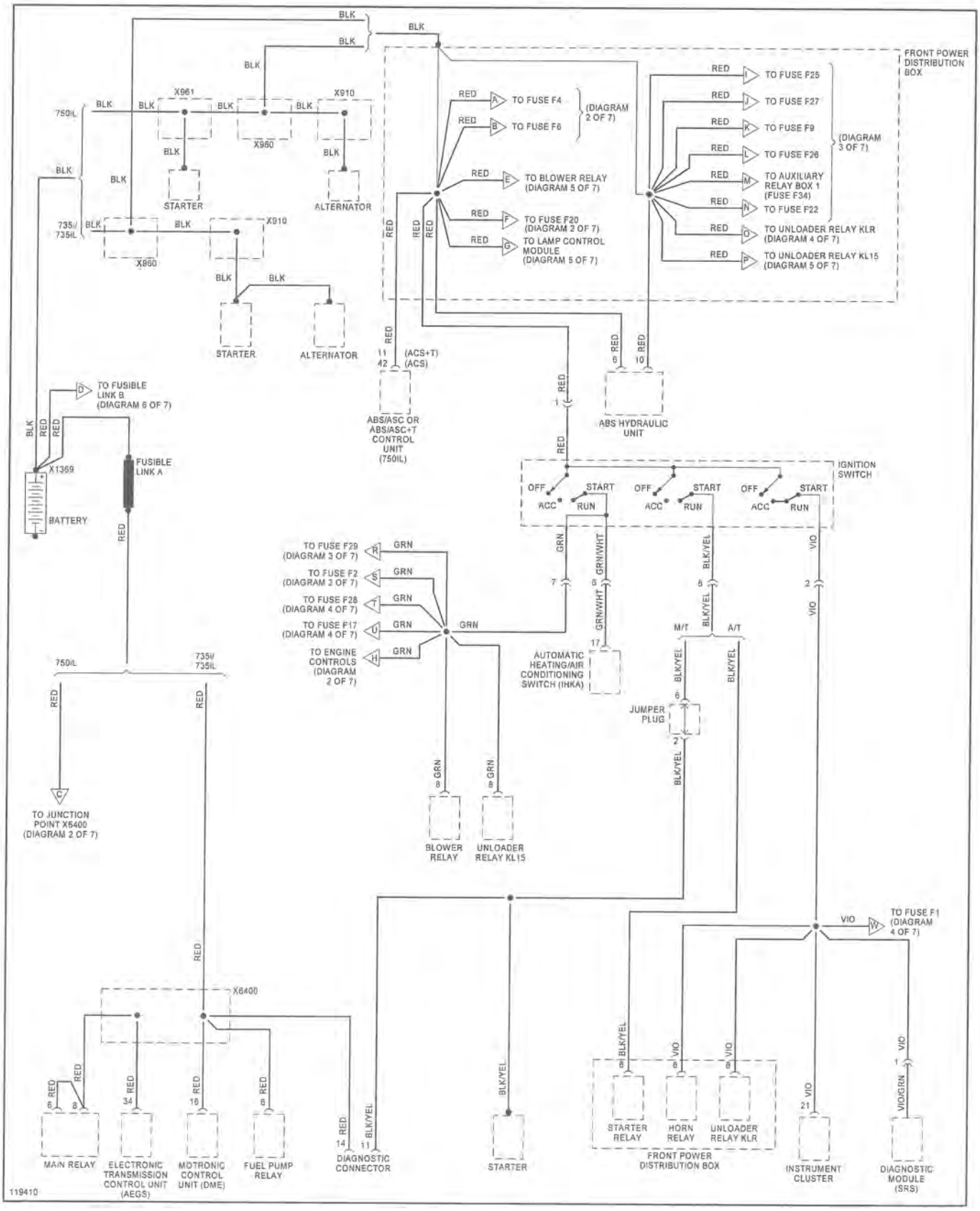


Power Distribution
1989-90 (7 of 7)

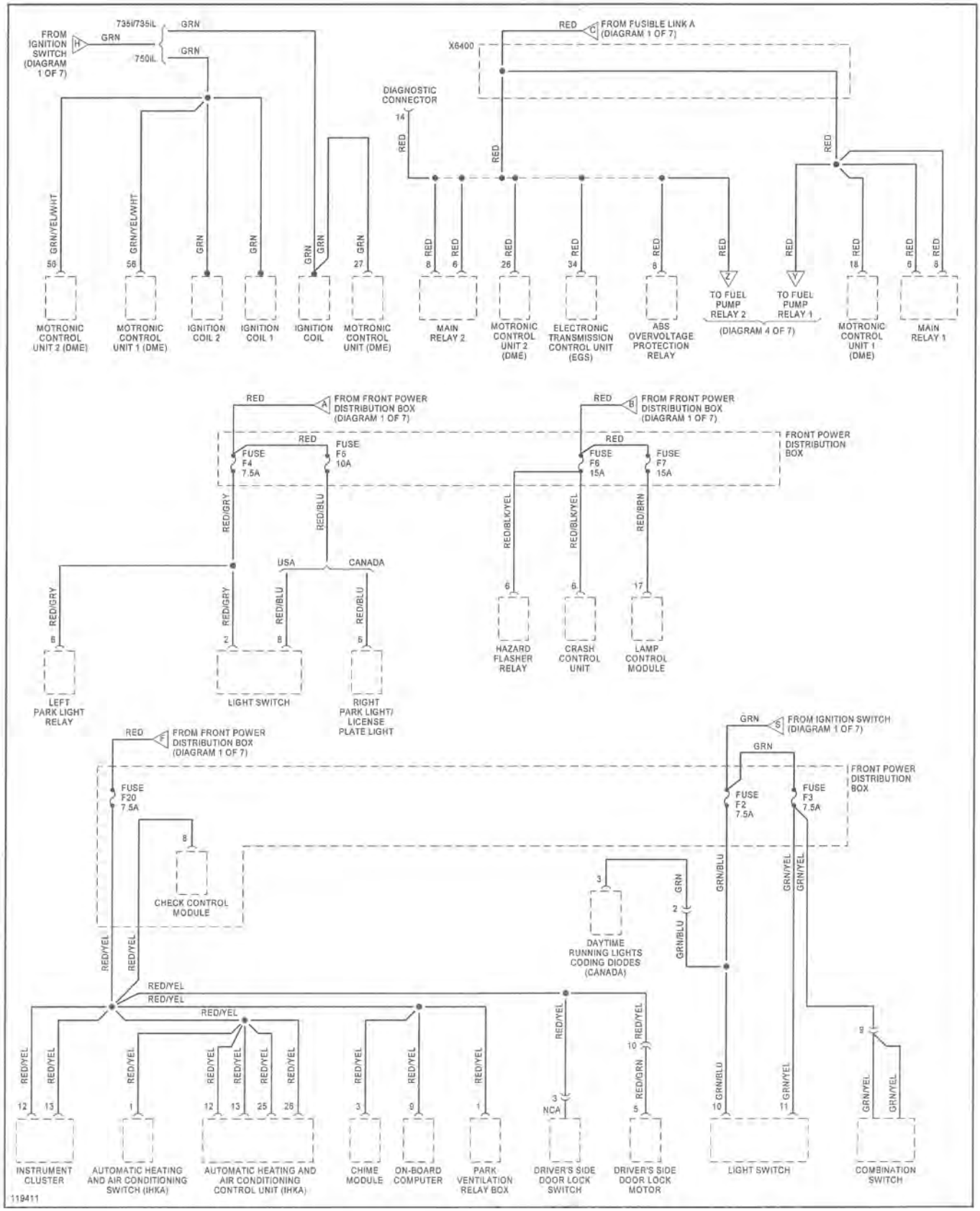


Power Distribution

1991 (1 of 7)

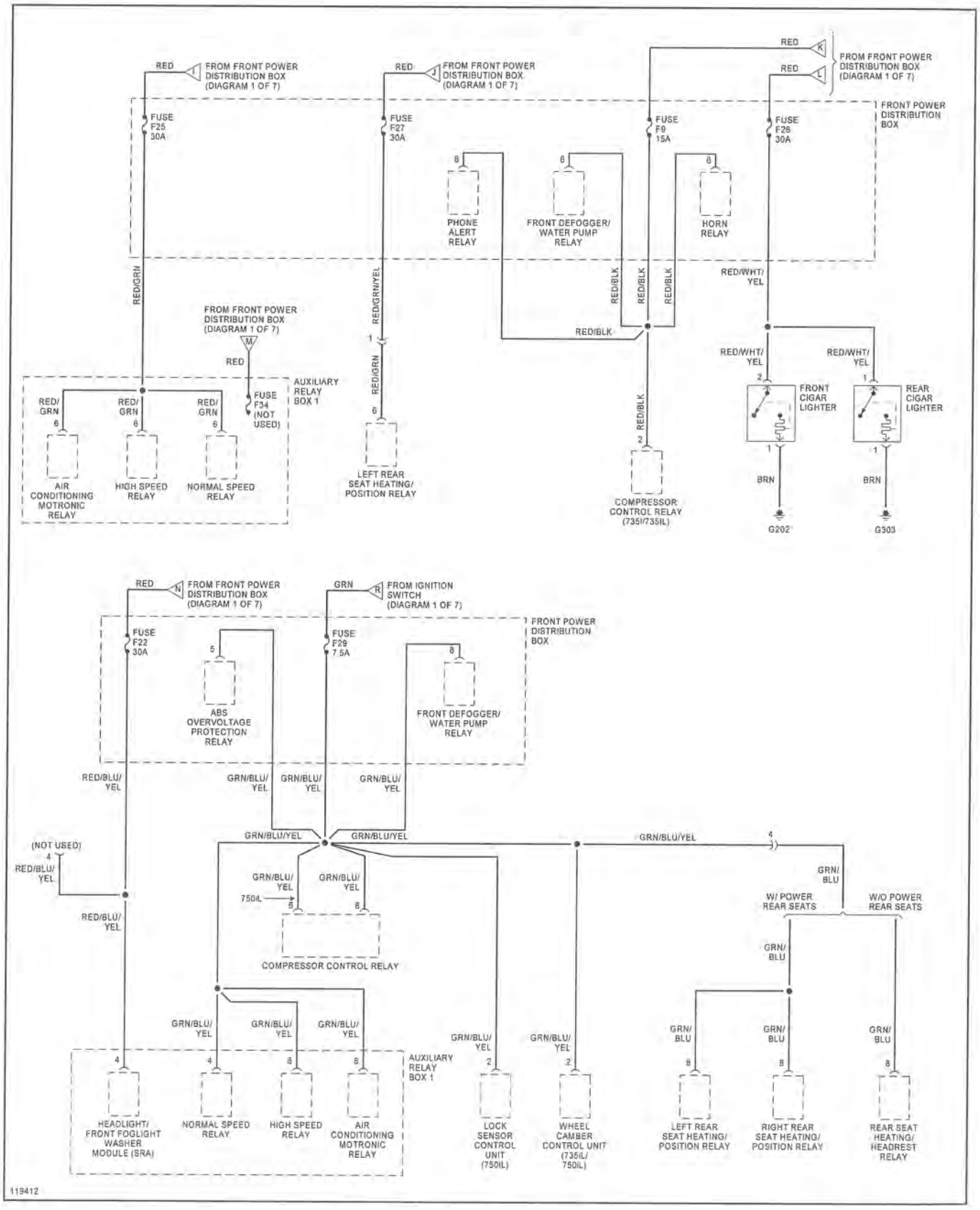


Power Distribution
1991 (2 of 7)

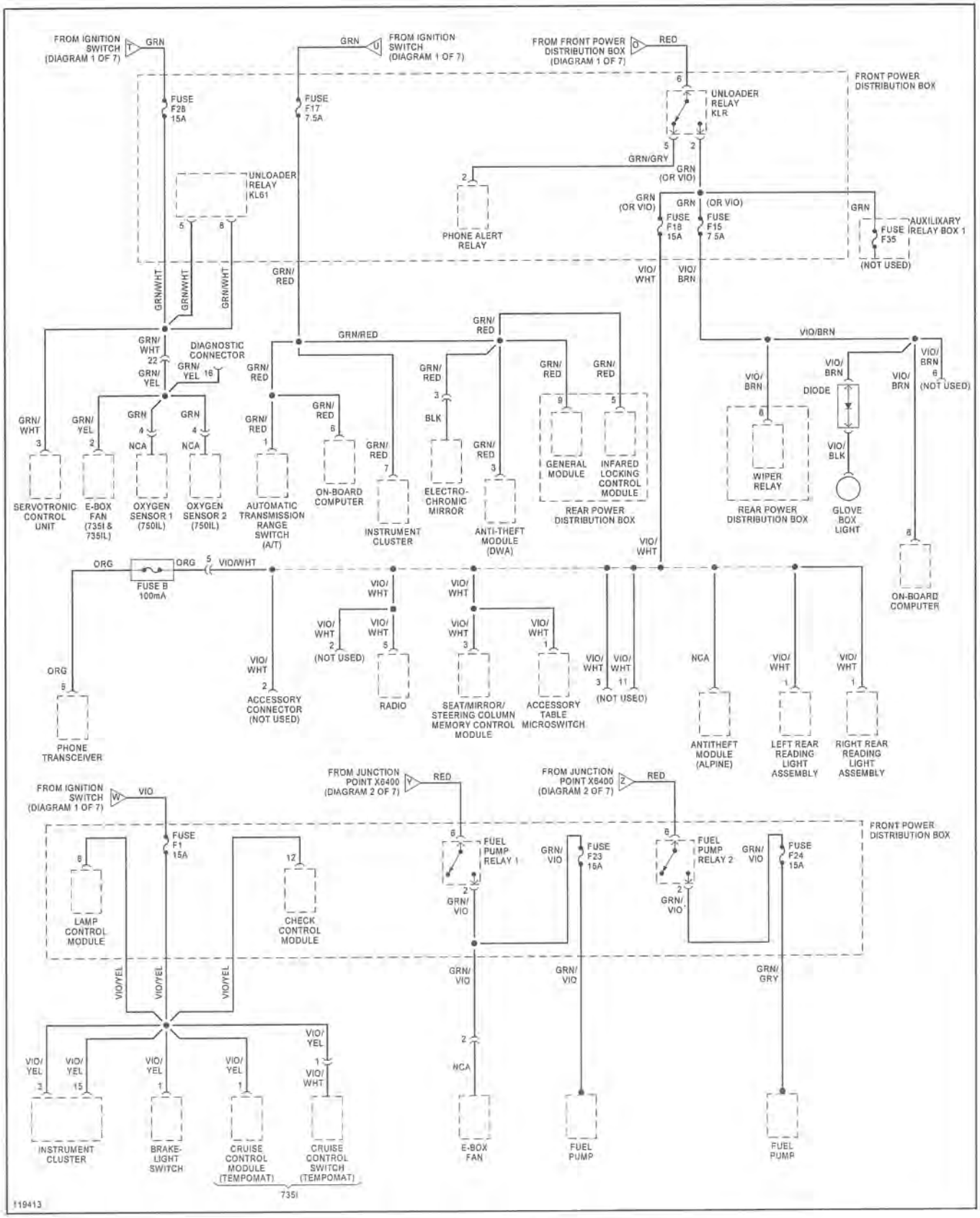


Power Distribution

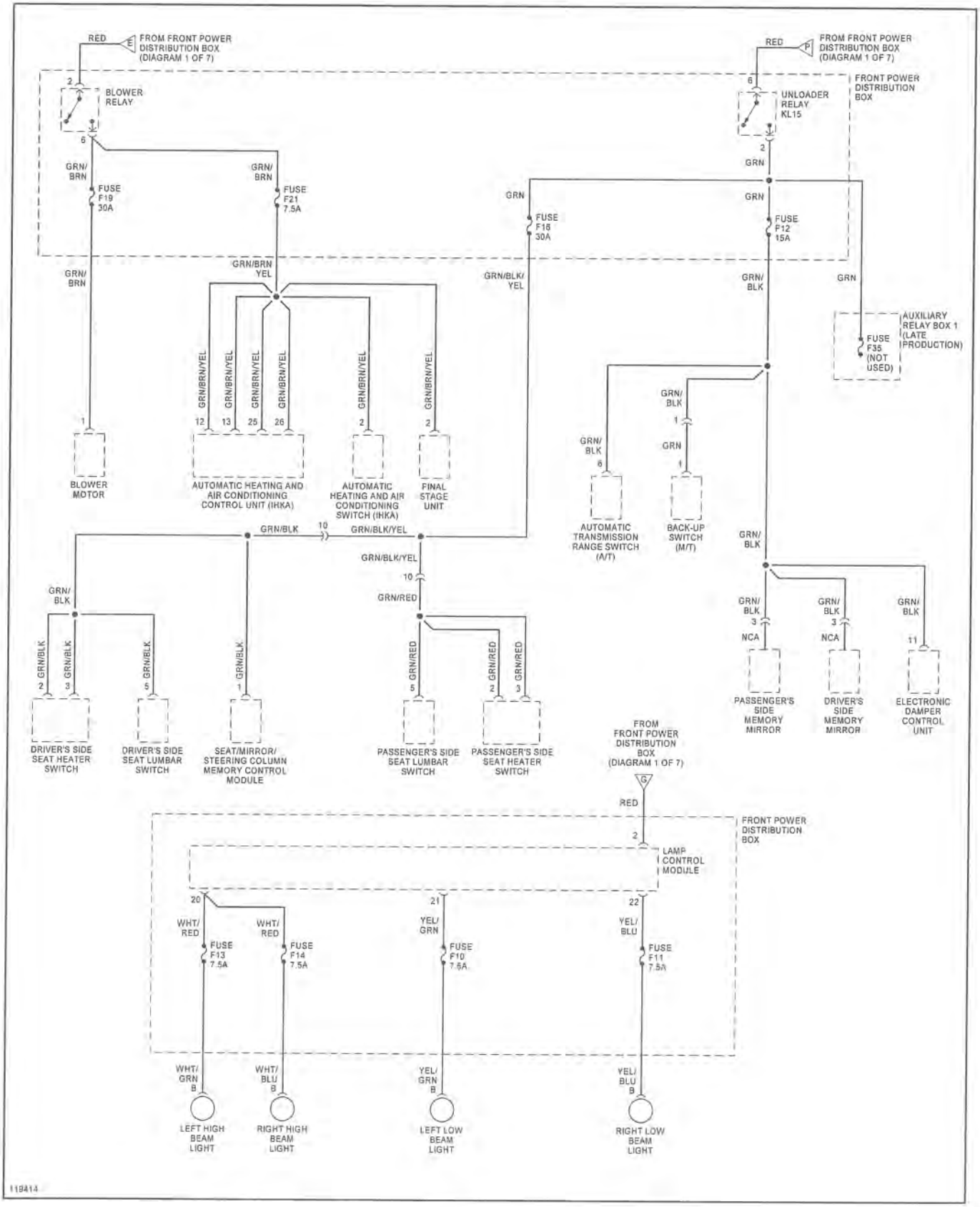
1991 (3 of 7)



Power Distribution
1991 (4 of 7)

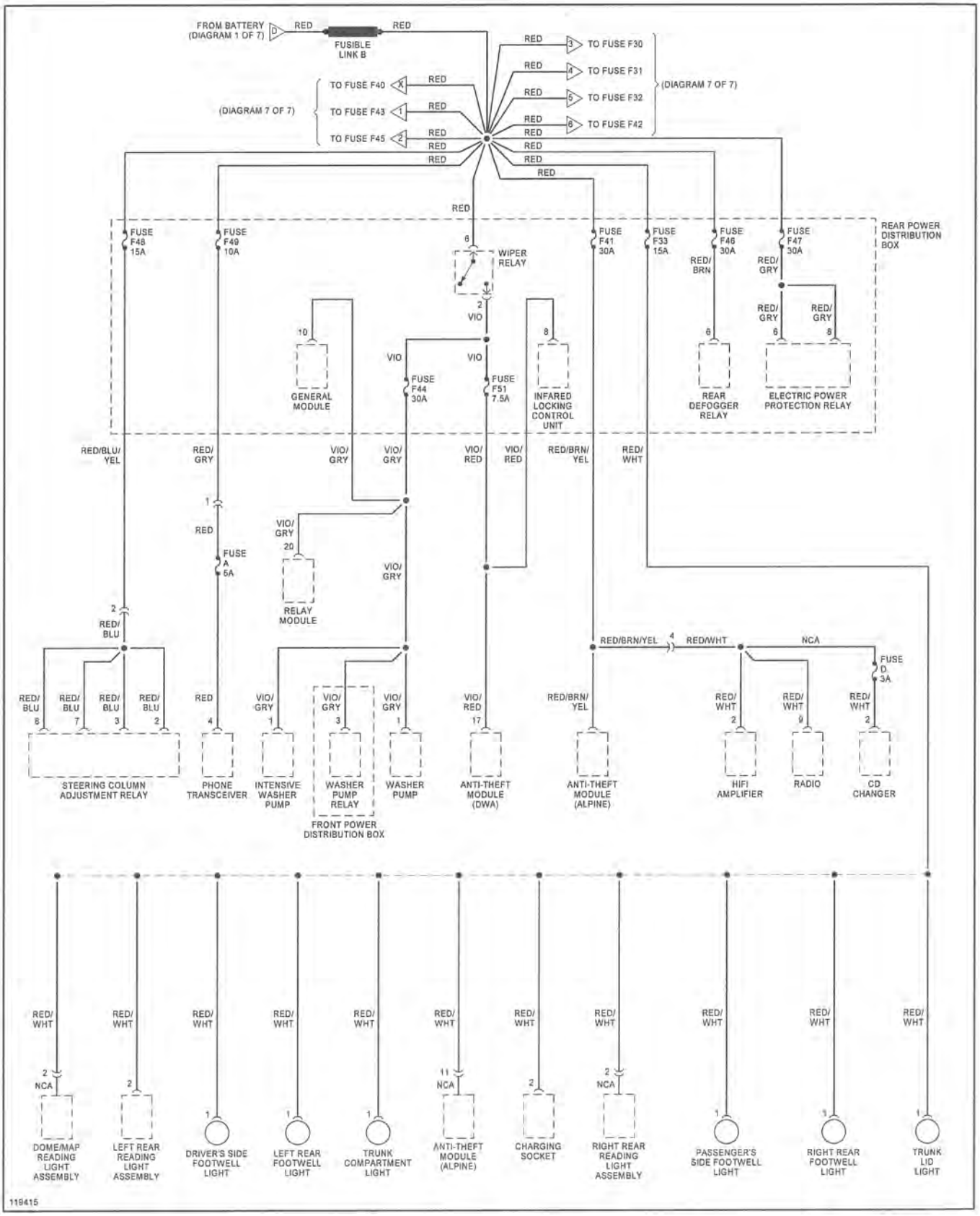


Power Distribution
1991 (5 of 7)



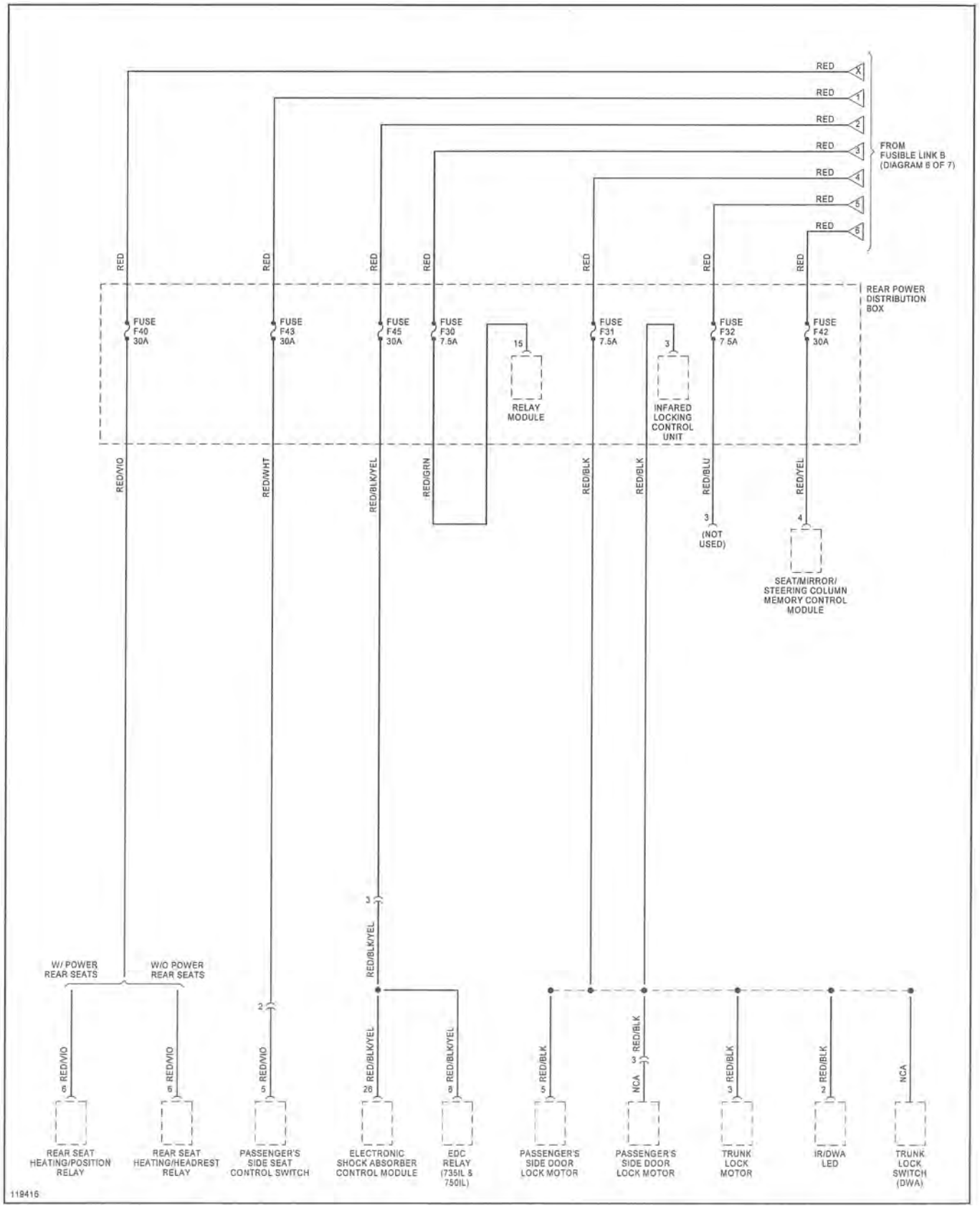
Power Distribution

1991 (6 of 7)



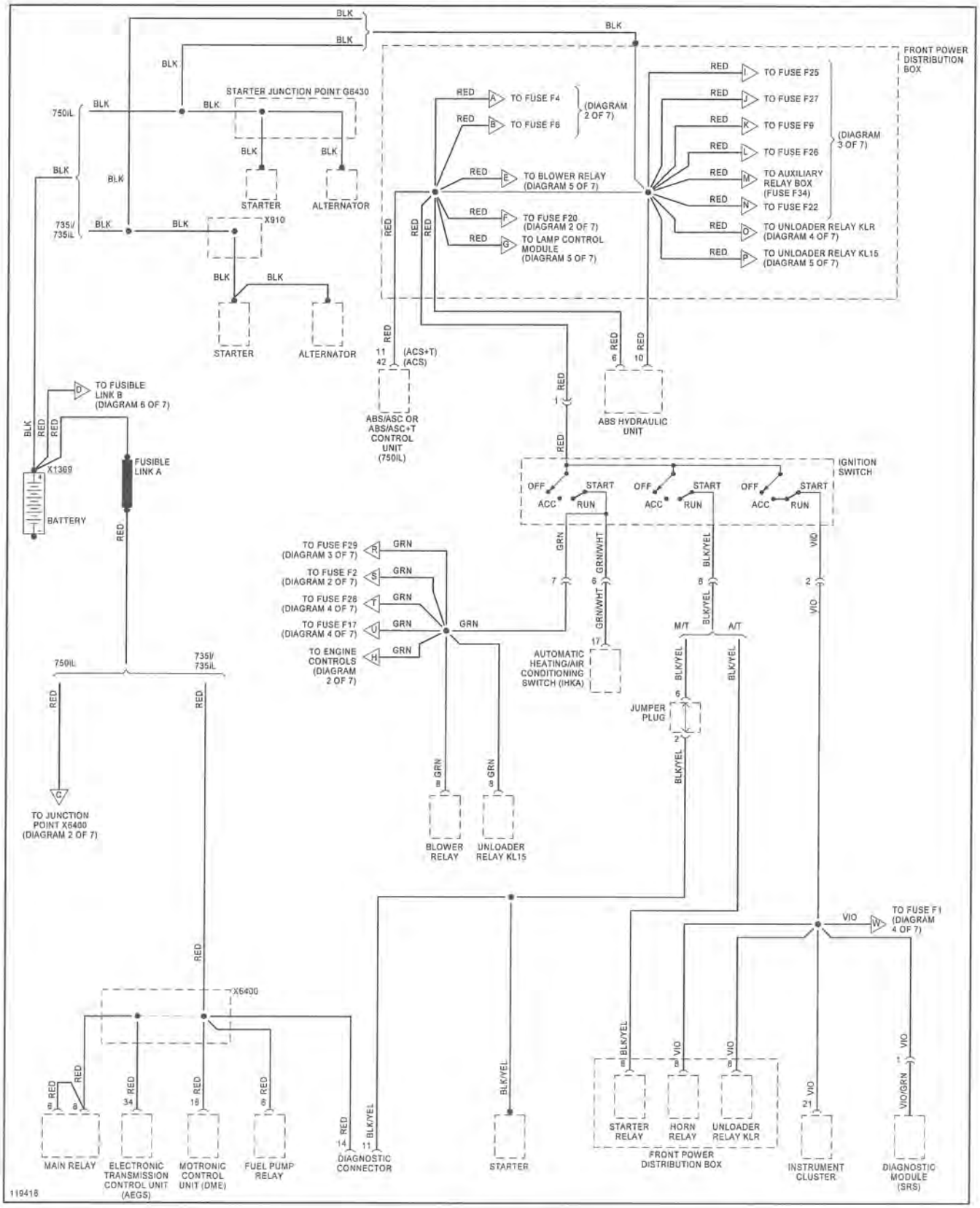
Power Distribution

1991 (7 of 7)



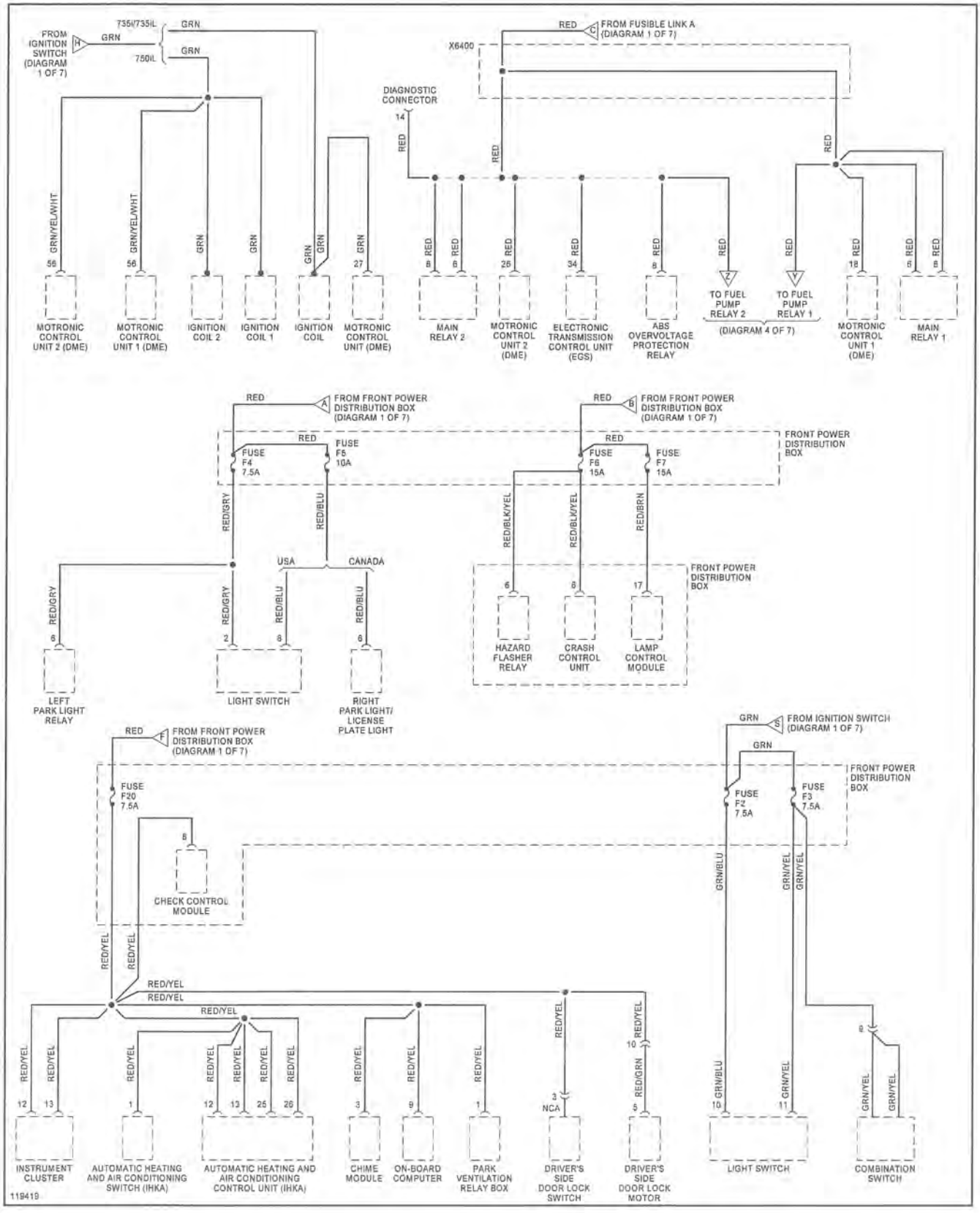
Power Distribution

1992 (1 of 7)



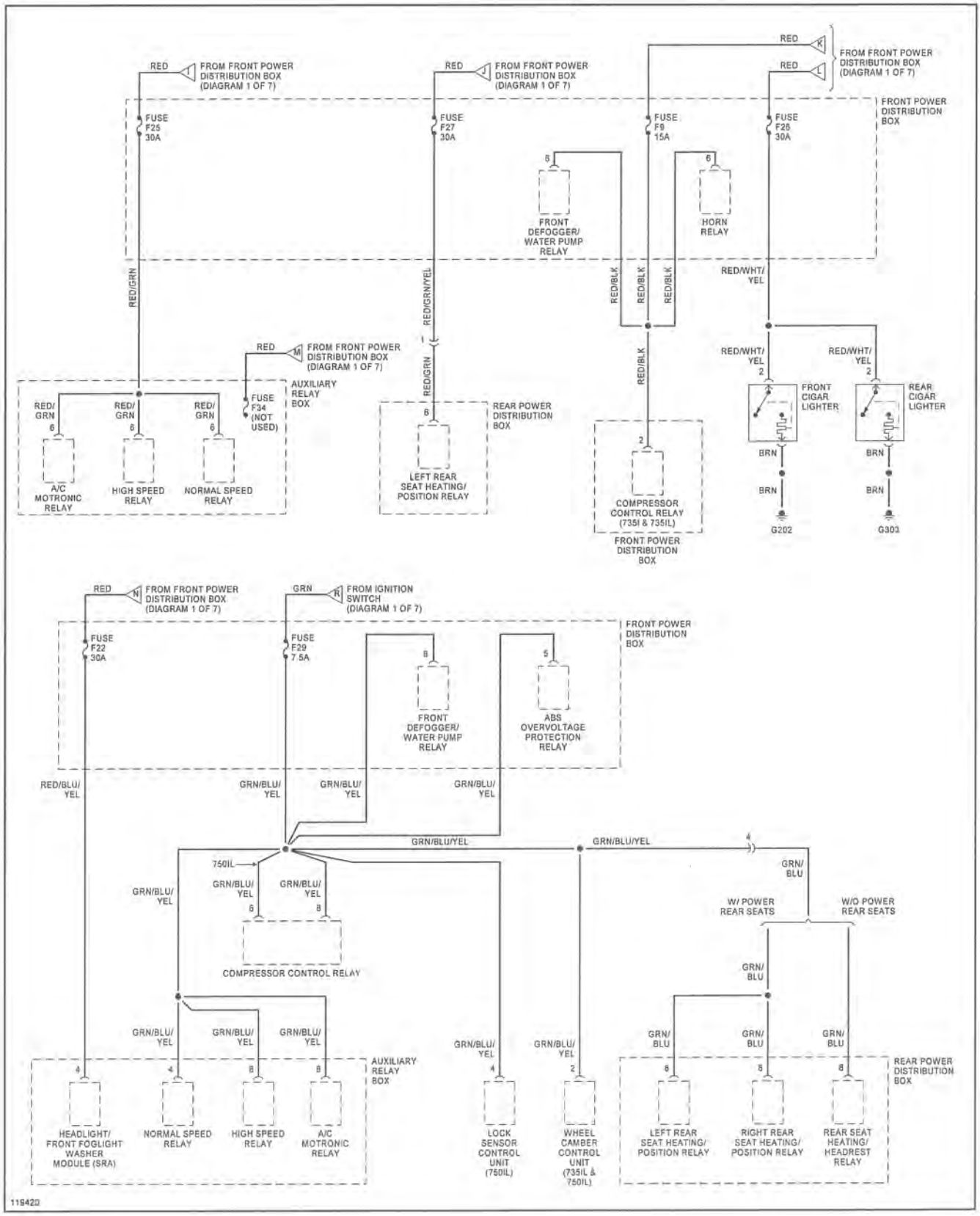
Power Distribution

1992 (2 of 7)



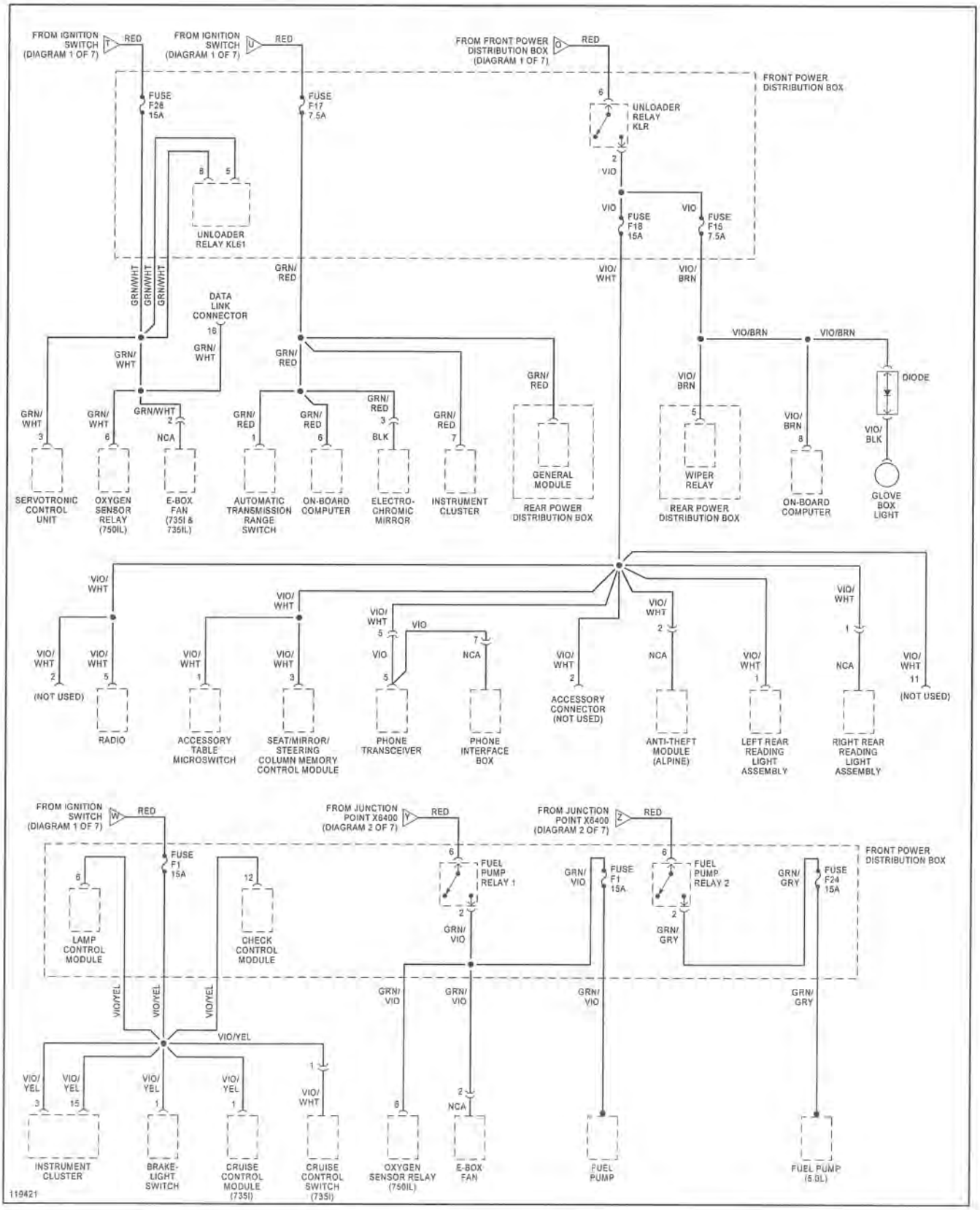
Power Distribution

1992 (3 of 7)



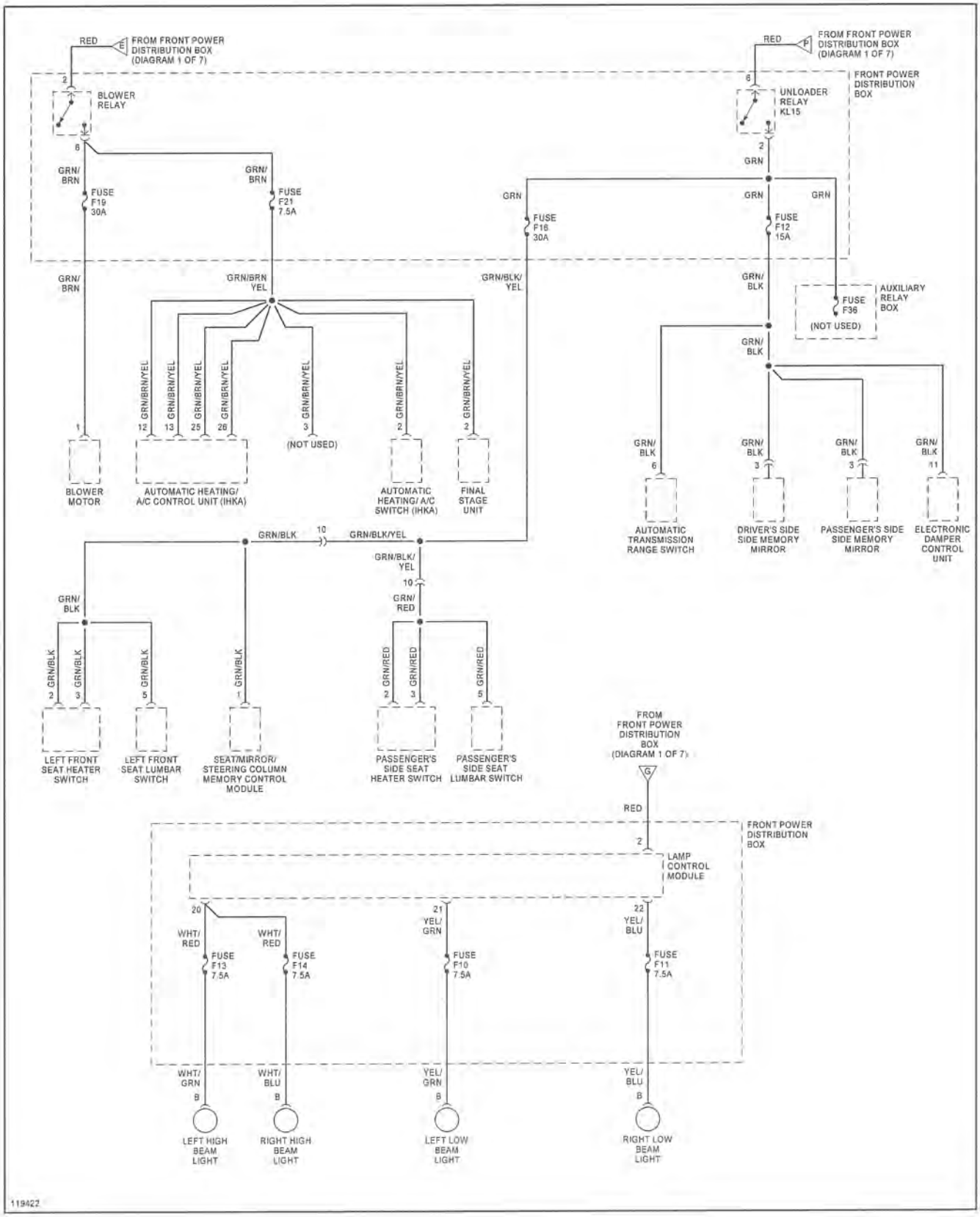
Power Distribution

1992 (4 of 7)



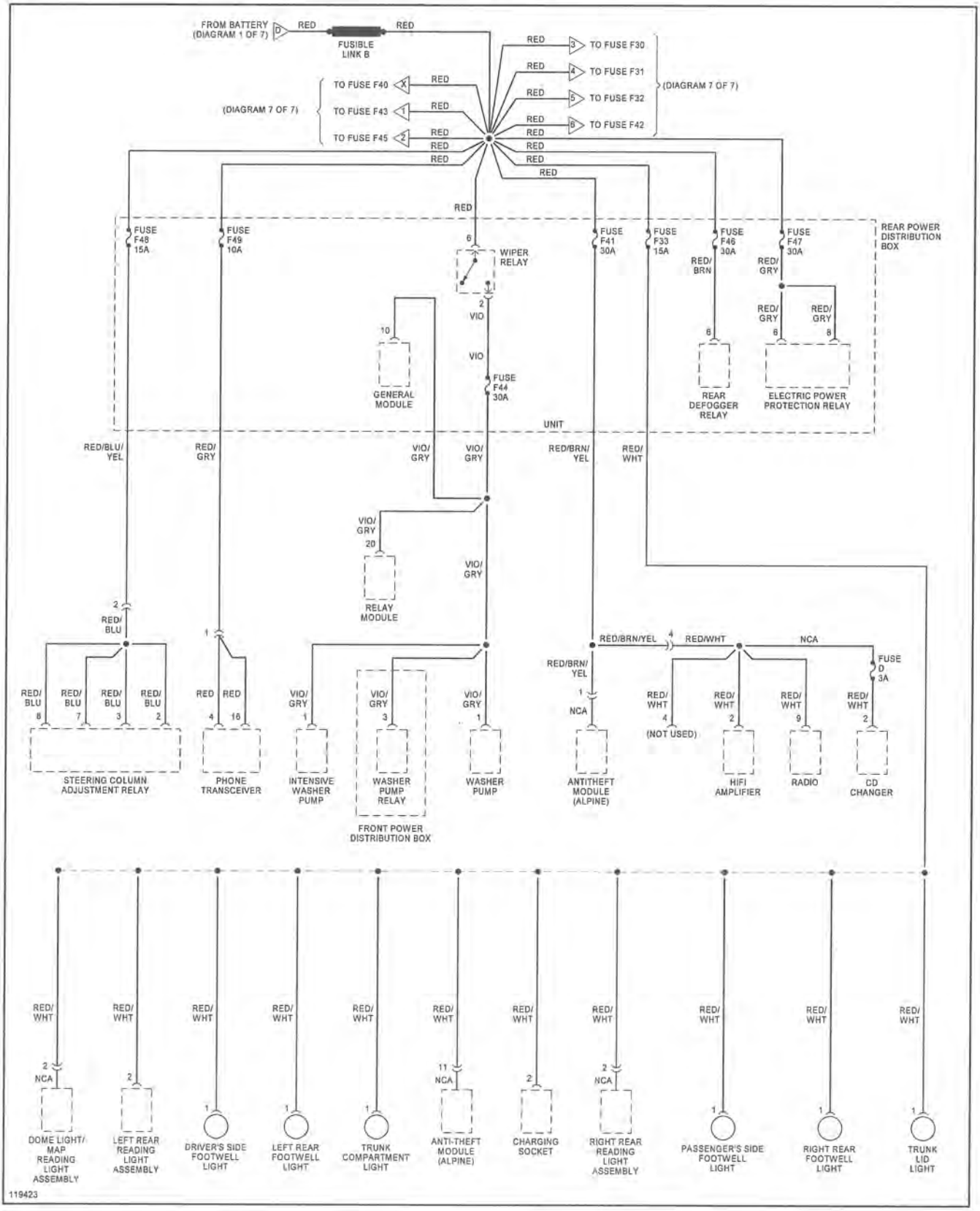
Power Distribution

1992 (5 of 7)



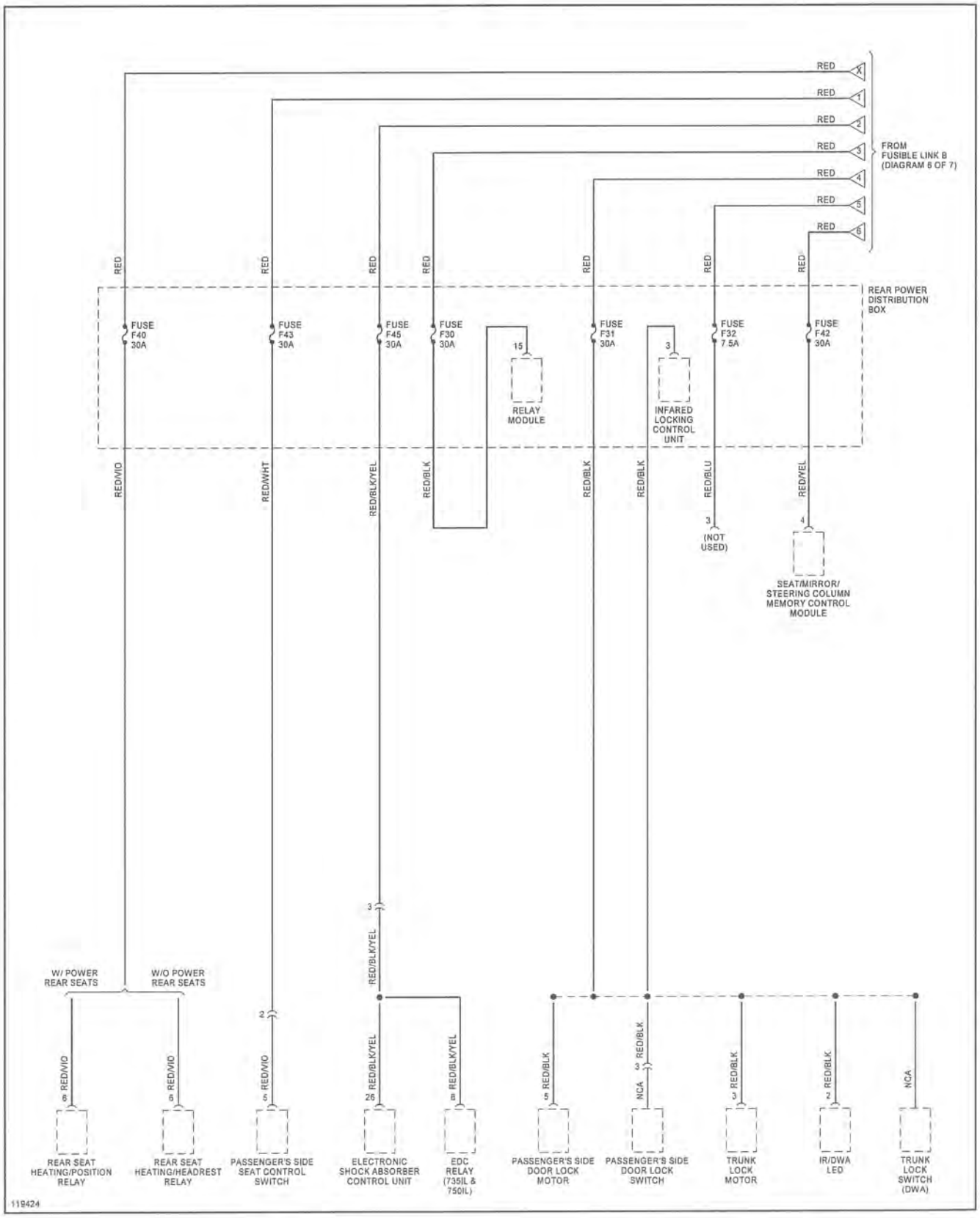
Power Distribution

1992 (6 of 7)



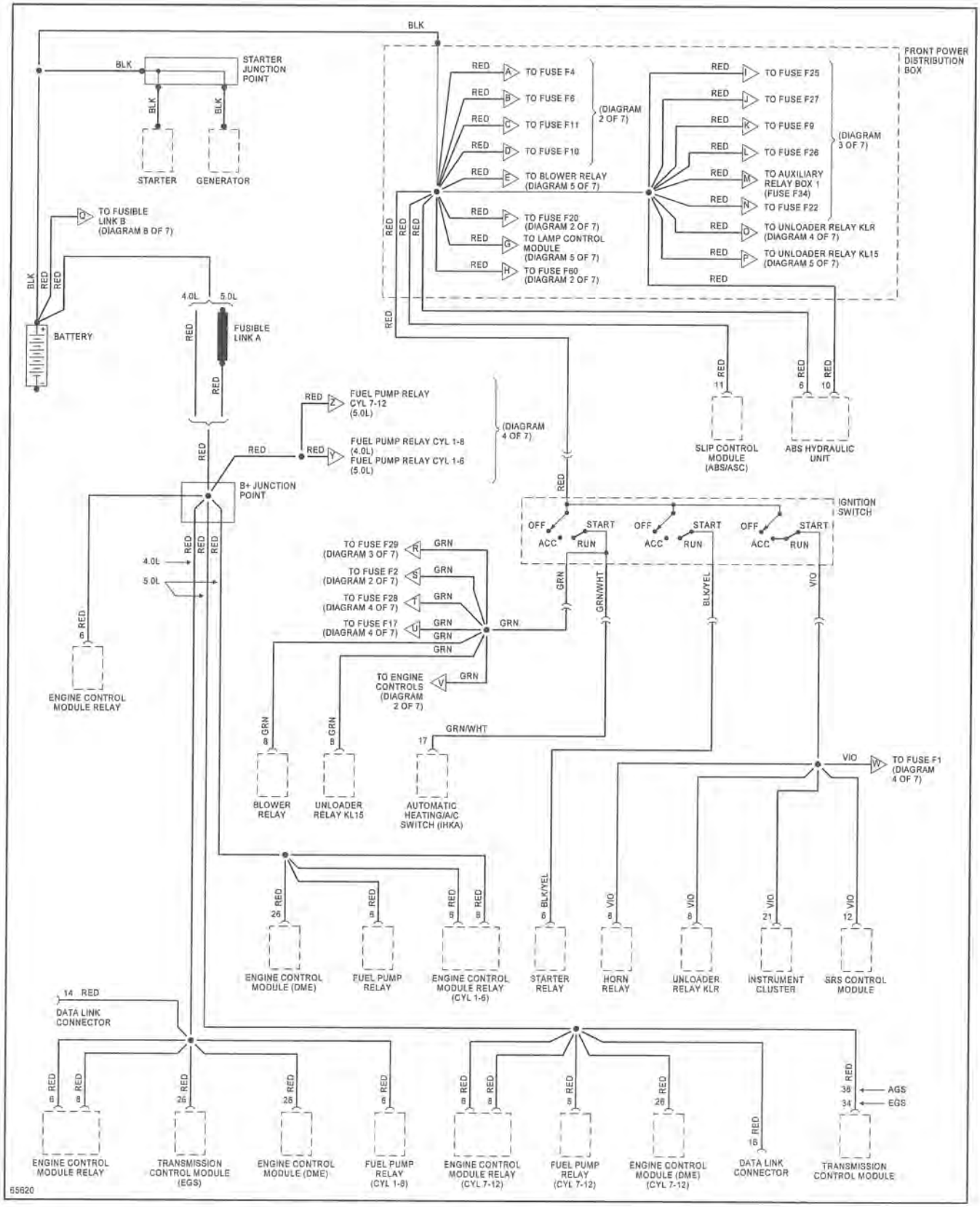
Power Distribution

1992 (7 of 7)



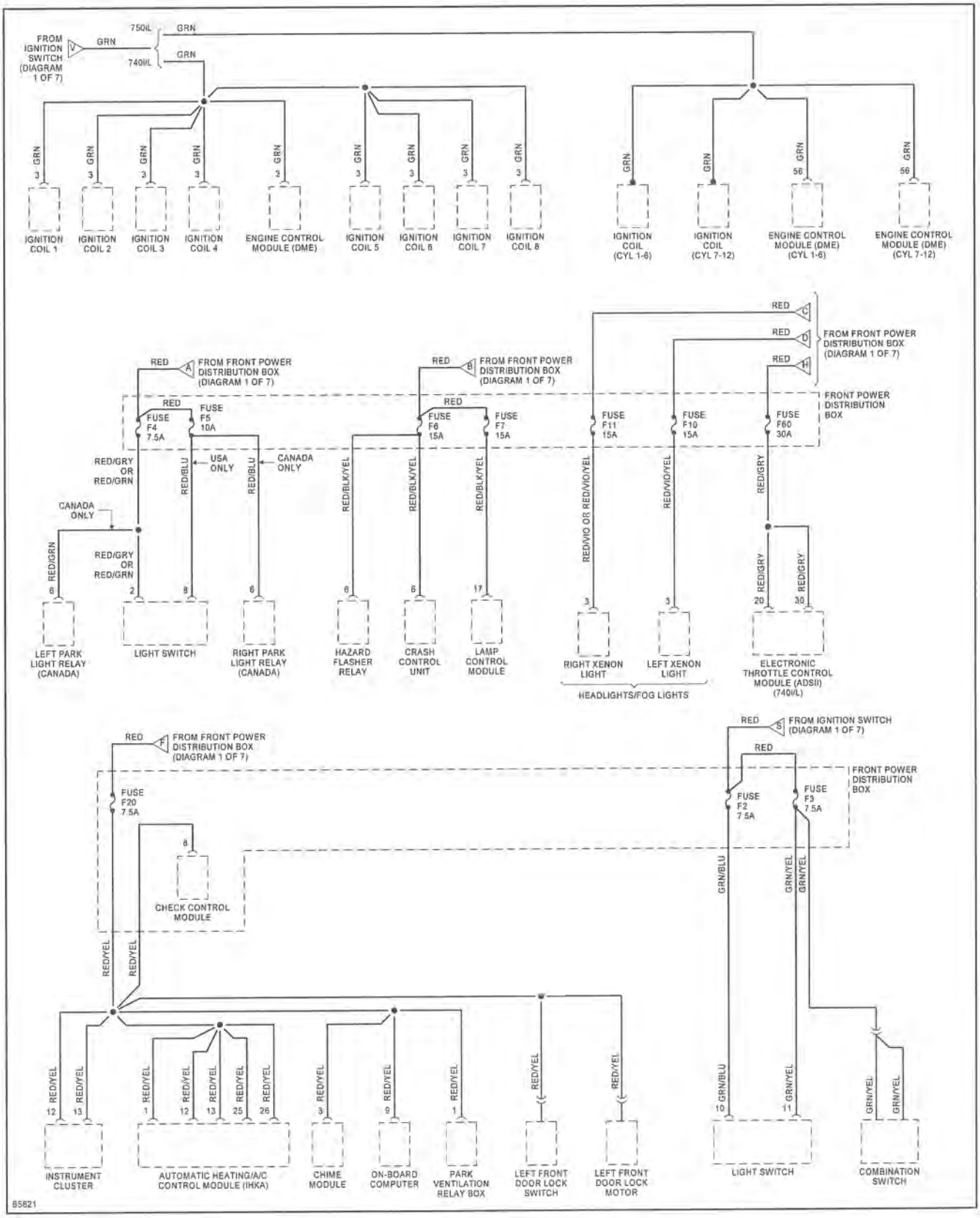
Power Distribution

1993-94 (1 of 7)



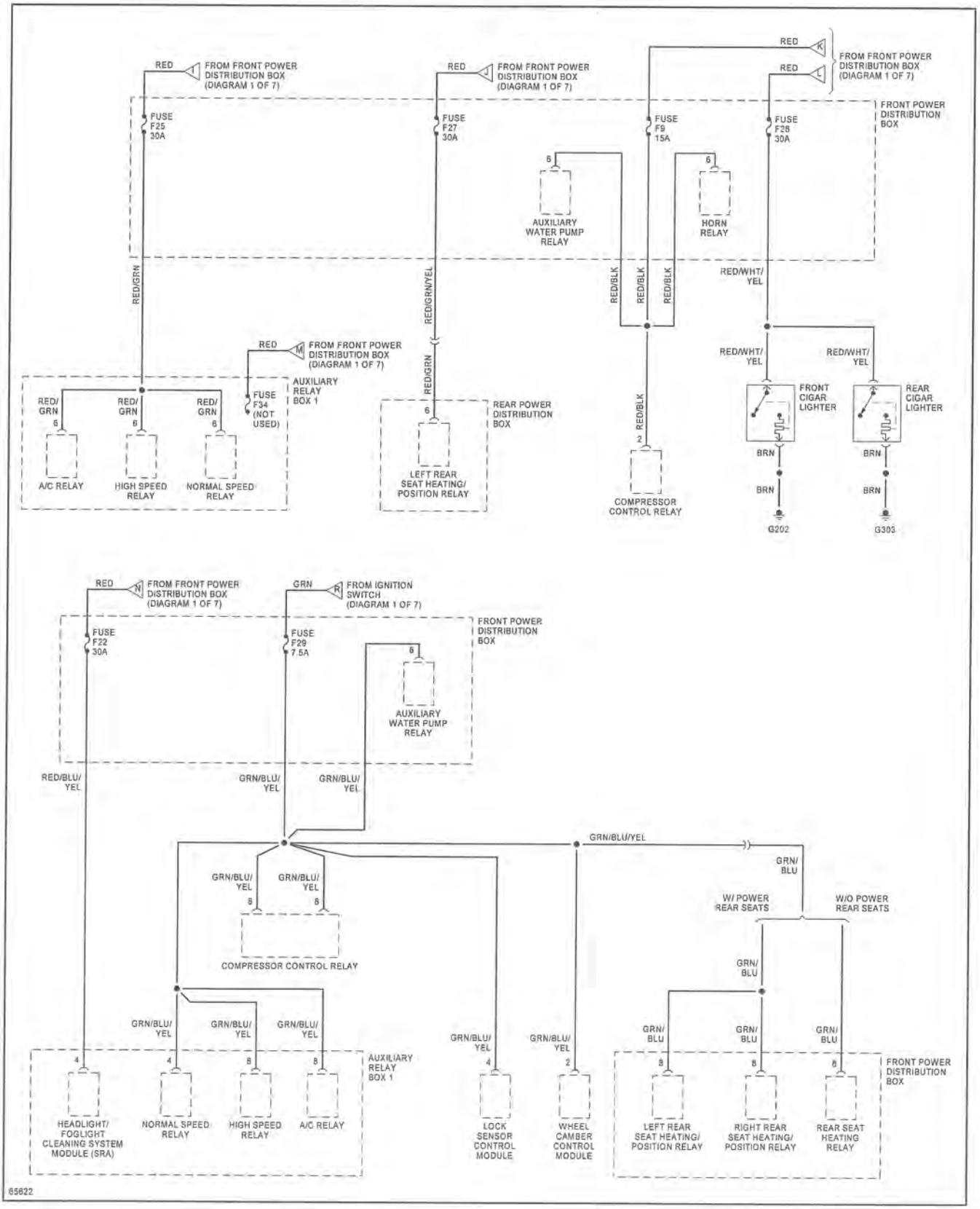
Power Distribution

1993-94 (2 of 7)



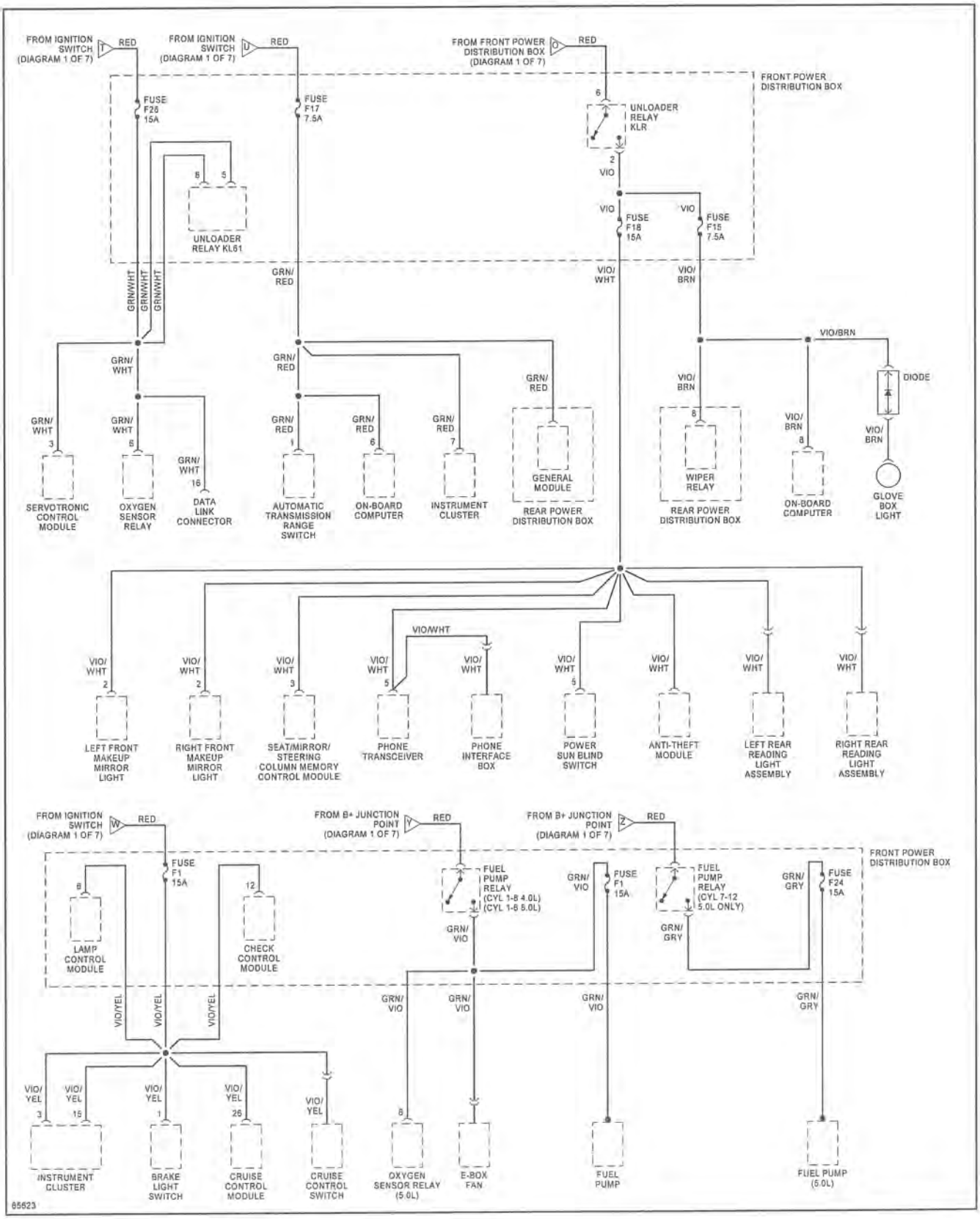
Power Distribution

1993-94 (3 of 7)



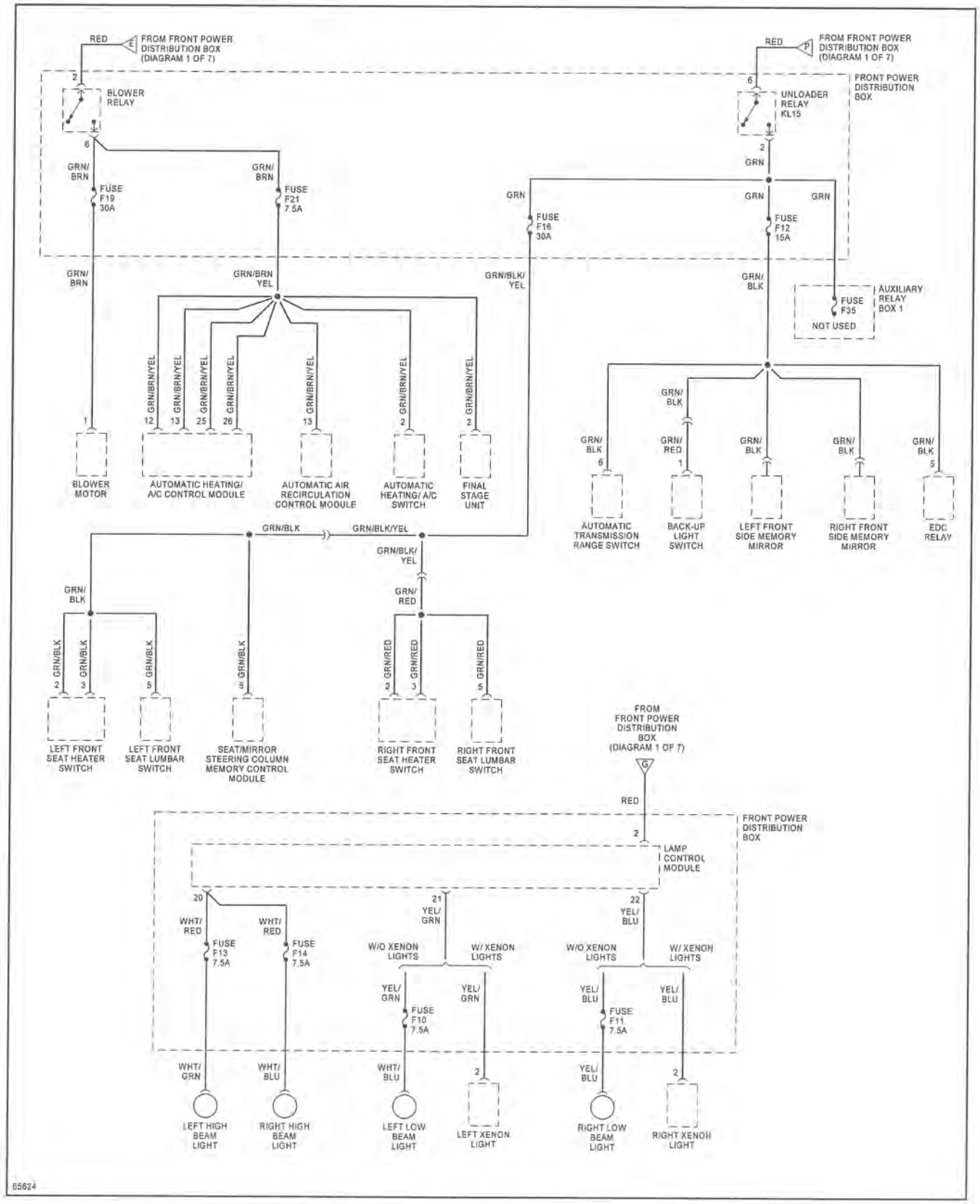
Power Distribution

1993-94 (4 of 7)



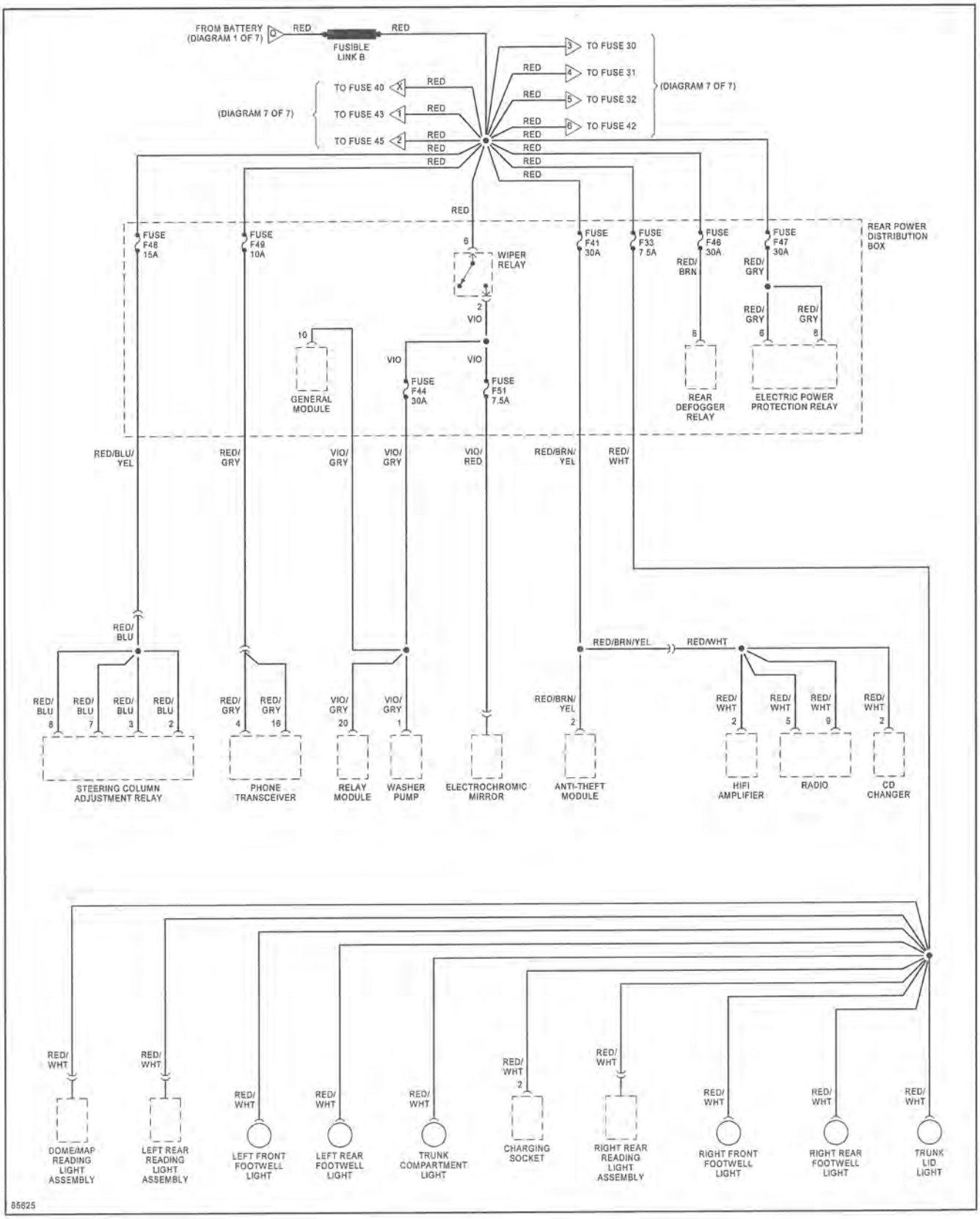
Power Distribution

1993-94 (5 of 7)



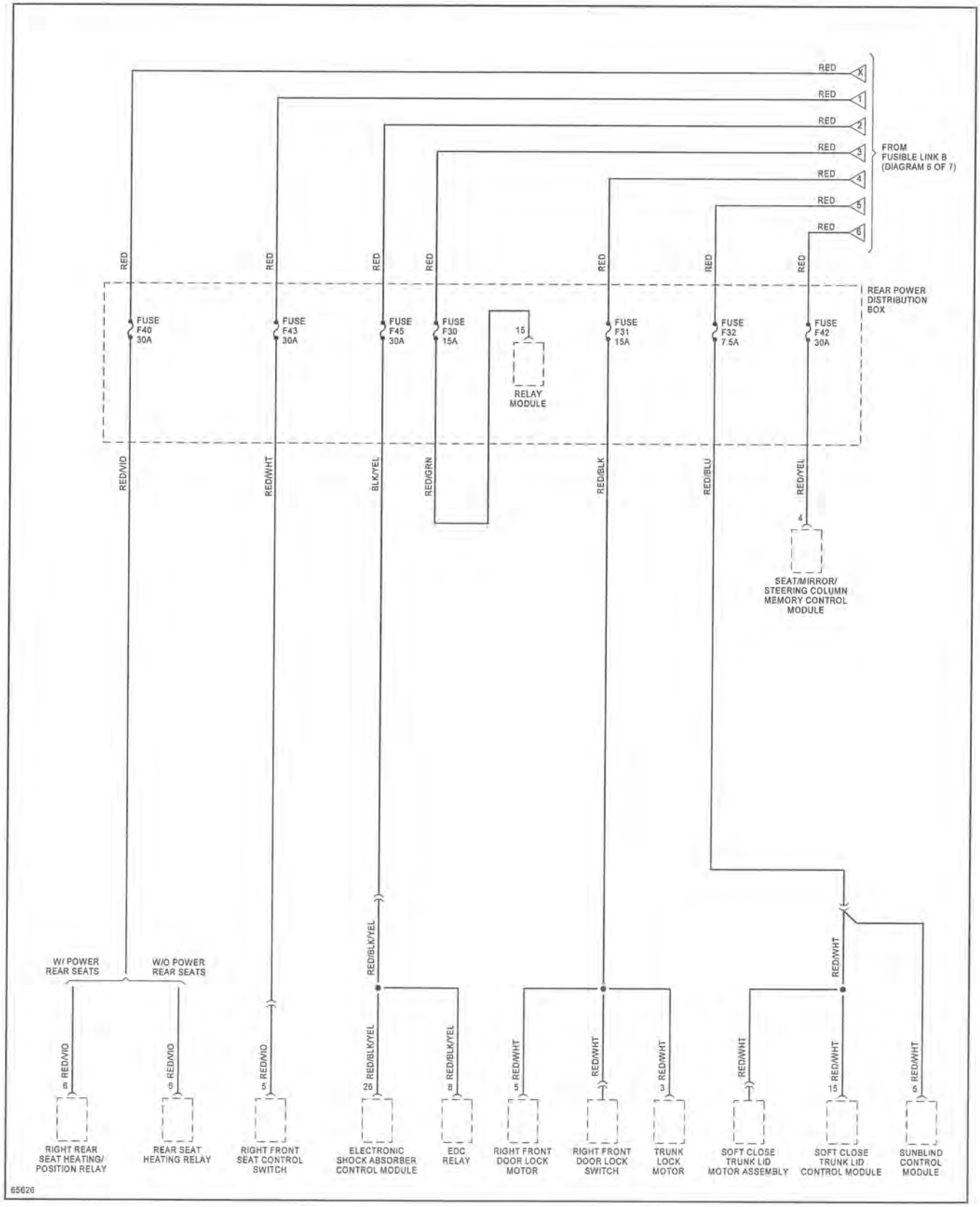
Power Distribution

1993-94 (6 of 7)



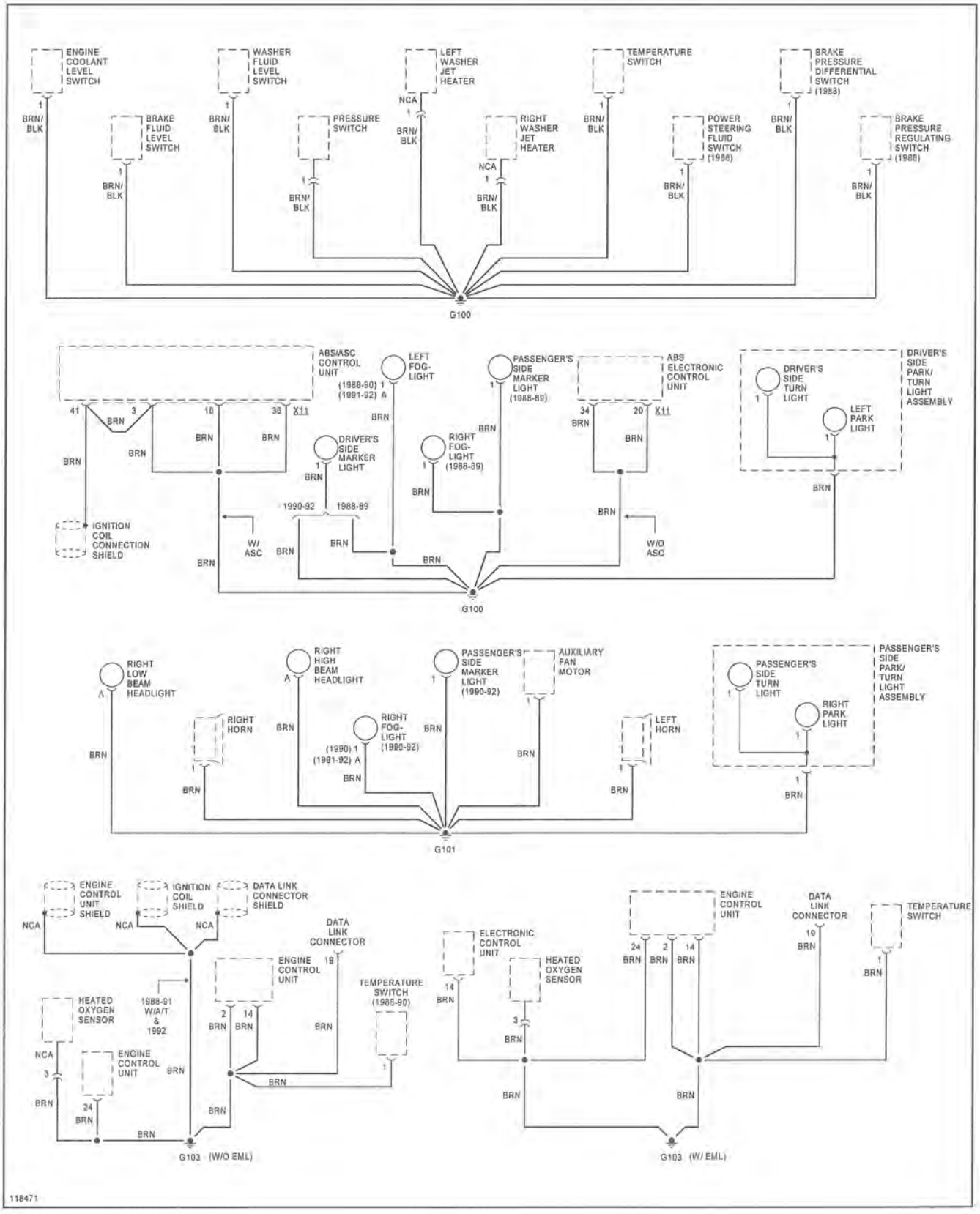
Power Distribution

1993-94 (7 of 7)



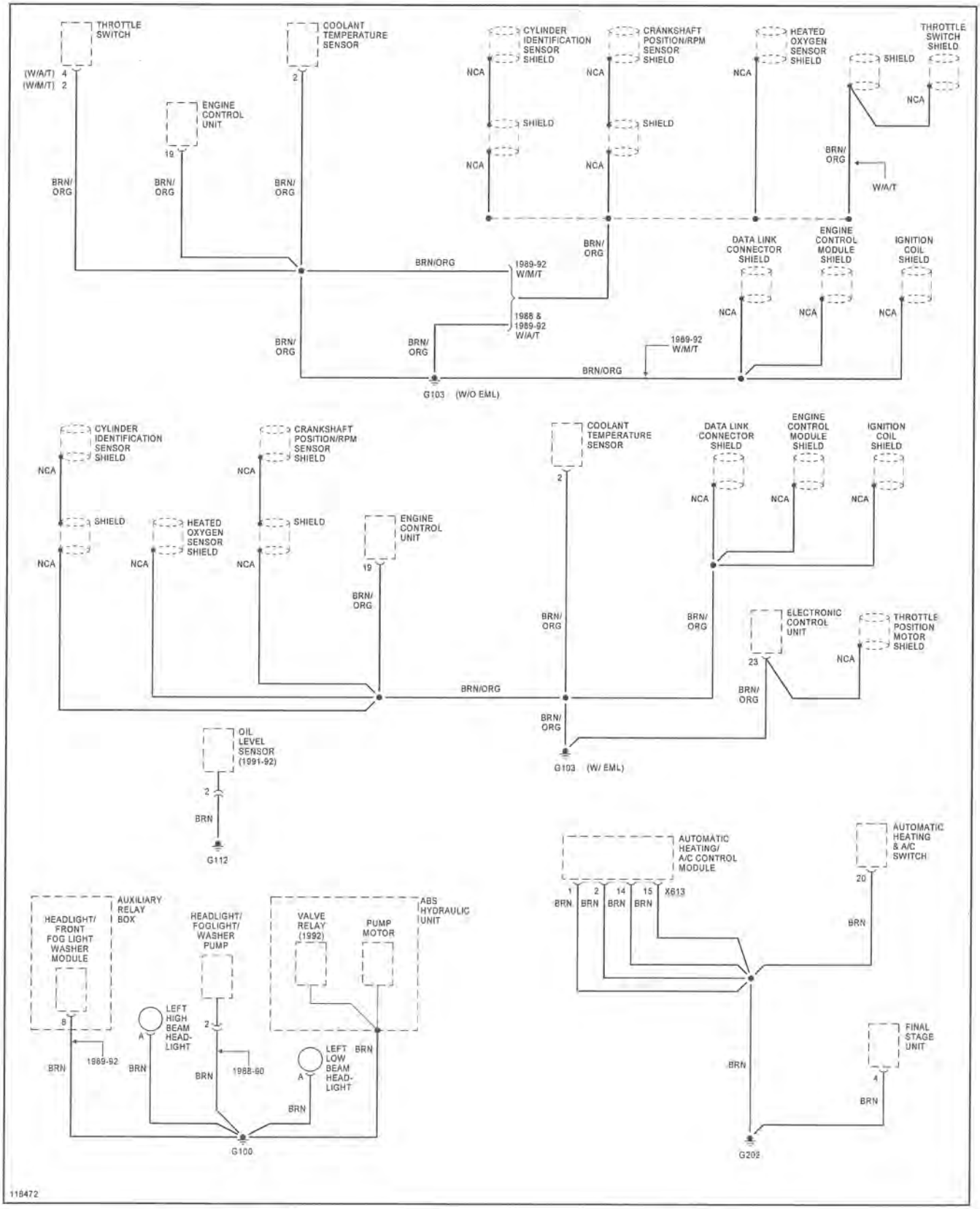
Ground Distribution

1988-92 735i & 735iL (1 of 7)



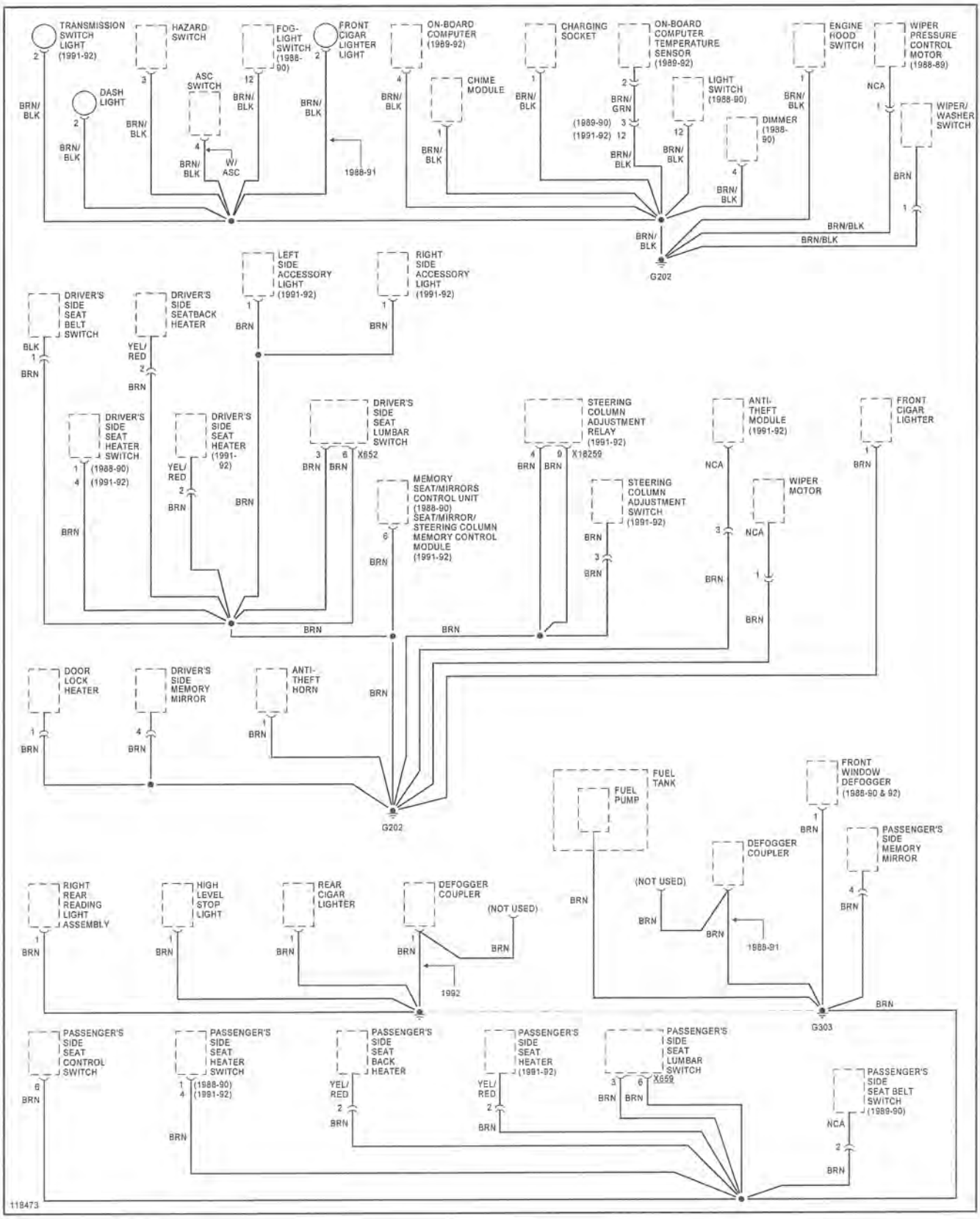
Ground Distribution

1988-92 735i & 735iL (2 of 7)



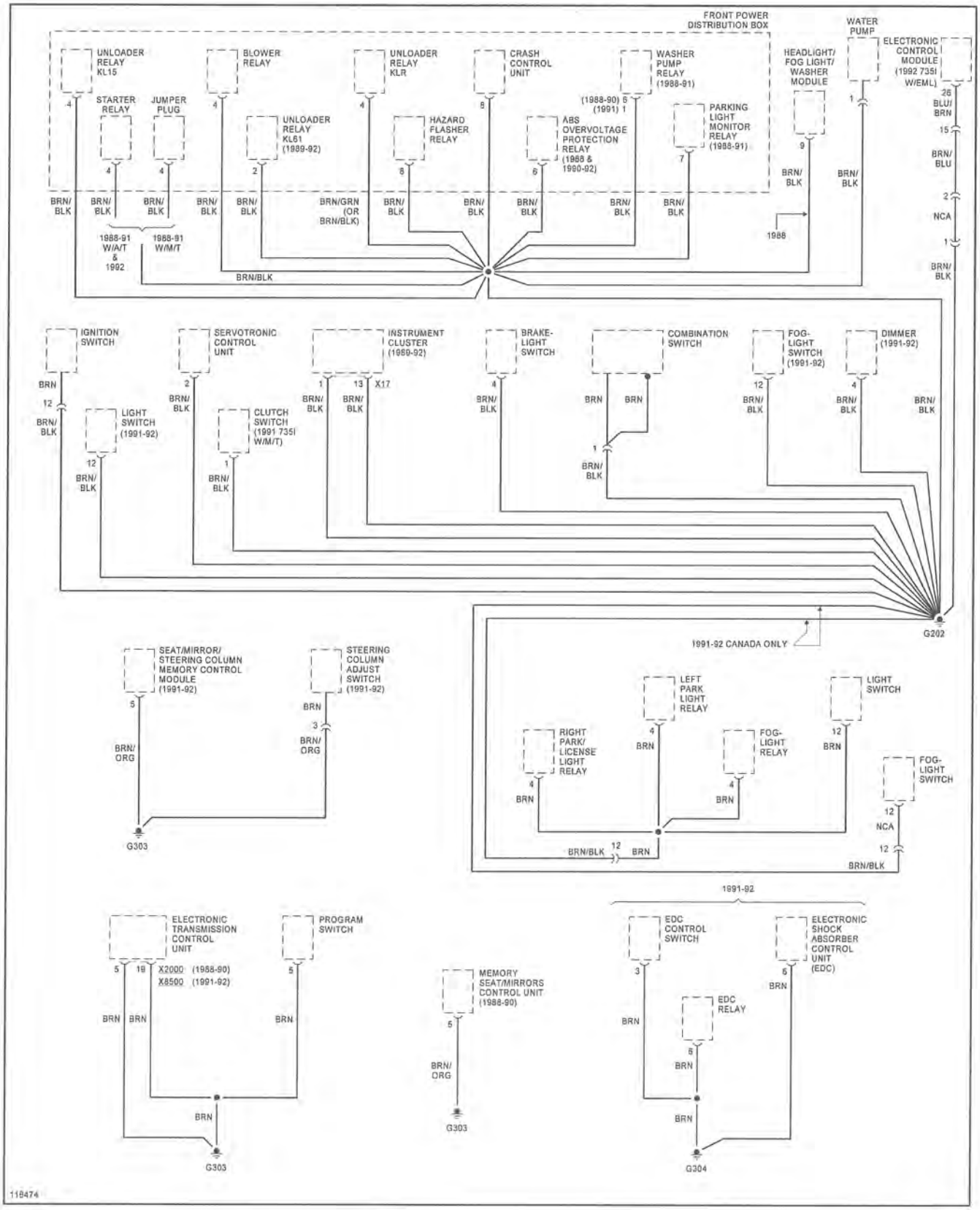
Ground Distribution

1988-92 735i & 735iL (3 of 7)



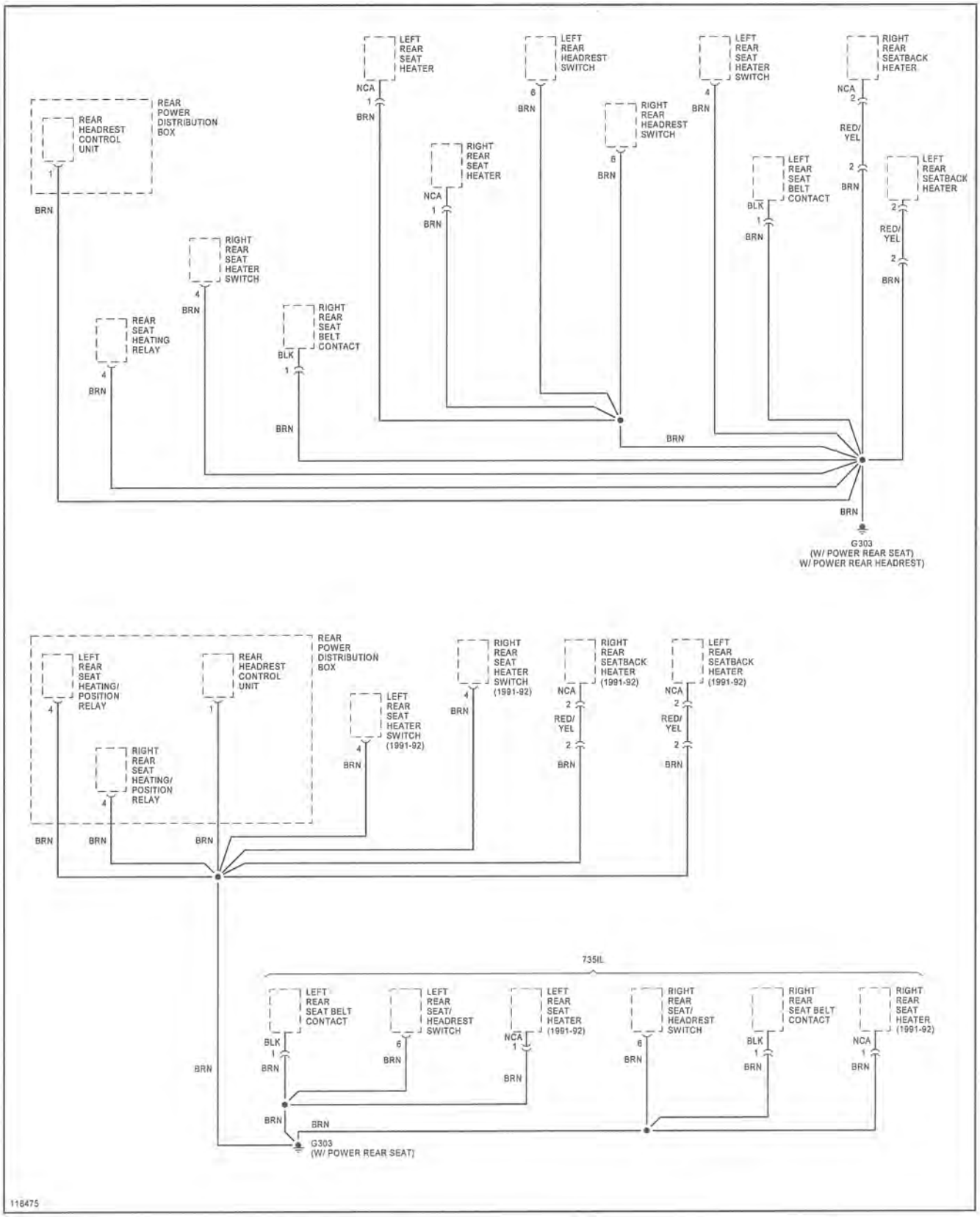
Ground Distribution

1988-92 735i & 735iL (4 of 7)



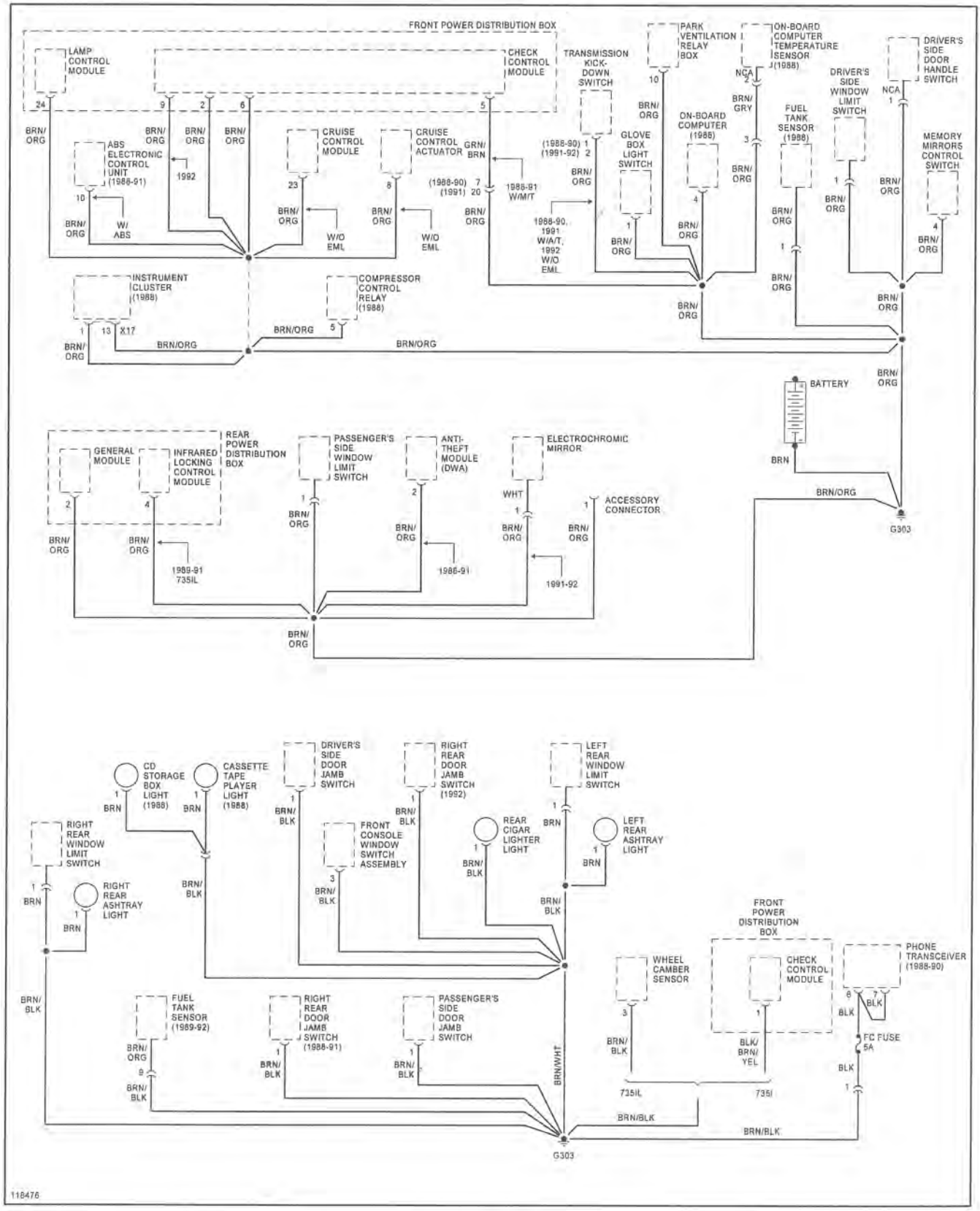
Ground Distribution

1988-92 735i & 735iL (5 of 7)



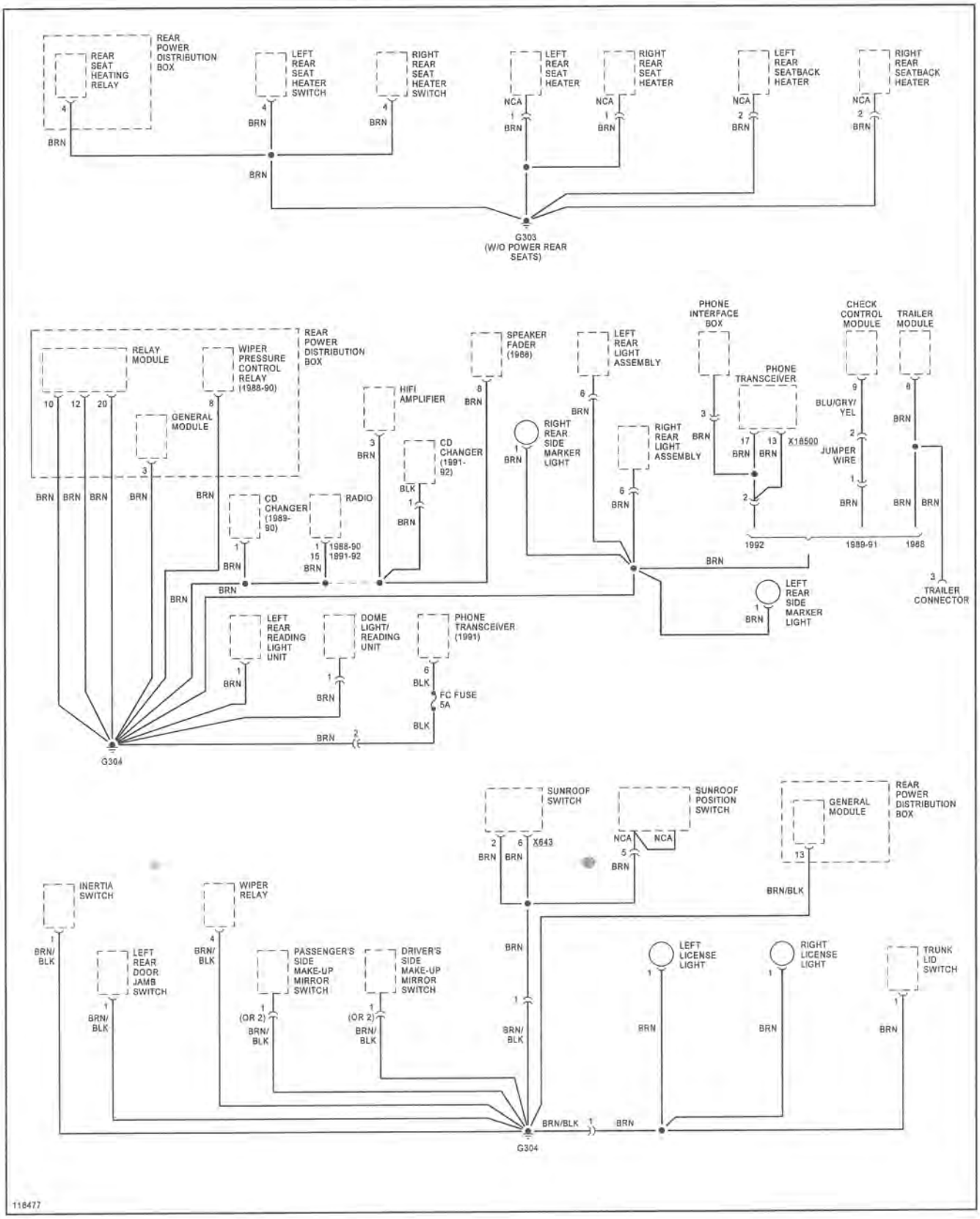
Ground Distribution

1988-92 735i & 735iL (6 of 7)



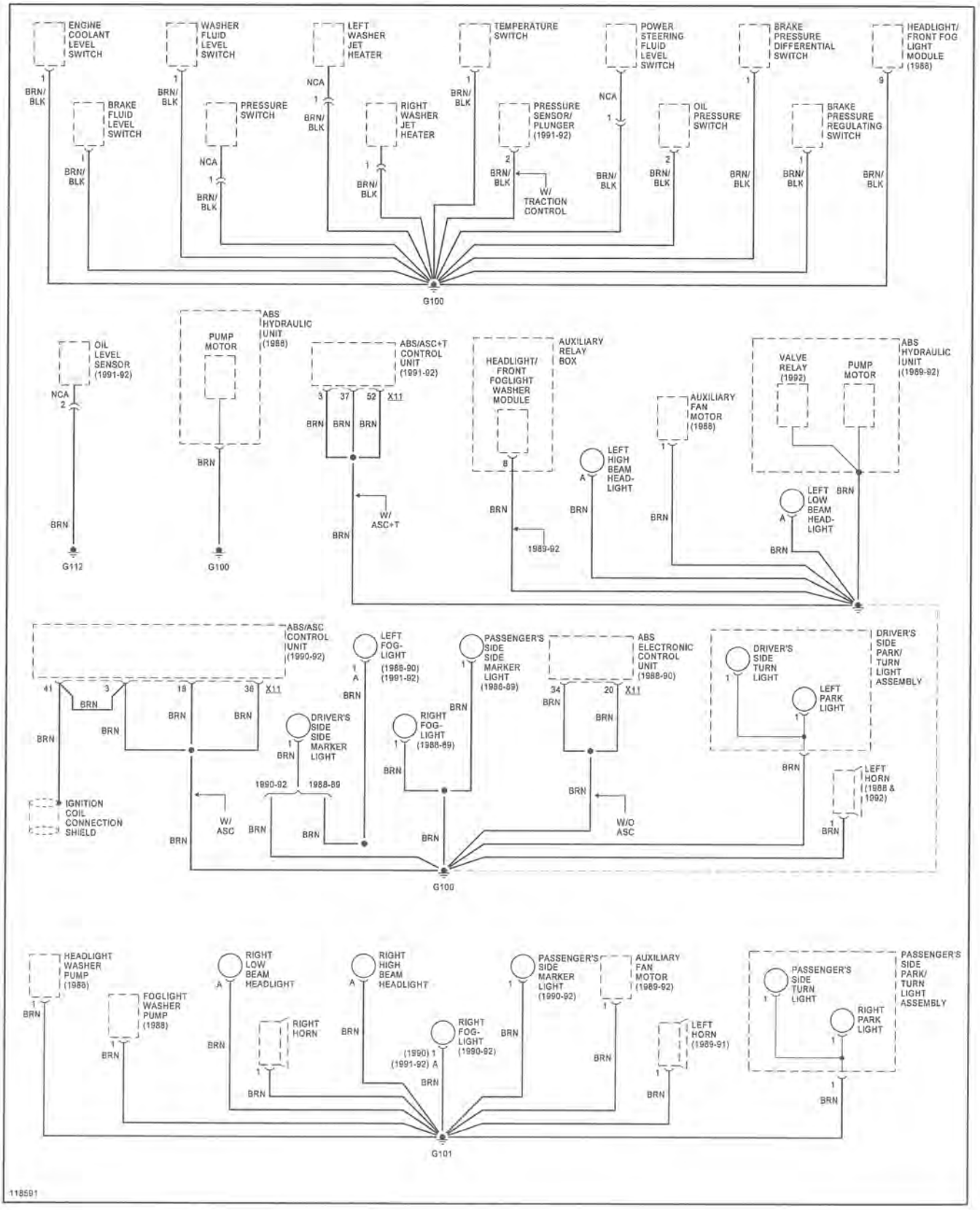
Ground Distribution

1988-92 735i & 735iL (7 of 7)



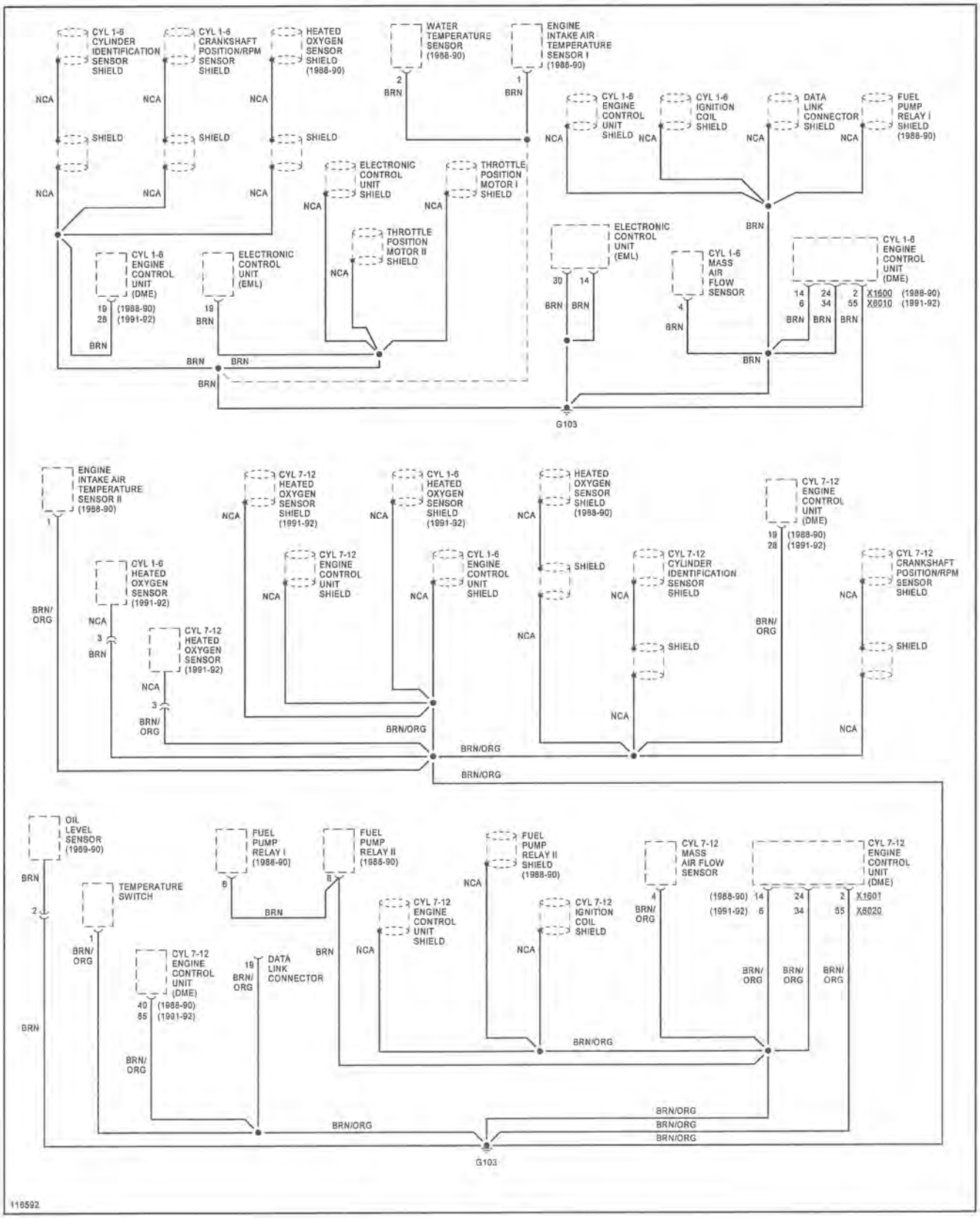
Ground Distribution

1988-92 750iL (1 of 7)



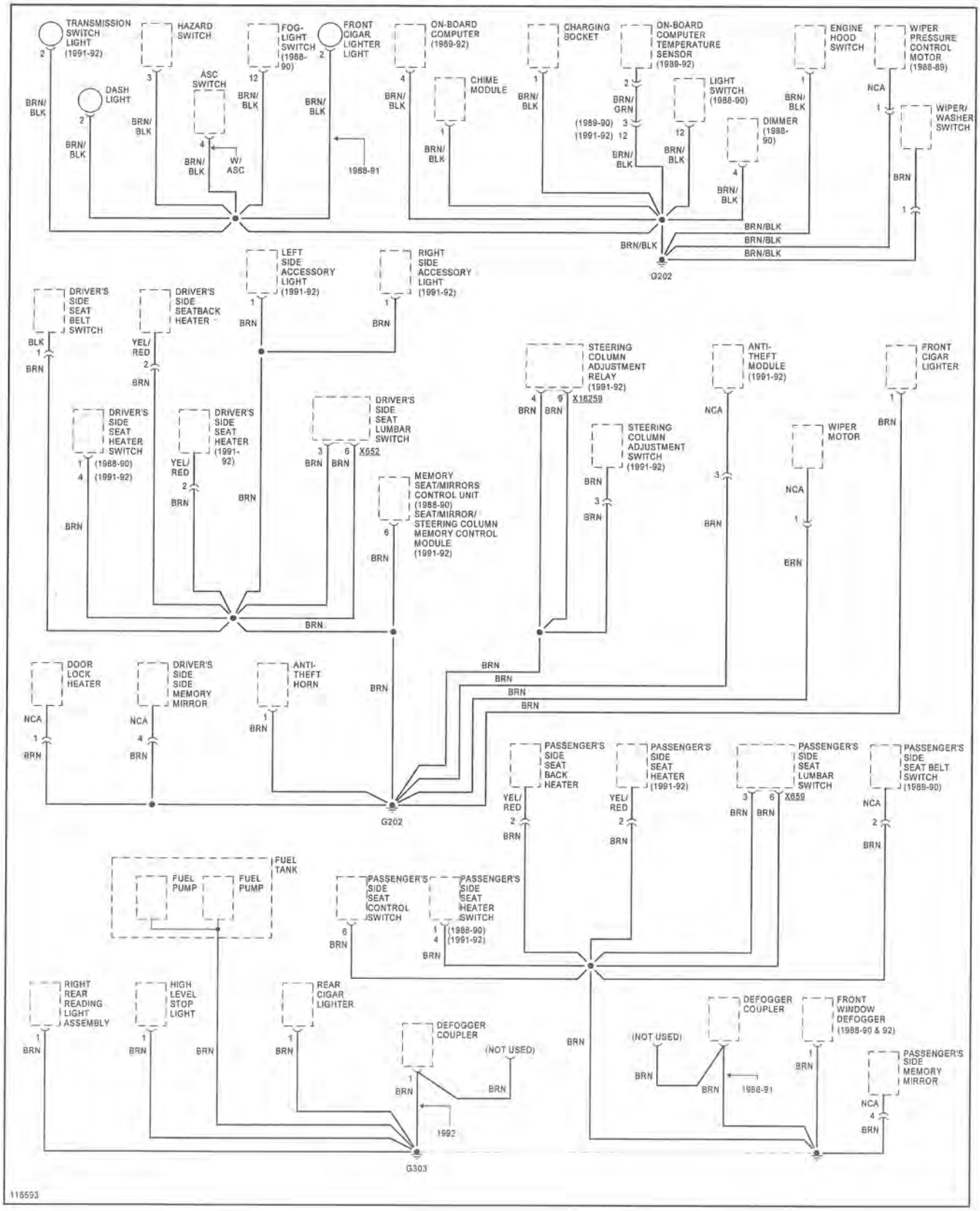
Ground Distribution

1988-92 750iL (2 of 7)



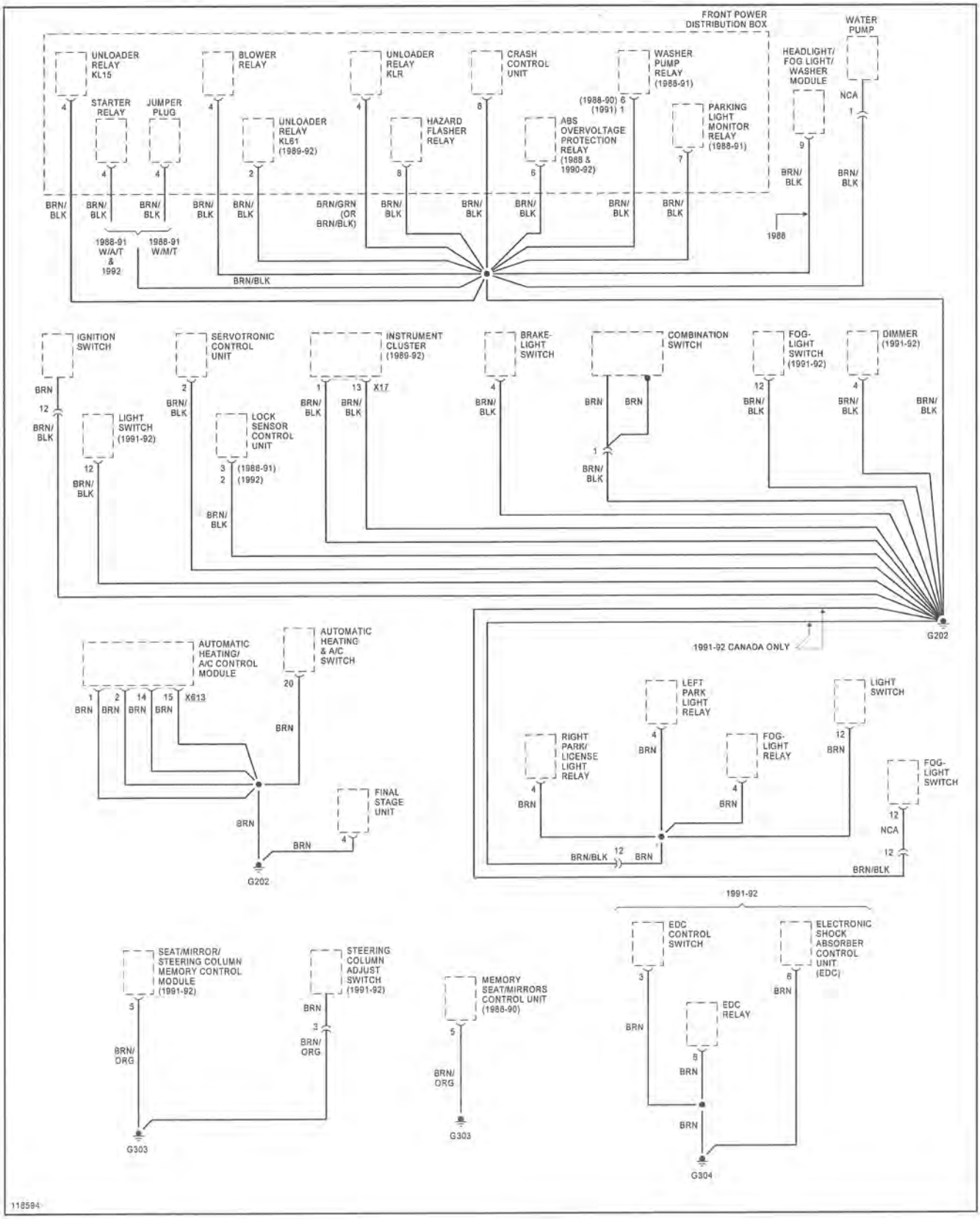
Ground Distribution

1988-92 750iL (3 of 7)



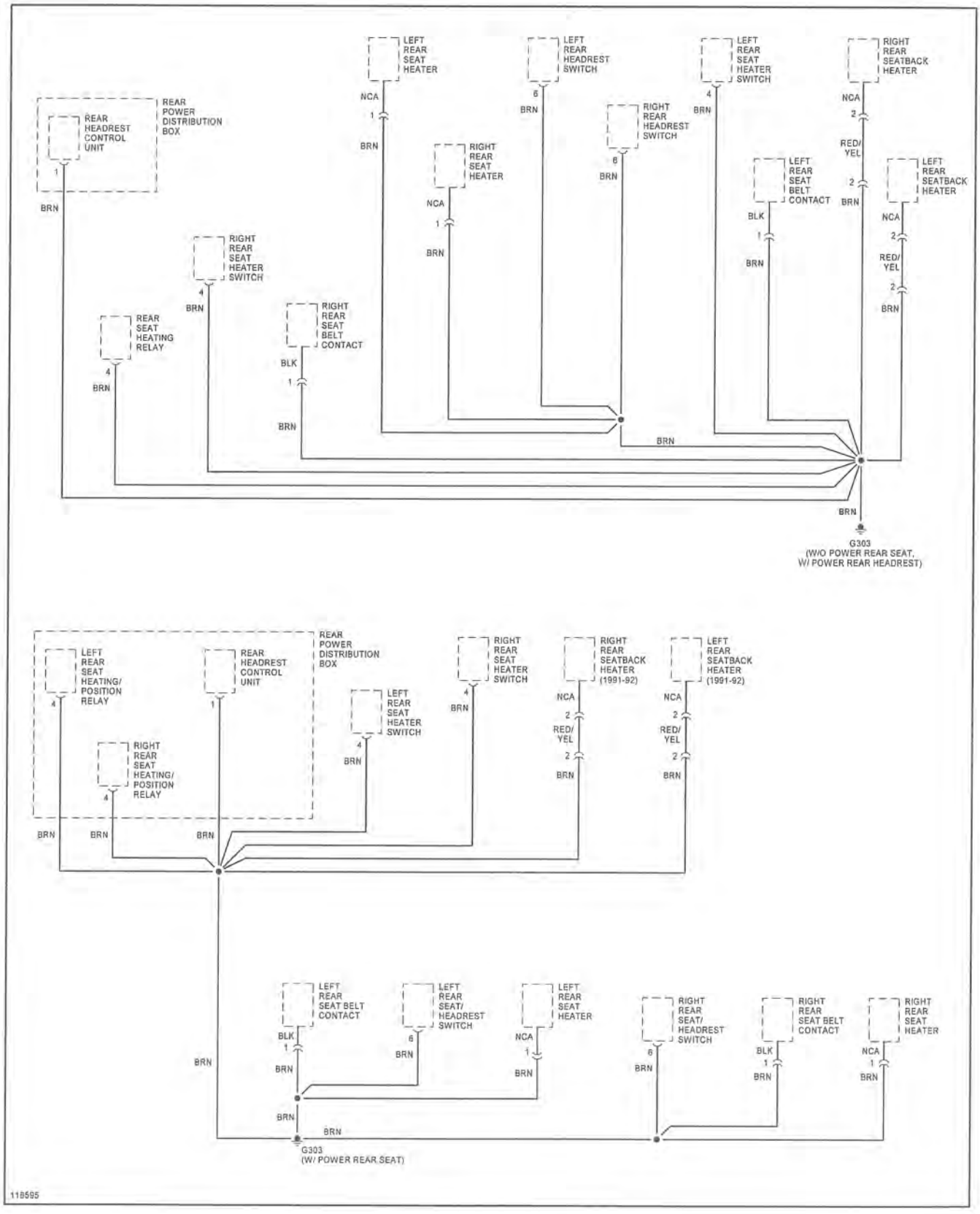
Ground Distribution

1988-92 750iL (4 of 7)



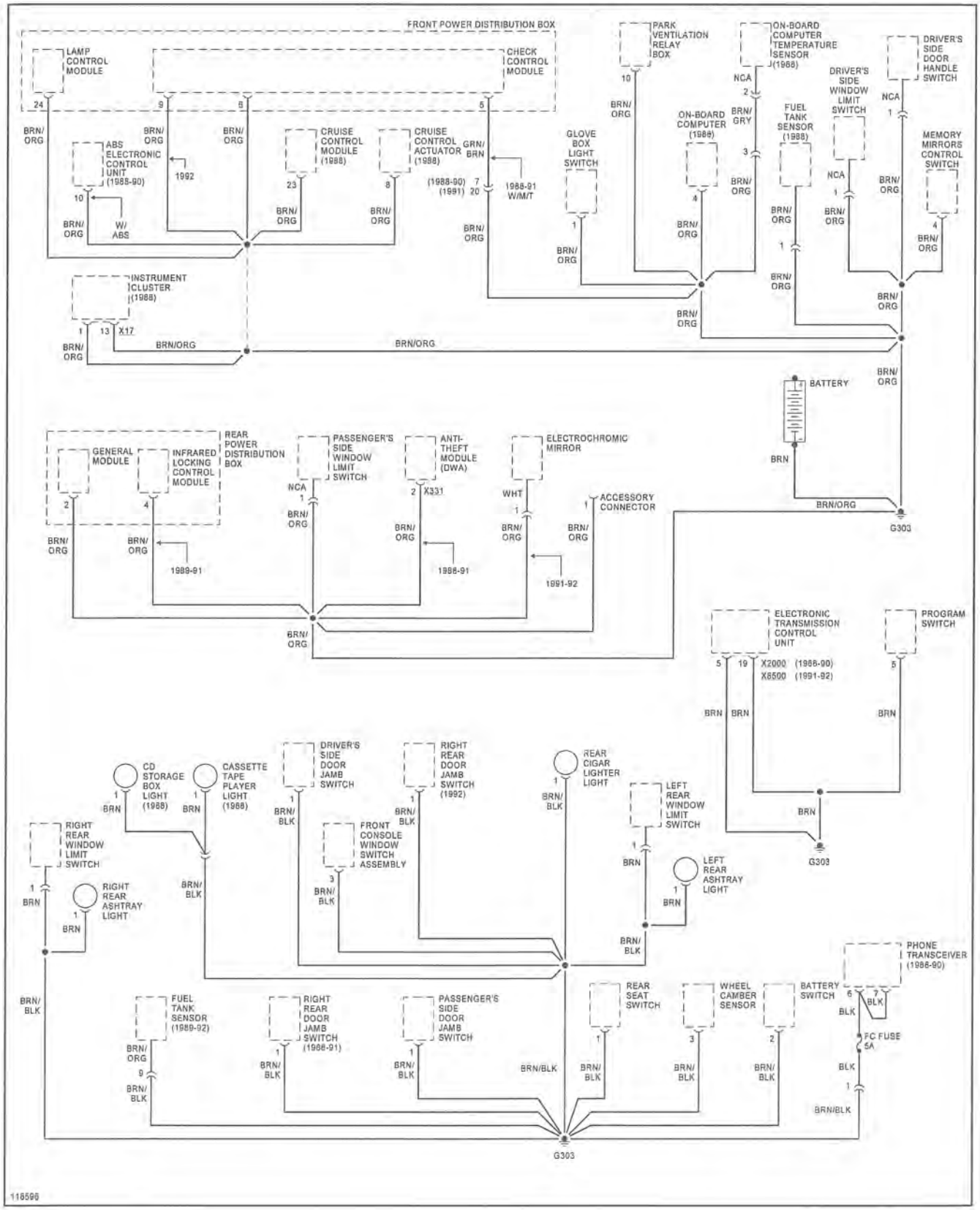
Ground Distribution

1988-92 750iL (5 of 7)



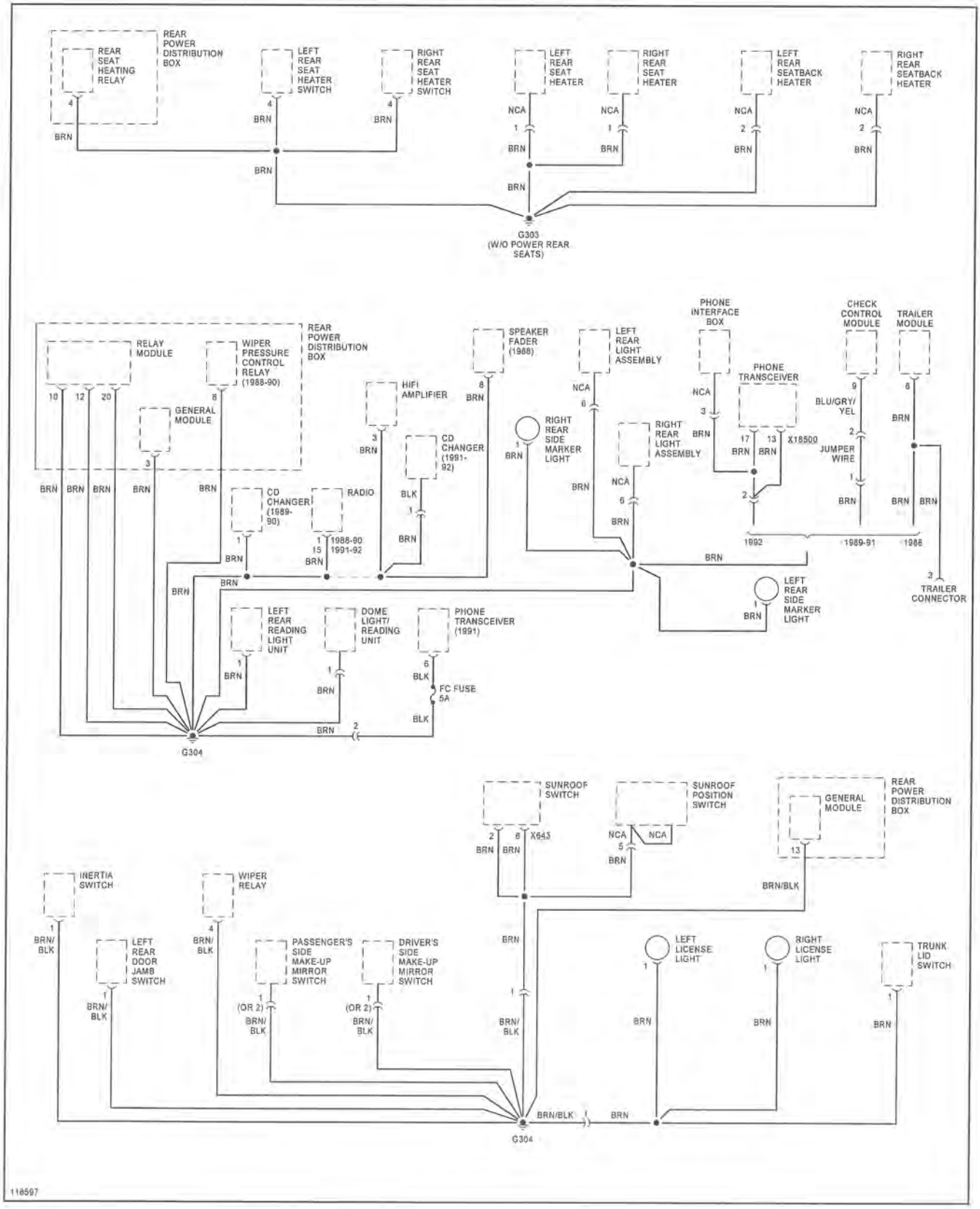
Ground Distribution

1988-92 750iL (6 of 7)



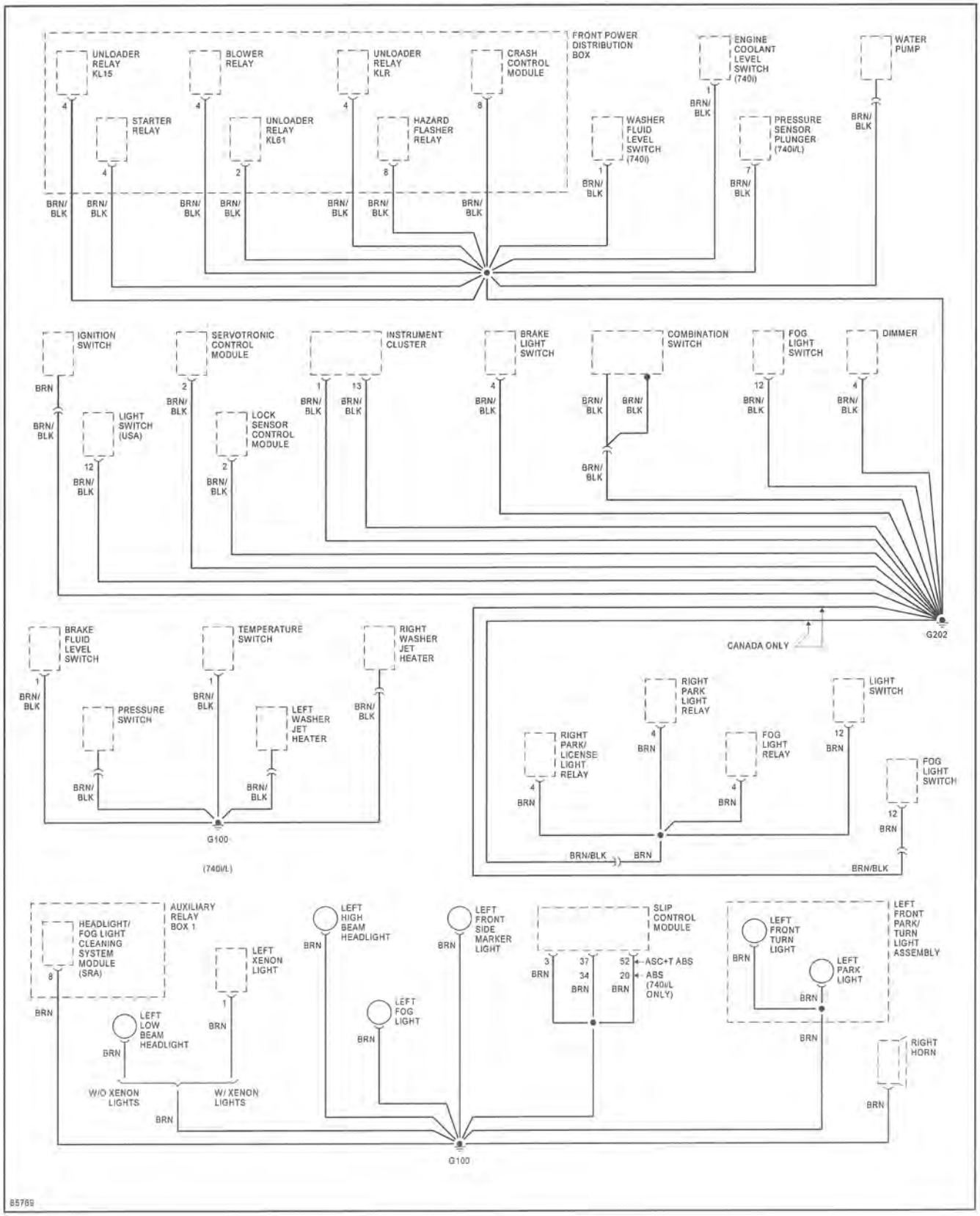
Ground Distribution

1988-92 750iL (7 of 7)



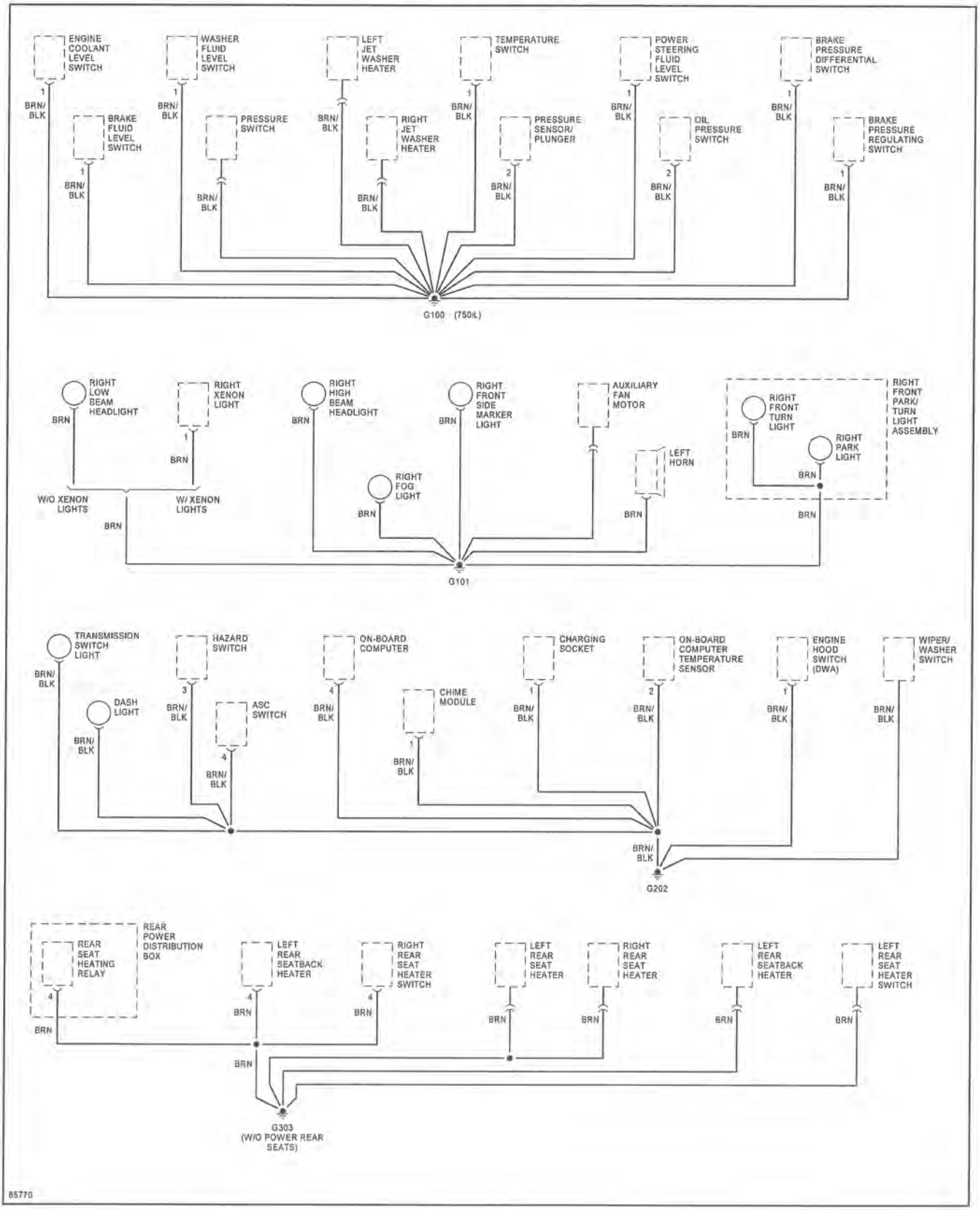
Ground Distribution

1993-94 (1 of 7)



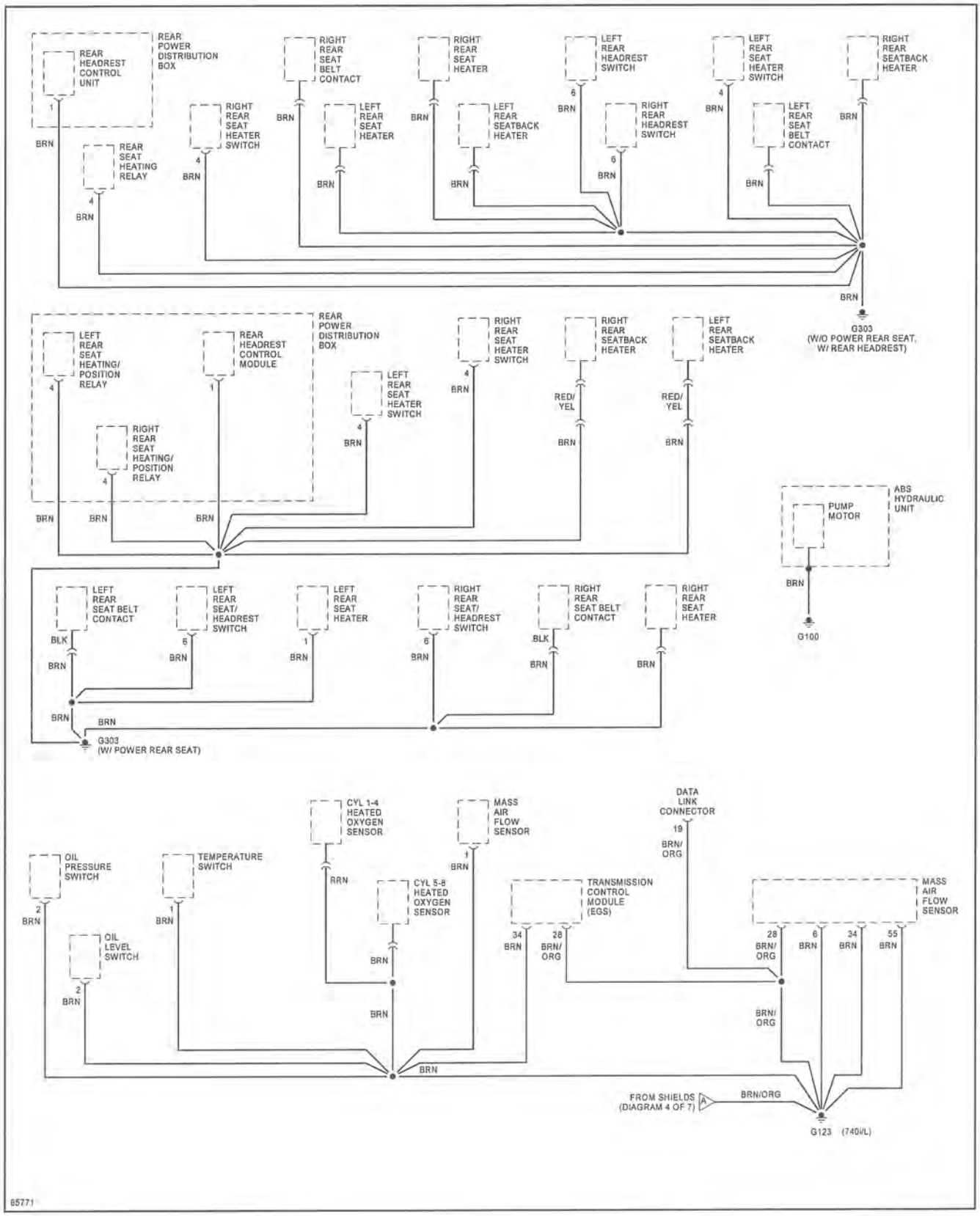
Ground Distribution

1993-94 (2 of 7)



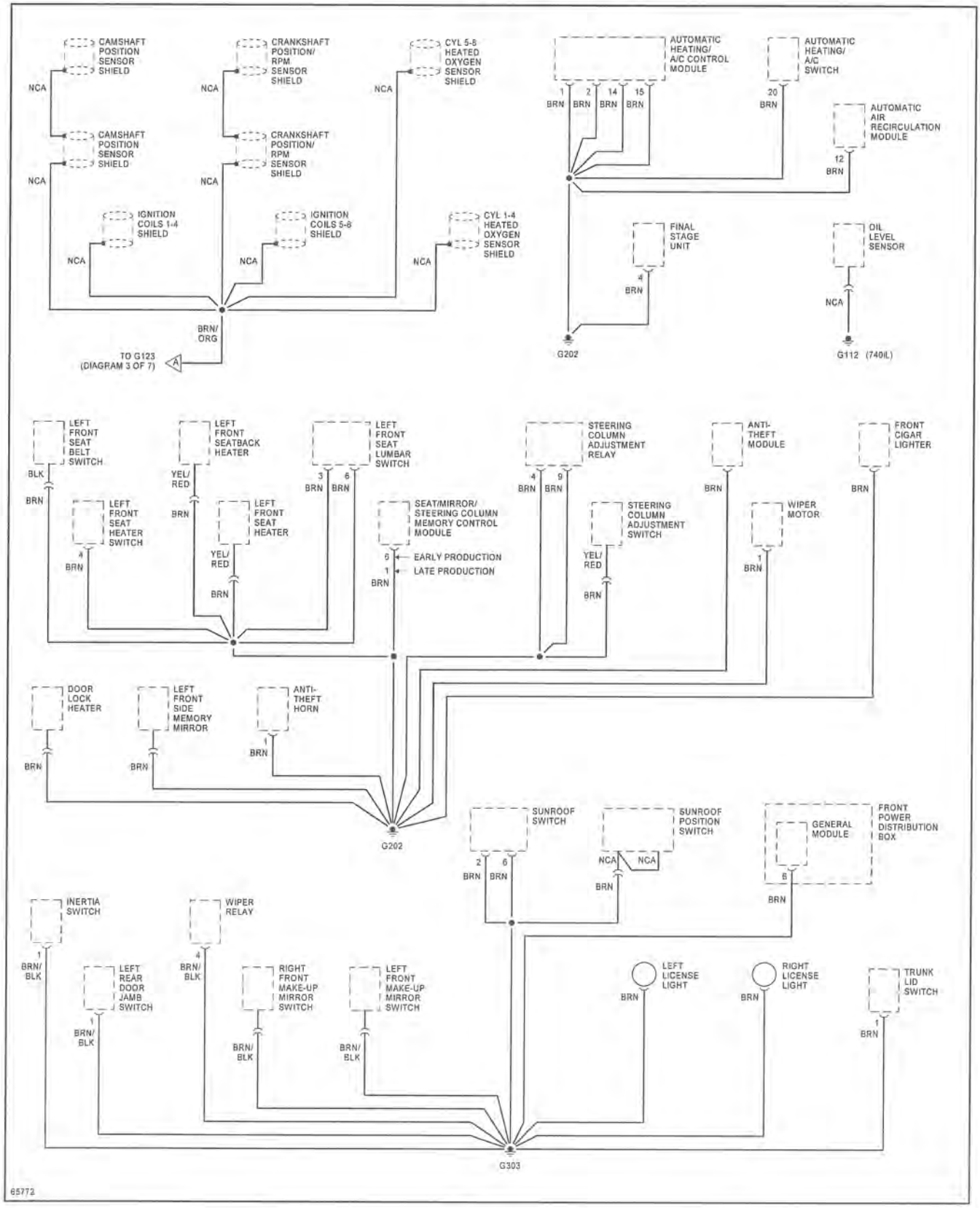
Ground Distribution

1993-94 (3 of 7)



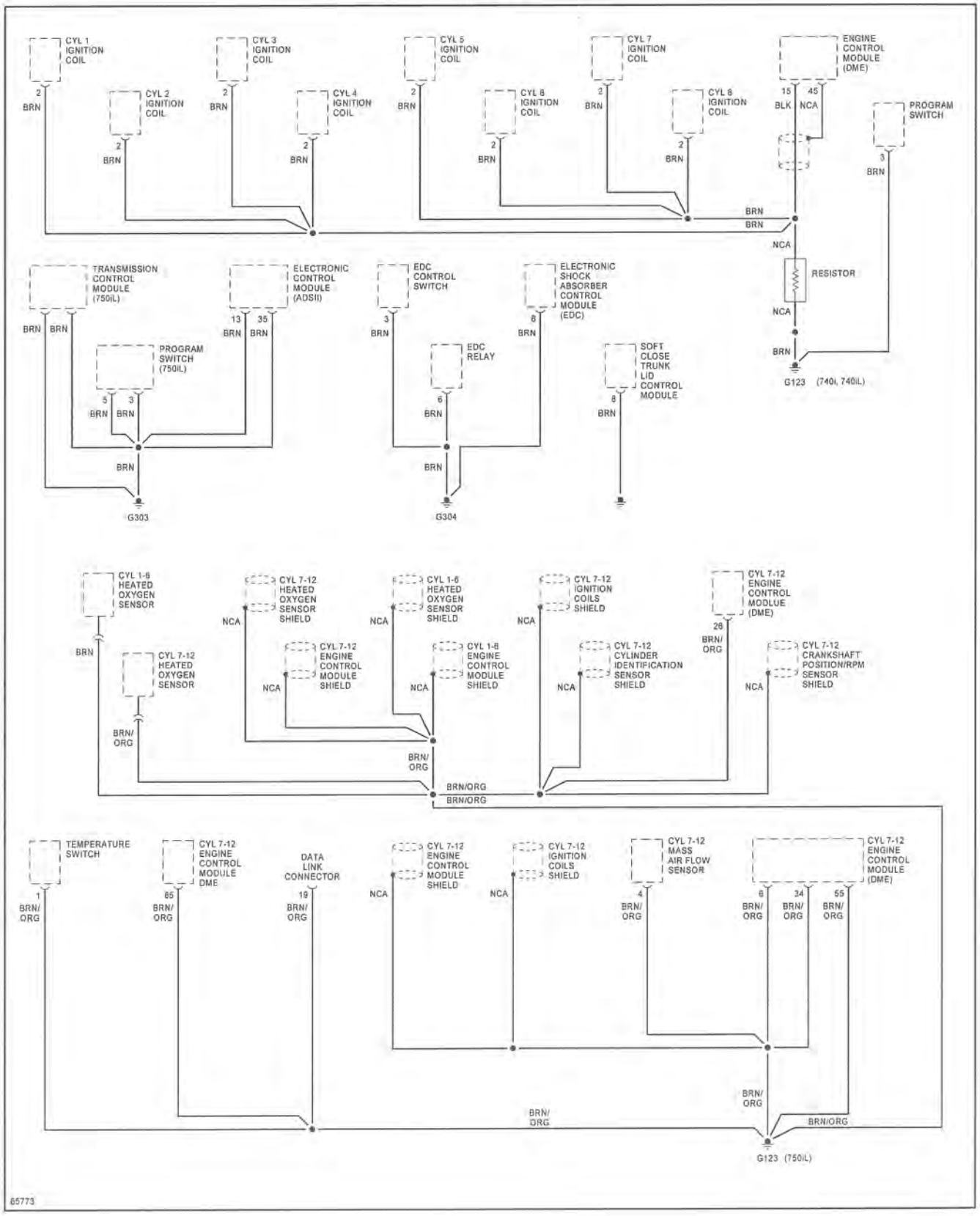
Ground Distribution

1993-94 (4 of 7)



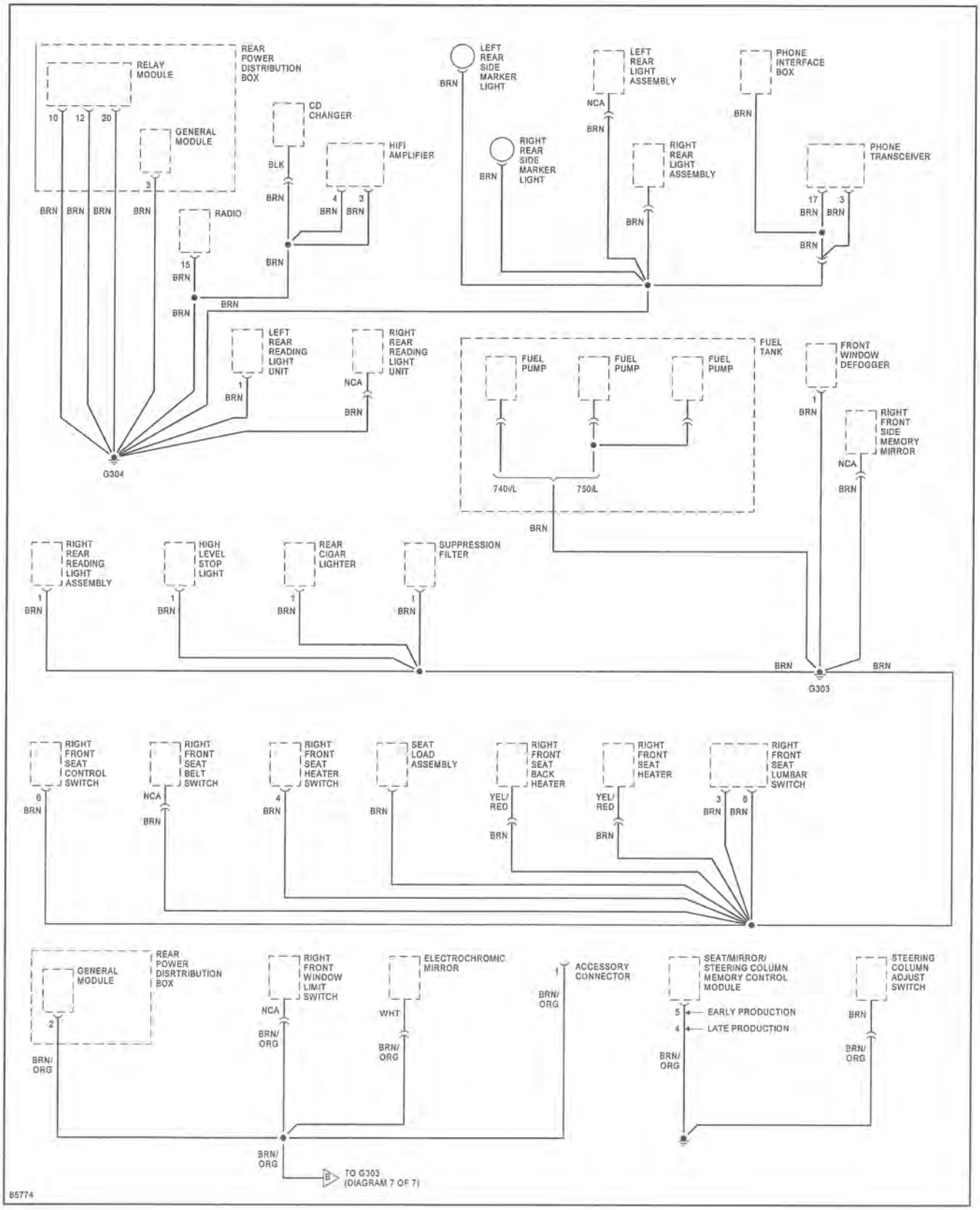
Ground Distribution

1993-94 (5 of 7)



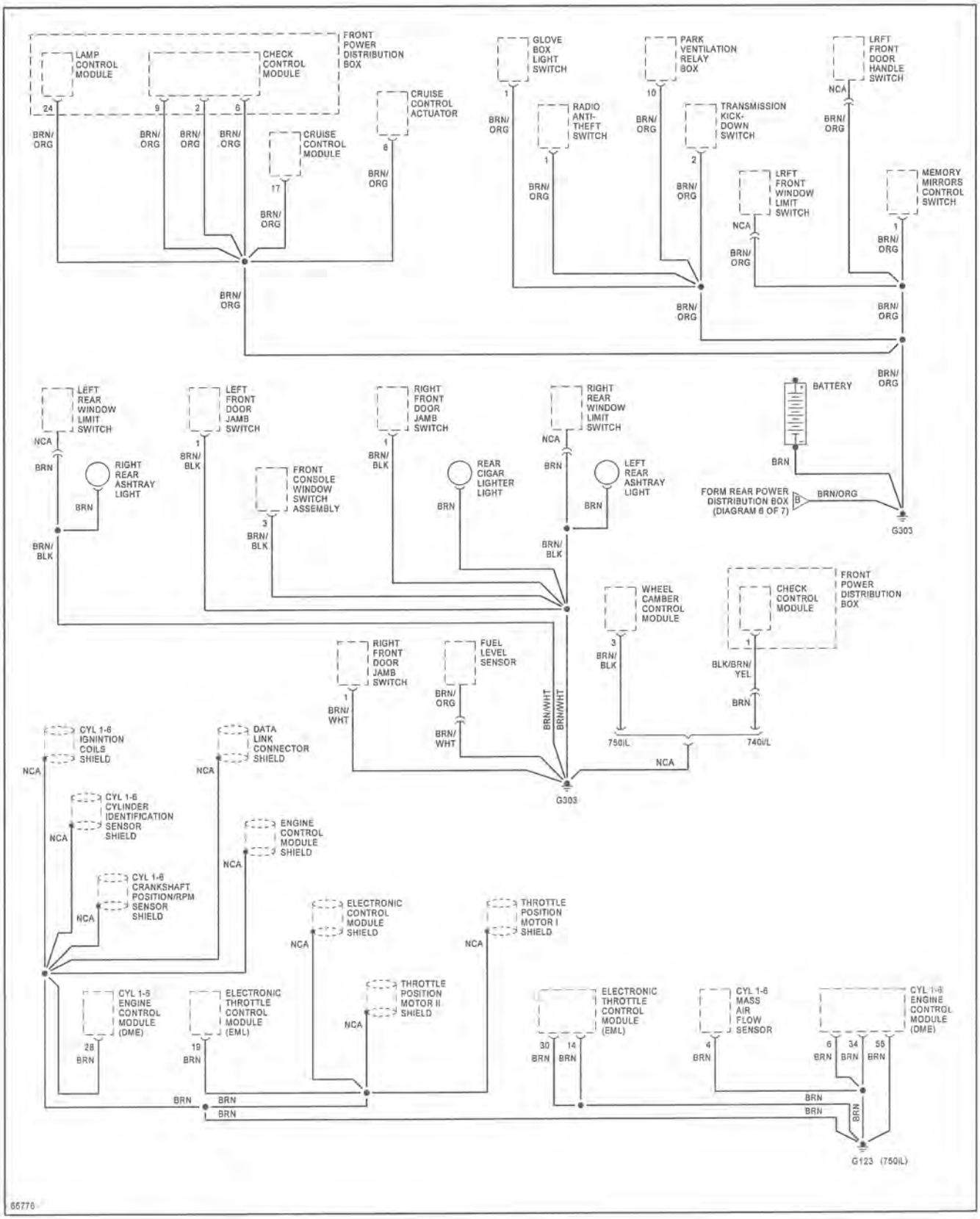
Ground Distribution

1993-94 (6 of 7)

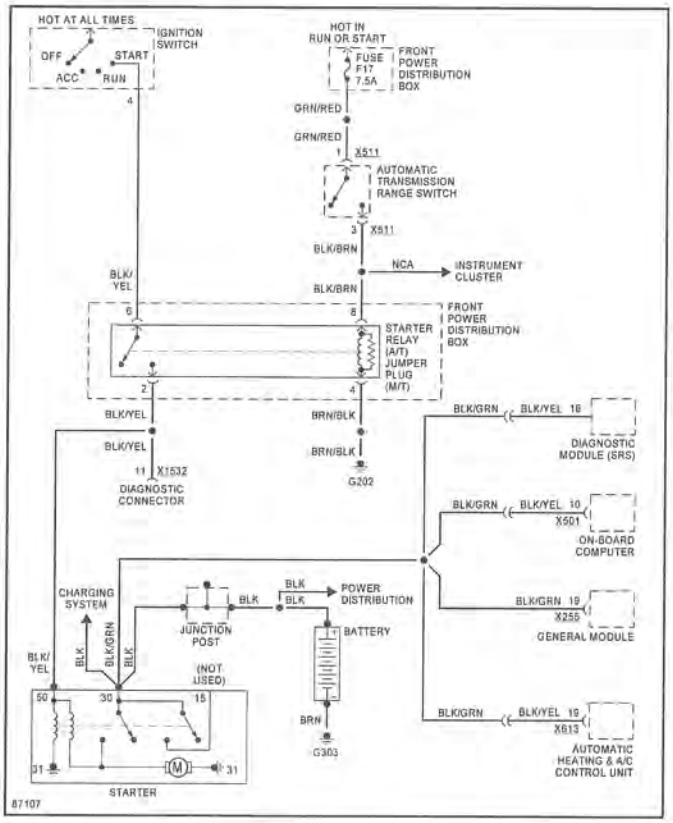


Ground Distribution

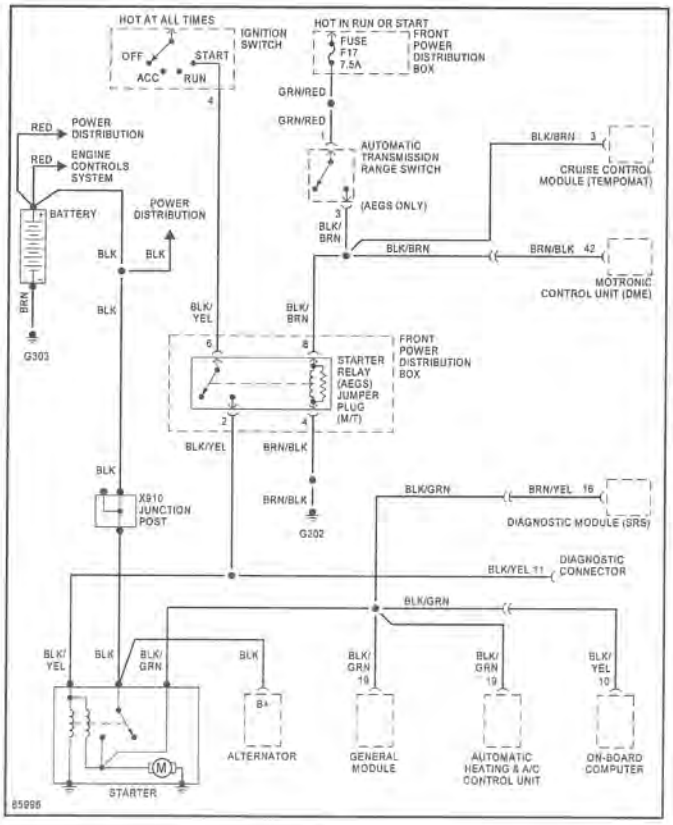
1993-94 (7 of 7)



Starting



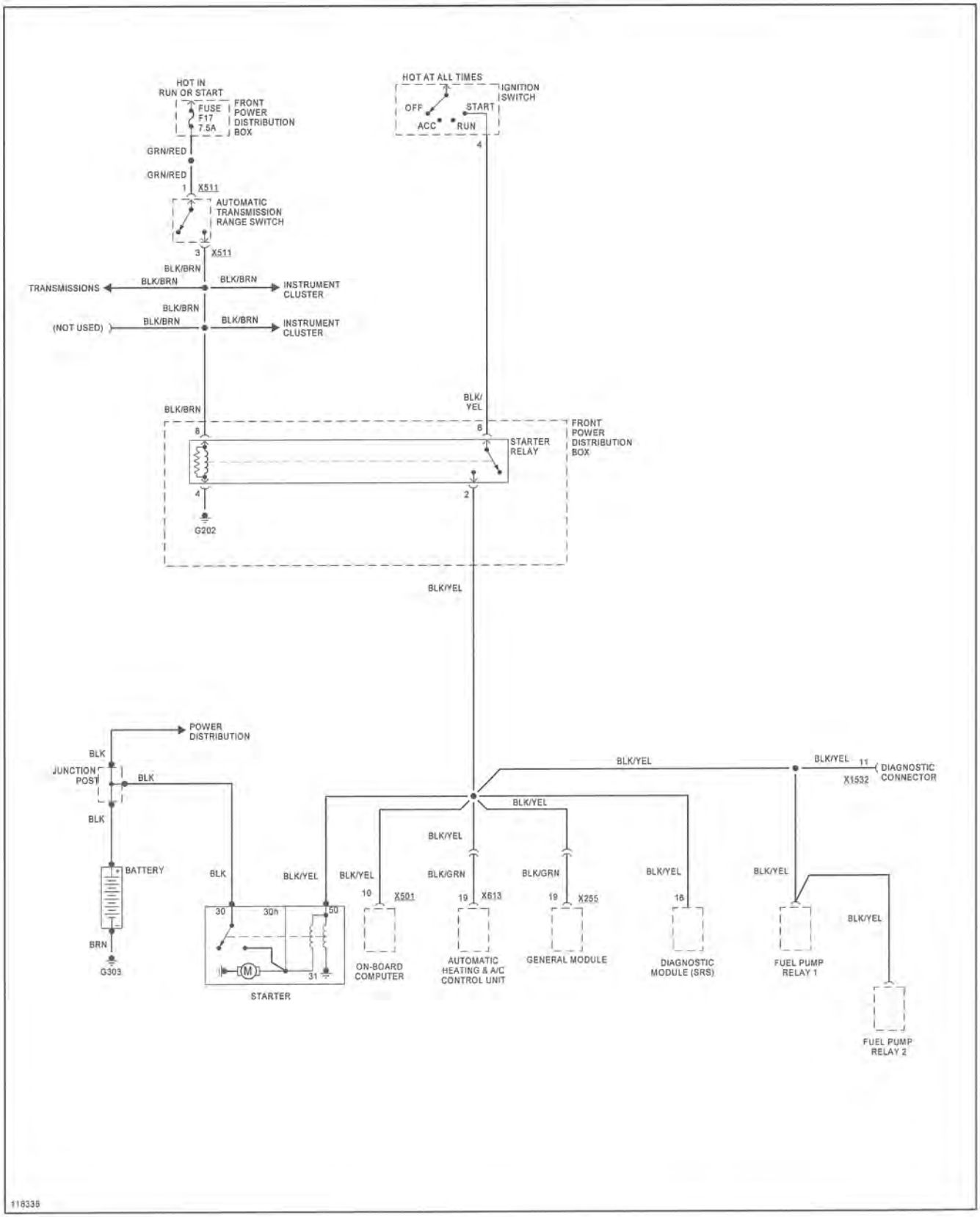
1988-89
735i & 735iL,
1988
750iL



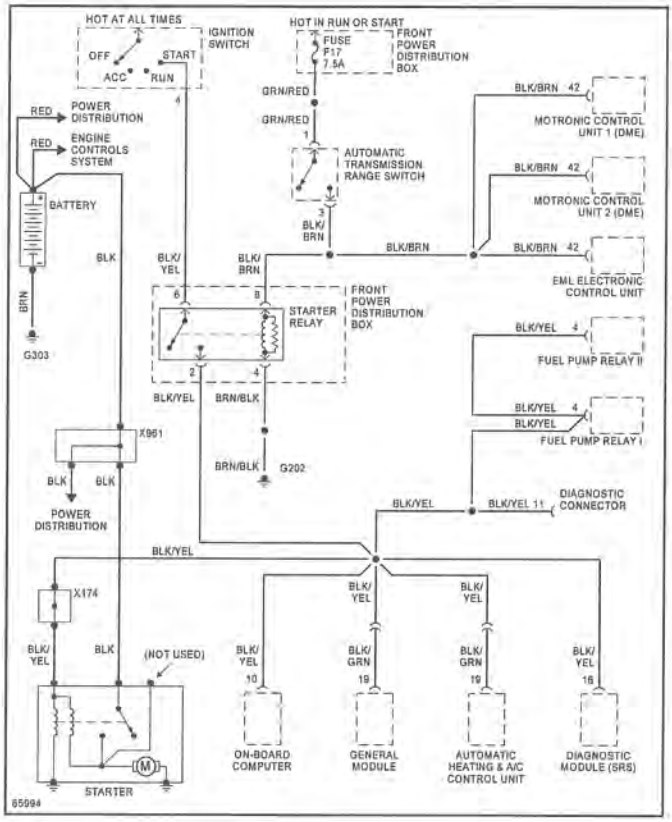
1990
735i & 735iL

Starting

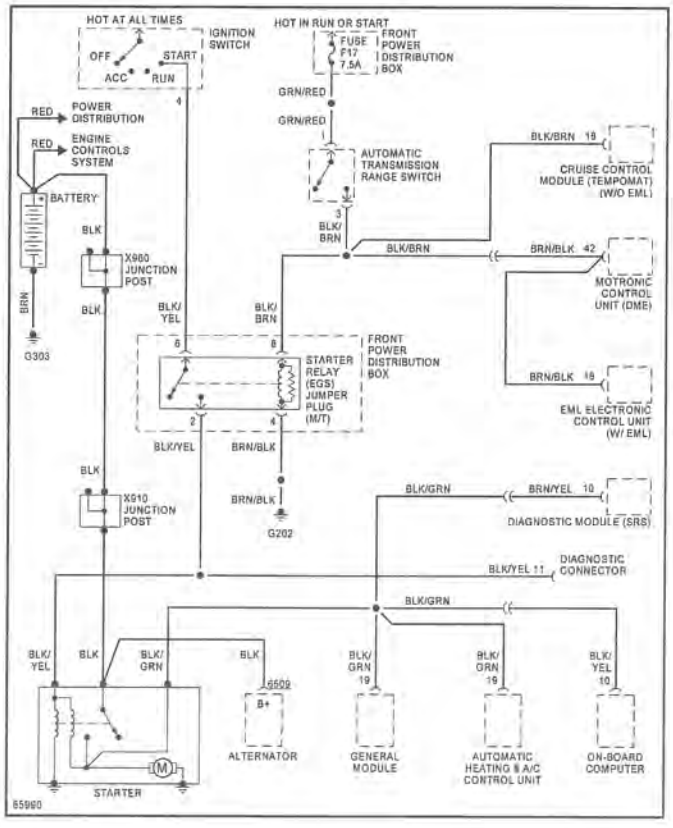
1989 750iL



Starting

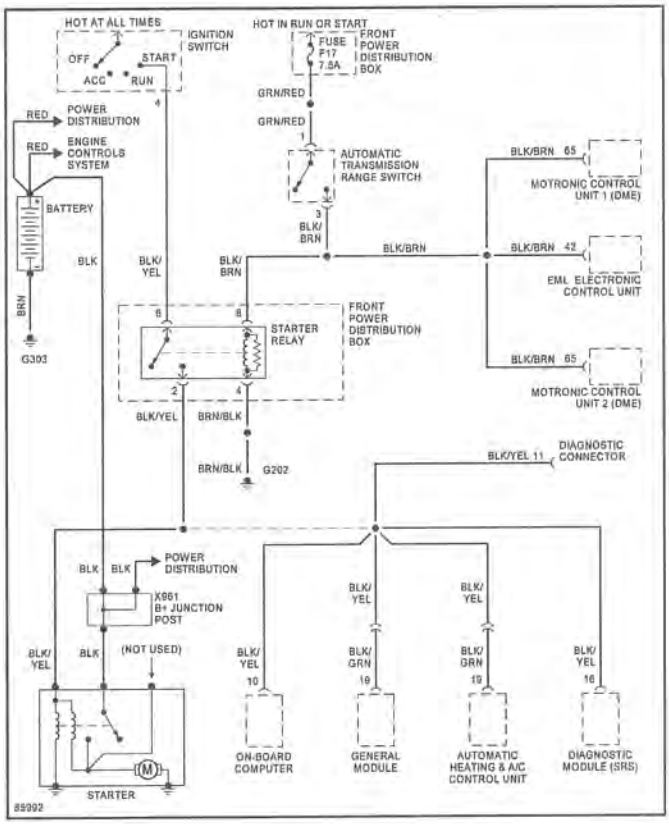


1990
750iL

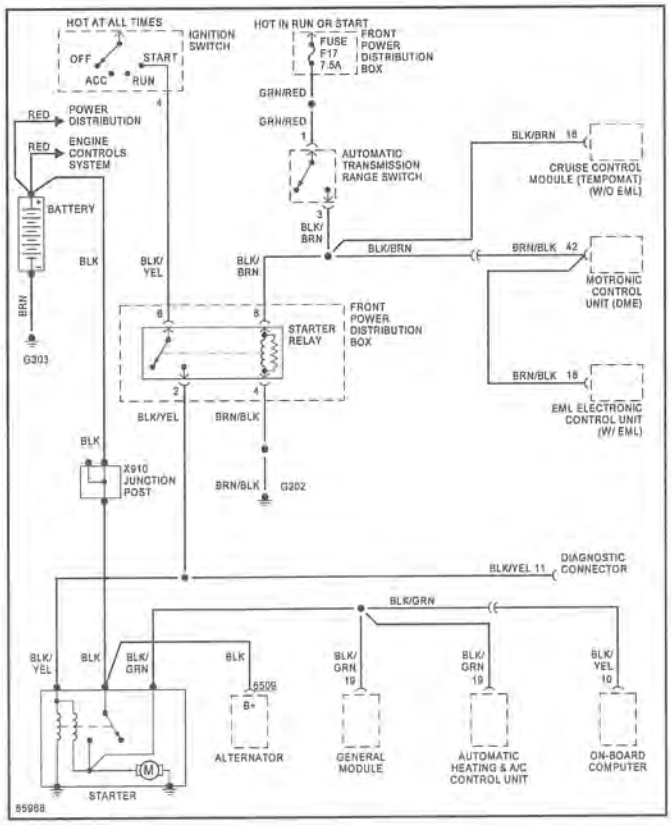


1991
735i & 735iL

Starting

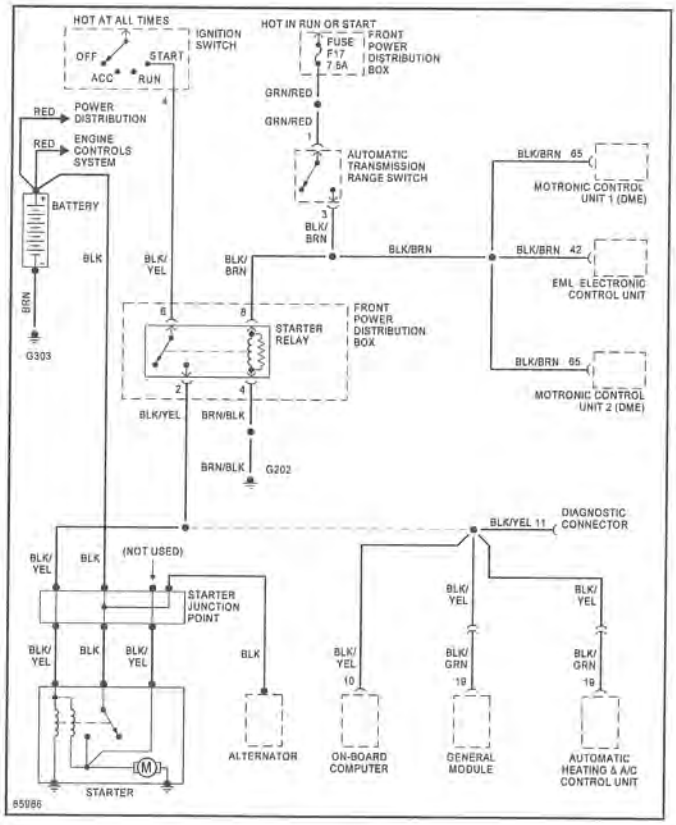


1991
750iL

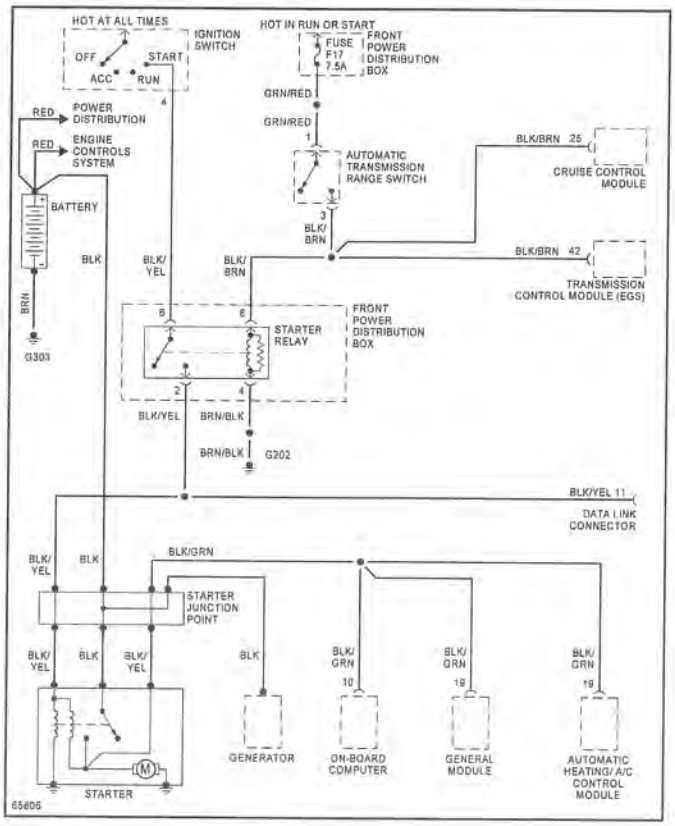


1992
735i & 735iL

Starting

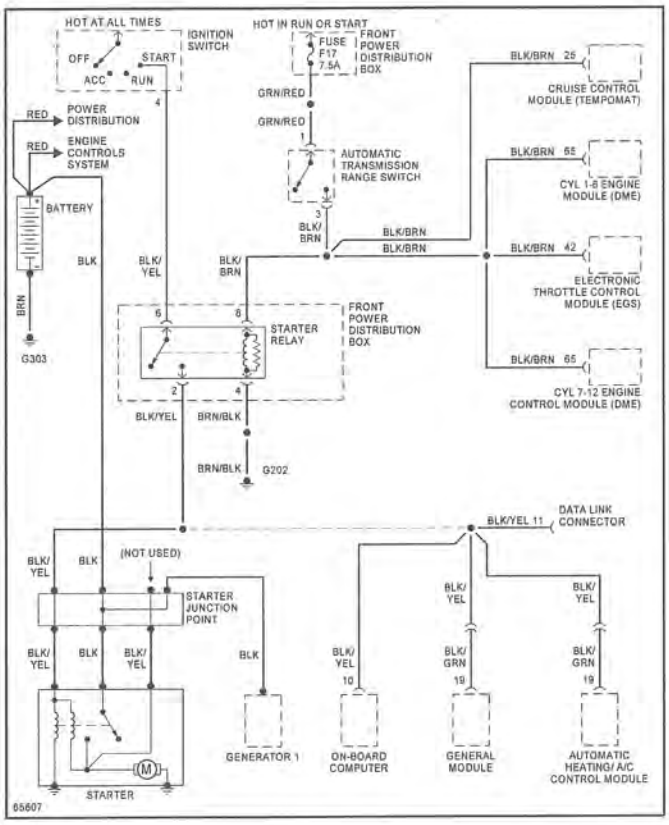


1992
750iL



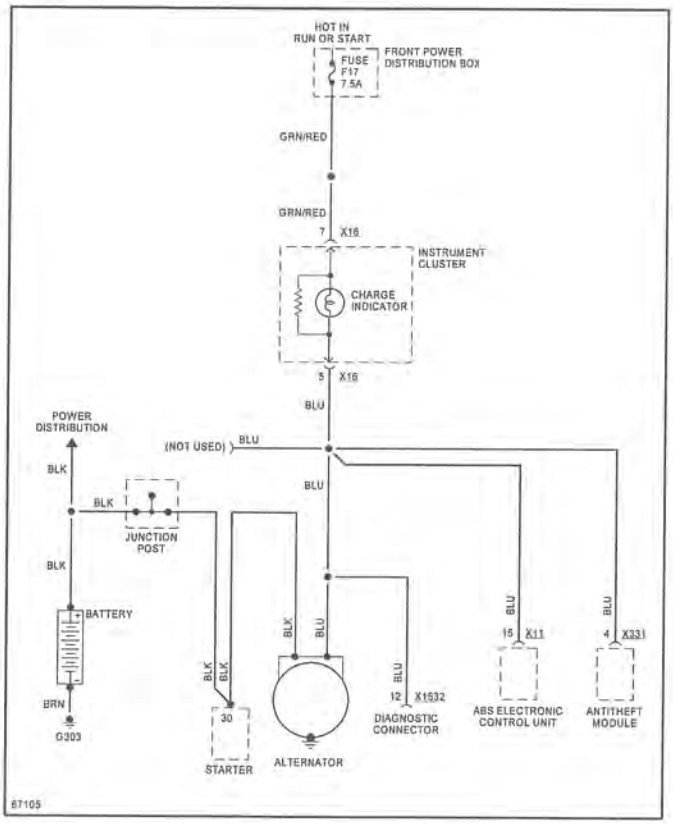
1993-94
740i & 740iL

Starting

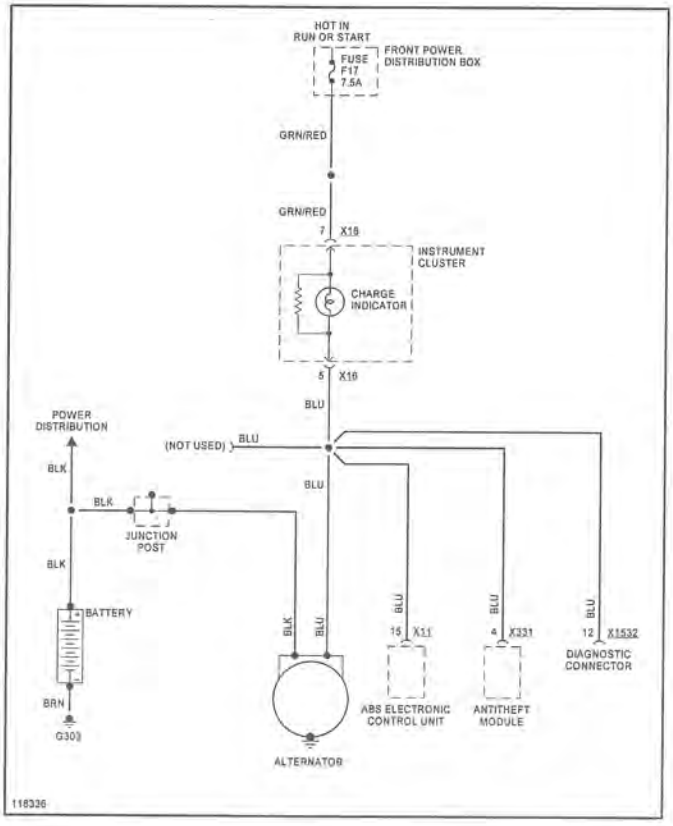


1993-94
750iL

Charging System

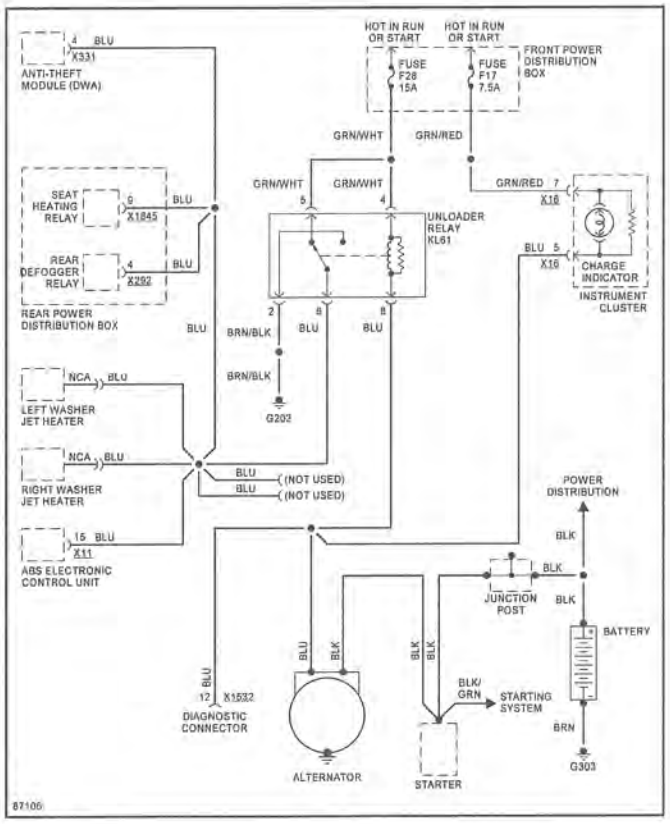


1988
735i & 735iL

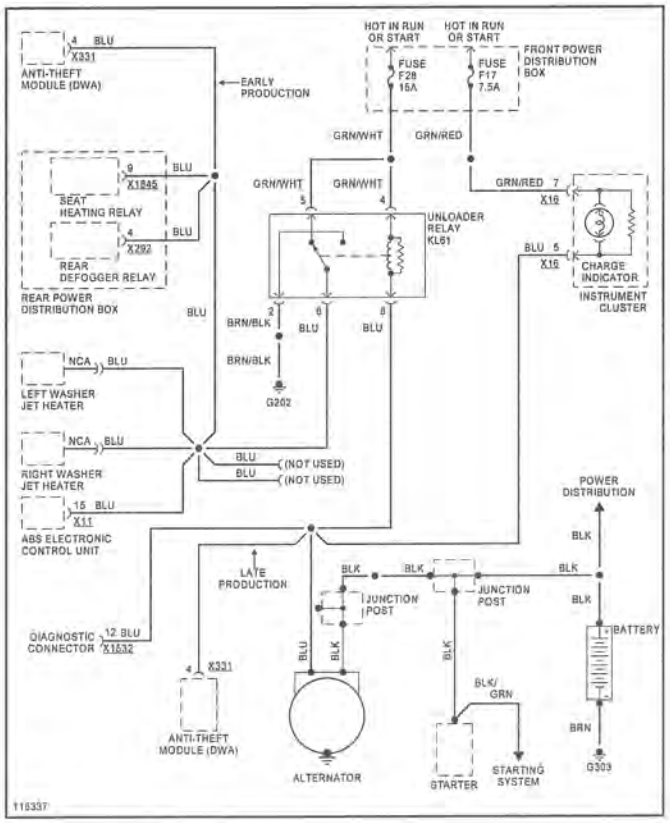


1988
750iL

Charging System

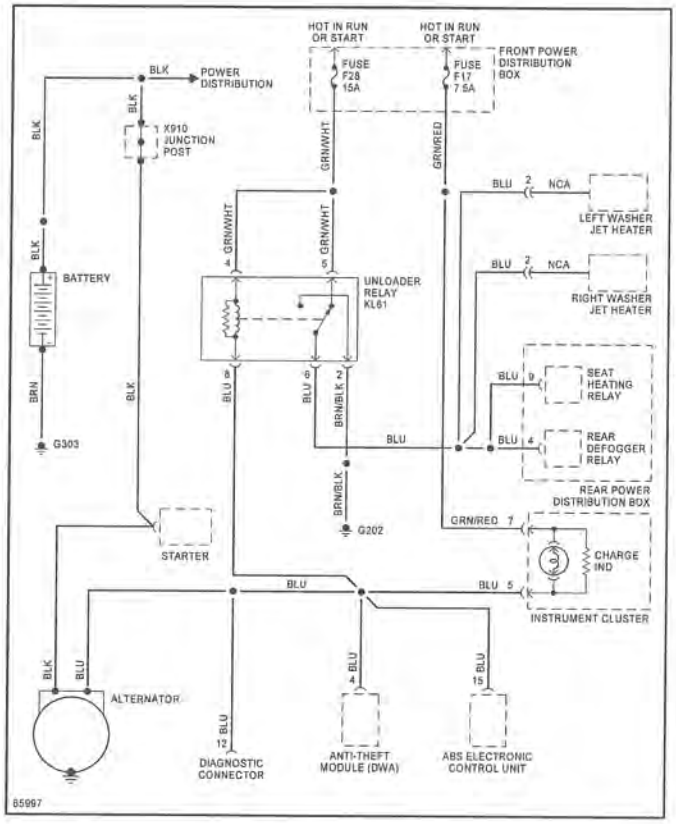


1989
735i & 735iL

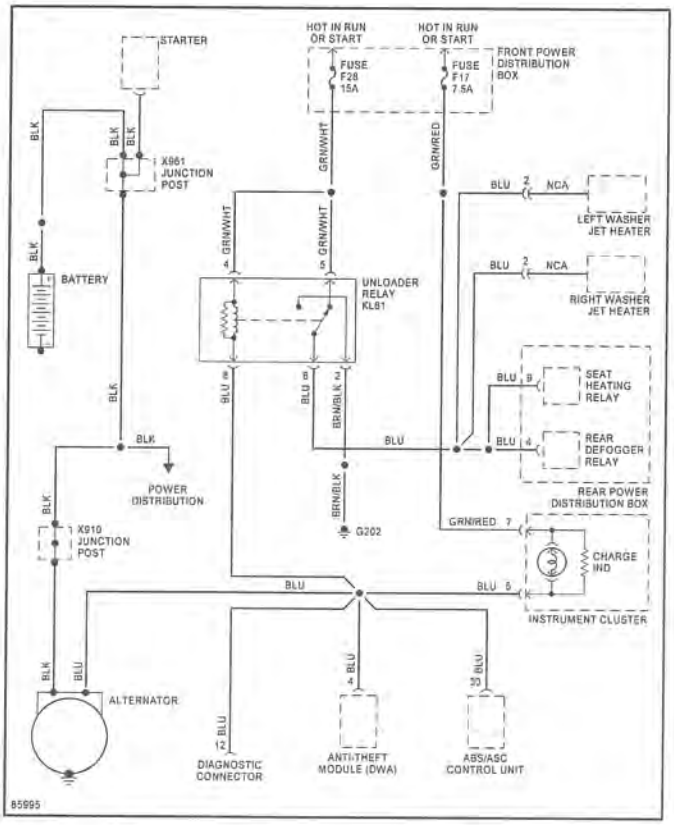


1989
750iL

Charging System

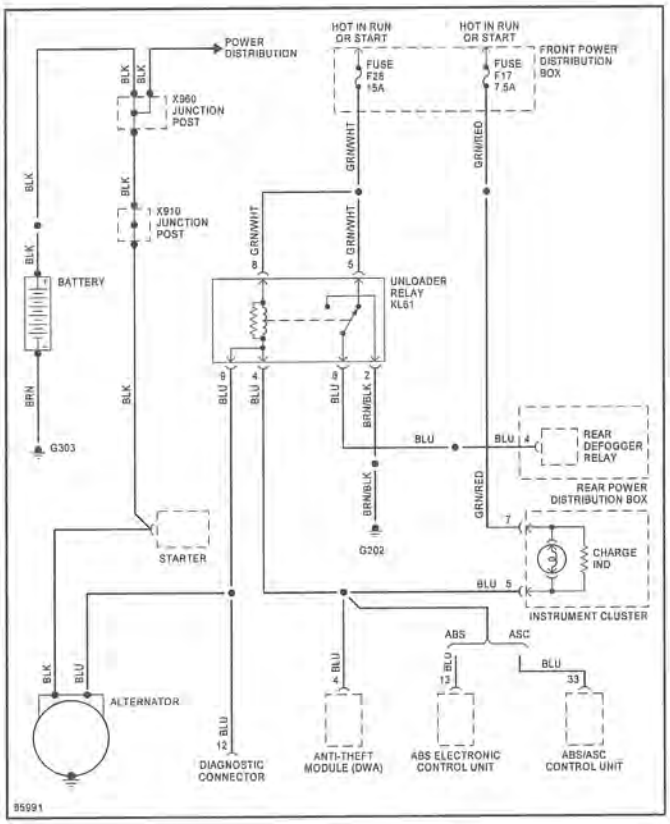


1990
735i & 735iL

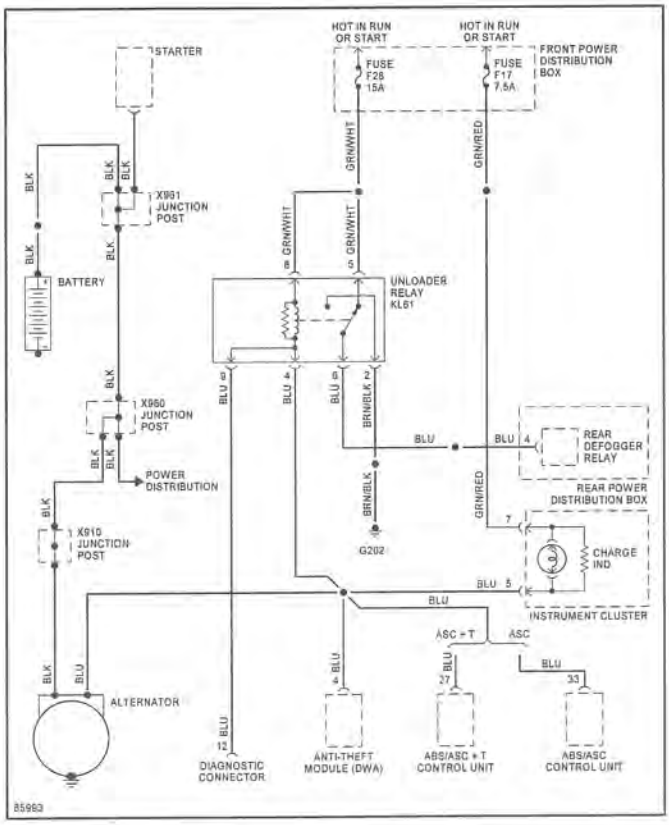


1990
750iL

Charging System

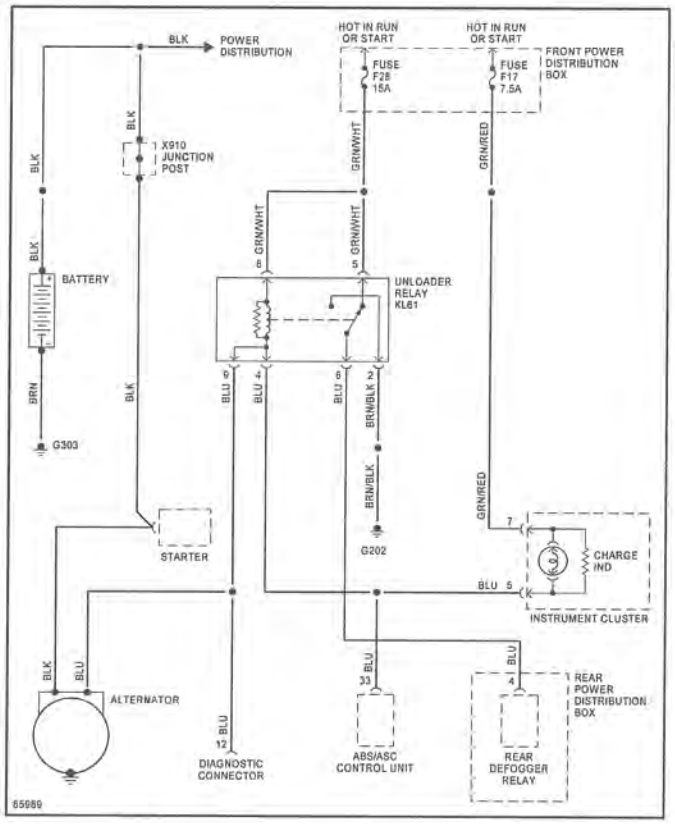


1991
735i & 735iL

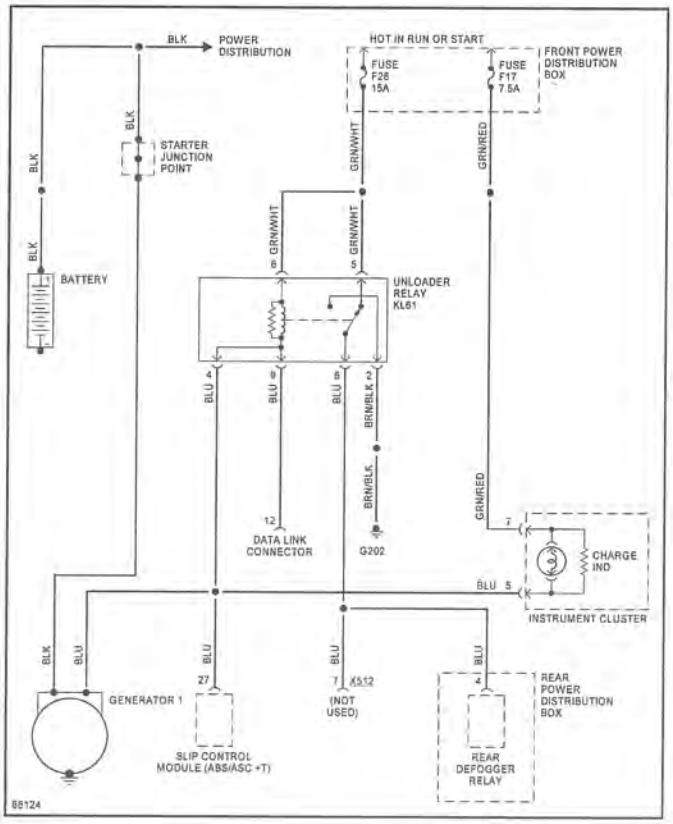


1991
750iL

Charging System

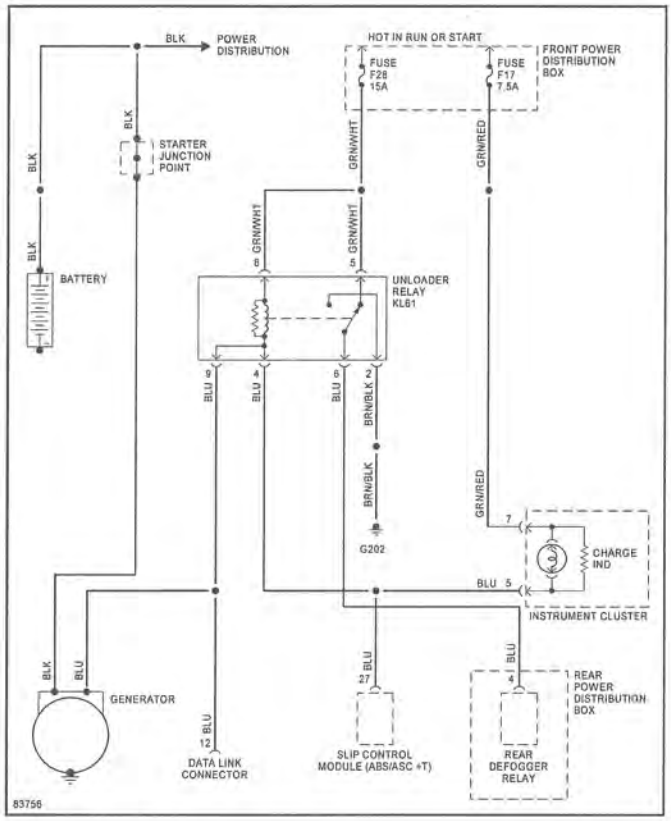


1992
735i & 735iL



1992-94
750iL

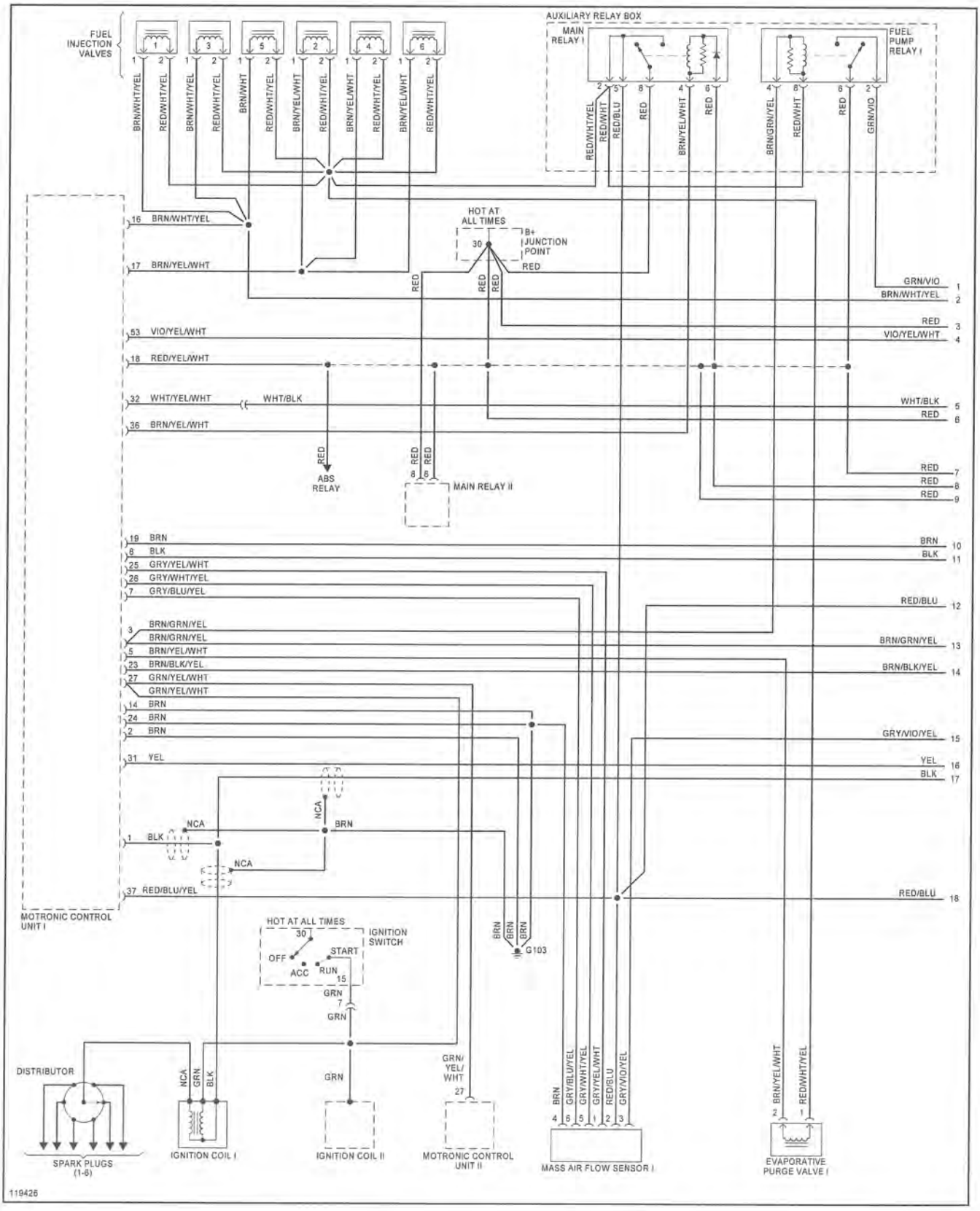
Charging System



1993-94
740i & 740iL

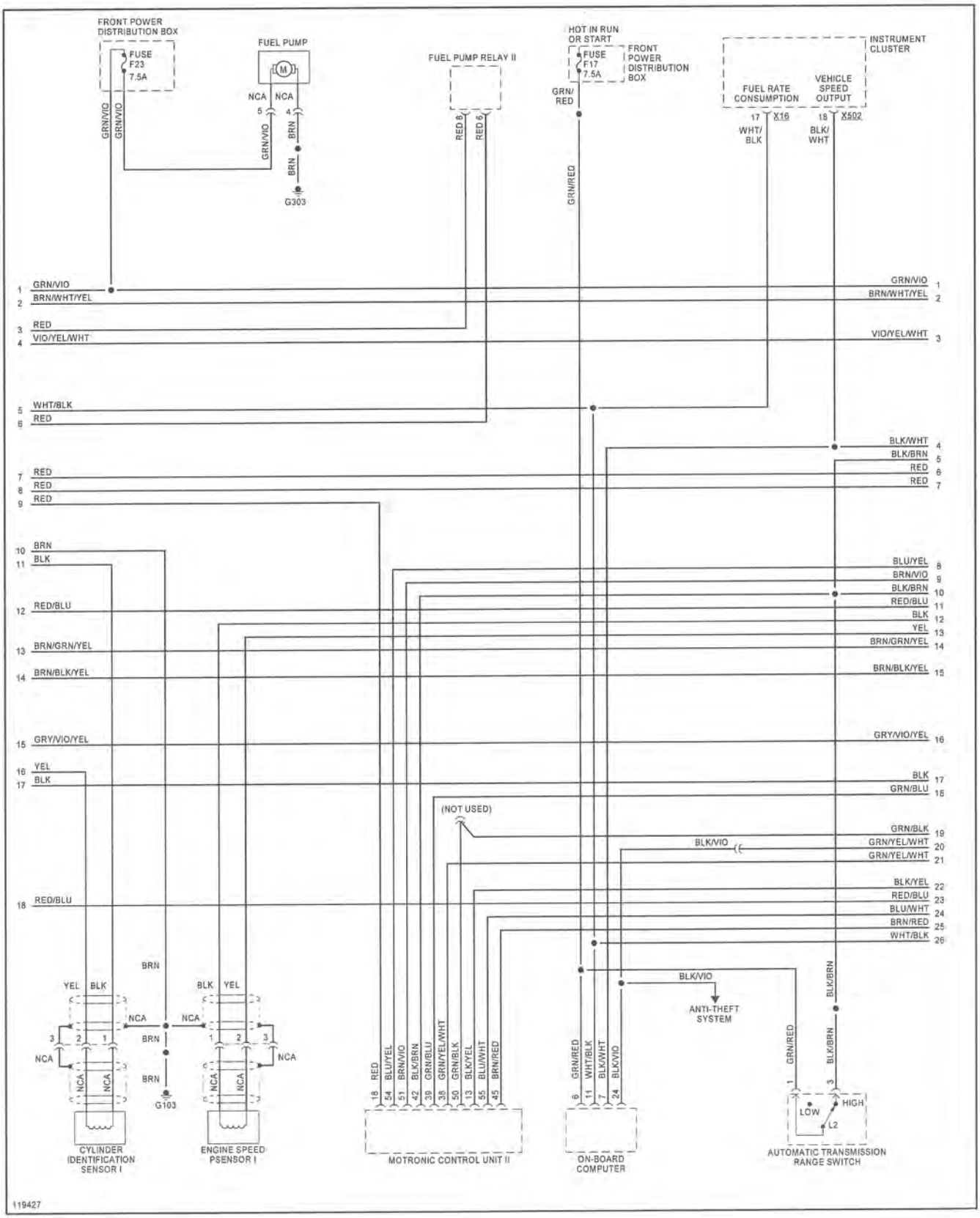
Engine Management

1988 750iL Early Production (1 of 6)



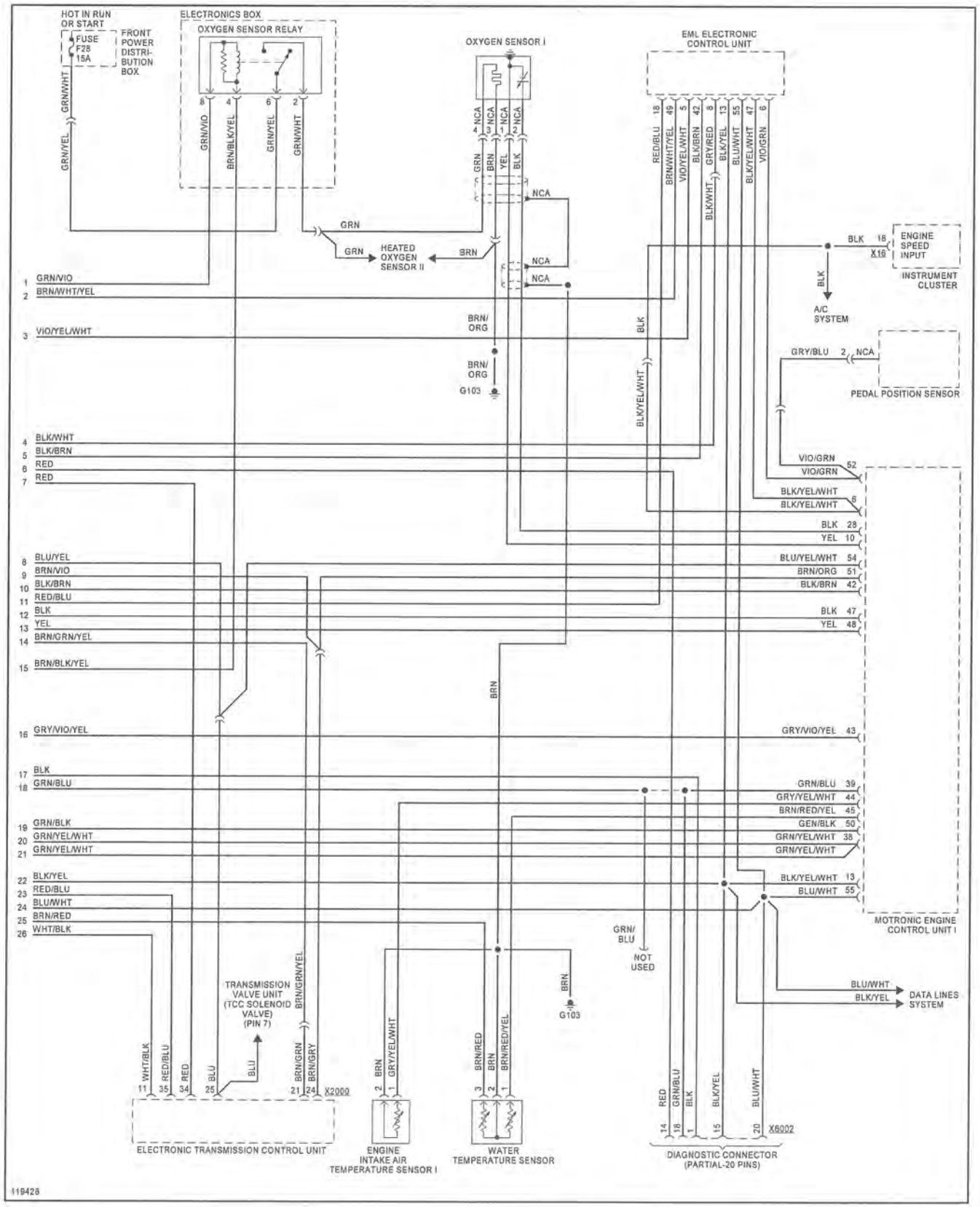
Engine Management

1988 750iL Early Production (2 of 6)



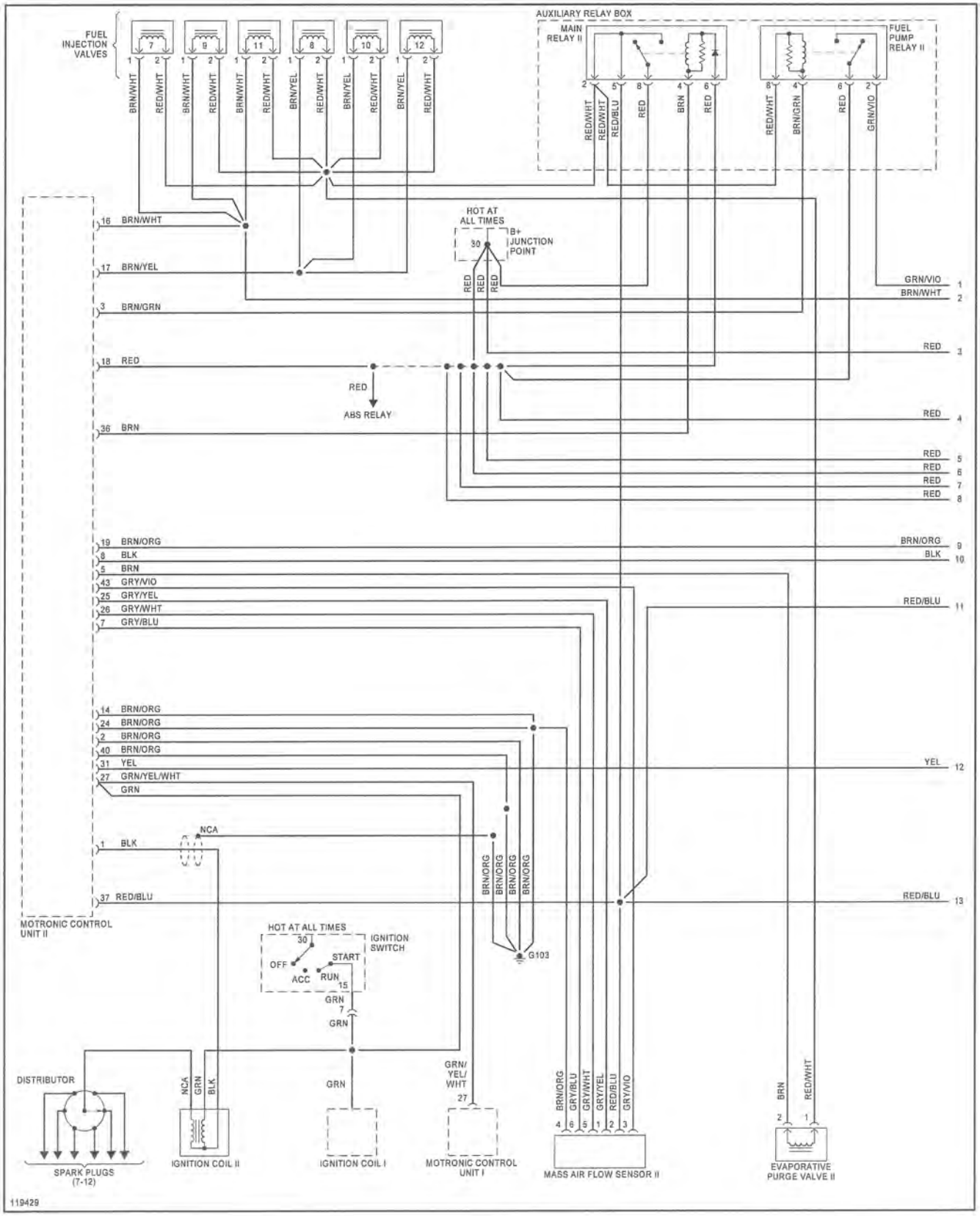
Engine Management

1988 750iL Early Production (3 of 6)



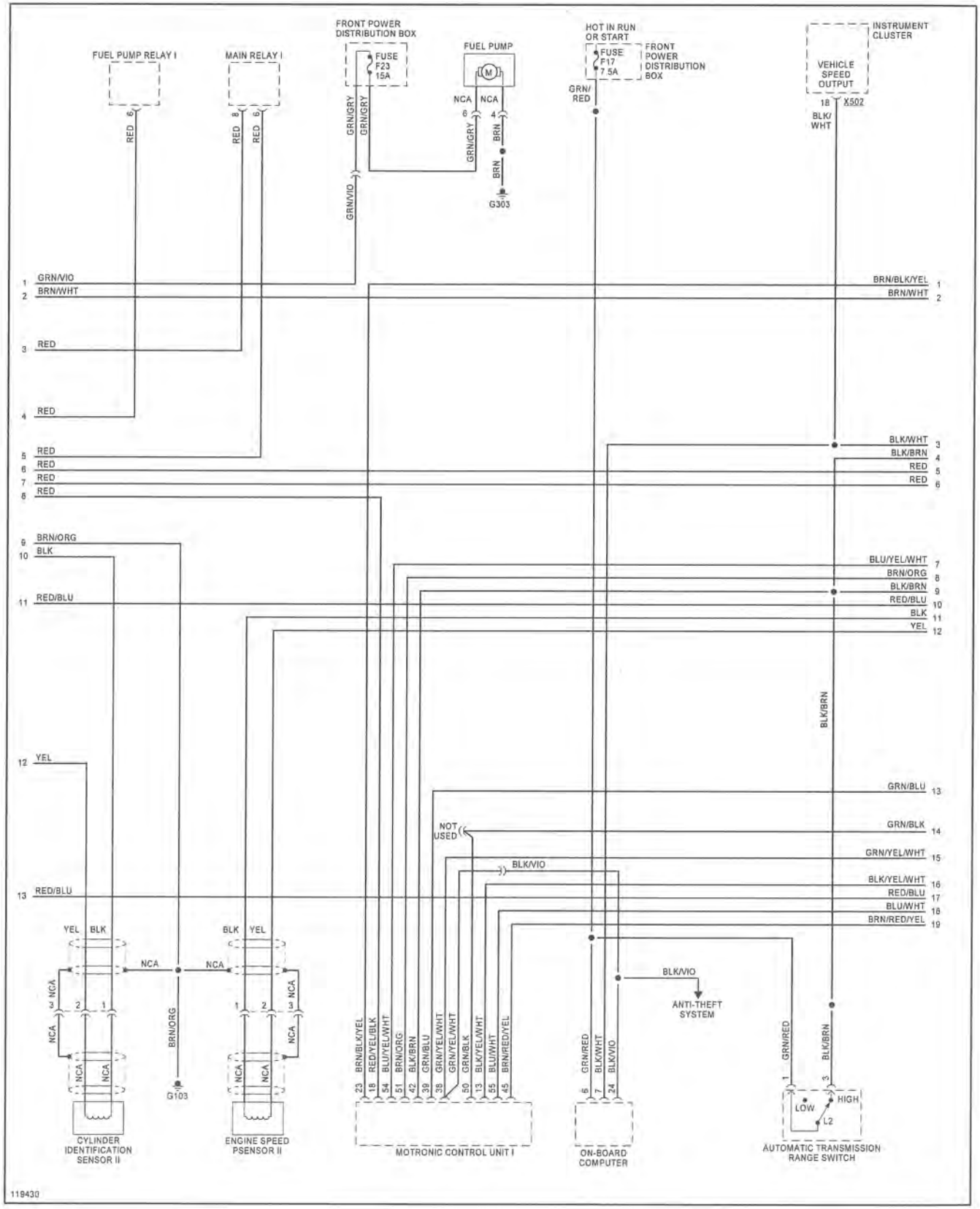
Engine Management

1988 750iL Early Production (4 of 6)



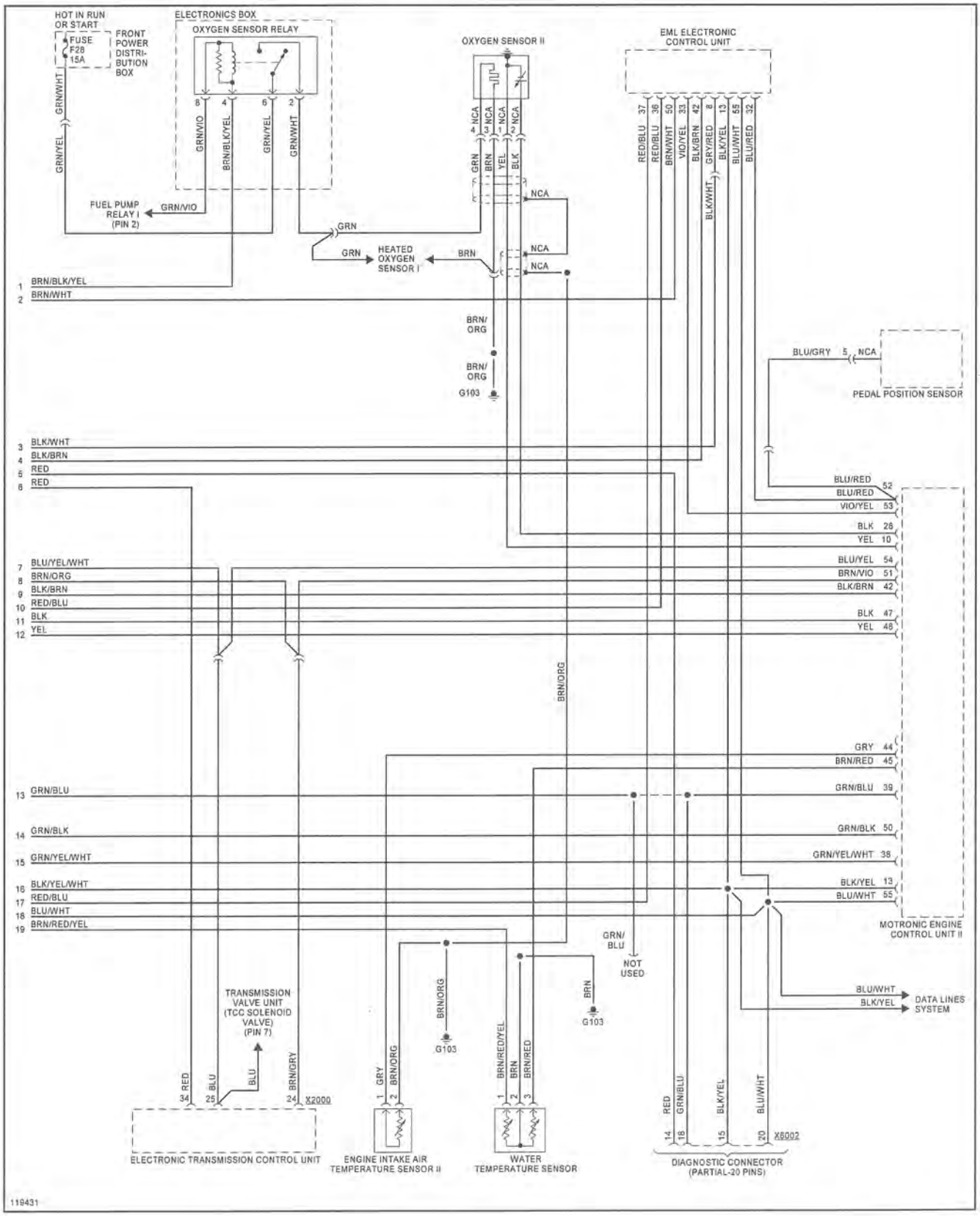
Engine Management

1988 750iL Early Production (5 of 6)



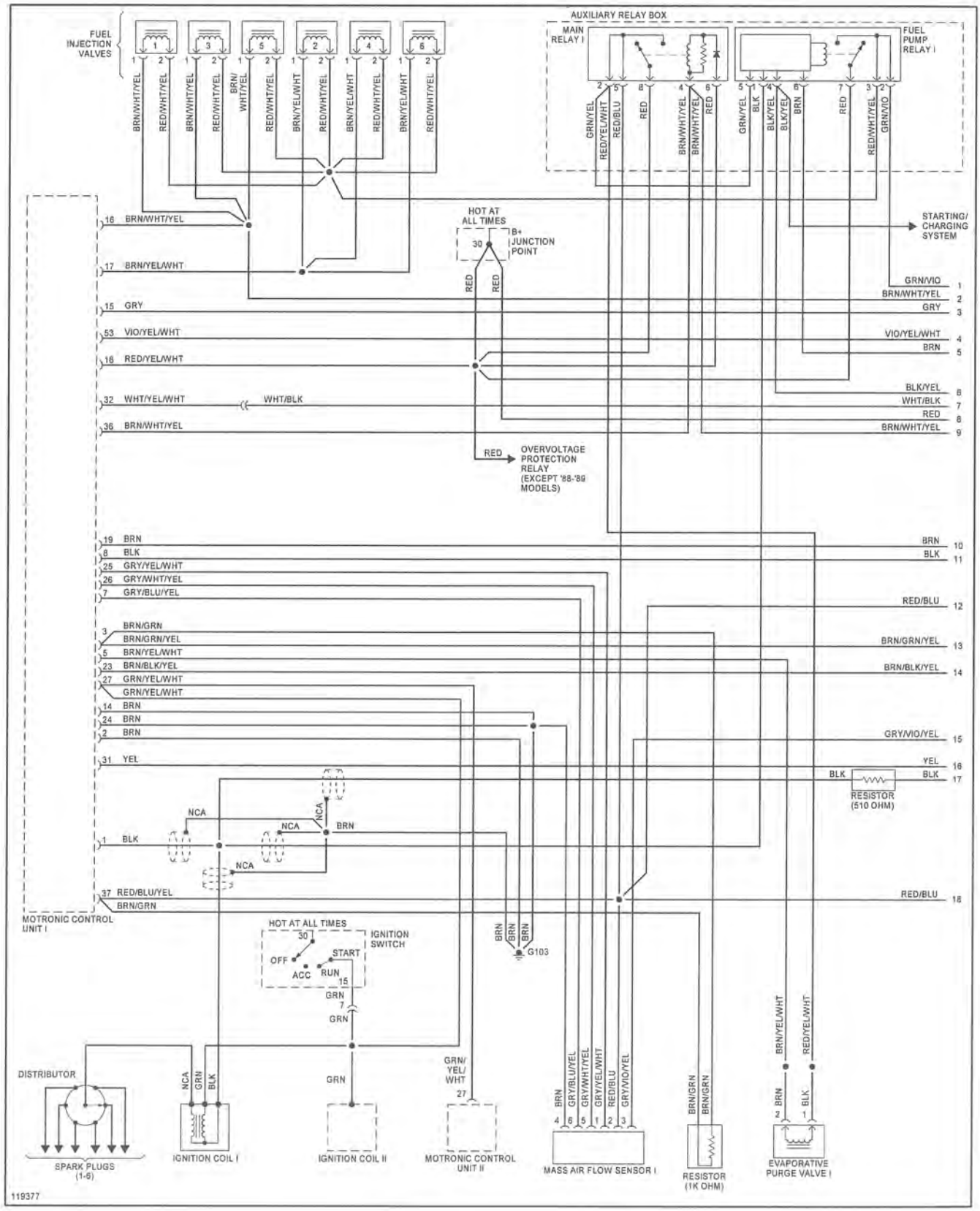
Engine Management

1988 750iL Early Production (6 of 6)



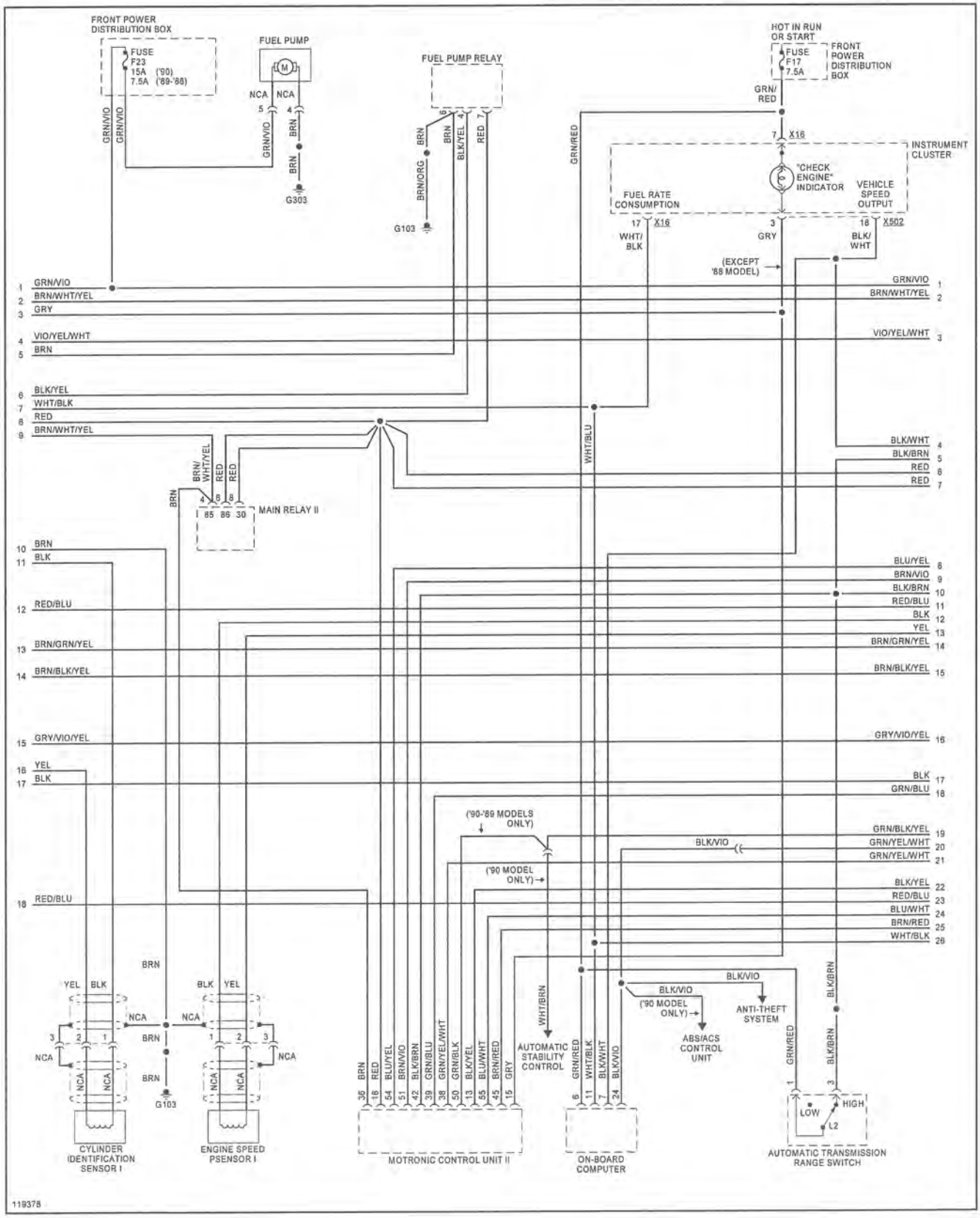
Engine Management

1988 750iL Late Production, 1989-90 750iL (1 of 6)



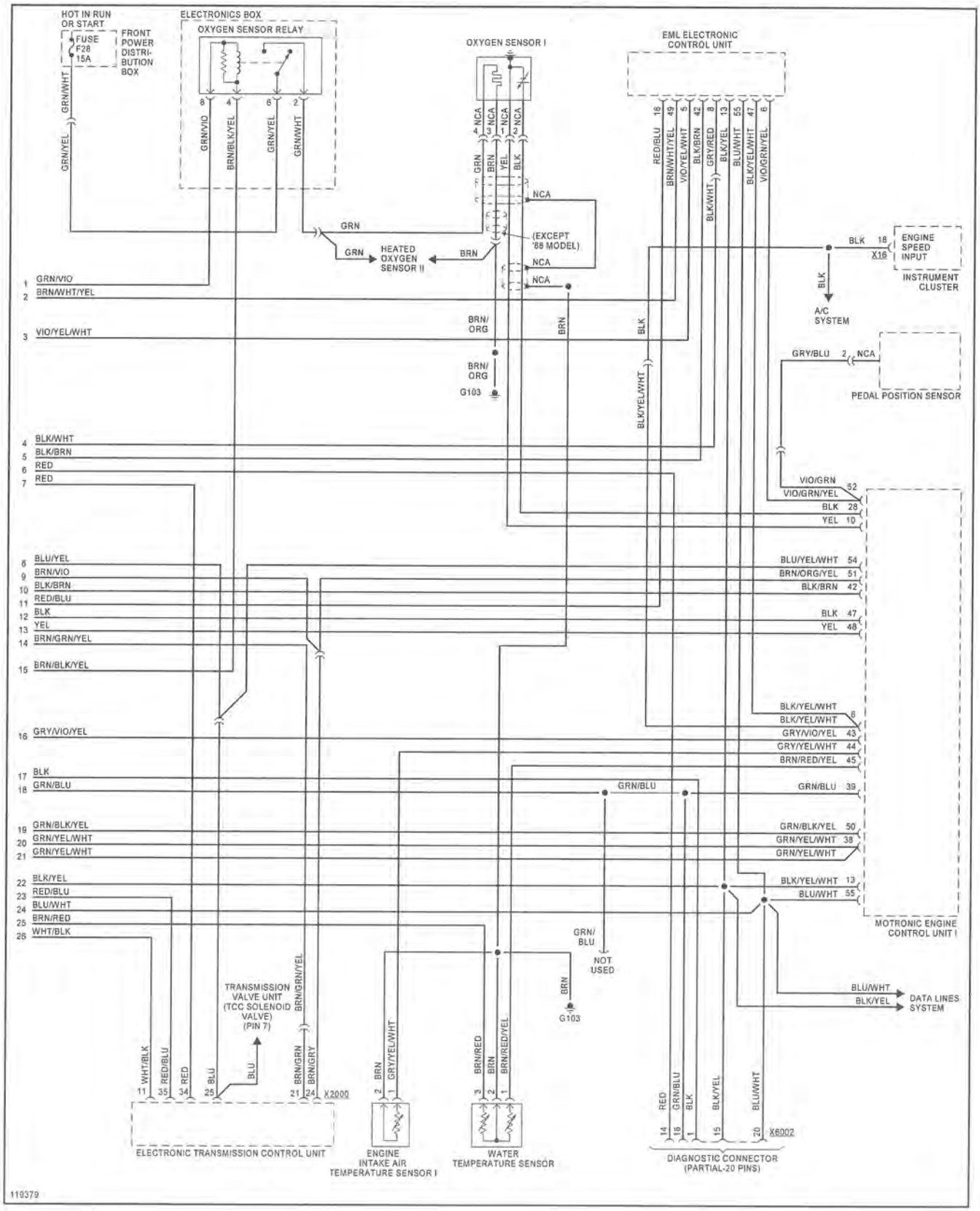
Engine Management

1988 750iL Late Production, 1989-90 750iL (2 of 6)



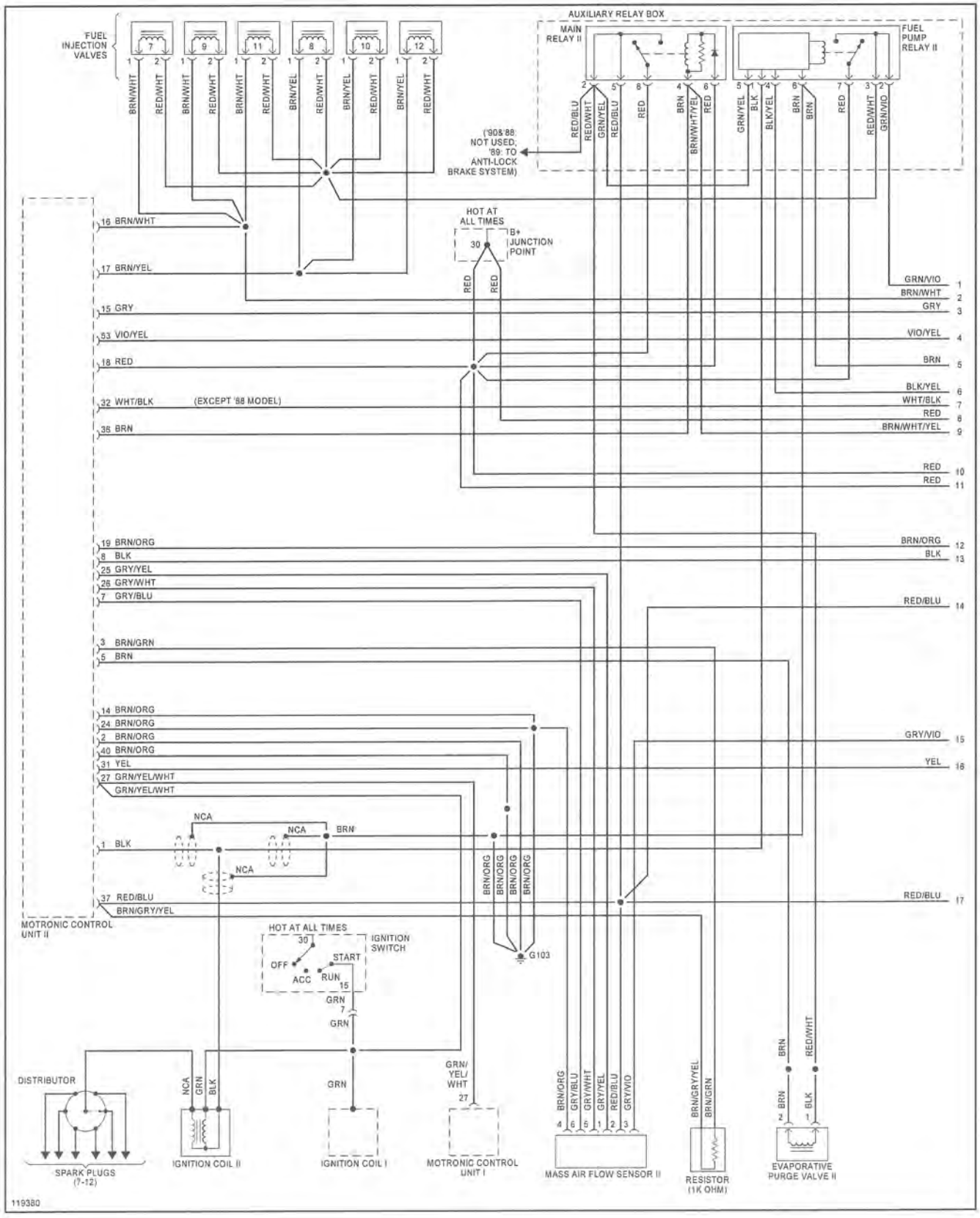
Engine Management

1988 750iL Late Production, 1989-90 750iL (3 of 6)



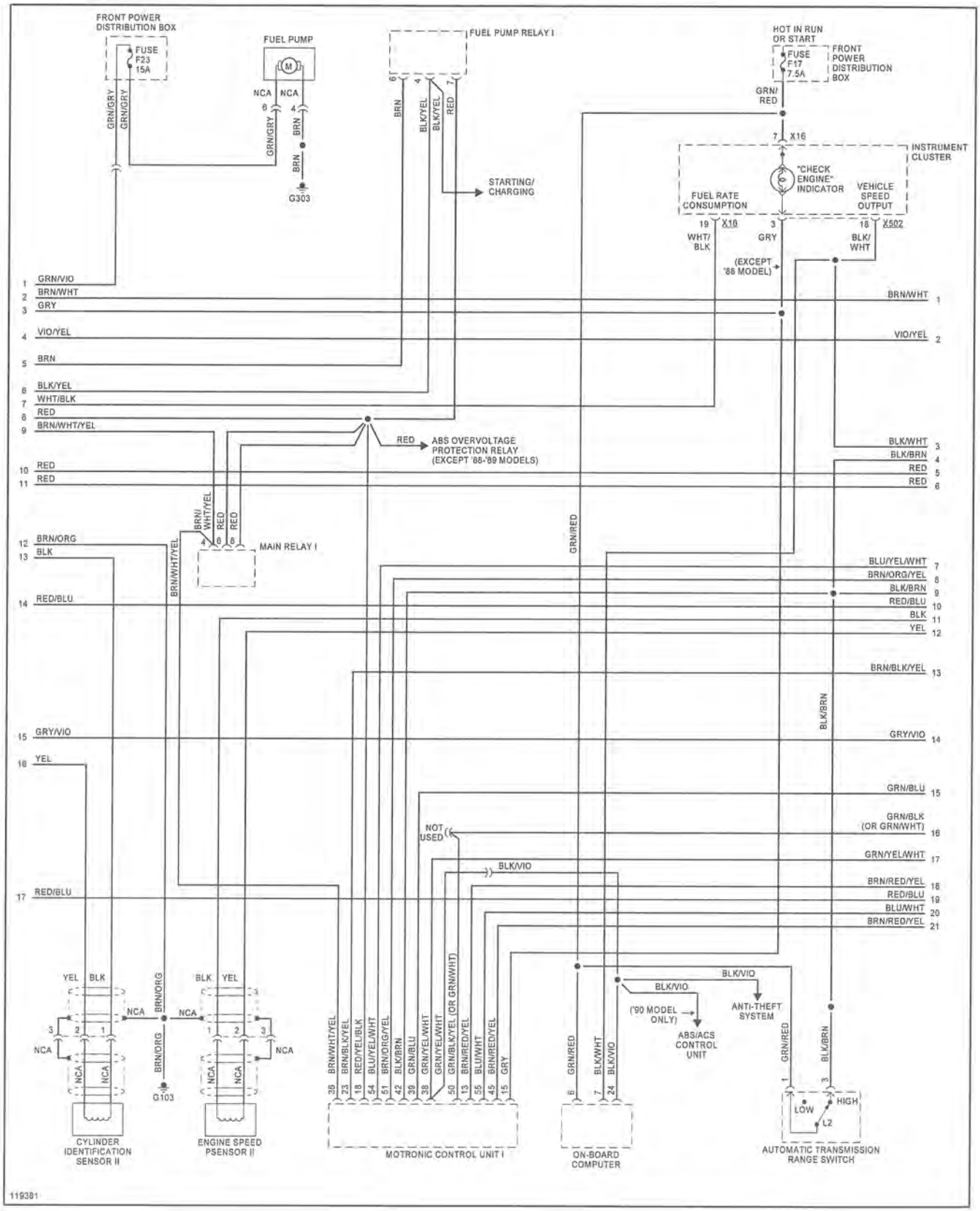
Engine Management

1988 750iL Late Production, 1989-90 750iL (4 of 6)



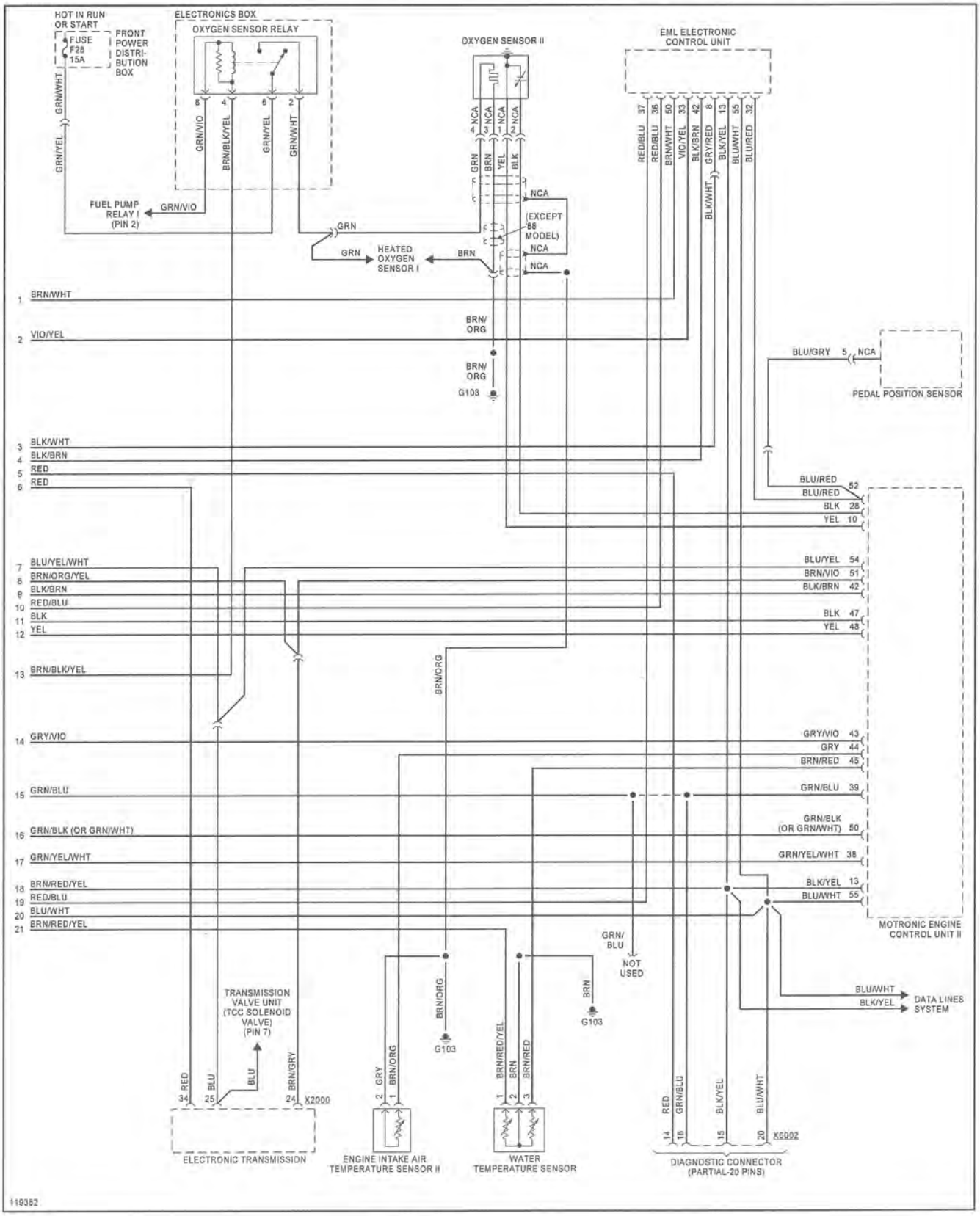
Engine Management

1988 750iL Late Production, 1989-90 750iL (5 of 6)



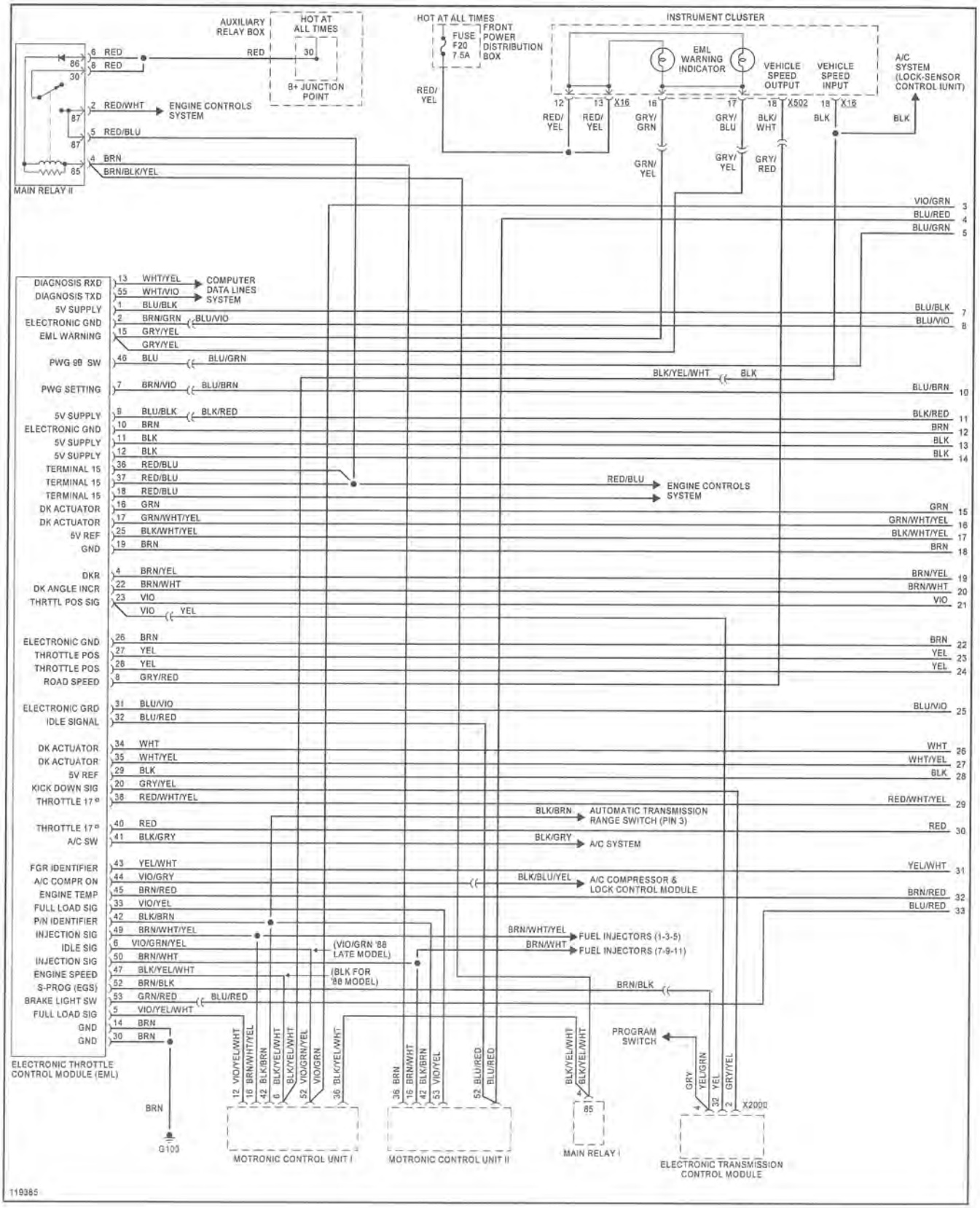
Engine Management

1988 750iL Late Production, 1989-90 750iL (6 of 6)



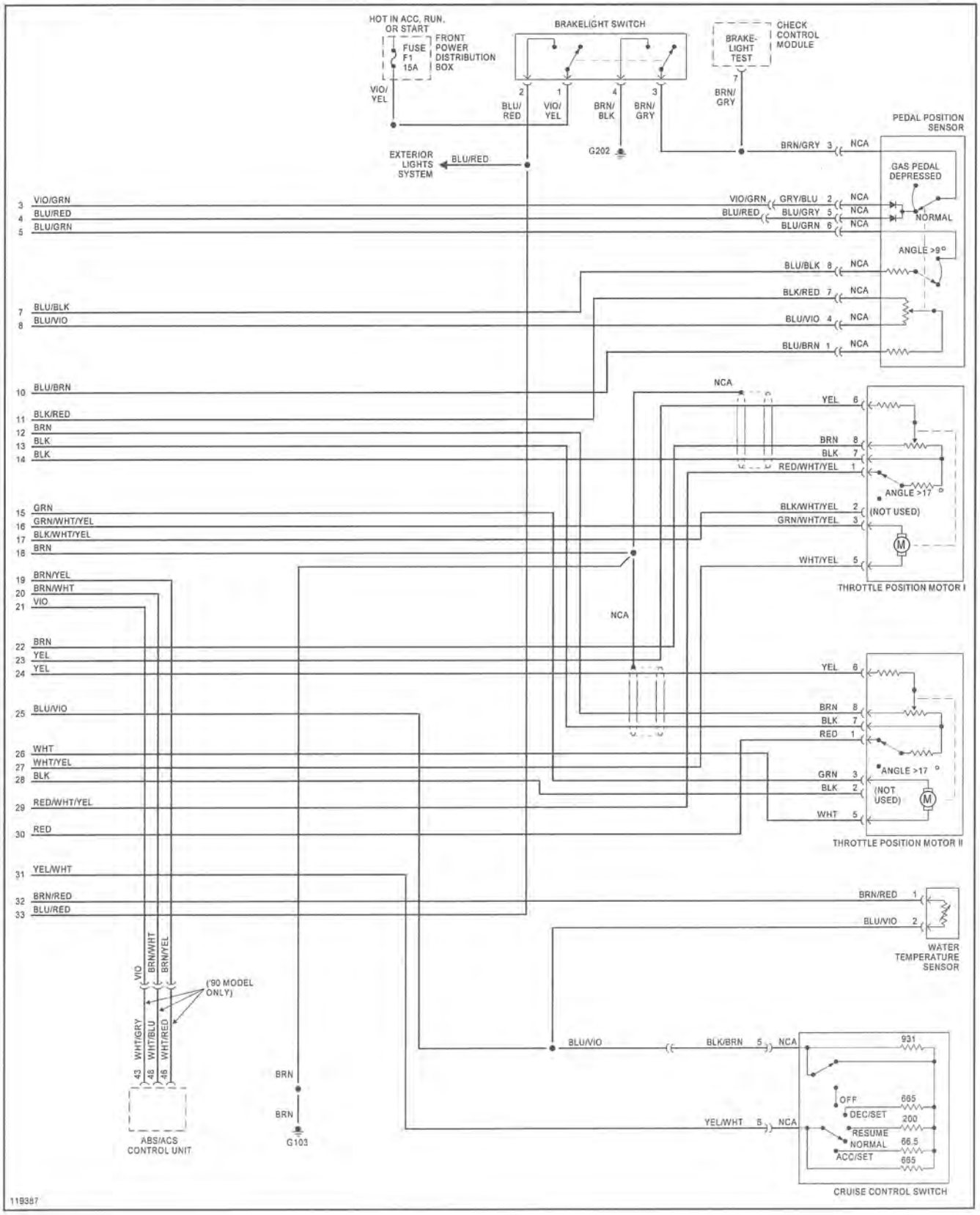
Engine Management

1988-90 750iL Electronic Throttle Control Circuit (1 of 2)



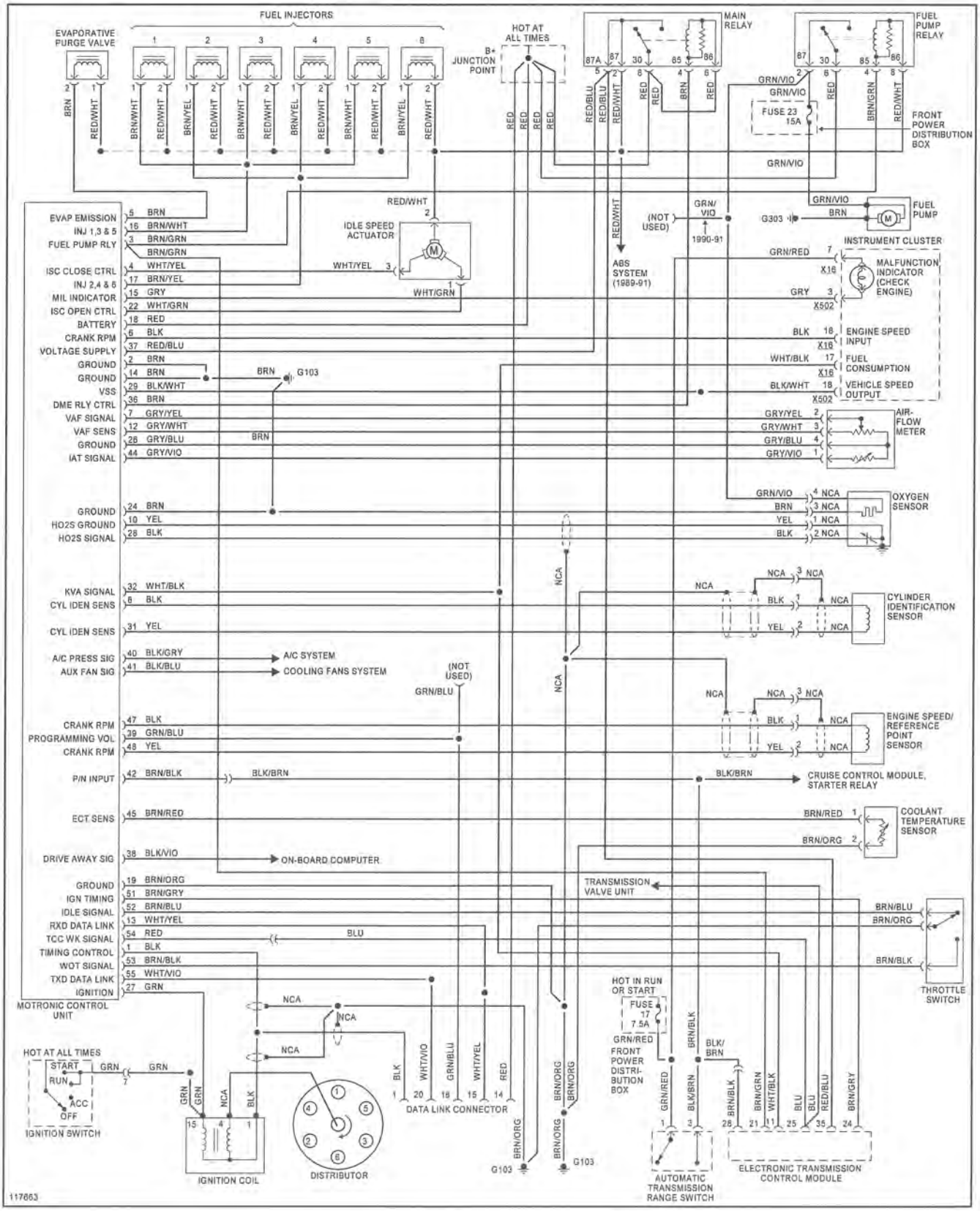
Engine Management

1988-90 750iL Electronic Throttle Control Circuit (2 of 2)



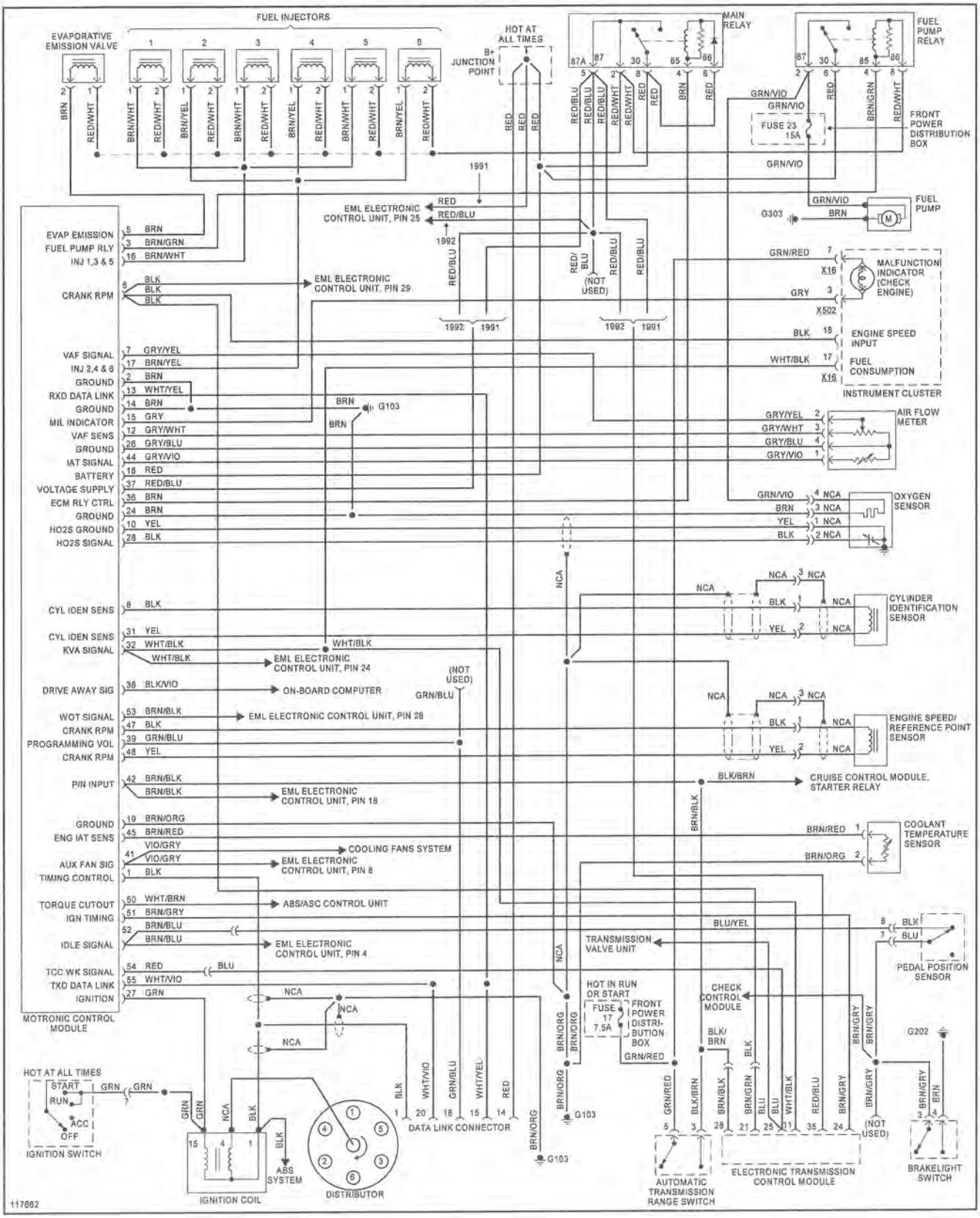
Engine Management

1988-90 735i & 735iL, 1991-92 735i & 735iL w/o Electronic Throttle



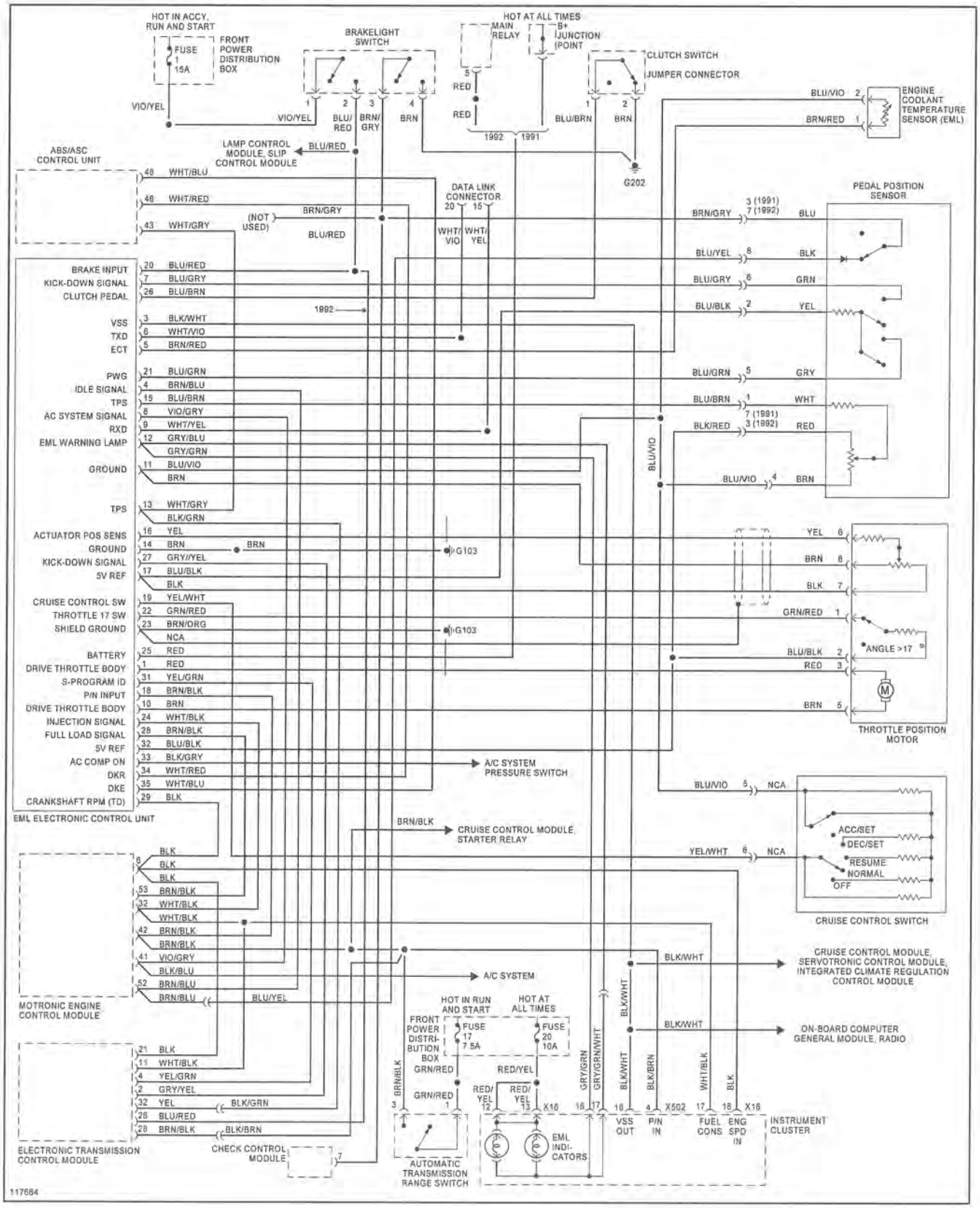
Engine Management

1991-92 735i & 735iL w/ Electronic Throttle

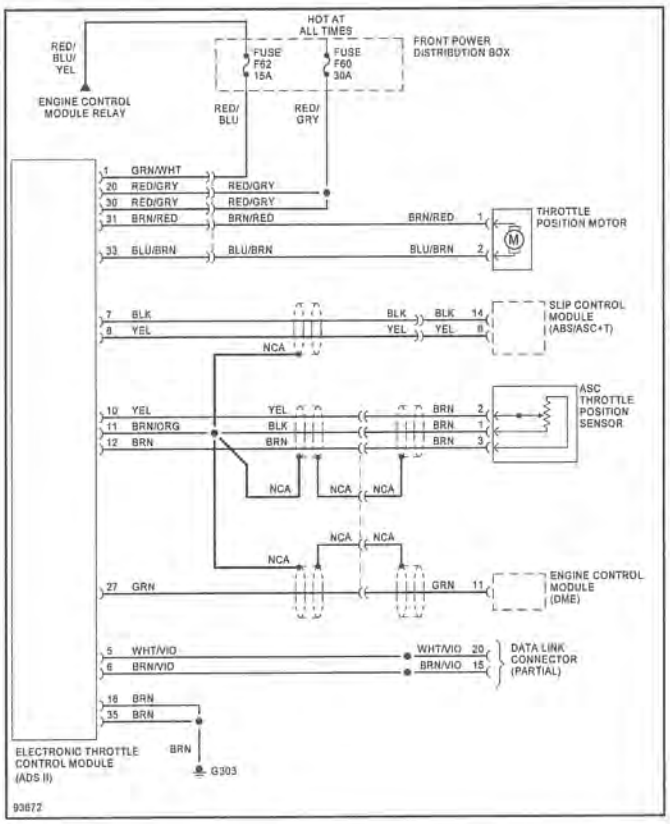


Engine Management

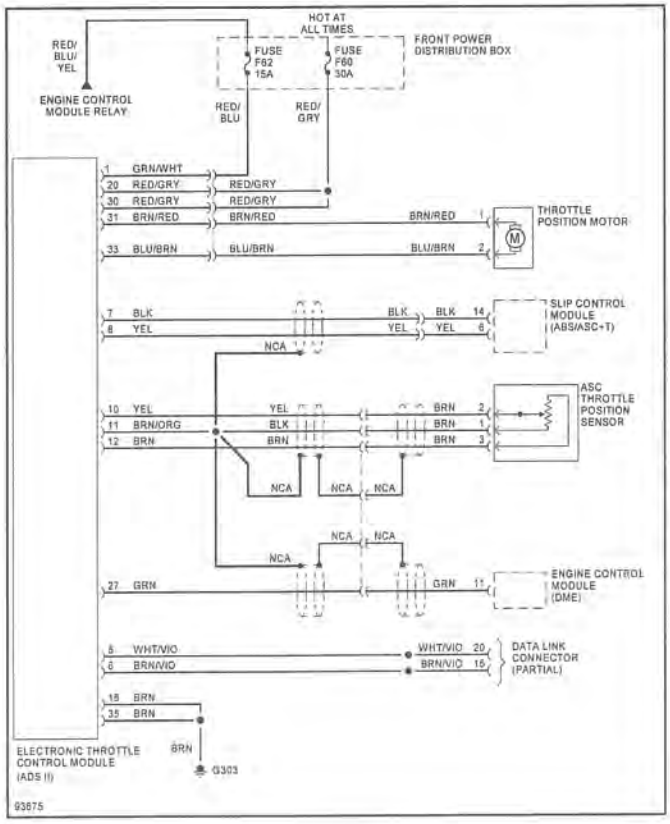
1991-92 735i & 735iL Electronic Throttle Control Circuit



Engine Management



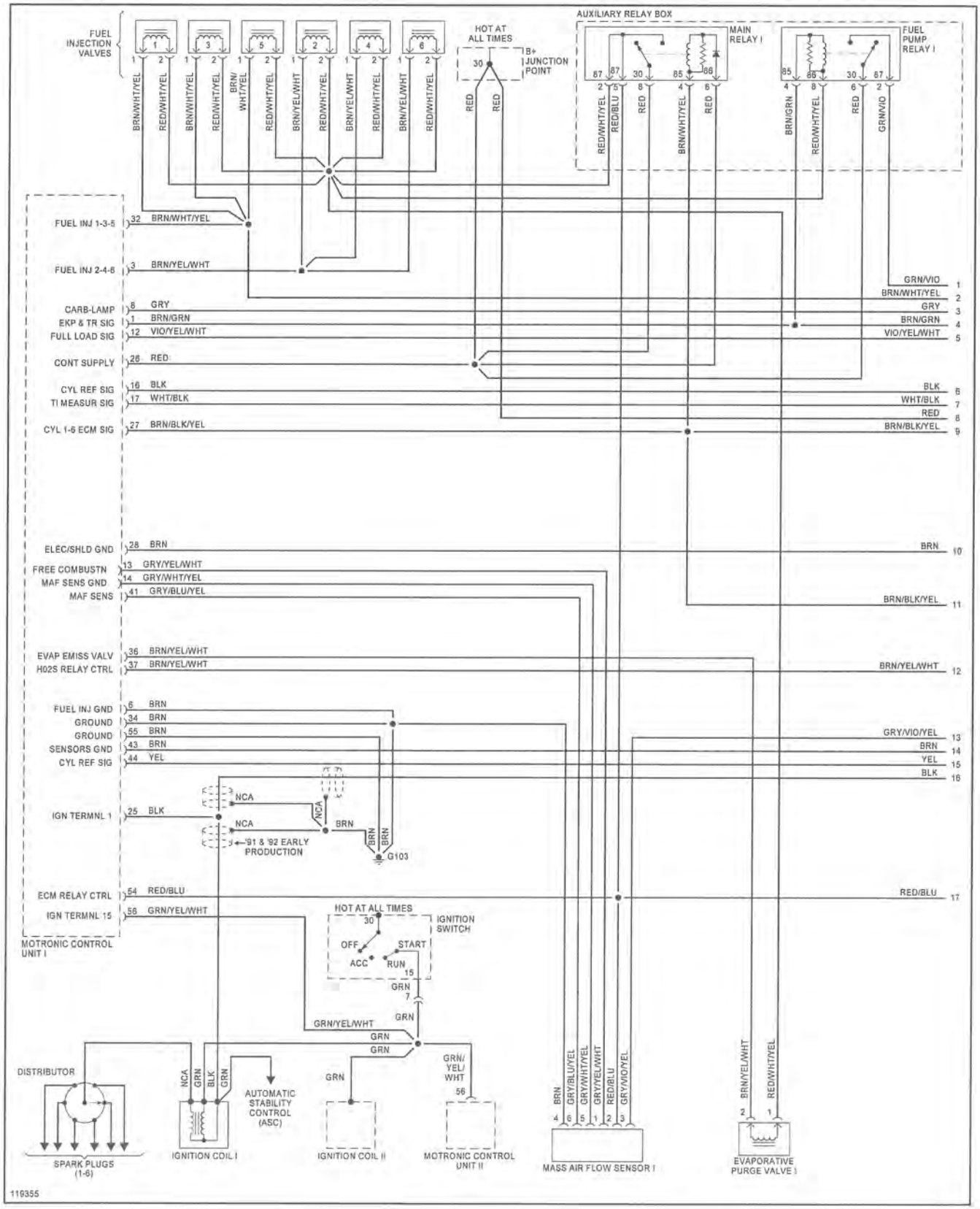
1993-94 740i Electronic Throttle Control Circuit



1993-94 740iL Electronic Throttle Control Circuit

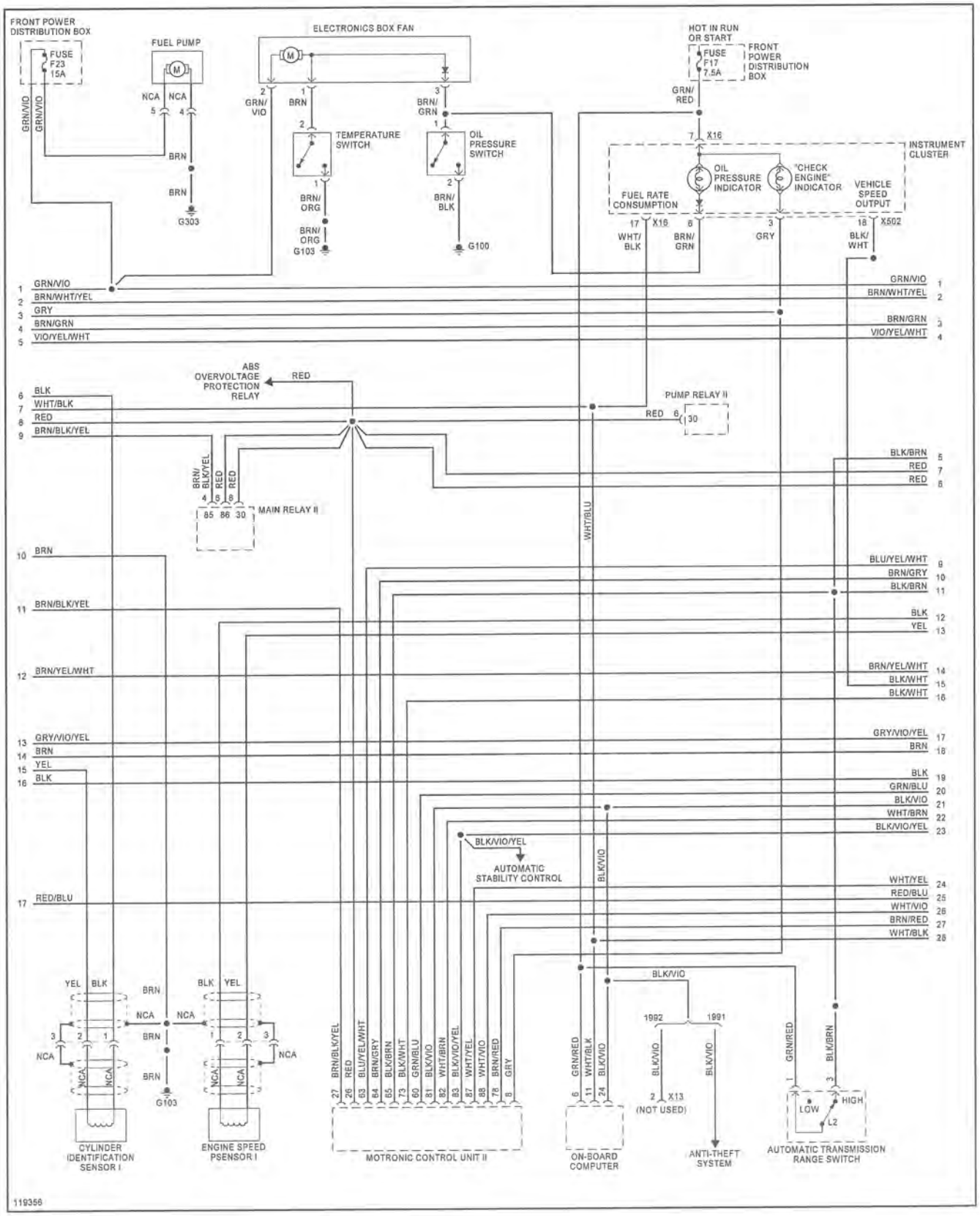
Engine Management

1991-92 750iL (1 of 6)



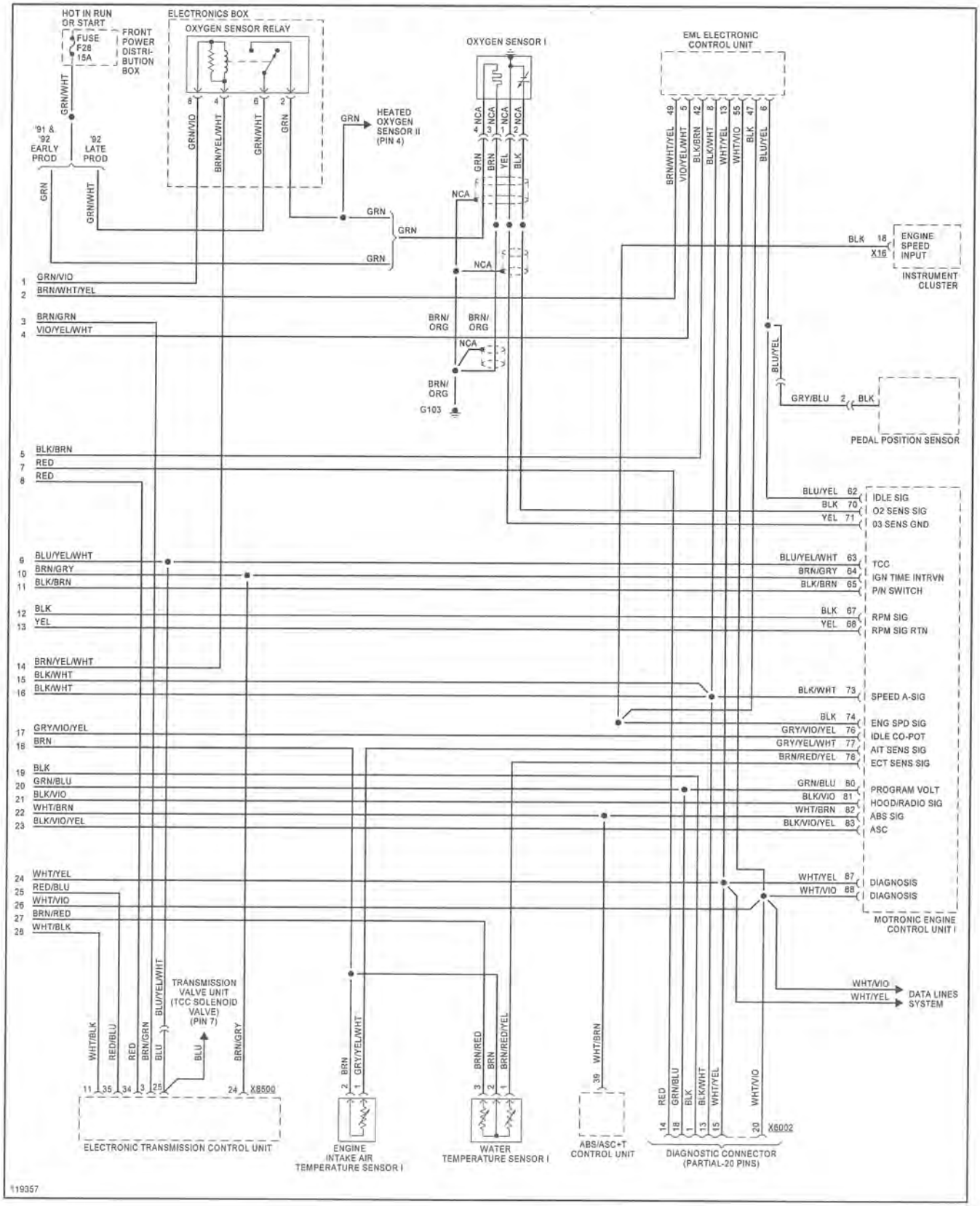
Engine Management

1991-92 750iL (2 of 6)



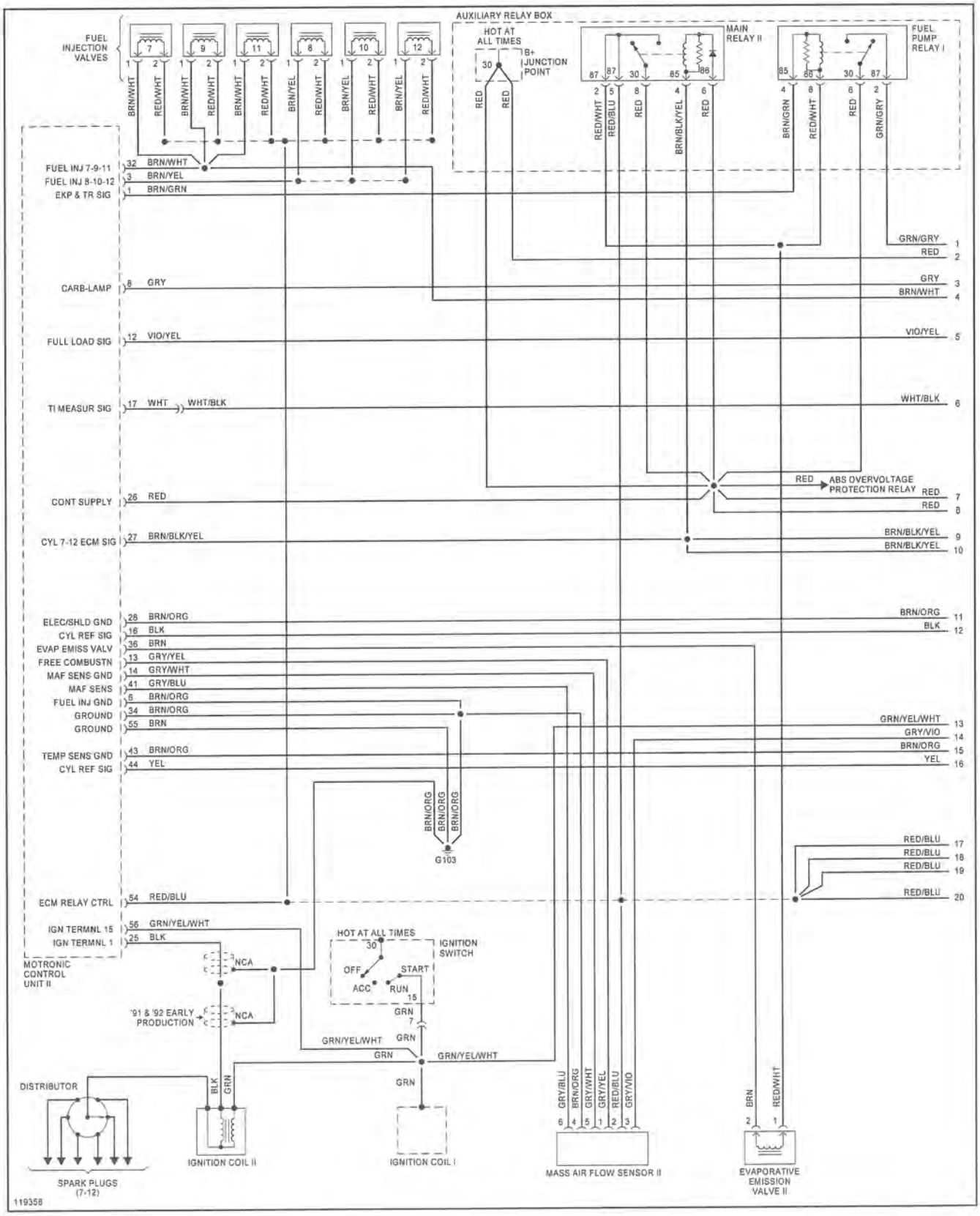
Engine Management

1991-92 750iL (3 of 6)



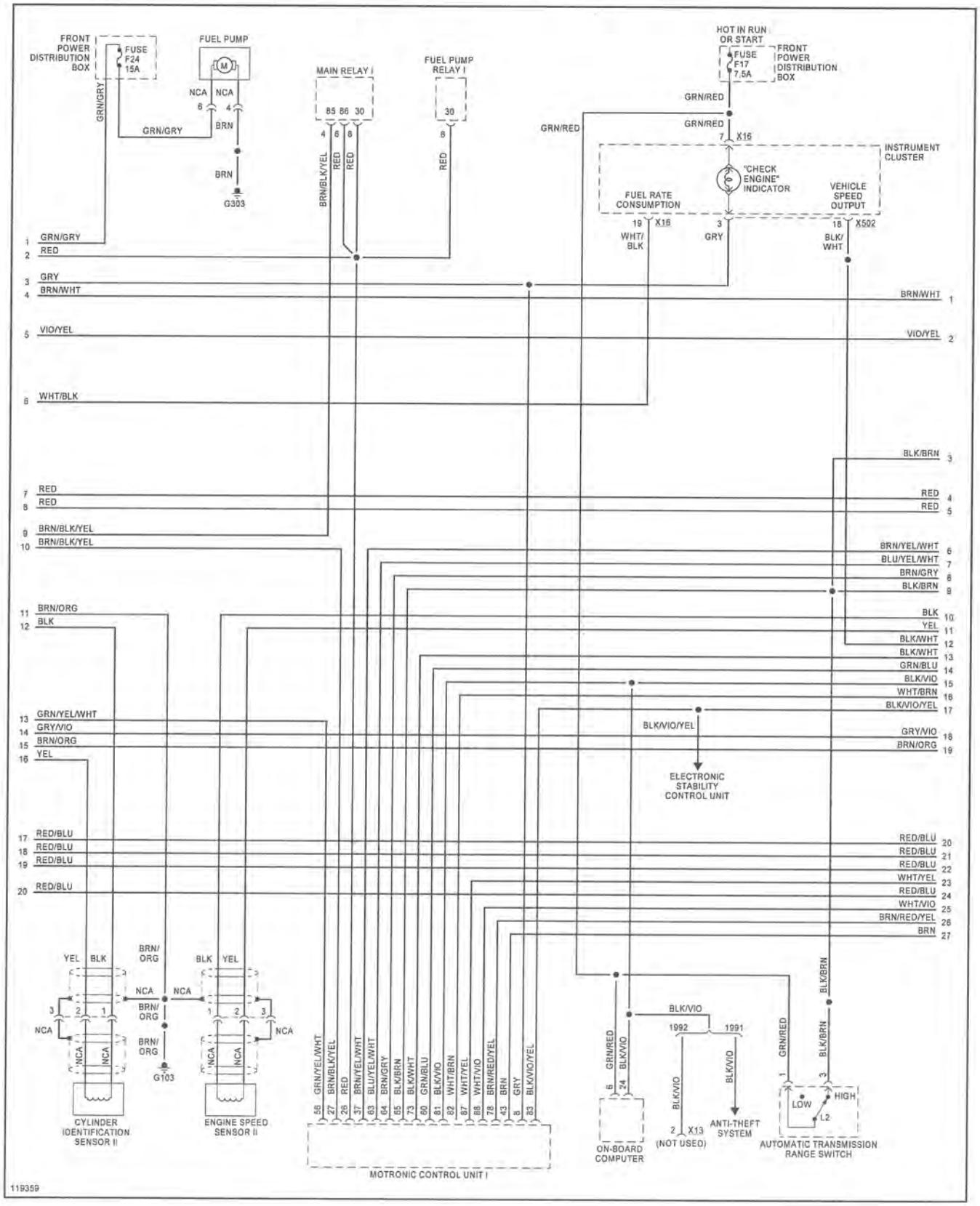
Engine Management

1991-92 750iL (4 of 6)



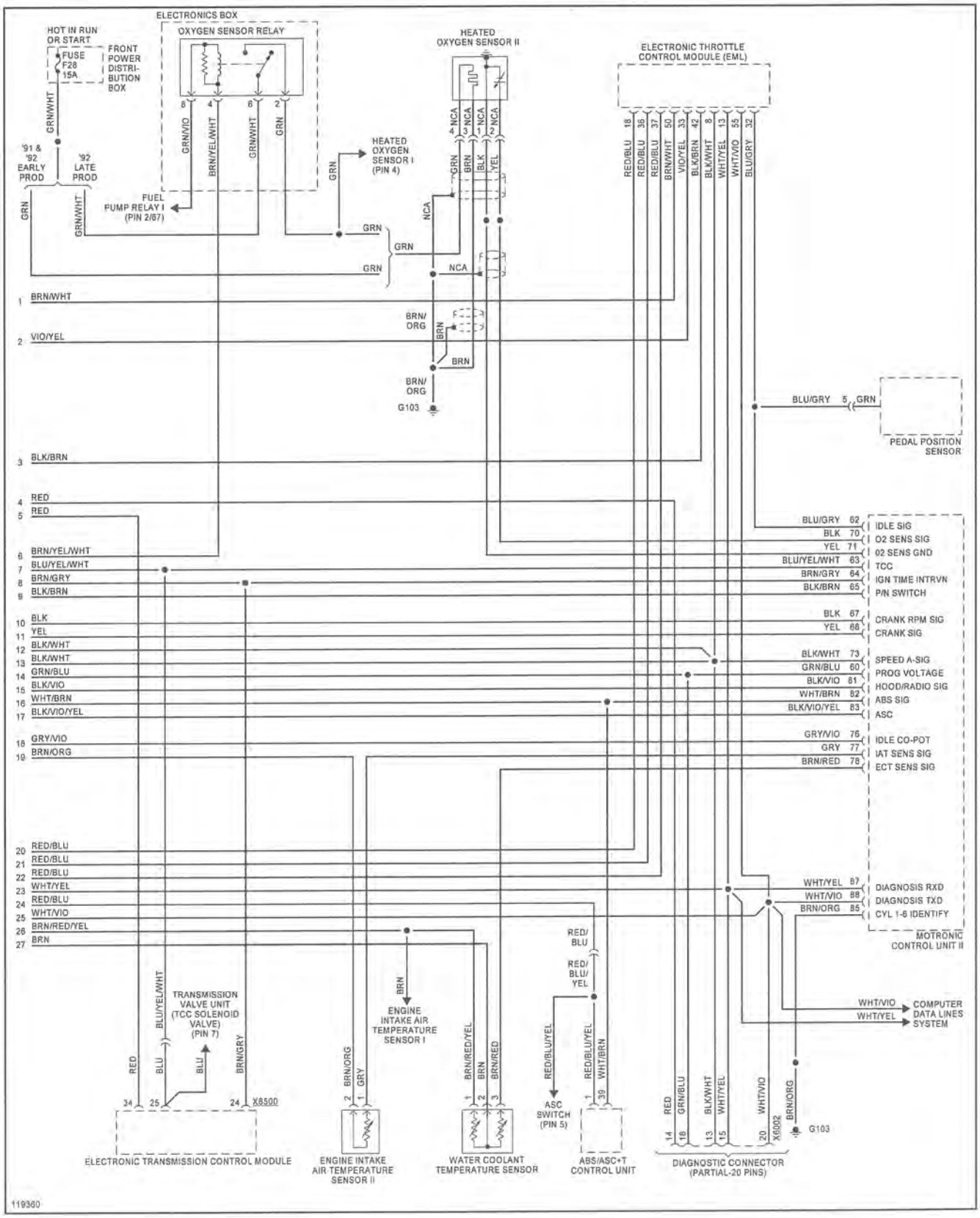
Engine Management

1991-92 750iL (5 of 6)



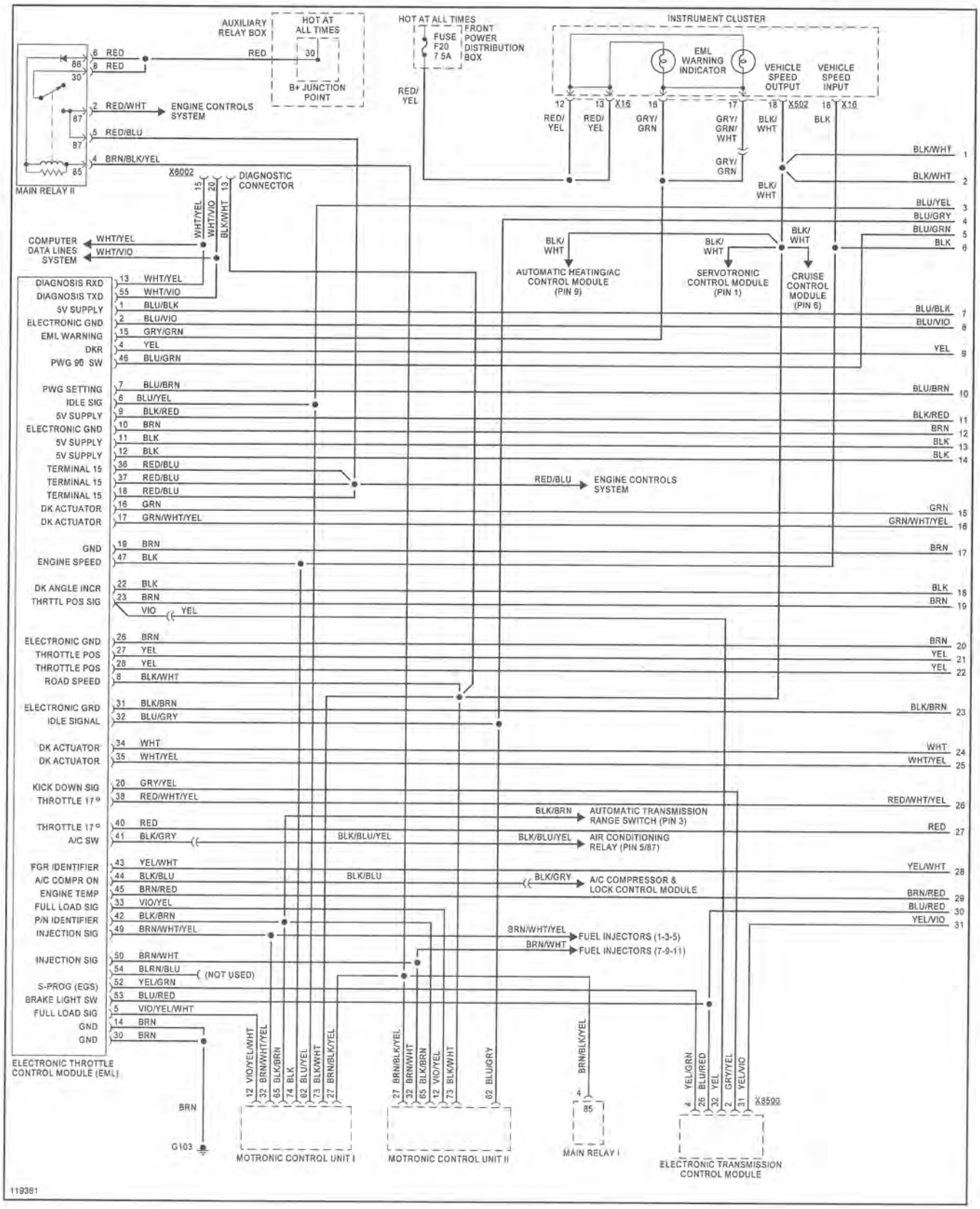
Engine Management

1991-92 750iL (6 of 6)



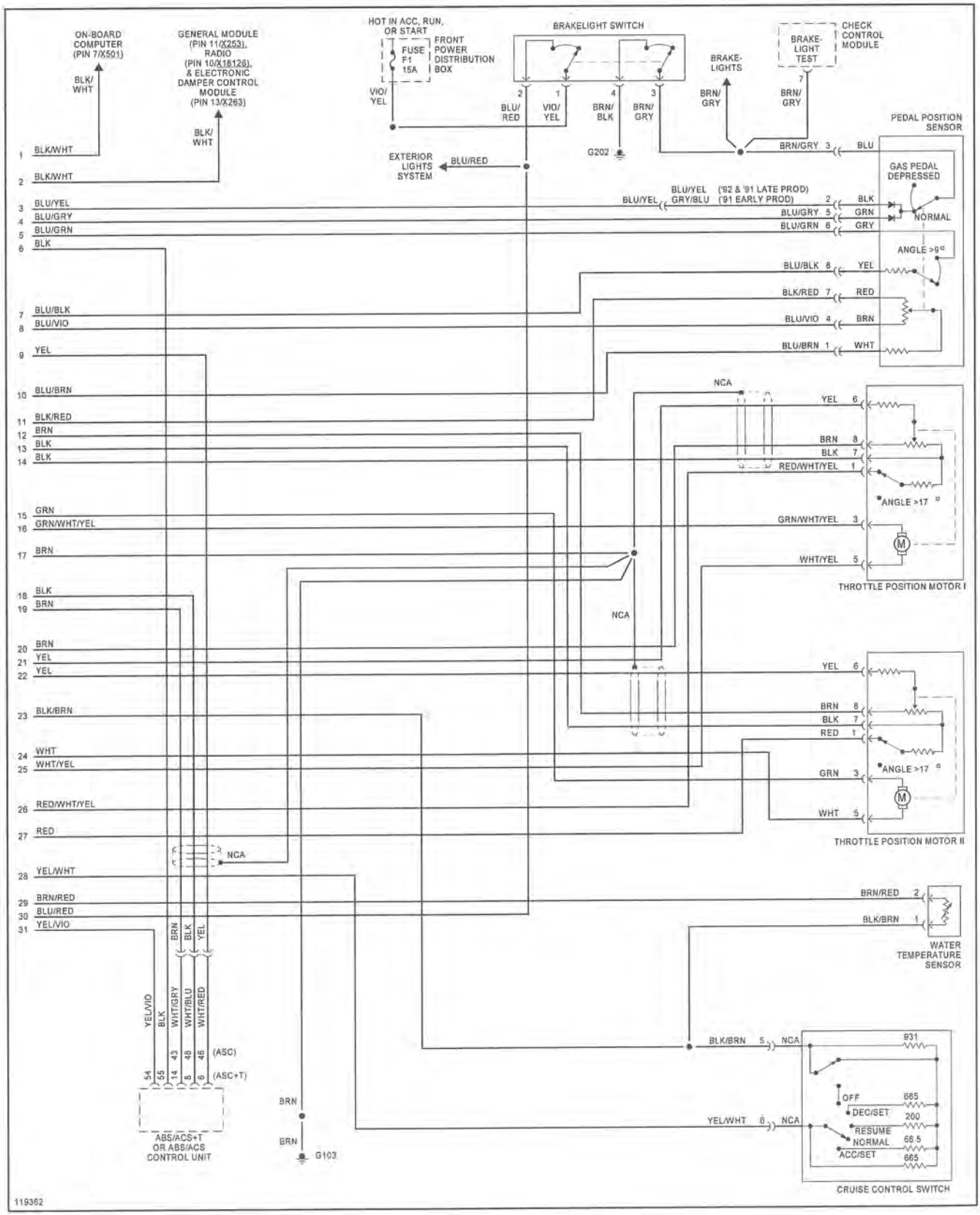
Engine Management

1991-92 750iL Electronic Throttle Control Circuit (1 of 2)



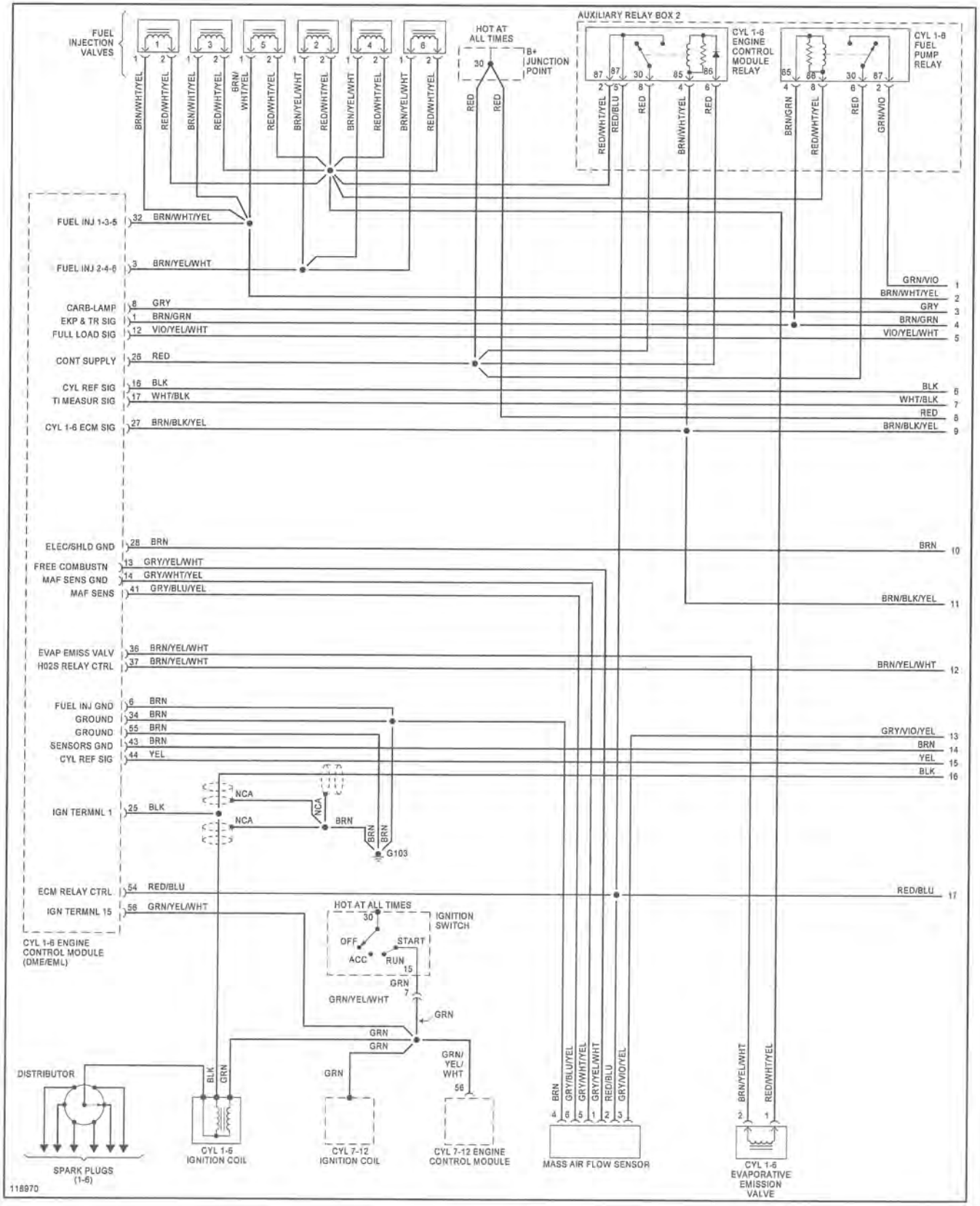
Engine Management

1991-92 750iL Electronic Throttle Control Circuit (2 of 2)



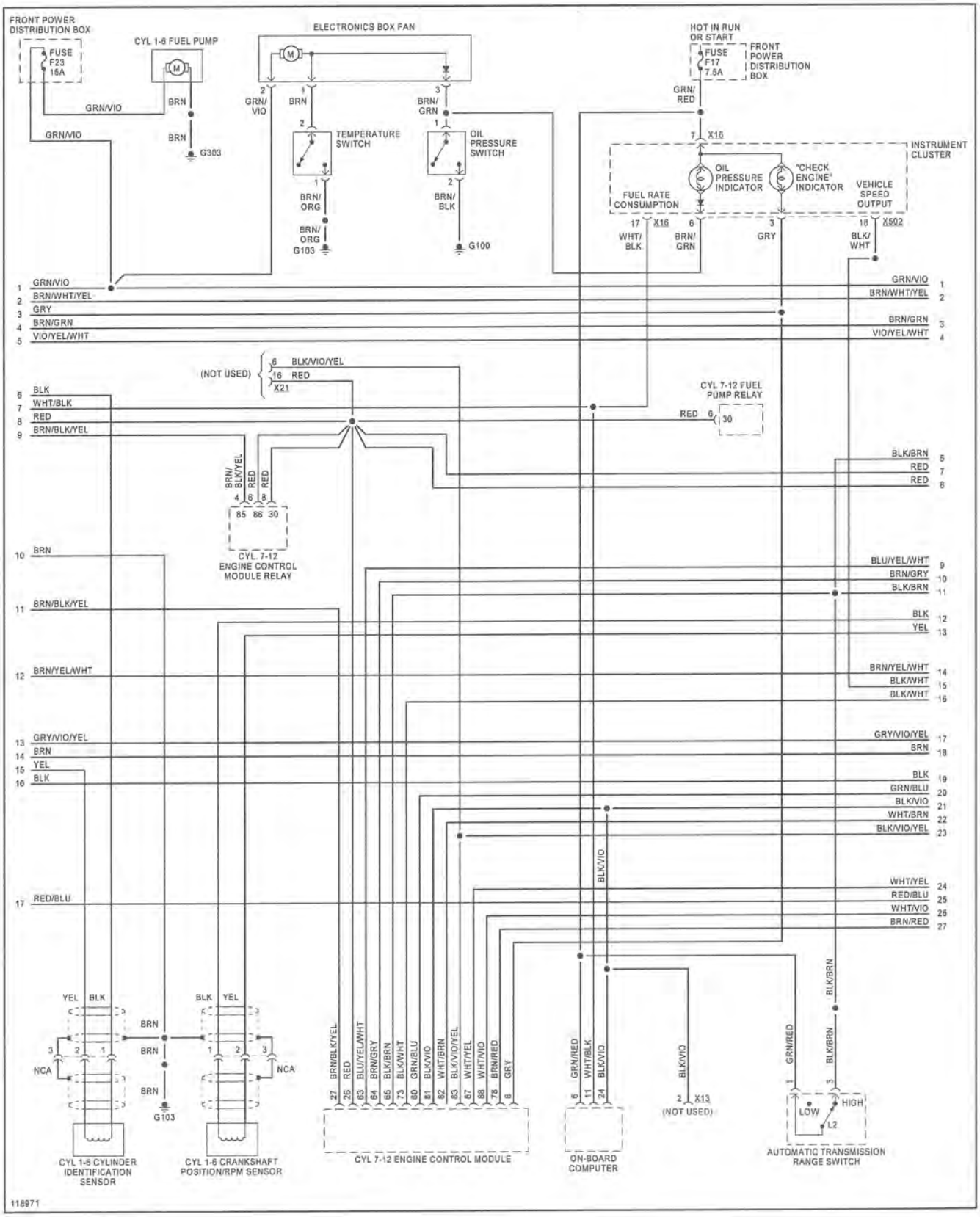
Engine Management

1993-94 750iL (1 of 6)



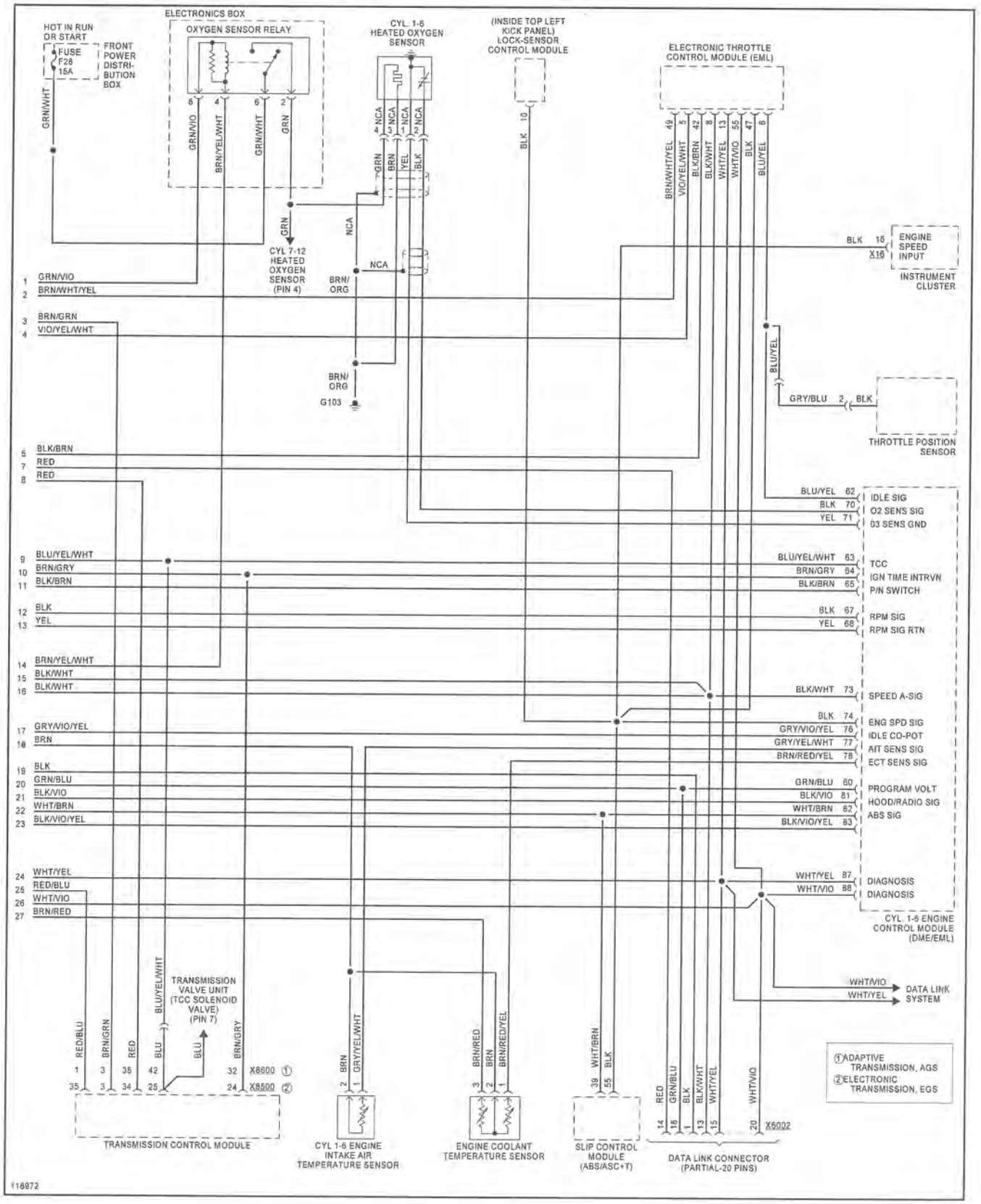
Engine Management

1993-94 750iL (2 of 6)



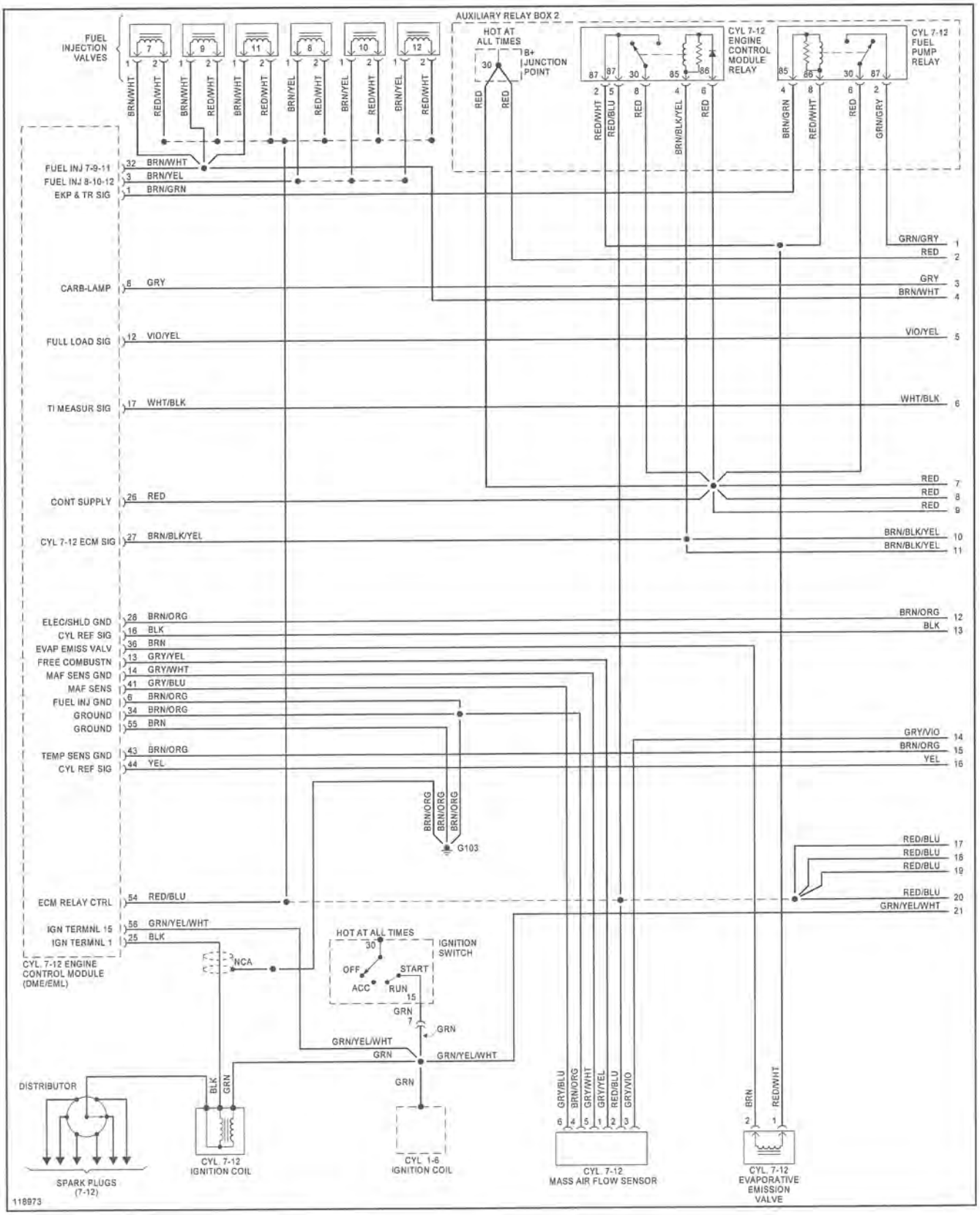
Engine Management

1993-94 750iL (3 of 6)



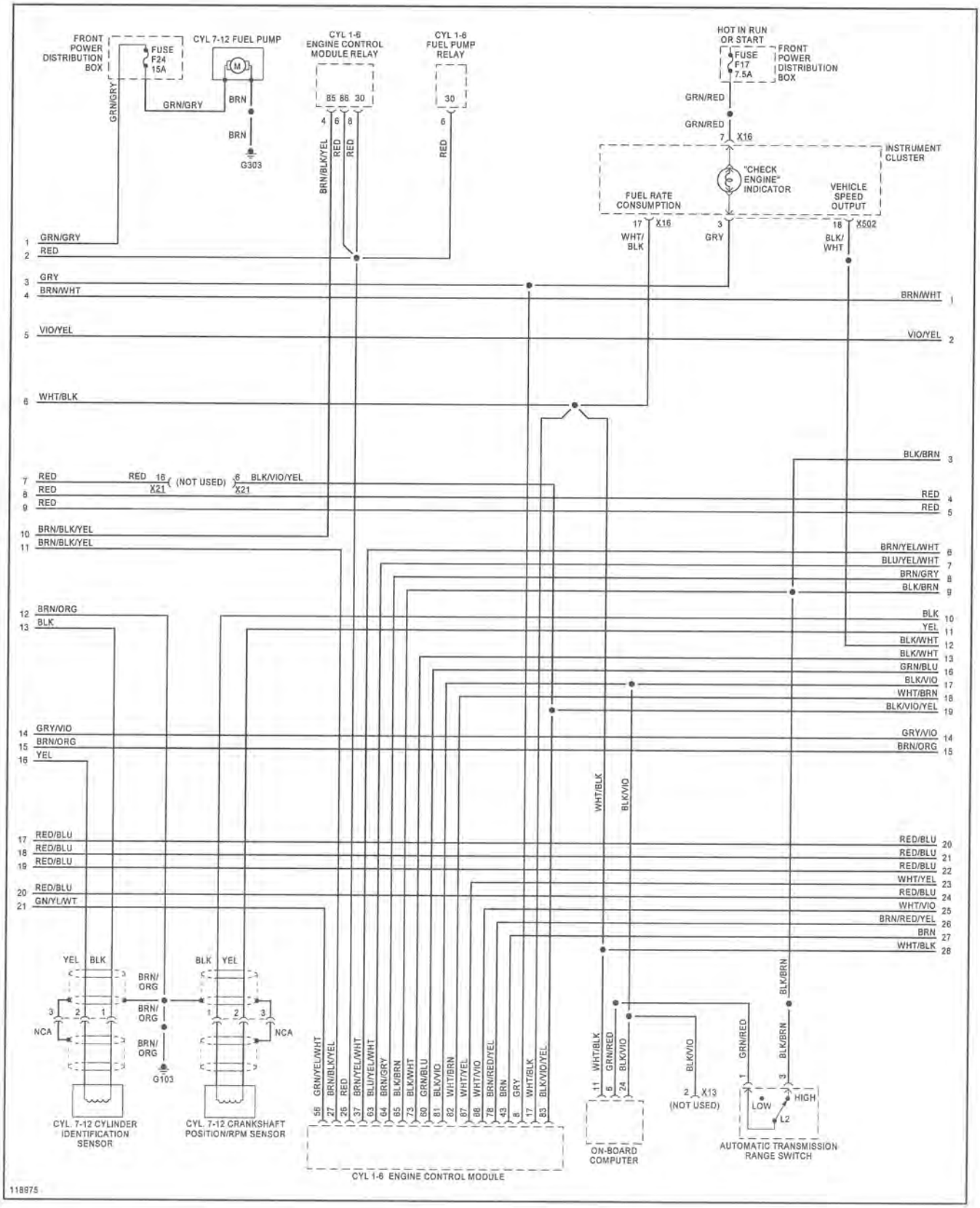
Engine Management

1993-94 750iL (4 of 6)



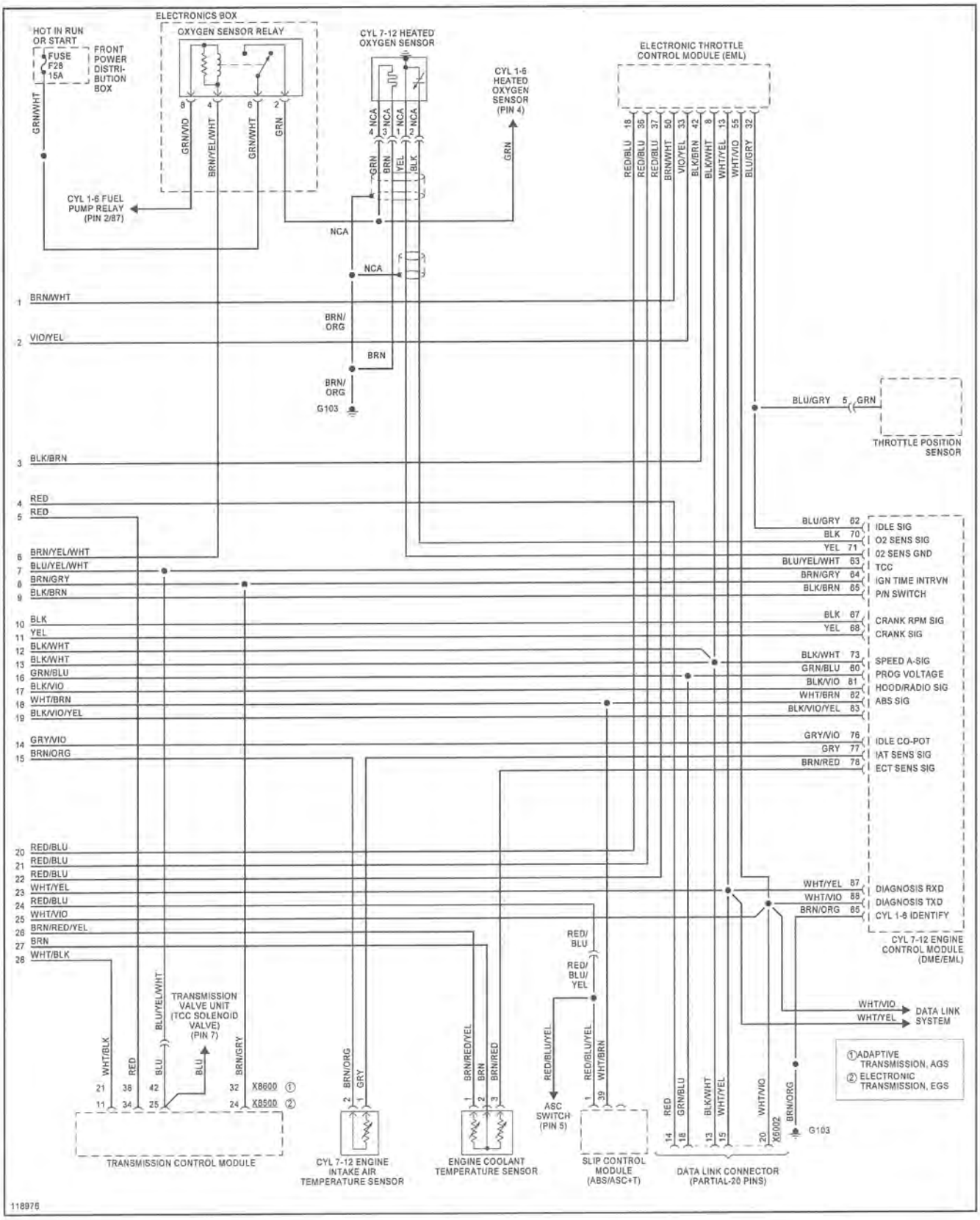
Engine Management

1993-94 750iL (5 of 6)



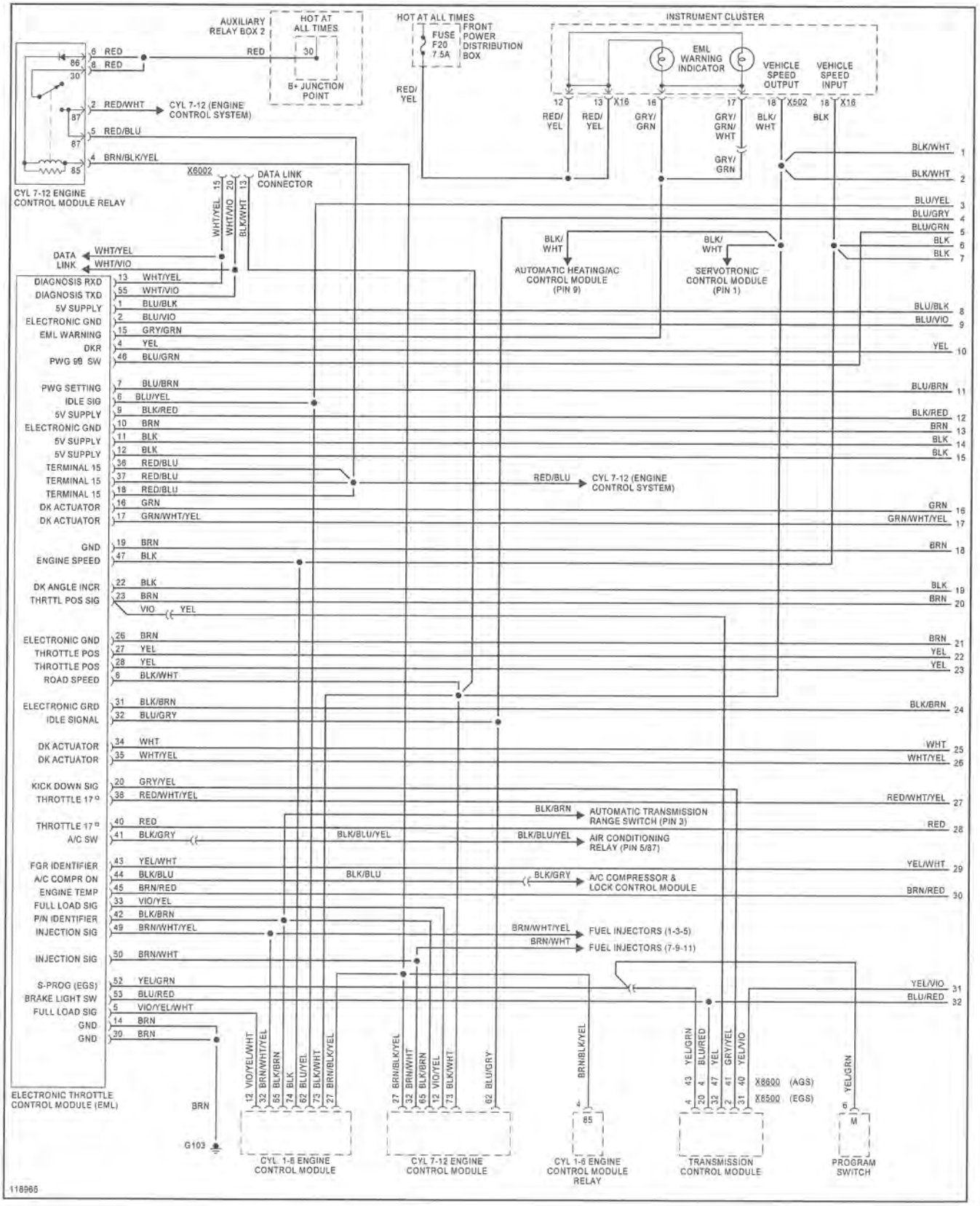
Engine Management

1993-94 750iL (6 of 6)



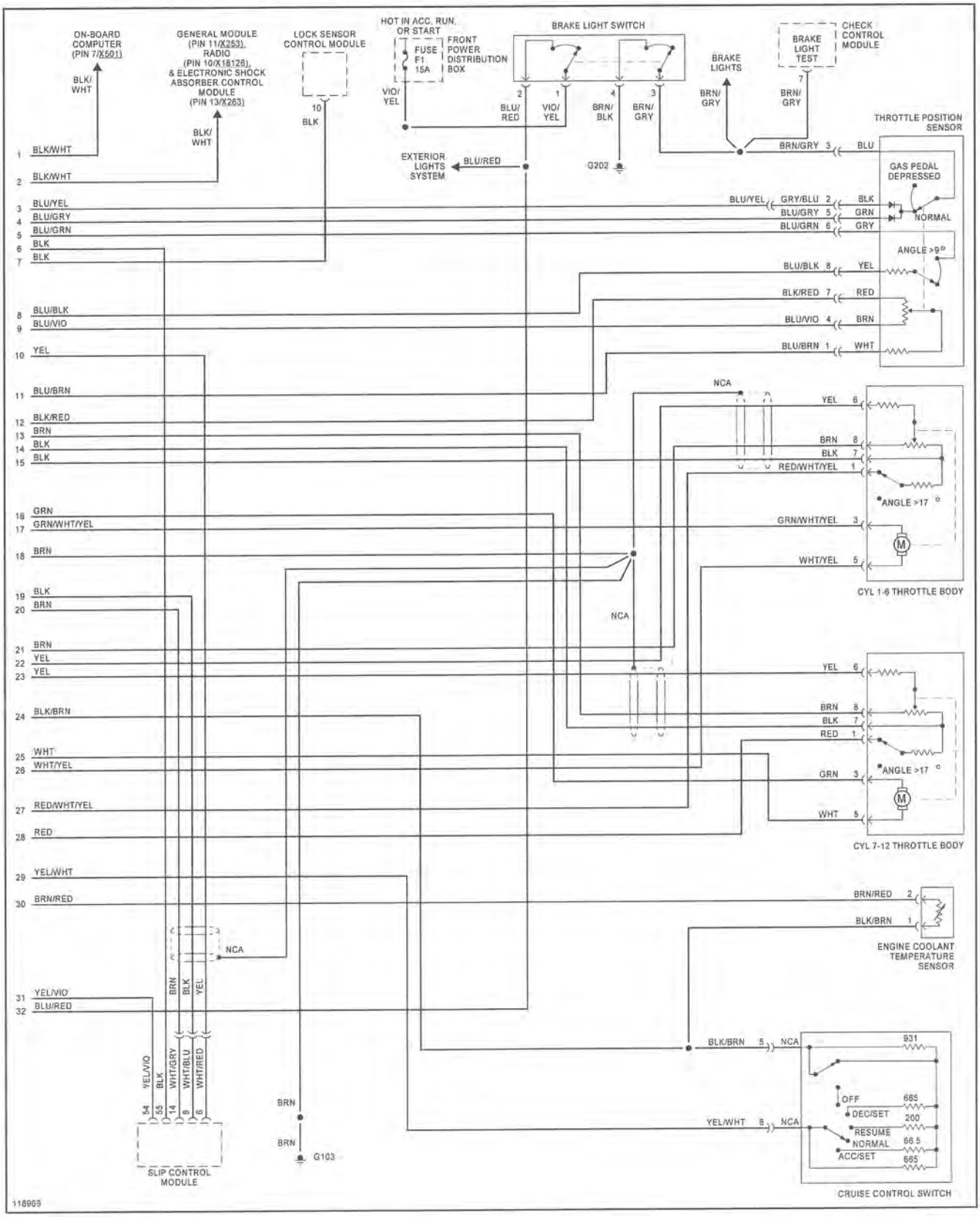
Engine Management

1993-94 750iL Electronic Throttle Control Circuit (1 of 2)



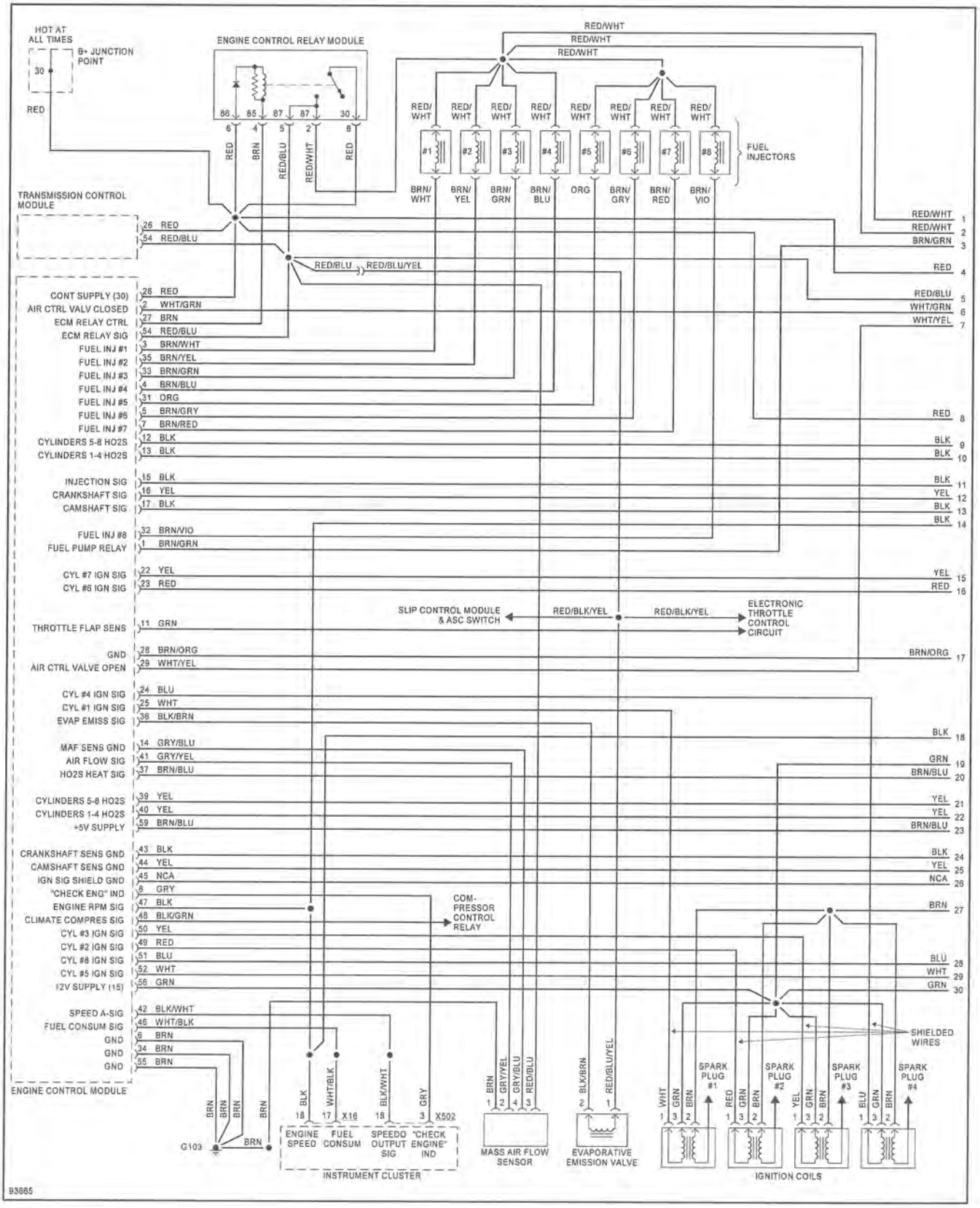
Engine Management

1993-94 750iL Electronic Throttle Control Circuit (2 of 2)



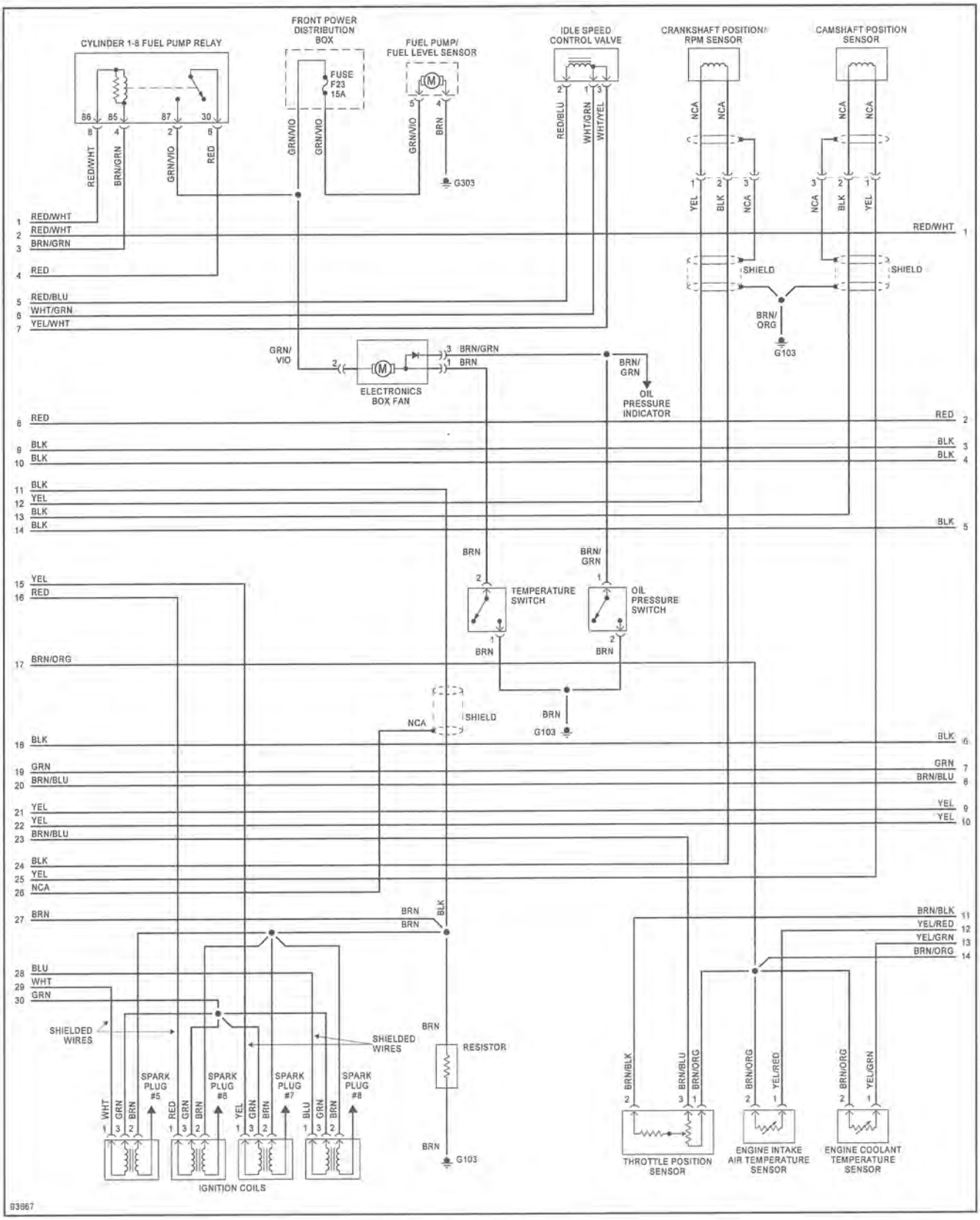
Engine Management

1993-94 740i (1 of 3)



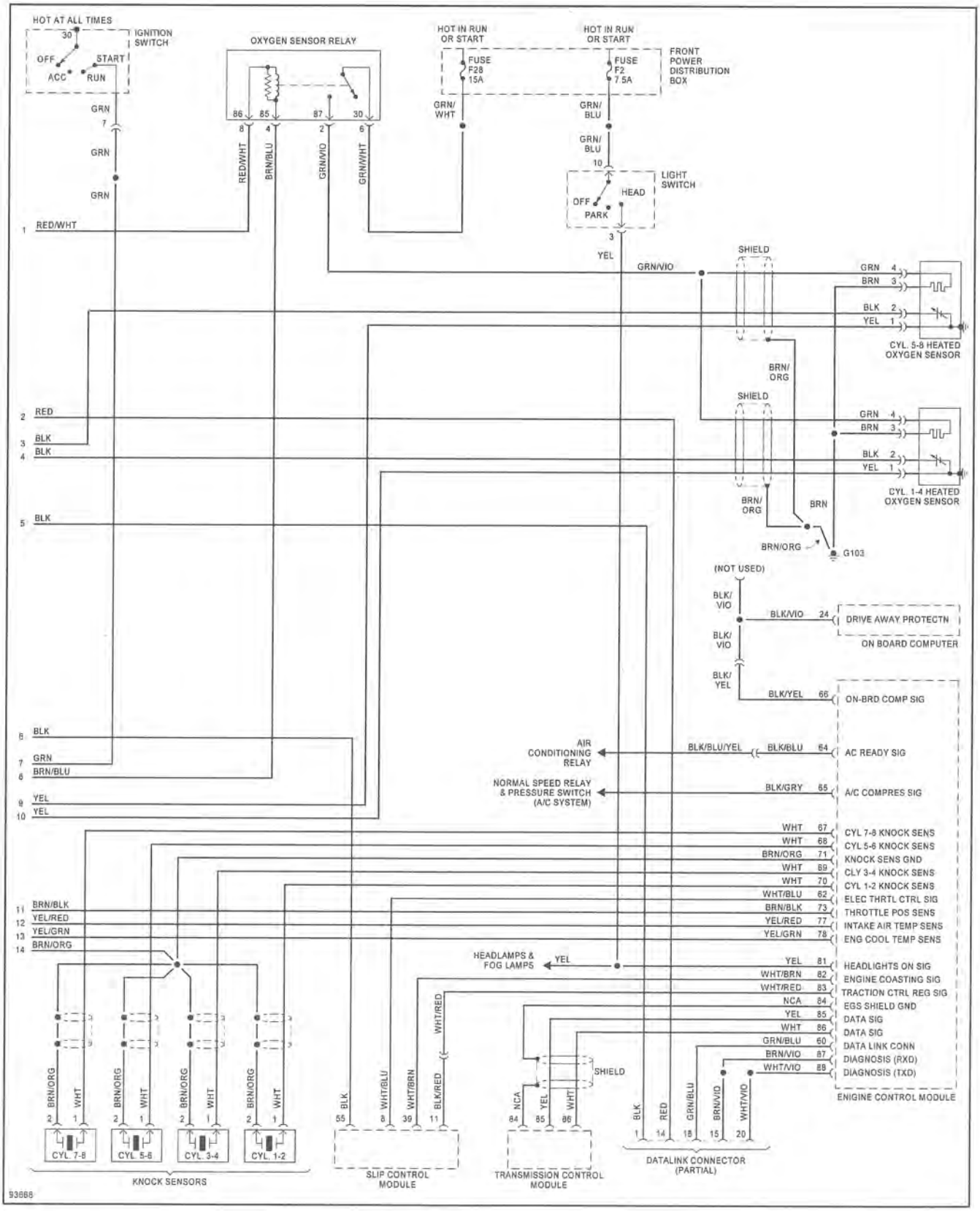
Engine Management

1993-94 740i (2 of 3)



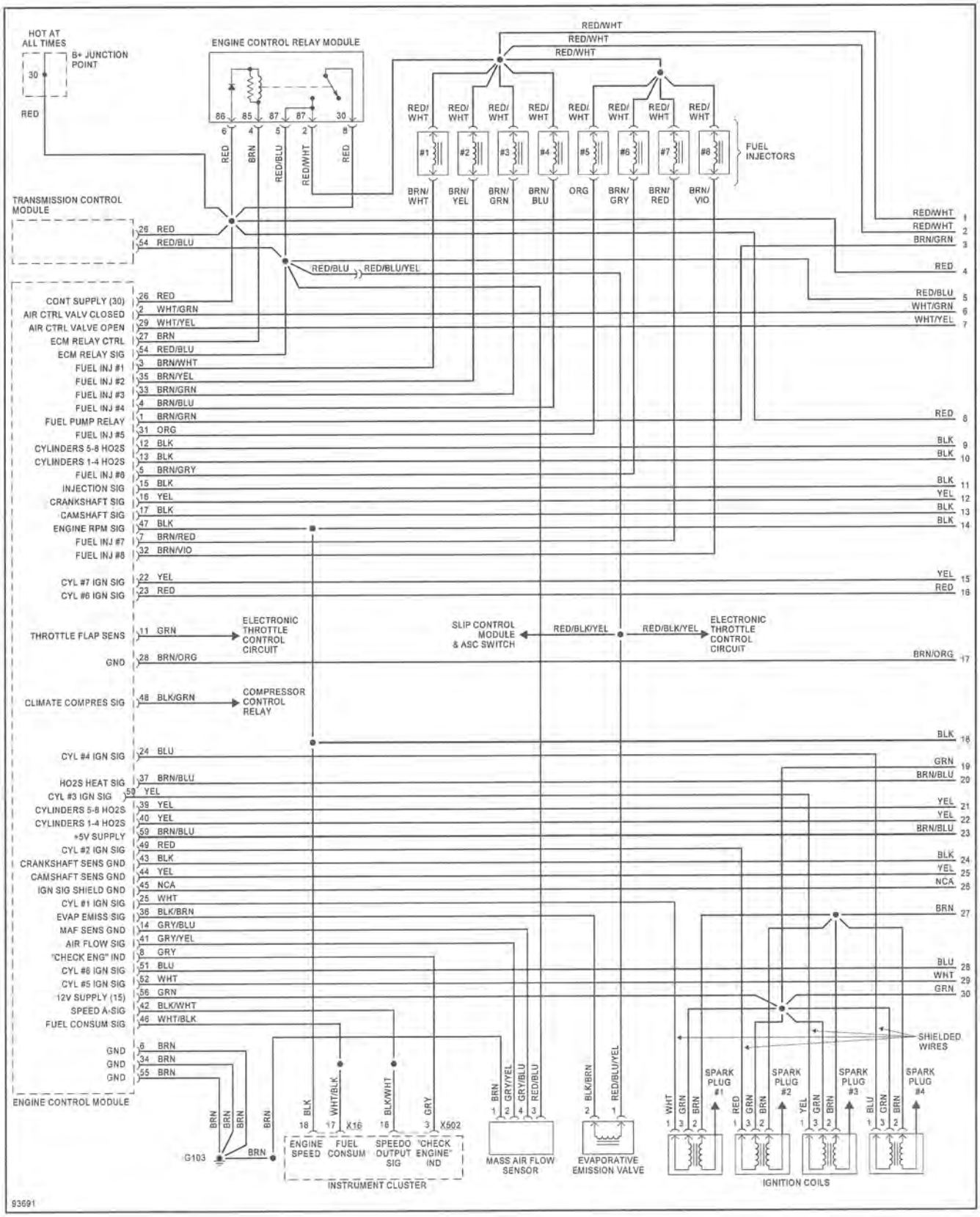
Engine Management

1993-94 740i (3 of 3)



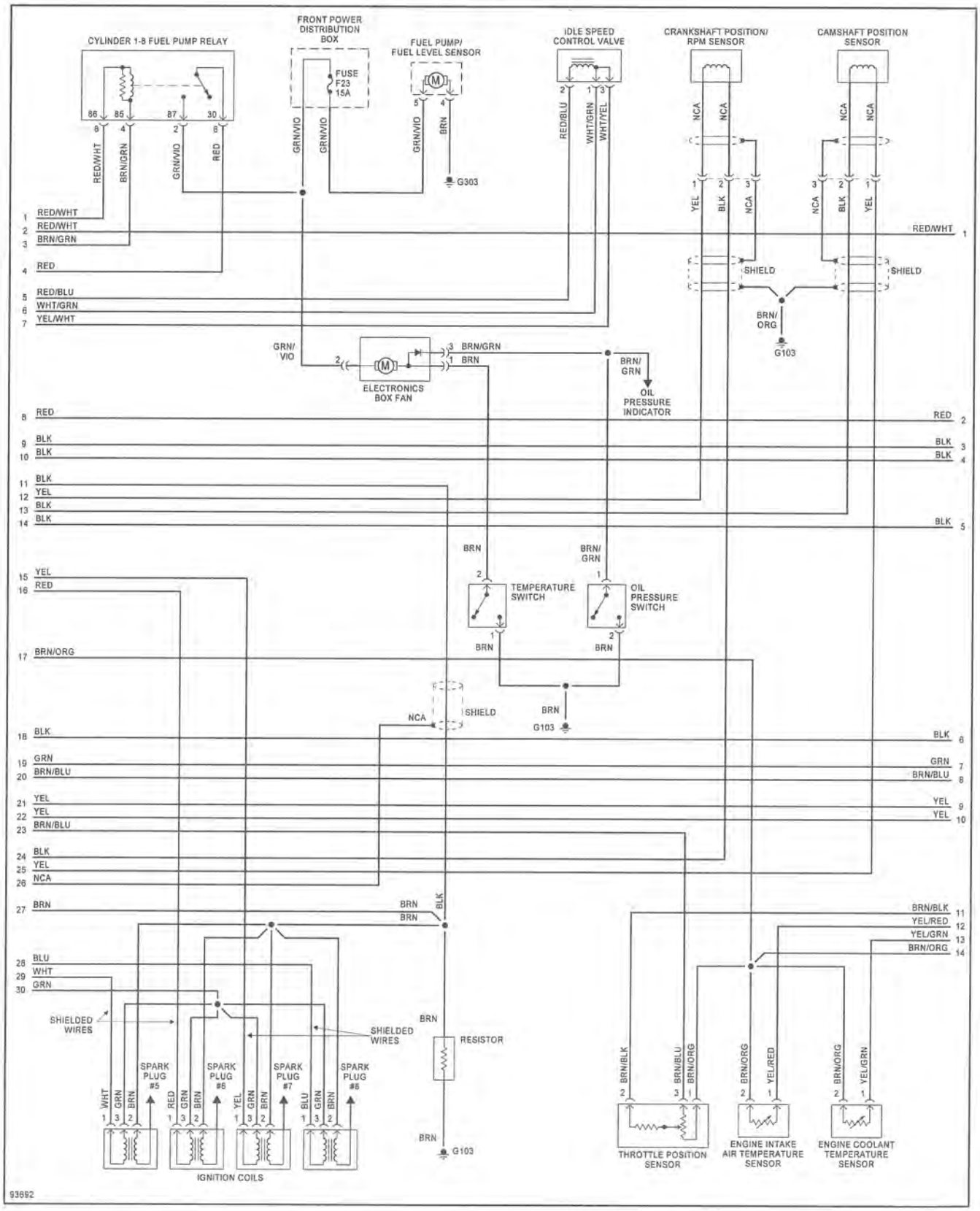
Engine Management

1993-94 740iL (1 of 3)



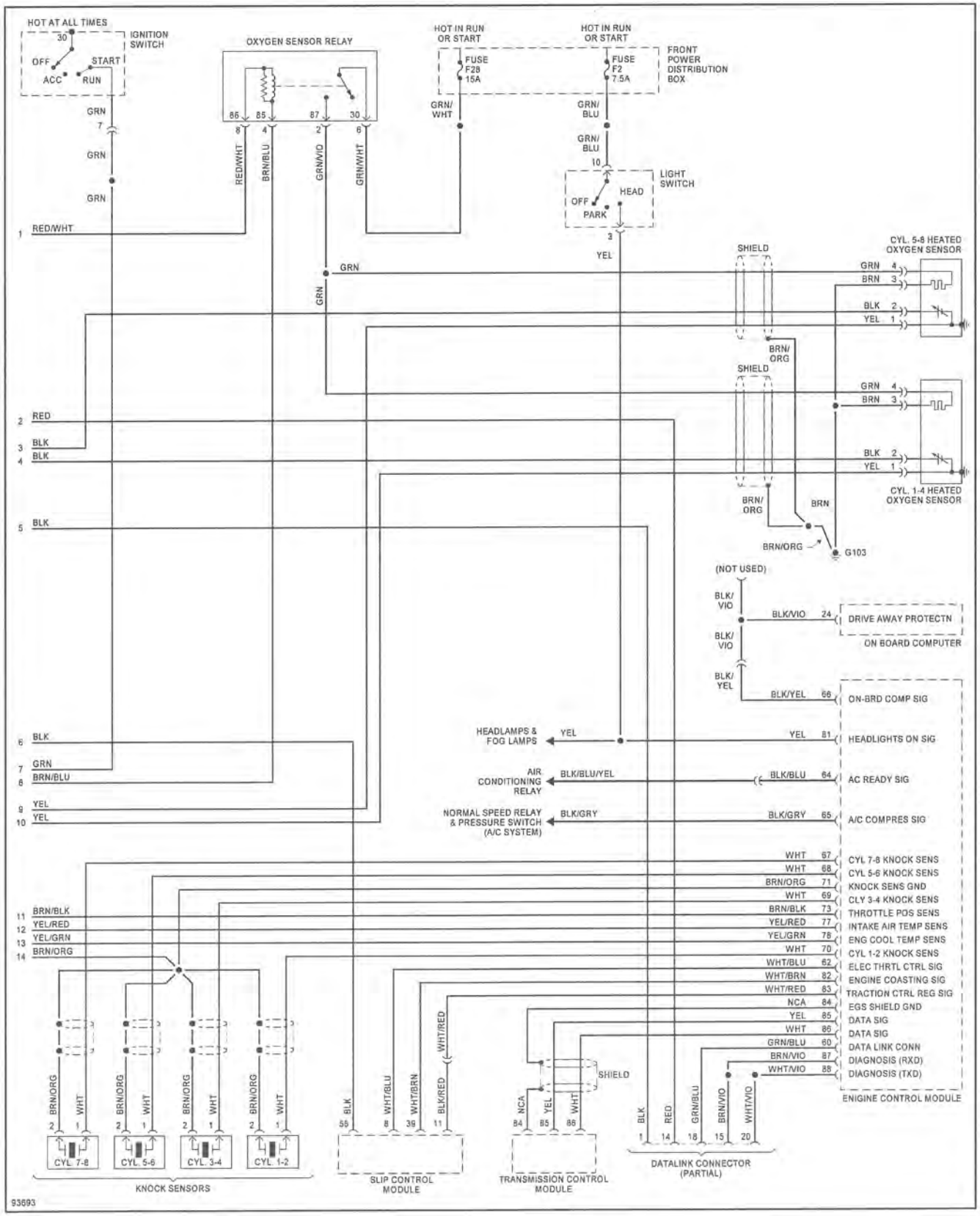
Engine Management

1993-94 740iL (2 of 3)



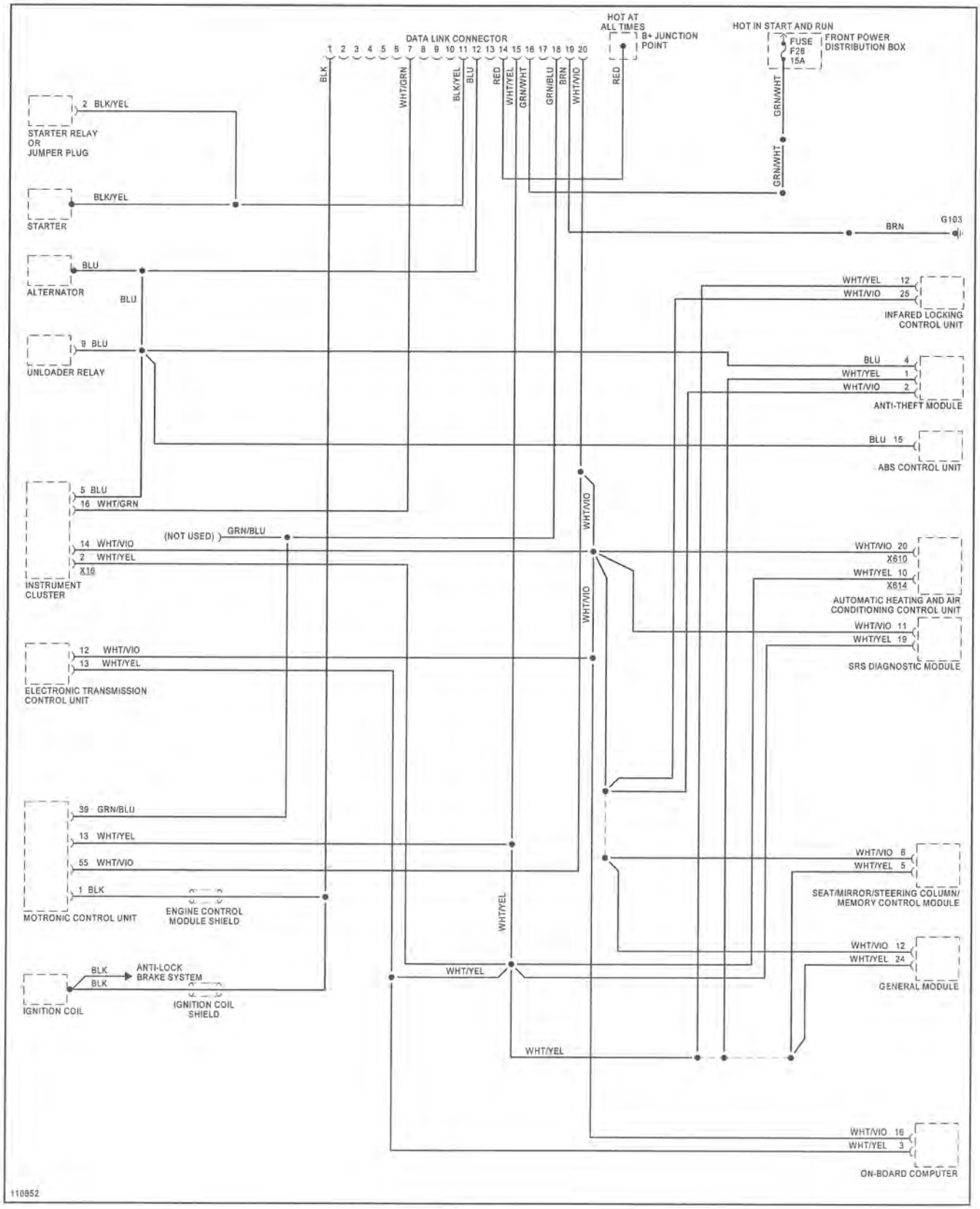
Engine Management

1993-94 740iL (3 of 3)



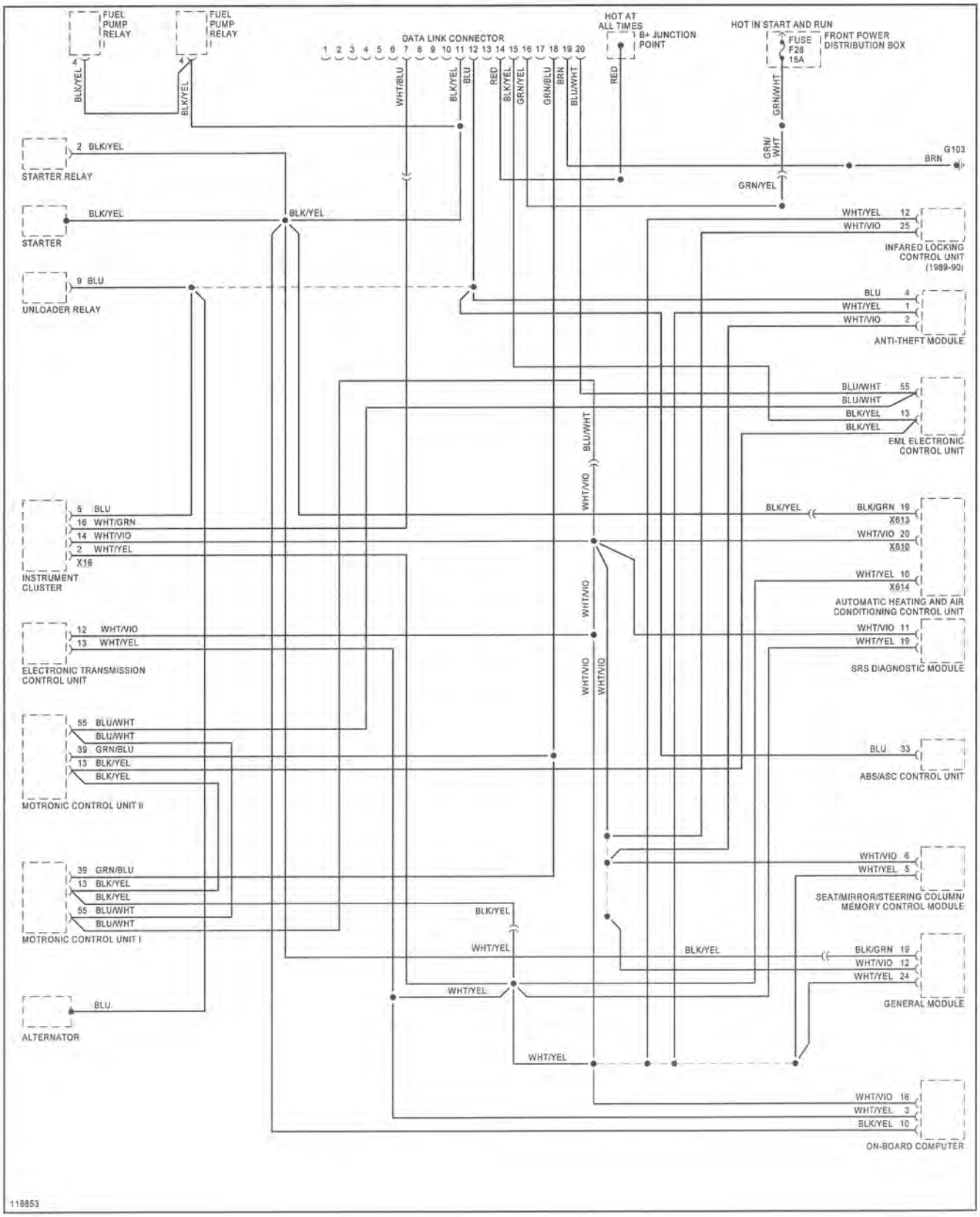
Data Link Connector

1988-90 735i & 735iL



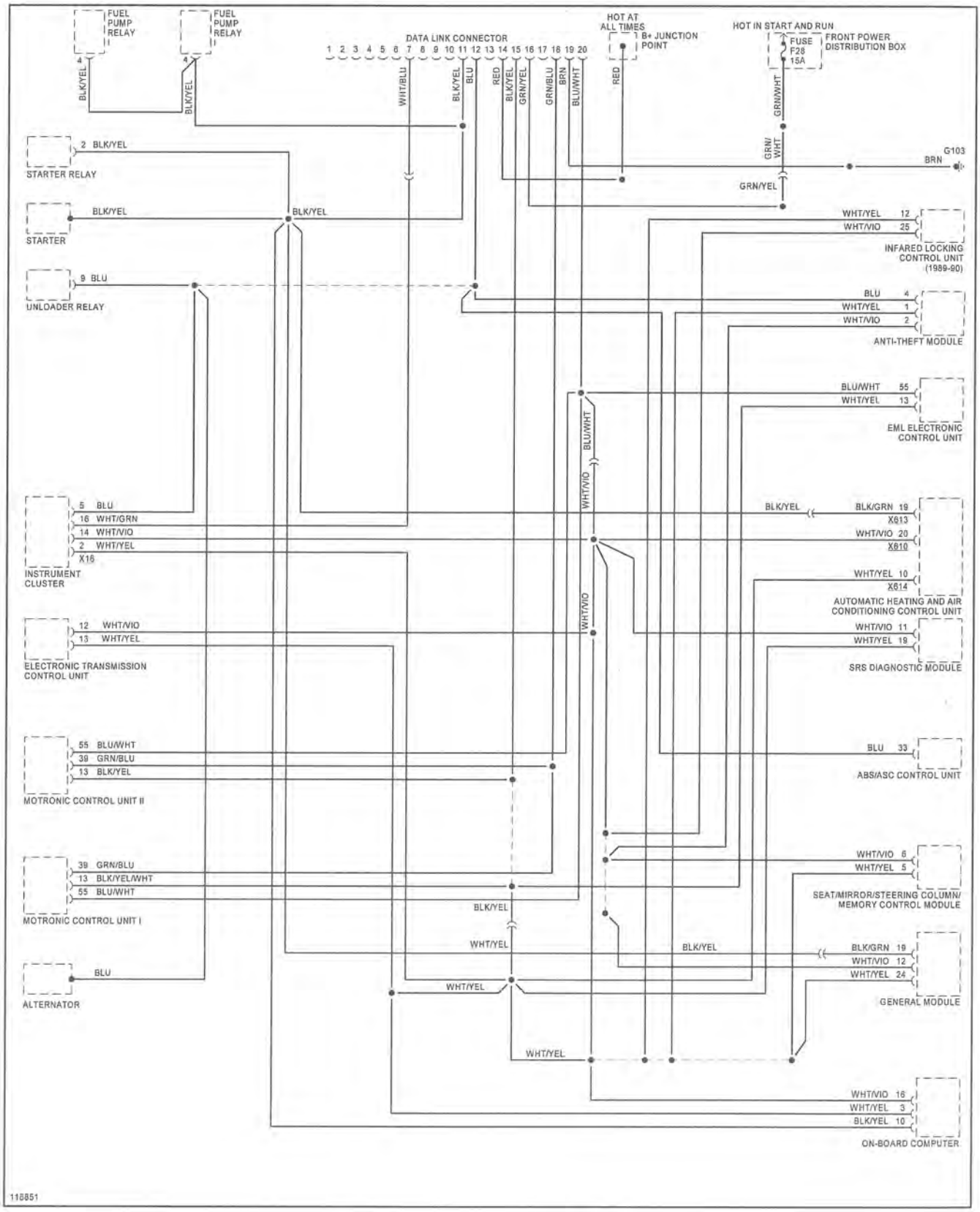
Data Link Connector

1988 750iL Early Production



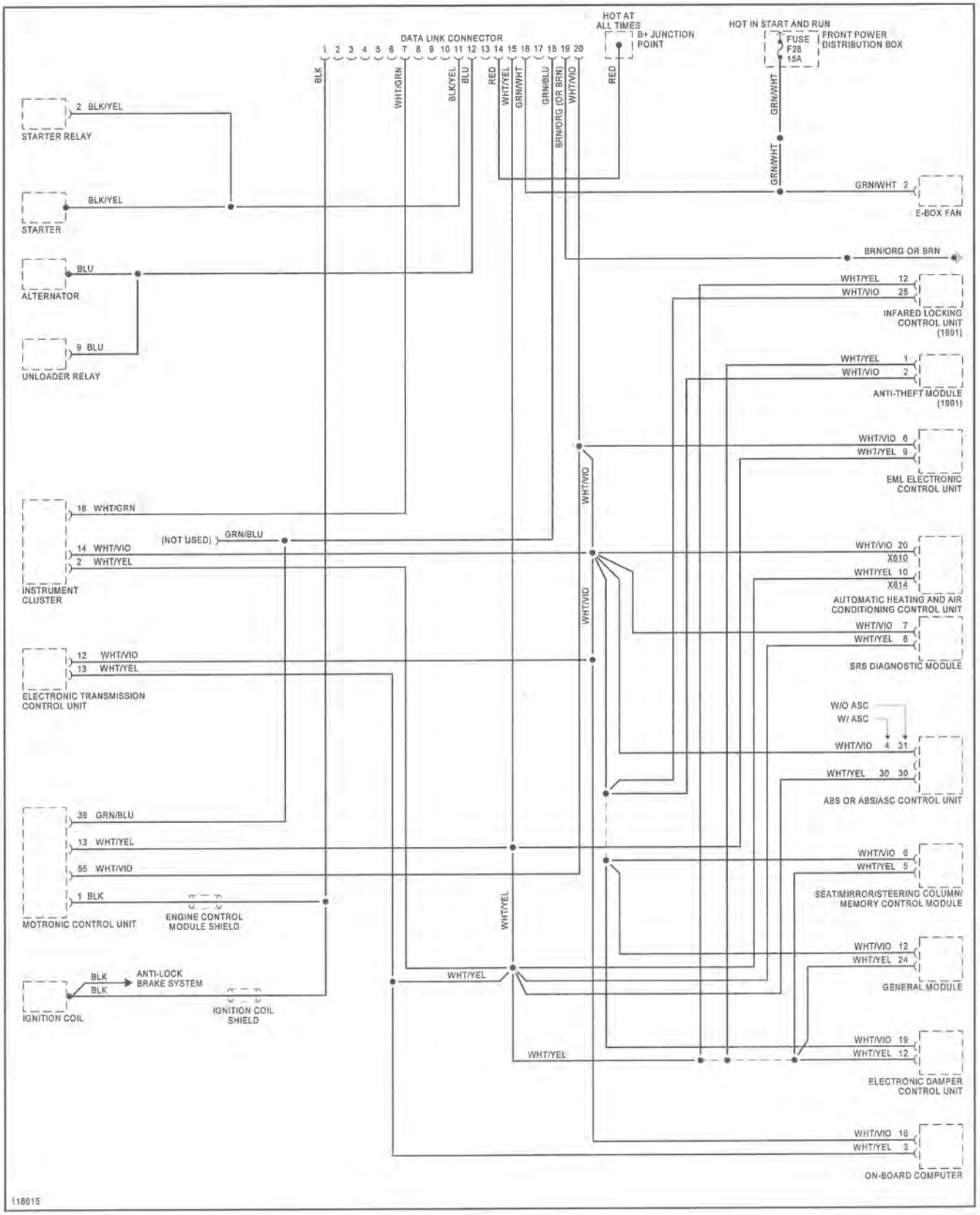
Data Link Connector

1988 750iL Late Production, 1989-90 750iL



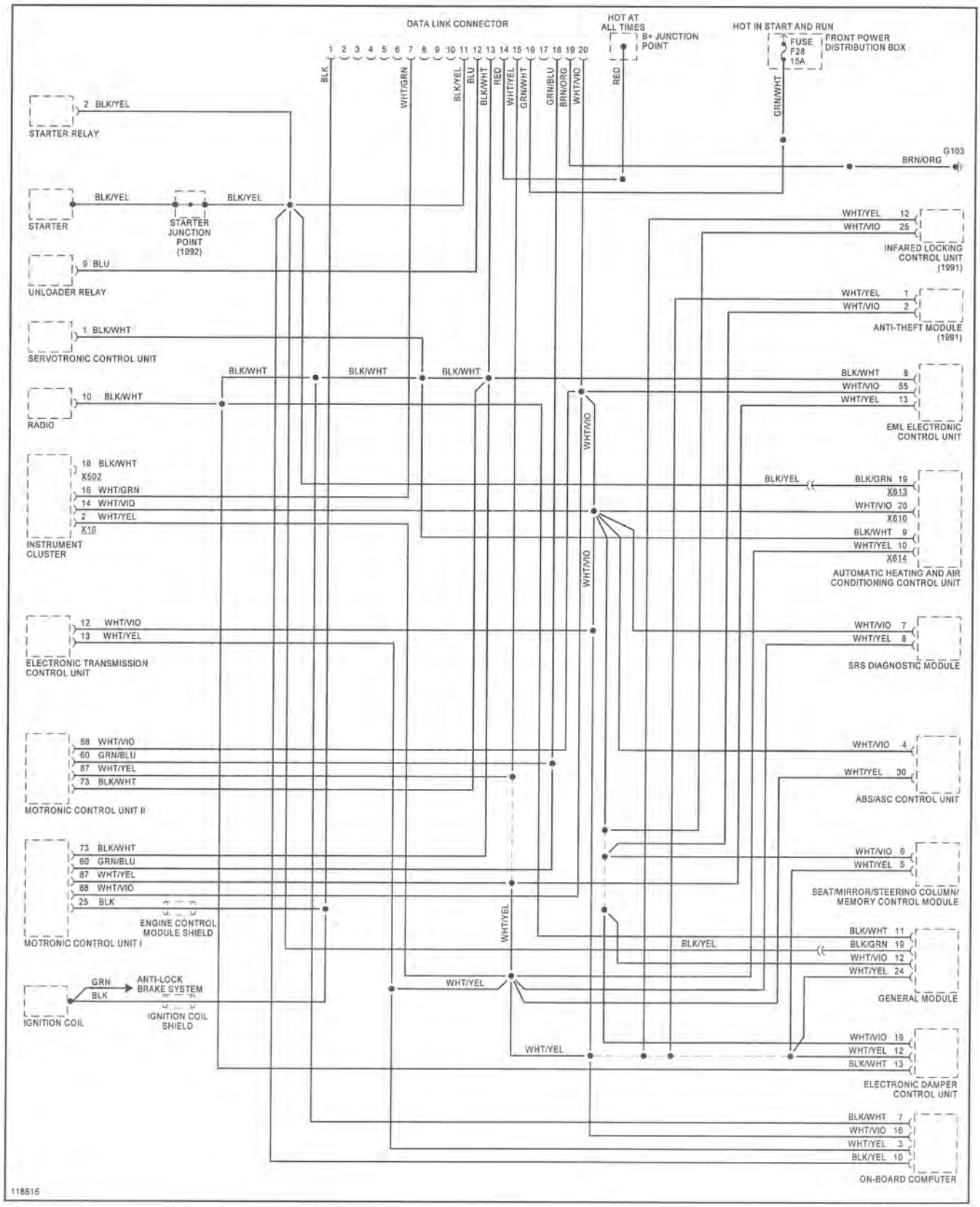
Data Link Connector

1991-92 735i & 735iL



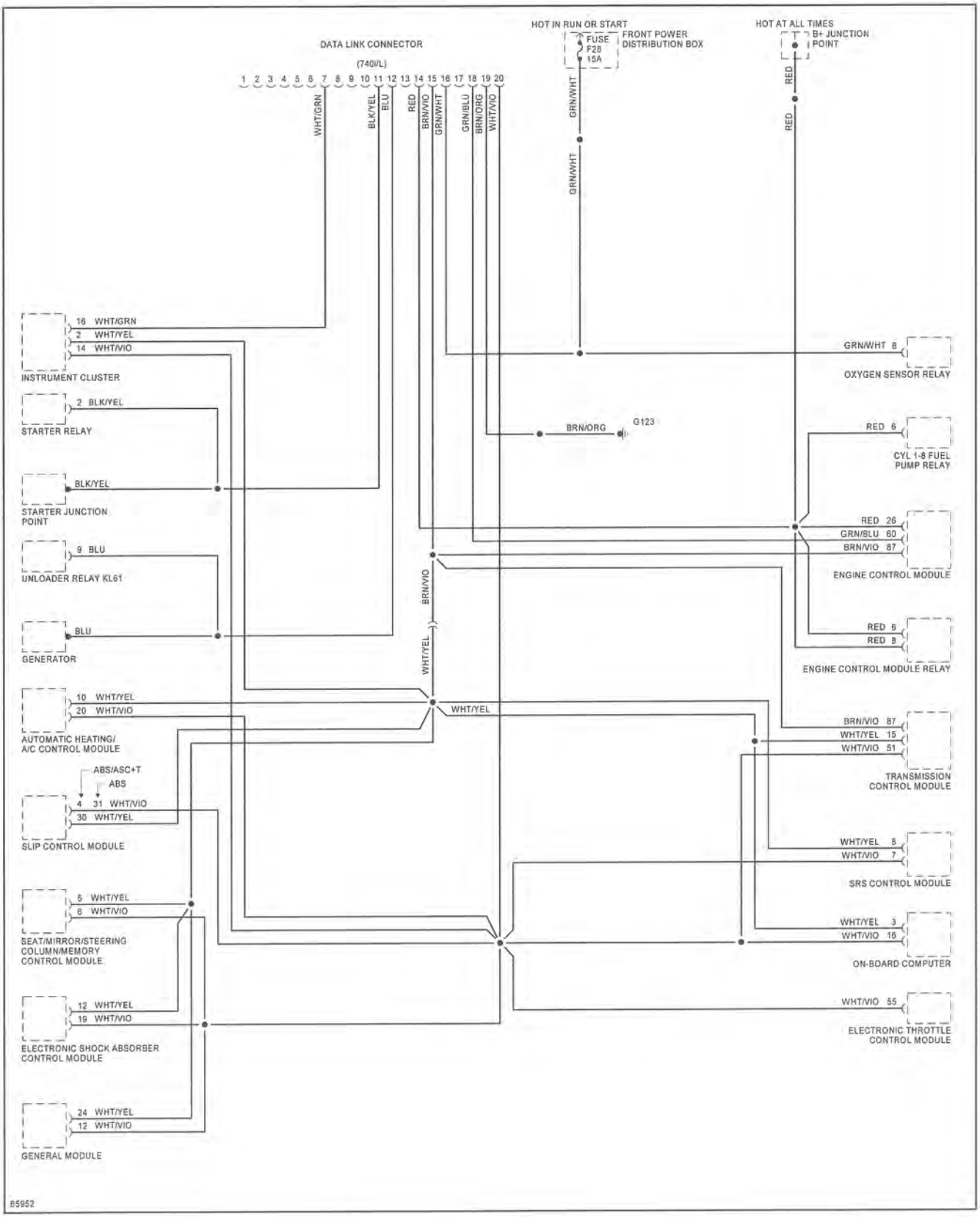
Data Link Connector

1991-92 750iL



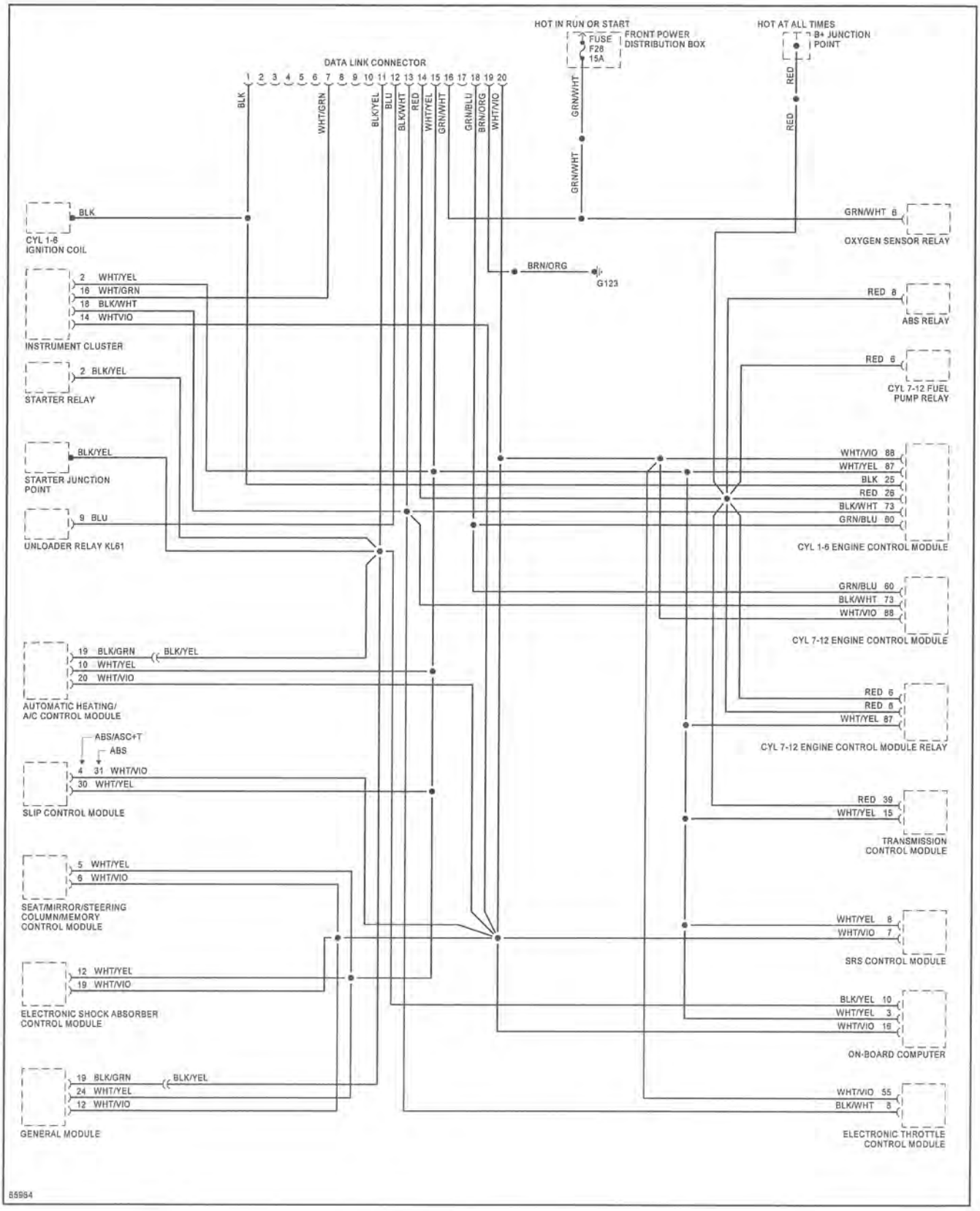
Data Link Connector

1993-94 740i &740iL, 1994 750iL

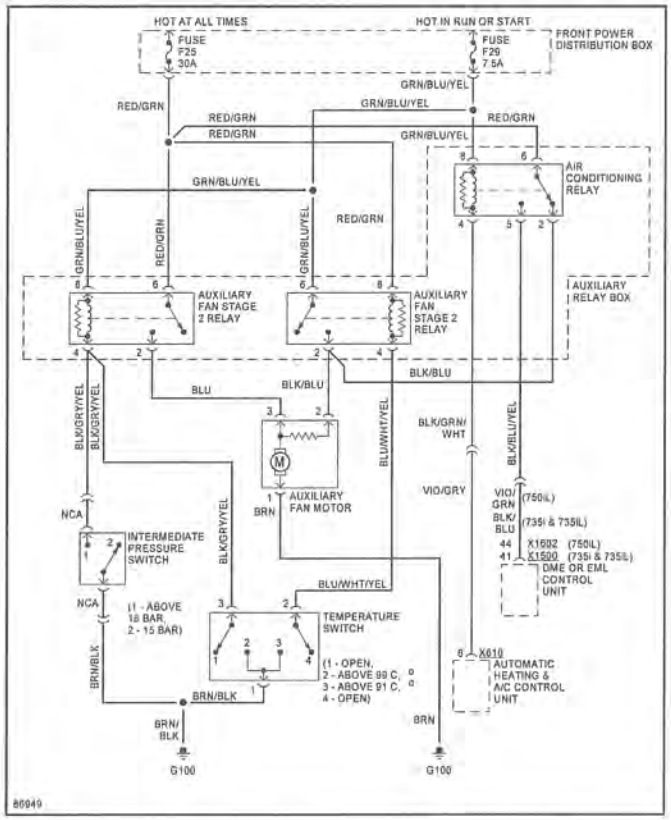


Data Link Connector

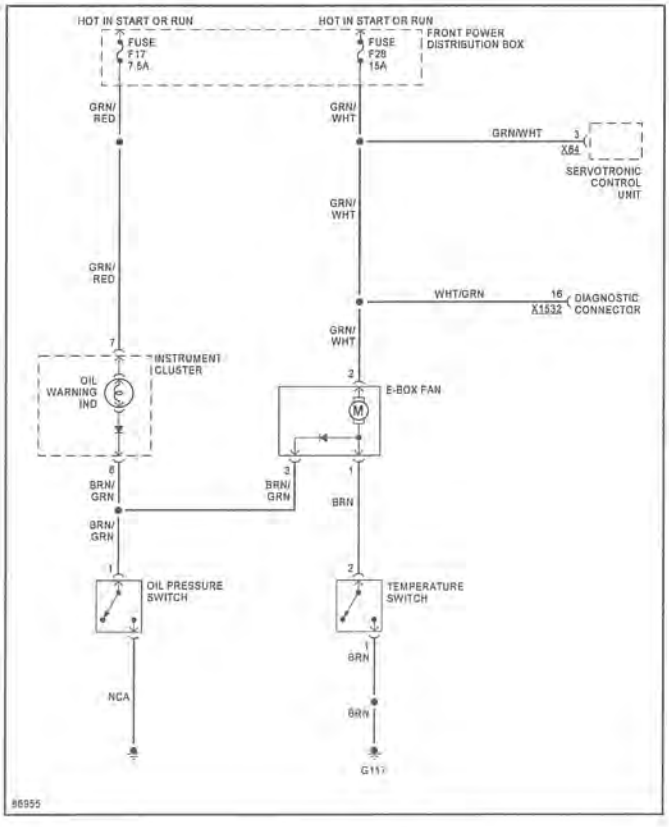
1993 750iL



Engine Cooling

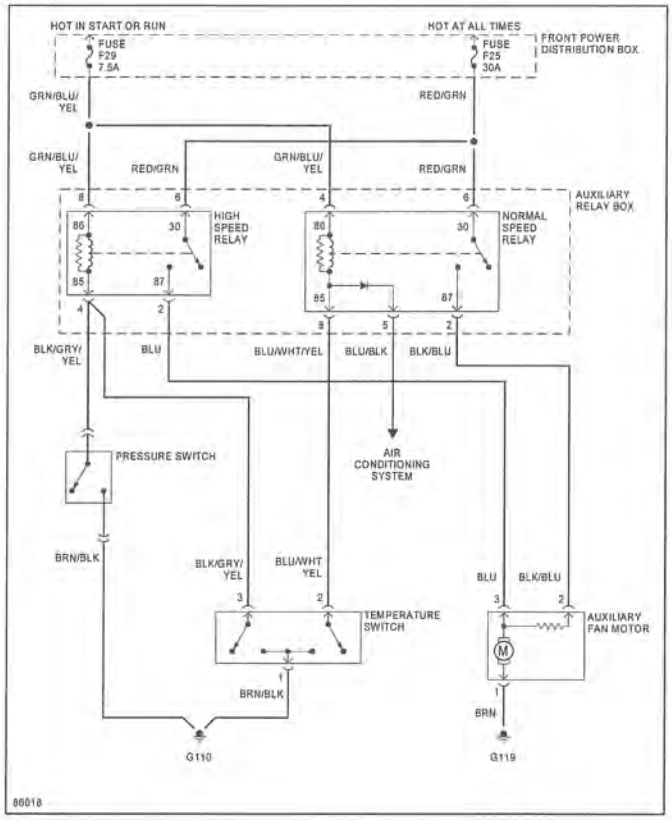


1988-89 Auxiliary Fan

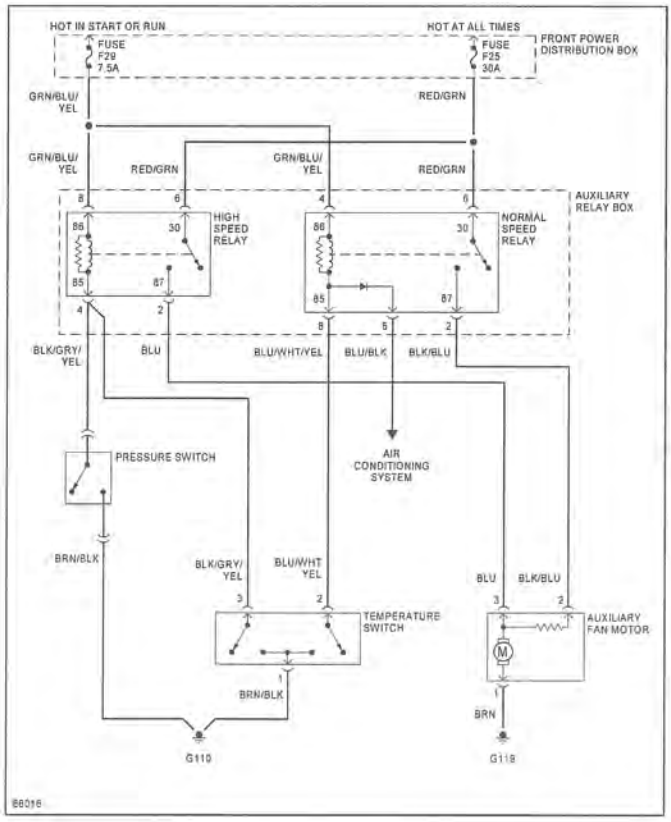


1988-89 E-Box Fan

Engine Cooling

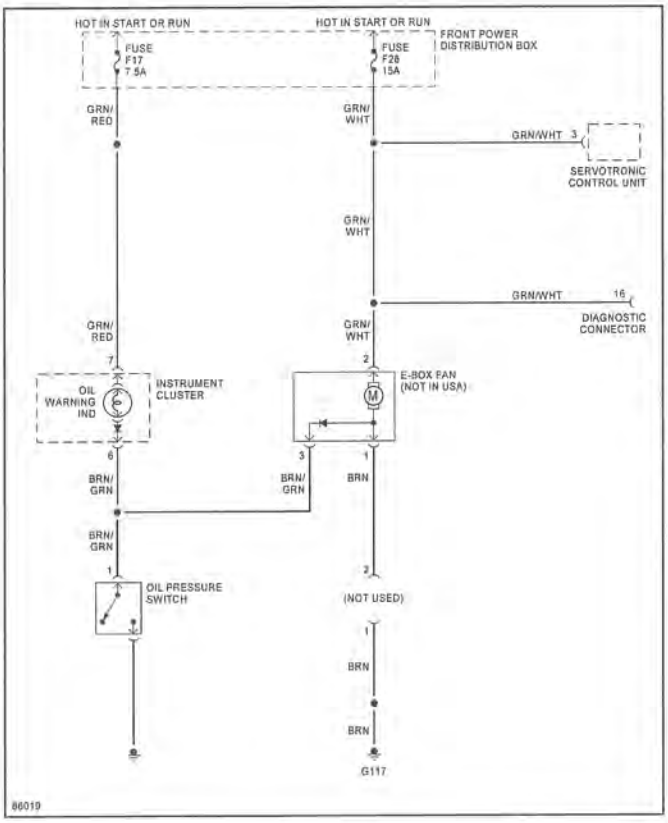


1990 735i & 735iL Auxiliary Fan

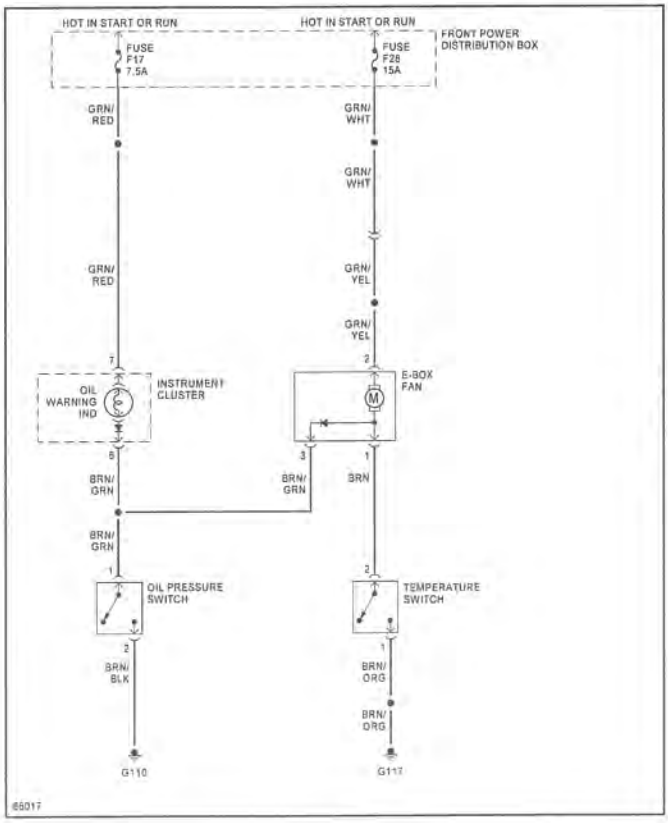


1990 750iL Auxiliary Fan

Engine Cooling

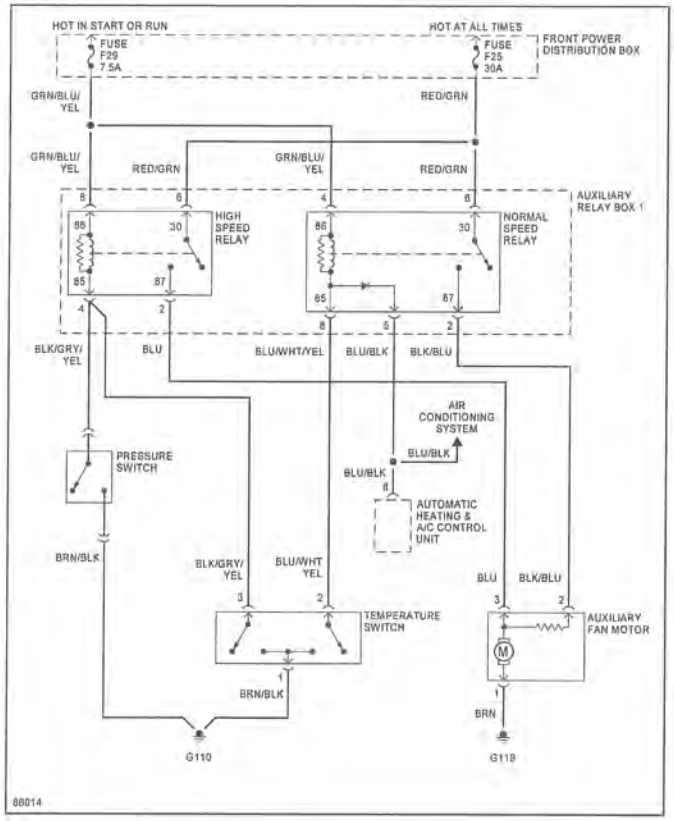


1990 735i & 735iL E-Box Fan

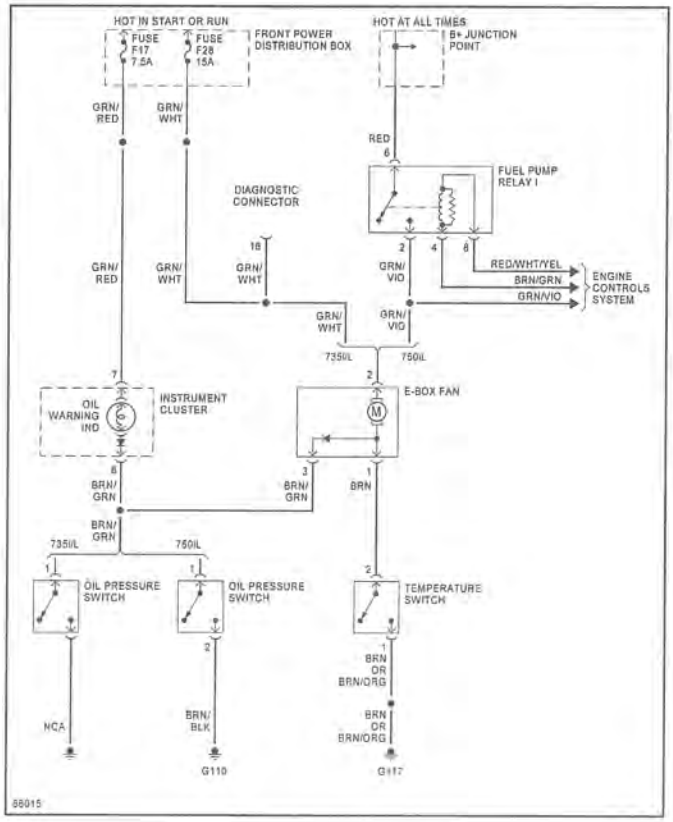


1990 750iL E-Box Fan

Engine Cooling



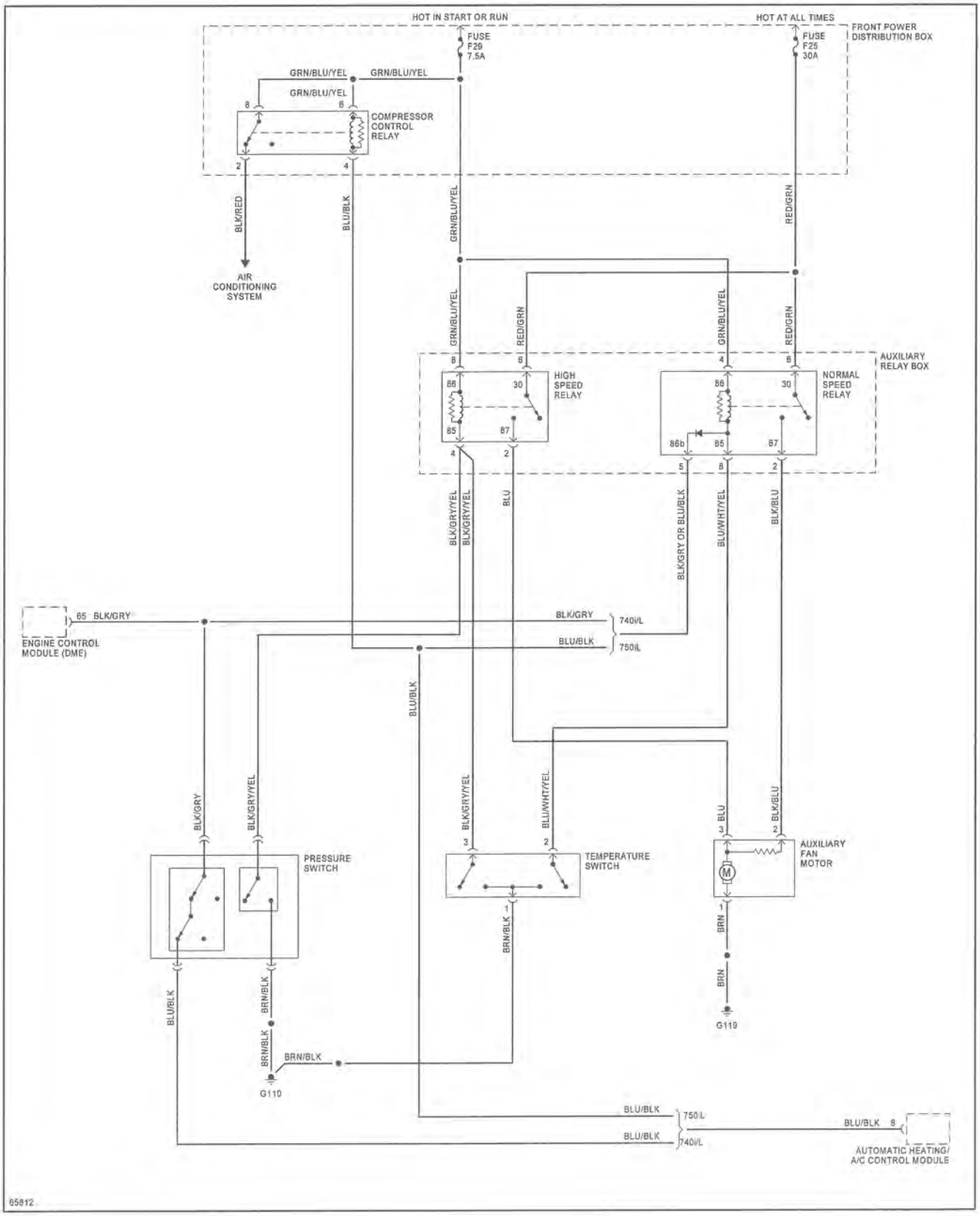
1991-92 Auxiliary Fan



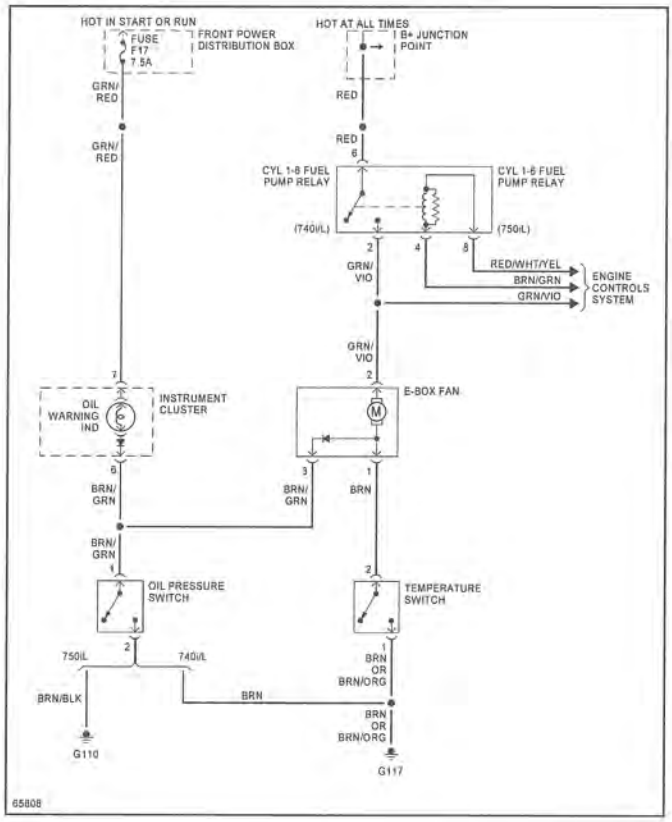
1991-92 E-Box Fan

Engine Cooling

1993-94 Auxiliary Fan



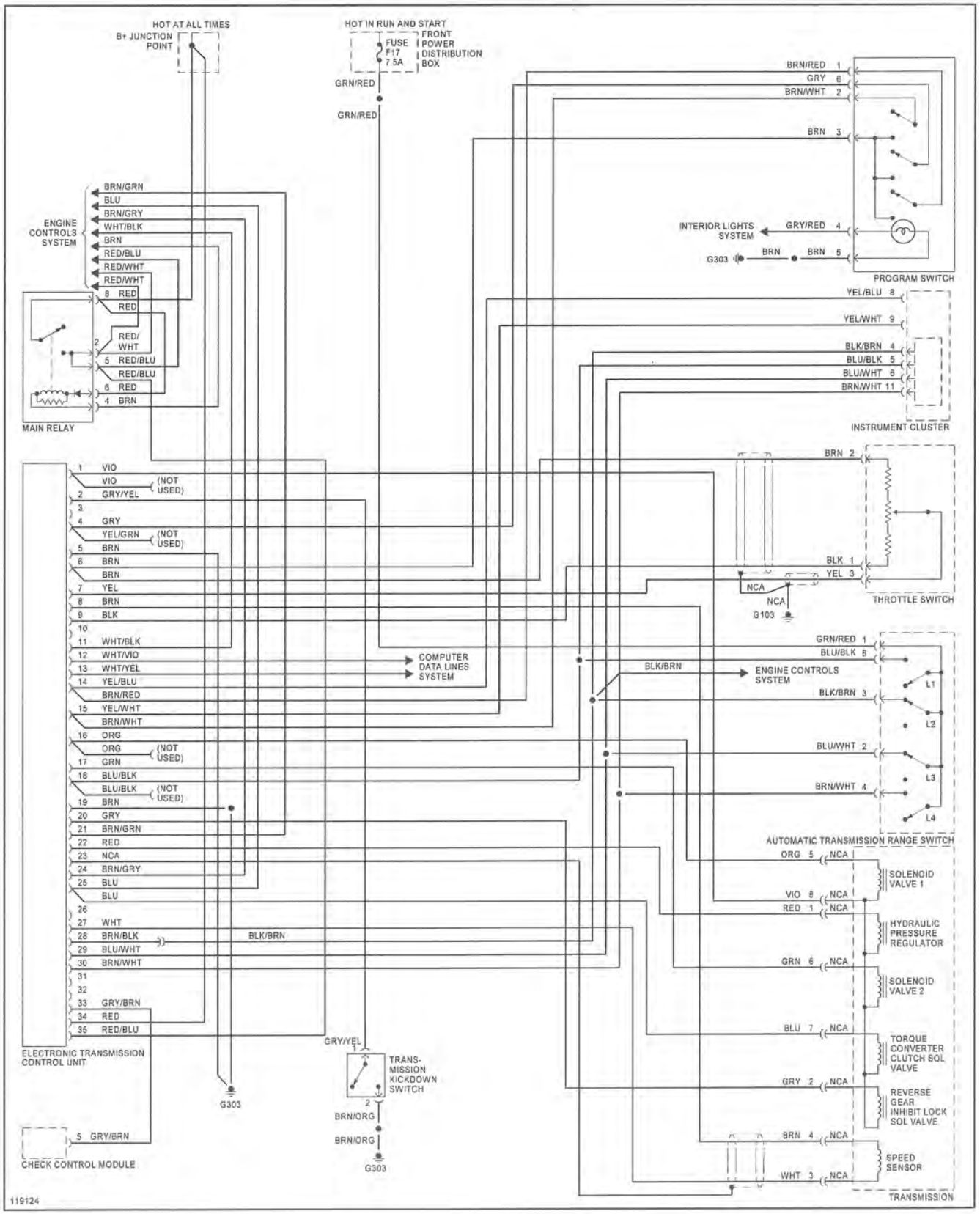
Engine Cooling



1993-94 E-Box Fan

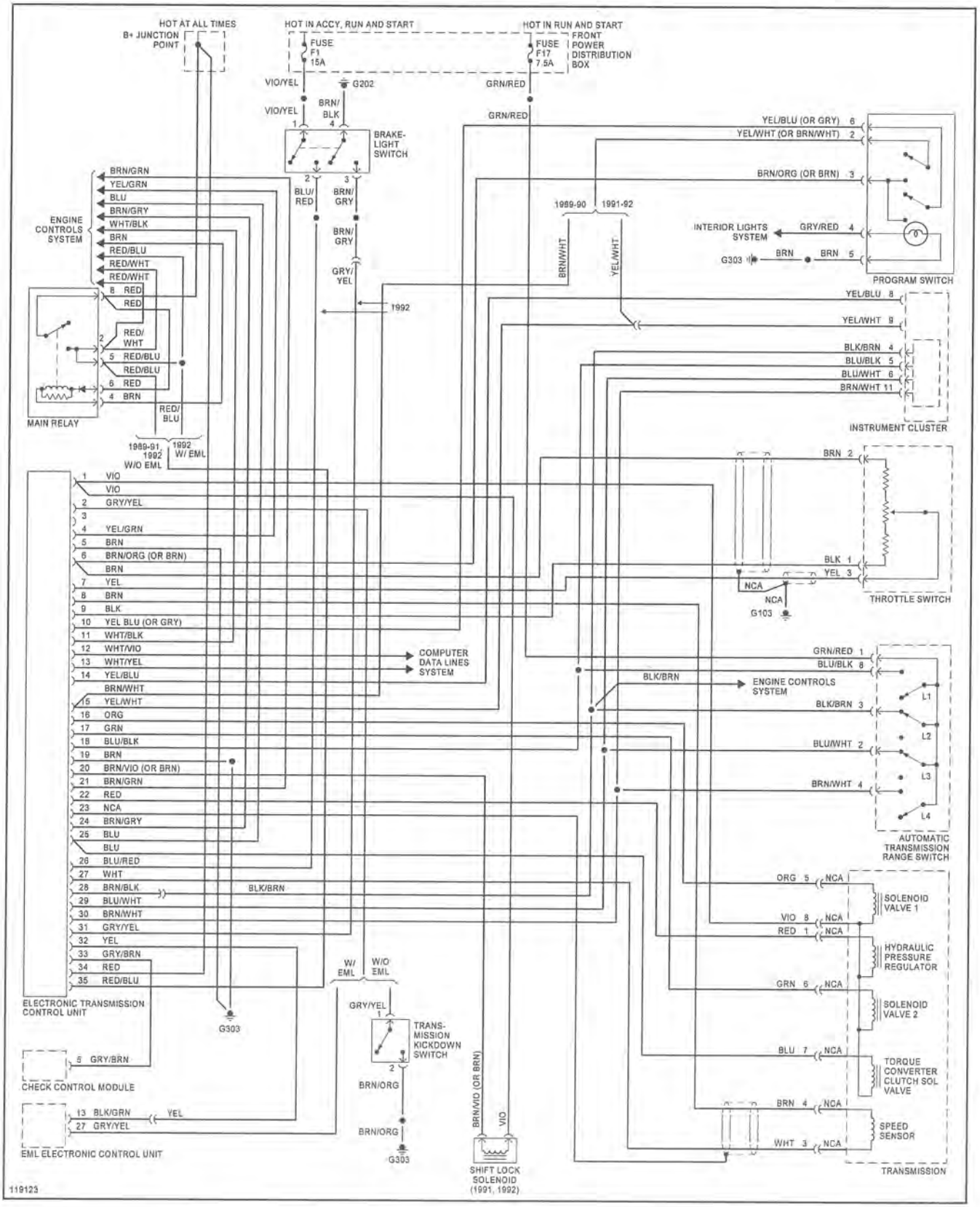
Transmission Electronics

1988 735i/735iL, 1989 735i/735iL w/ 3 Position Program Switch



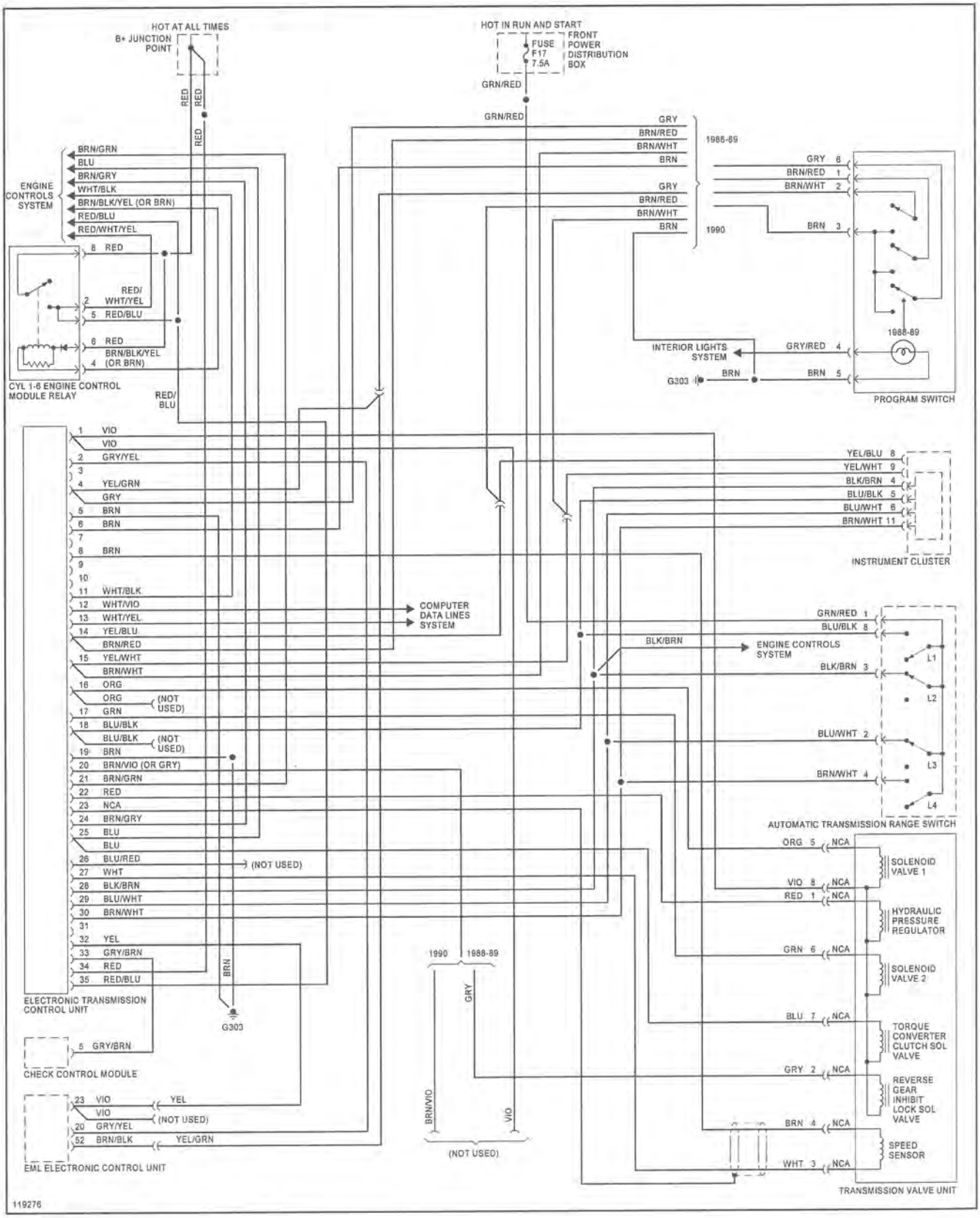
Transmission Electronics

1989 735i/735iL w/ 2 Position Program Switch, 1990-92 735i/735iL



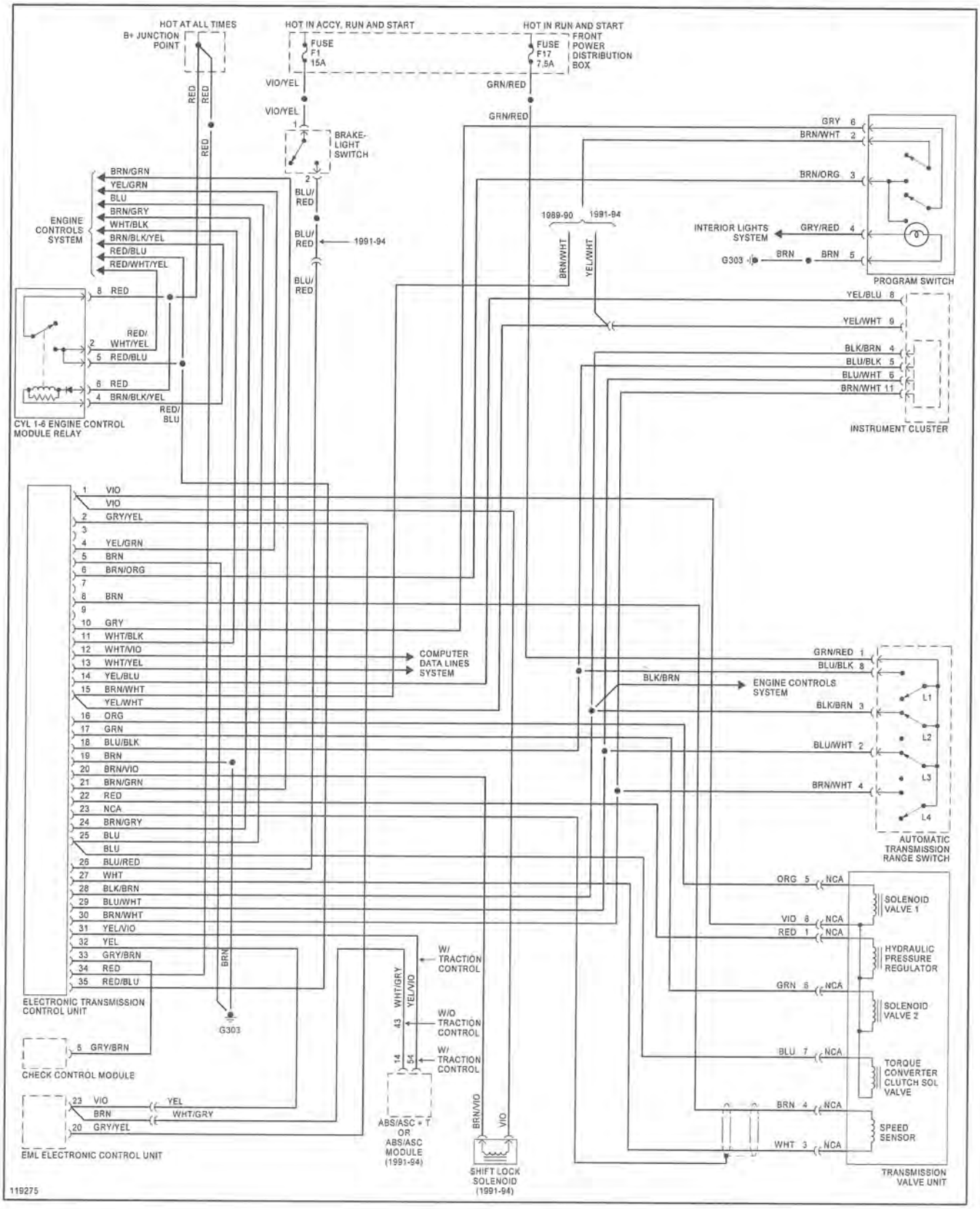
Transmission Electronics

1988-90 750iL w/ 3 Position Program Switch



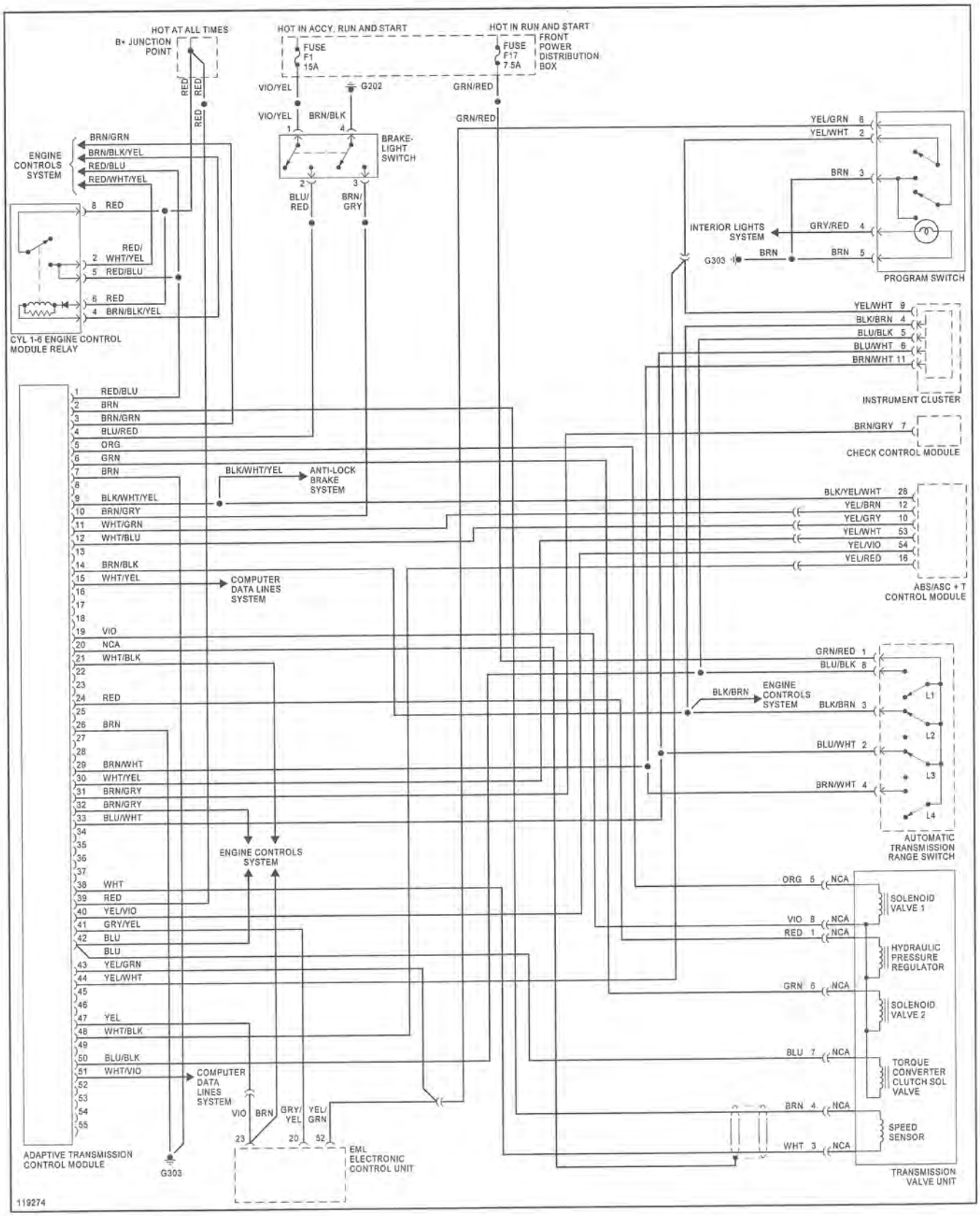
Transmission Electronics

1989-90 750iL w/ 2 Pos. Program Switch, 1991-94 750iL w/o Adaptive Trans.



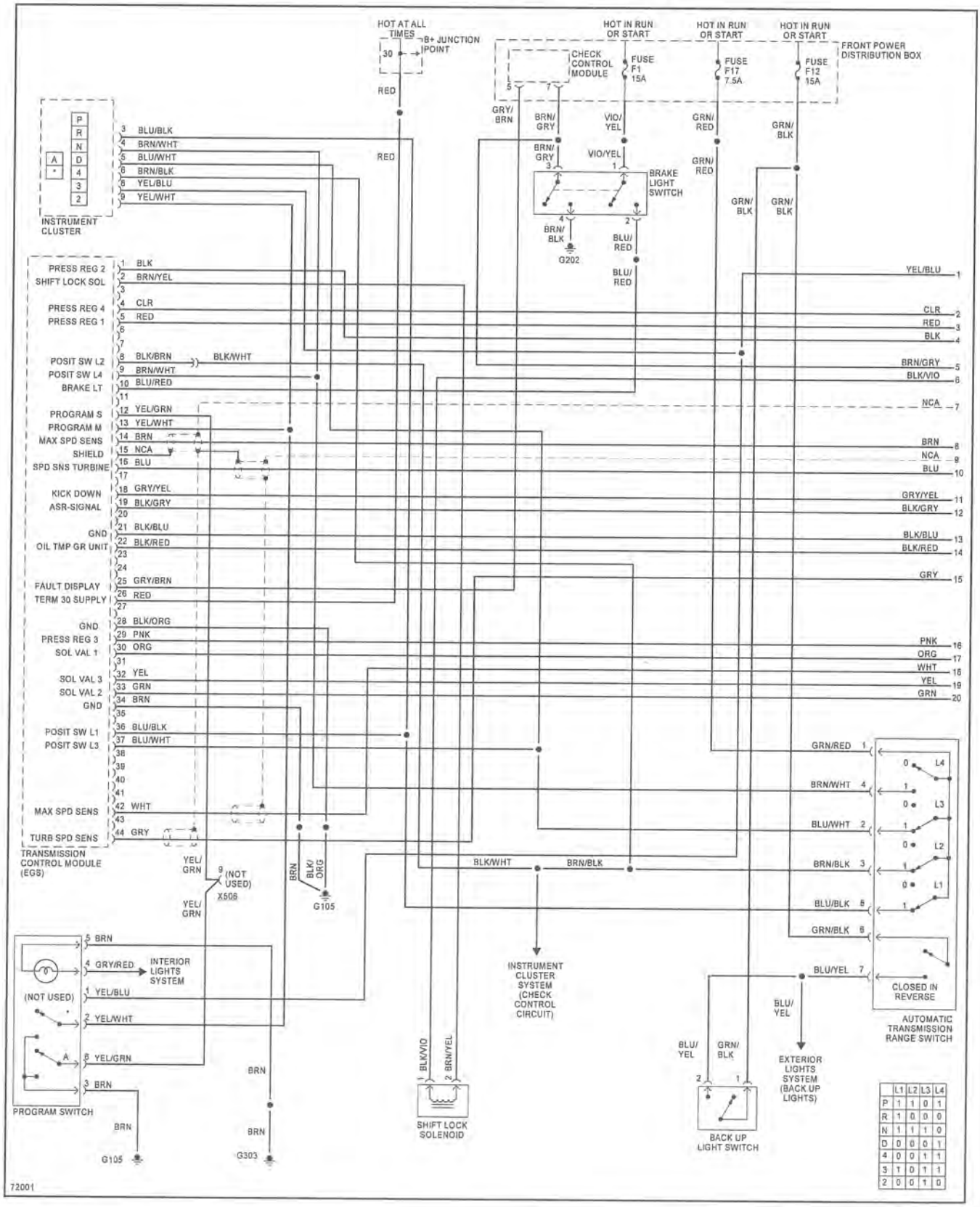
Transmission Electronics

1993-94 750iL w/ Adaptive Transmission



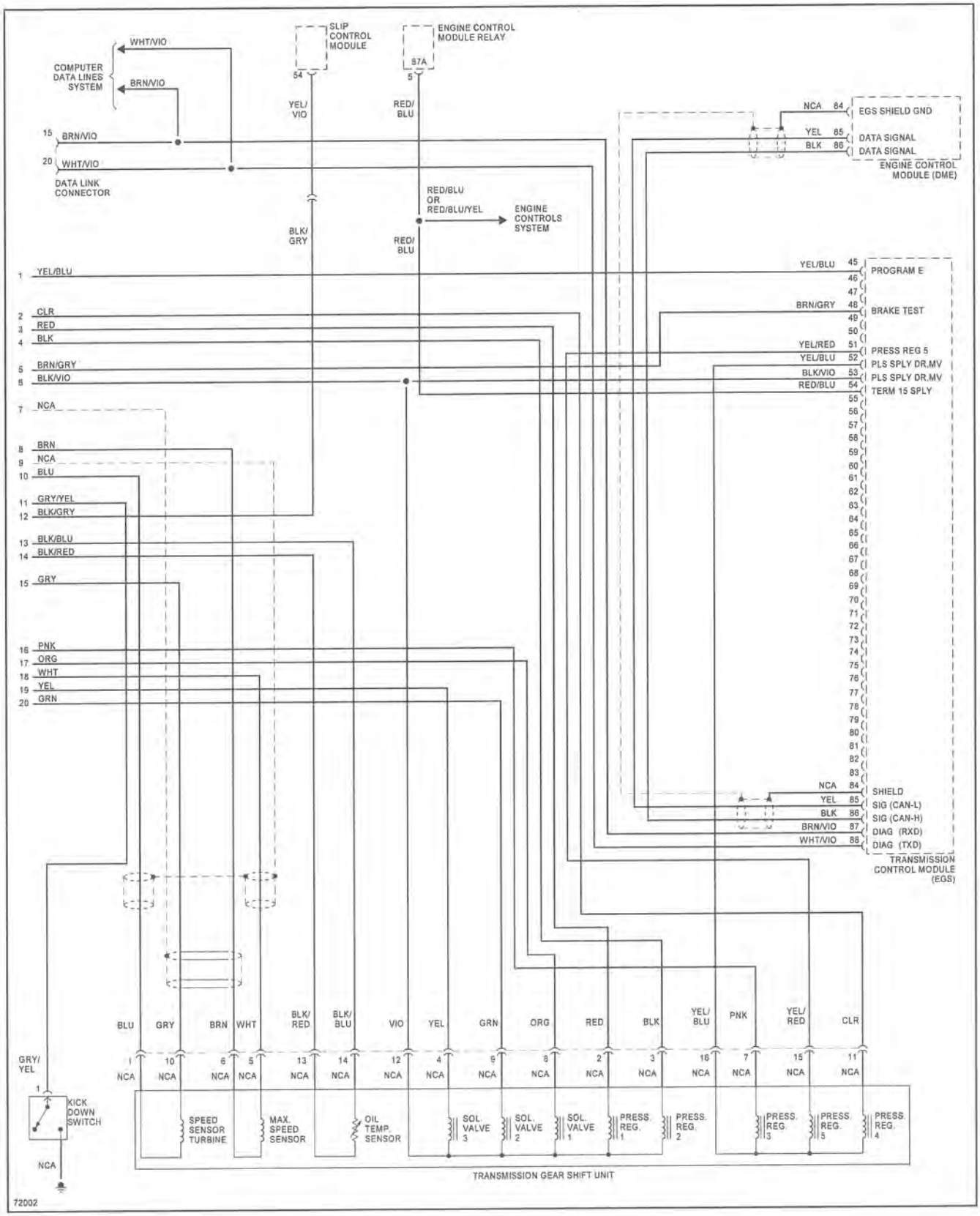
Transmission Electronics

1993-94 740i & 740iL (1 of 2)



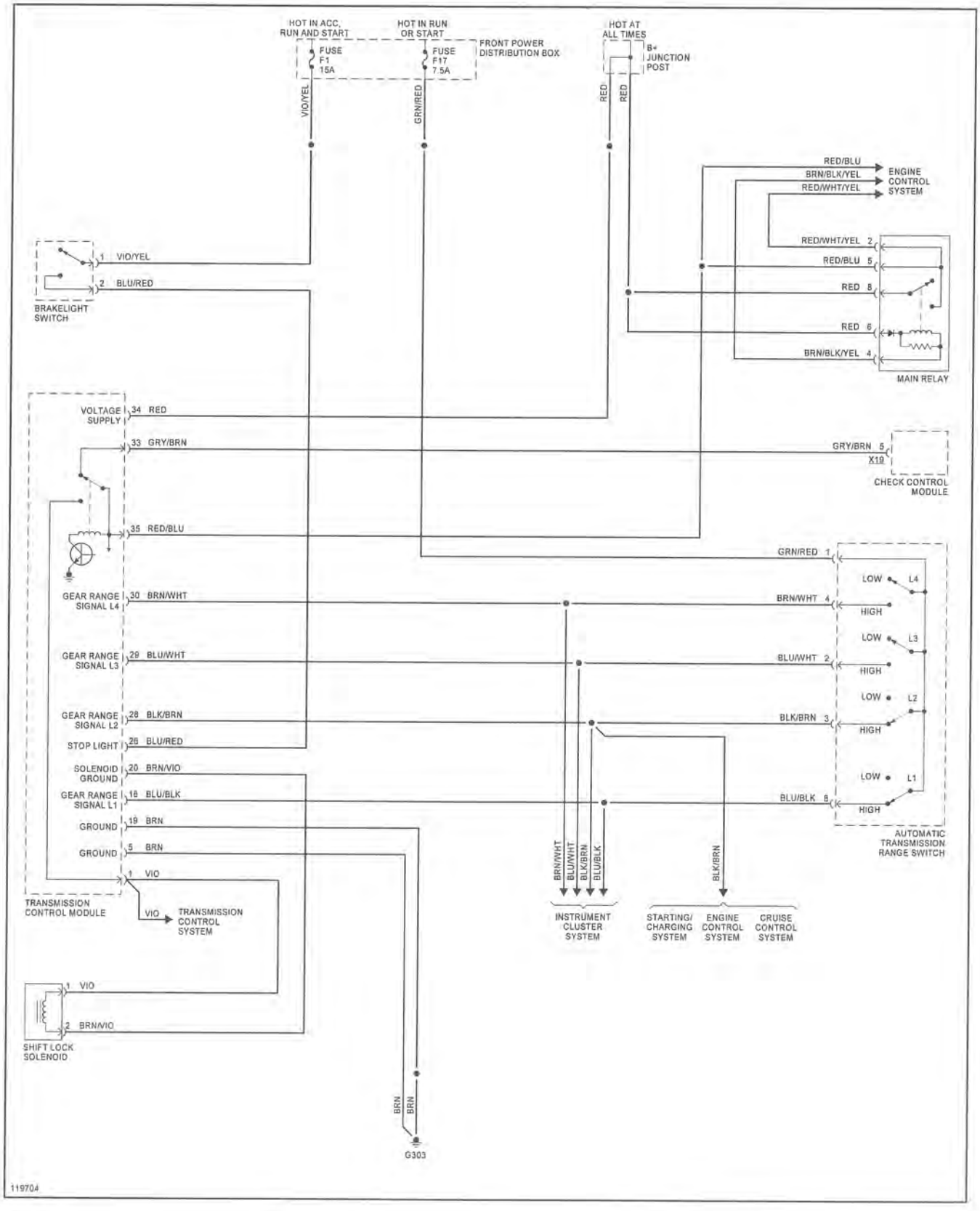
Transmission Electronics

1993-94 740i & 740iL (2 of 2)



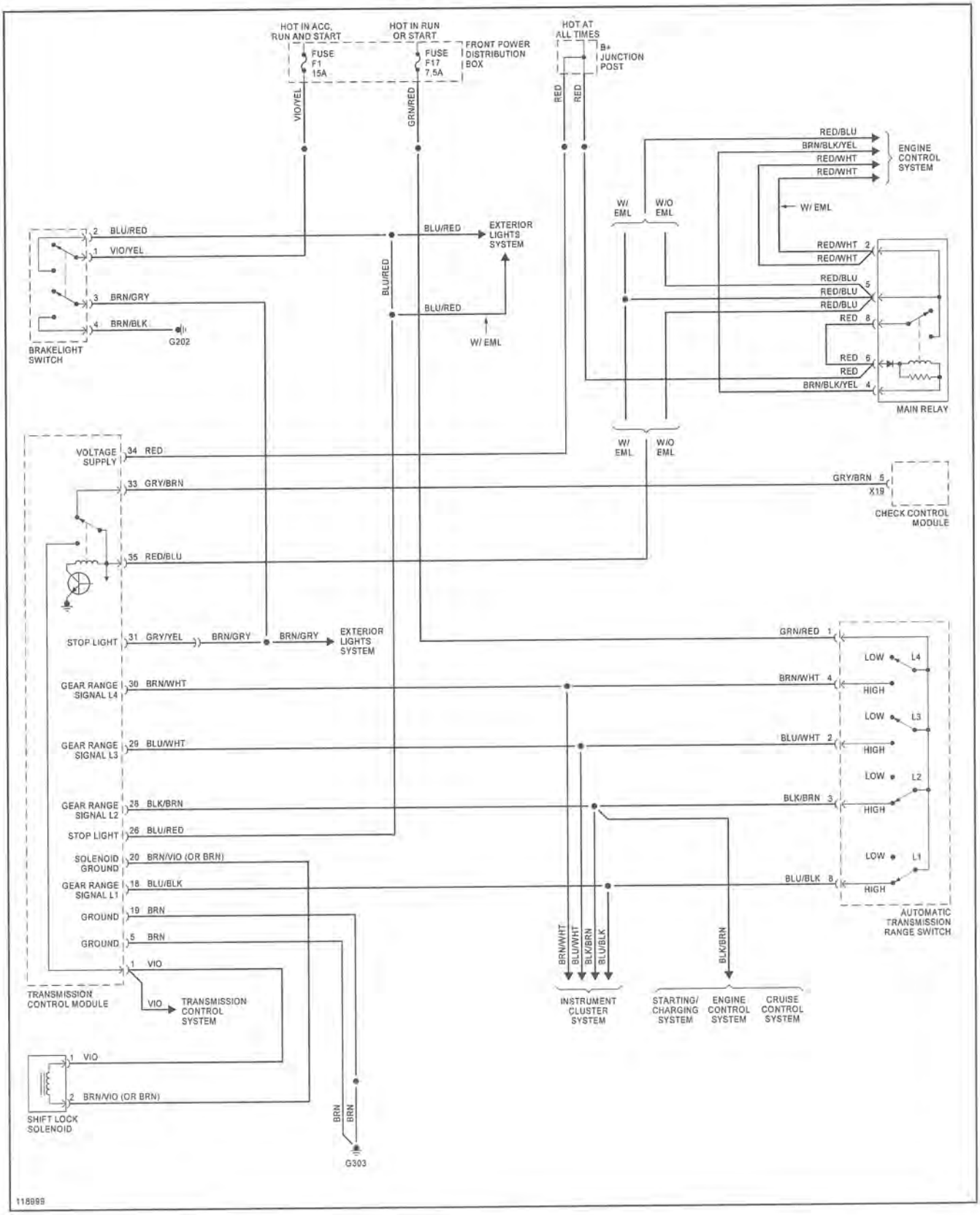
Shift Interlock

1991-94 750iL

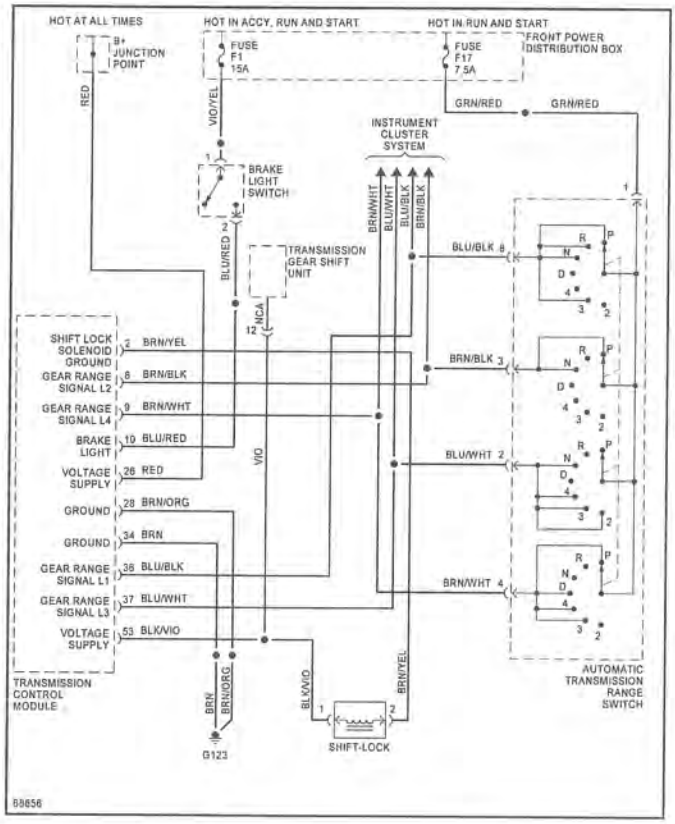


Shift Interlock

1992 735i & 735iL

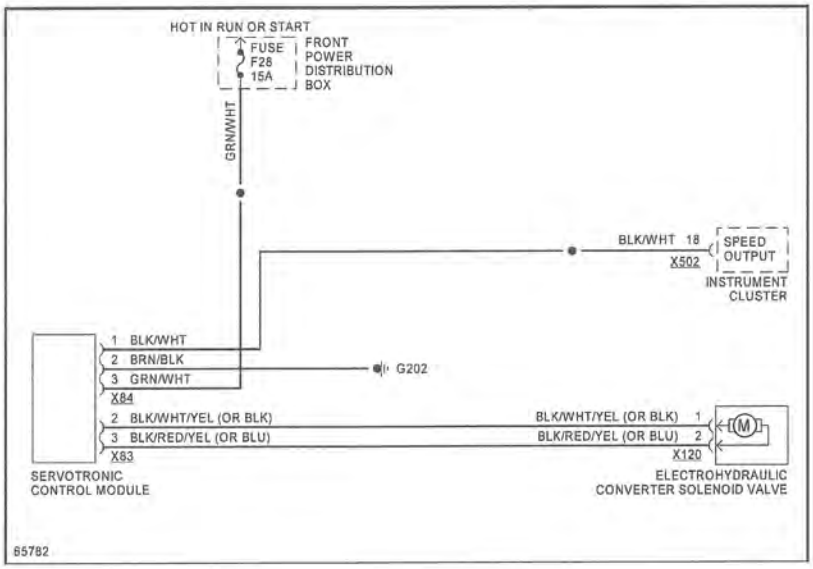


Shift Interlock



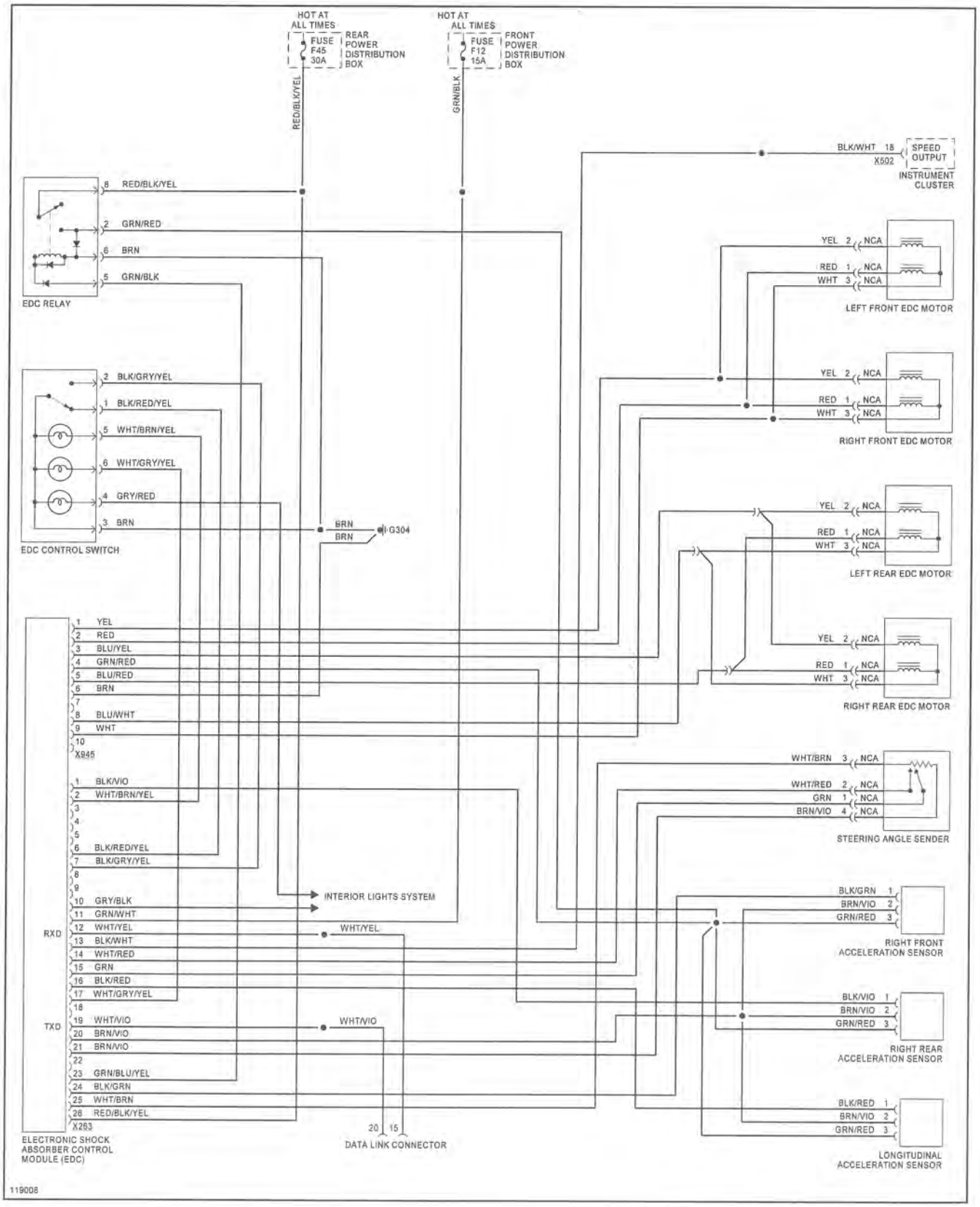
1993-94
740i & 740iL

Servotronic Steering (Electronic Power Steering)



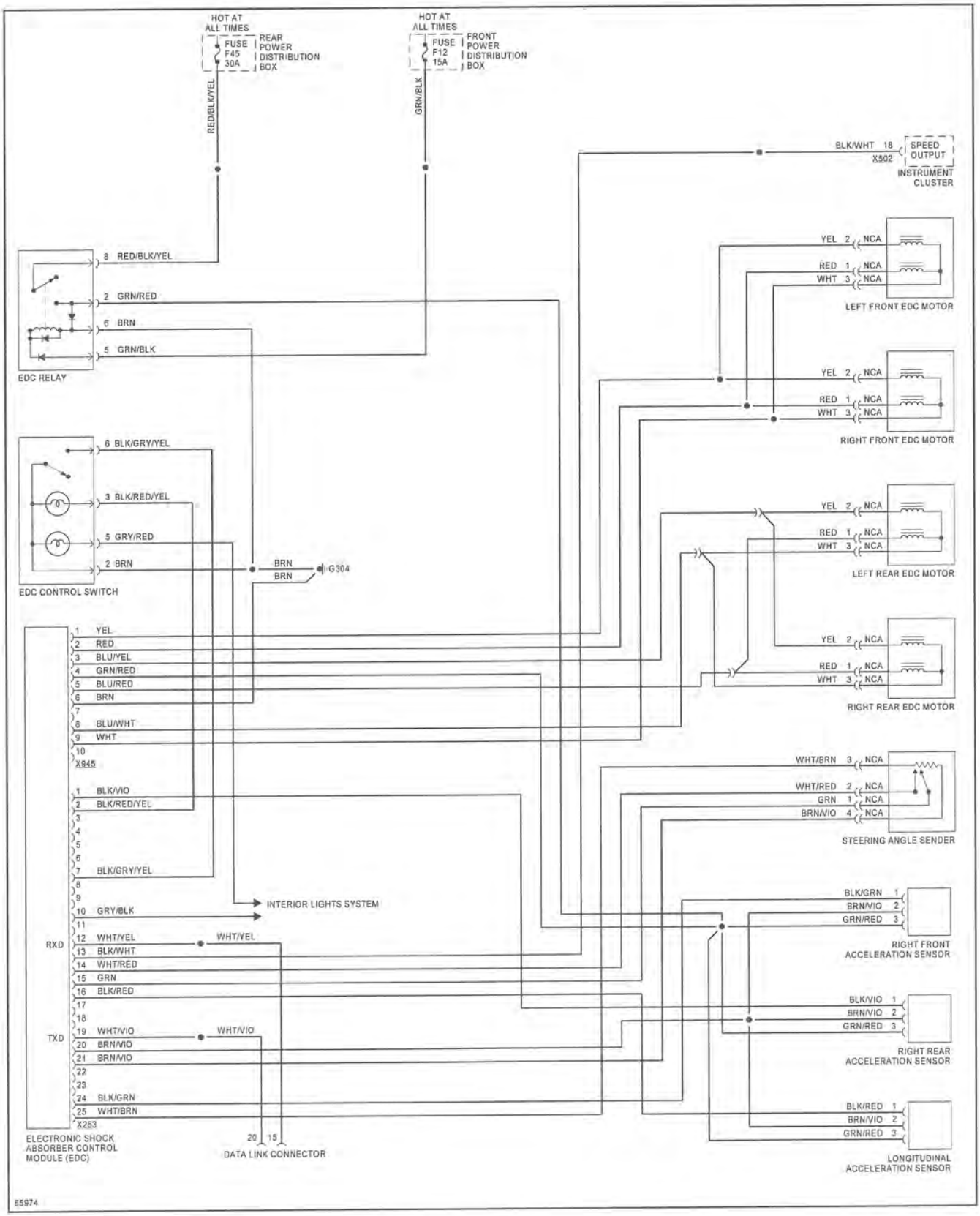
Electronic Damping Control

1991-92



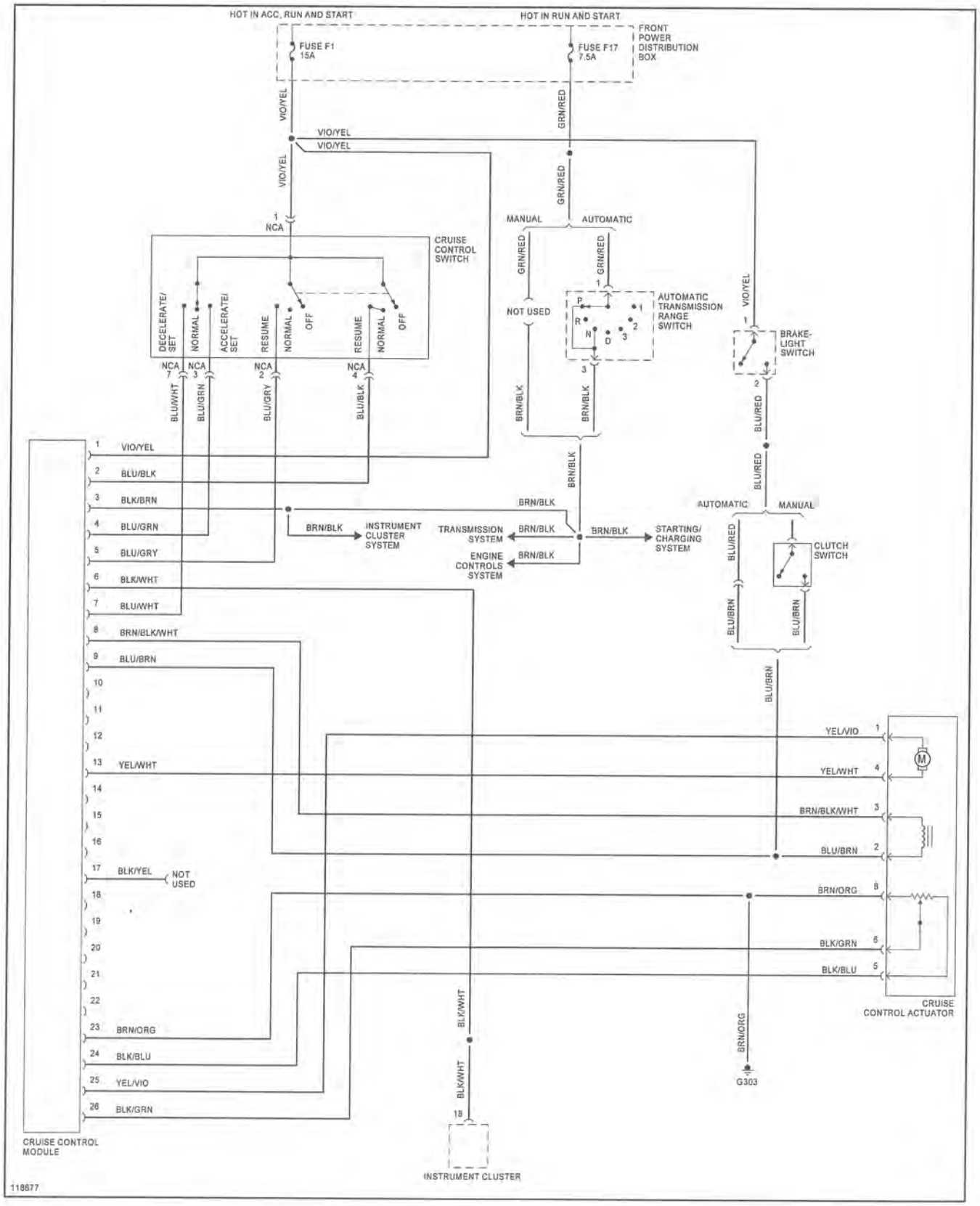
Electronic Damping Control

1993-94

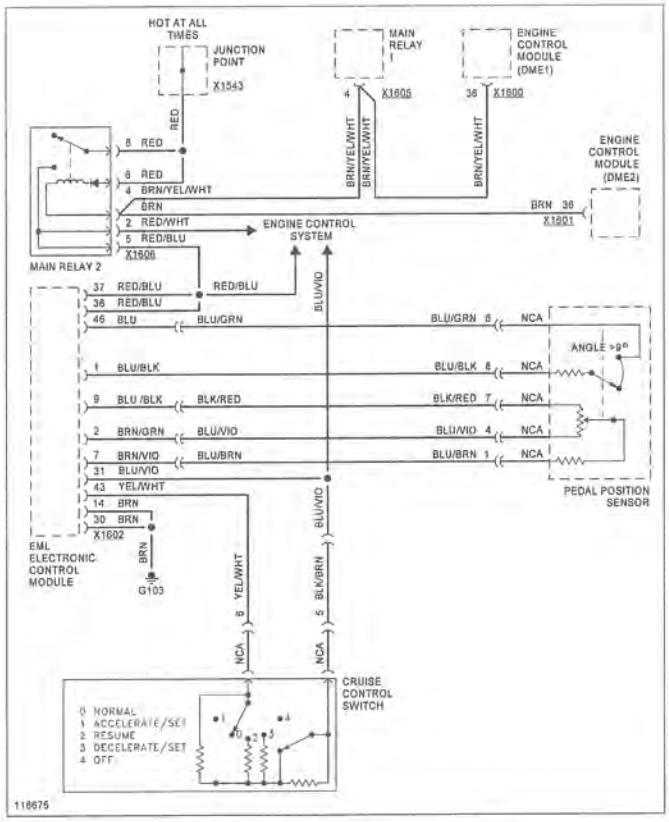


Cruise Control

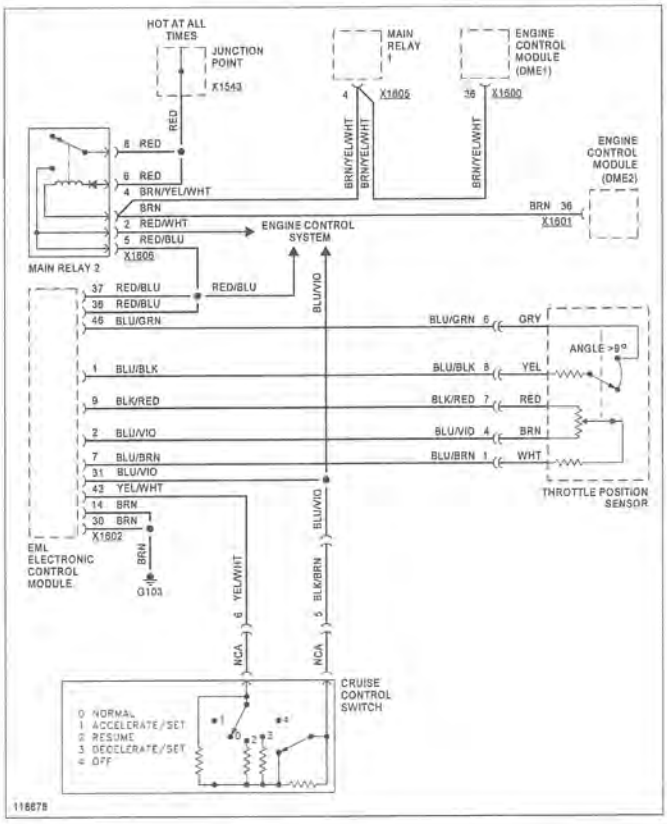
1988-92 w/ Tempomat



Cruise Control



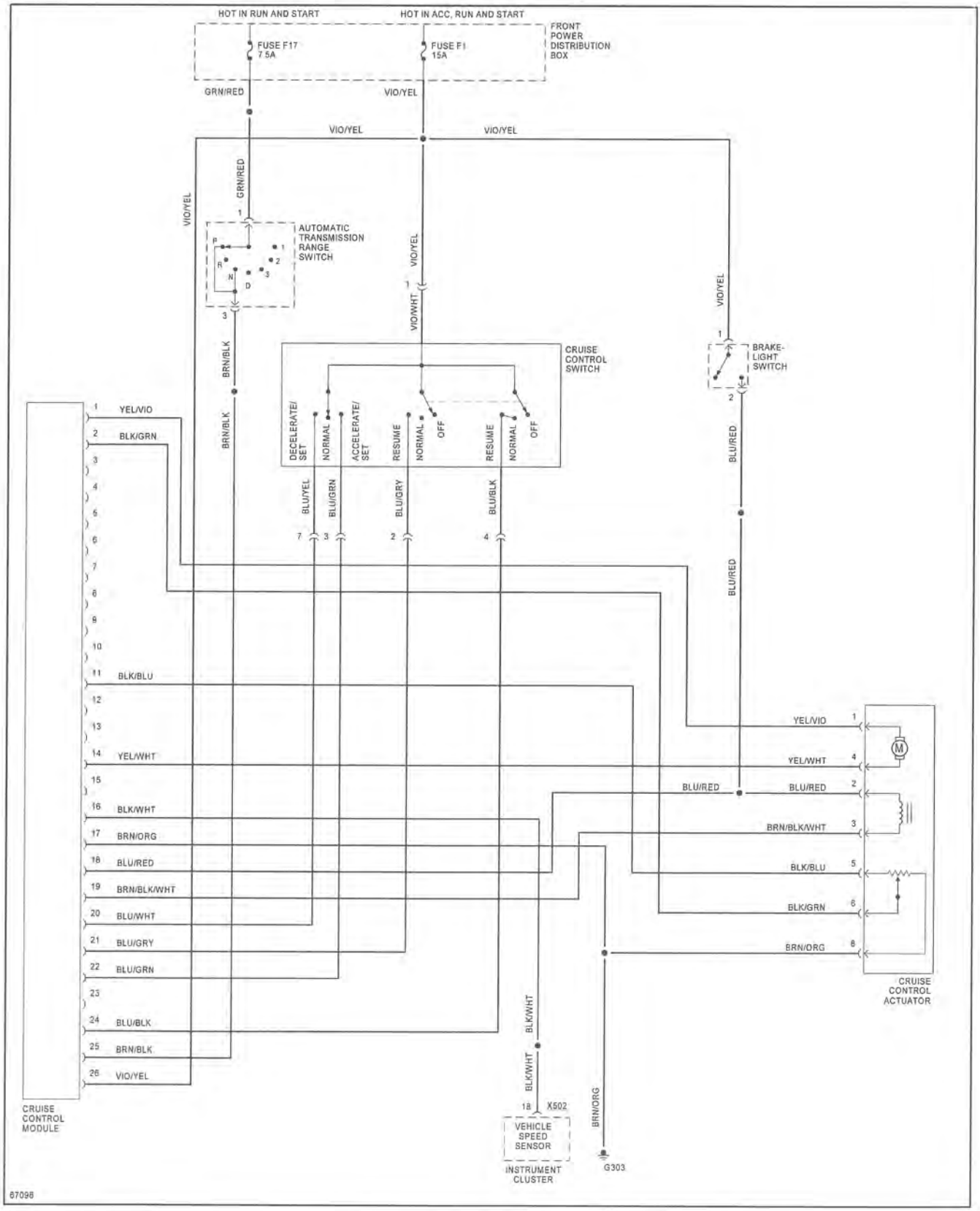
1988-90 w/ EML



1991-94 w/ EML

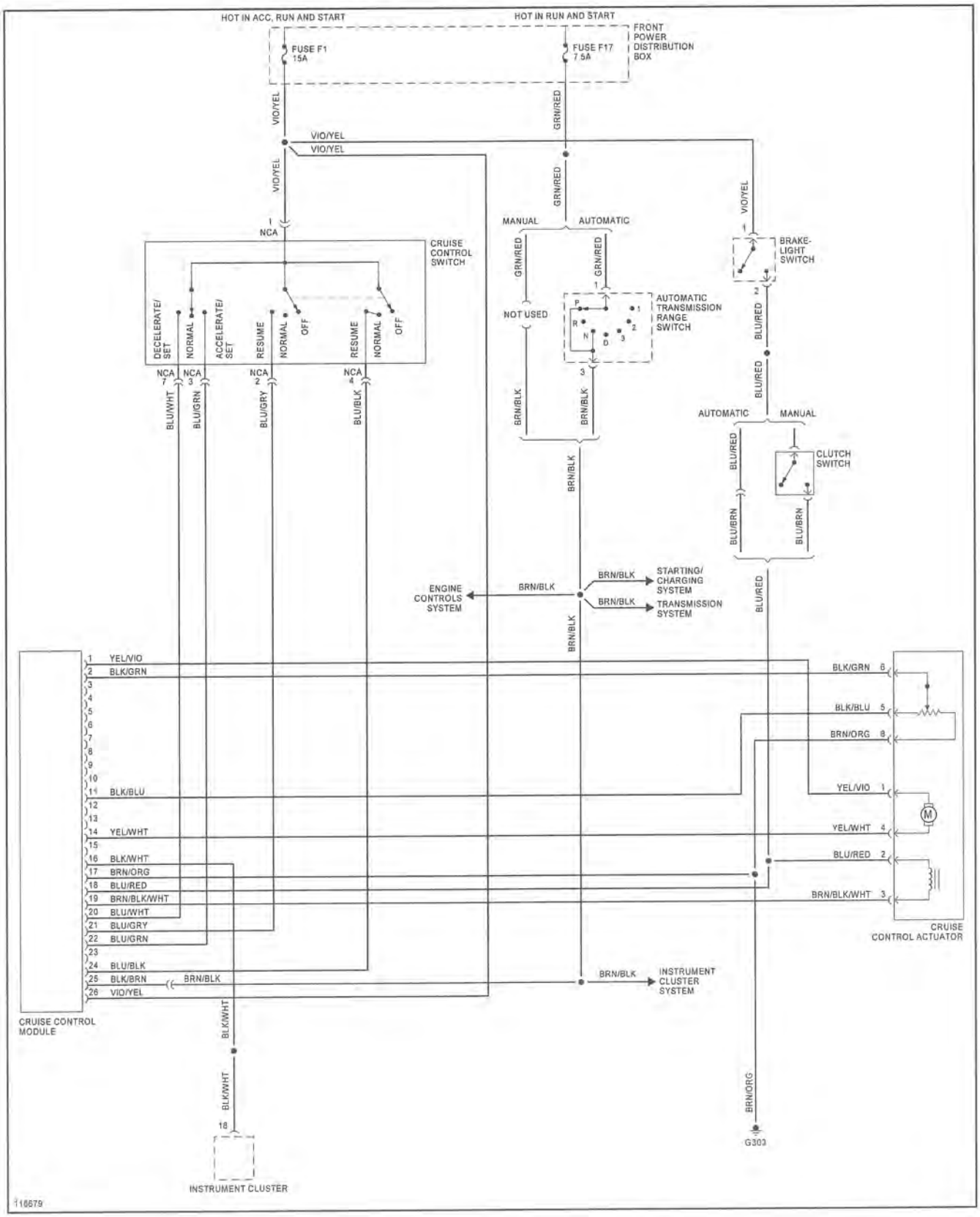
Cruise Control

1993-94 740i & 740iL



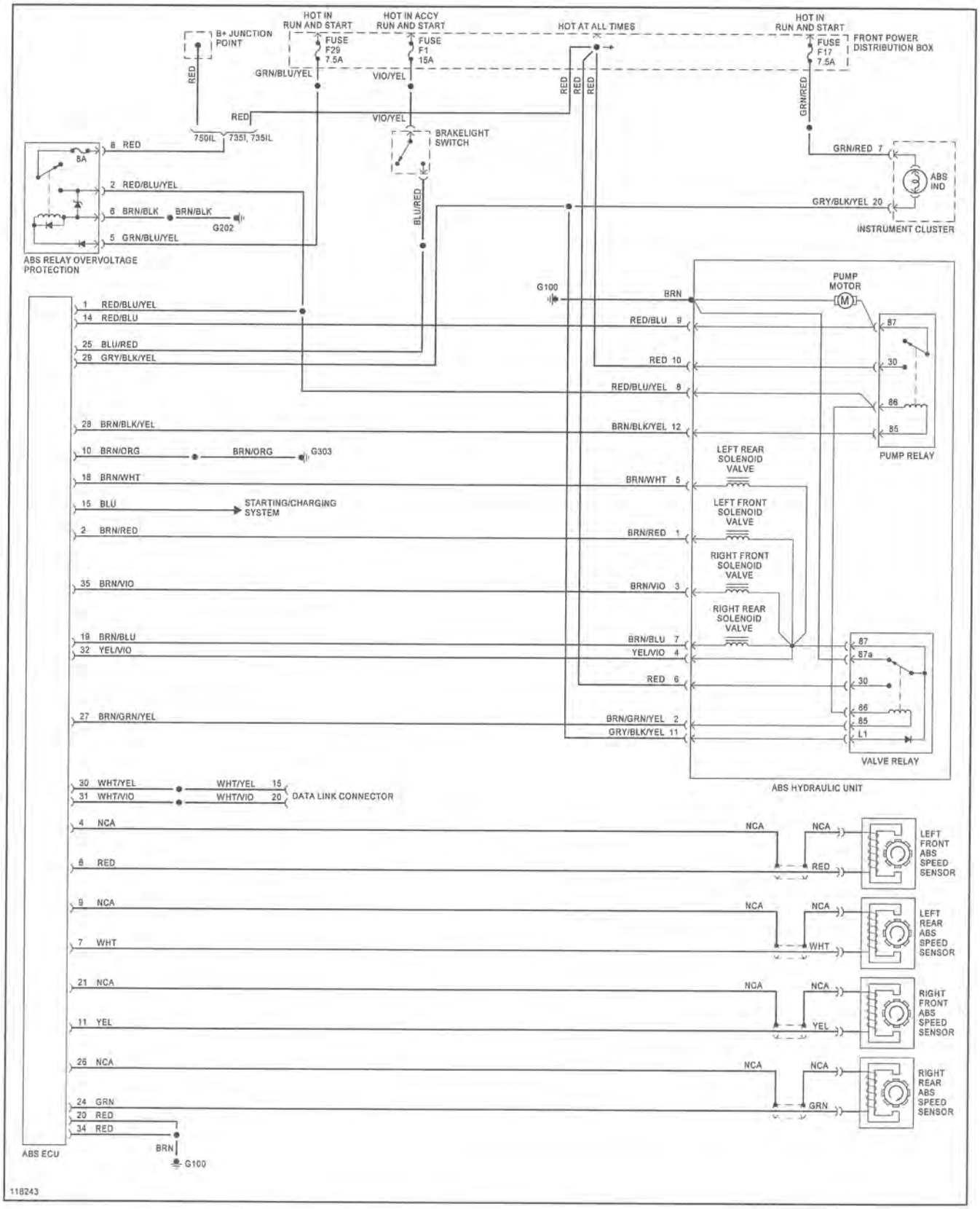
Cruise Control

1993-94 750iL w/ Tempomat



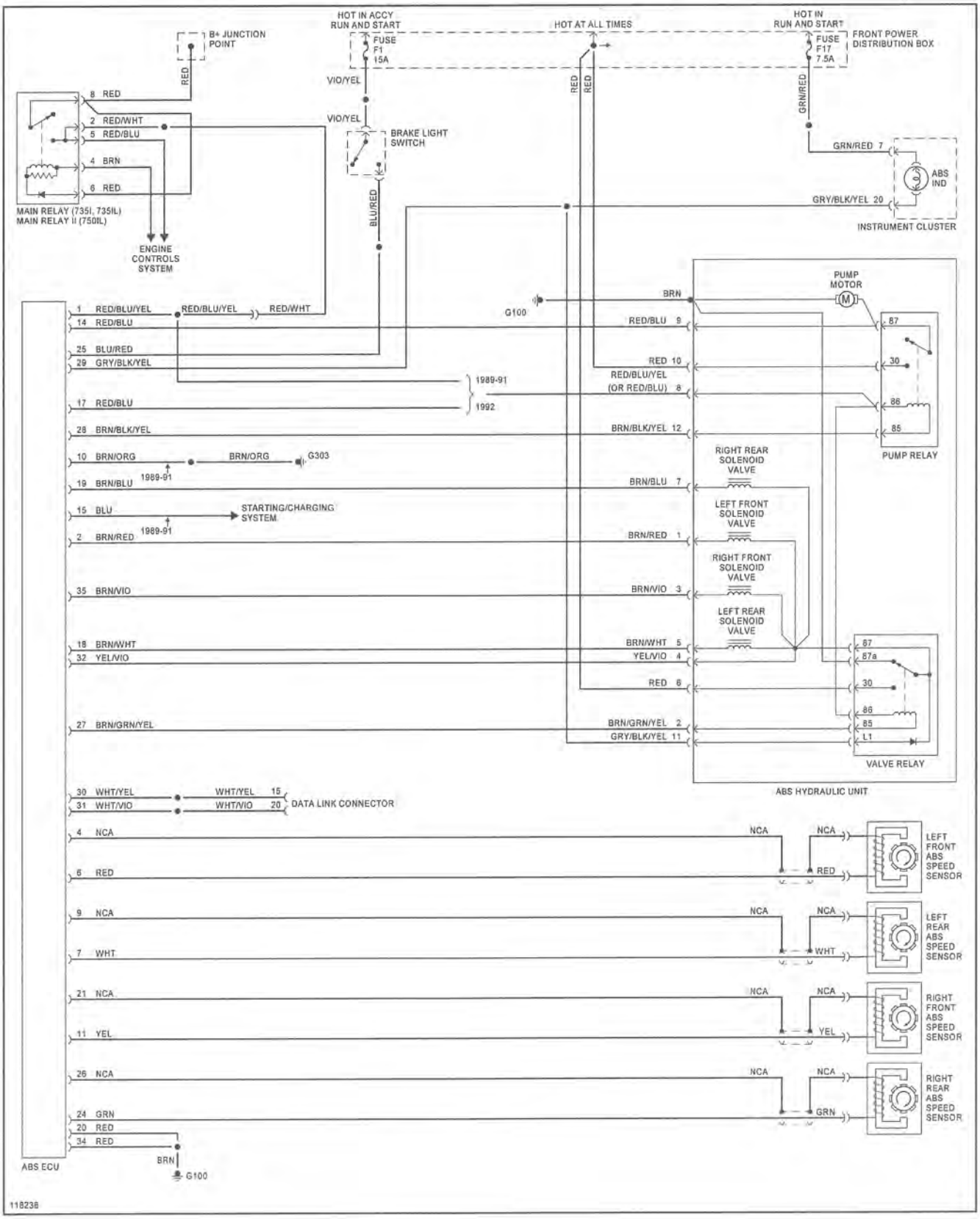
ABS

1988


HOT IN RUN AND START
HOT IN ACCY RUN AND START
HOT AT ALL TIMES
HOT IN RUN AND START
B+ JUNCTION POINT
FUSE F29 7.5A
FUSE F1 15A
FUSE F17 7.5A
FRONT POWER DISTRIBUTION BOX
RED
GRN/BLU/YEL
VIO/YEL
GRN/RED
750IL
735I, 735IL
BRAKELIGHT SWITCH
8 RED
6A
2 RED/BLU/YEL
6 BRN/BLK
BRN/BLK
G202
5 GRN/BLU/YEL
ABS RELAY OVERVOLTAGE PROTECTION
BLU/RED
GRN/RED 7
ABS IND
GRY/BLK/YEL 20
INSTRUMENT CLUSTER
G100
BRN
PUMP MOTOR
1 RED/BLU/YEL
14 RED/BLU
RED/BLU 9
25 BLU/RED
29 GRY/BLK/YEL
RED 10
RED/BLU/YEL 8
28 BRN/BLK/YEL
BRN/BLK/YEL 12
10 BRN/ORG
BRN/ORG
G303
18 BRN/WHT
BRN/WHT 5
15 BLU
STARTING/CHARGING SYSTEM
2 BRN/RED
BRN/RED 1
35 BRN/VIO
BRN/VIO 3
LEFT REAR SOLENOID VALVE
LEFT FRONT SOLENOID VALVE
RIGHT FRONT SOLENOID VALVE
RIGHT REAR SOLENOID VALVE
PUMP RELAY
VALVE RELAY
ABS HYDRAULIC UNIT
18 BRN/BLU
32 YEL/VIO
BRN/BLU 7
YEL/VIO 4
RED 6
27 BRN/GRN/YEL
BRN/GRN/YEL 2
GRY/BLK/YEL 11
30 WHT/YEL
31 WHT/VIO
WHT/YEL 15
WHT/VIO 20
DATA LINK CONNECTOR
4 NCA
6 RED
9 NCA
7 WHT
21 NCA
11 YEL
26 NCA
24 GRN
20 RED
34 RED
NCA
RED
WHT
YEL
GRN
LEFT FRONT ABS SPEED SENSOR
LEFT REAR ABS SPEED SENSOR
RIGHT FRONT ABS SPEED SENSOR
RIGHT REAR ABS SPEED SENSOR
ABS ECU
BRN
G100
118243

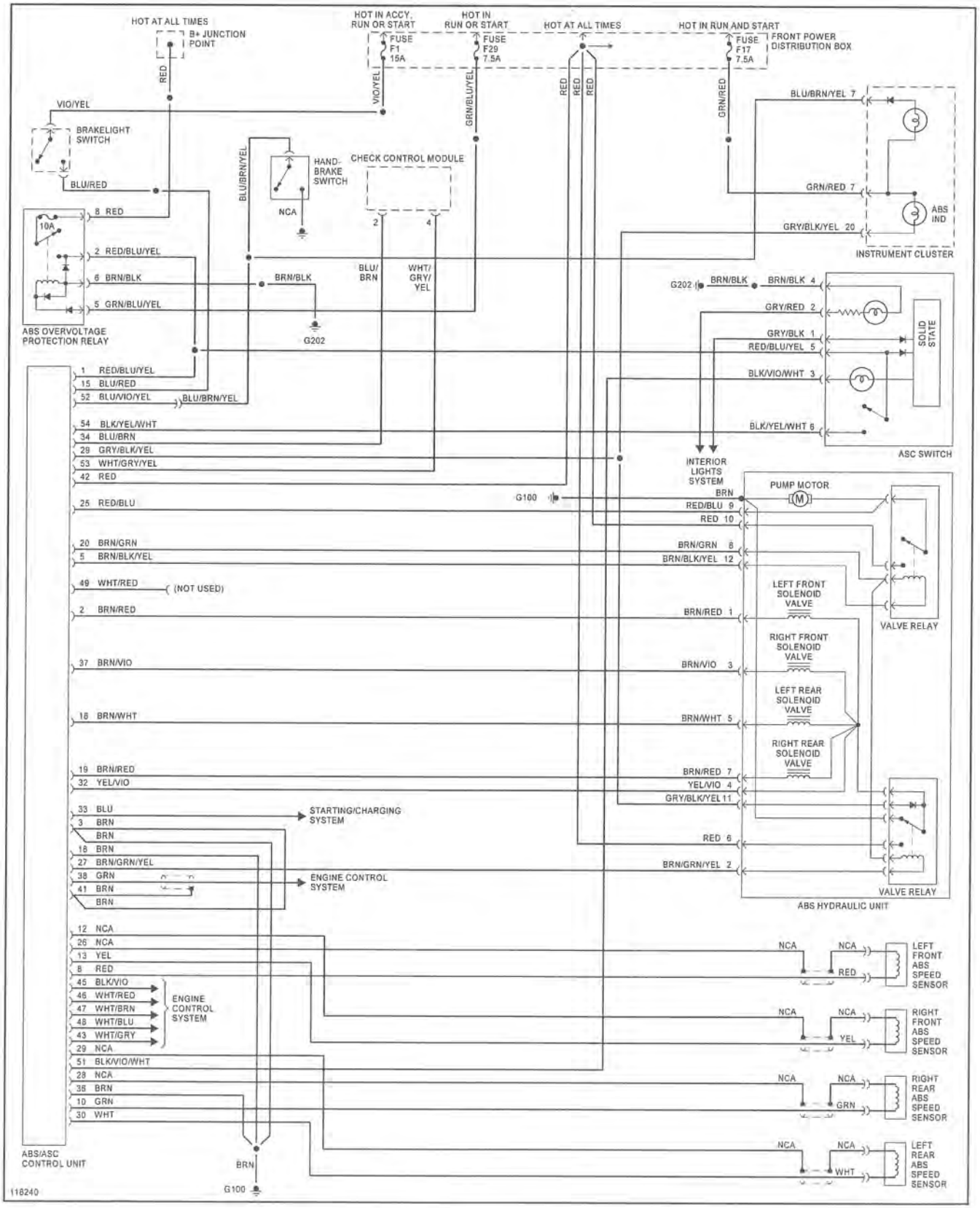
ABS

1989-1990 735i/iL, 750iL 1991-92 735i/iL w/o ASC



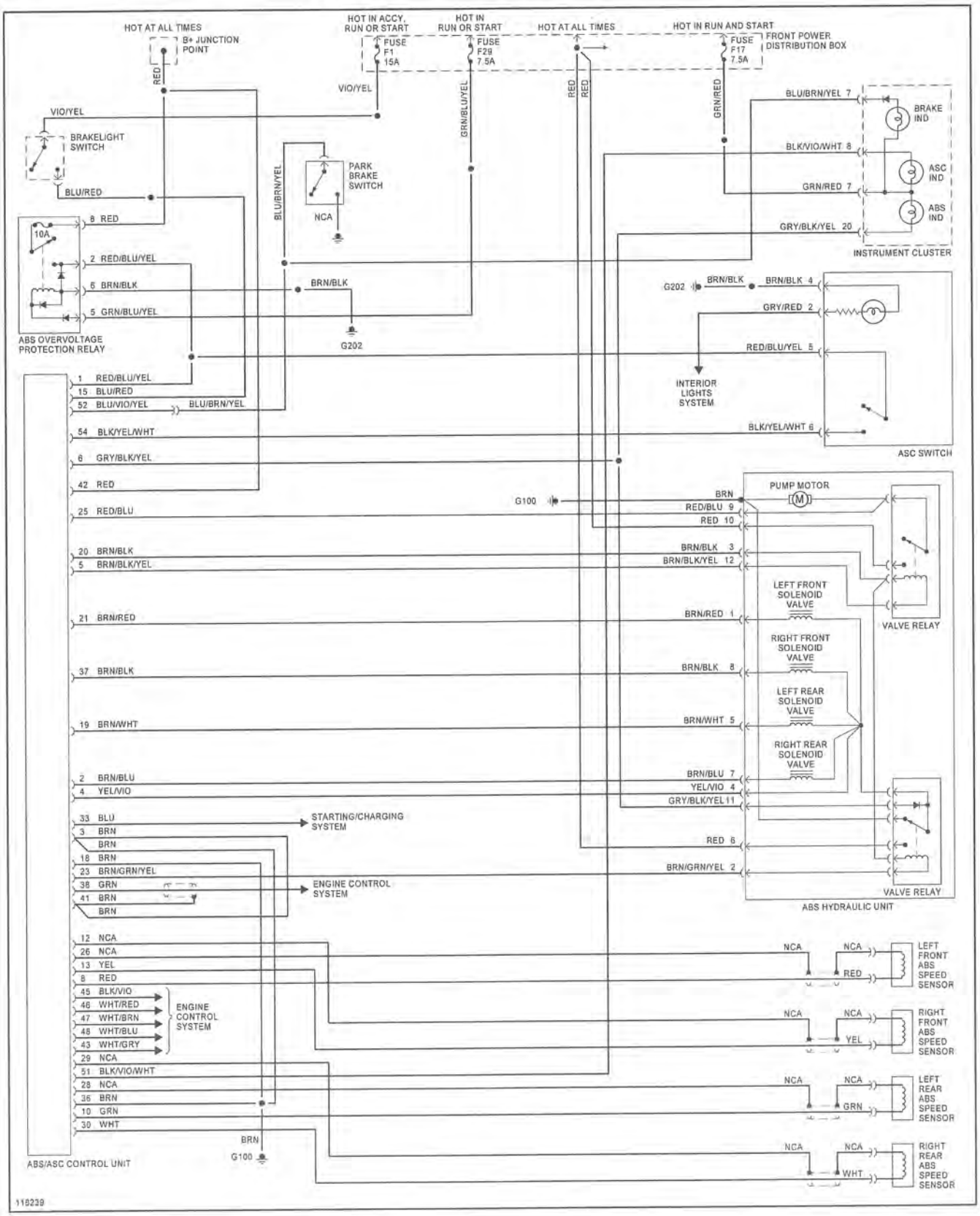
ABS

1990 750iL



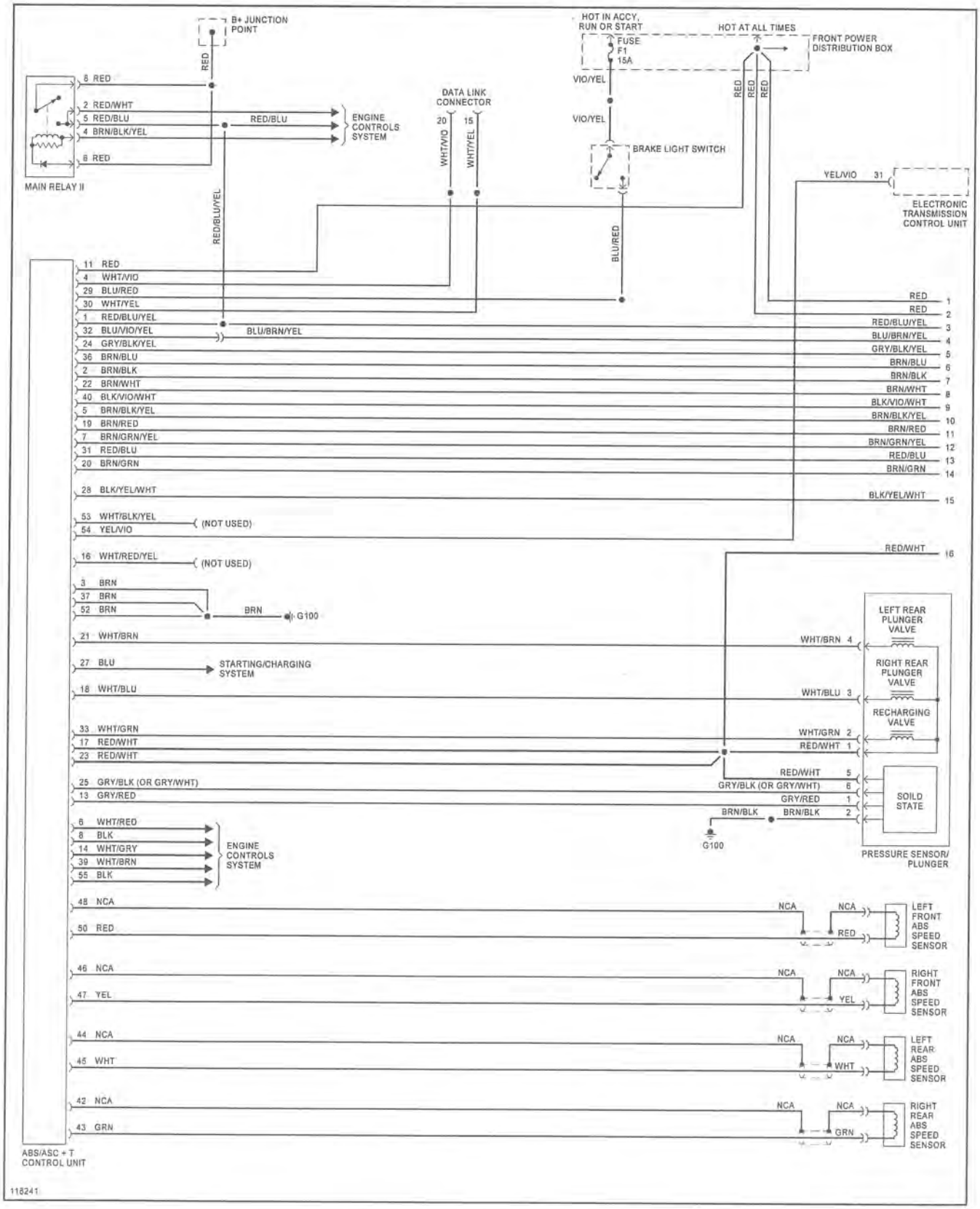
ABS

1991-92 735i & 735iL w/ ASC



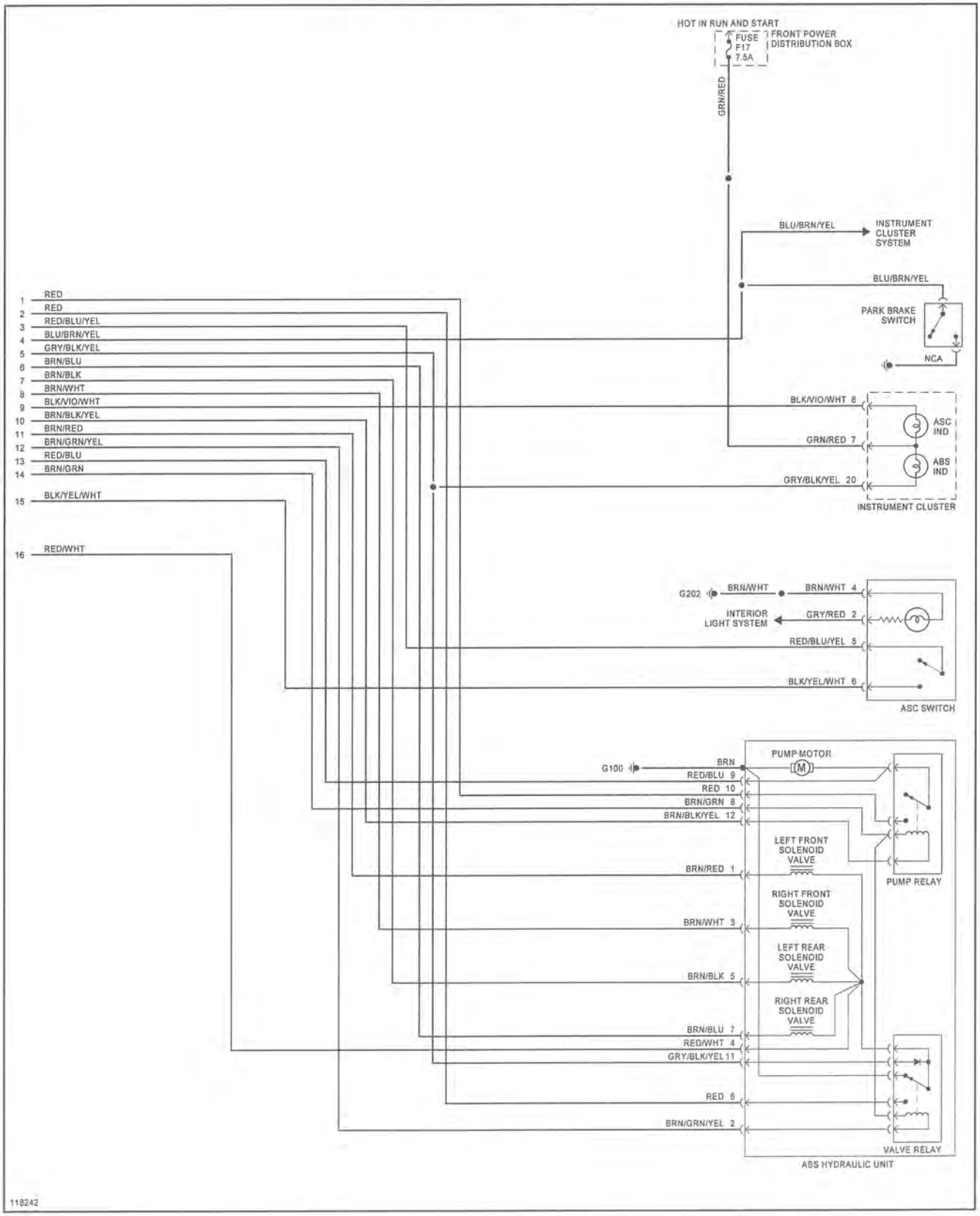
ABS

1991-92 750iL (1 of 2)



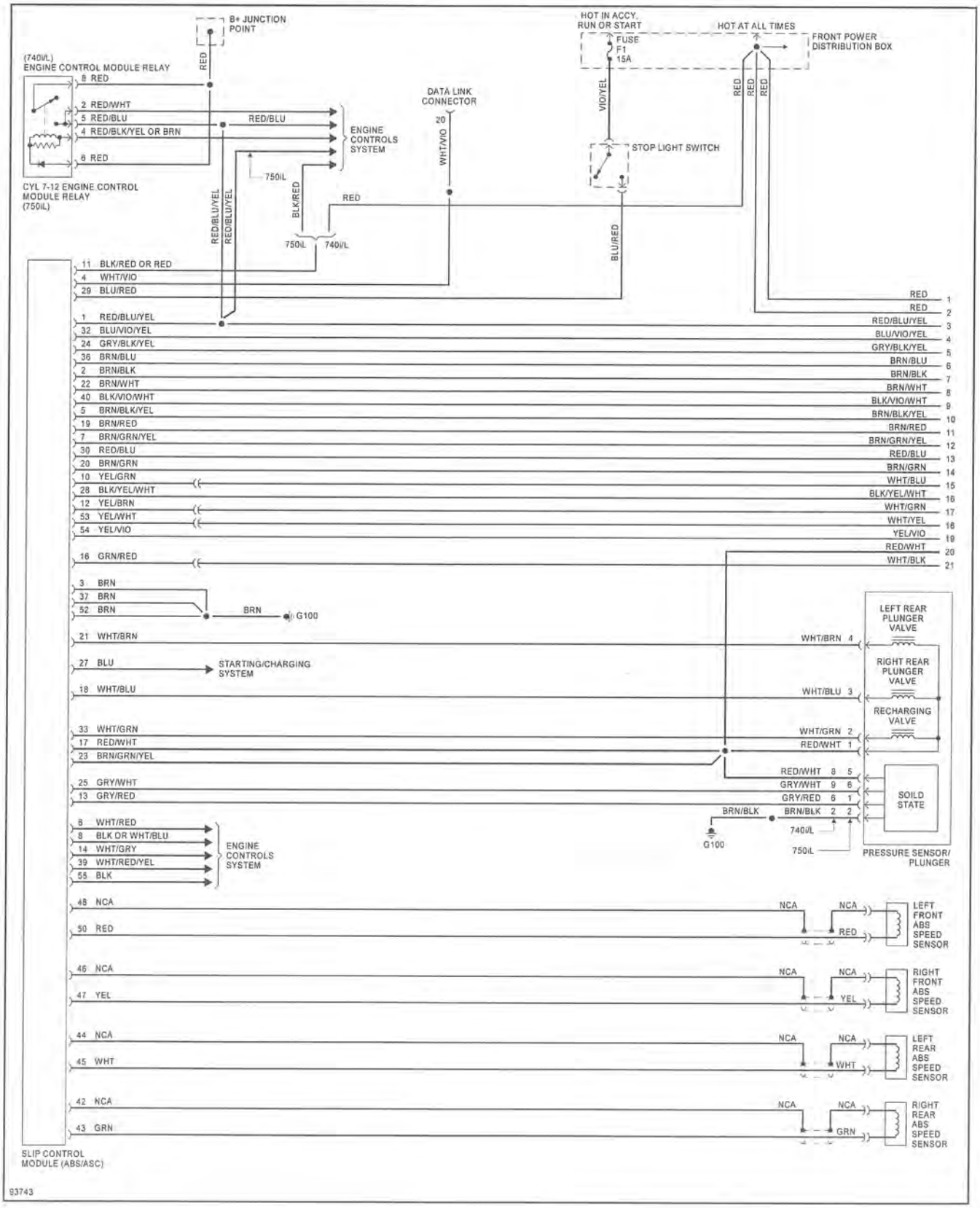
ABS

1991-92 750iL (2 of 2)



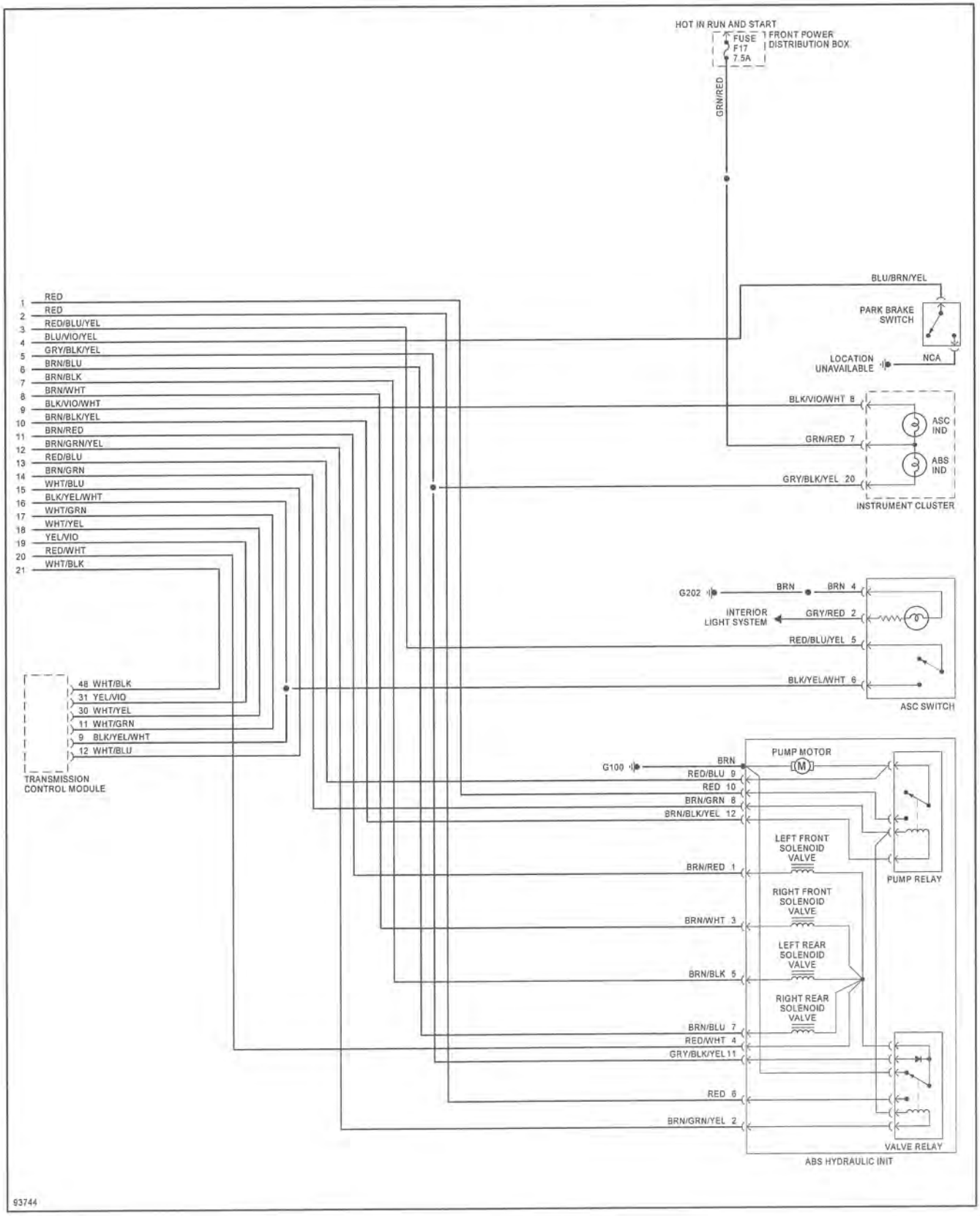
ABS

1993-94 w/ Traction Control (1 of 2)



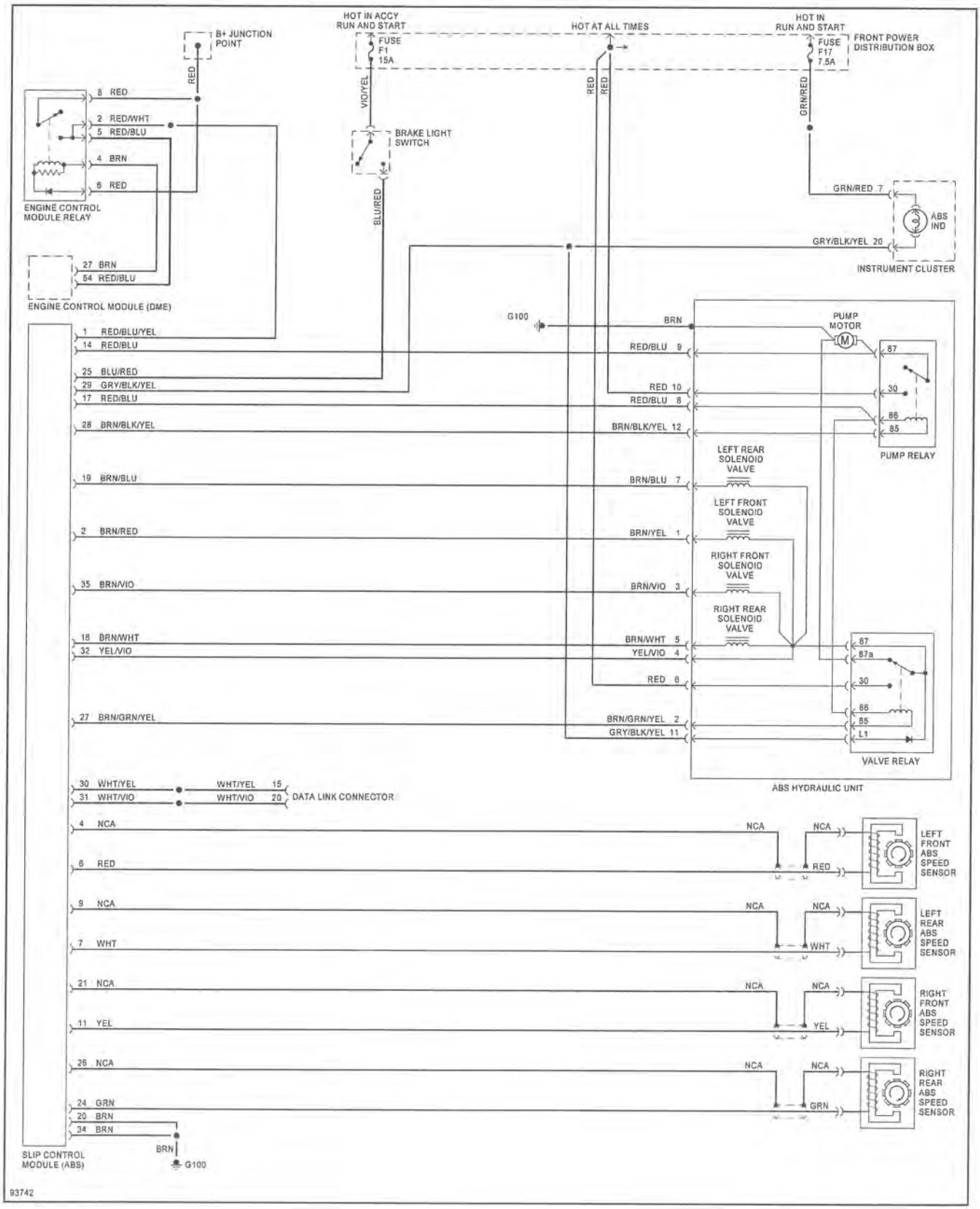
ABS

1993-94 w/ Traction Control (2 of 2)



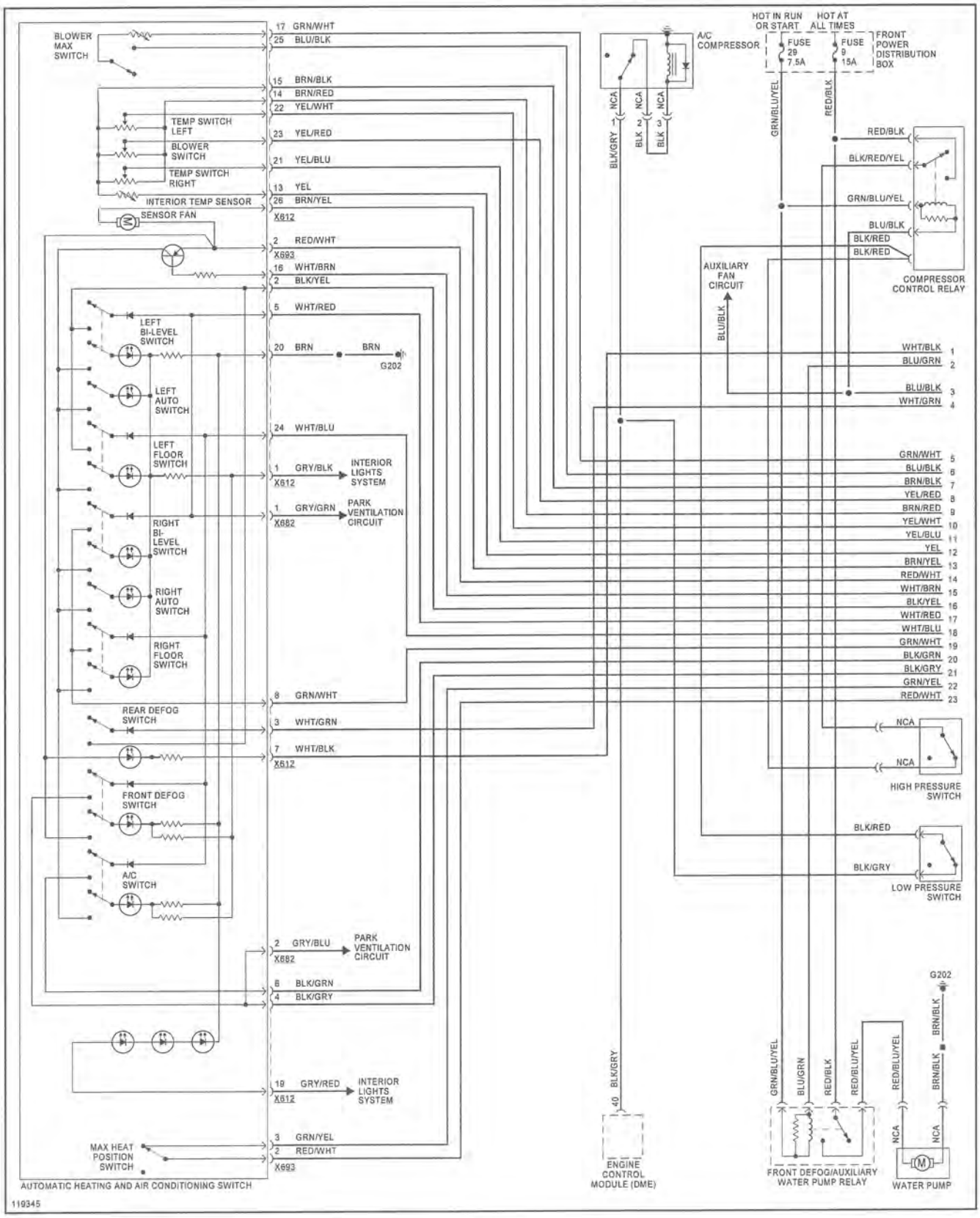
ABS

1993-94 w/o Traction Control



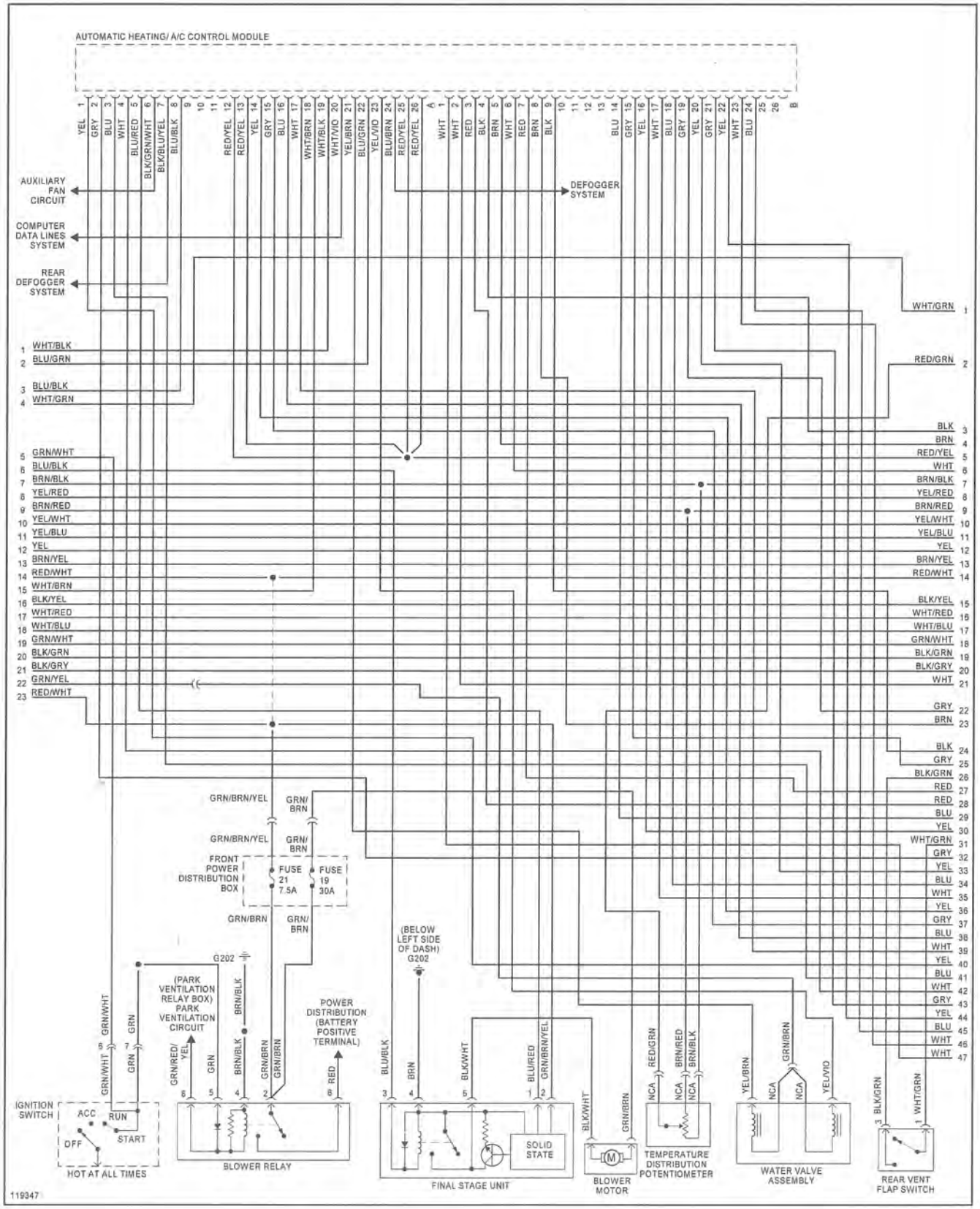
Air Conditioning & Heating

1988 735i & 735iL (1 of 3)



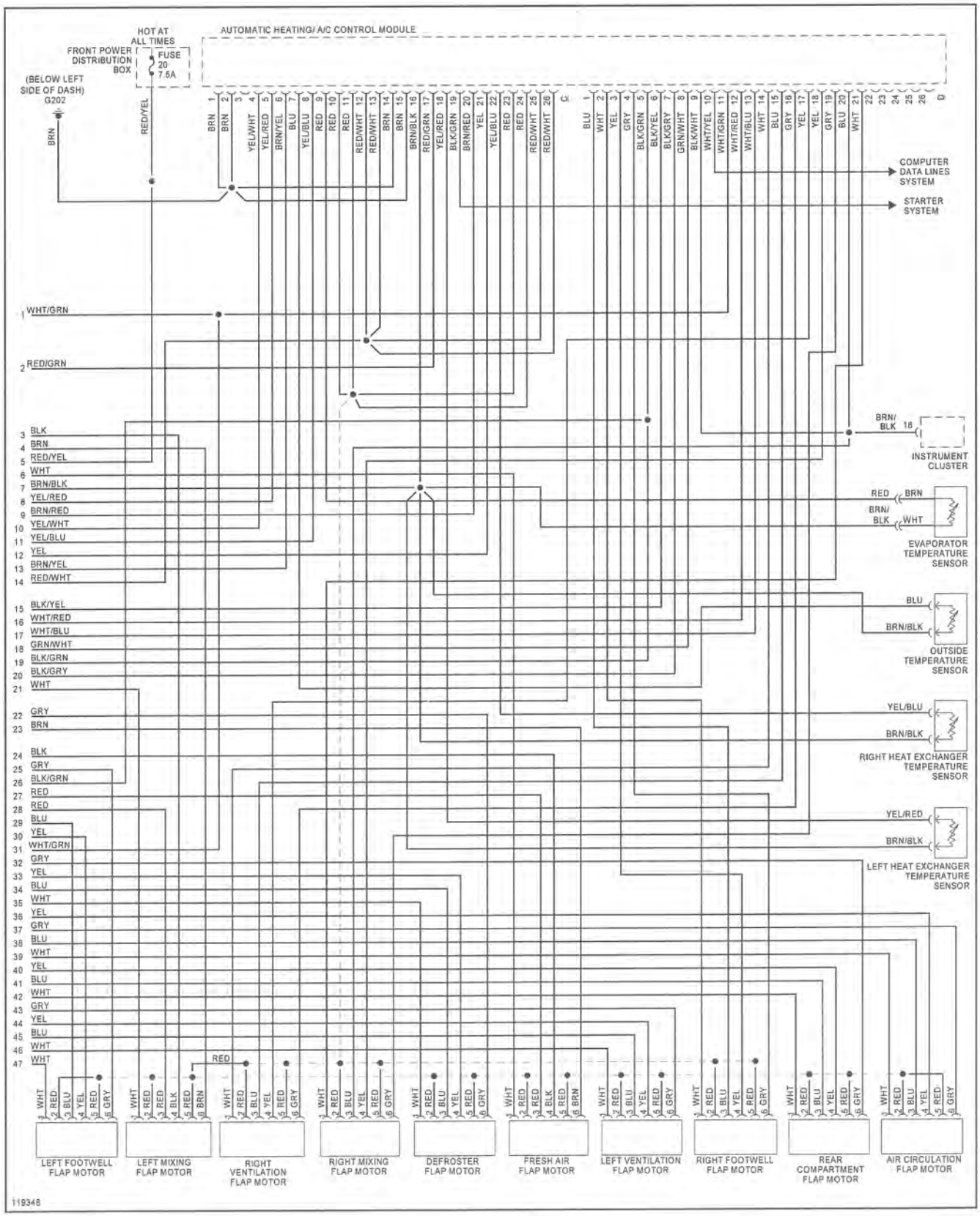
Air Conditioning & Heating

1988 735i & 735iL (2 of 3)



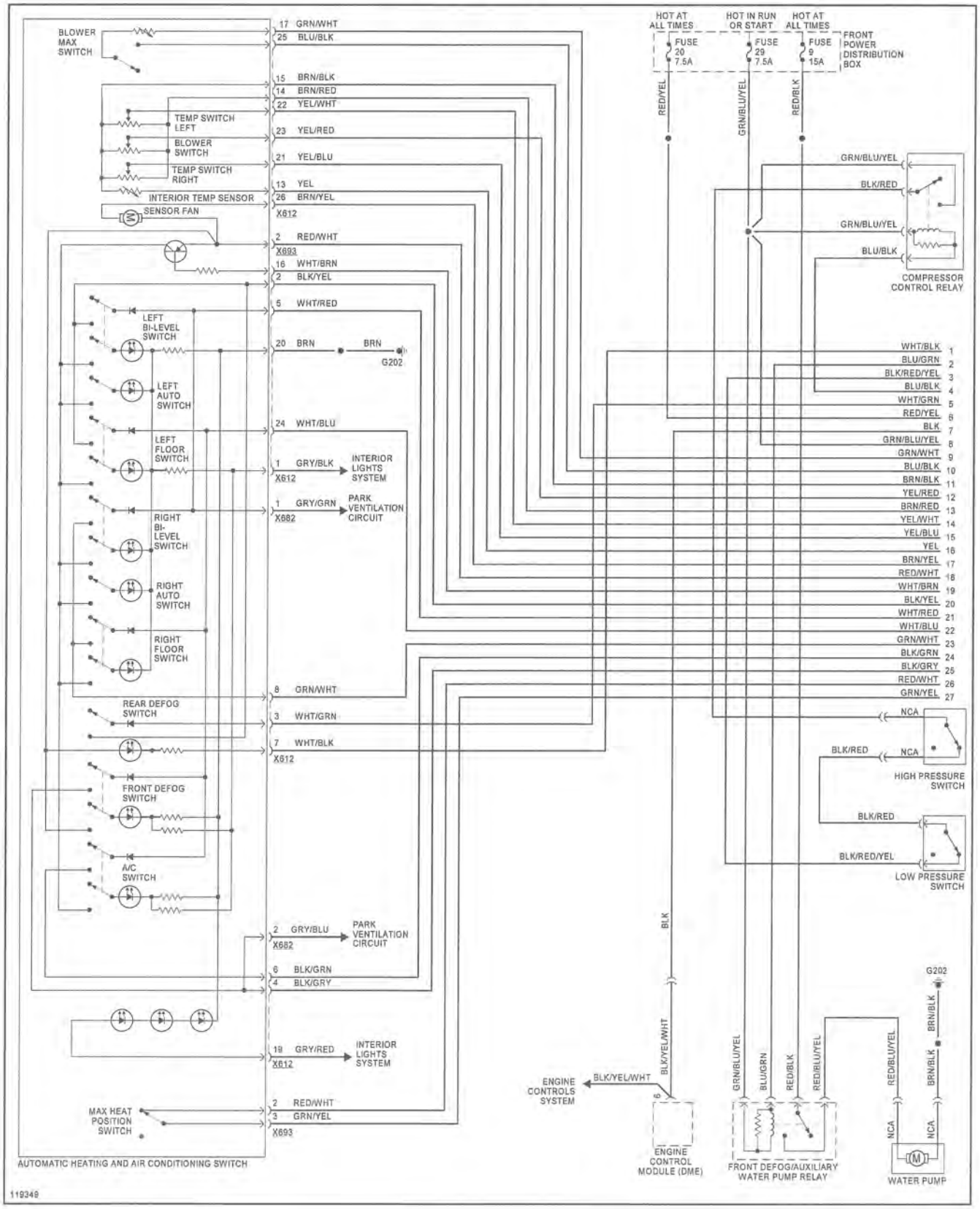
Air Conditioning & Heating

1988 735i & 735iL (3 of 3)



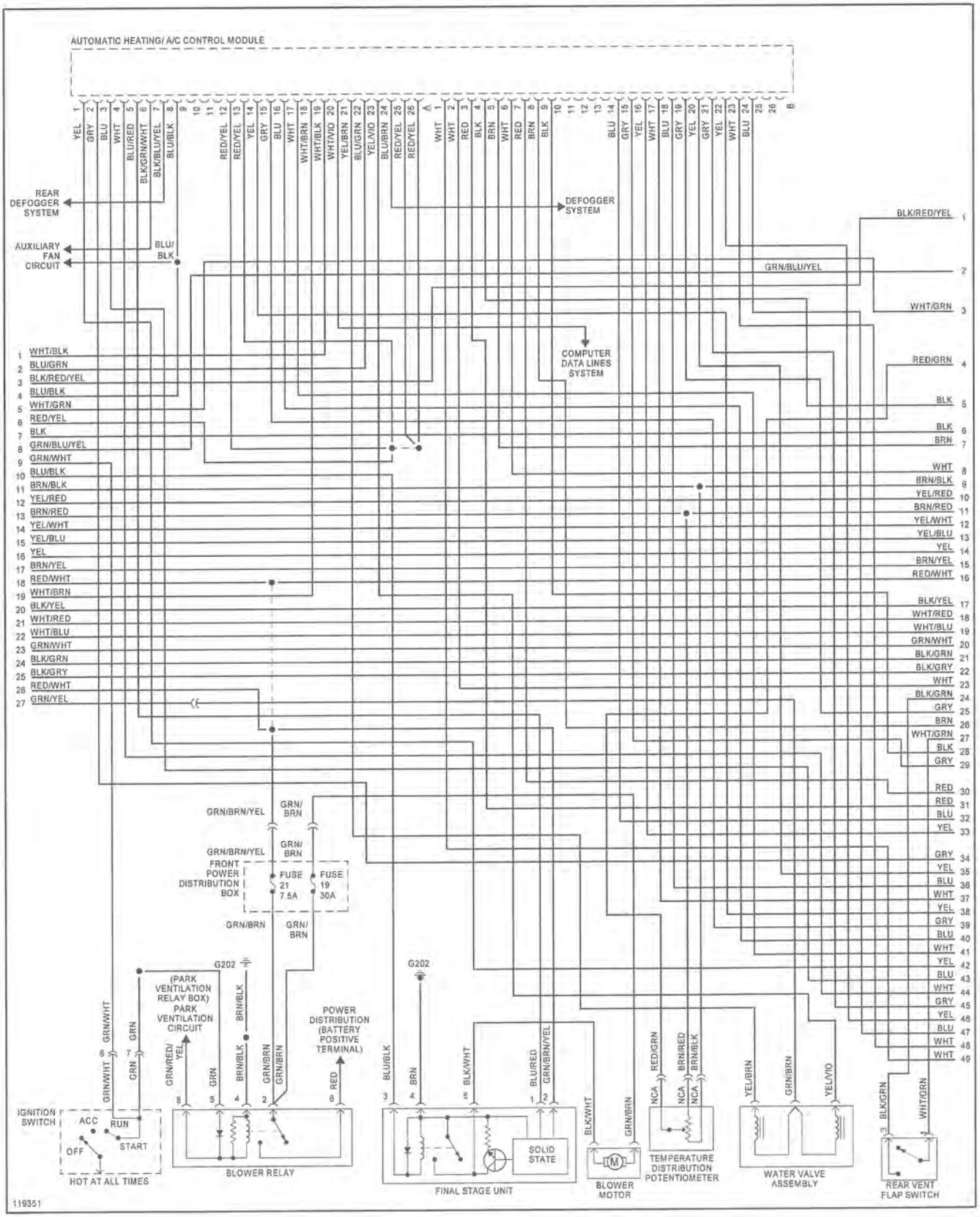
Air Conditioning & Heating

1988 750iL (1 of 3)



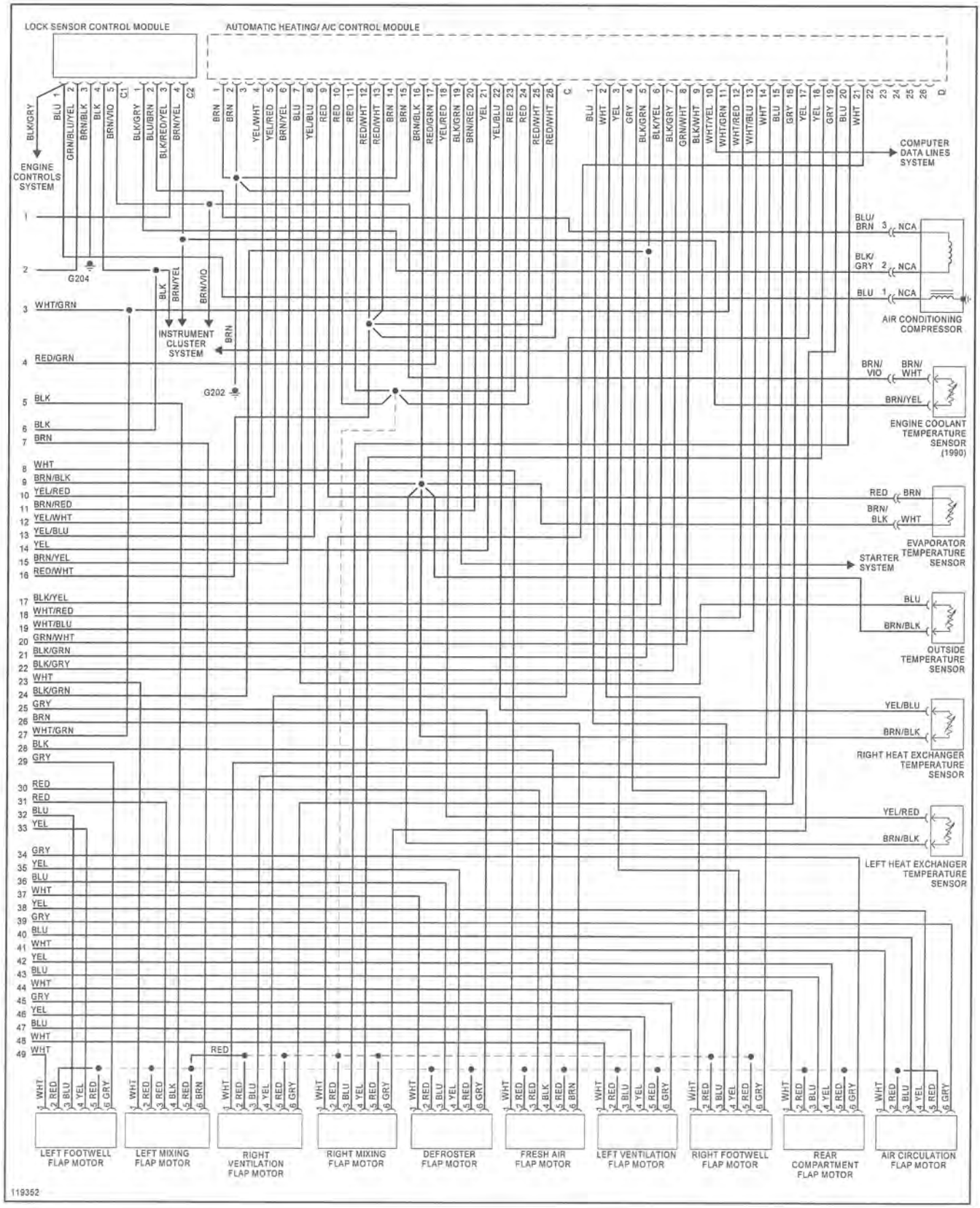
Air Conditioning & Heating

1988 750iL (2 of 3)



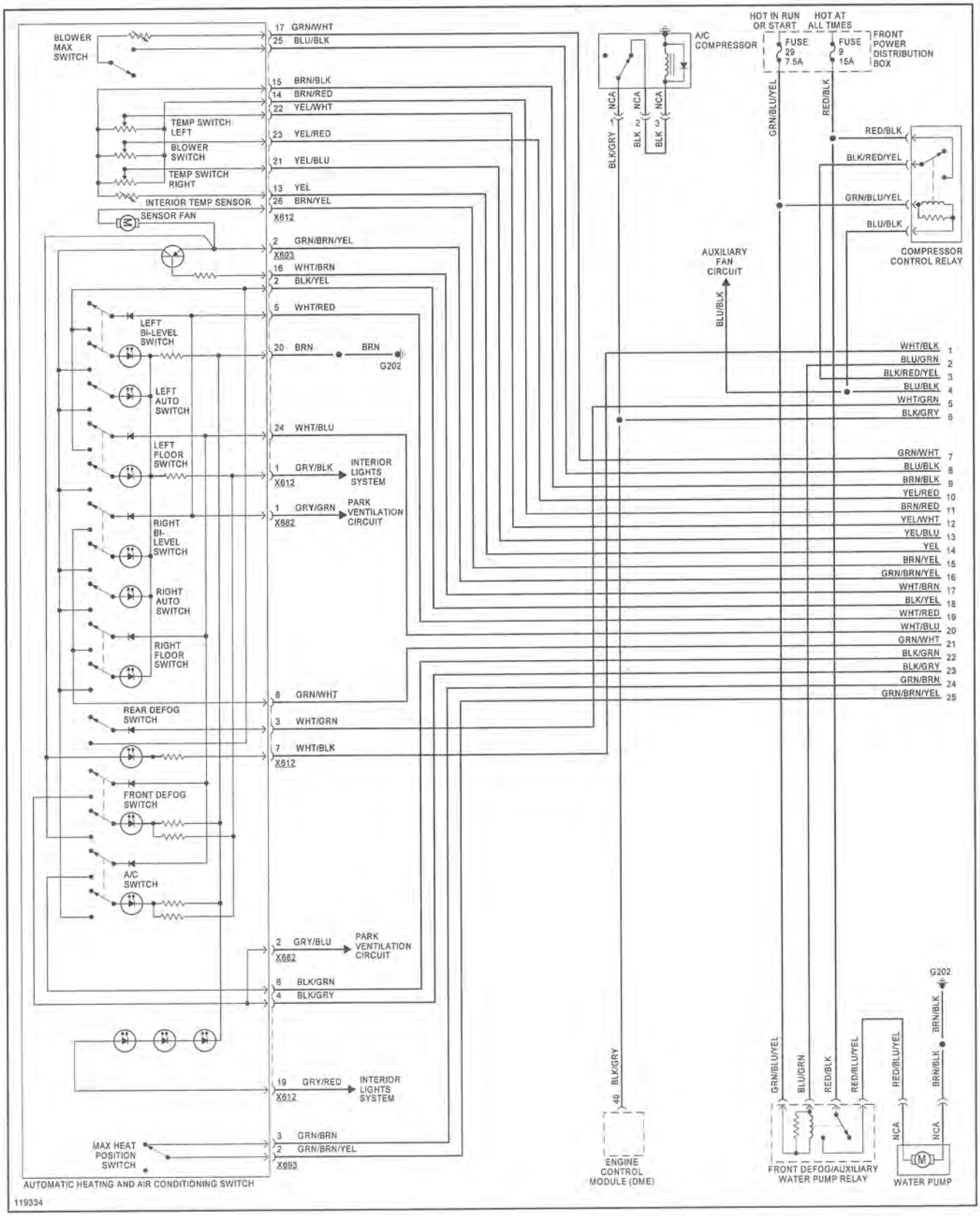
Air Conditioning & Heating

1988 750iL (3 of 3)



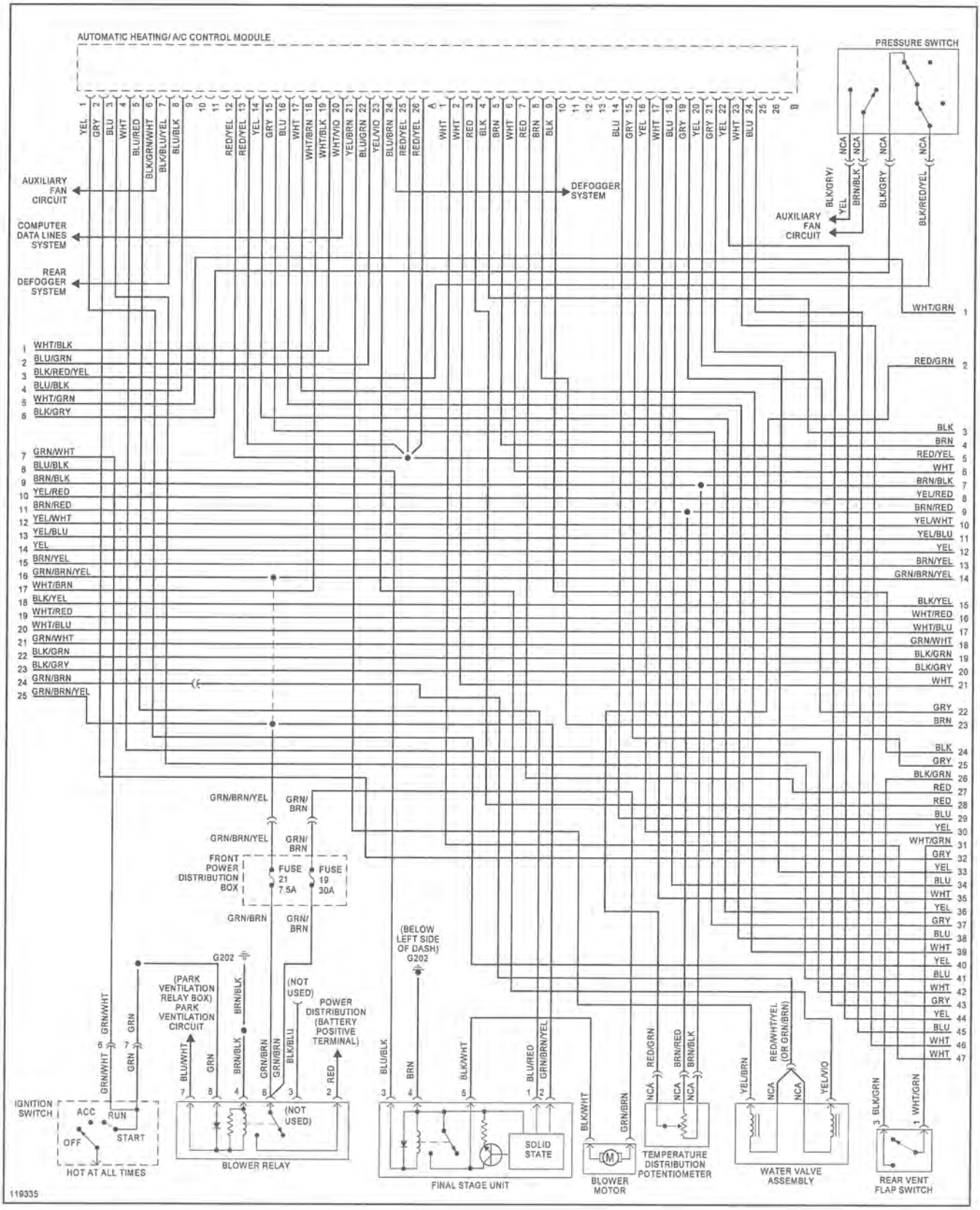
Air Conditioning & Heating

1989-90 735i & 735iL (1 of 3)



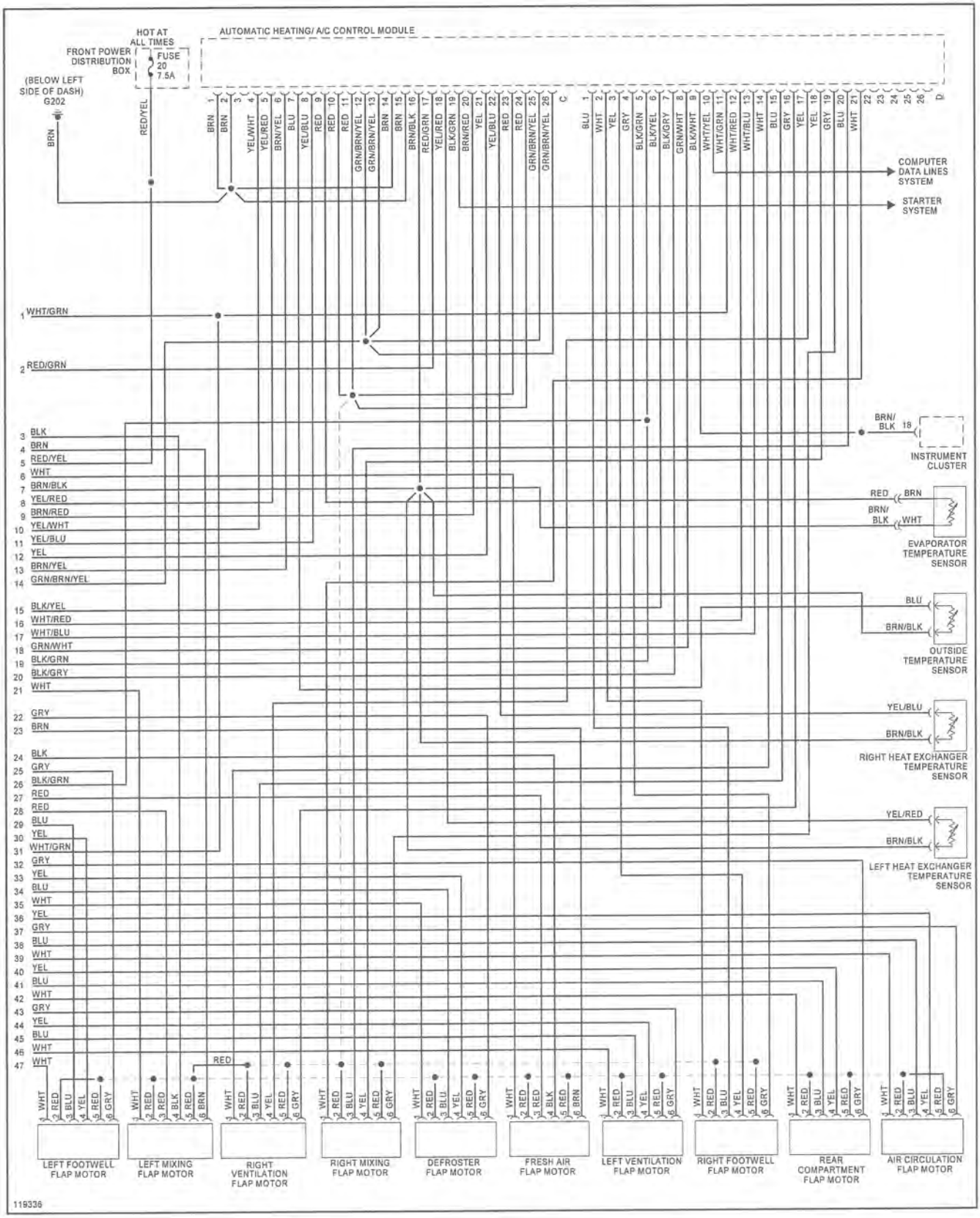
Air Conditioning & Heating

1989-90 735i & 735iL (2 of 3)



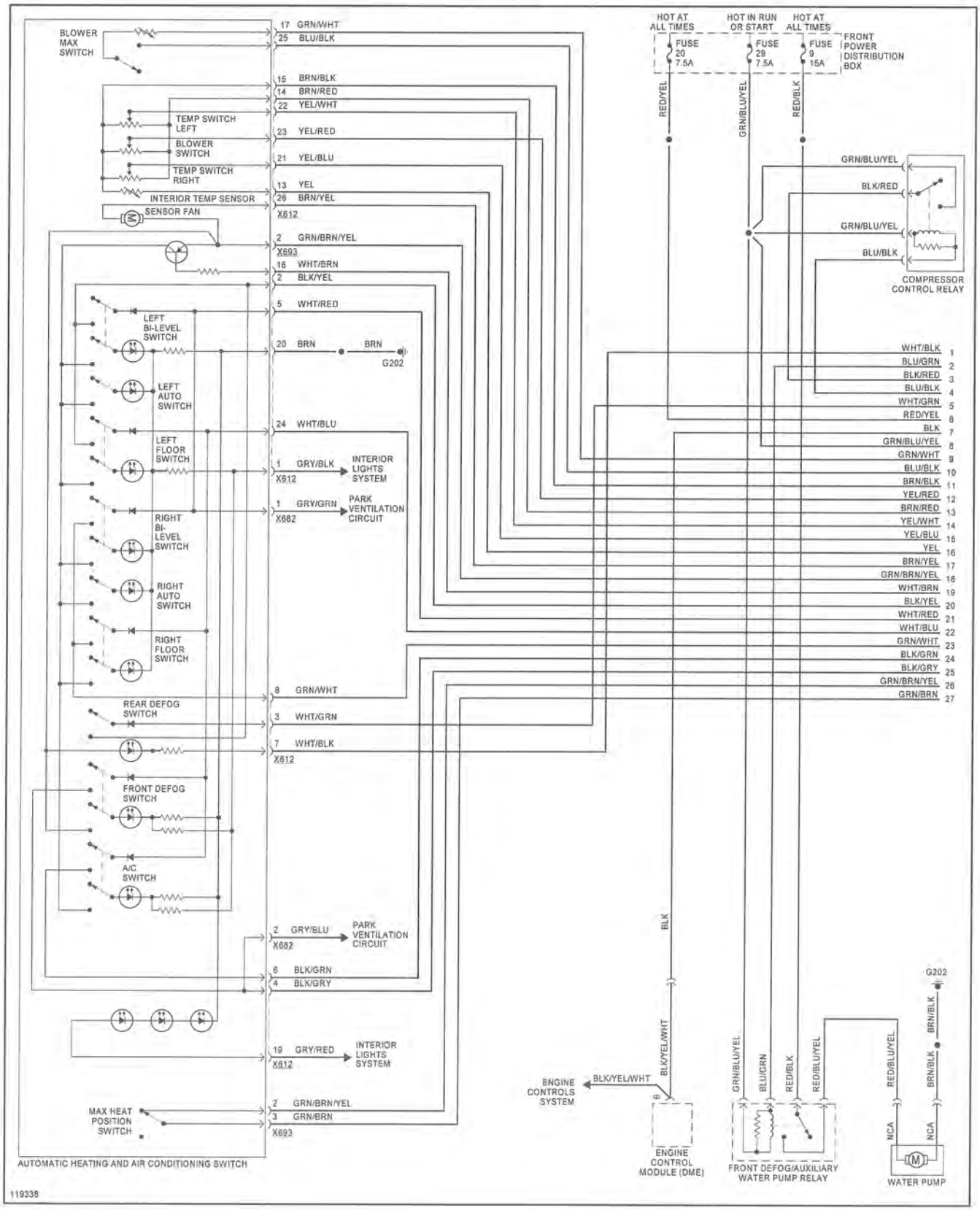
Air Conditioning & Heating

1989-90 735i & 735iL (3 of 3)



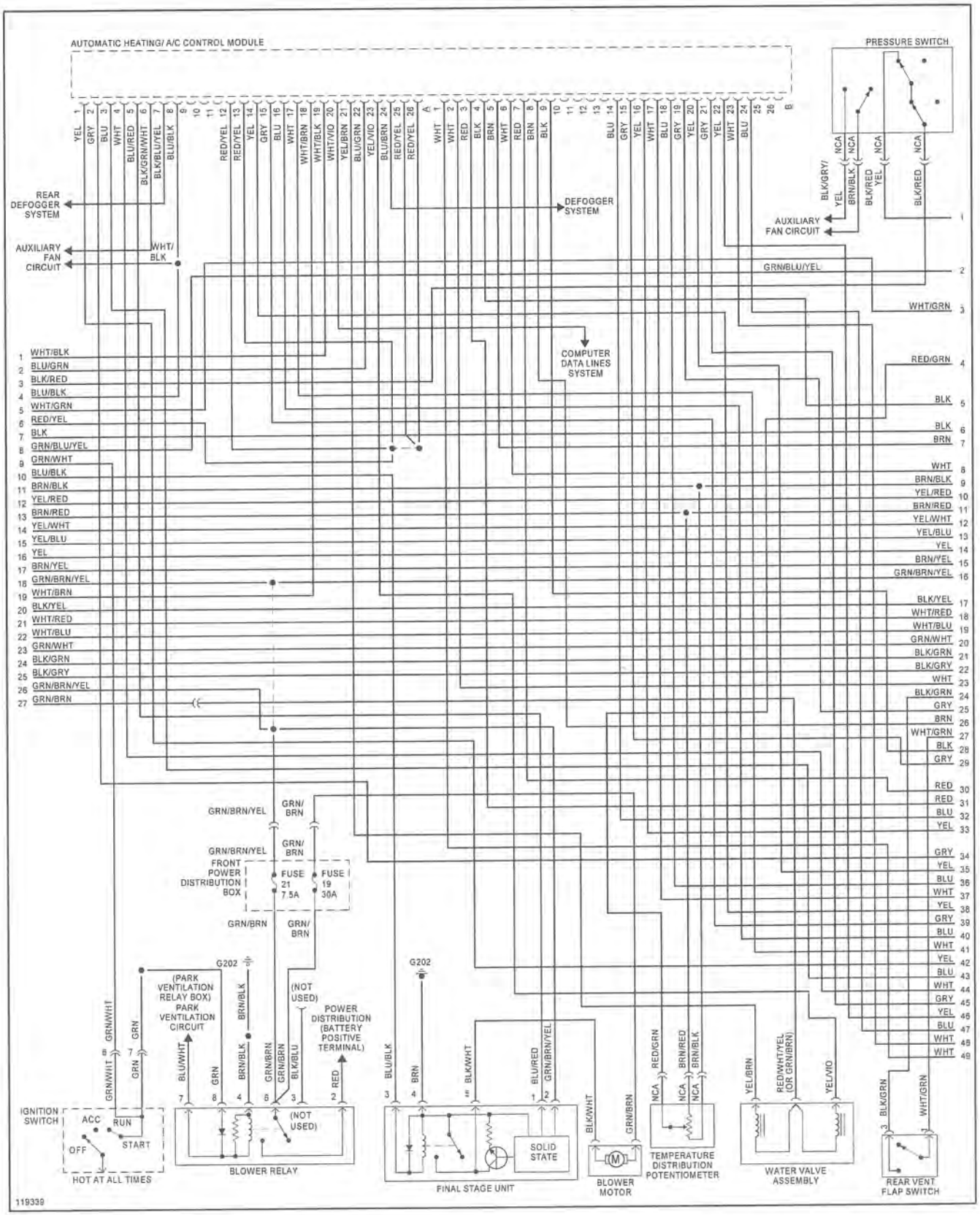
Air Conditioning & Heating

1989-90 750iL (1 of 3)



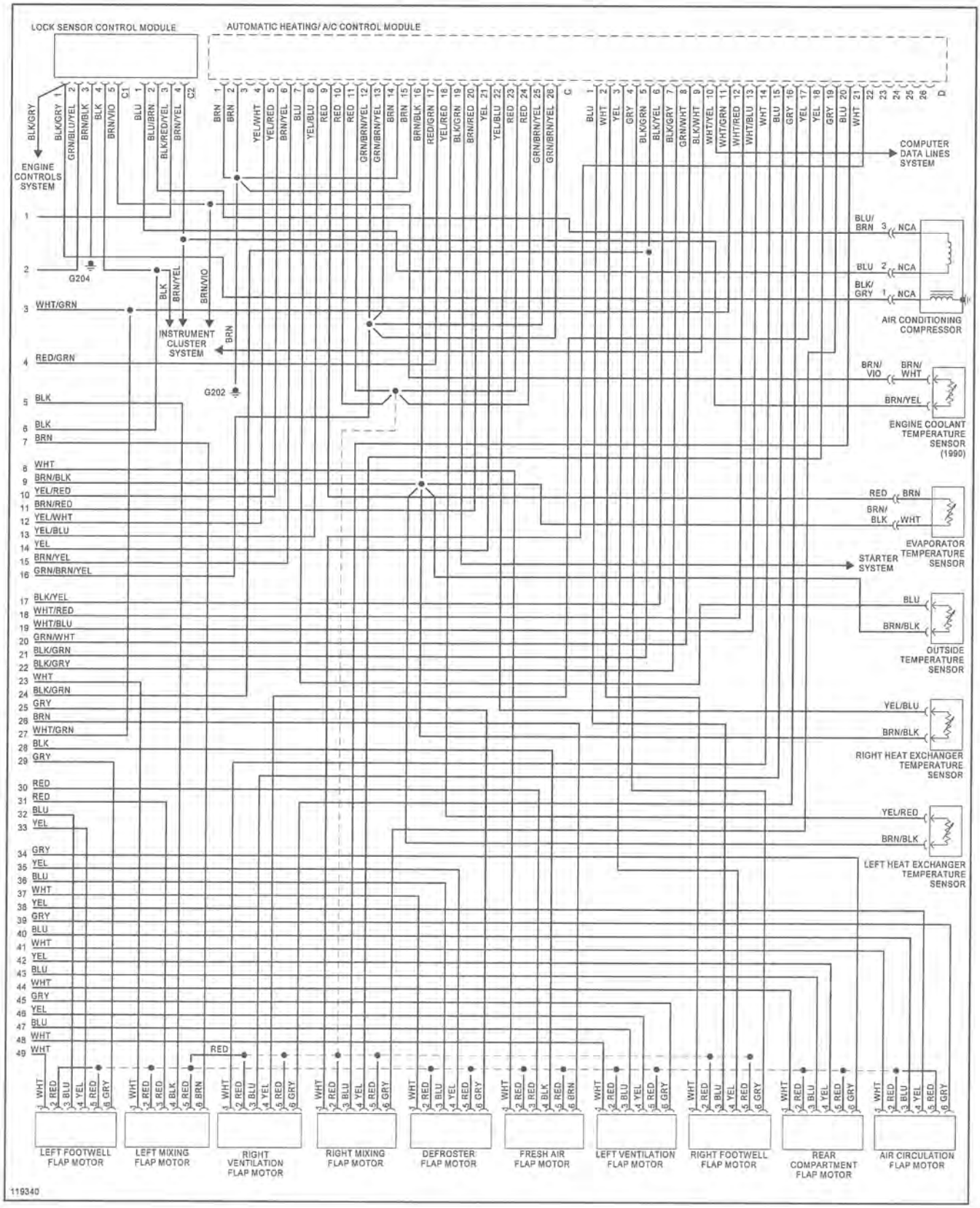
Air Conditioning & Heating

1989-90 750iL (2 of 3)



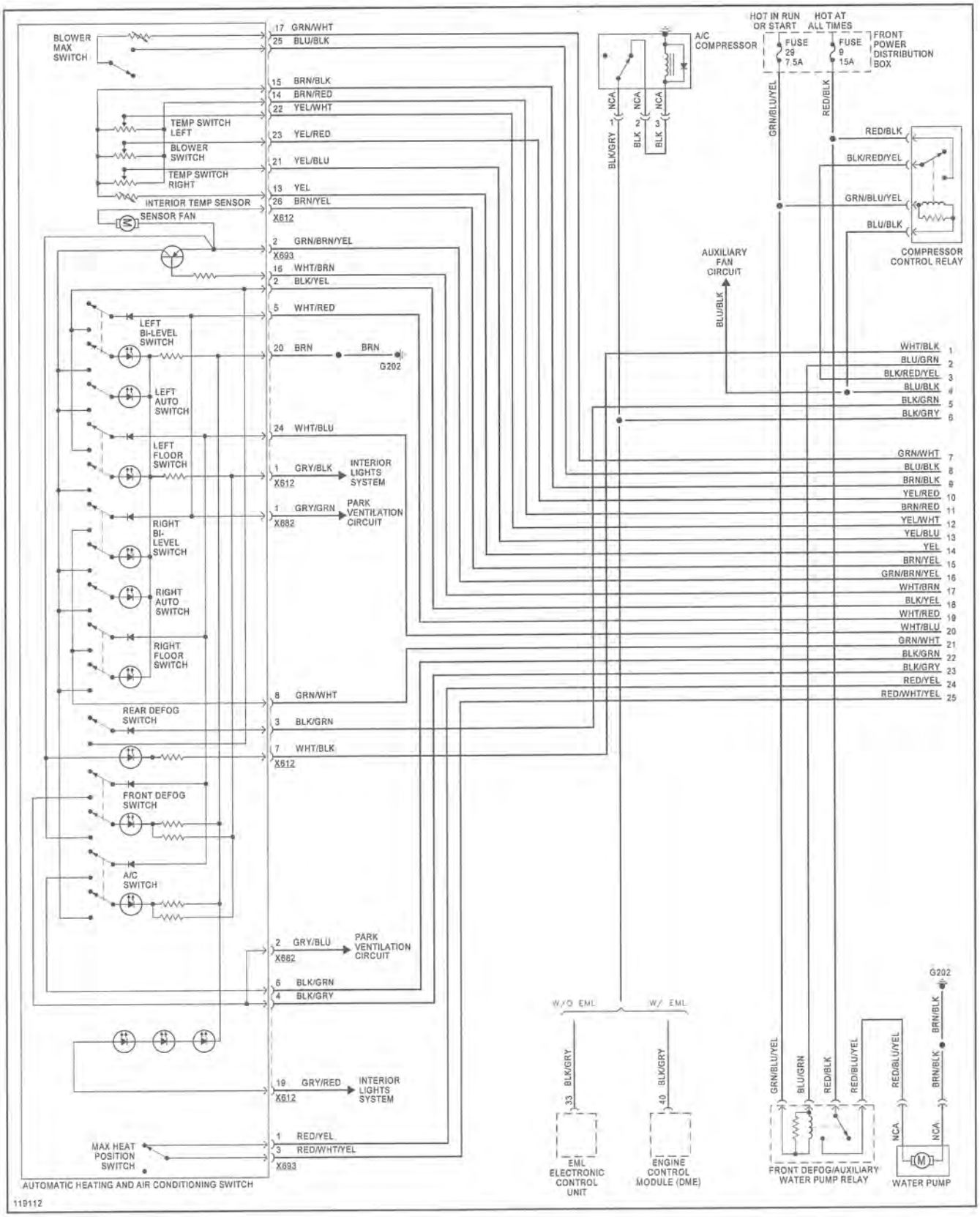
Air Conditioning & Heating

1989-90 750iL (3 of 3)



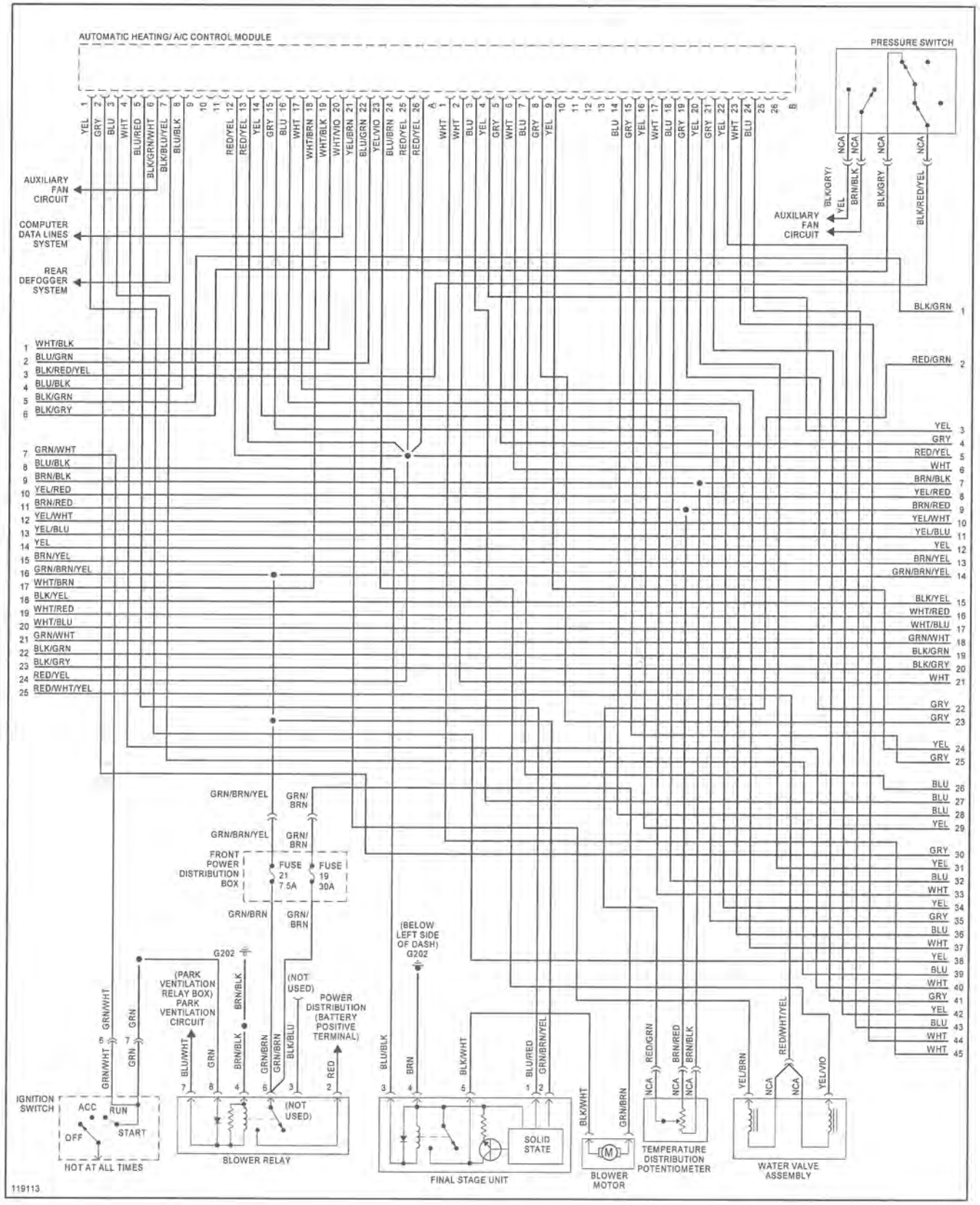
Air Conditioning & Heating

1991-92 735i & 735iL (1 of 3)



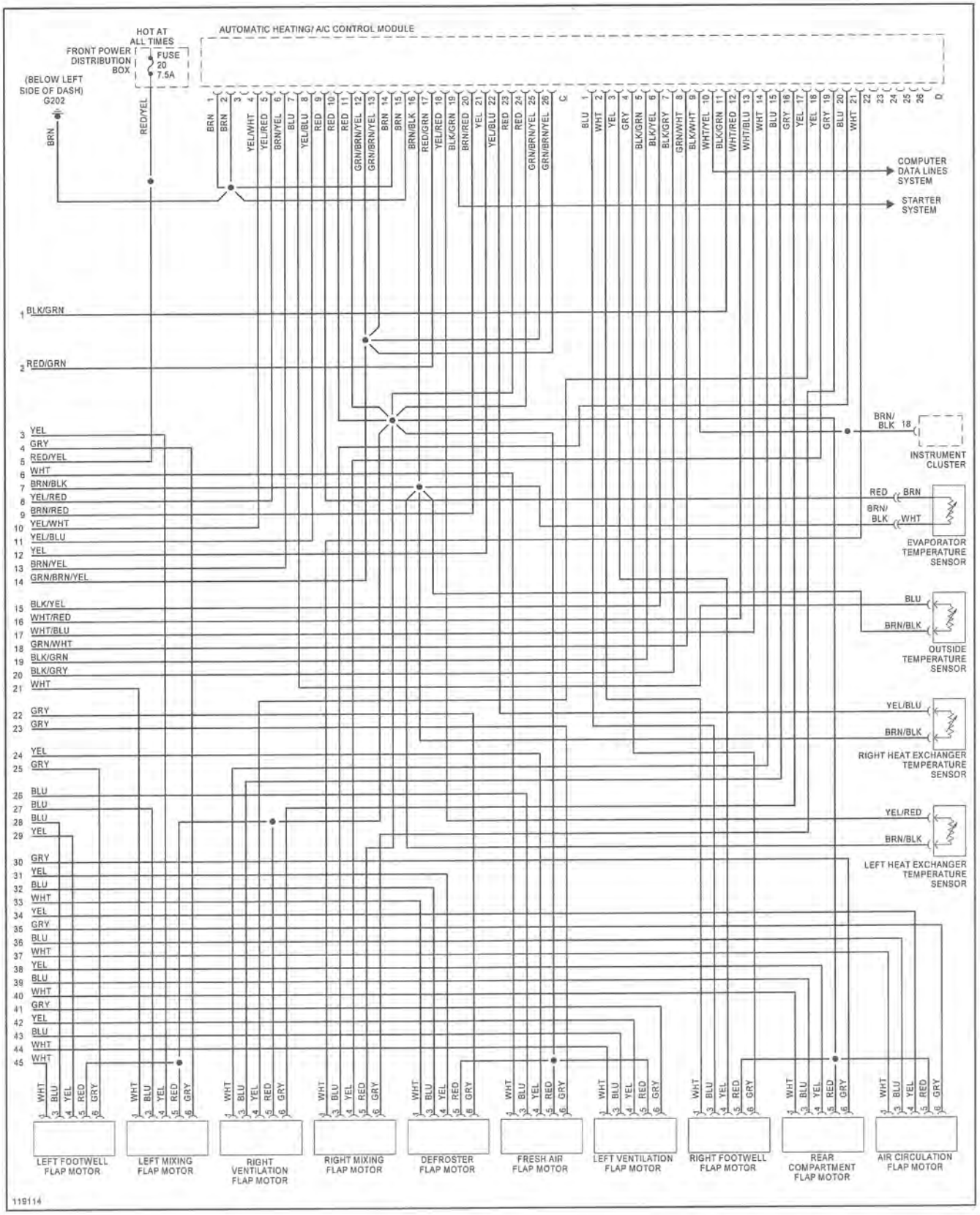
Air Conditioning & Heating

1991-92 735i & 735iL (2 of 3)



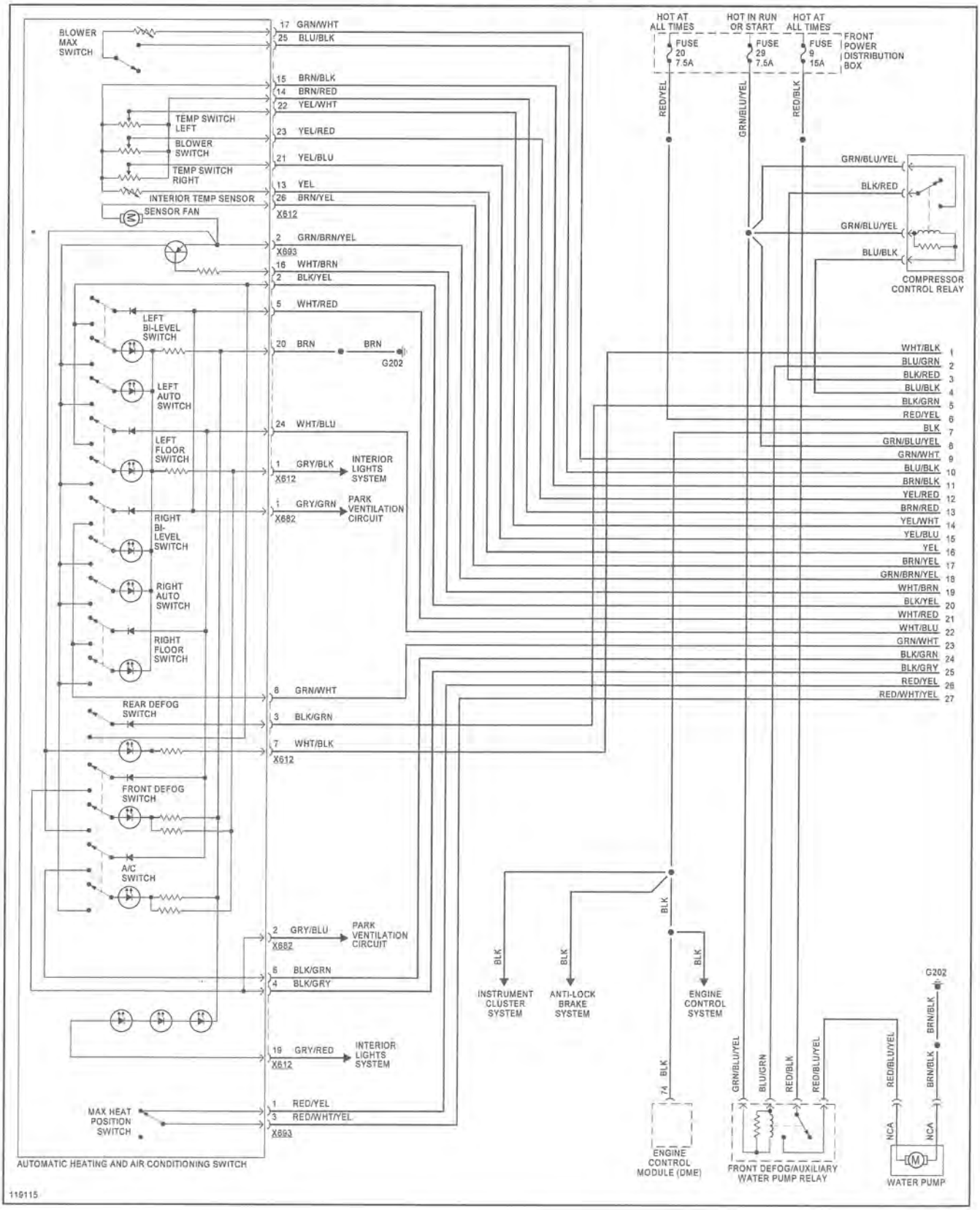
Air Conditioning & Heating

1991-92 735i & 735iL (3 of 3)



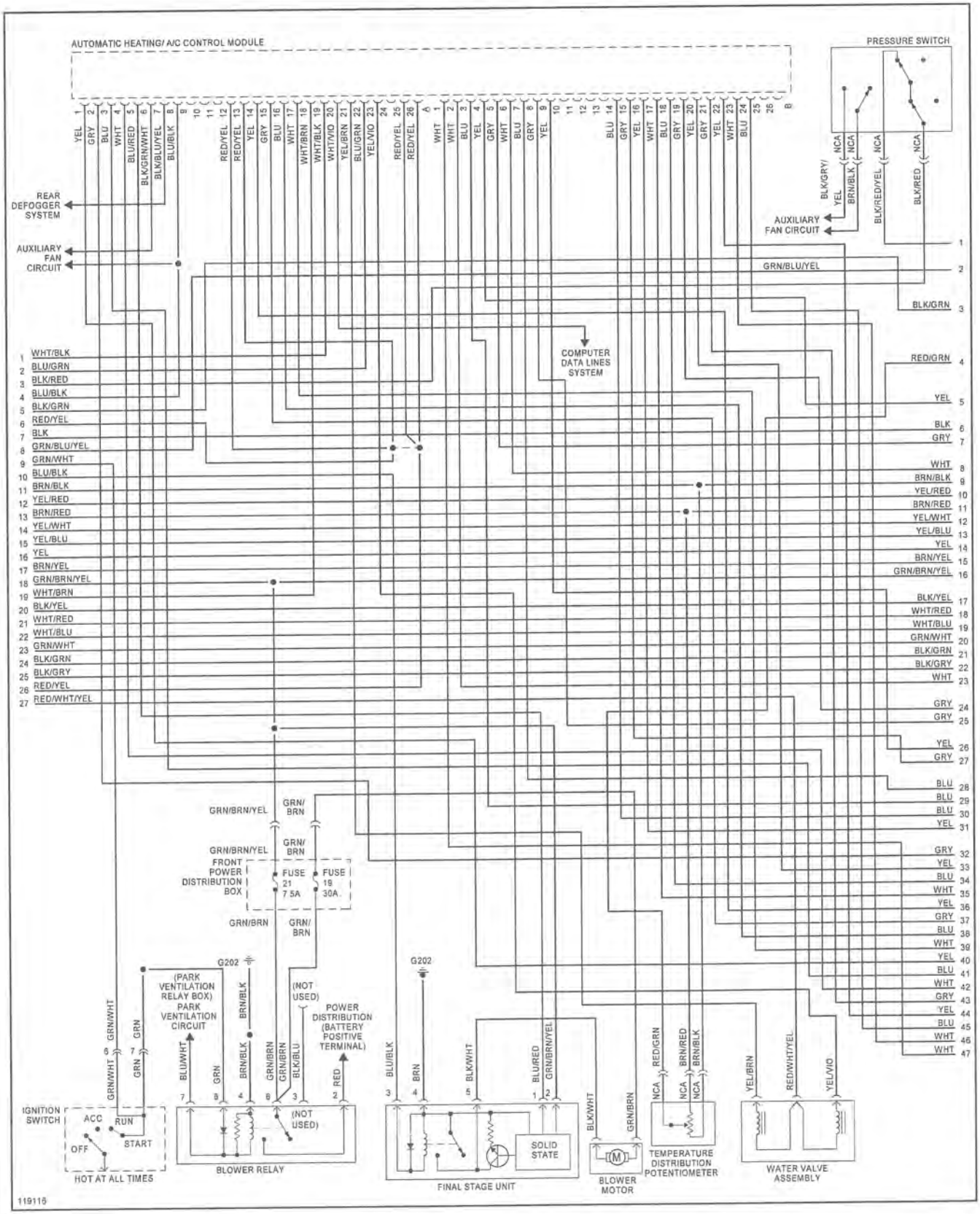
Air Conditioning & Heating

1991-92 750iL (1 of 3)



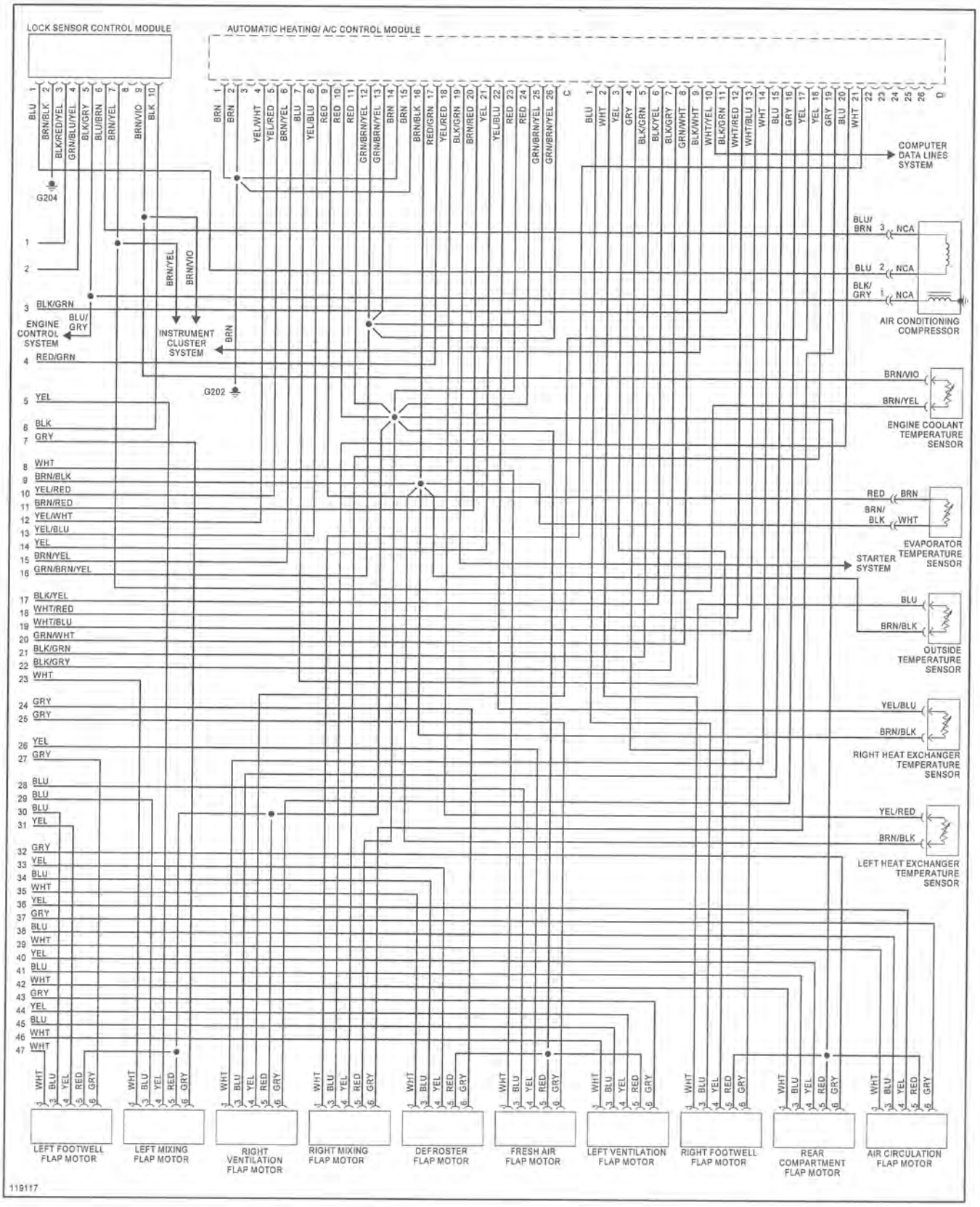
Air Conditioning & Heating

1991-92 750iL (2 of 3)



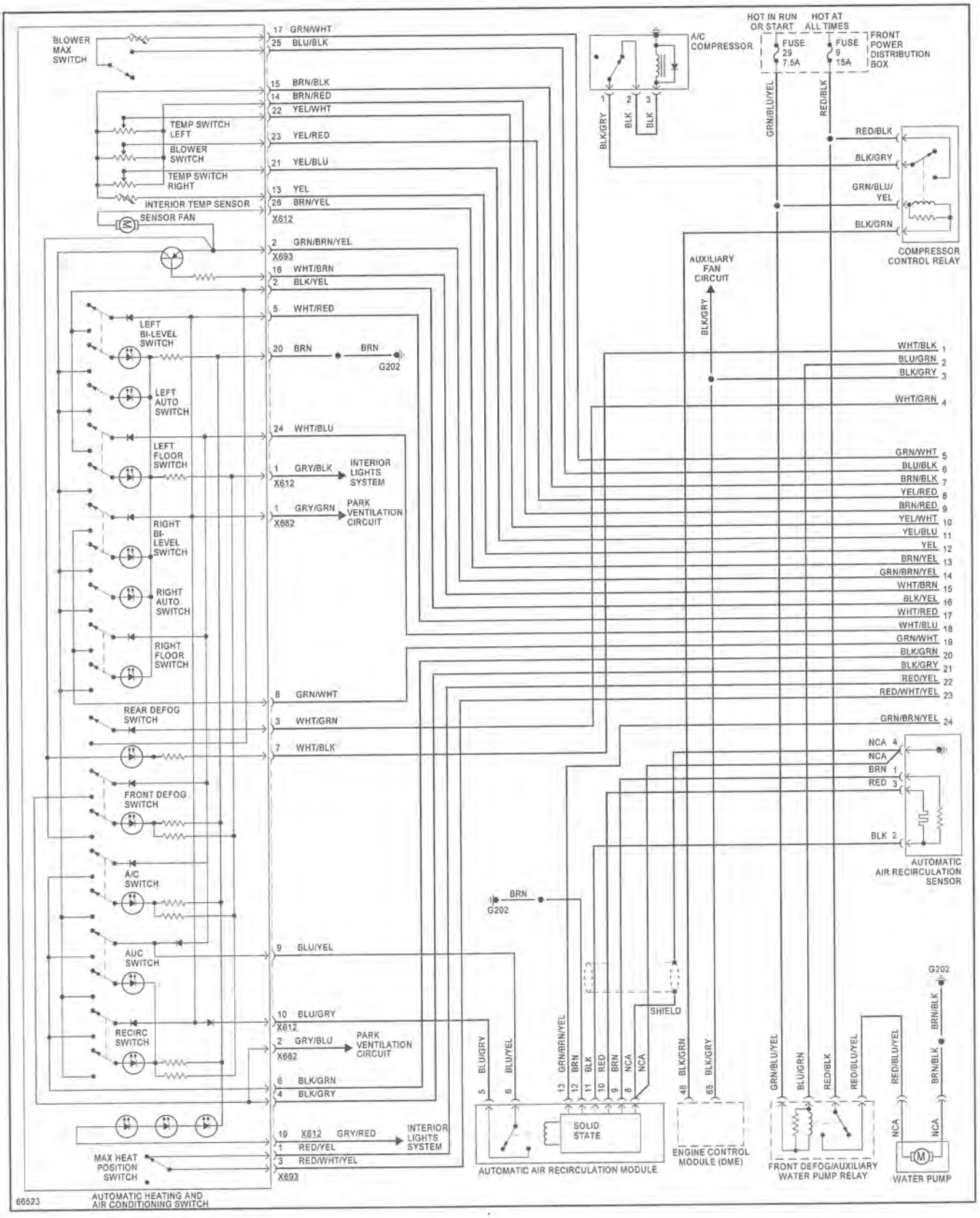
Air Conditioning & Heating

1991-92 750iL (3 of 3)



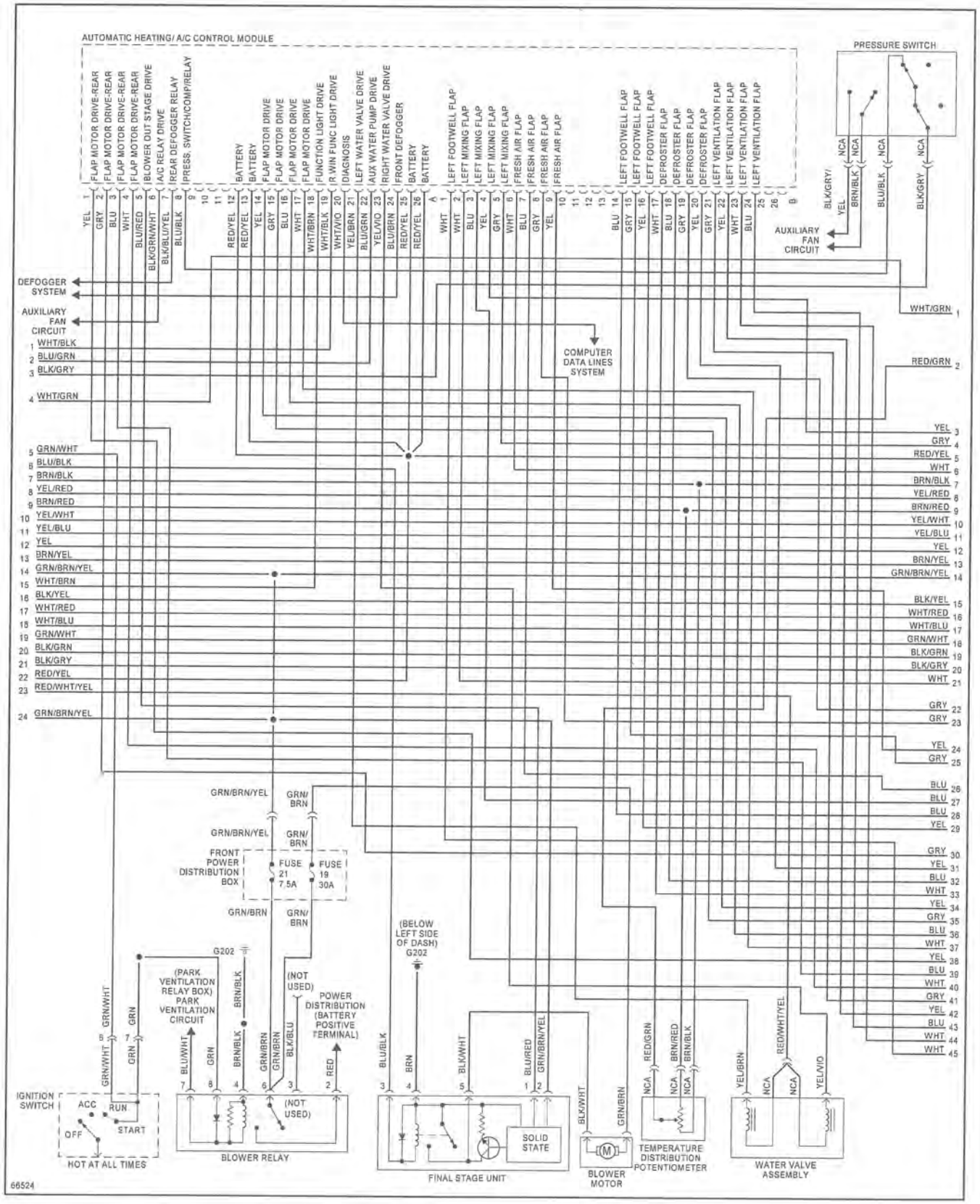
Air Conditioning & Heating

1993-94 740i & 740iL (1 of 3)



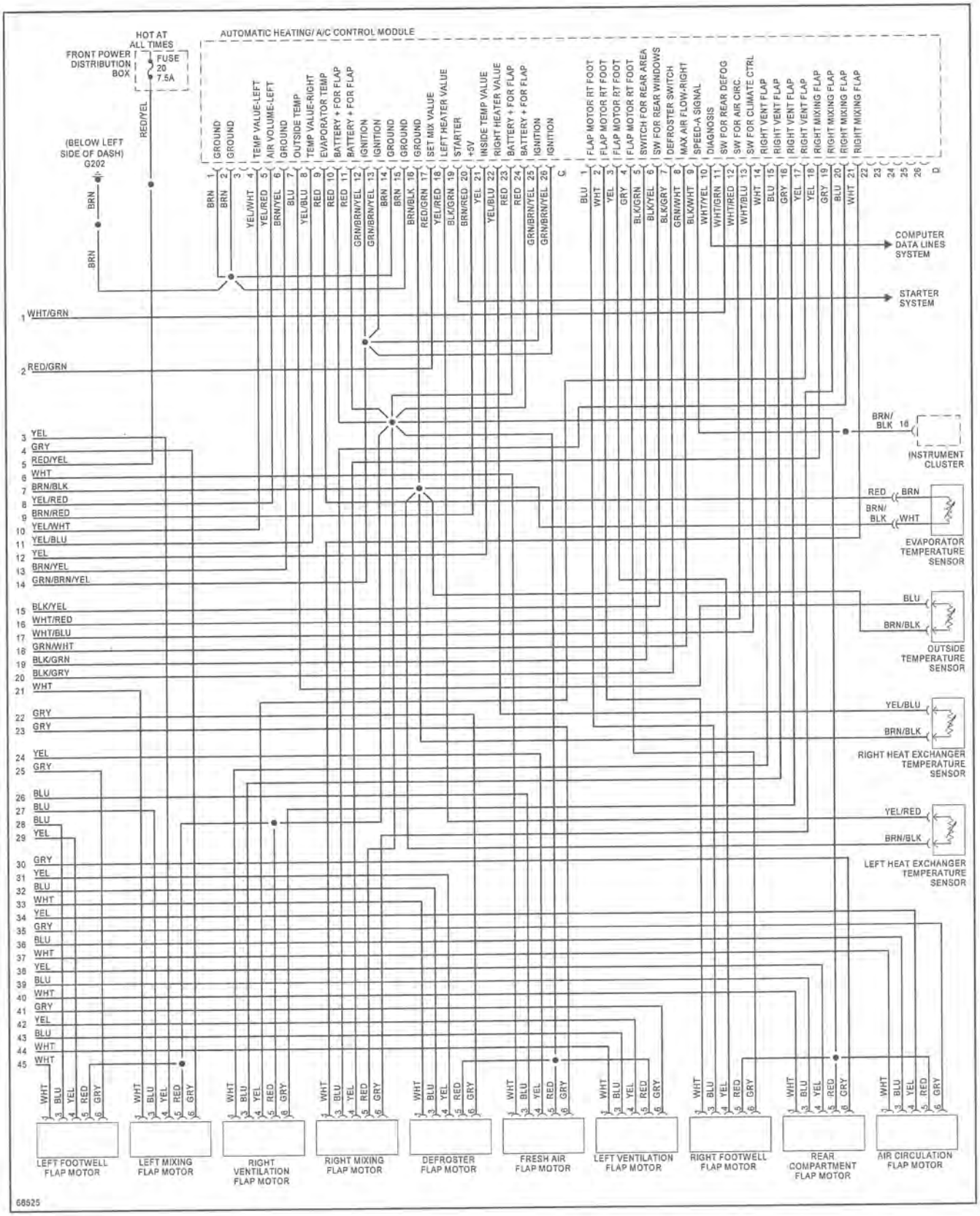
Air Conditioning & Heating

1993-94 740i & 740iL (2 of 3)



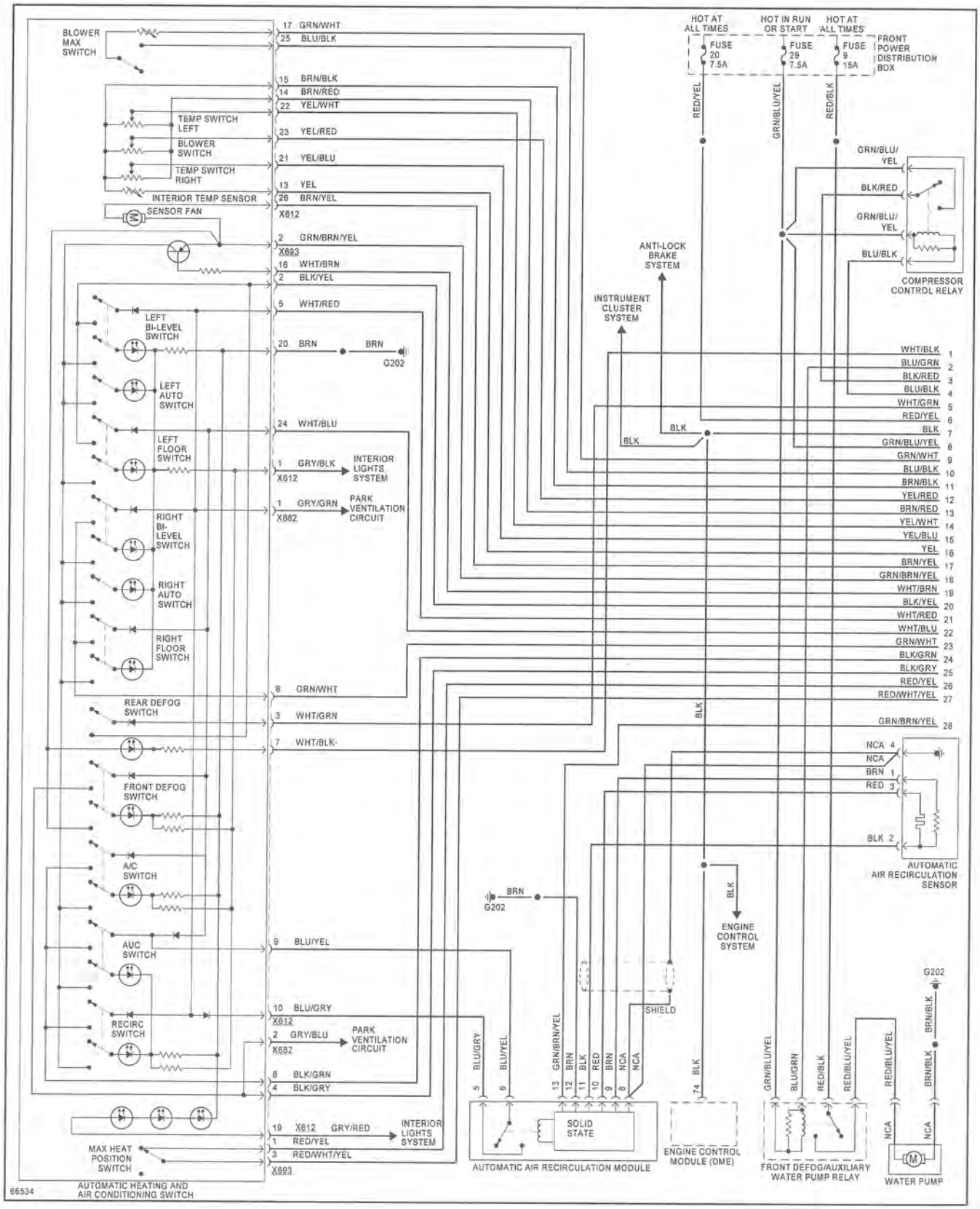
Air Conditioning & Heating

1993-94 740i & 740iL (3 of 3)



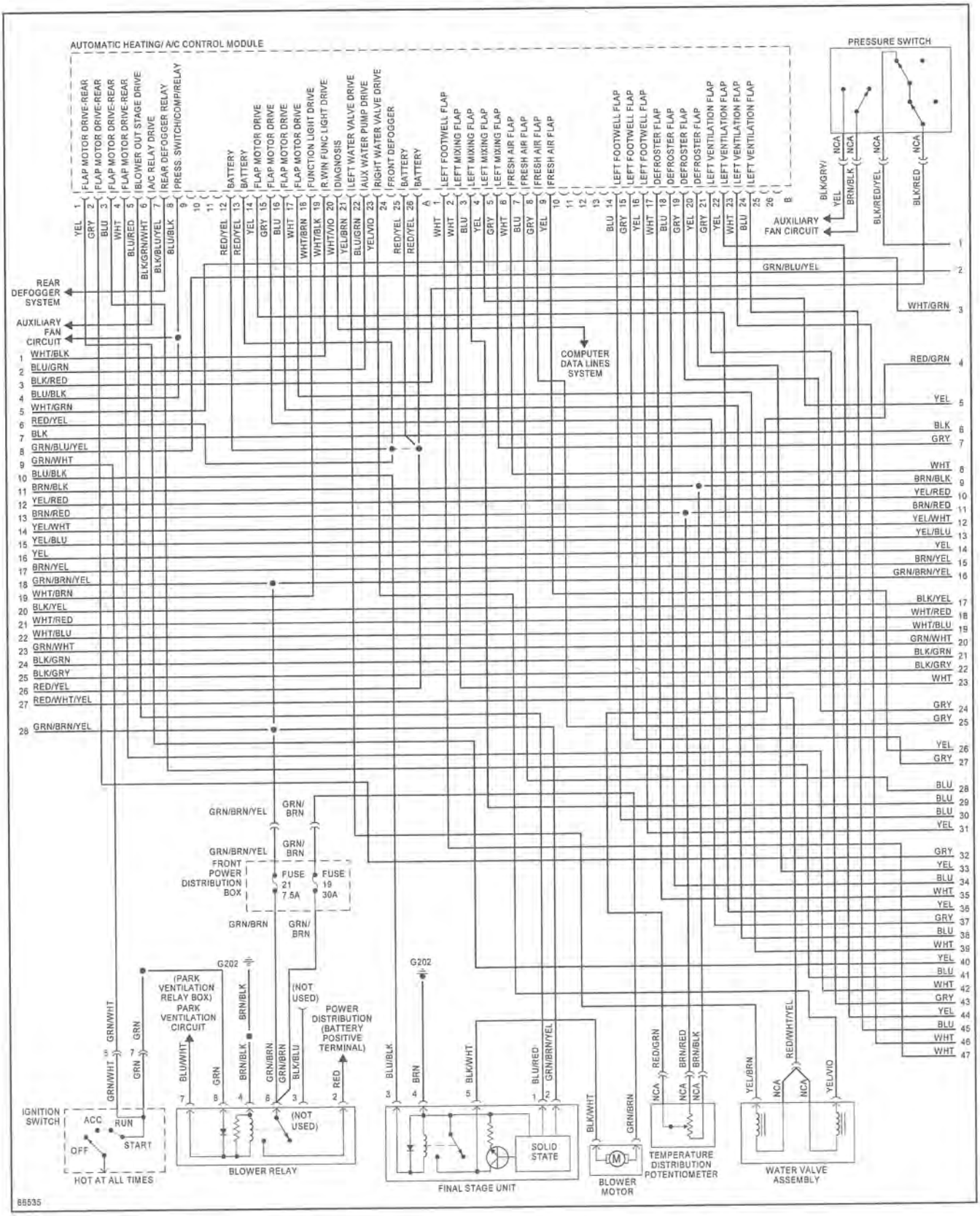
Air Conditioning & Heating

1993-94 750iL (1 of 3)



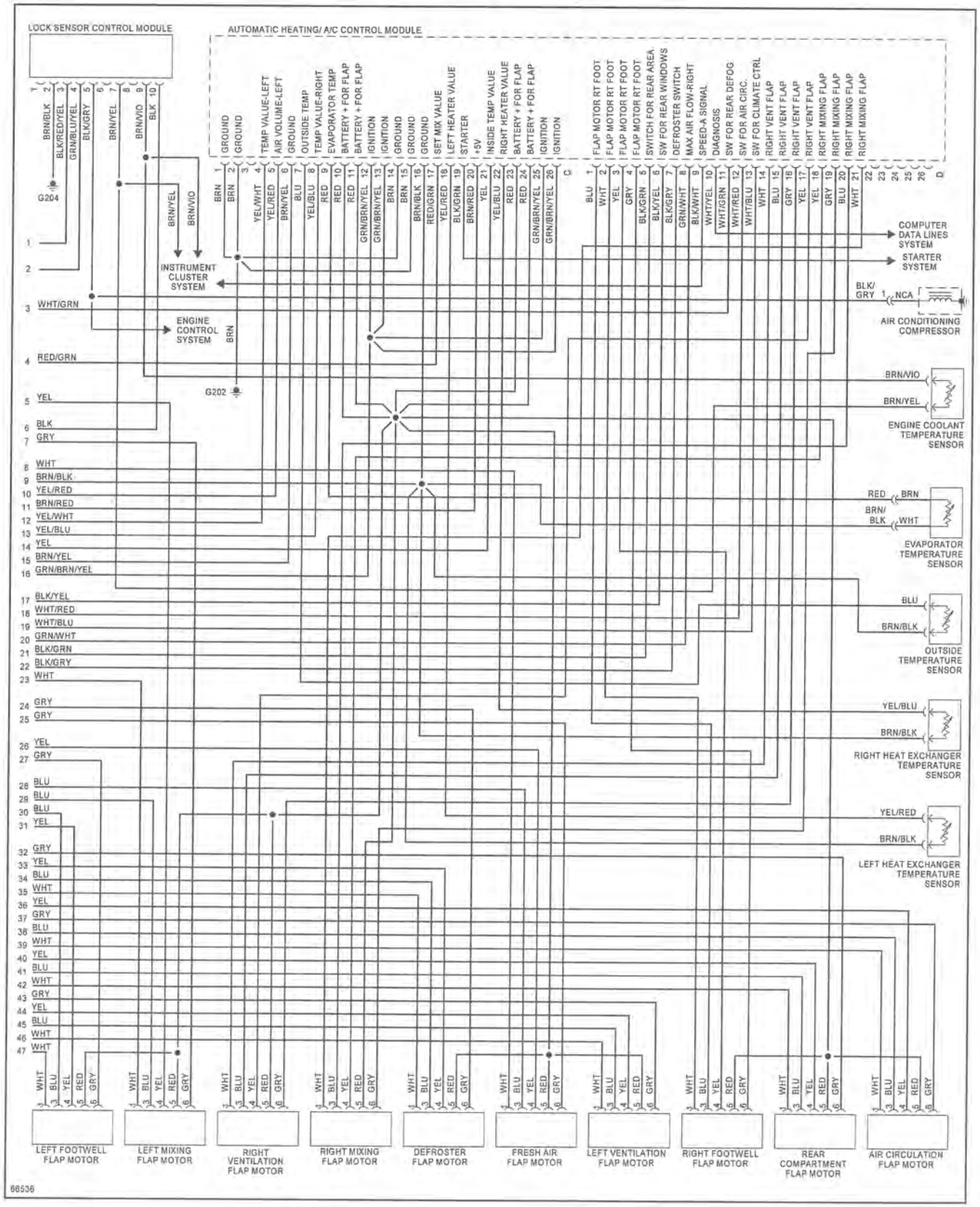
Air Conditioning & Heating

1993-94 750iL (2 of 3)

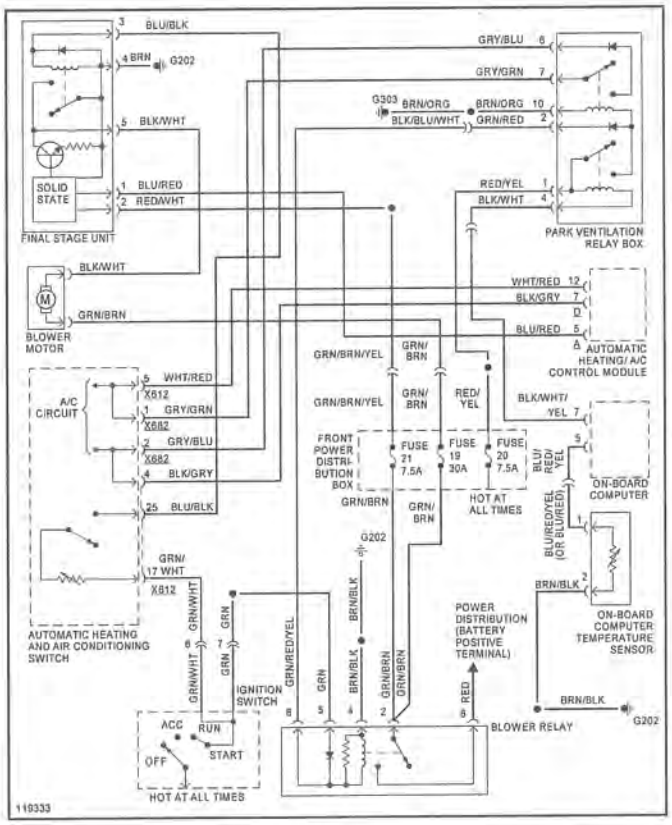


Air Conditioning & Heating

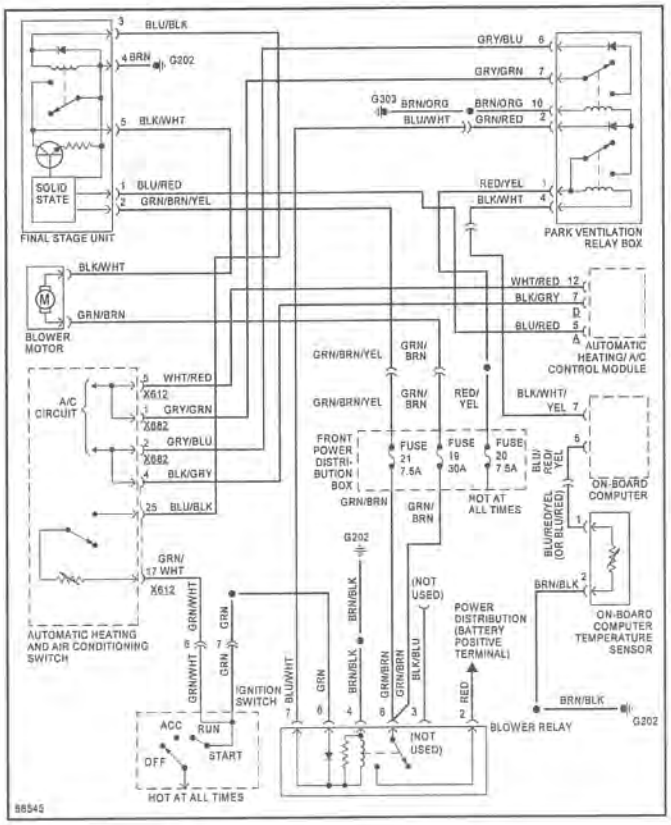
1993-94 750iL (3 of 3)



Air Conditioning & Heating

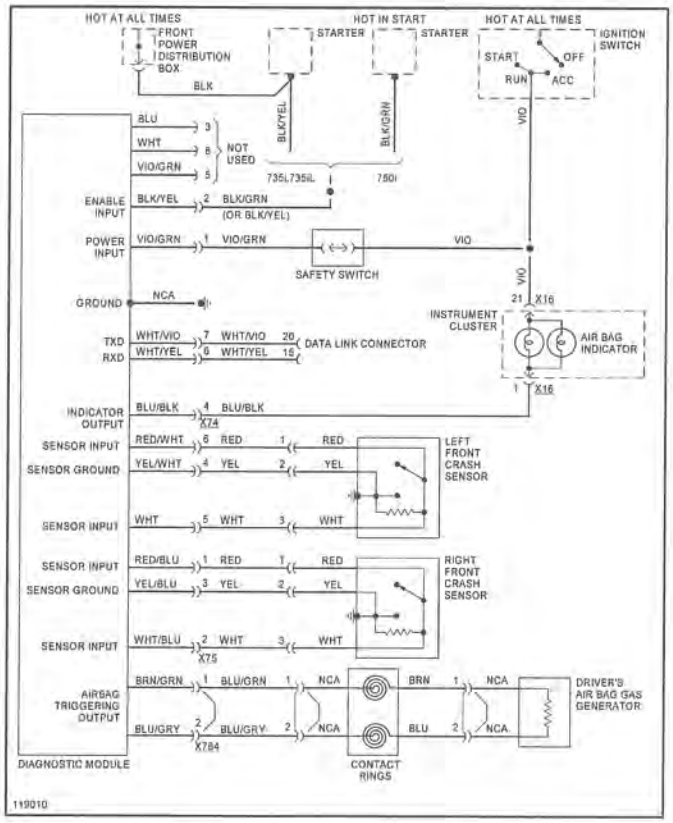


1988 Park Ventilation

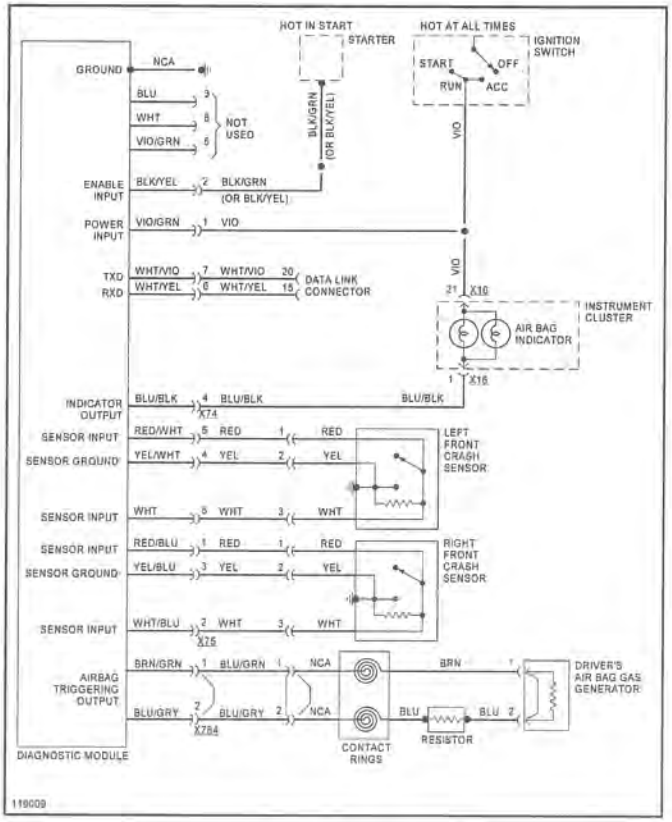


1989-94 Park Ventilation

Air Bag (Supplemental Restraint System)

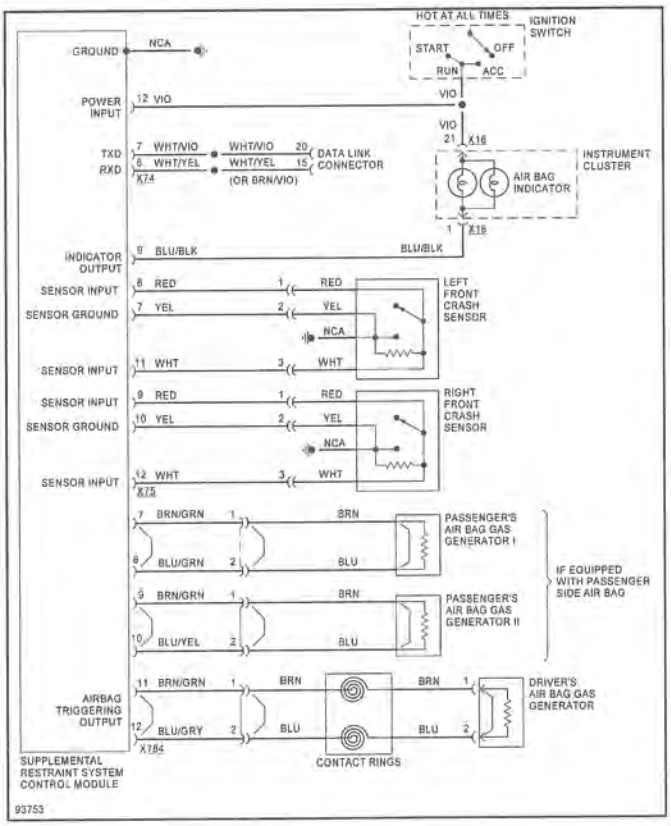


1988

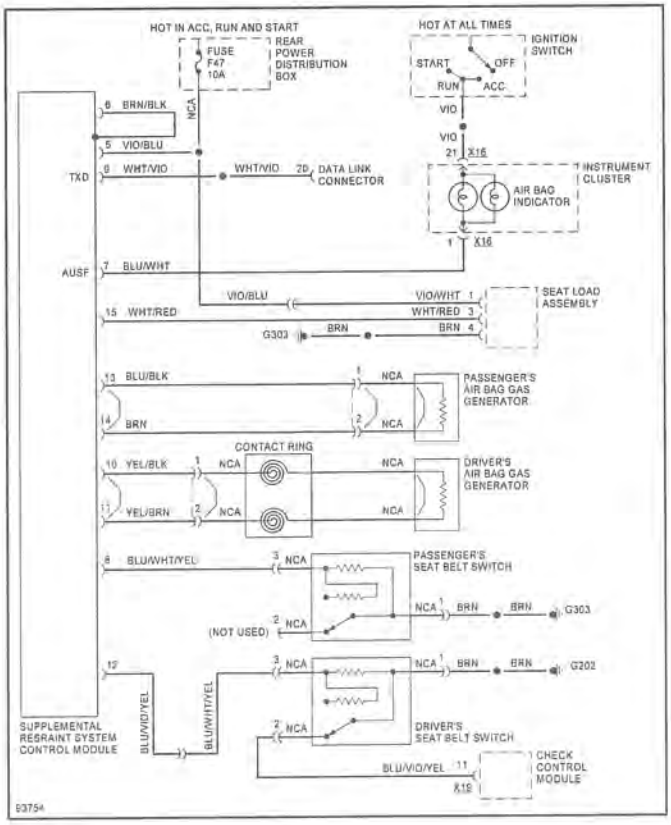


1989-91

Air Bag (Supplemental Restraint System)



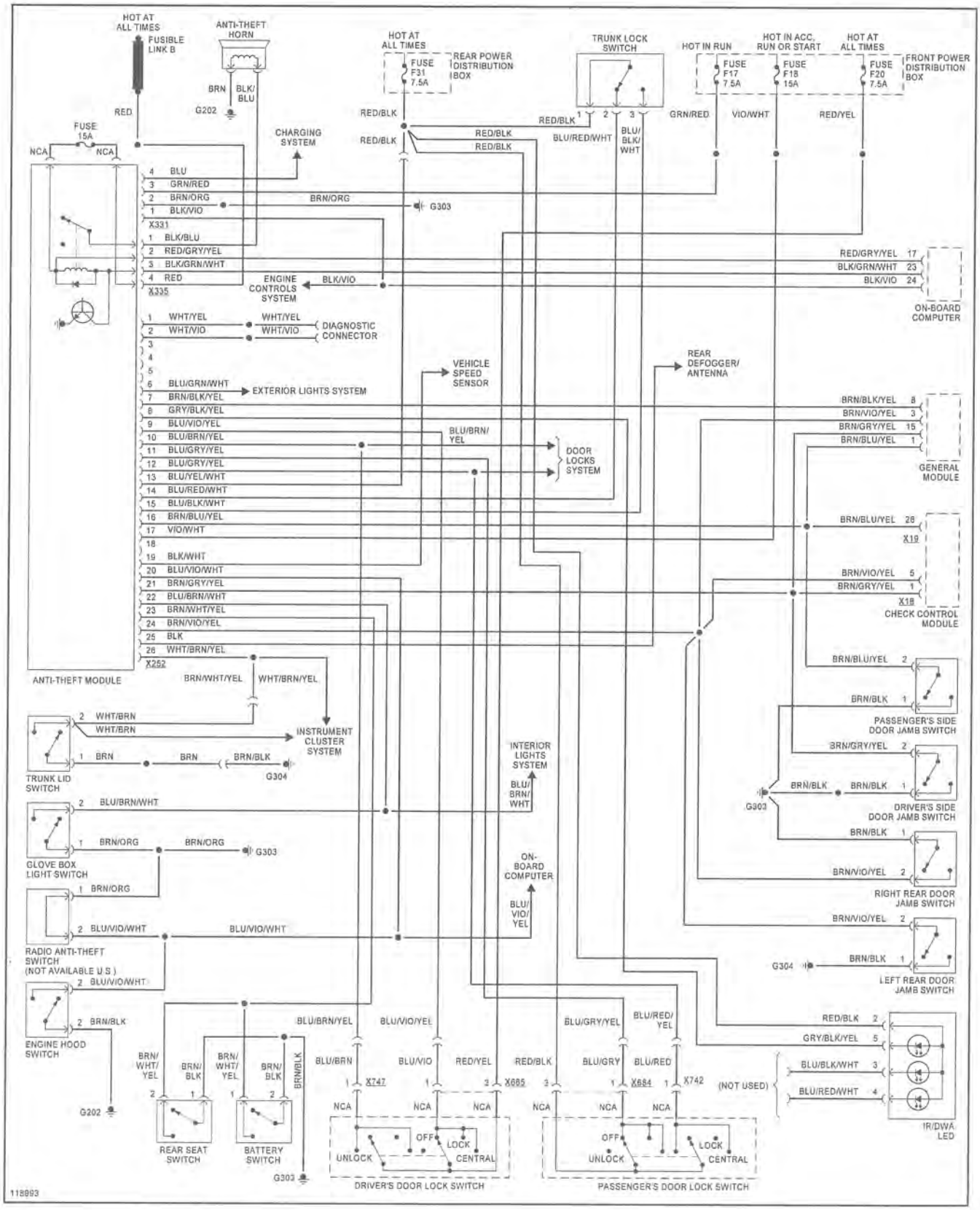
1992, 1993 Early Production



1993 Late Production, 1994

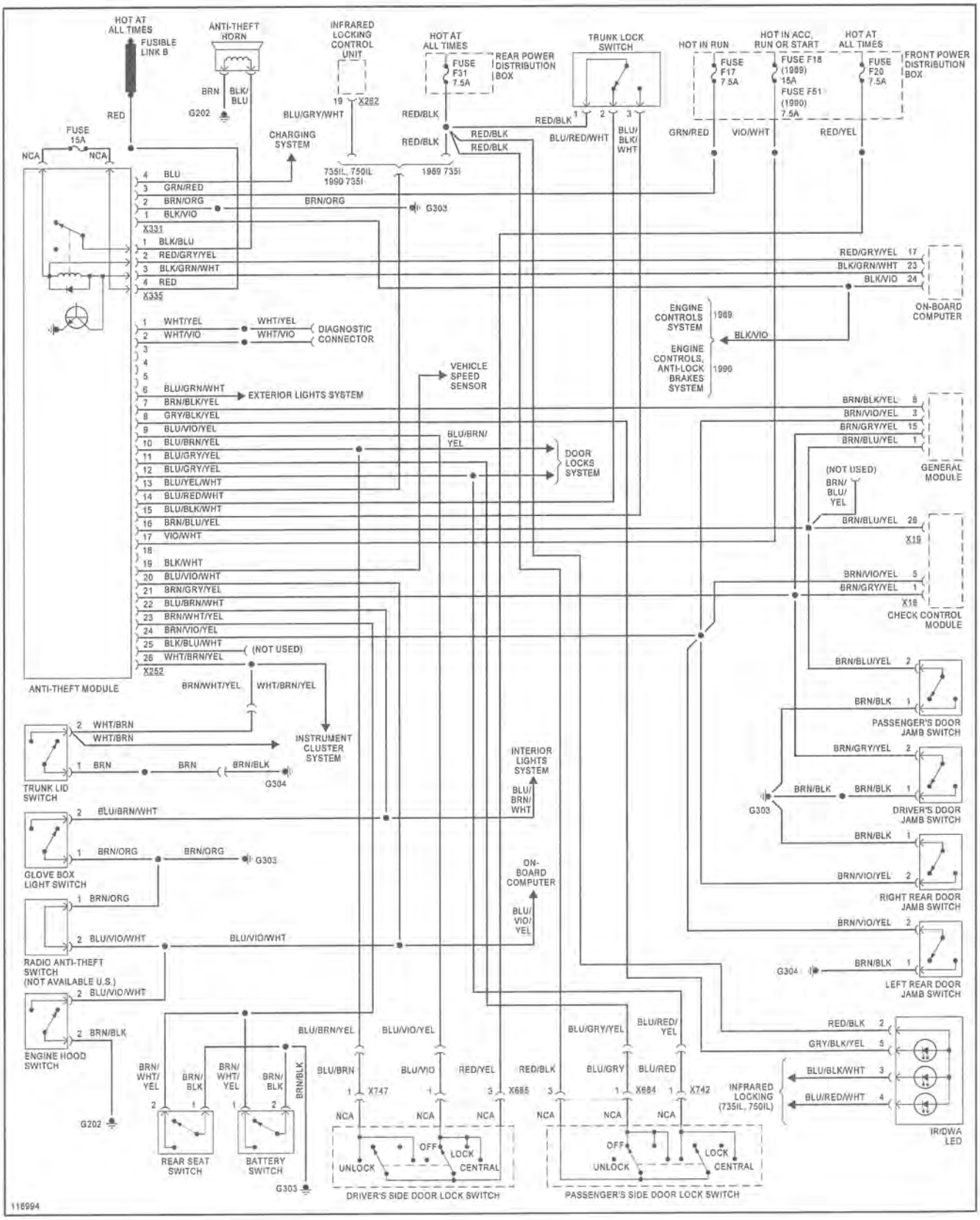
Anti-Theft

1988



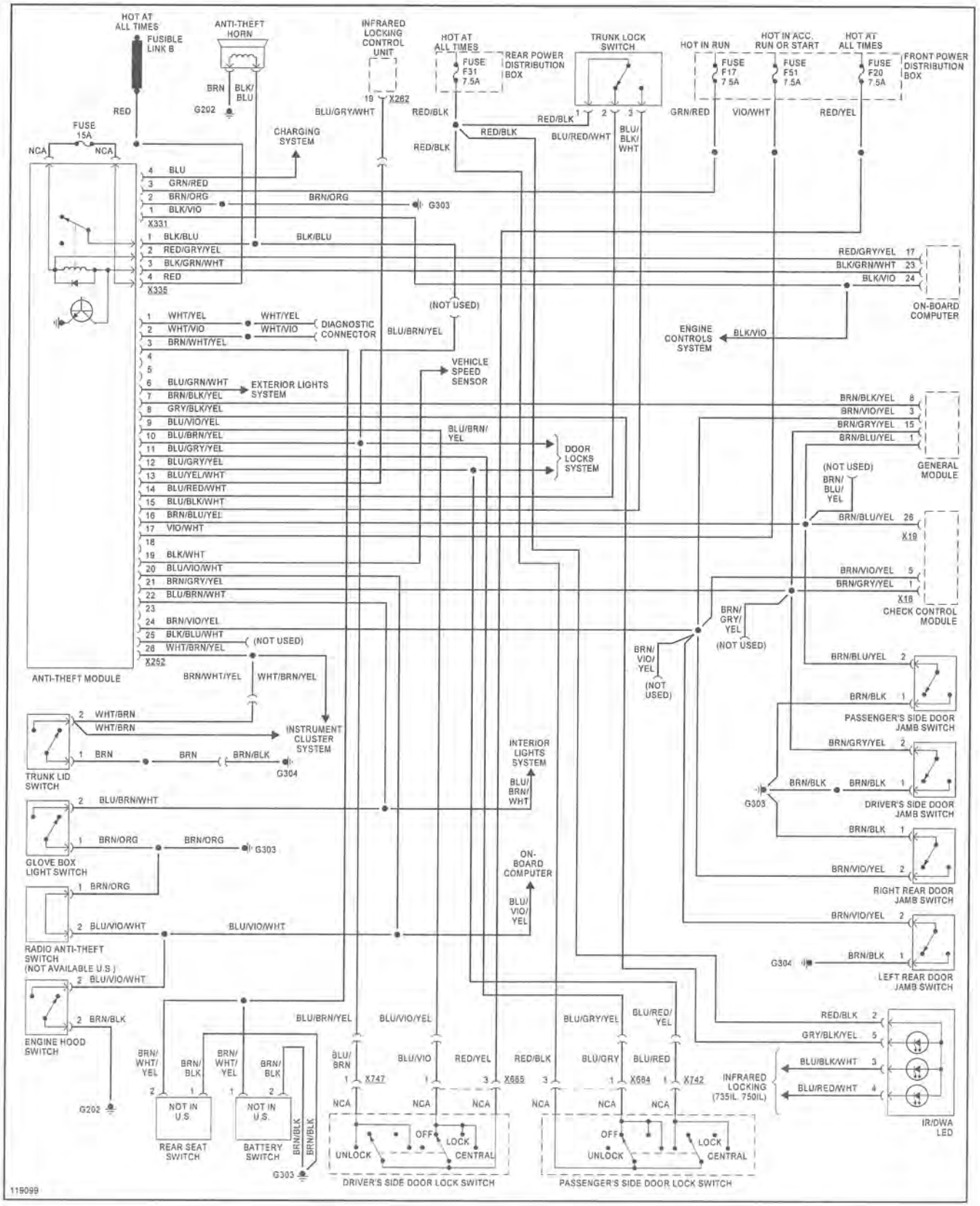
Anti-Theft

1989-90



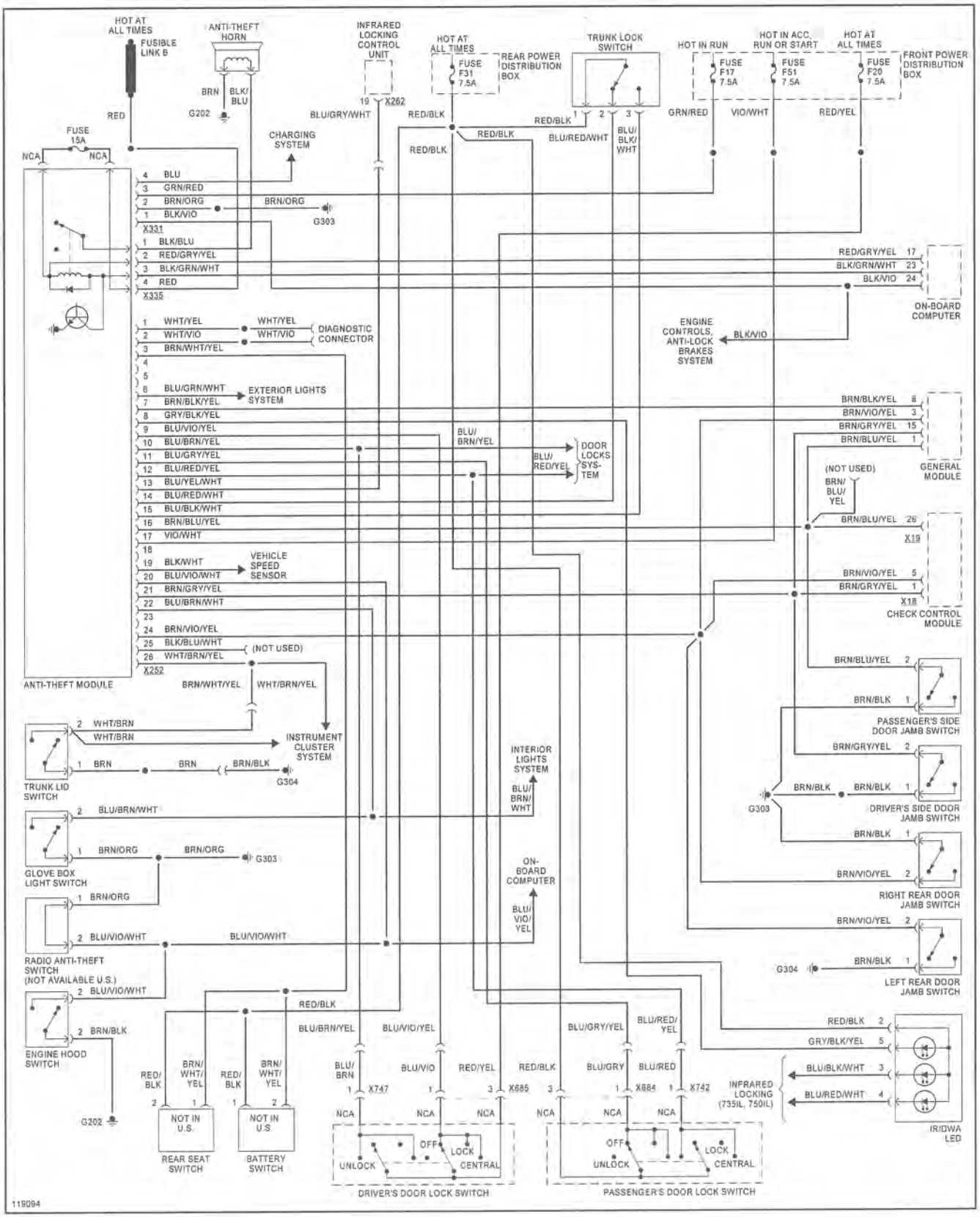
Anti-Theft

1991 Early Production w/DWA



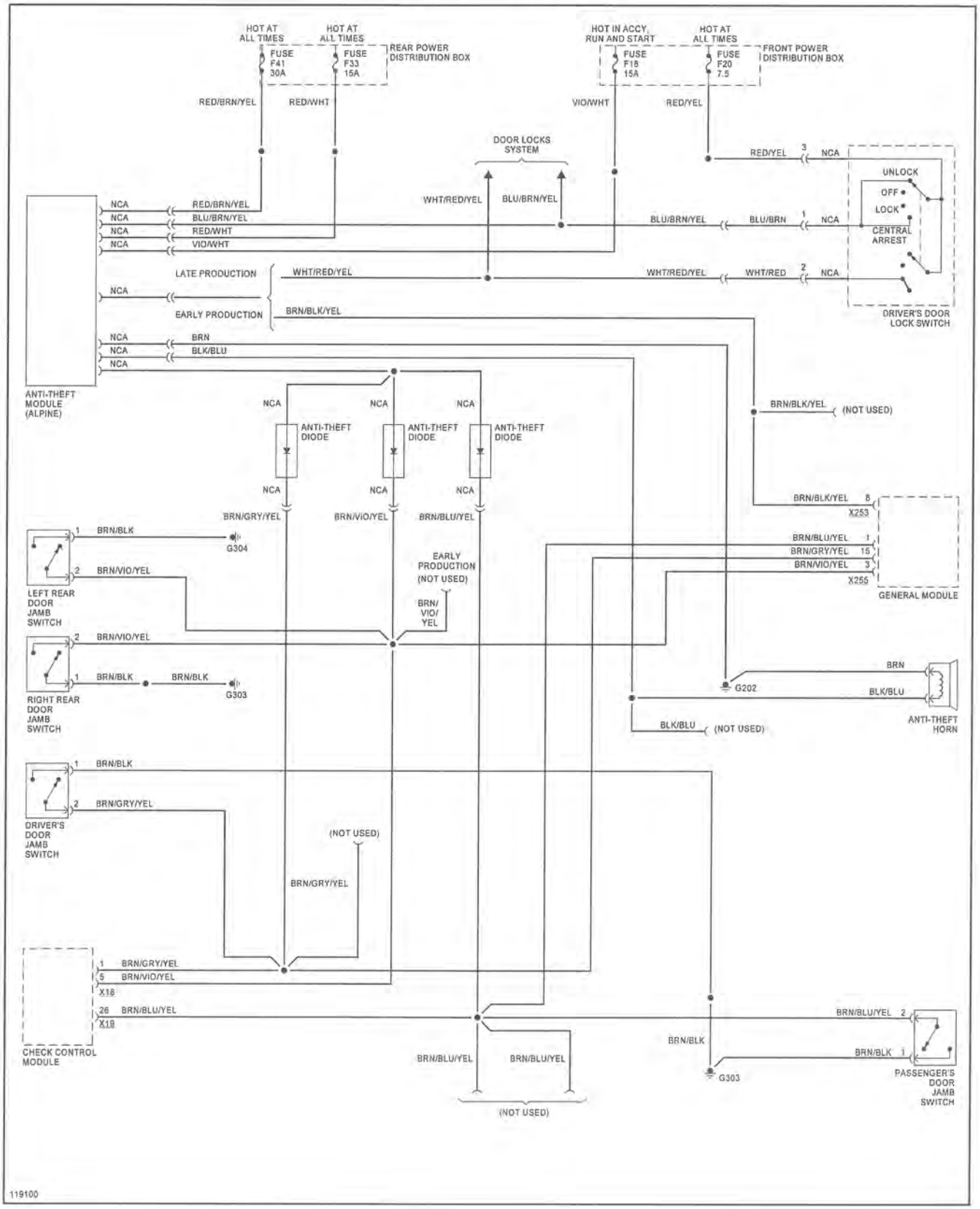
Anti-Theft

1991 Late Production w/DWA



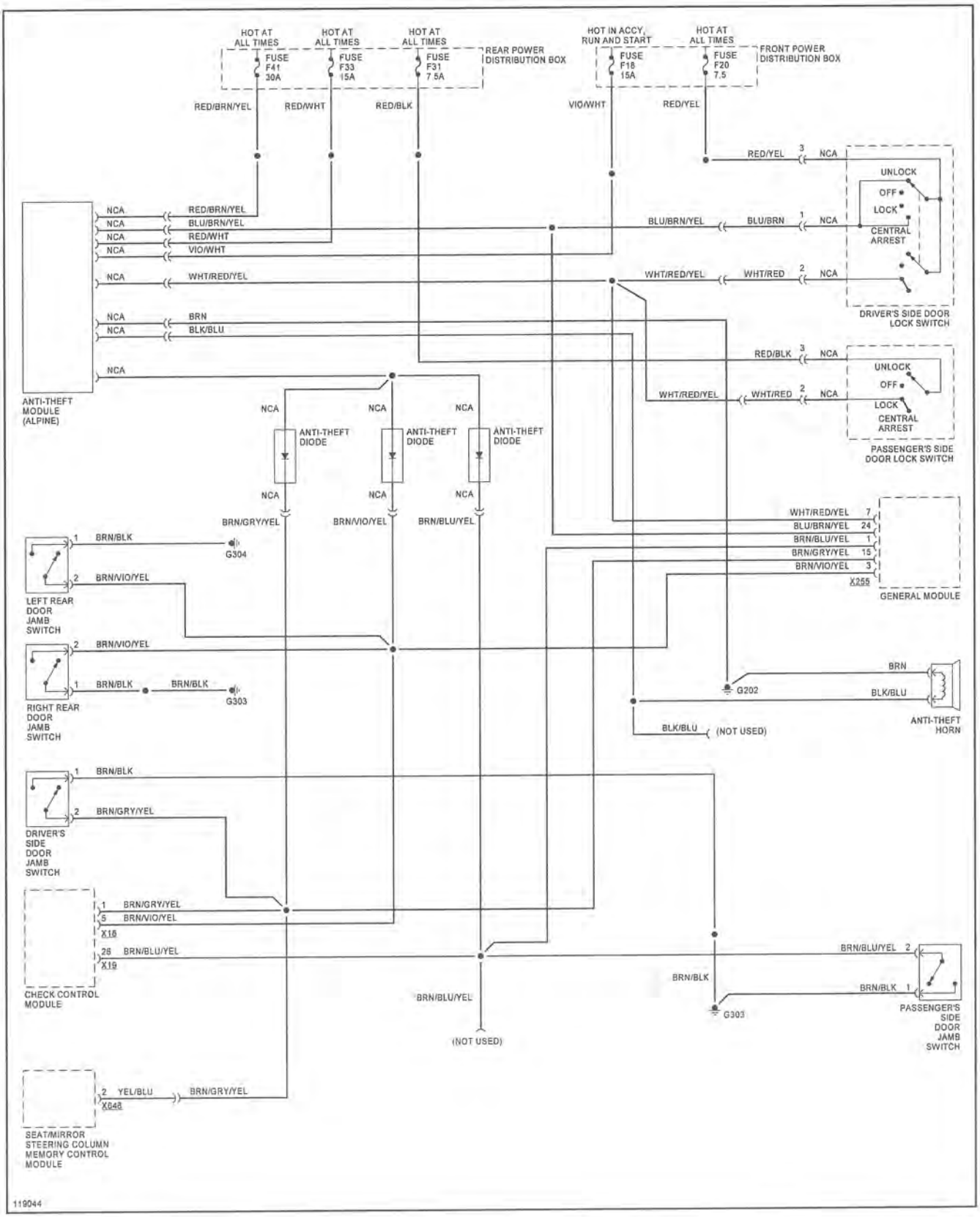
Anti-Theft

1991 Alpine System



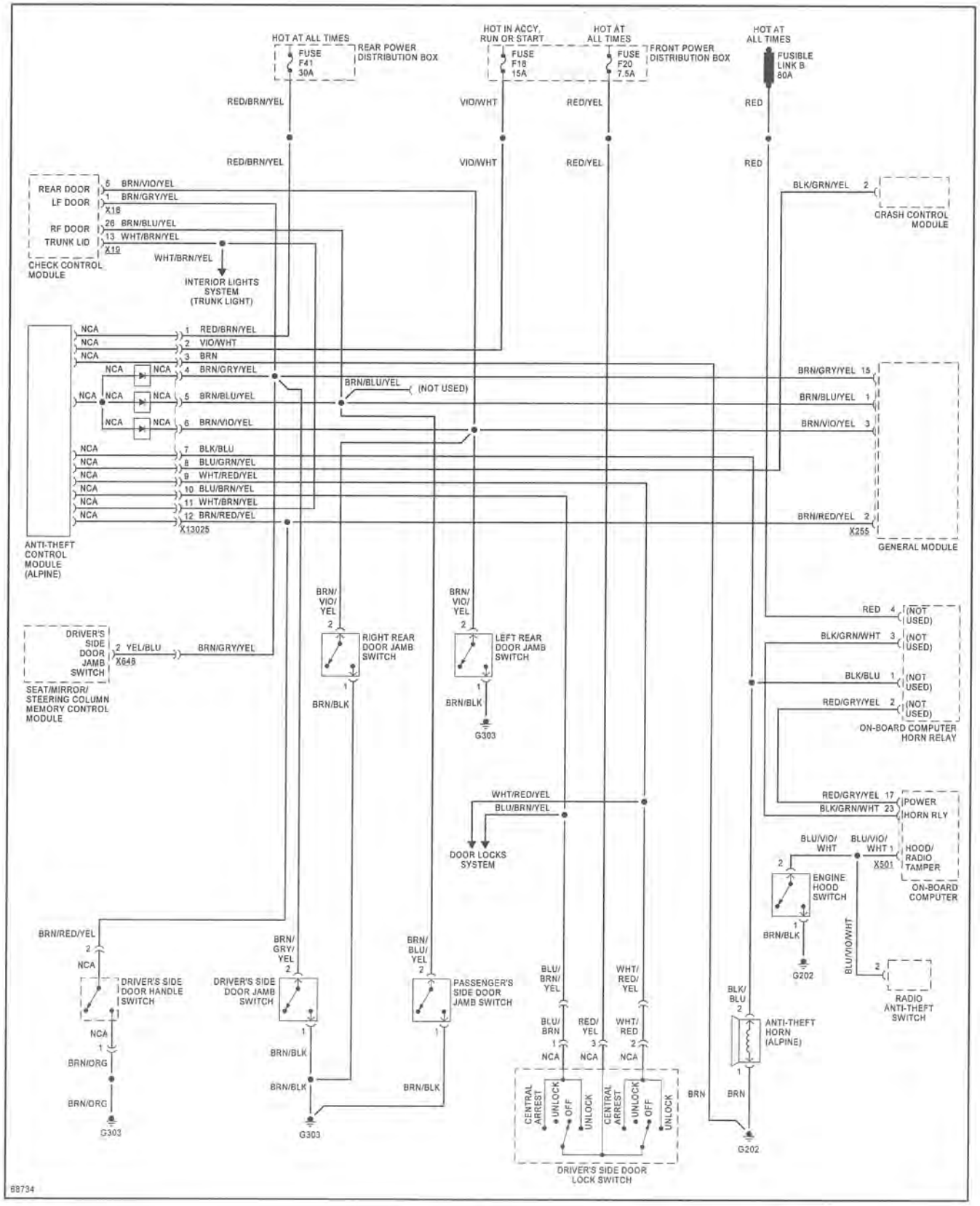
Anti-Theft

1992

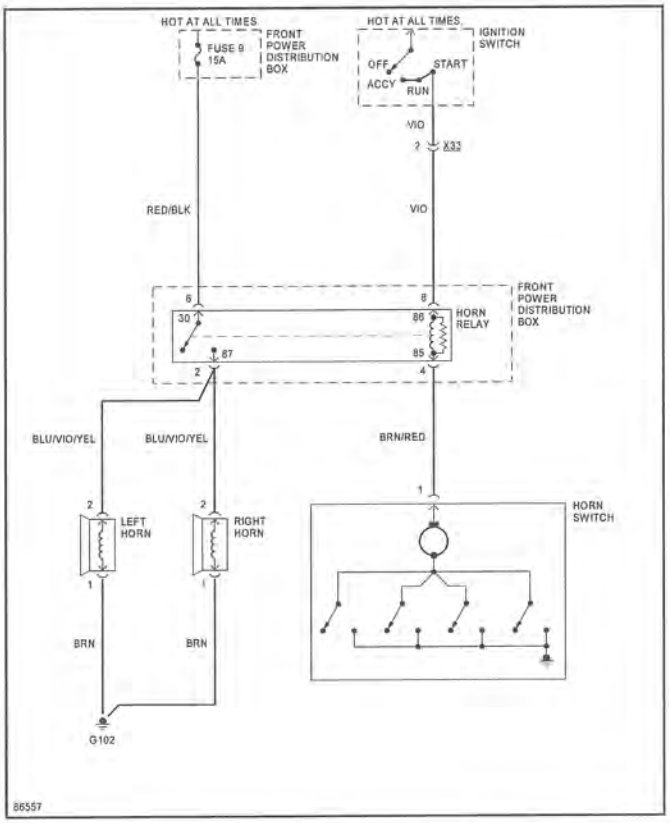


Anti-Theft

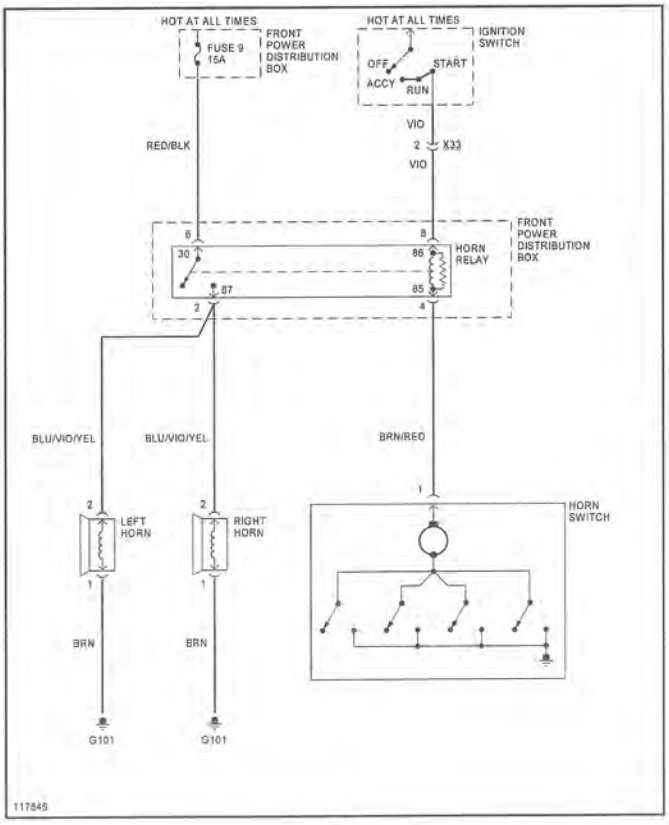
1993-94



Horns

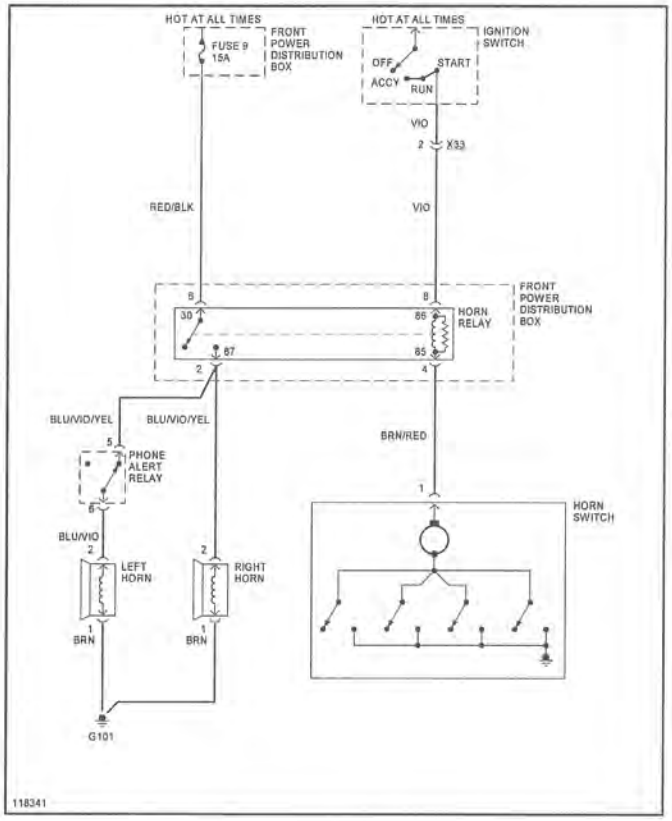


1988
735i & 735iL

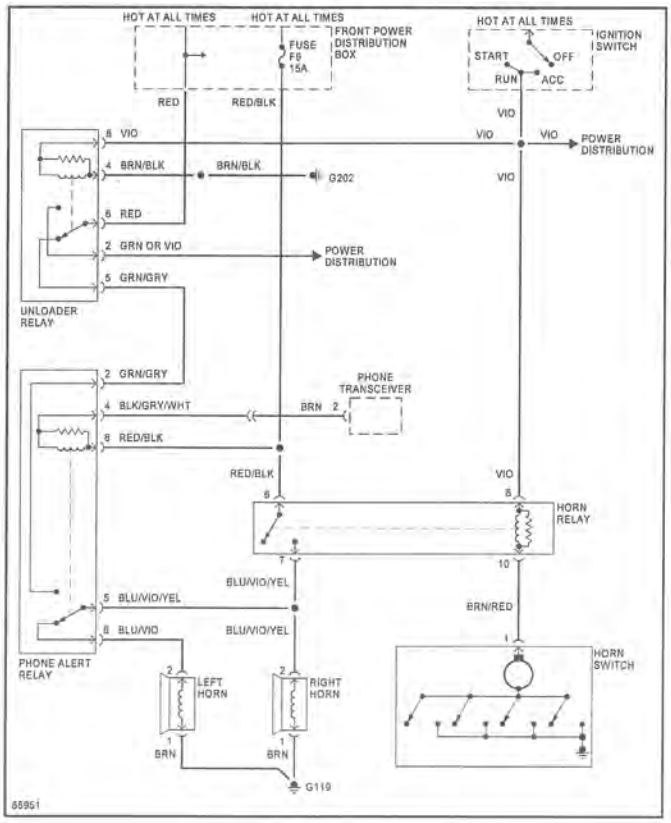


1988
750iL

Horns

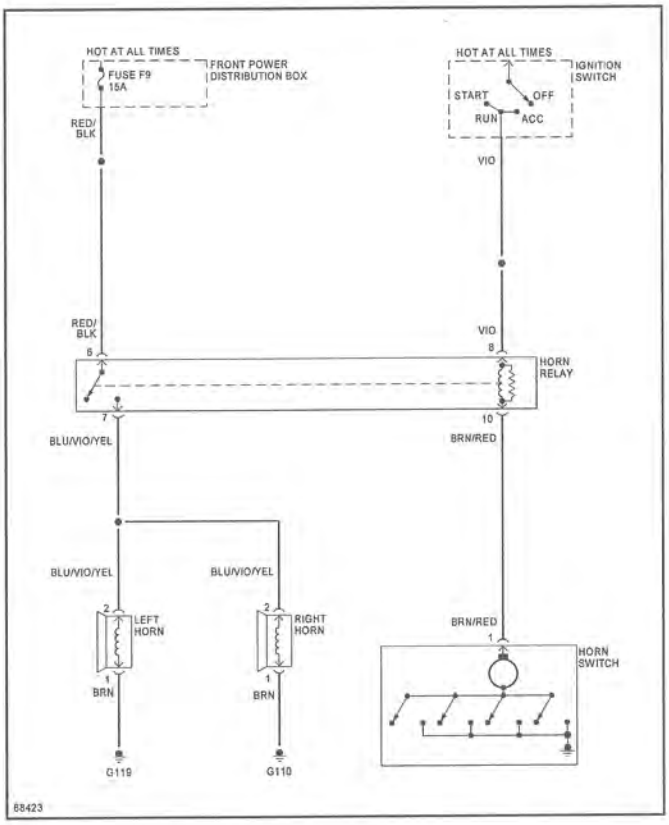


1989



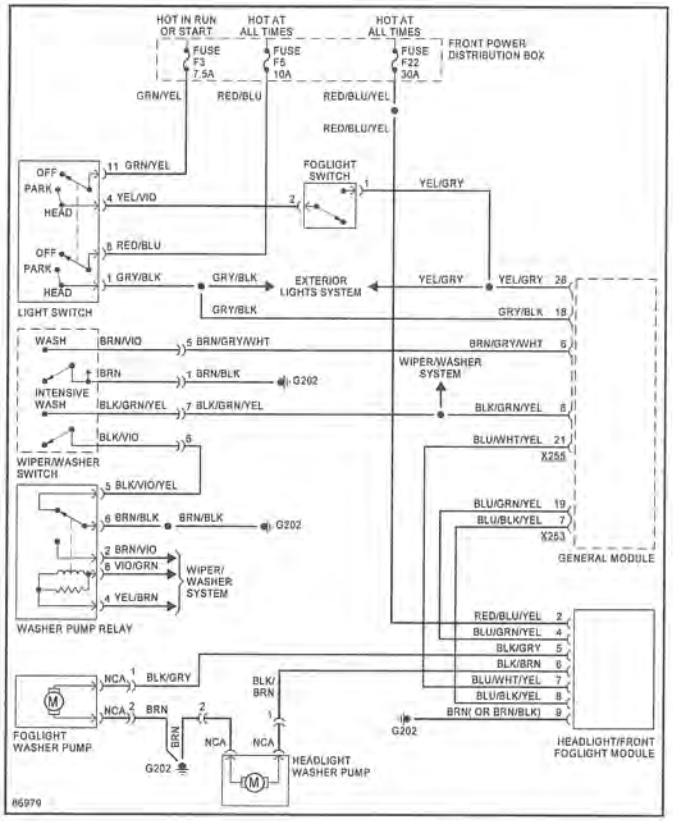
1990-1991

Horns

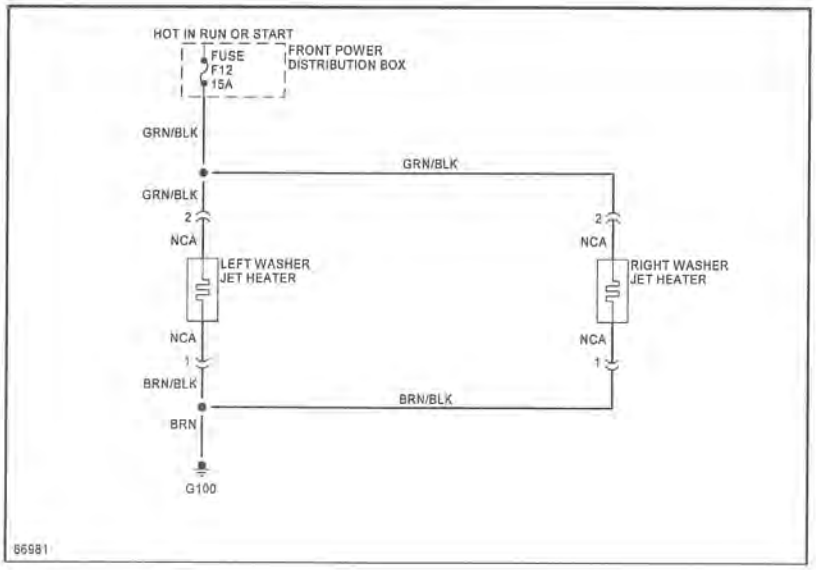


1992-94

Wiper/Washer

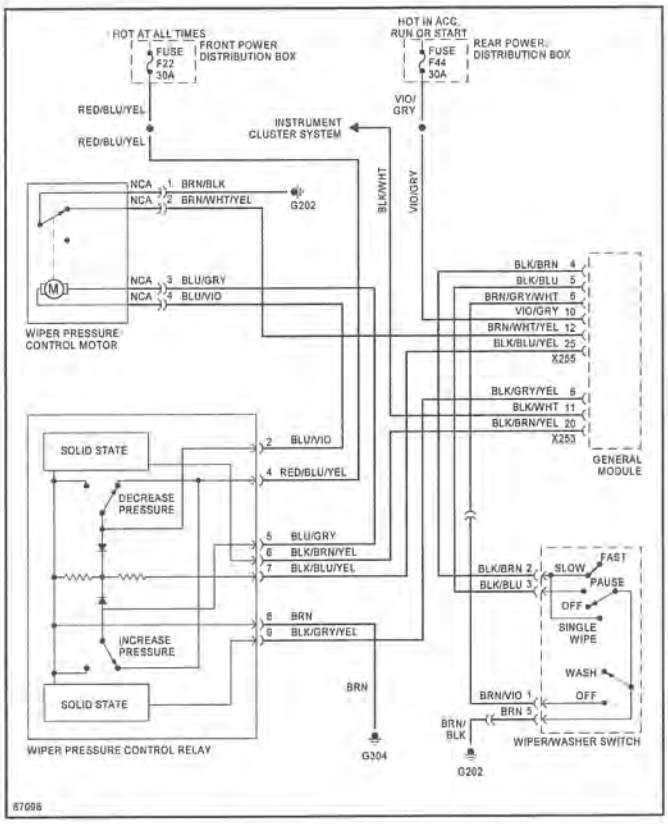


1988 Headlamp/ Foglamp Washer

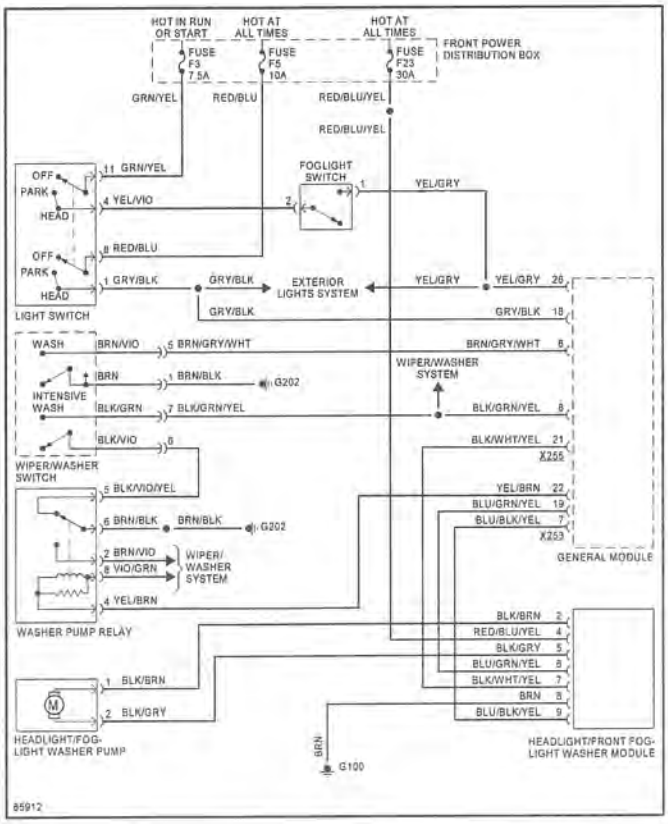


1988 Washer Jet Heater

Wiper/Washer



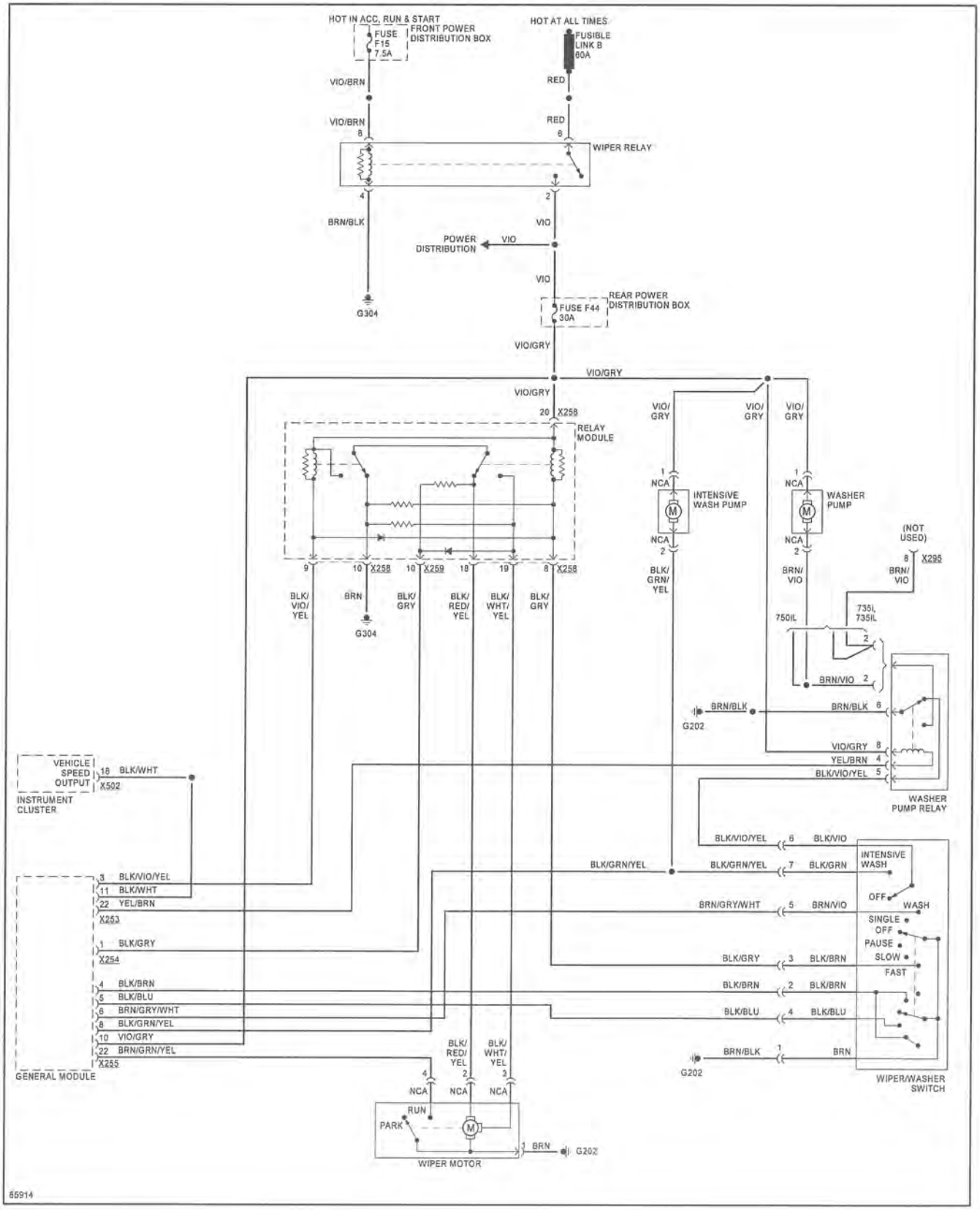
1988-89 Wiper Pressure Control



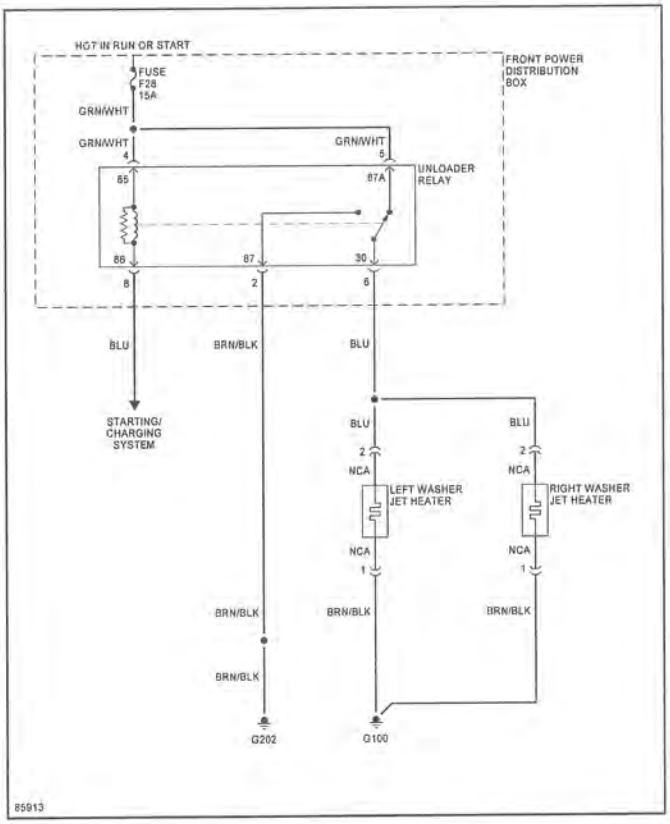
1989-90 Headlamp/ Foglamp Washer

Wiper/Washer

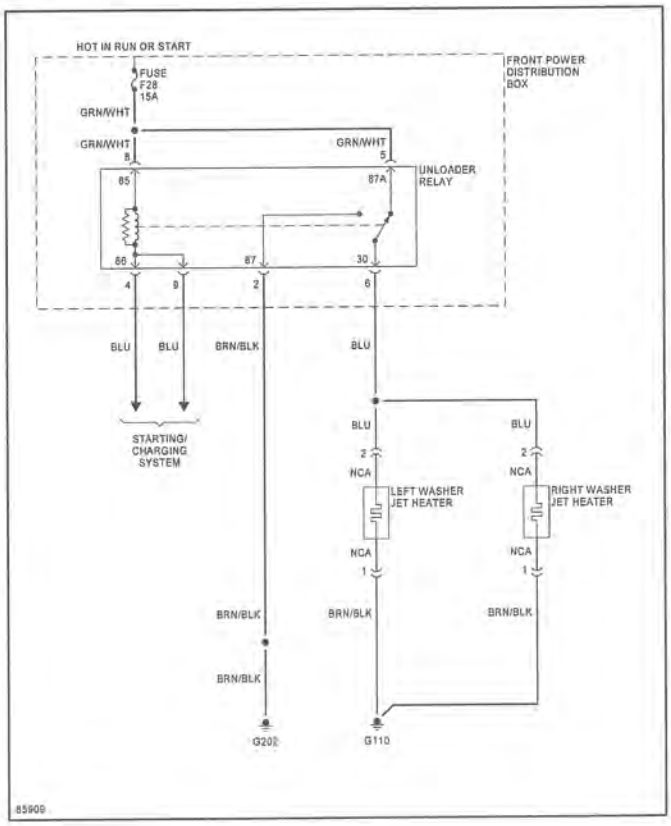
1988-90



Wiper/Washer

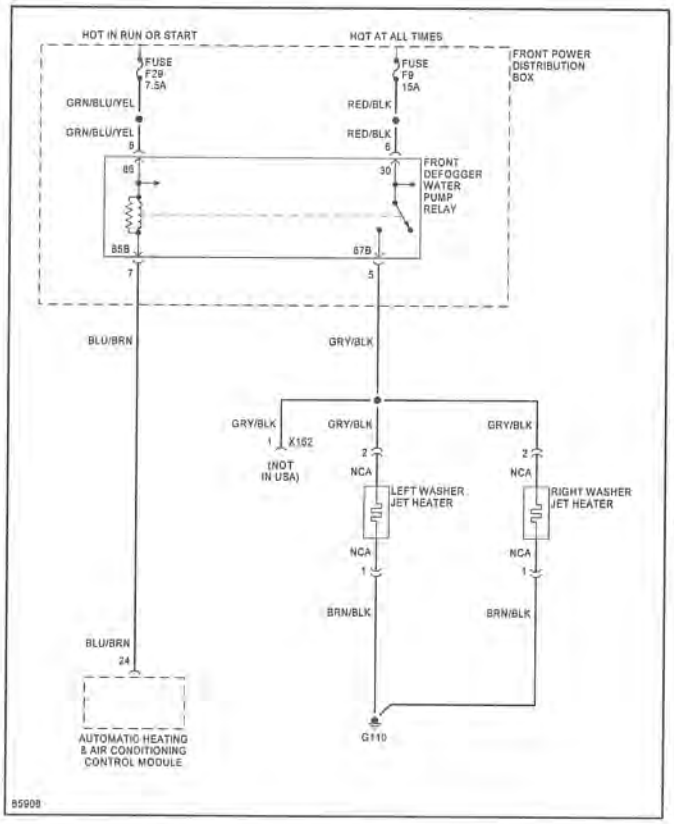


1989-90 Washer Jet Heater

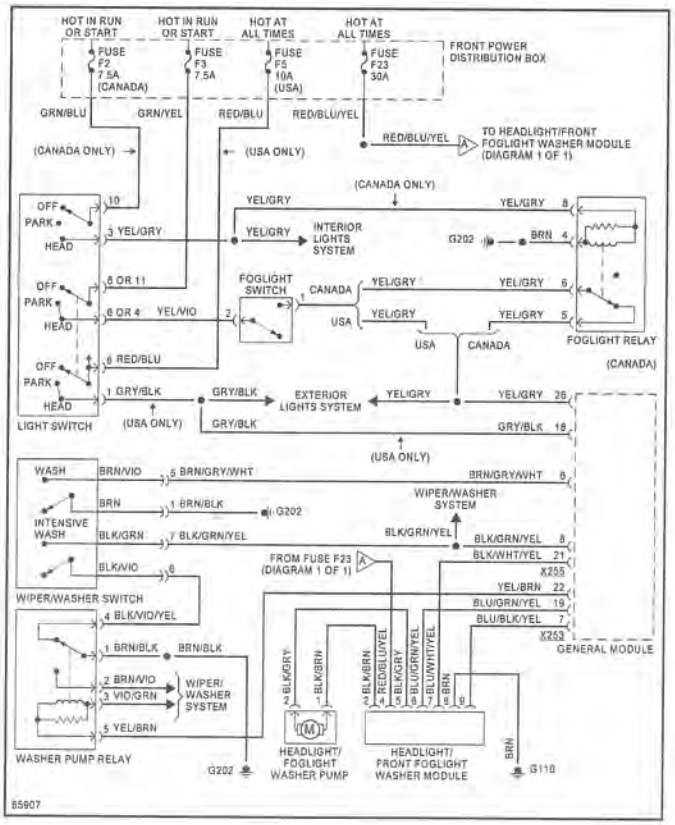


1991 Washer Jet Heater (Early Production)

Wiper/Washer



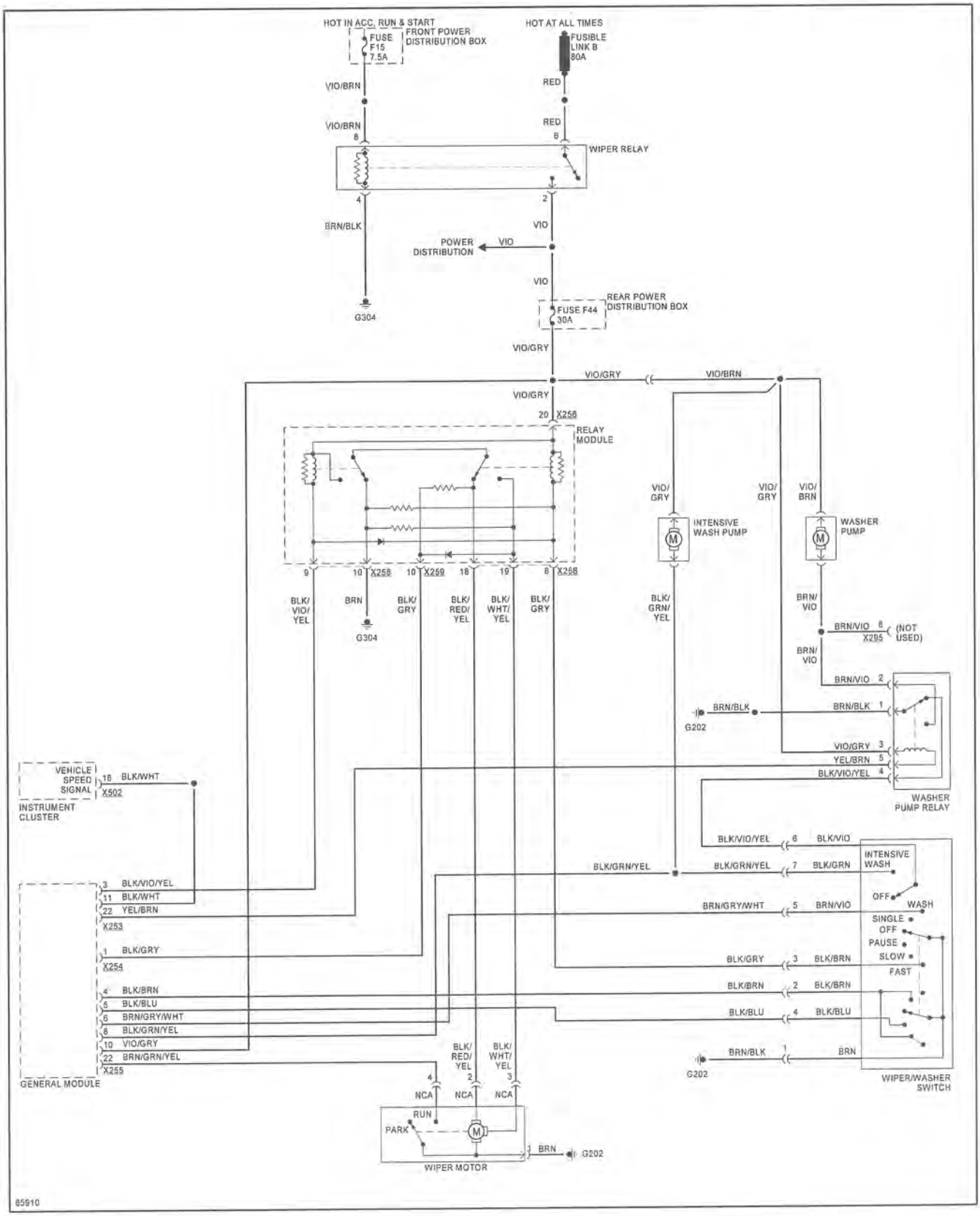
1991 Washer Jet Heater (Late Production)



1991 Headlamp/ Foglamp Washer

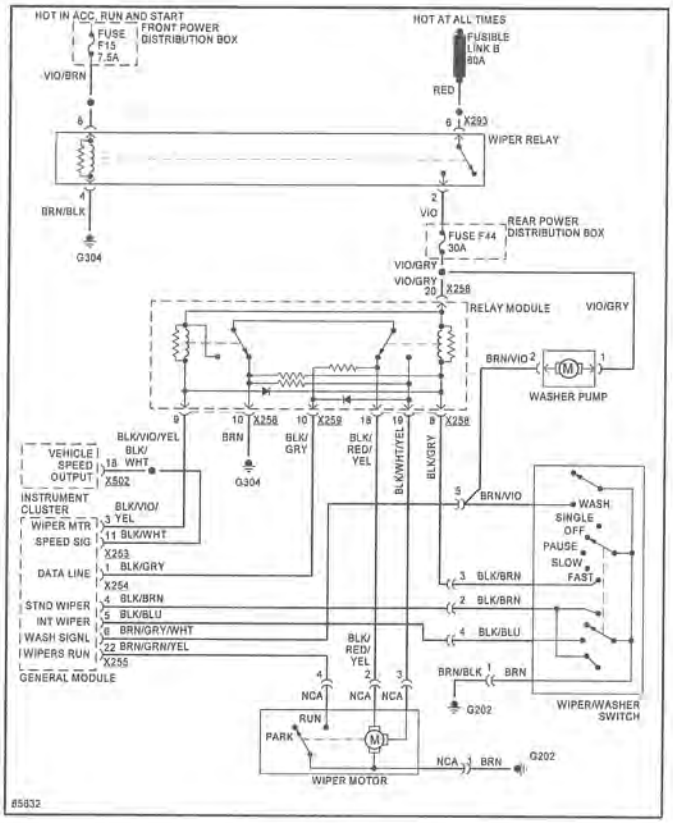
Wiper/Washer

1991

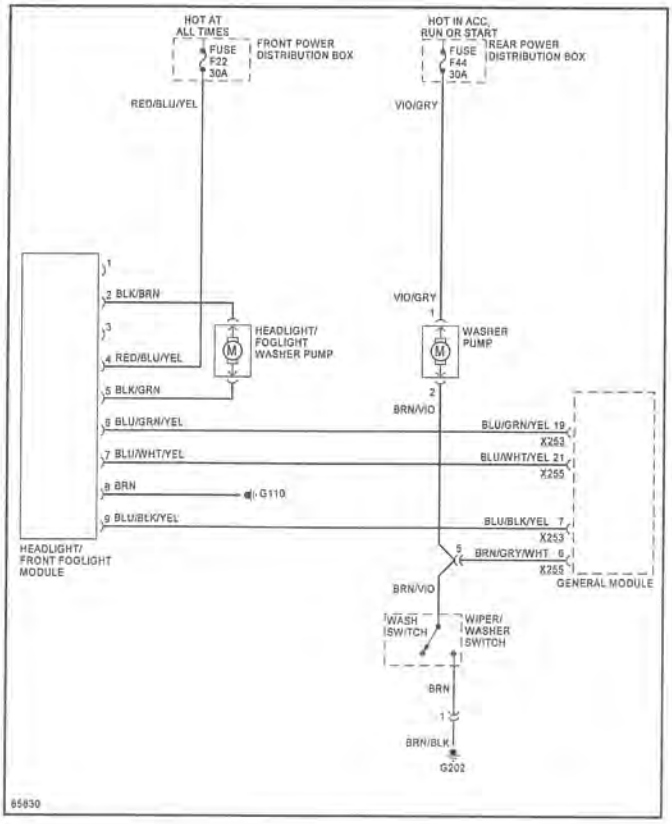


Wiper/Washer

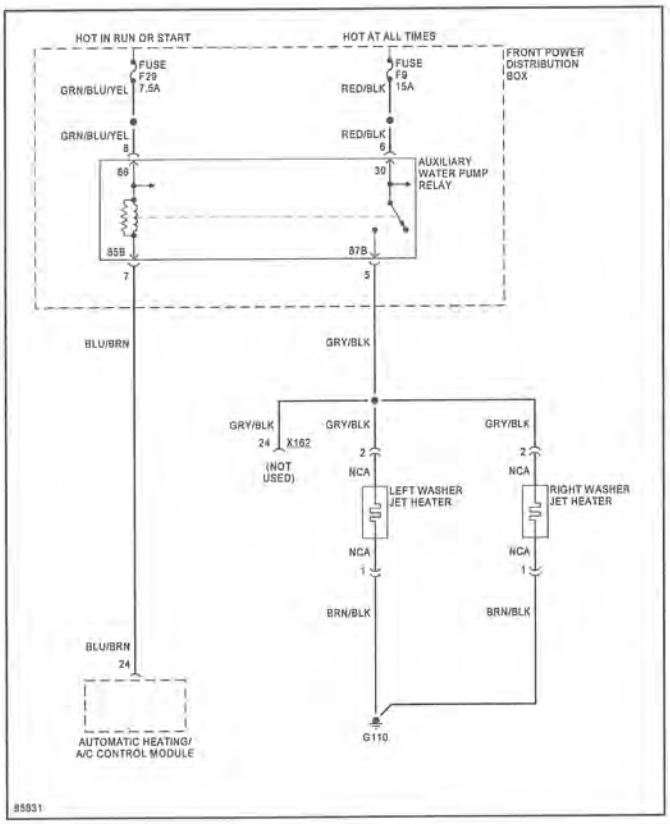
1992



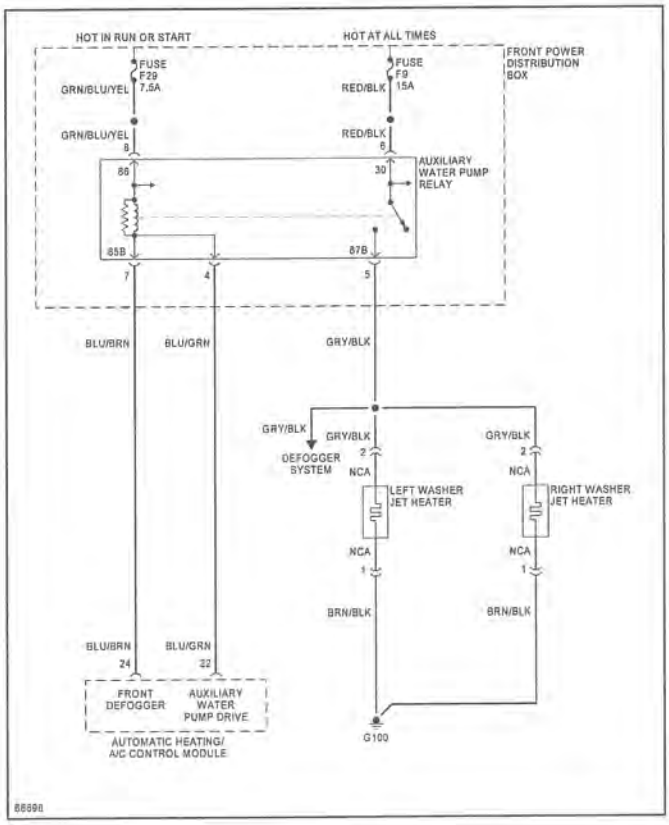
1992 Headlamp/ Foglamp Washer



Wiper/Washer

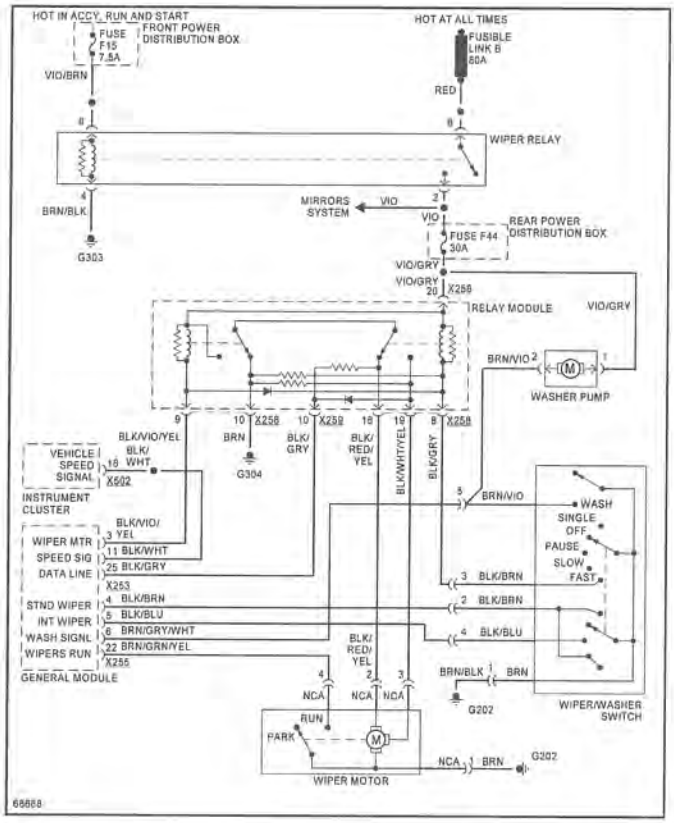


1992 Washer Jet Heater

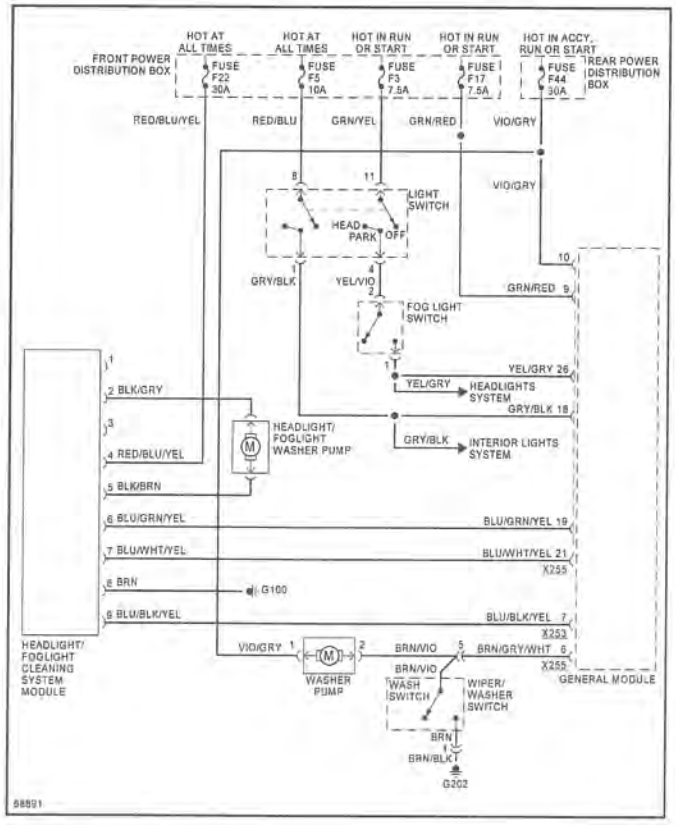


1993-94 Washer Jet Heater

Wiper/Washer



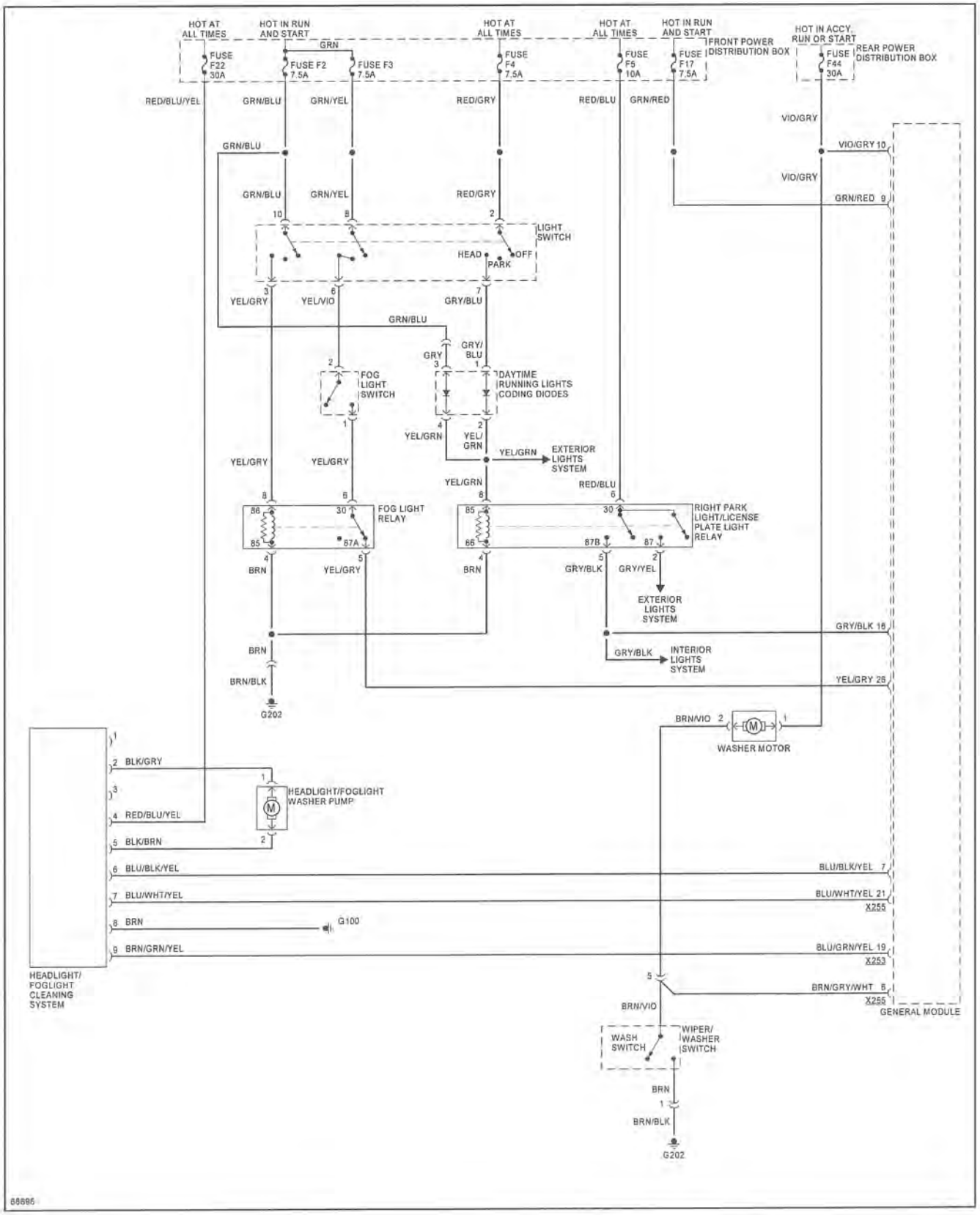
1993-94



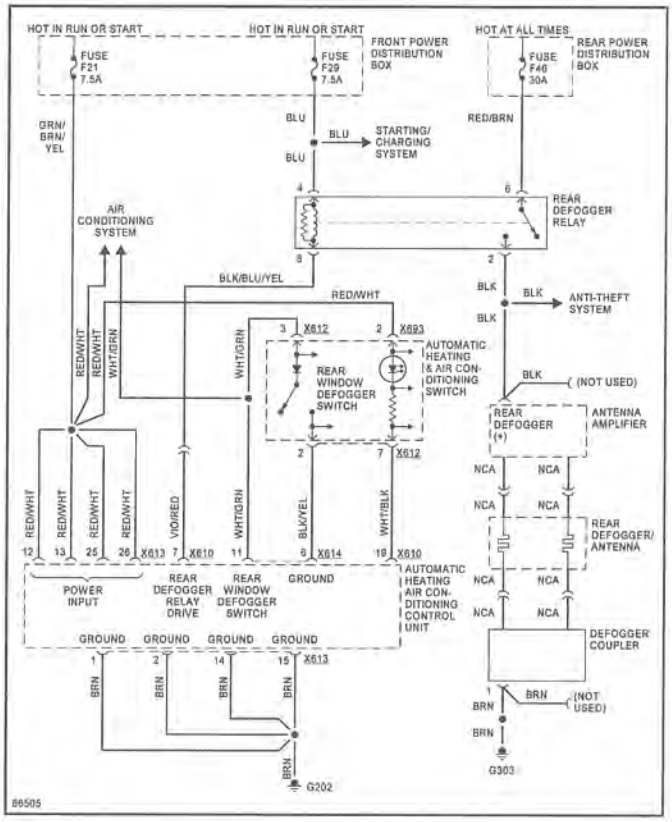
1993-94 Headlamp/ Foglamp Washer (USA)

Wiper/Washer

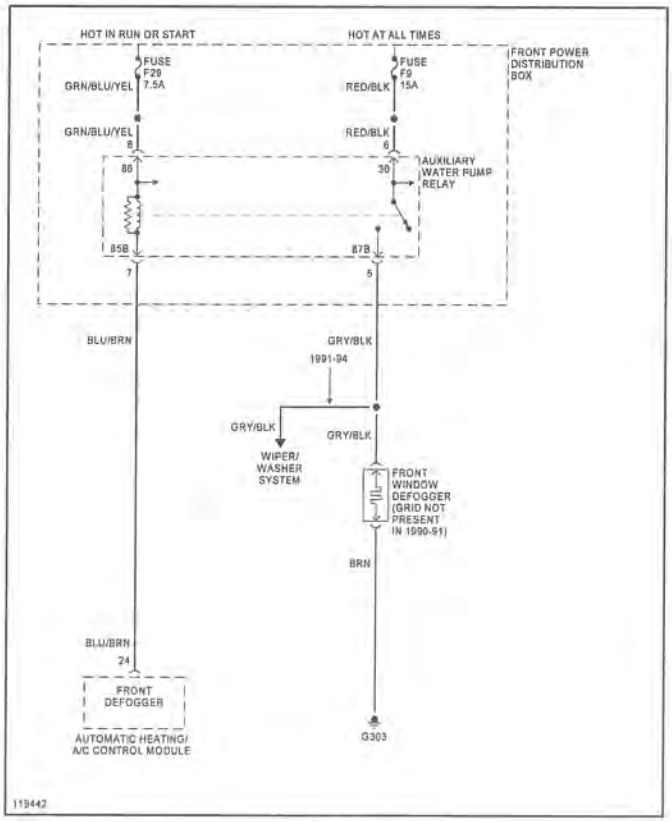
1993-94 Headlamp/Foglamp Washer (Canada)



Defogger

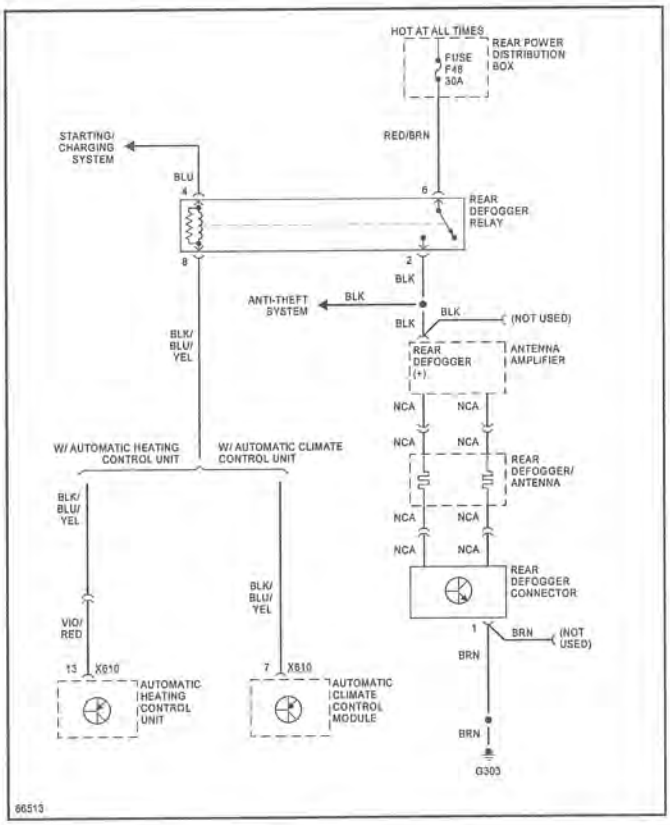


1988 Rear Defogger

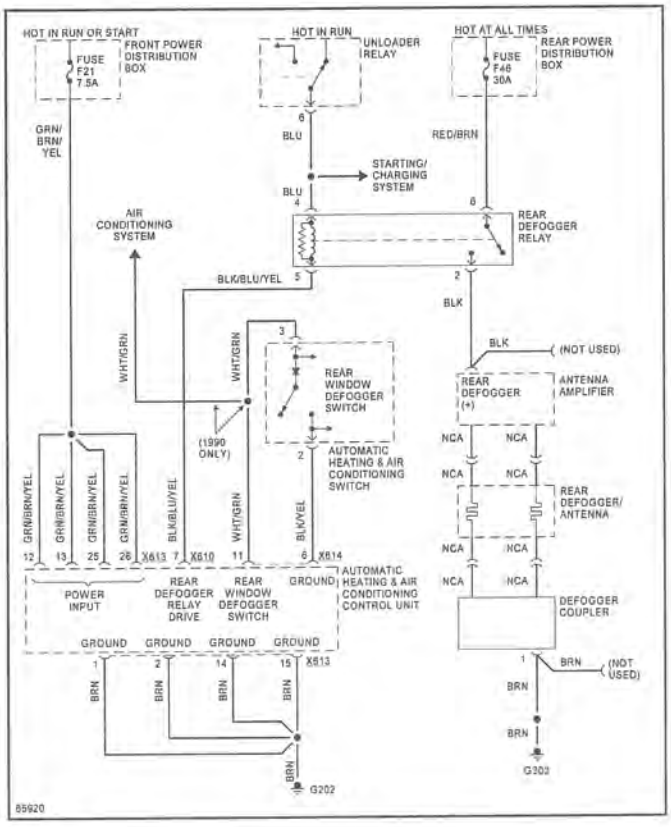


1988-94 Front Defogger

Defogger

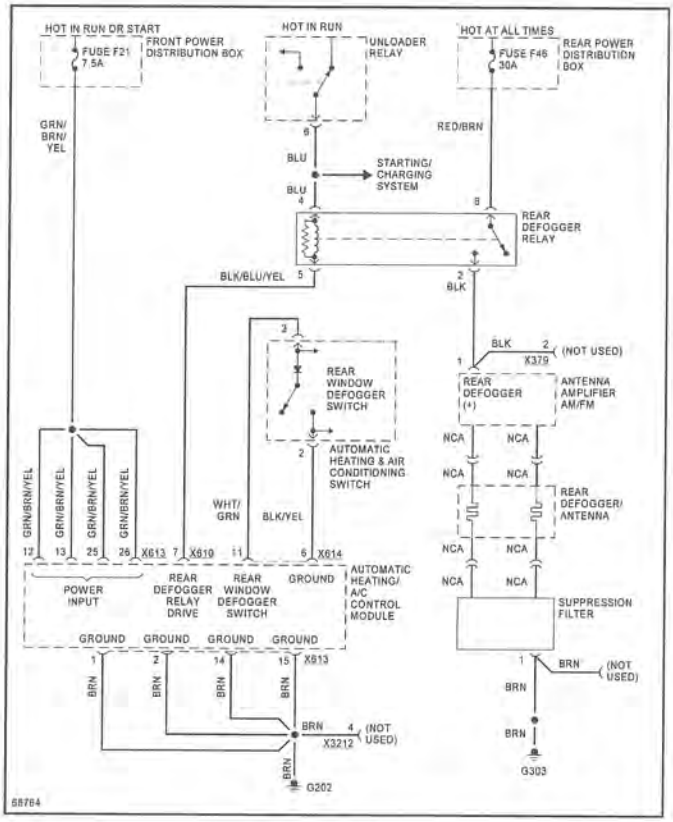


1989



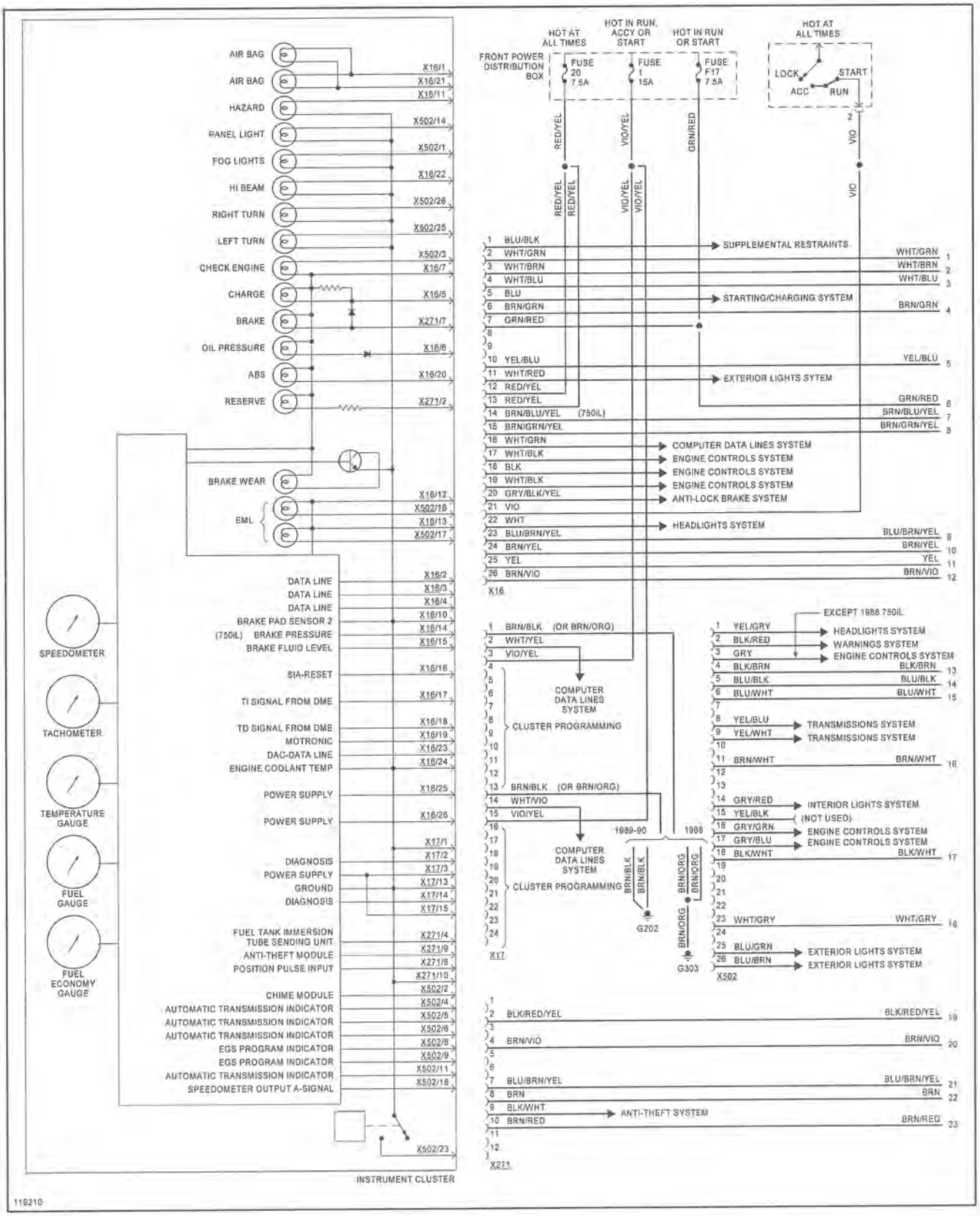
1990-92

Defogger



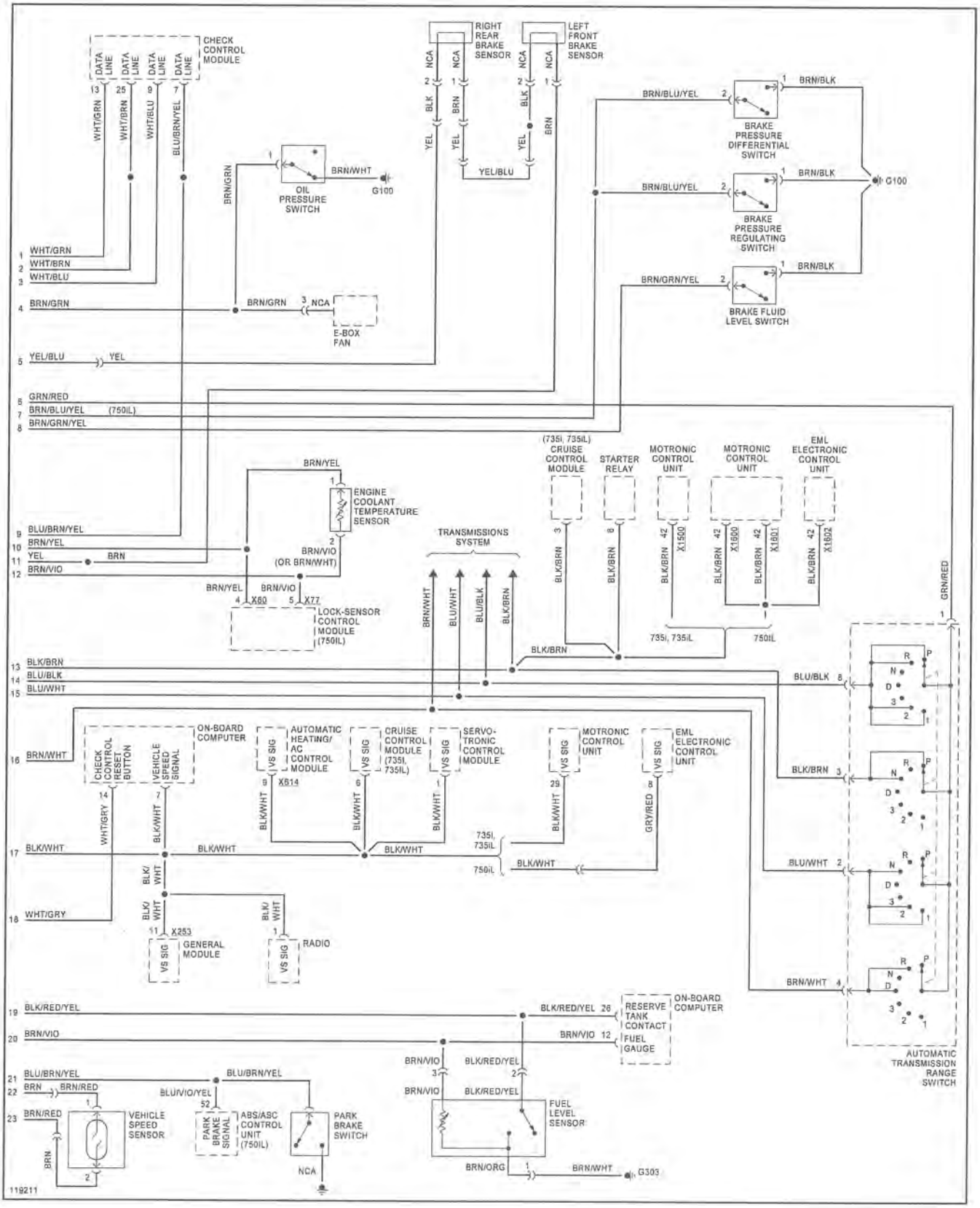
1993-94

Instrument Panel
1988-90 (1 of 2)



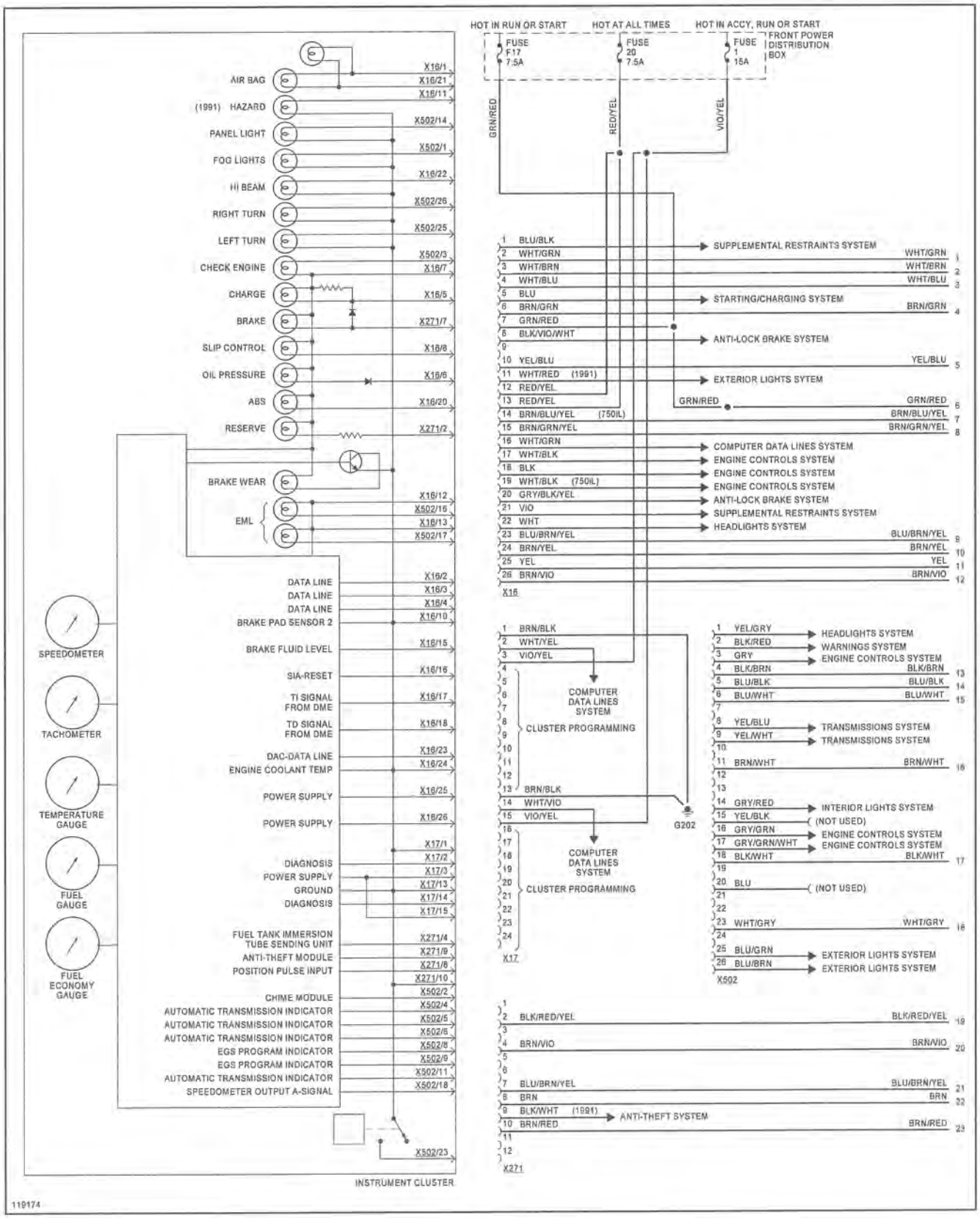
Instrument Panel

1988-90 (2 of 2)



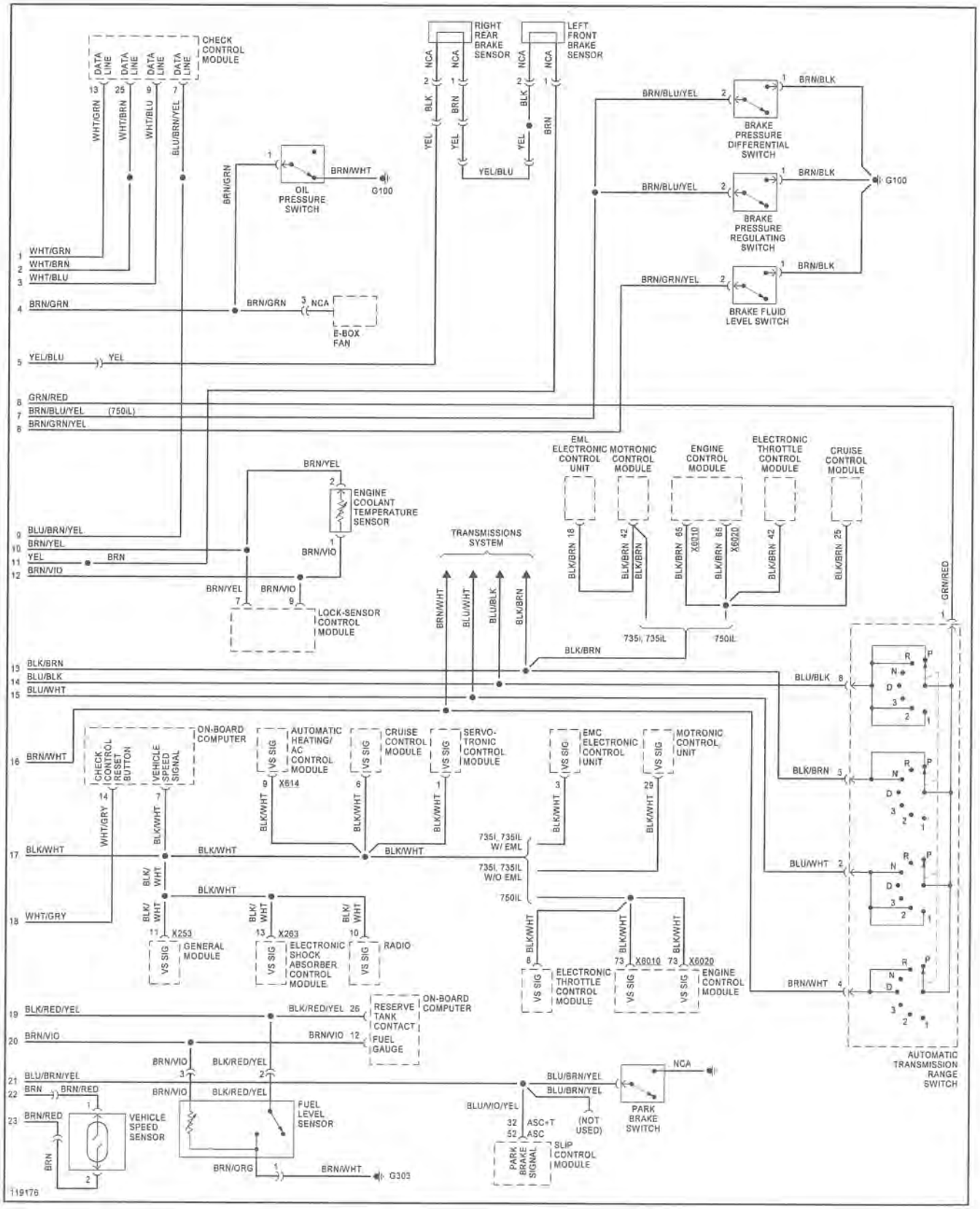
Instrument Panel

1991-92 (1 of 2)



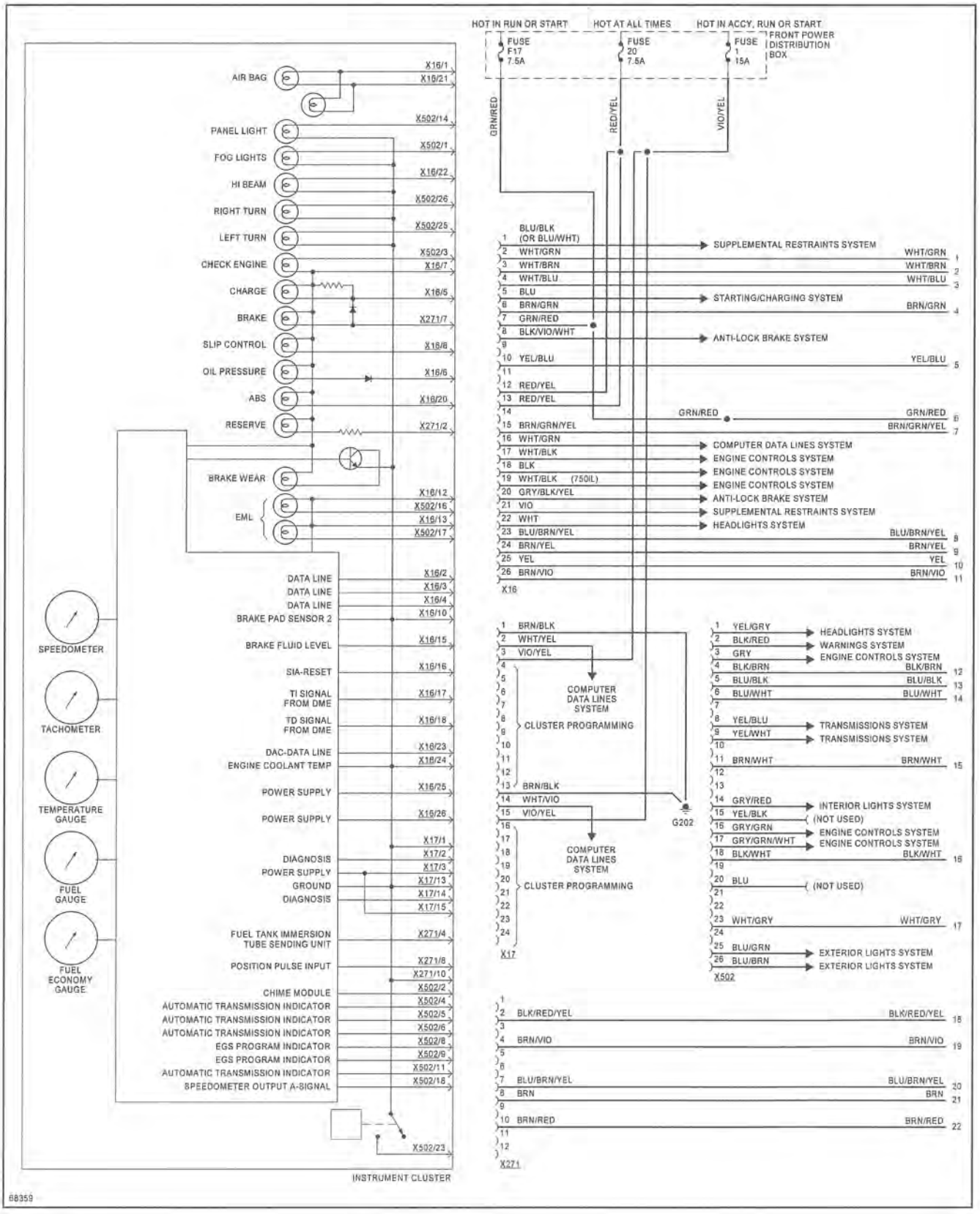
Instrument Panel

1991-92 (2 of 2)



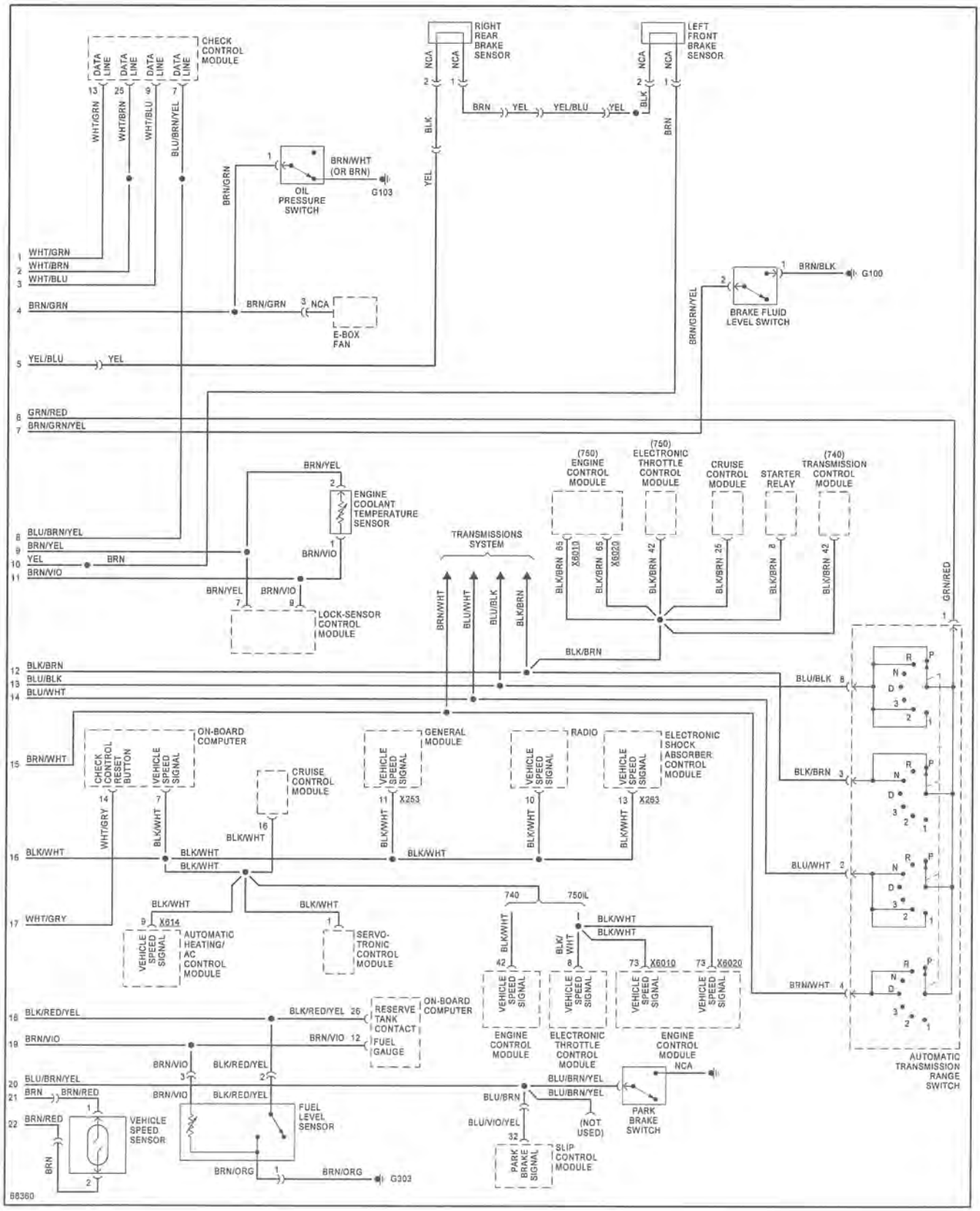
Instrument Panel

1993-94 (1 of 2)



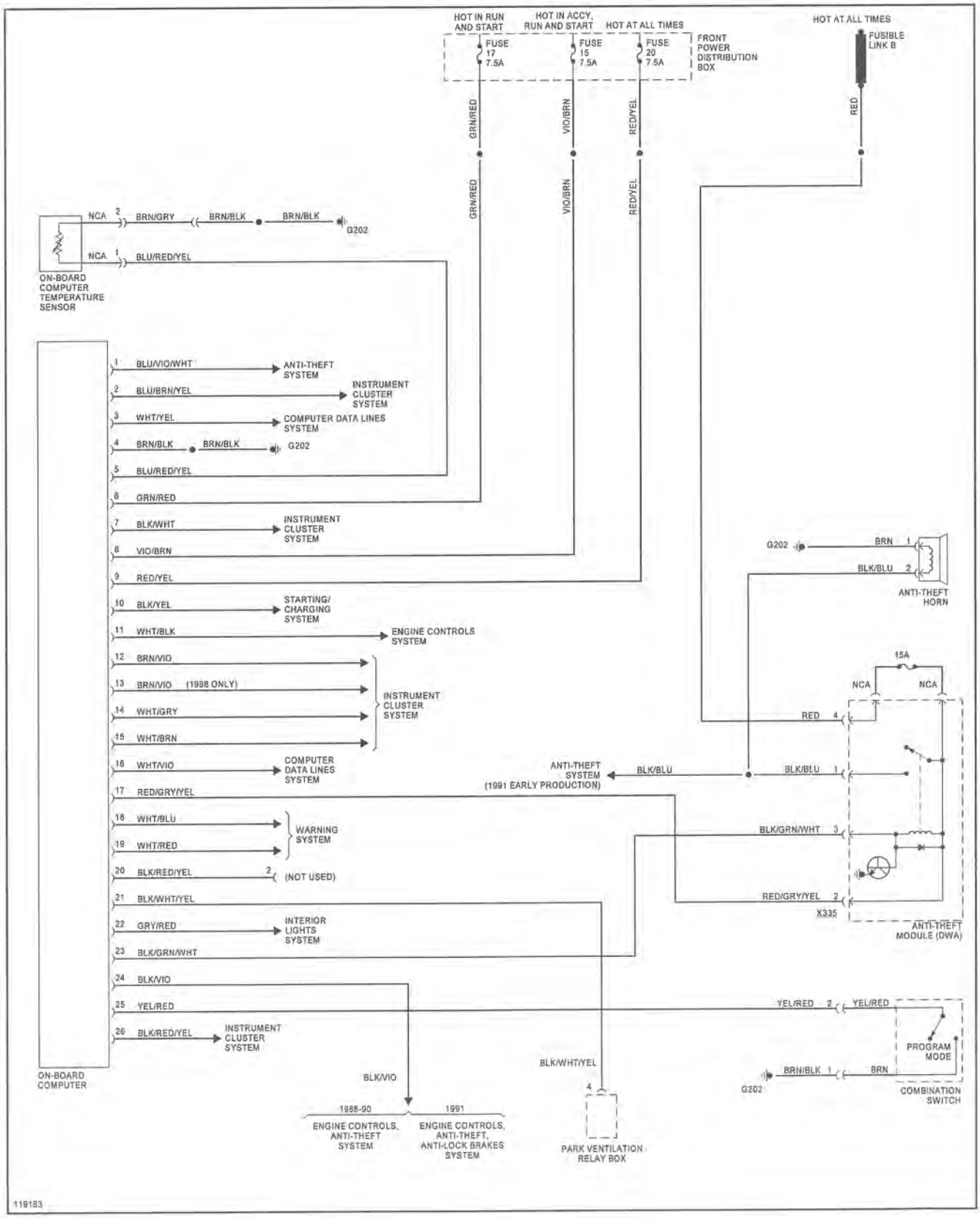
Instrument Panel

1993-94 (2 of 2)



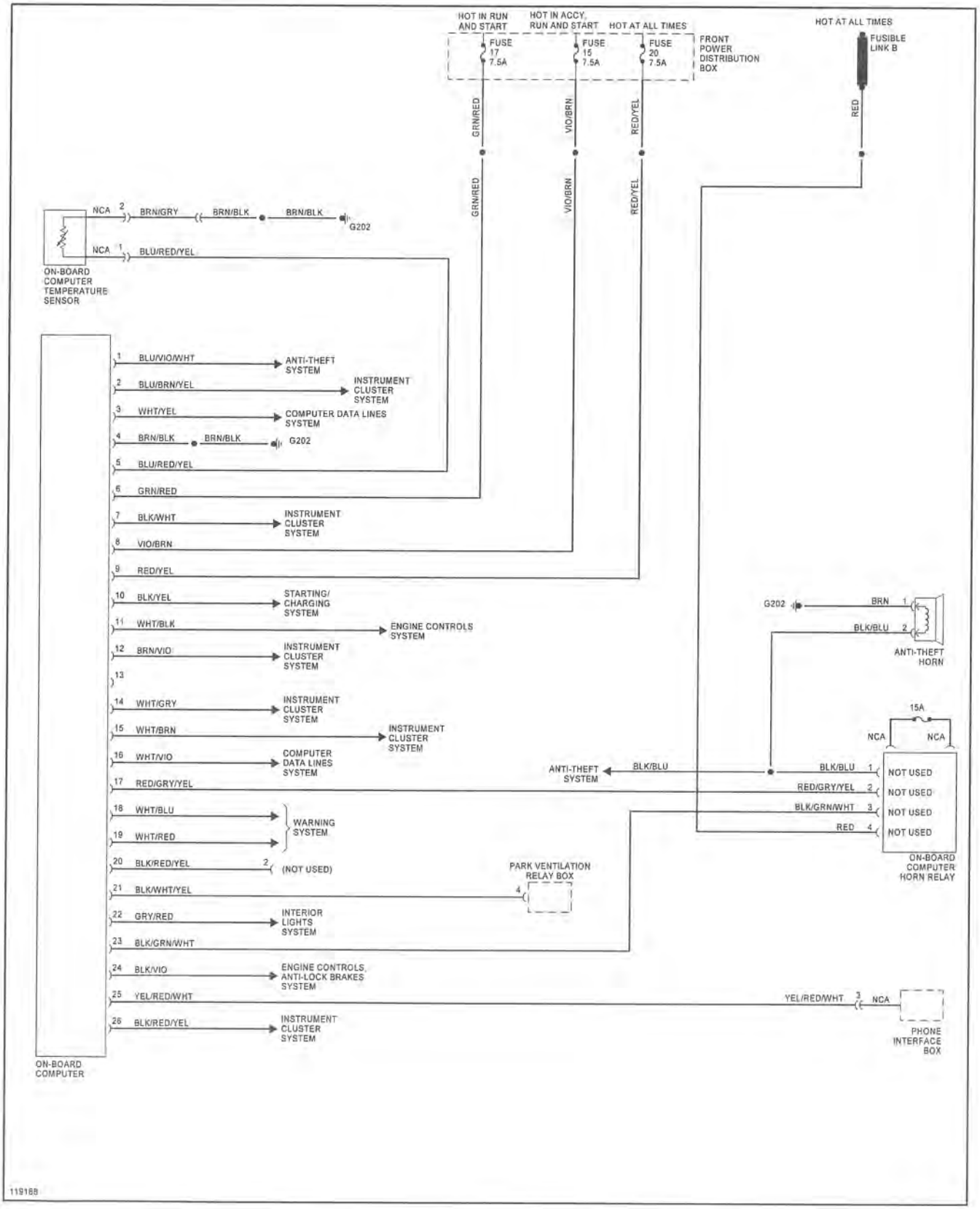
On-Board Computer

1988-91



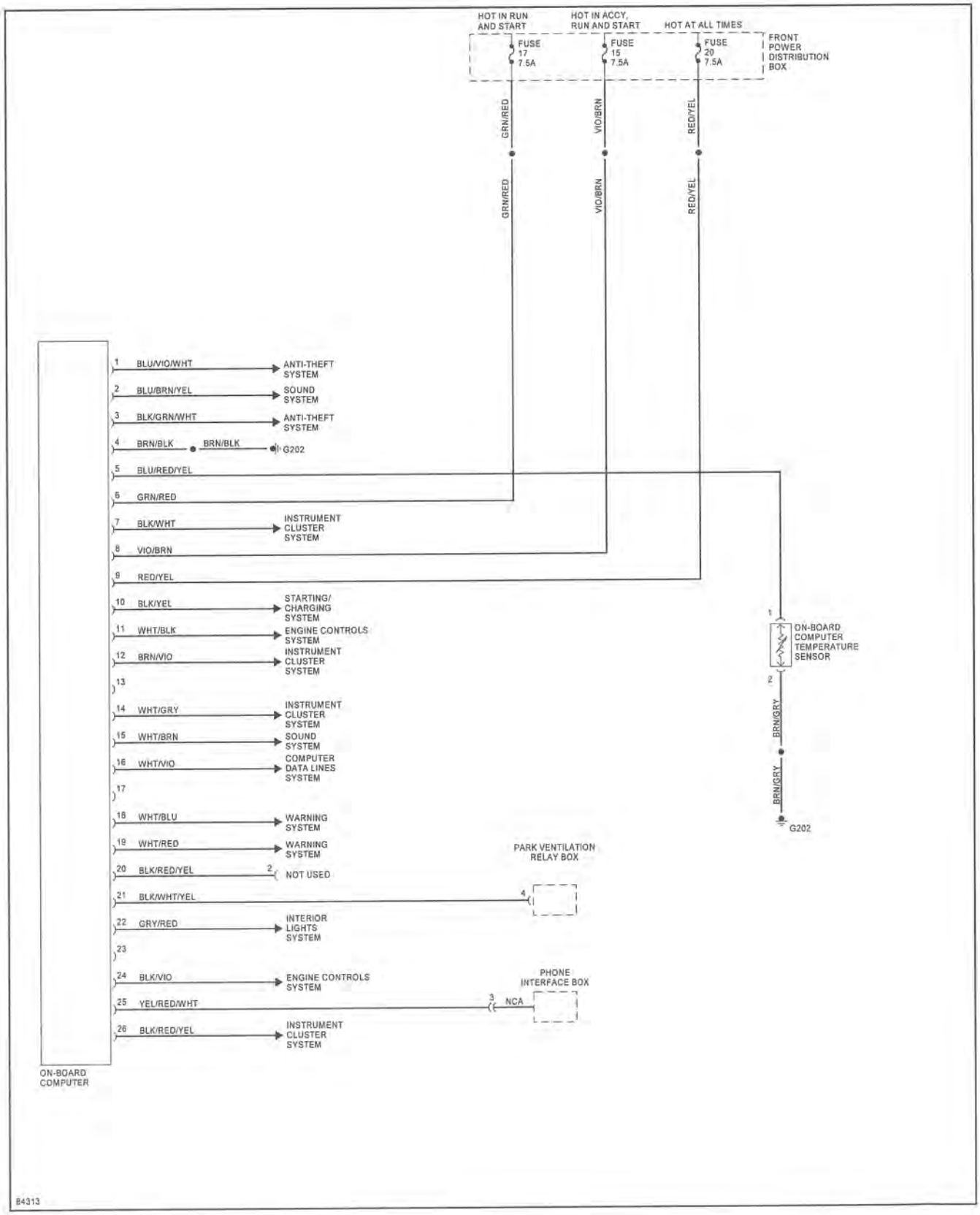
On-Board Computer

1992

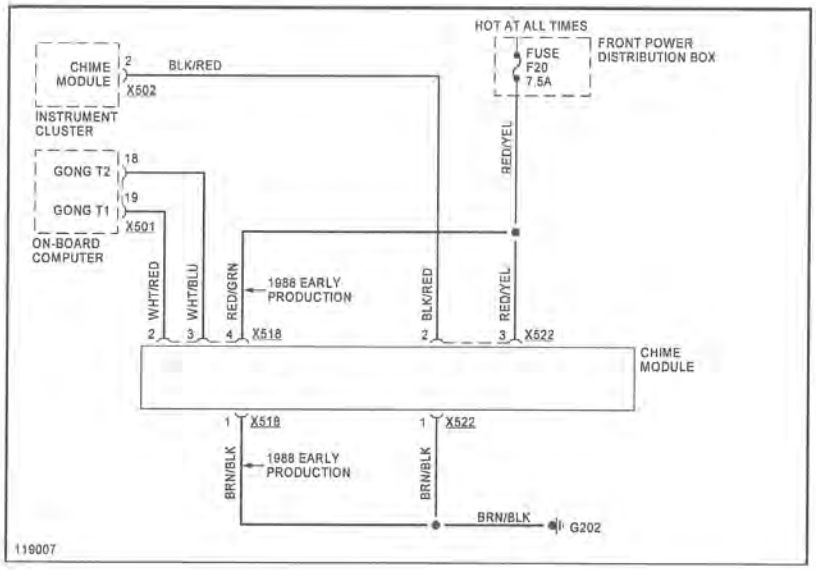


On-Board Computer

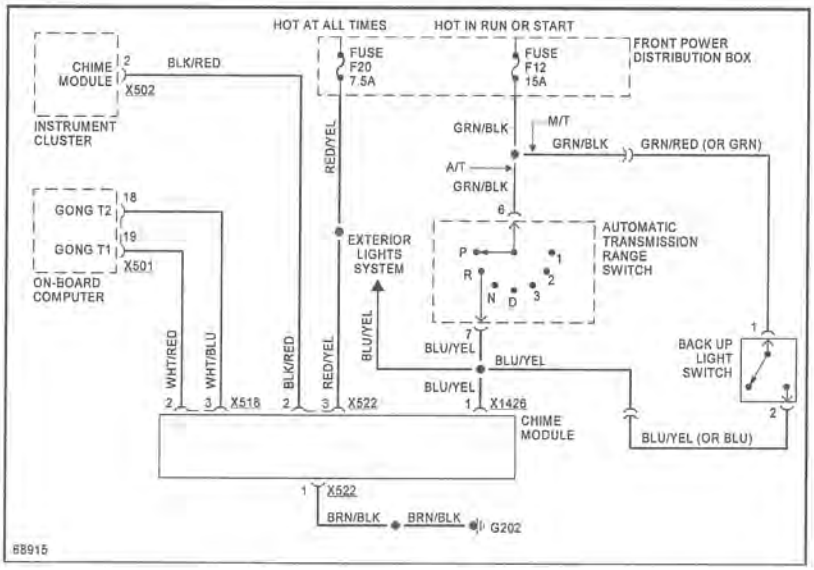
1993-94



Warning System: Chimes



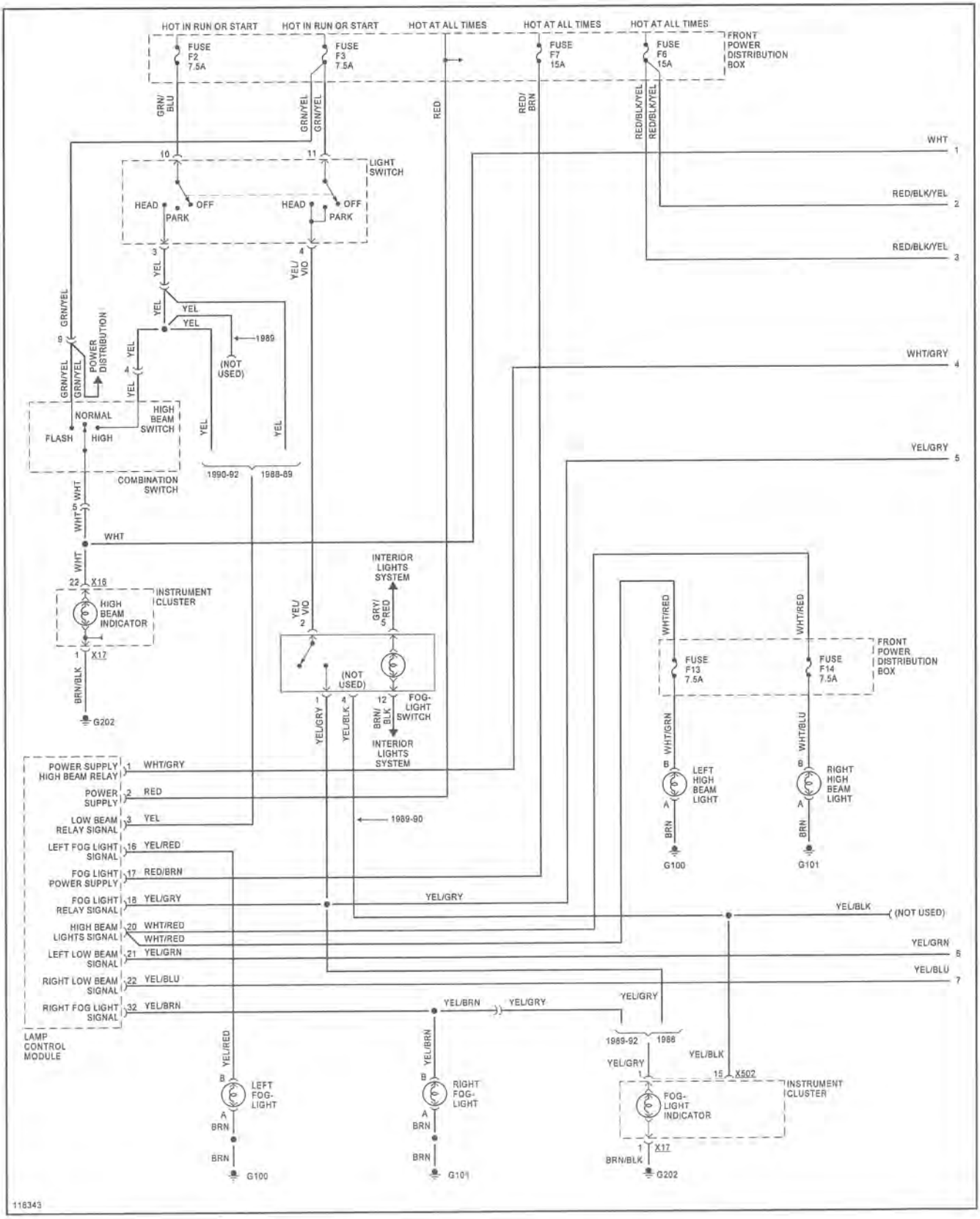
1988-89



1990-94

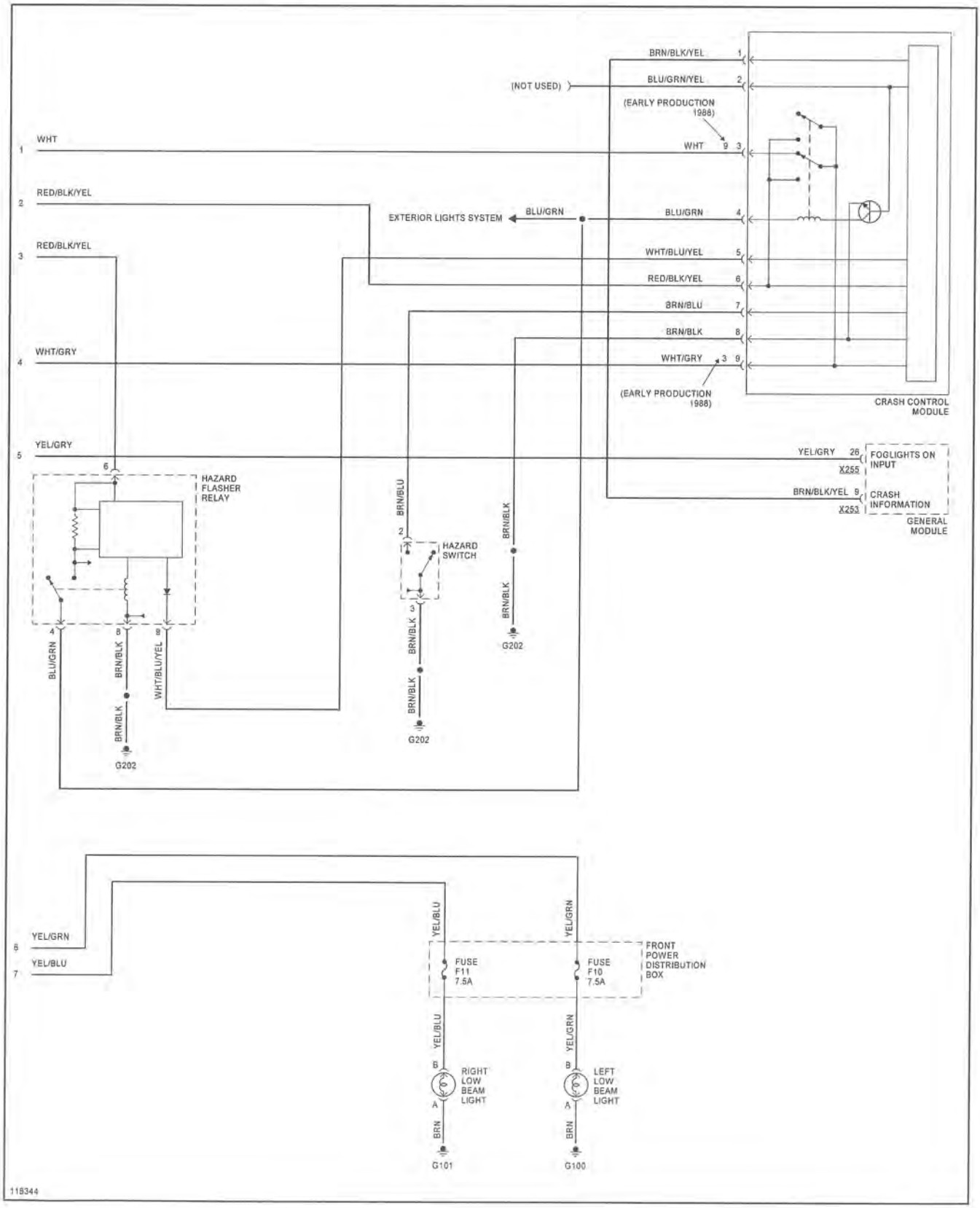
Headlights/Foglights

1988-90, 1991-92 w/o DRL (1 of 2)



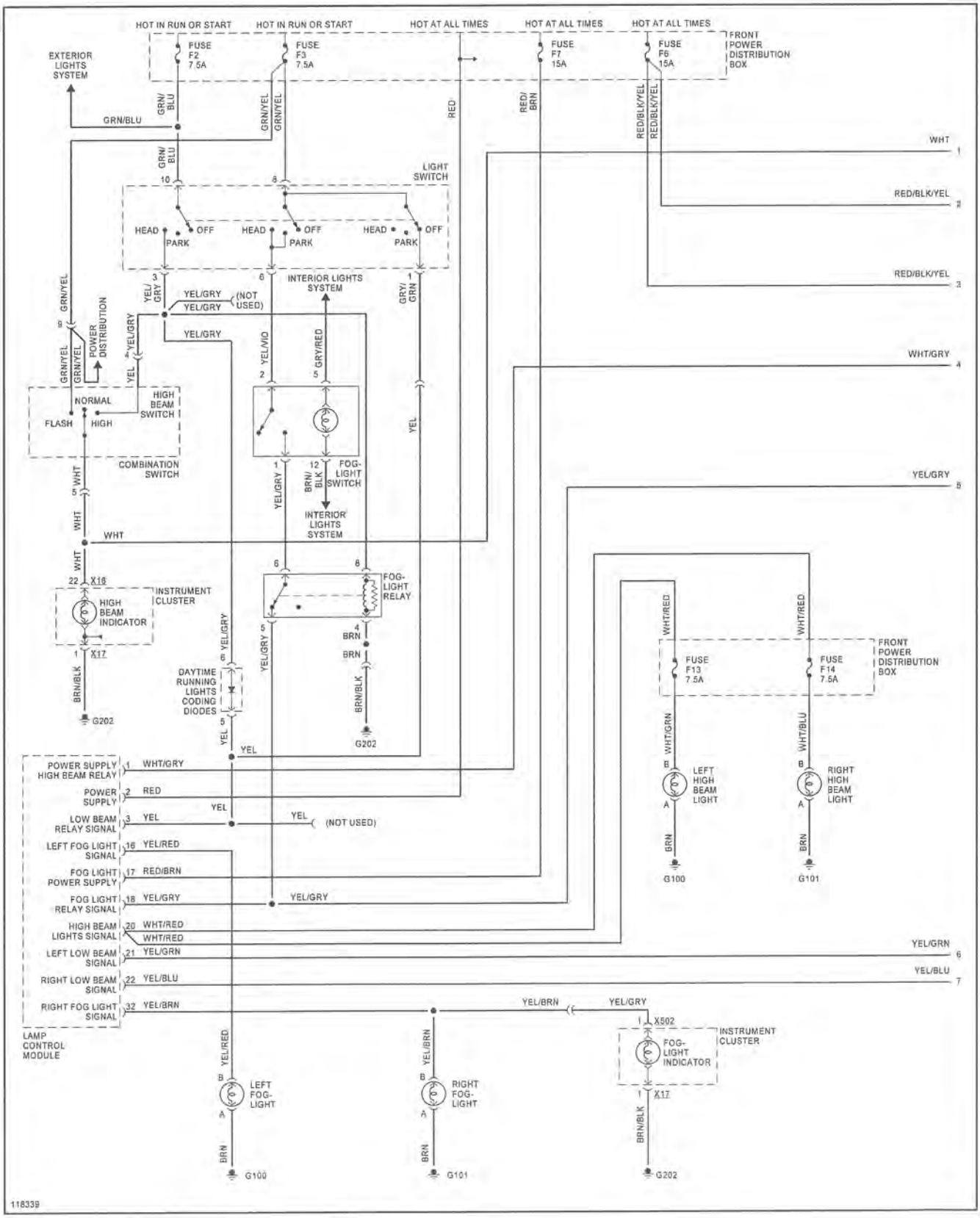
Headlights/Foglights

1988-90, 1991-92 w/o DRL (2 of 2)



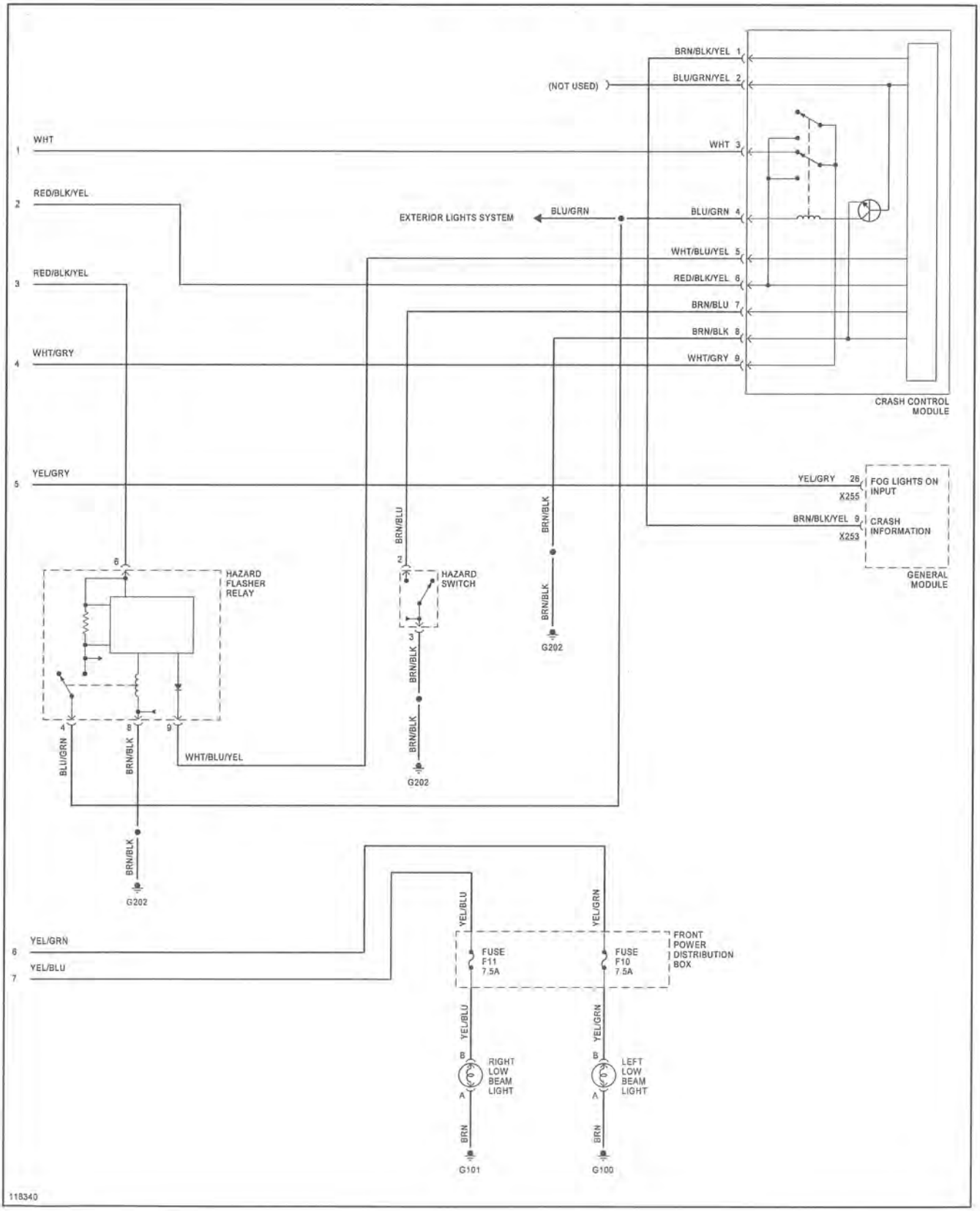
Headlights/Foglights

1991-92 w/ DRL (1 of 2)



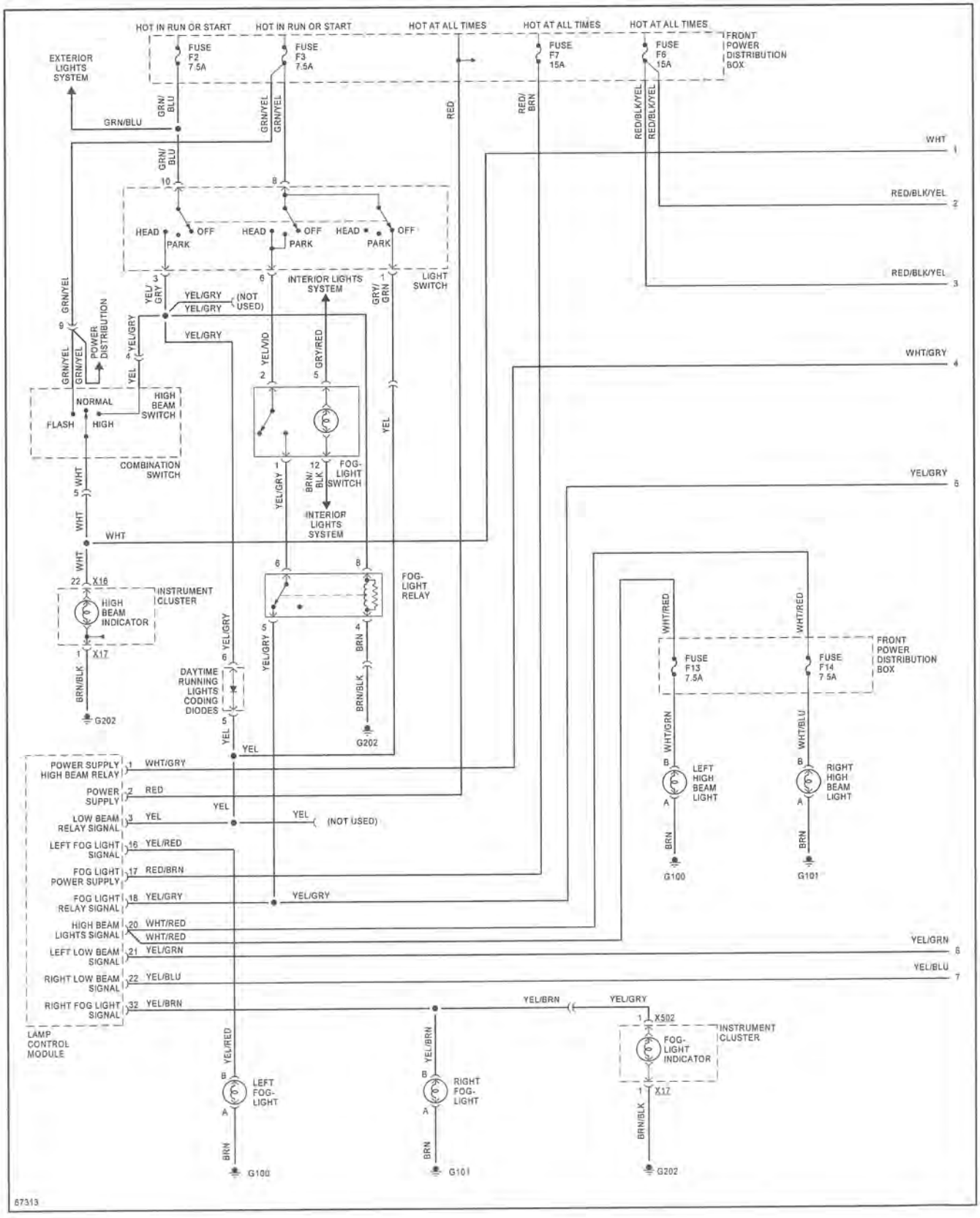
Headlights/Foglights

1991-92 w/ DRL (2 of 2)



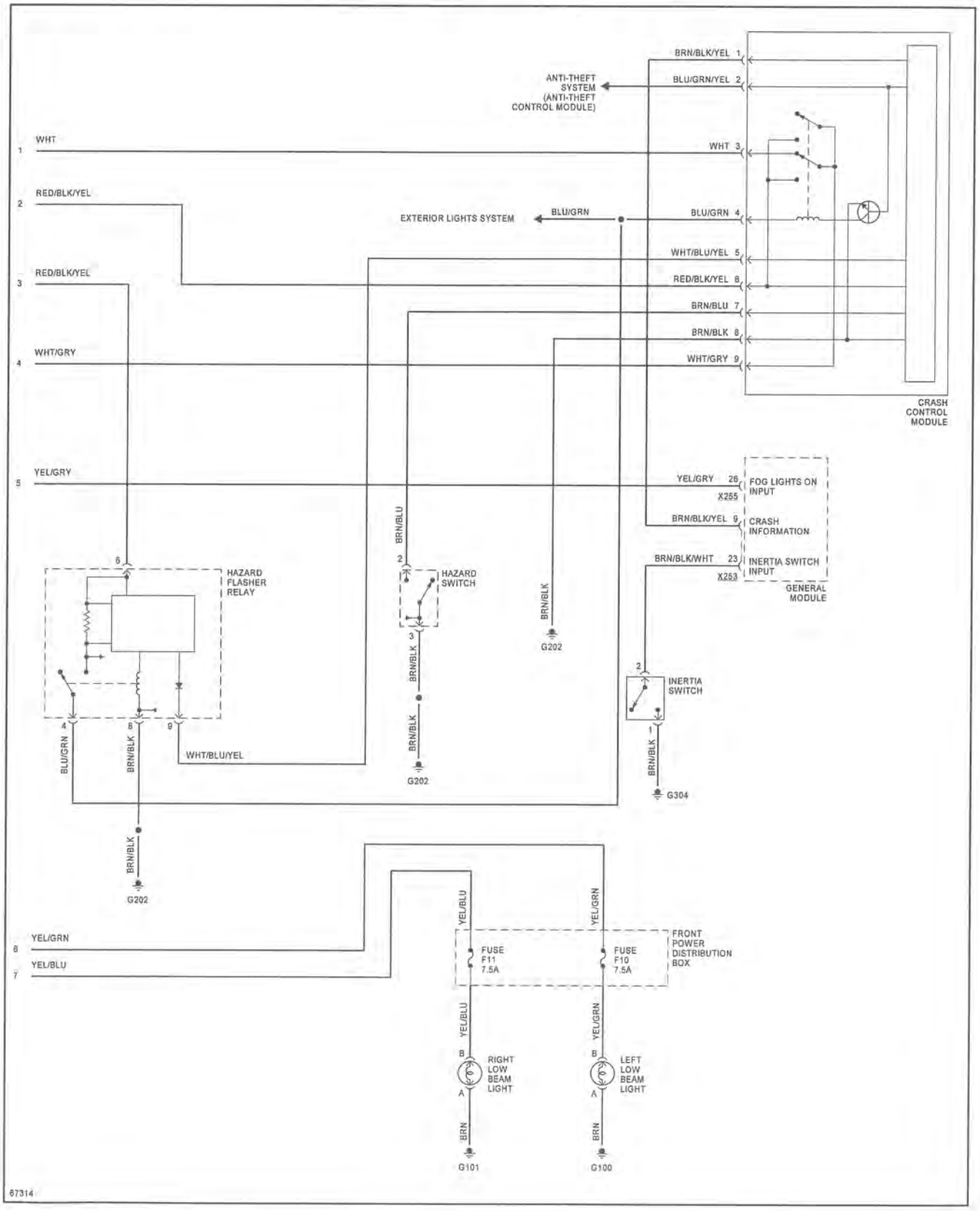
Headlights/Foglights

1993-94 w/ DRL (1 of 2)



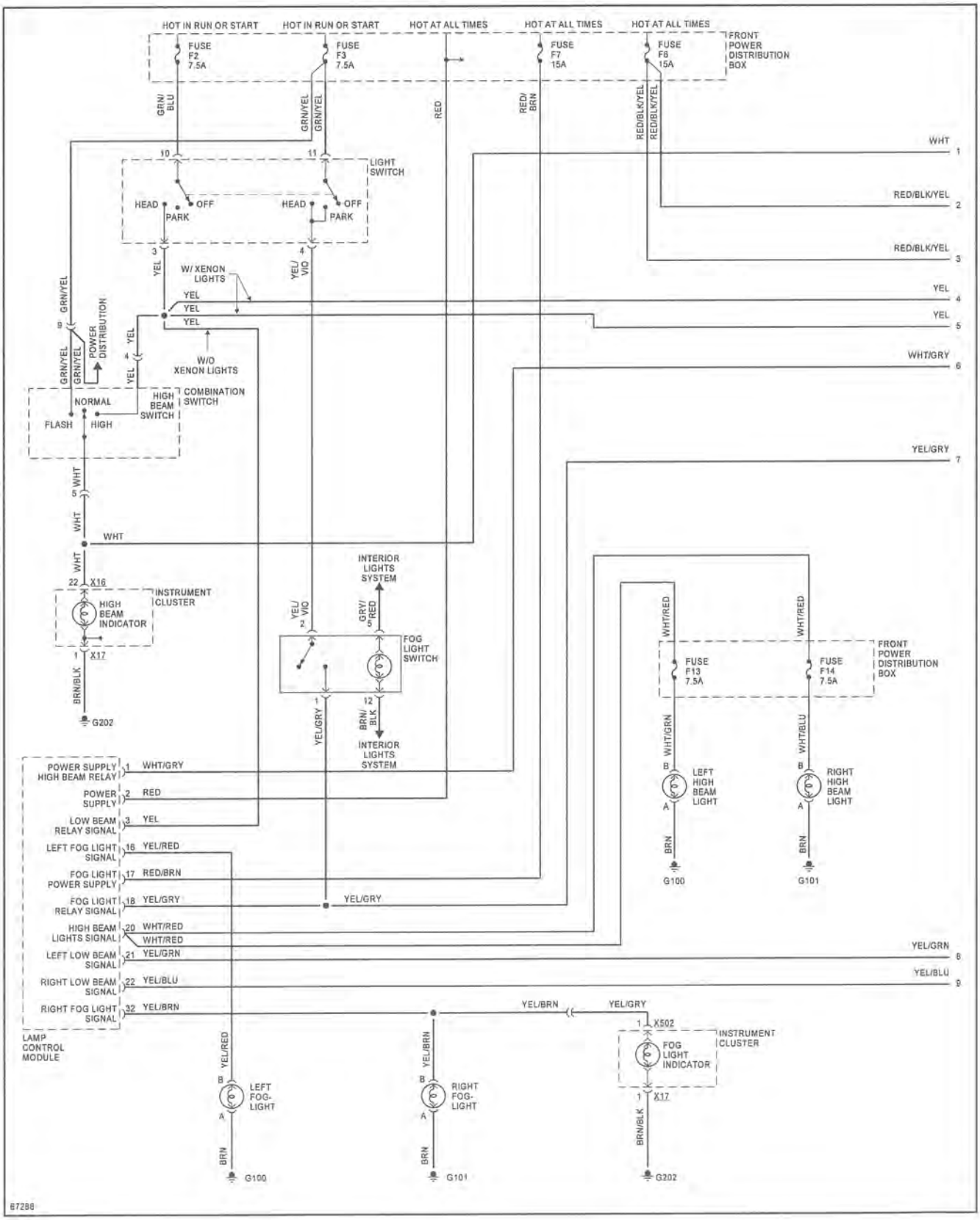
Headlights/Foglights

1993-94 w/ DRL (2 of 2)



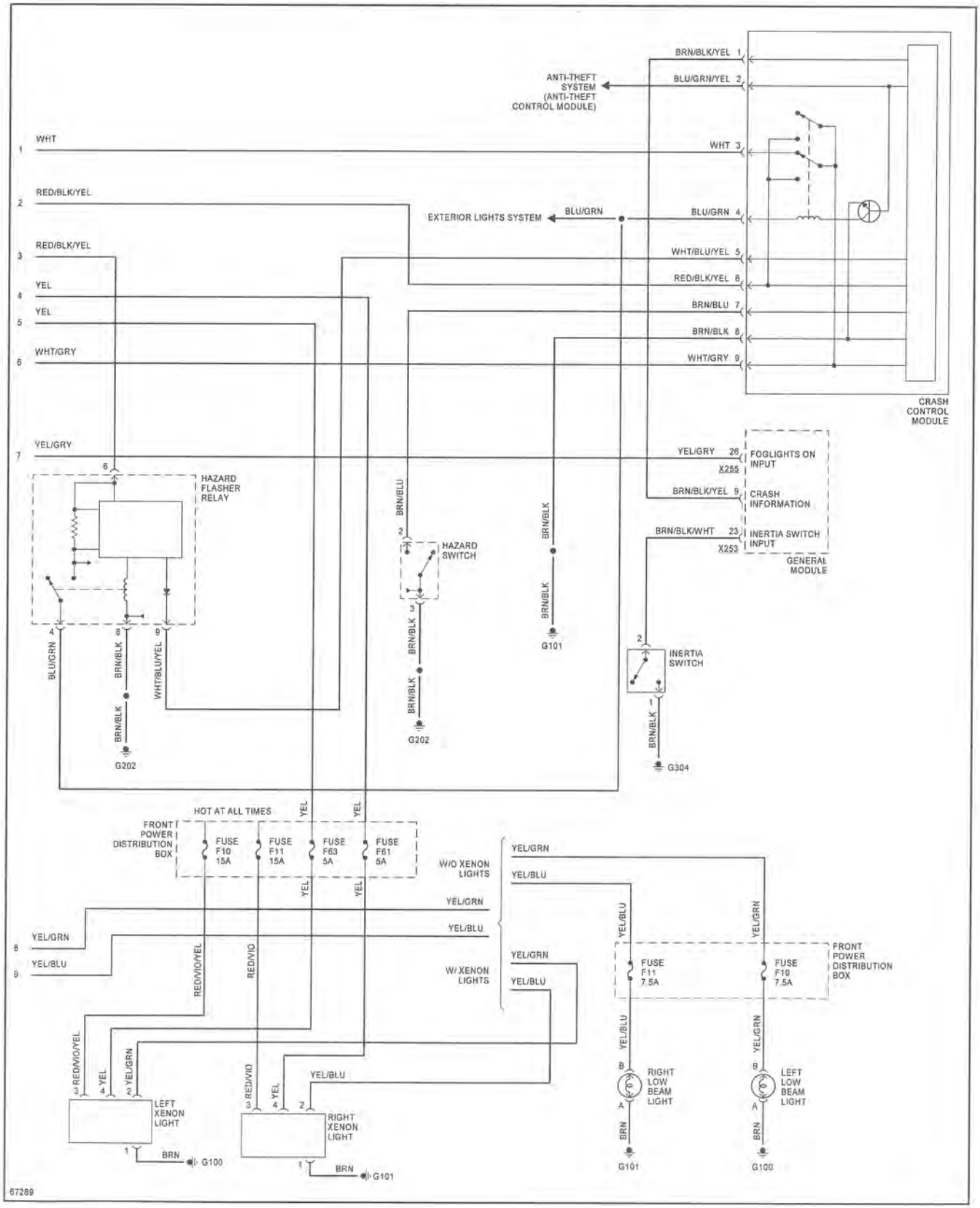
Headlights/Foglights

1993-94 w/o DRL (1 of 2)



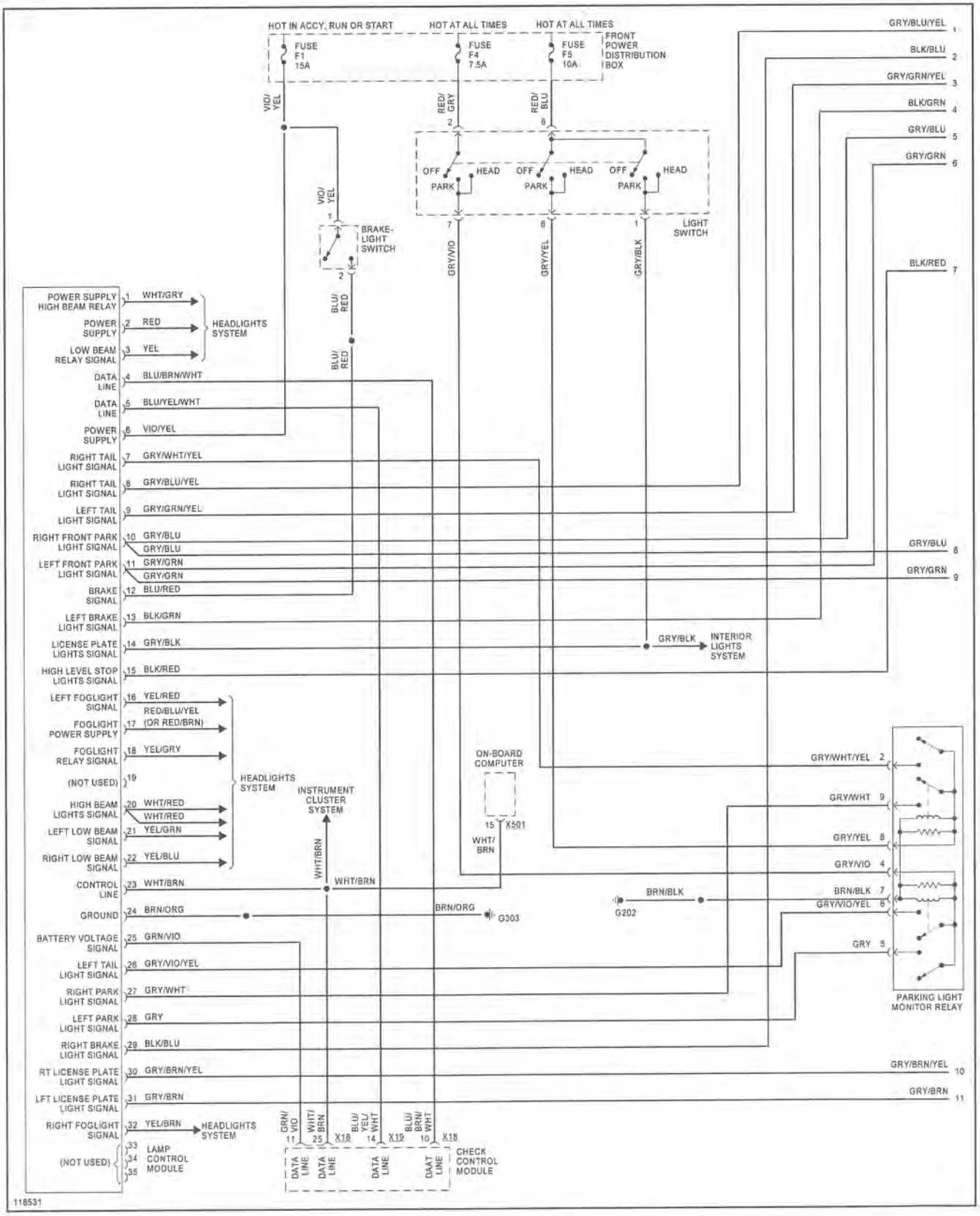
Headlights/Foglights

1993-94 w/o DRL (2 of 2)

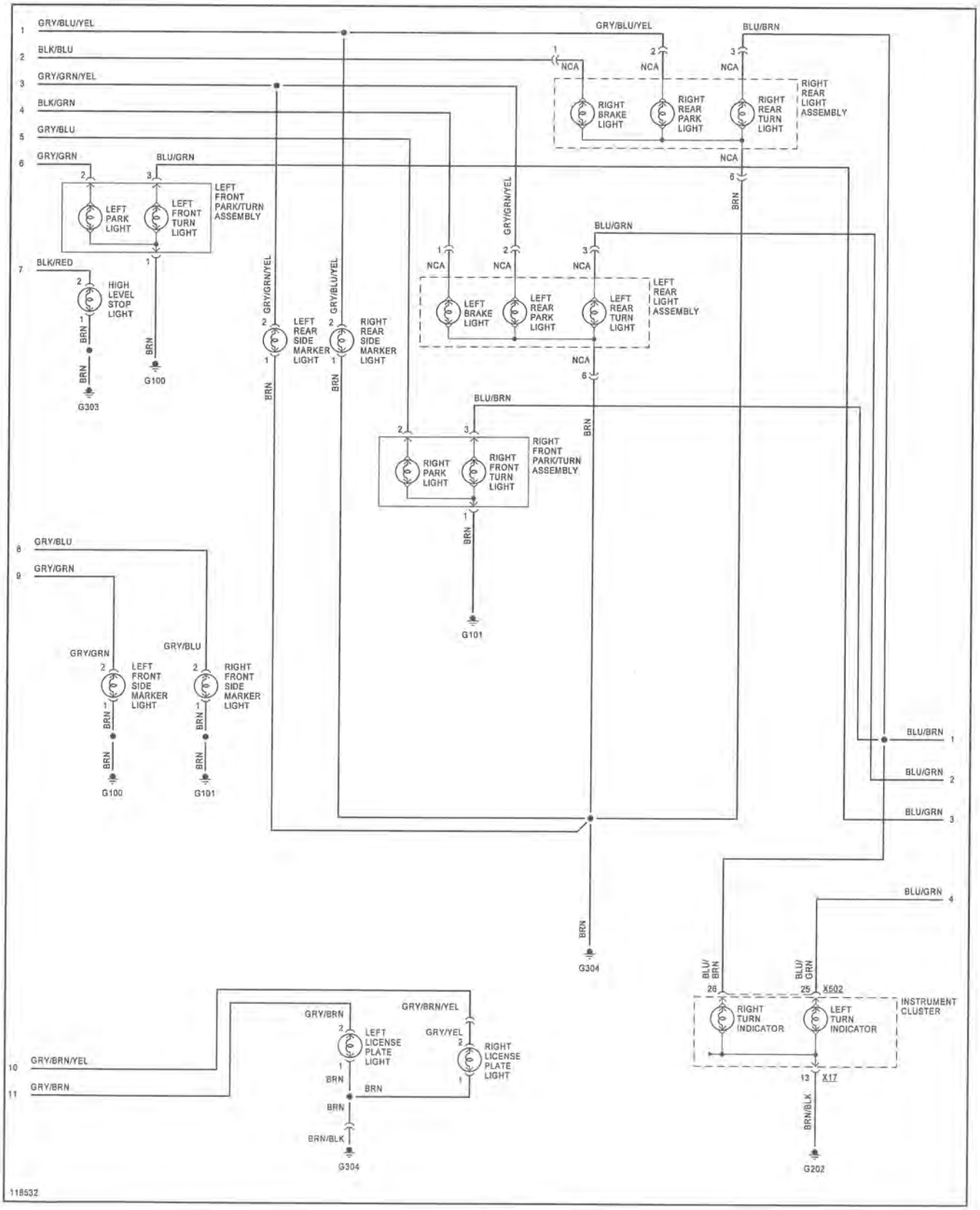


Exterior Lights

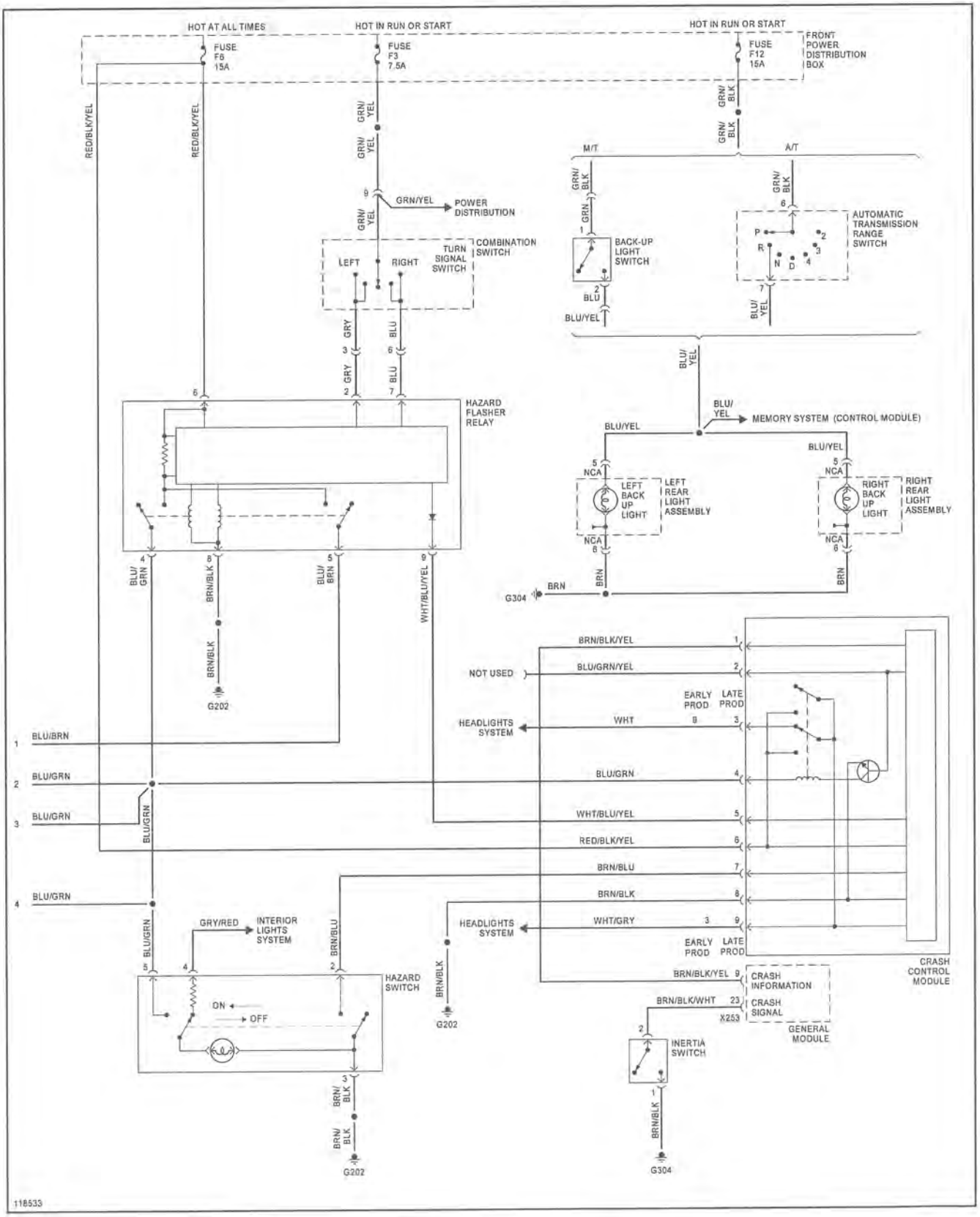
1988 (1 of 3)



Exterior Lights
1988 (2 of 3)

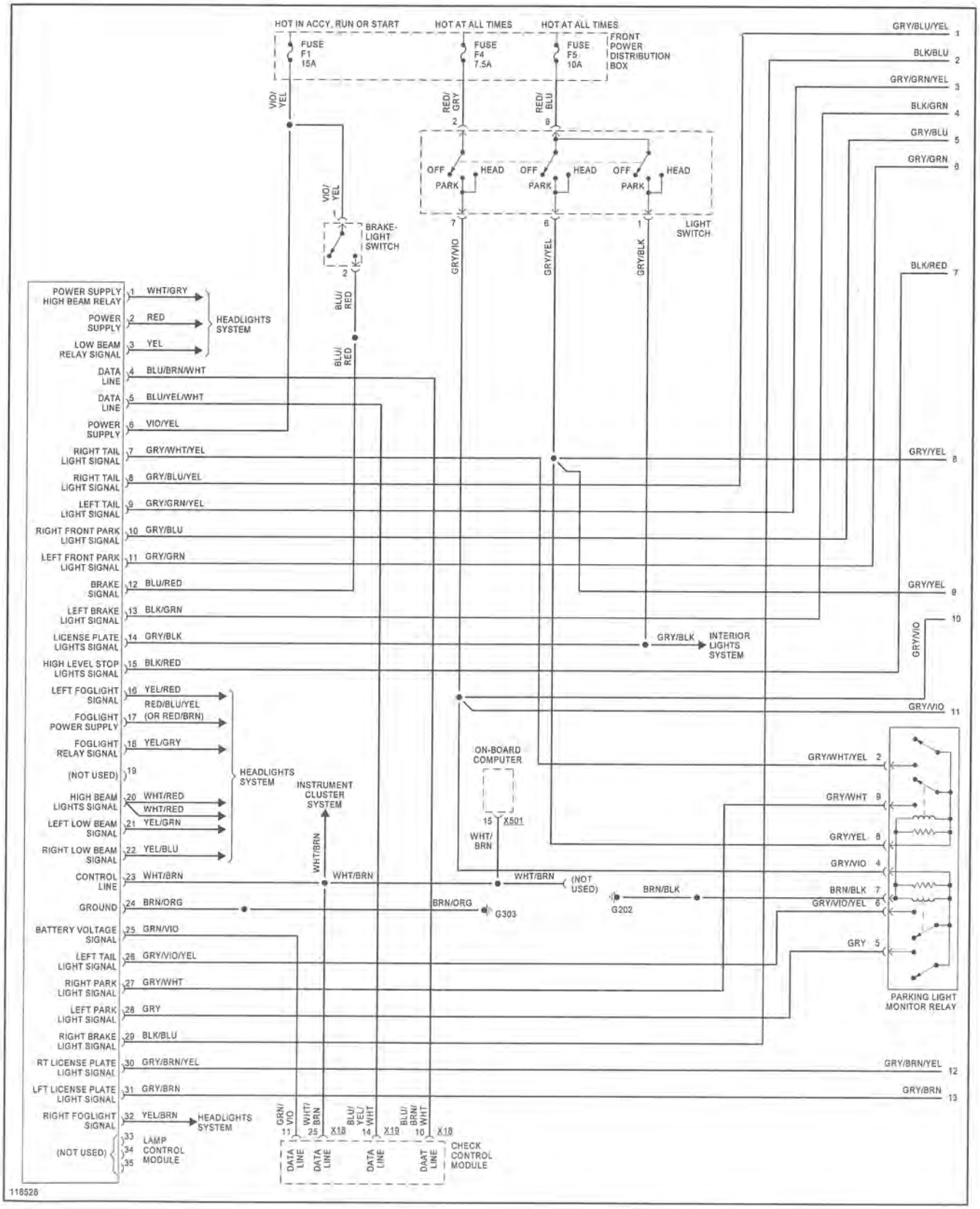


Exterior Lights
1988 (3 of 3)

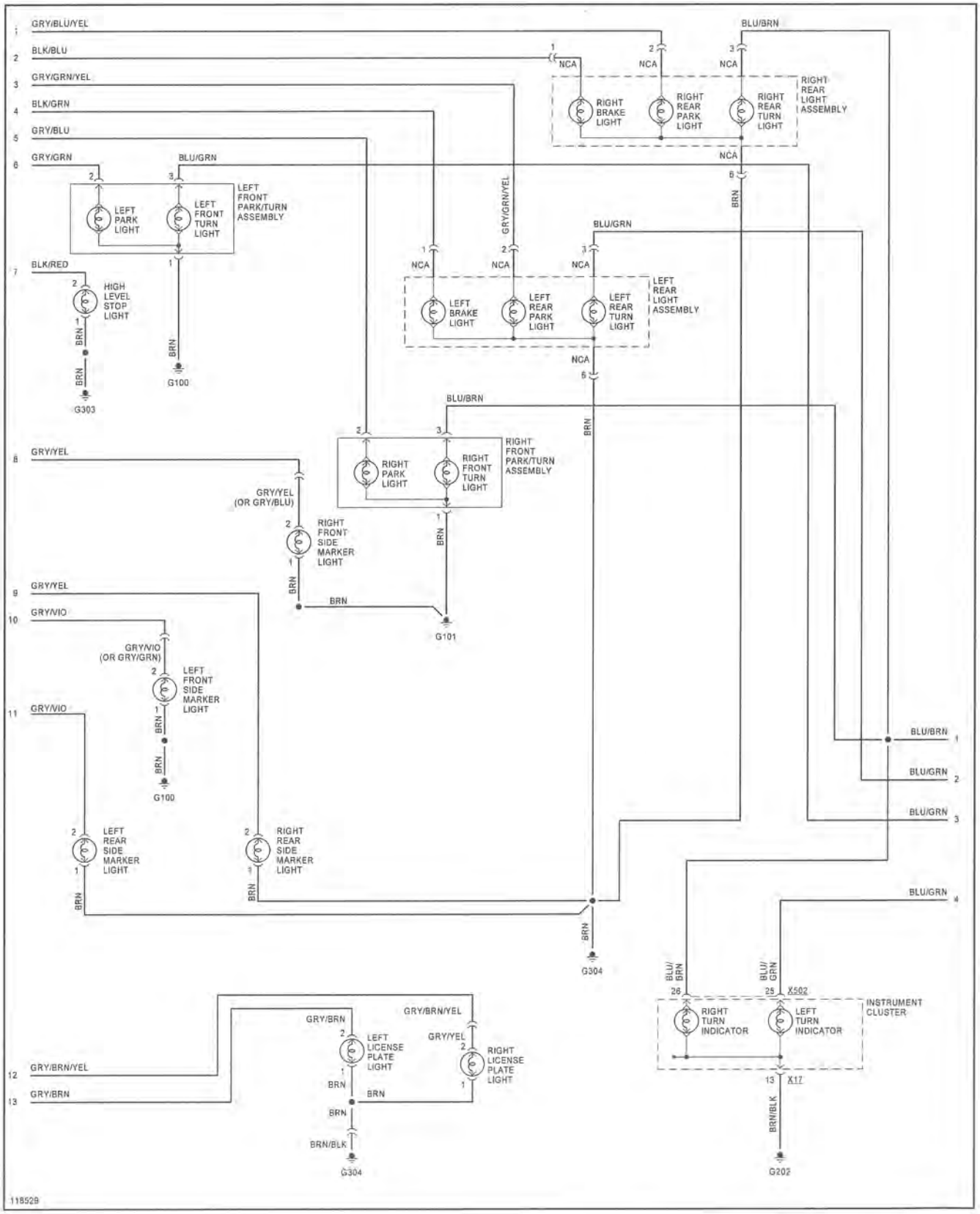


Exterior Lights

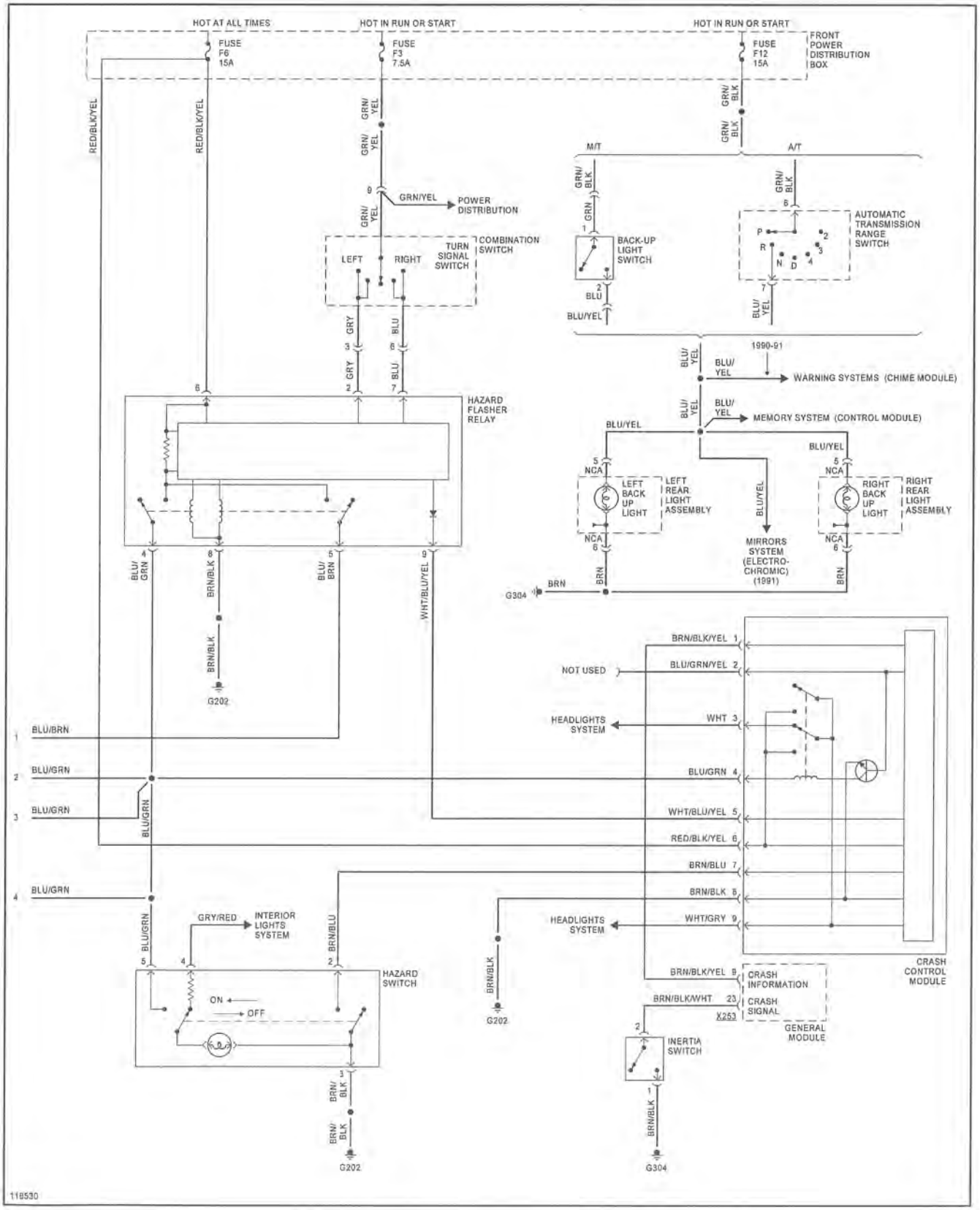
1989-90, 1991 USA (1 of 3)



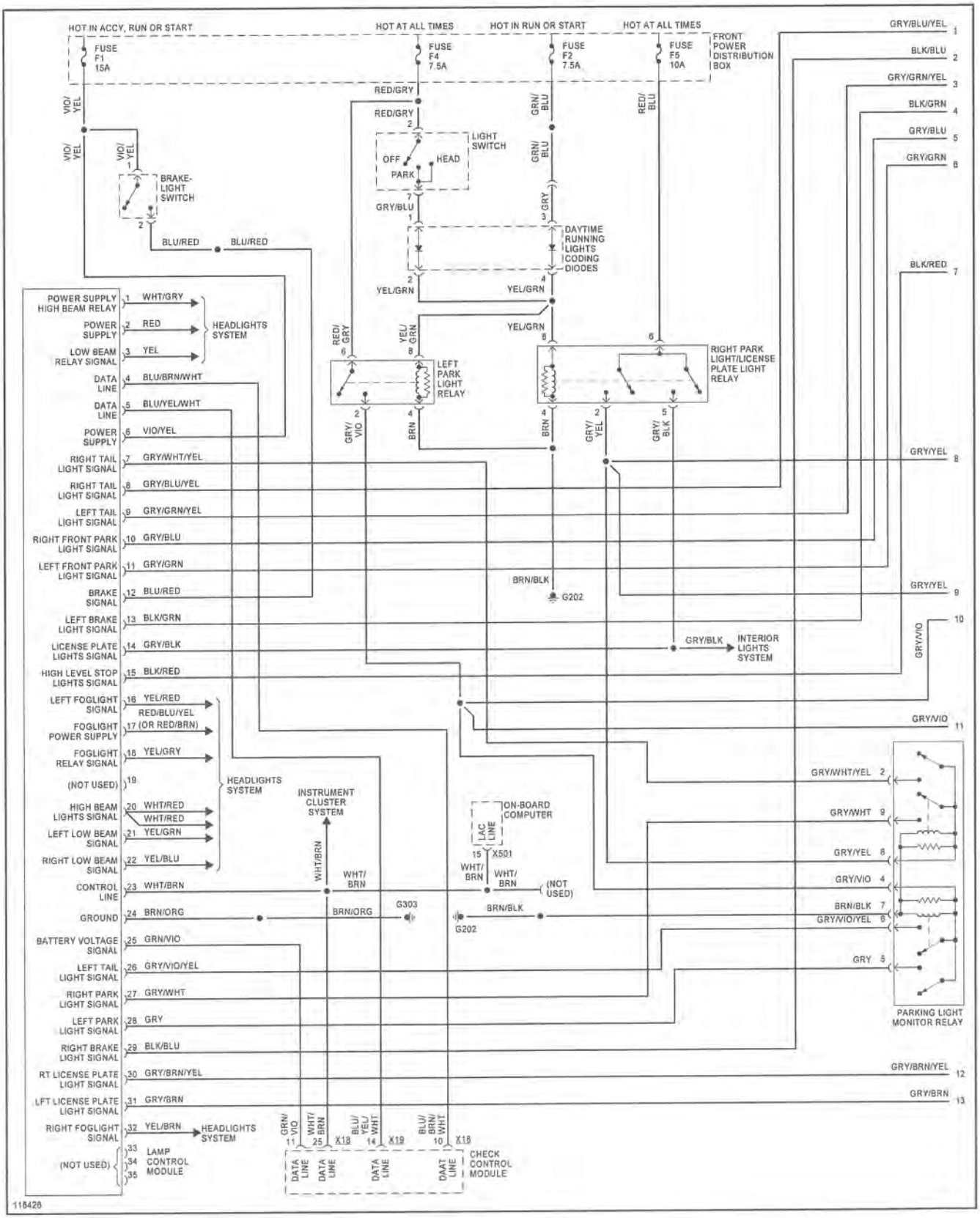
Exterior Lights
1989-90, 1991 USA (2 of 3)



Exterior Lights
1989-90, 1991 USA (3 of 3)

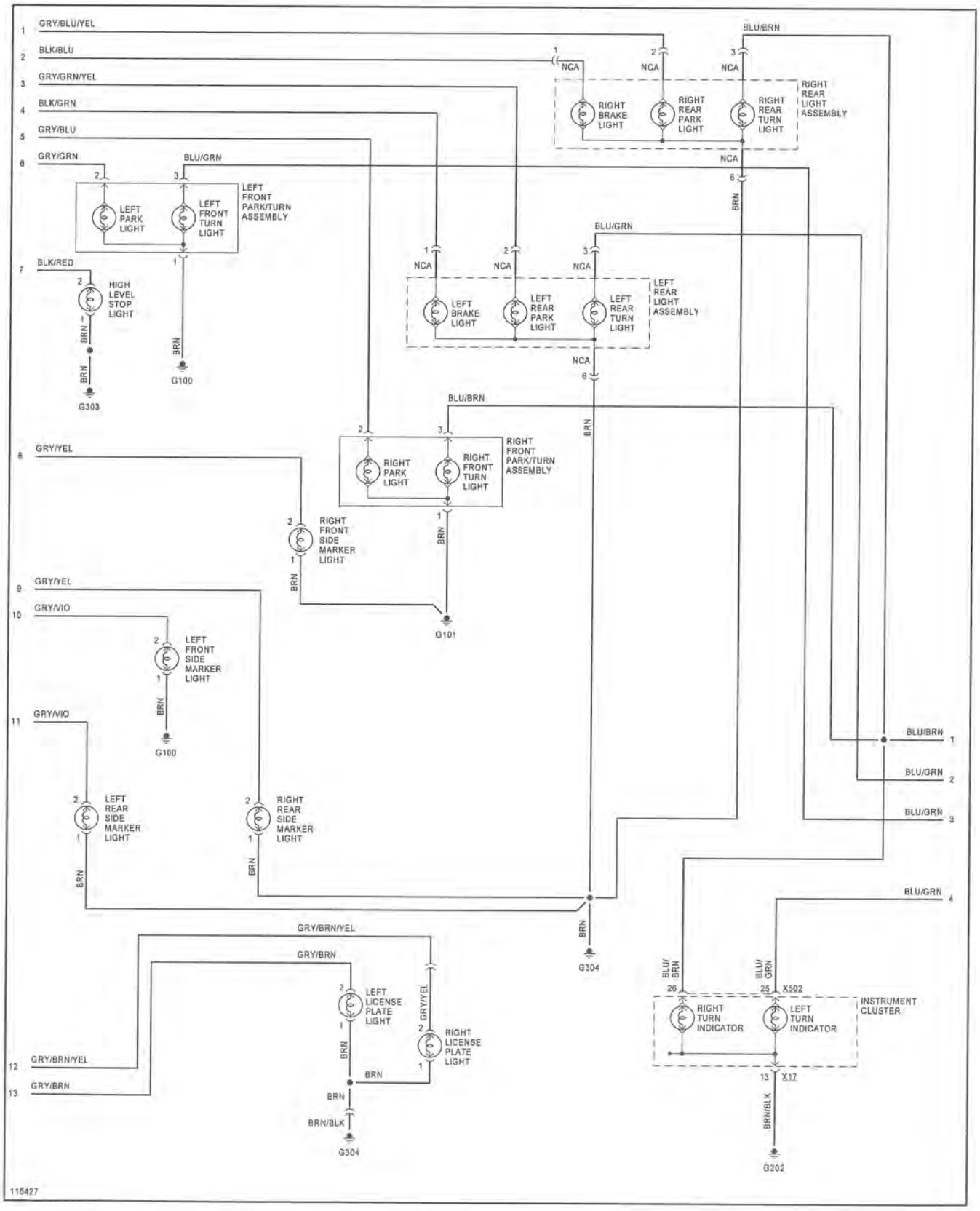


Exterior Lights
1991 Canada (1 of 3)

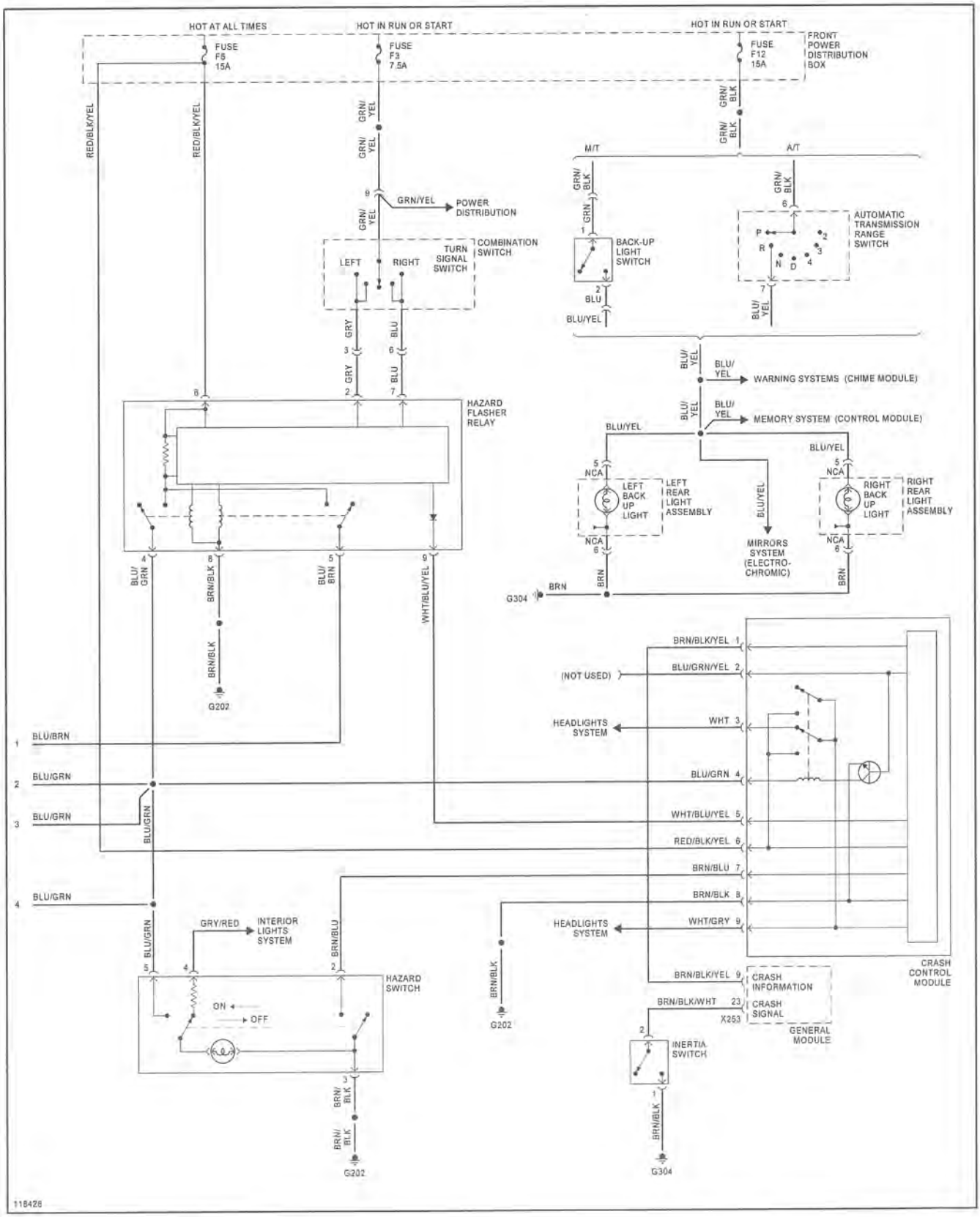


Exterior Lights

1991 Canada (2 of 3)

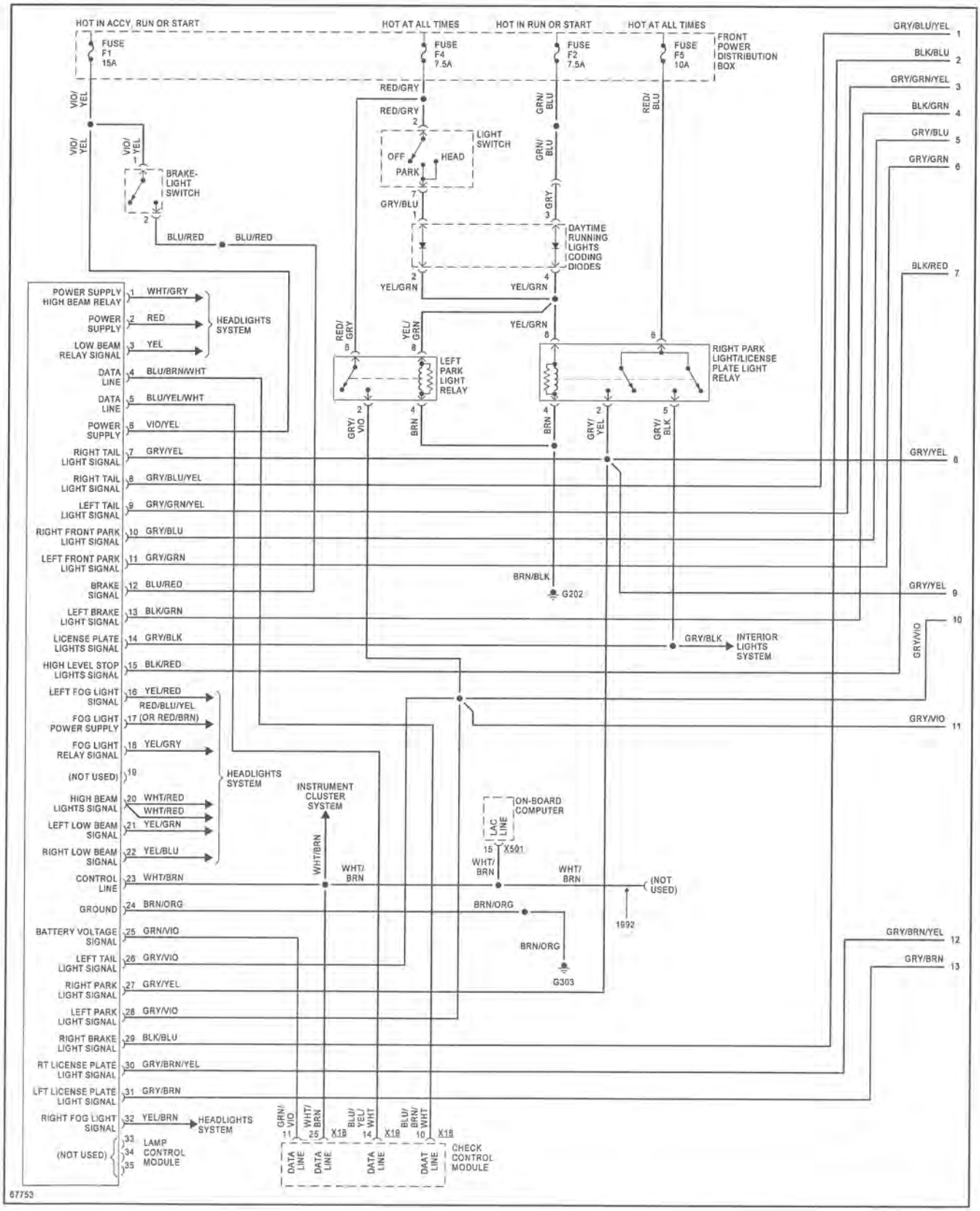


Exterior Lights
1991 Canada (3 of 3)

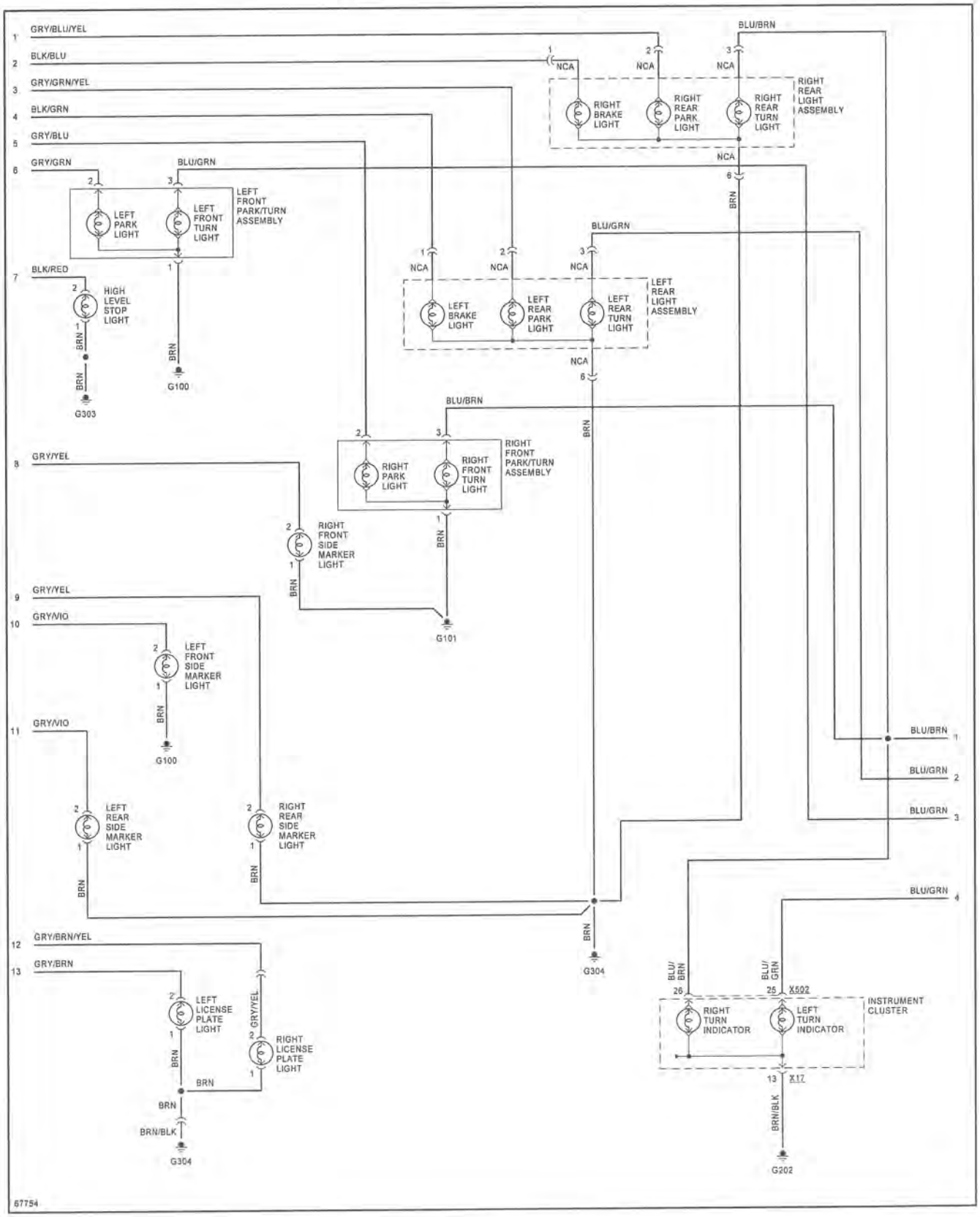


Exterior Lights

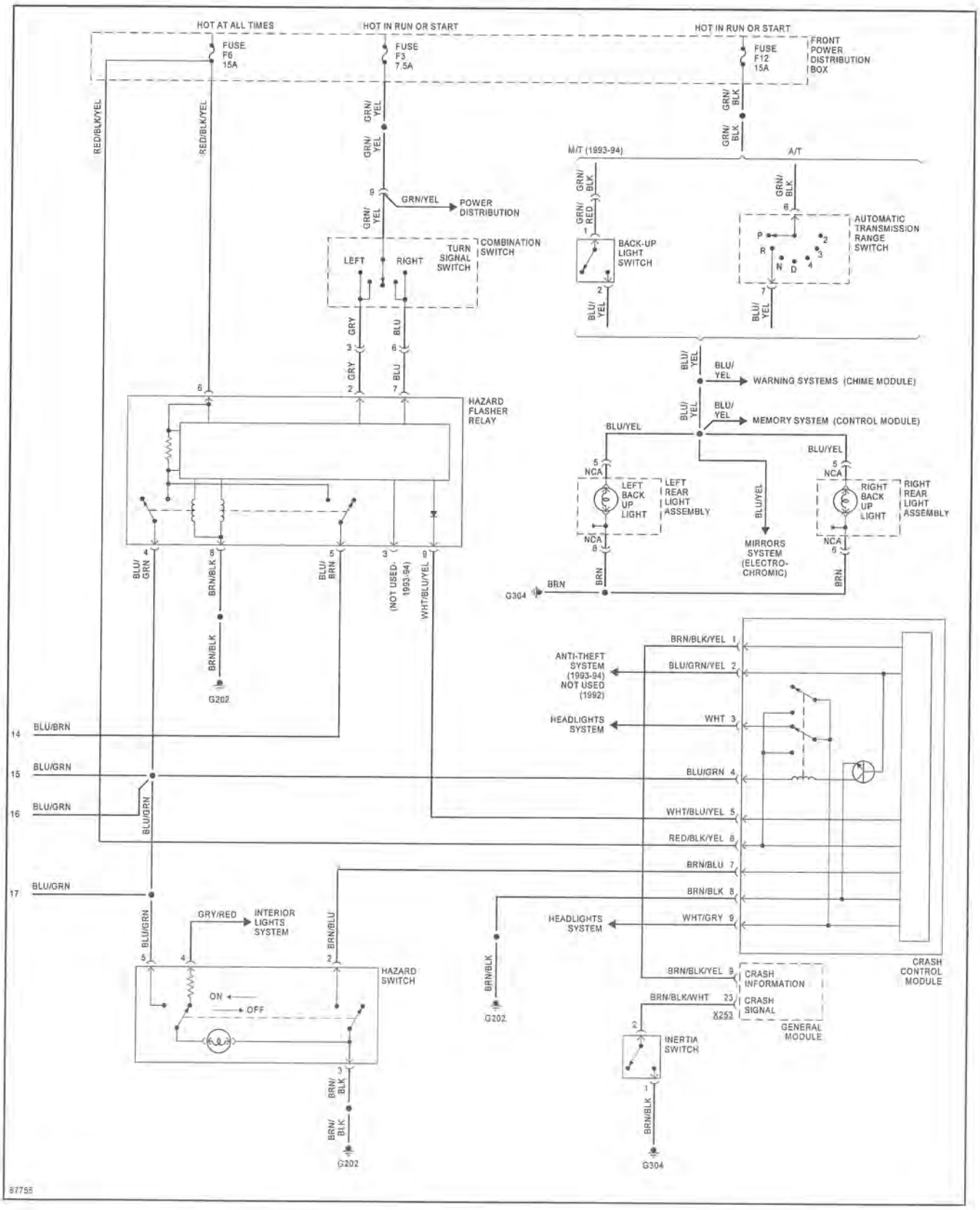
1992-94 Canada (1 of 3)



Exterior Lights
1992-94 Canada (2 of 3)

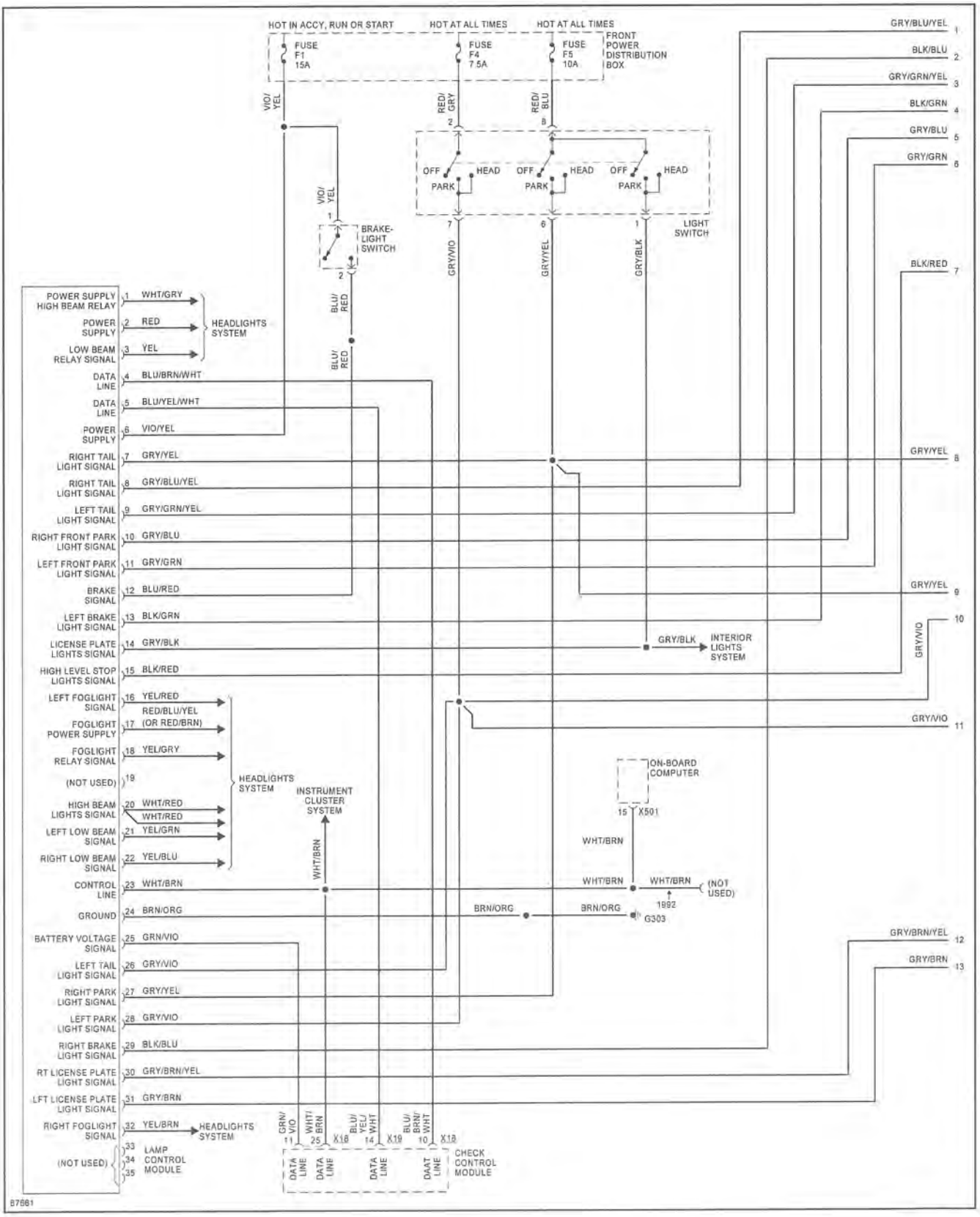


Exterior Lights
1992-94 Canada (3 of 3)

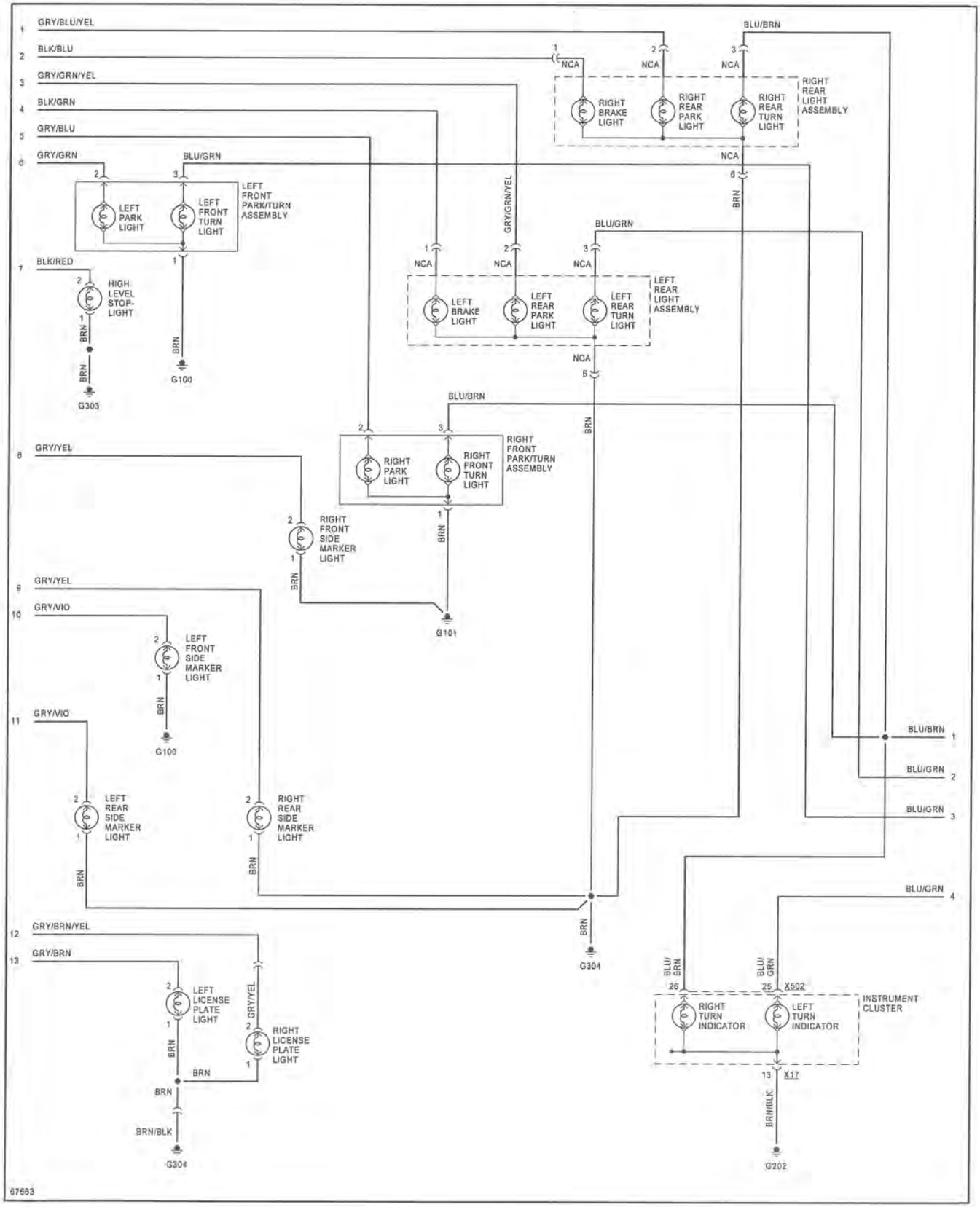


Exterior Lights

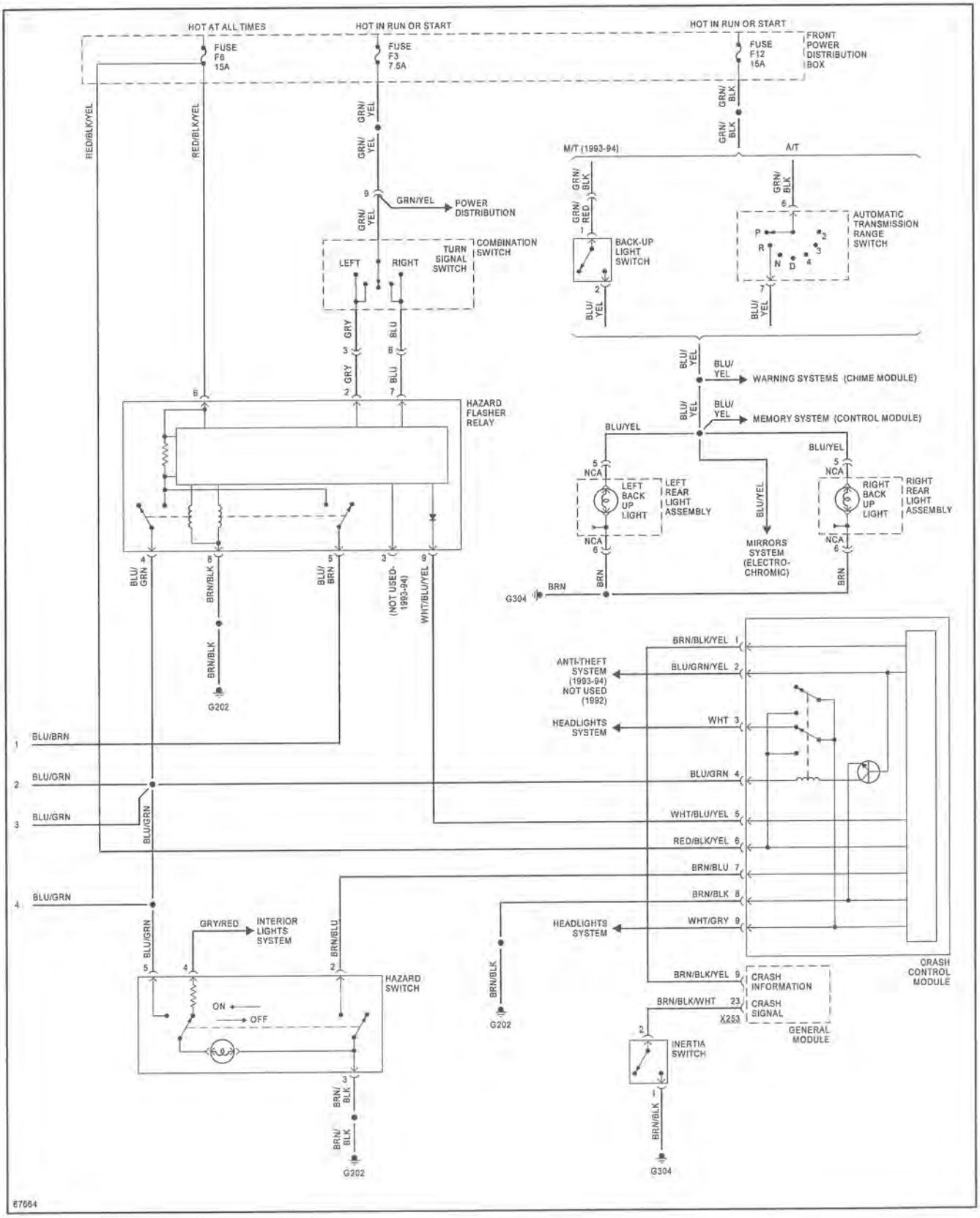
1992-94 USA (1 of 3)



Exterior Lights
1992-94 USA (2 of 3)

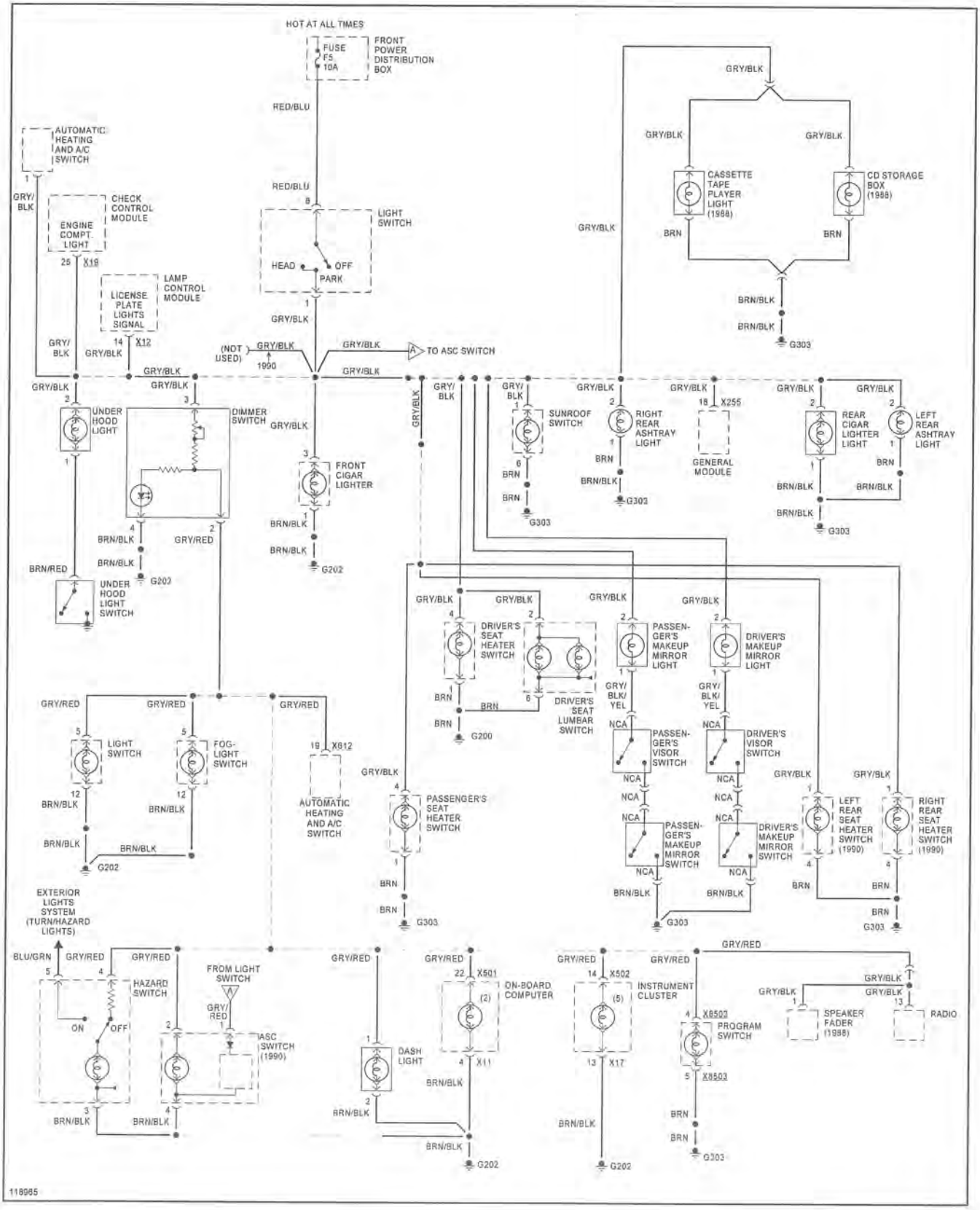


Exterior Lights
1992-94 USA (3 of 3)



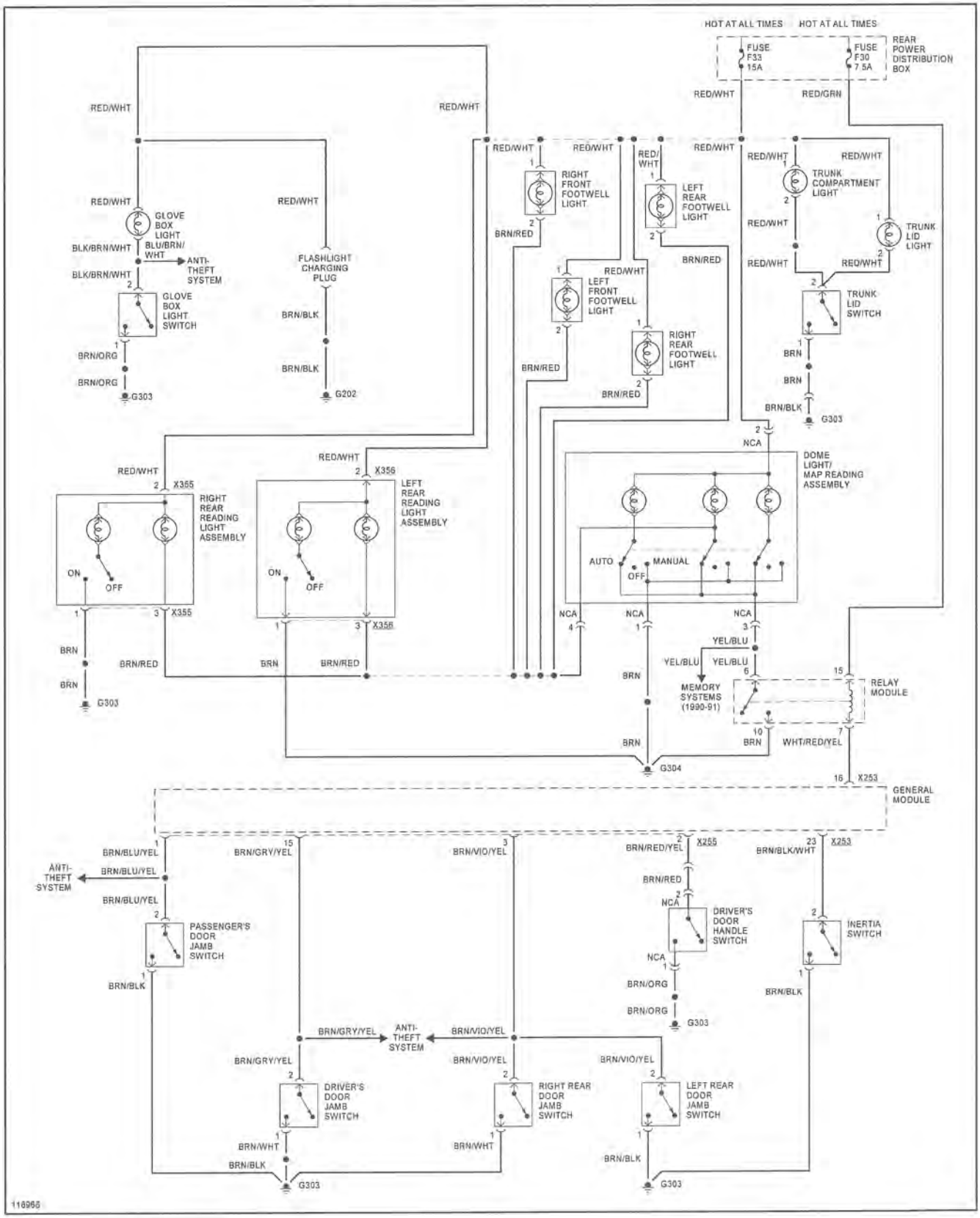
Interior Lights/Illumination

1988-90 Instrument Illumination Circuit



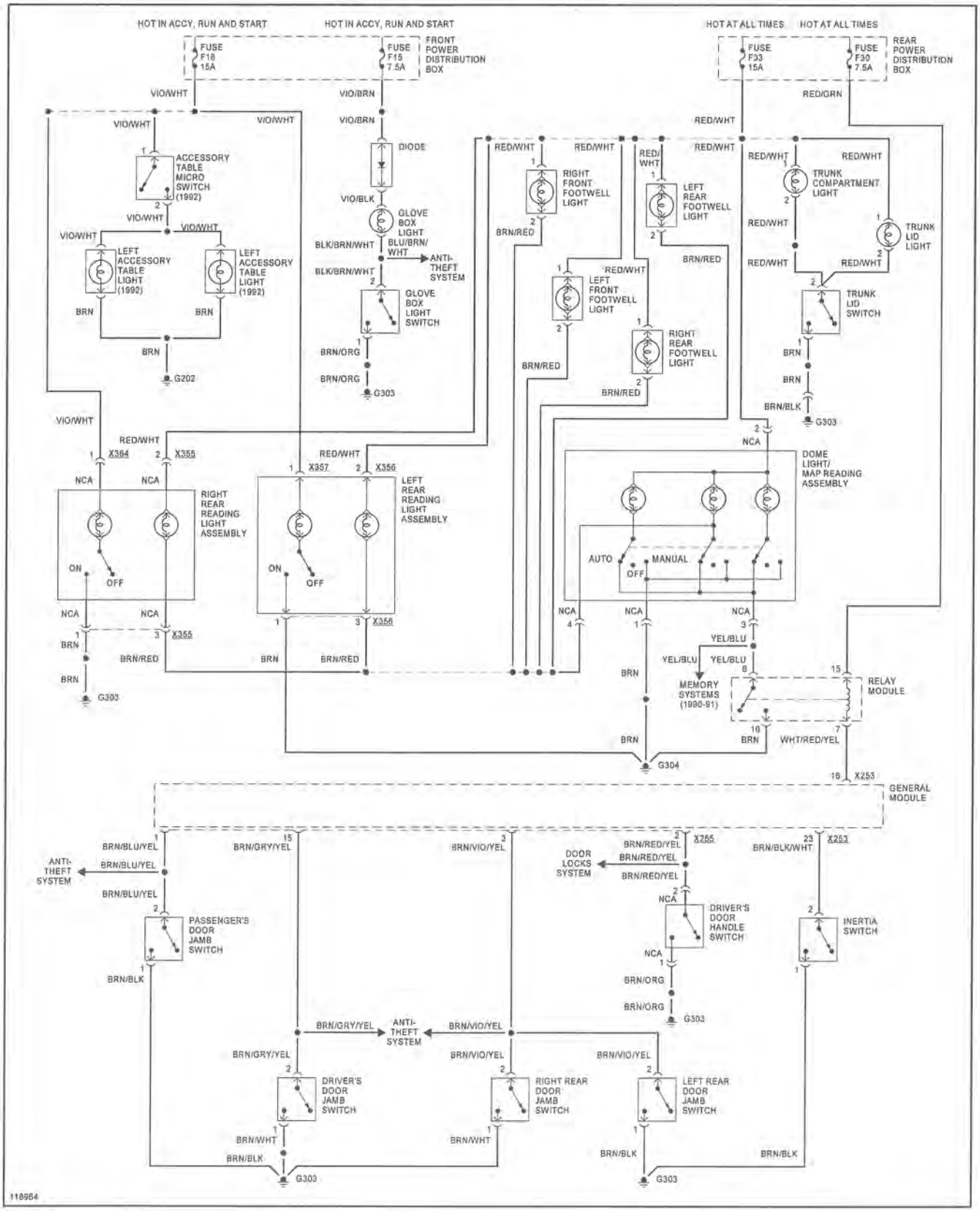
Interior Lights/Illumination

1988 Courtesy Lamps Circuit



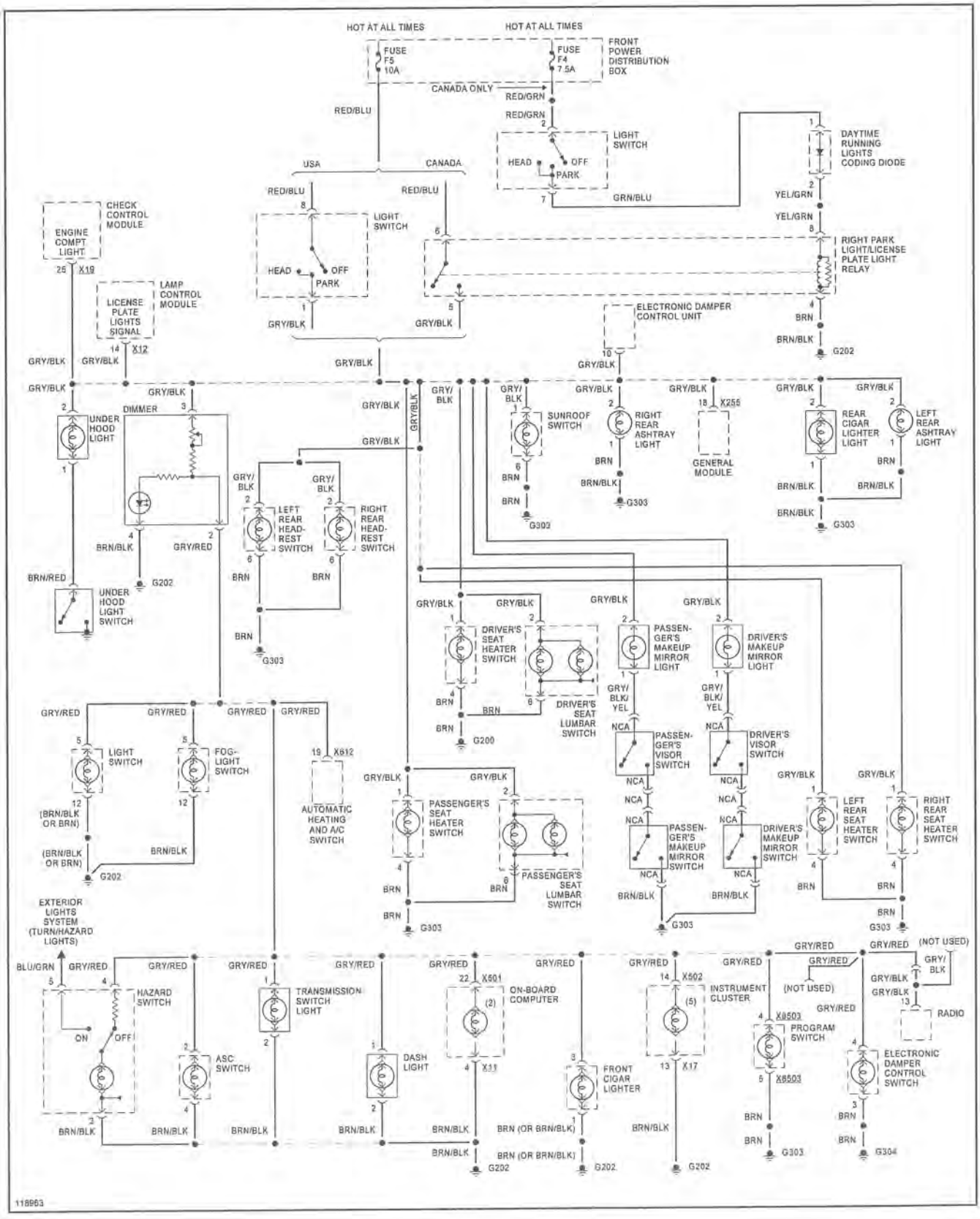
Interior Lights/Illumination

1989-92 Courtesy Lamps Circuit



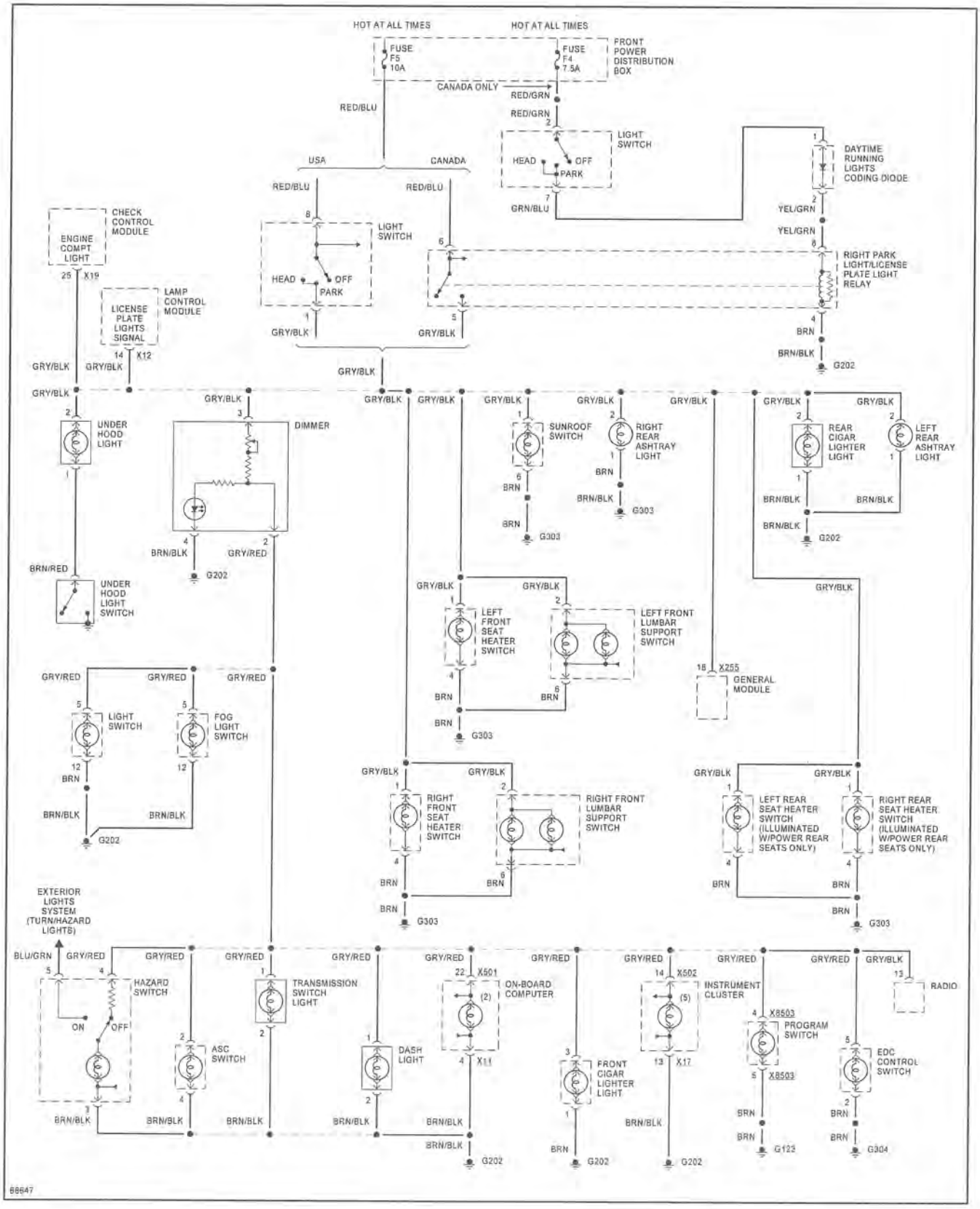
Interior Lights/Illumination

1991-92 Instrument Illumination Circuit



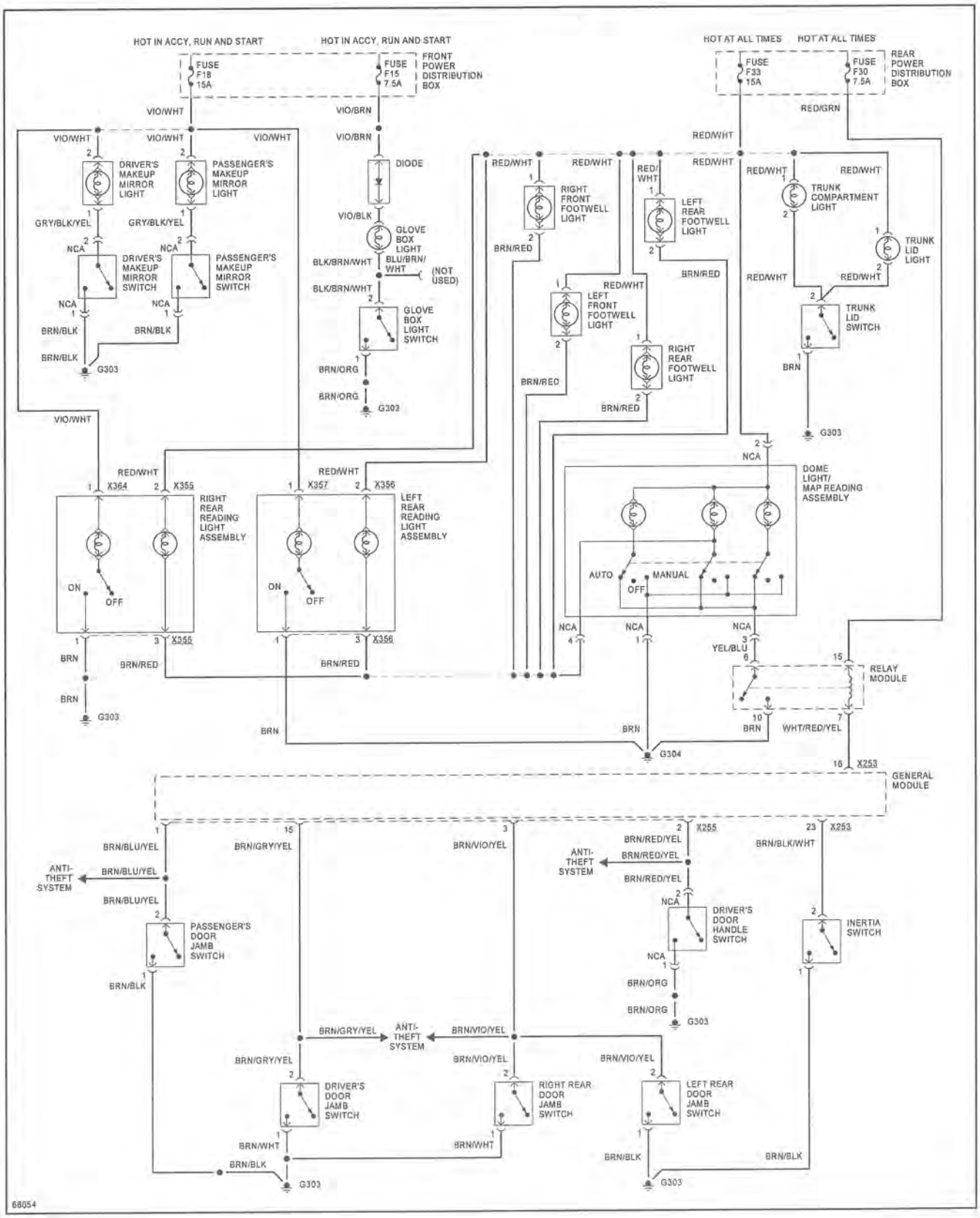
Interior Lights/Illumination

1993-94 (1 of 2)



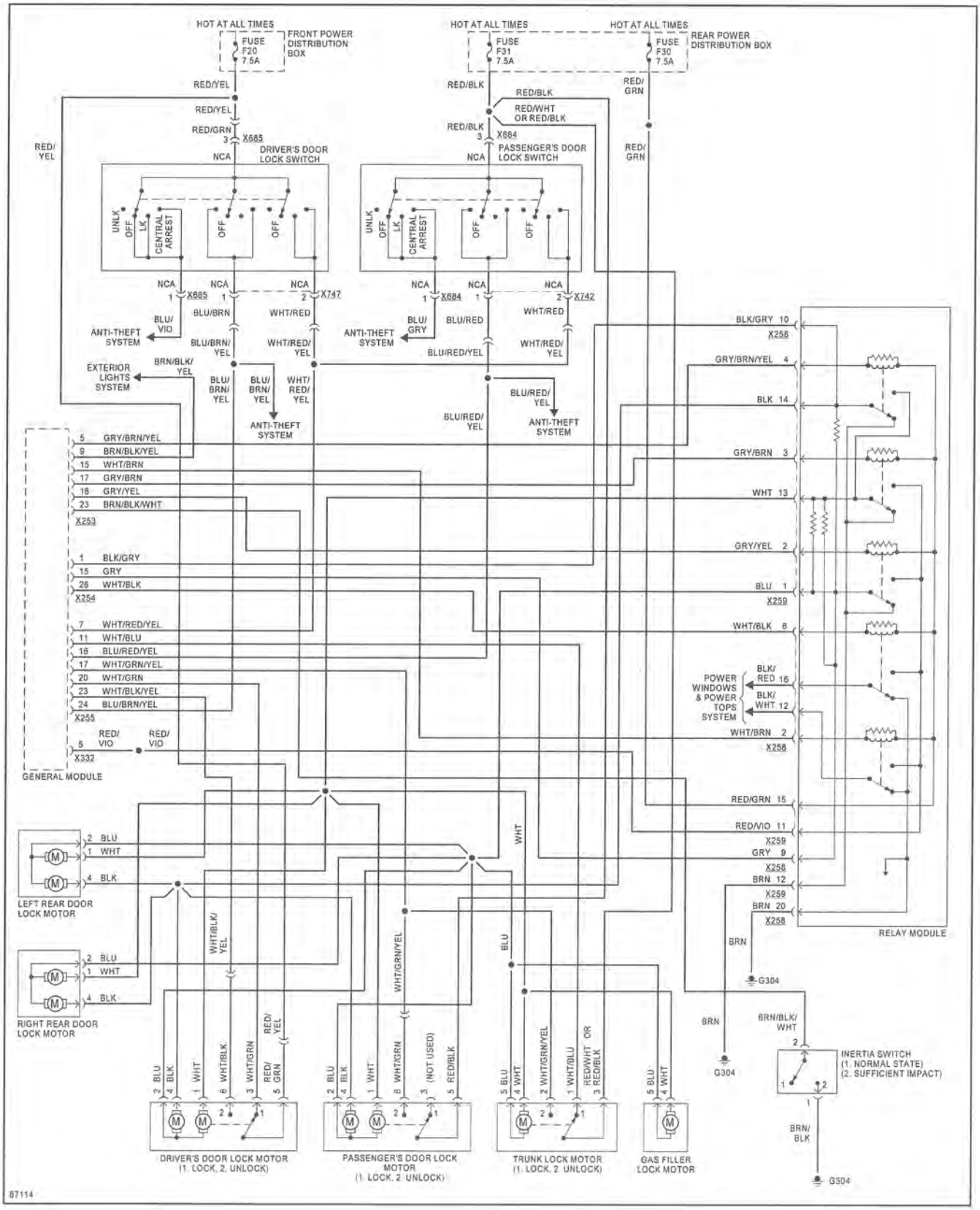
Interior Lights/Illumination

1993-94 (2 of 2)



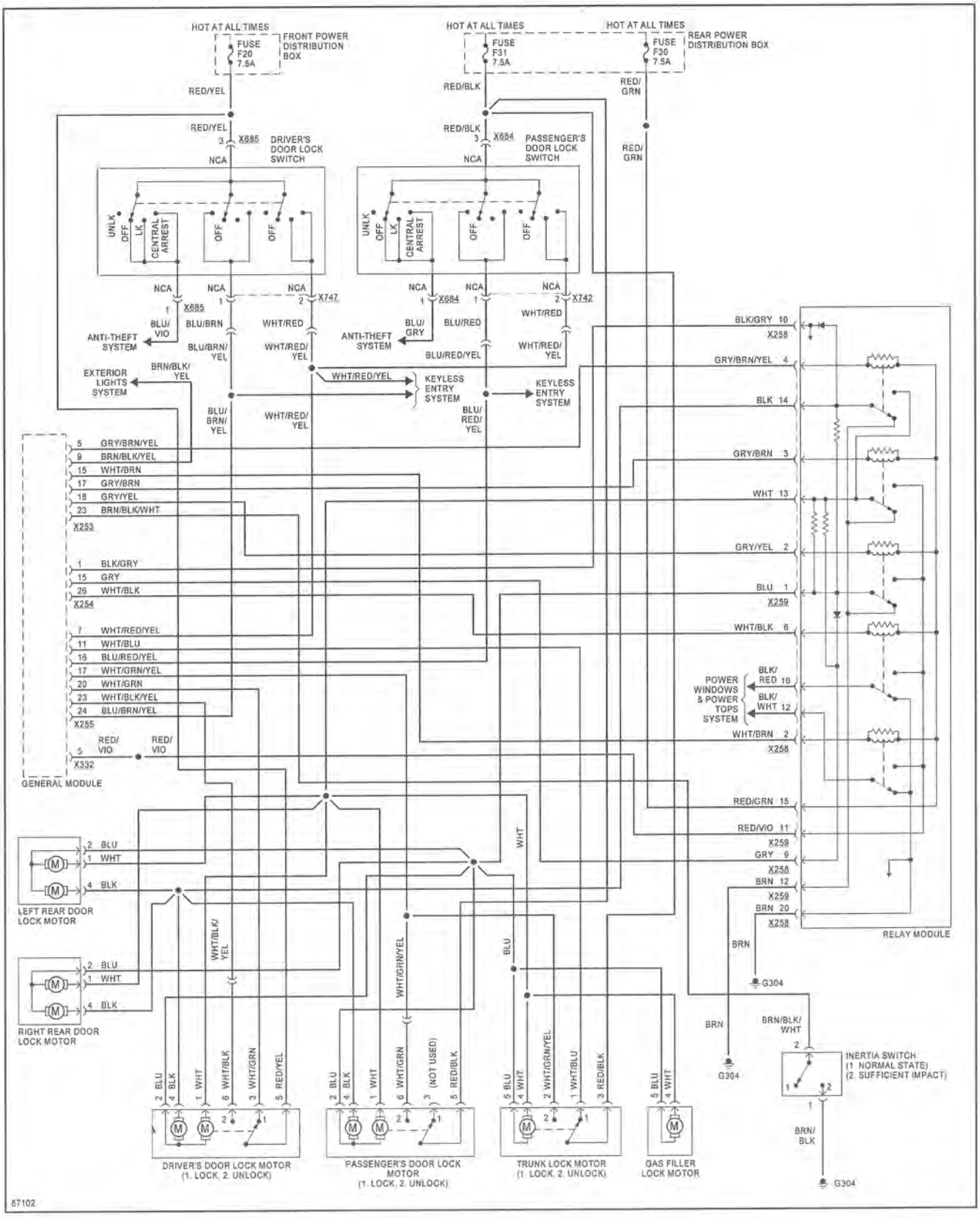
Power Door Locks

1988



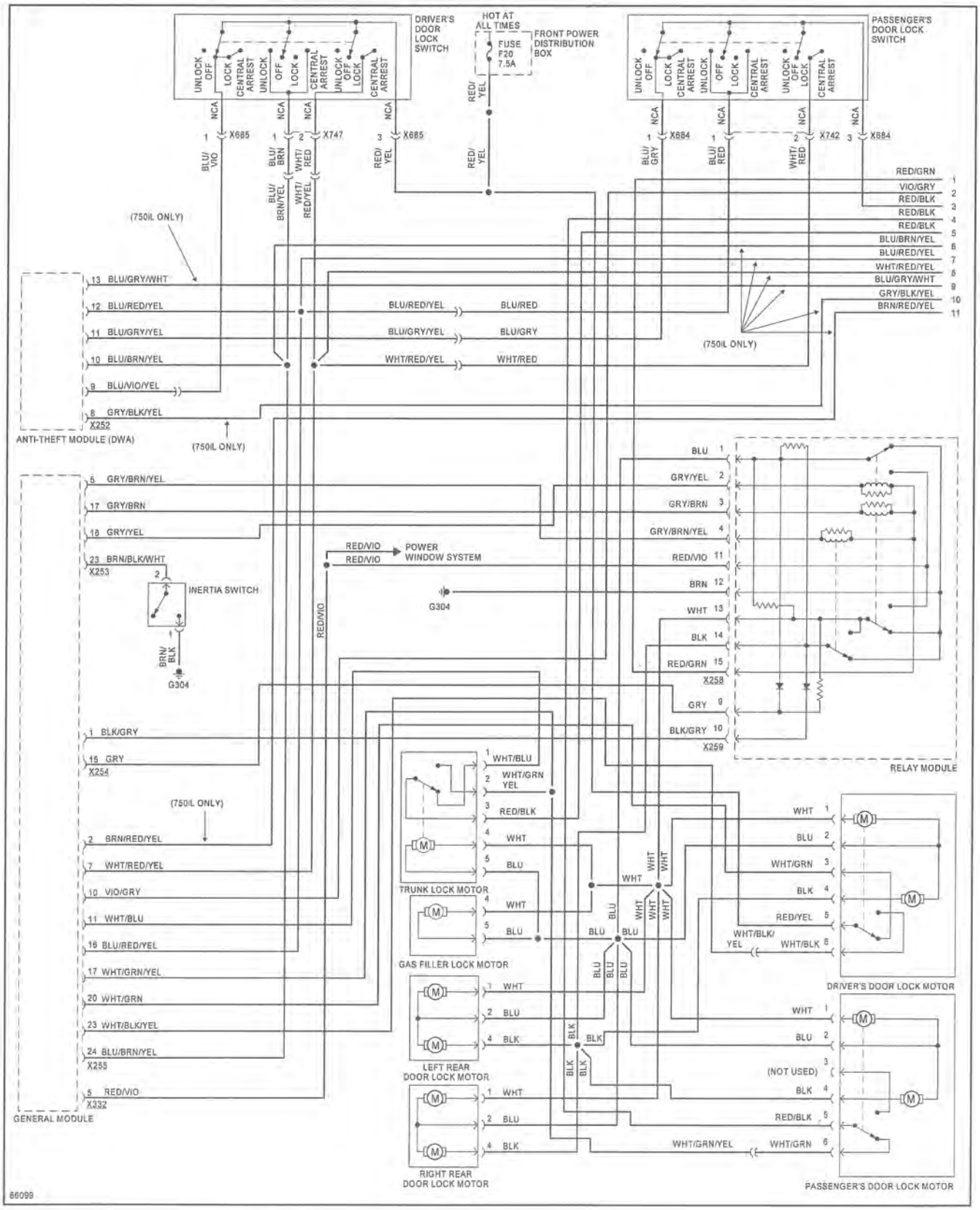
Power Door Locks

1989



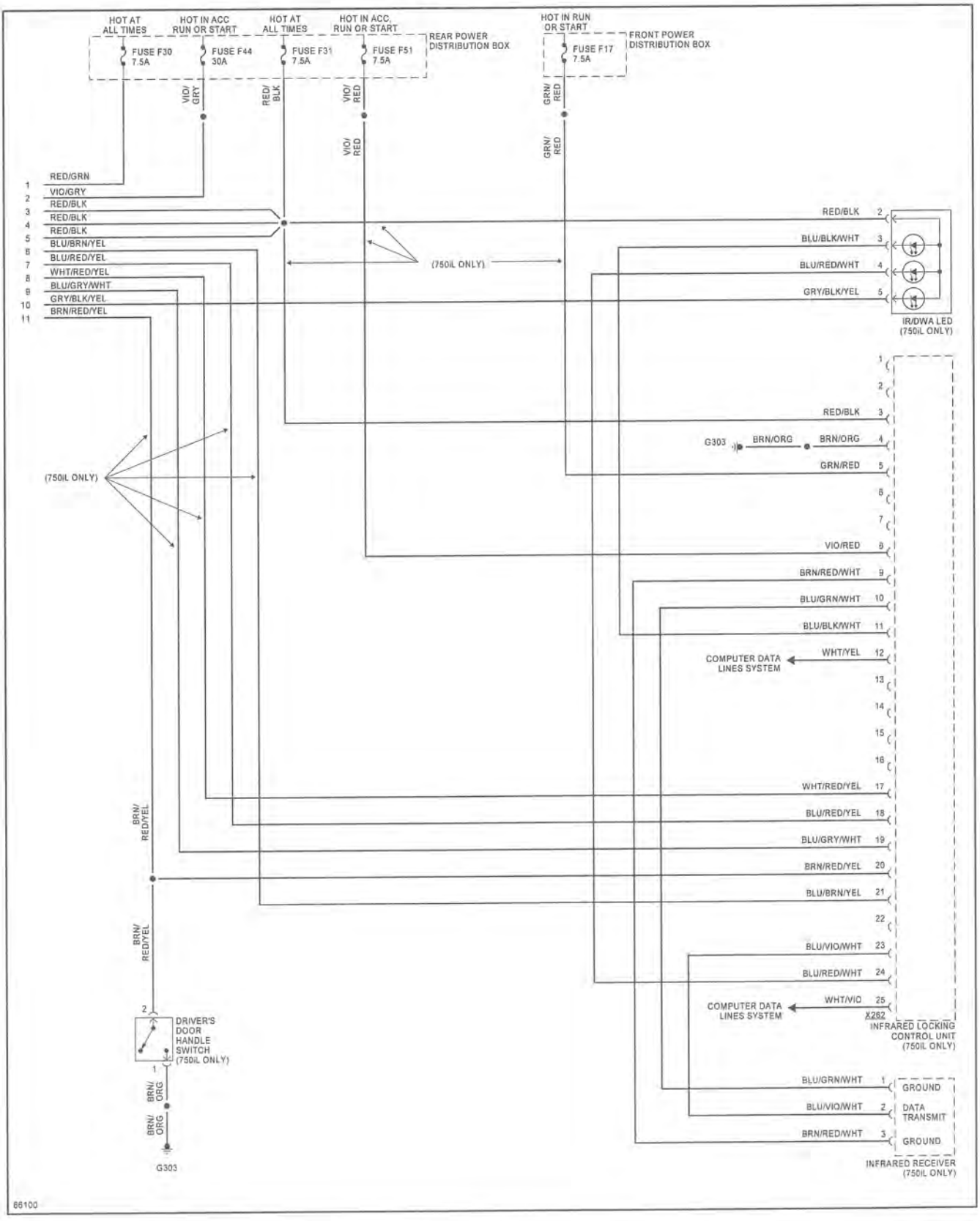
Power Door Locks

1990-91 (1 of 2)



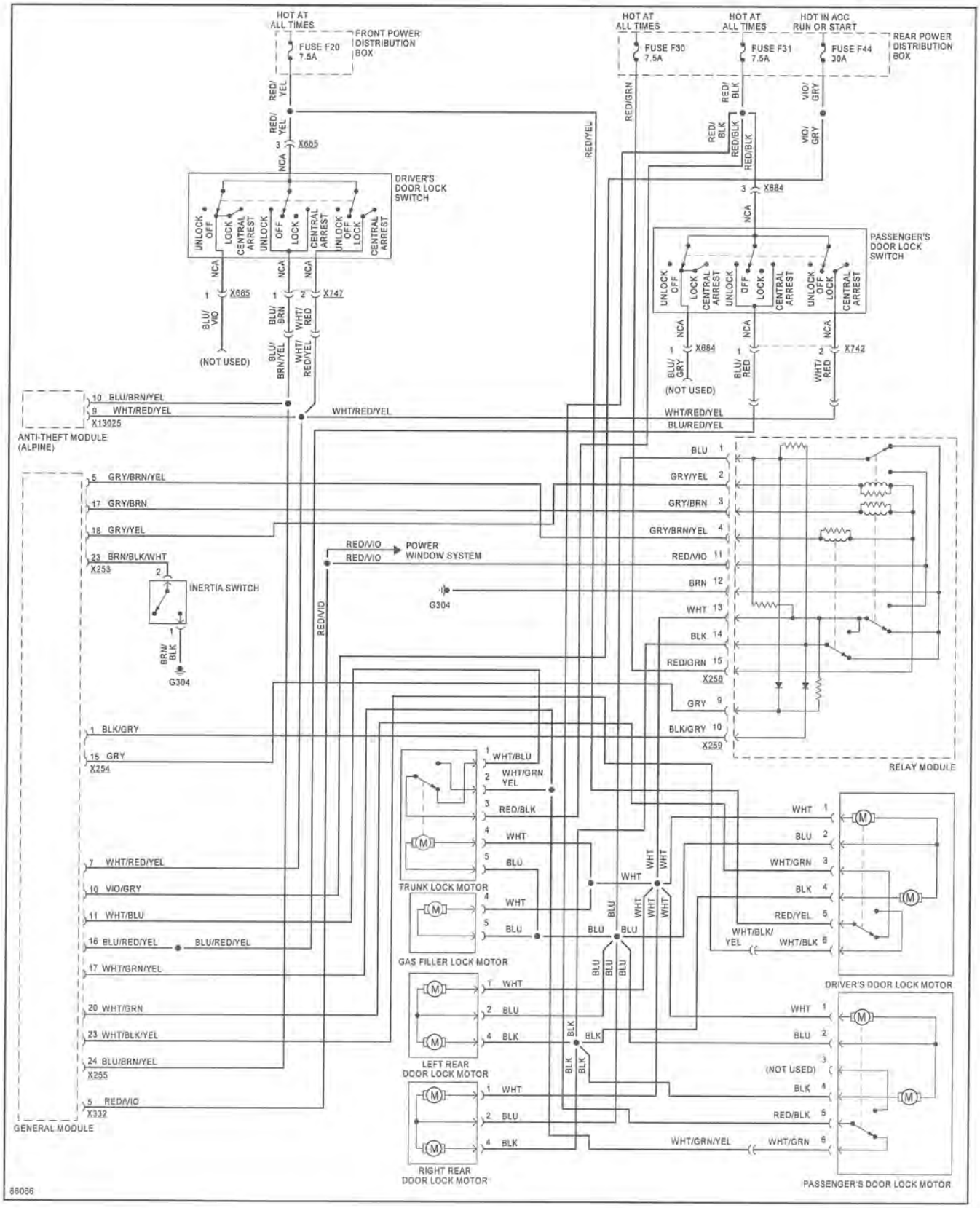
Power Door Locks

1990-91 (2 of 2)



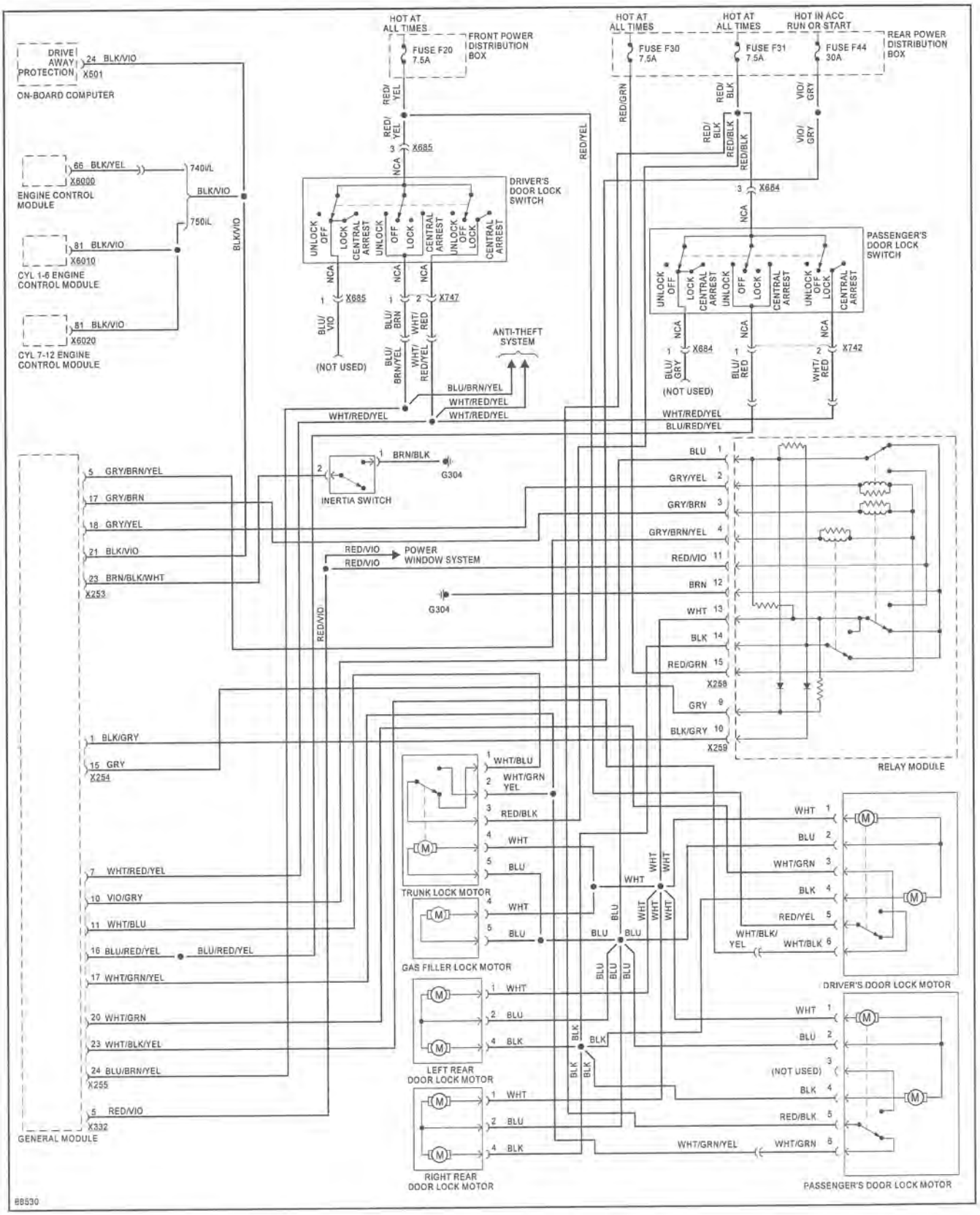
Power Door Locks

1992



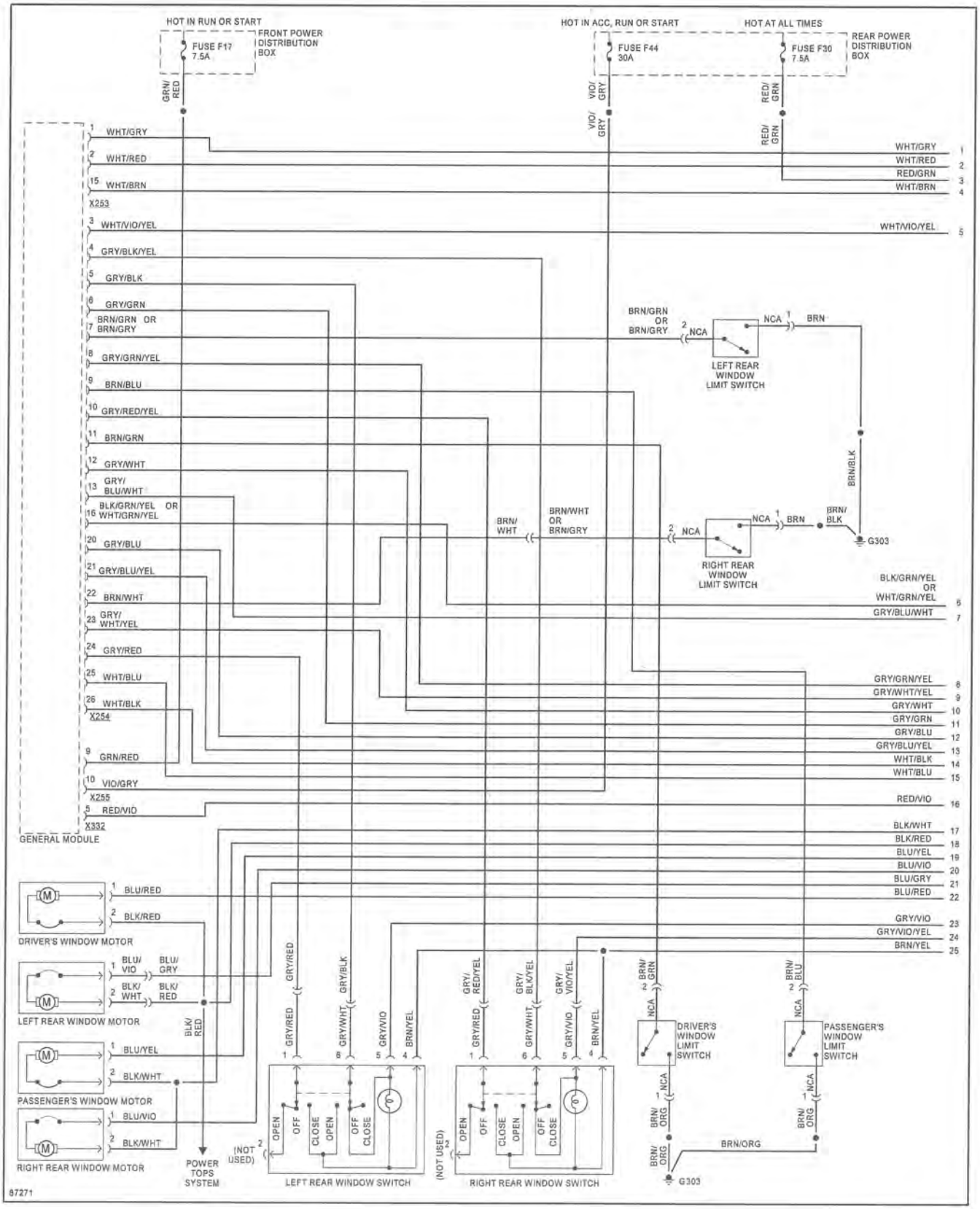
Power Door Locks

1993-94



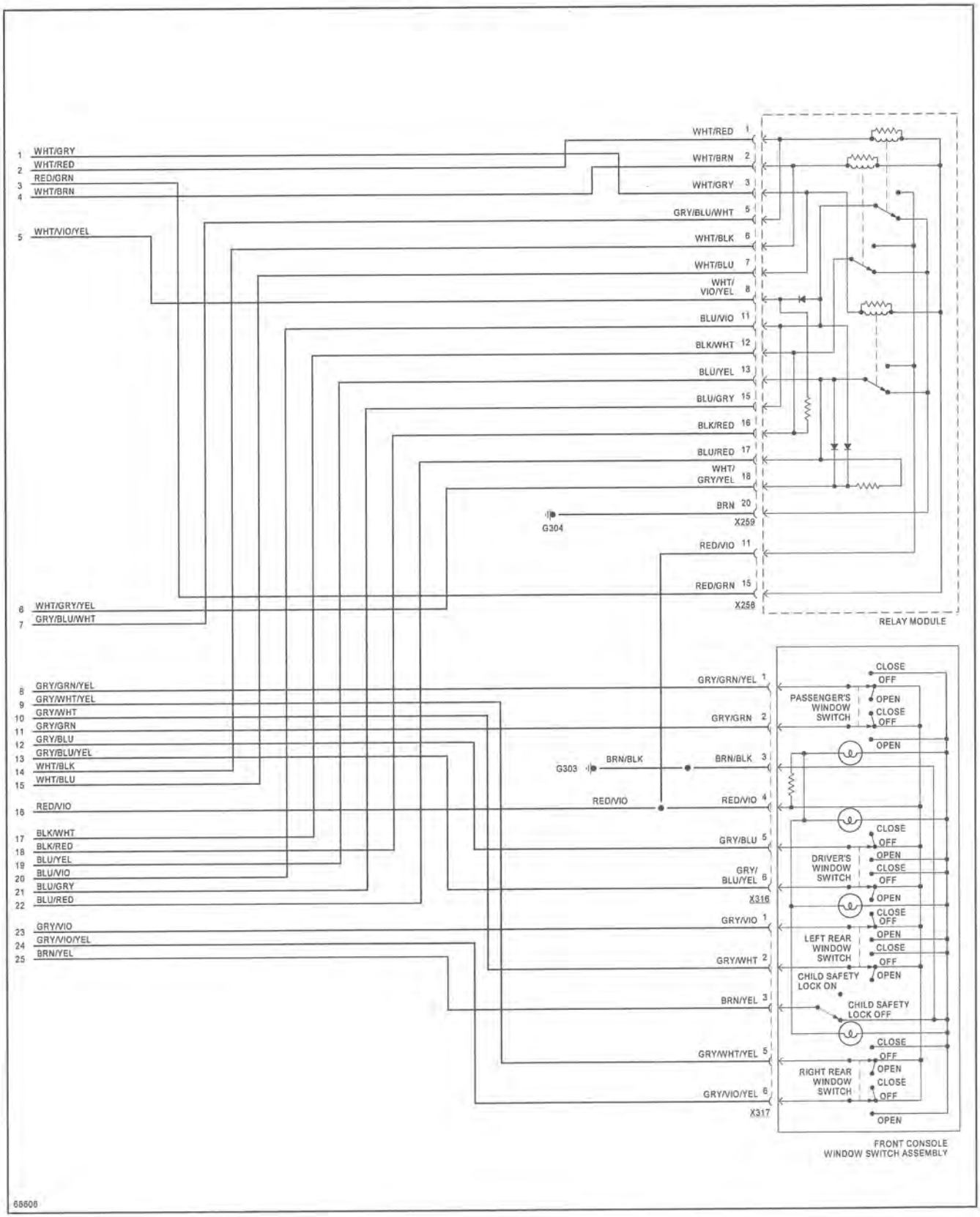
Power Windows

1988-89 (1 of 2)



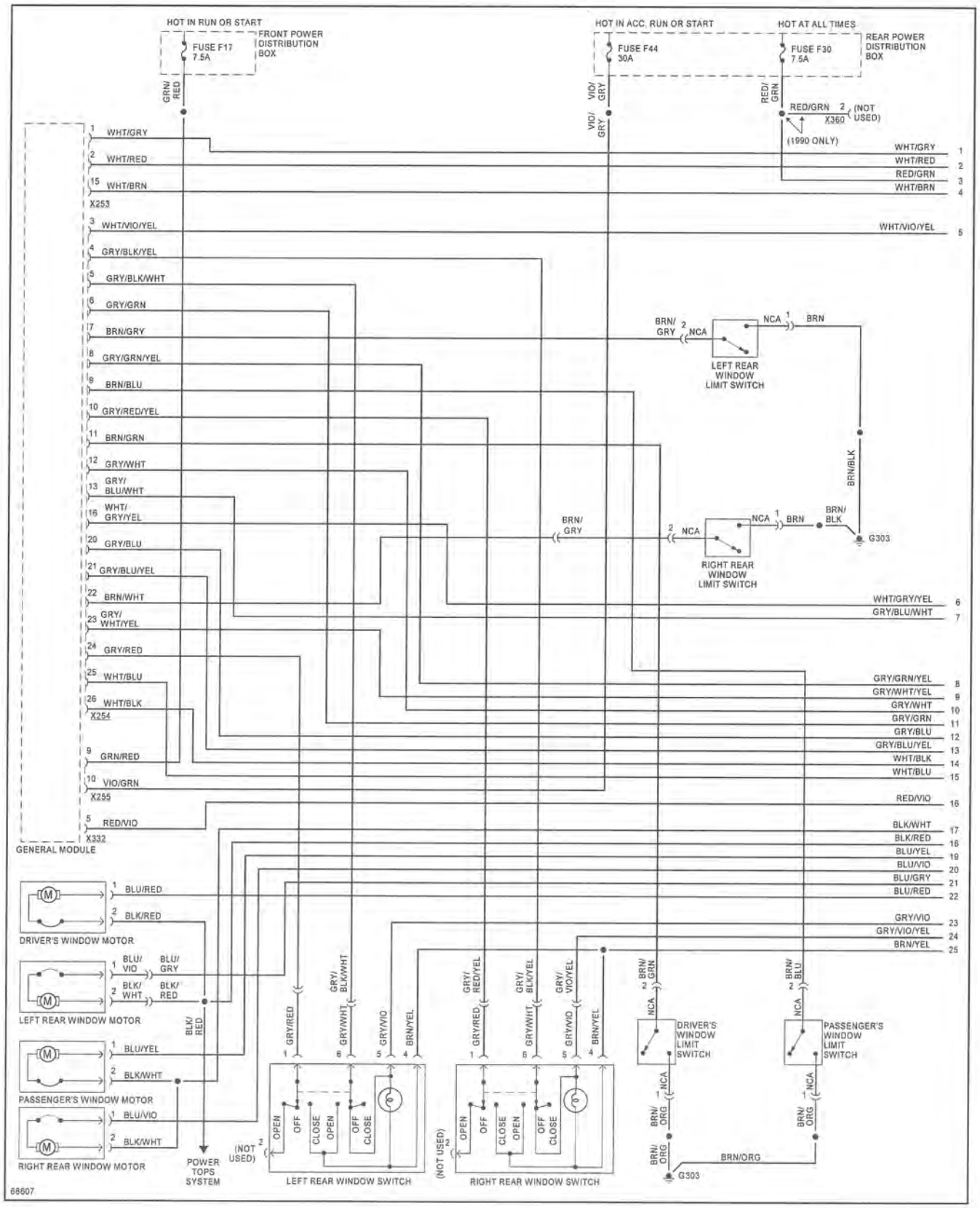
Power Windows

1988-89 (2 of 2)



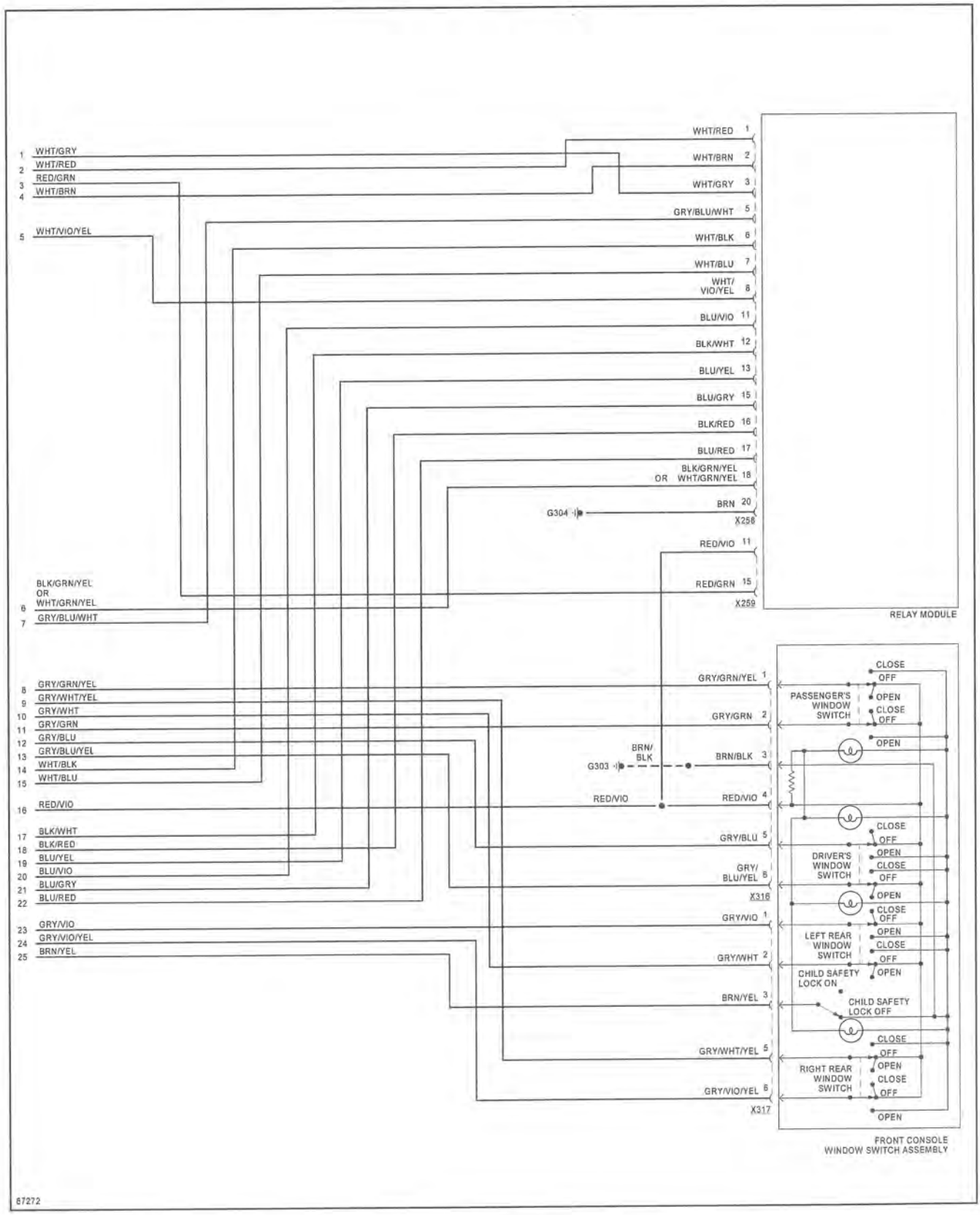
Power Windows

1990-94 (1 of 2)

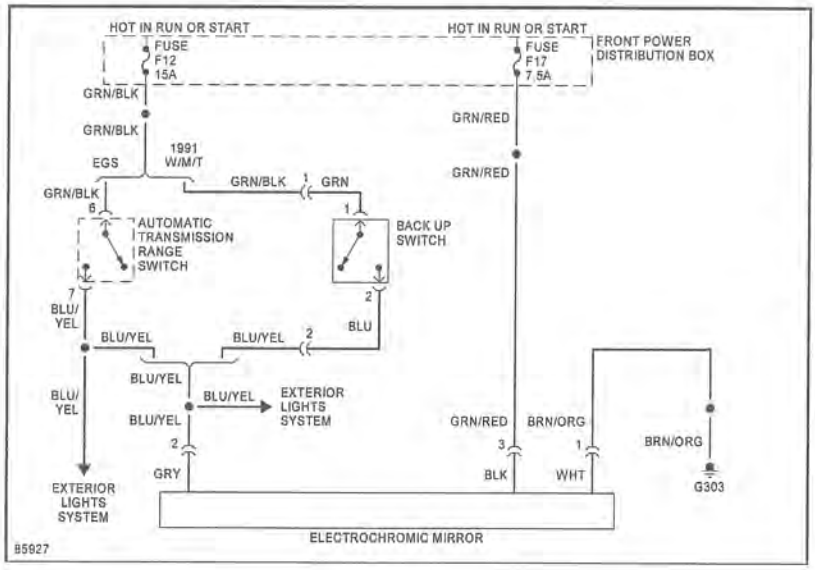


Power Windows

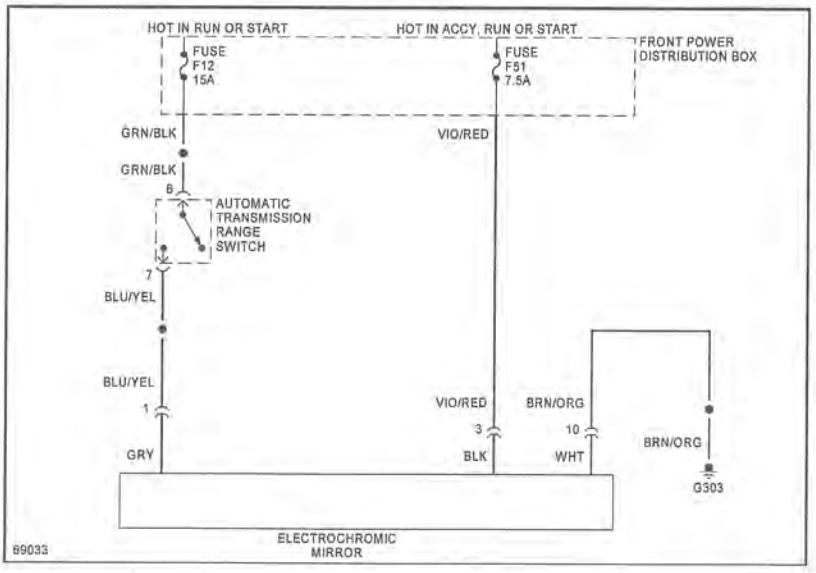
1990-94 (2 of 2)



Power Mirrors

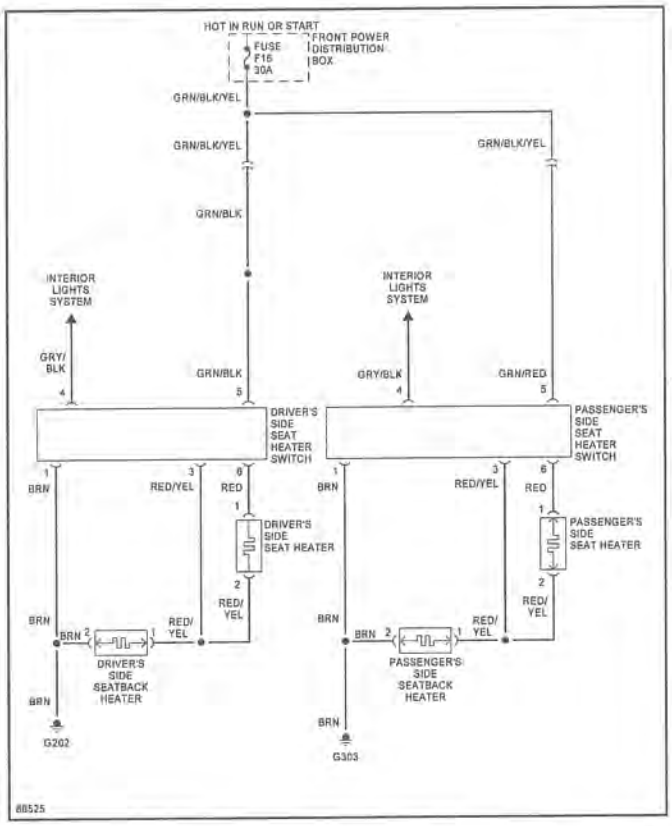


1991-92 Electro-chromic Mirror

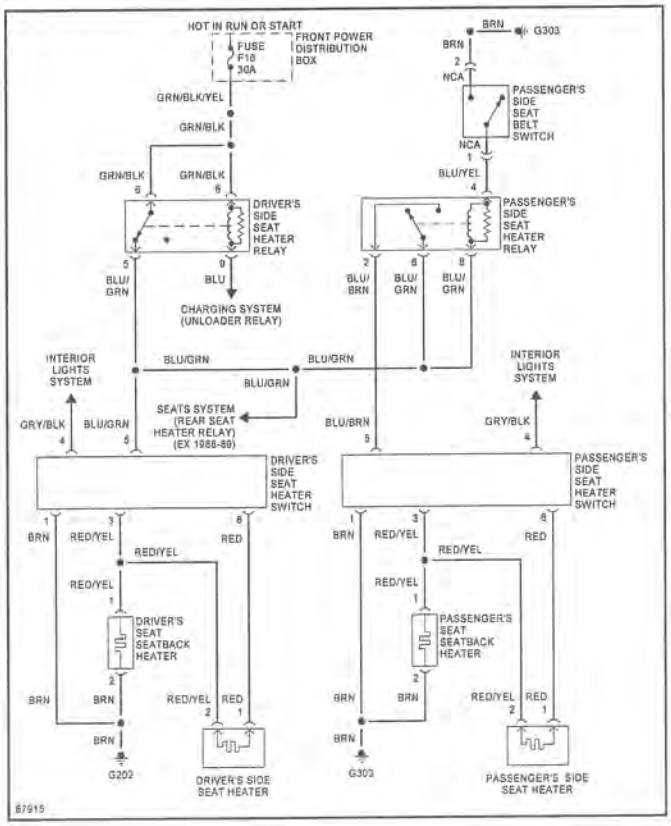


1993-94 Electro-chromic Mirror

Power Seats

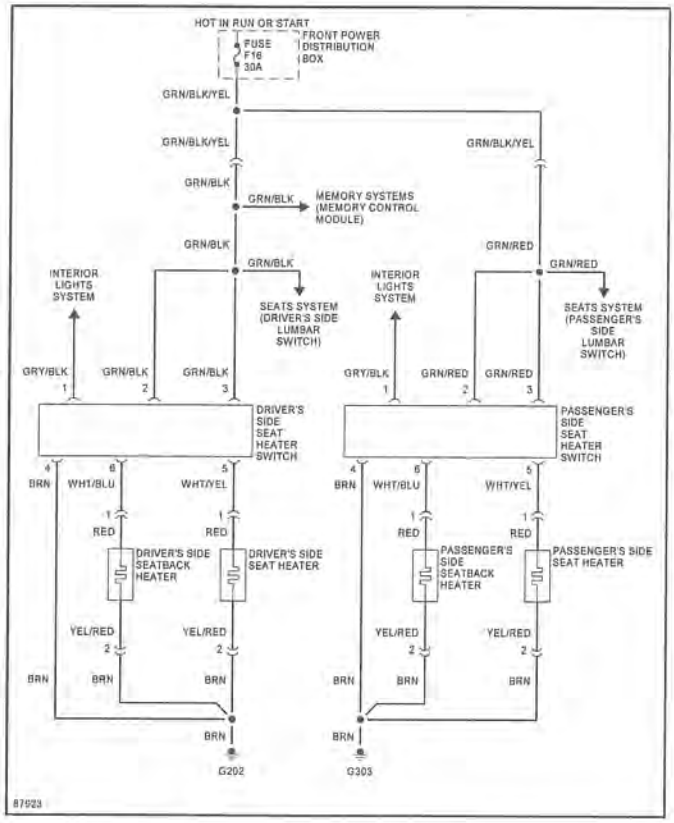


1988 Front Heater Circuit

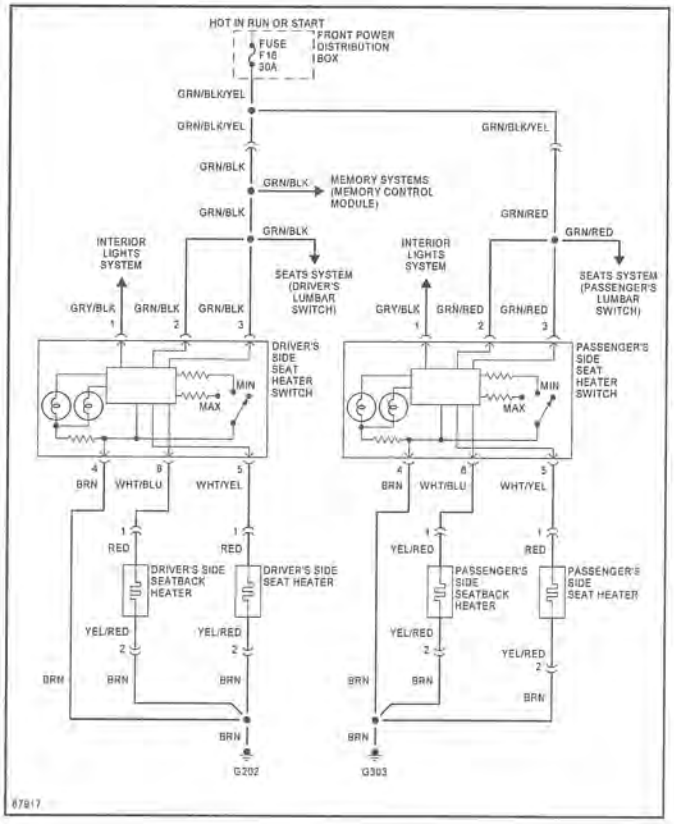


1989-90 Front Heater Circuit

Power Seats

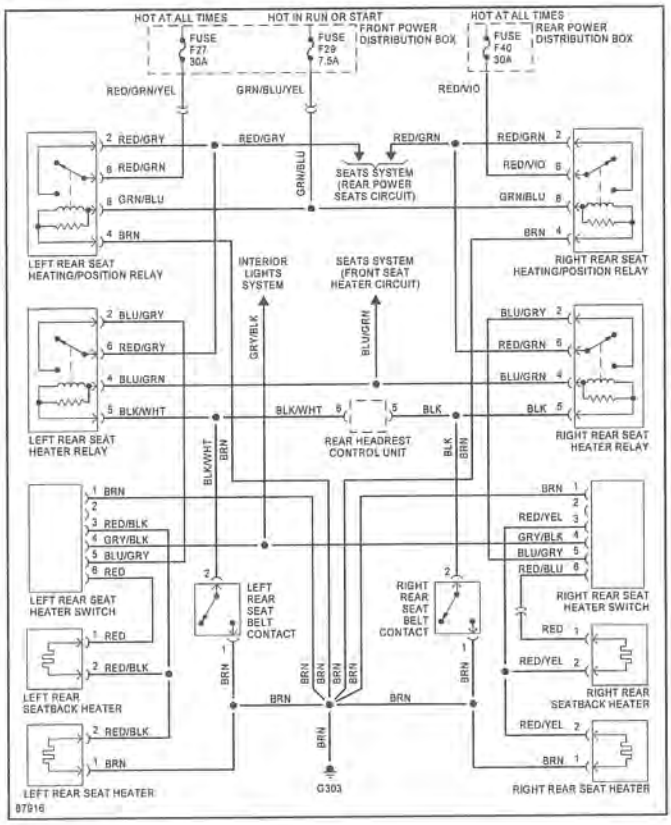


1991-92 Front Heater Circuit

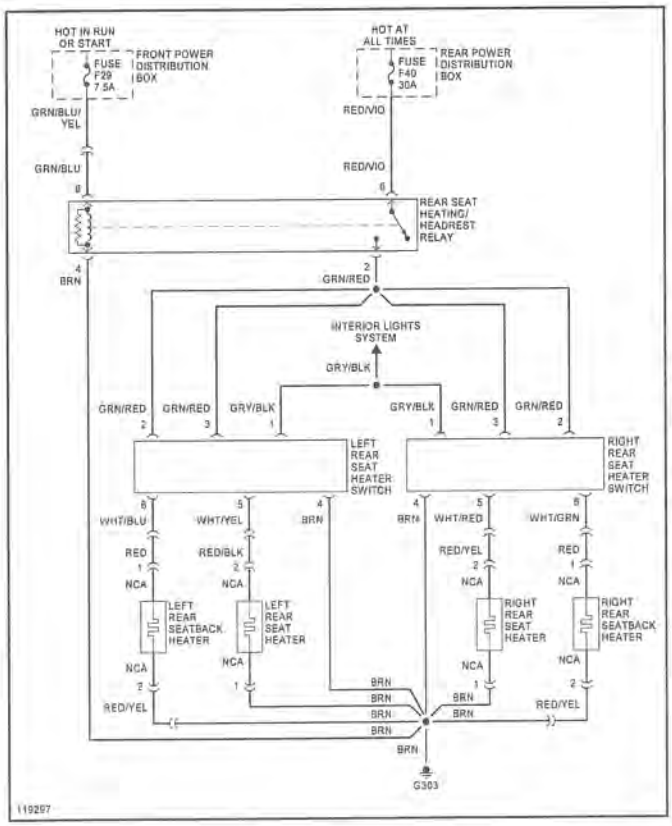


1993-94 Front Heater Circuit

Power Seats

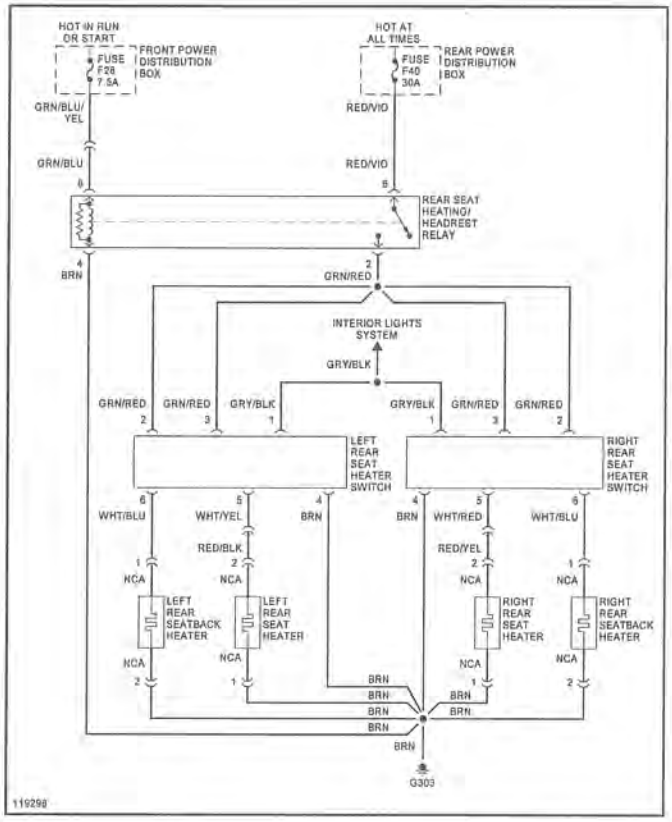


1990 750iL Rear Seat Heater Circuit

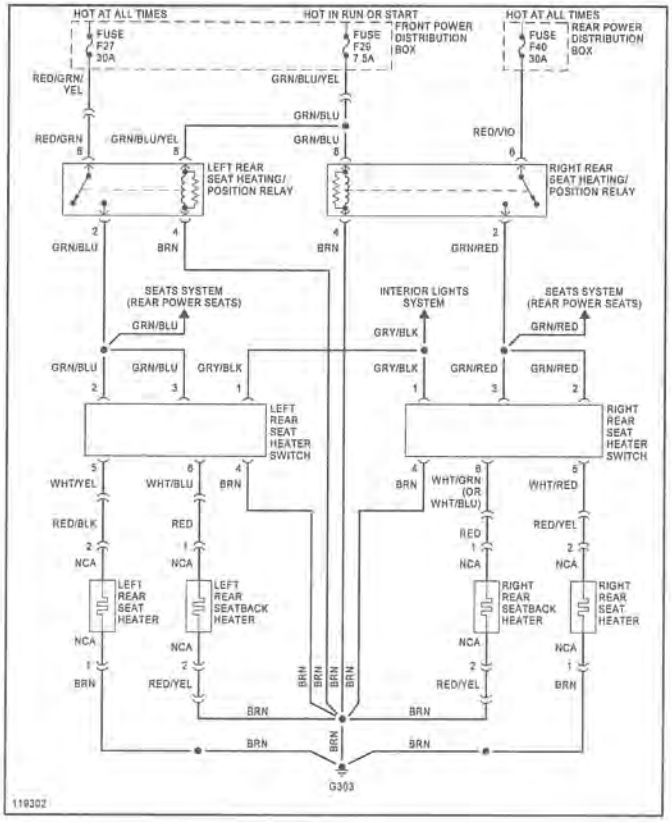


1991 Rear Seat Heater Circuit w/ Rear Power Seat Headrest

Power Seats

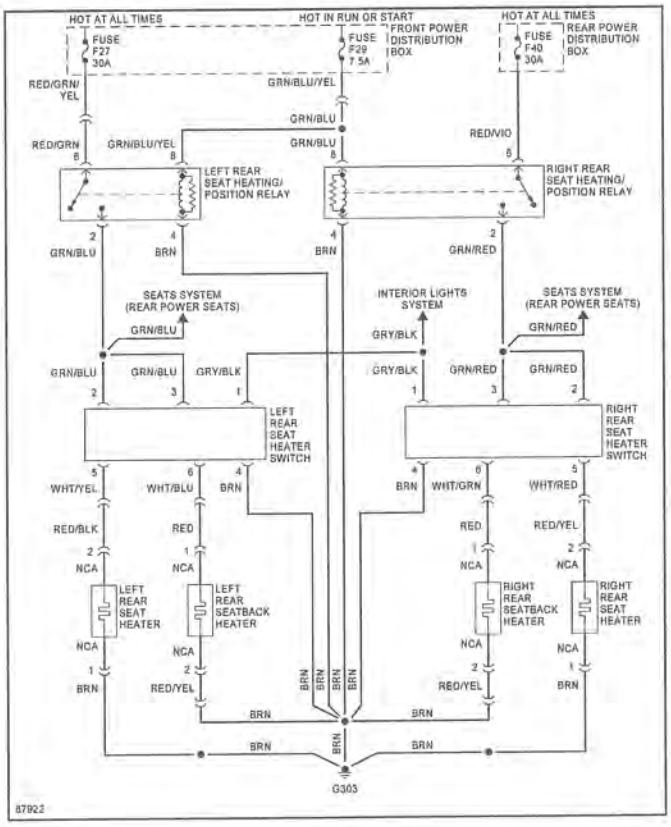


1991 Rear Seat Heater Circuit w/o Rear Power Seat Headrest

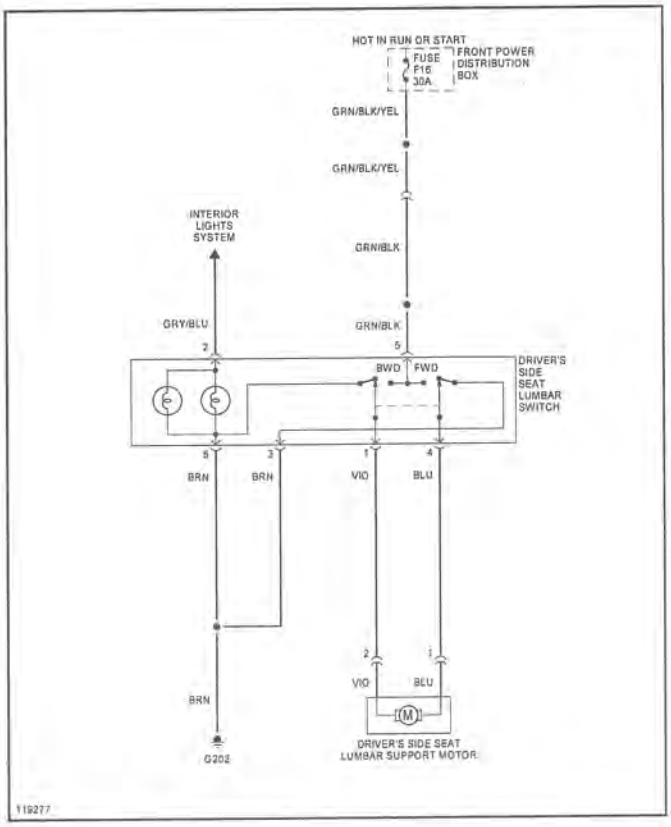


1992 735i, 735iL, 750iL, 1993-94 750iL Rear Seat Heater Circuit w/o Rear Power Seat Headrest

Power Seats

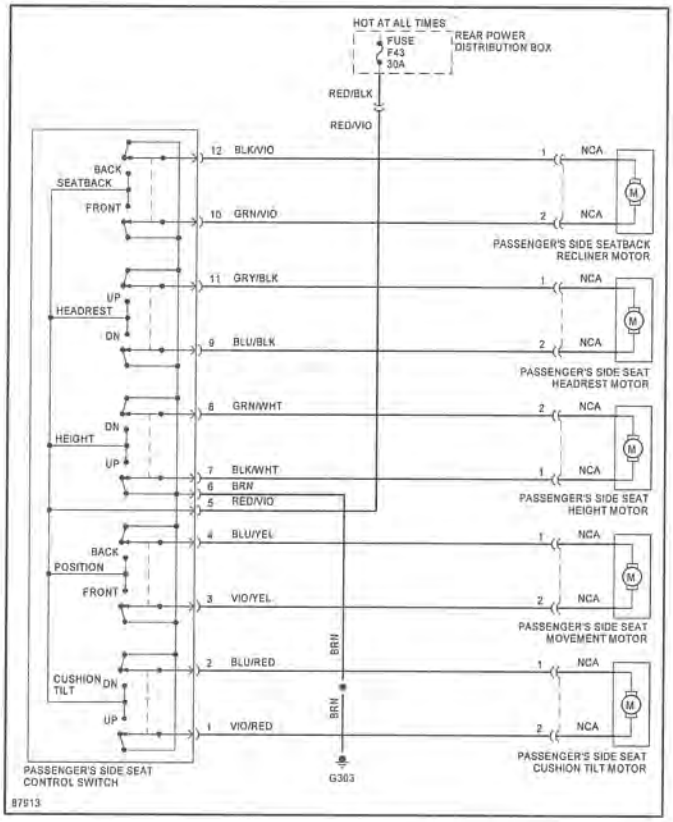


1991-92
735i, 735iL, 750iL,
1993-94
750iL
Rear Seat Heater Circuit w/ Rear Power Seat Headrest

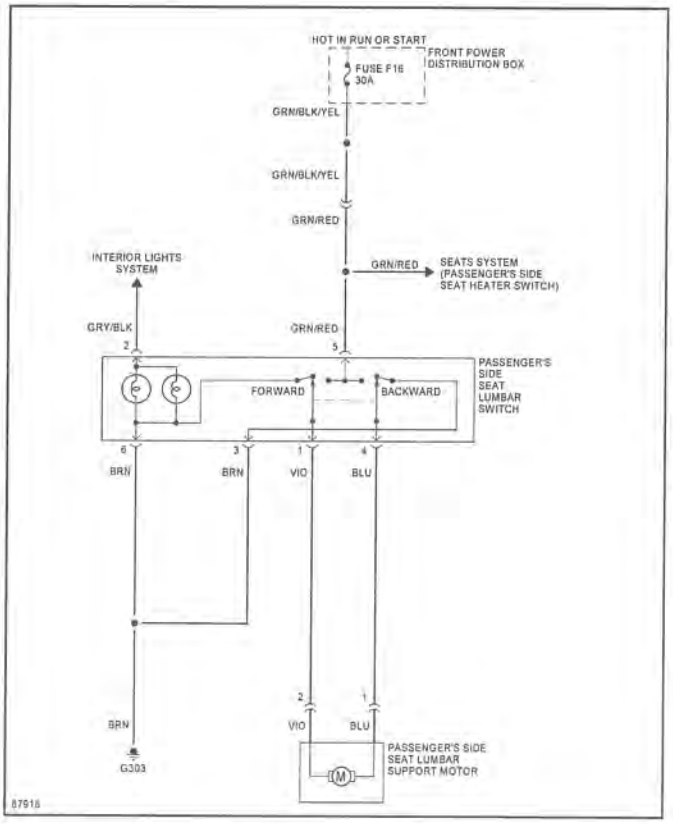


Driver's Lumbar Circuit

Power Seats



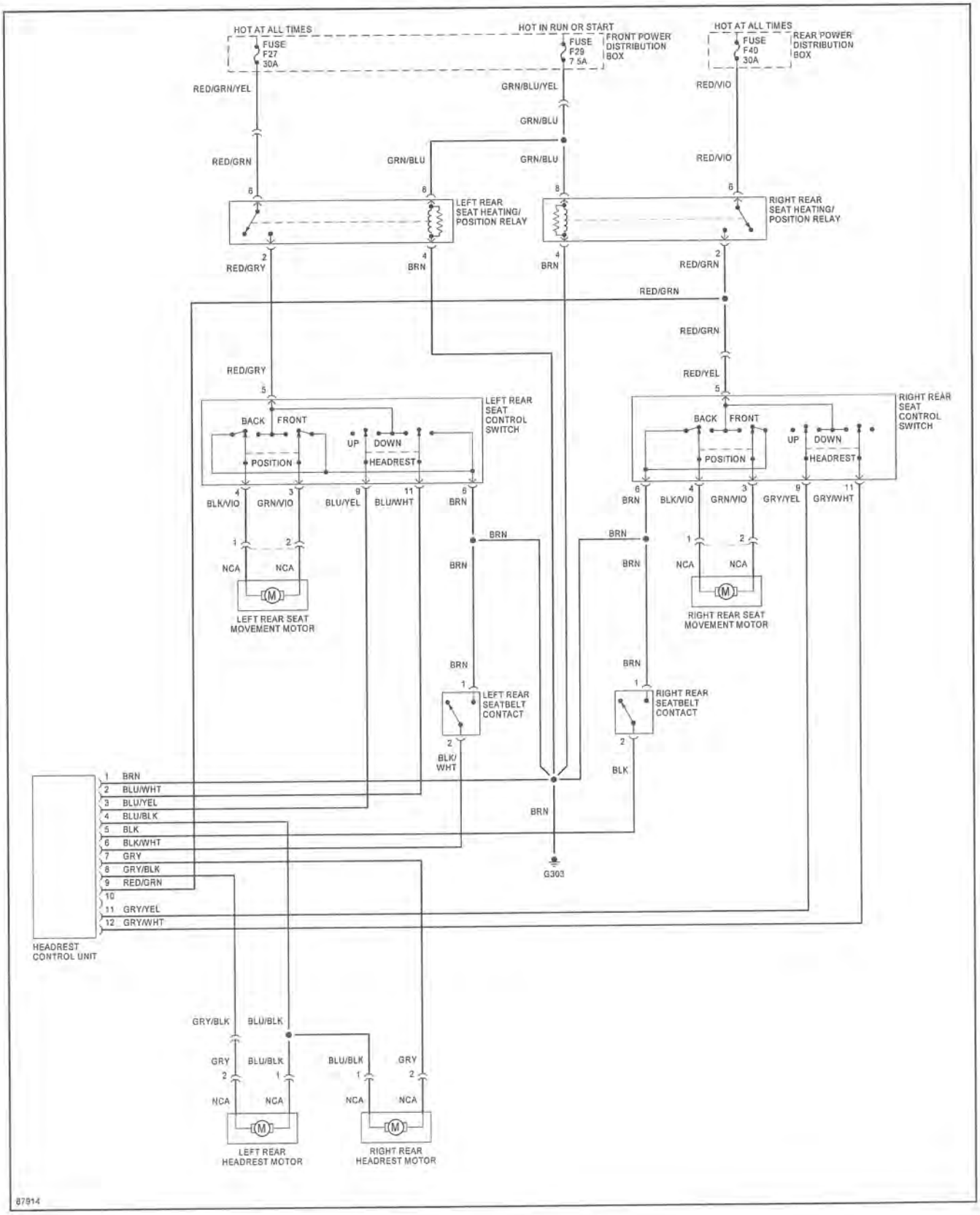
Passenger's Power Seat Circuit



1991-94 750iL Passenger's Lumbar Circuit

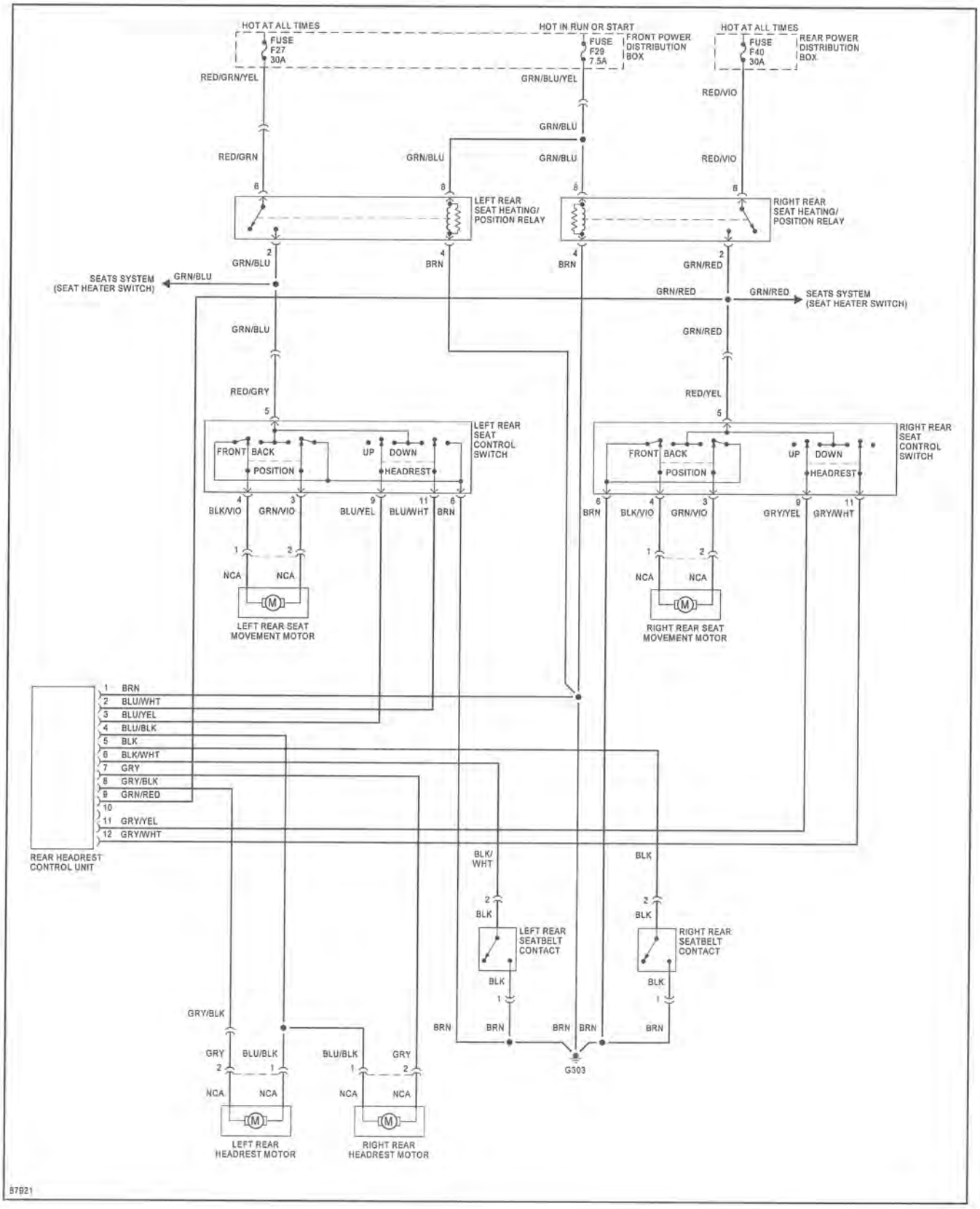
Power Seats

1988-90 Rear Power Seat/Headrest Circuit



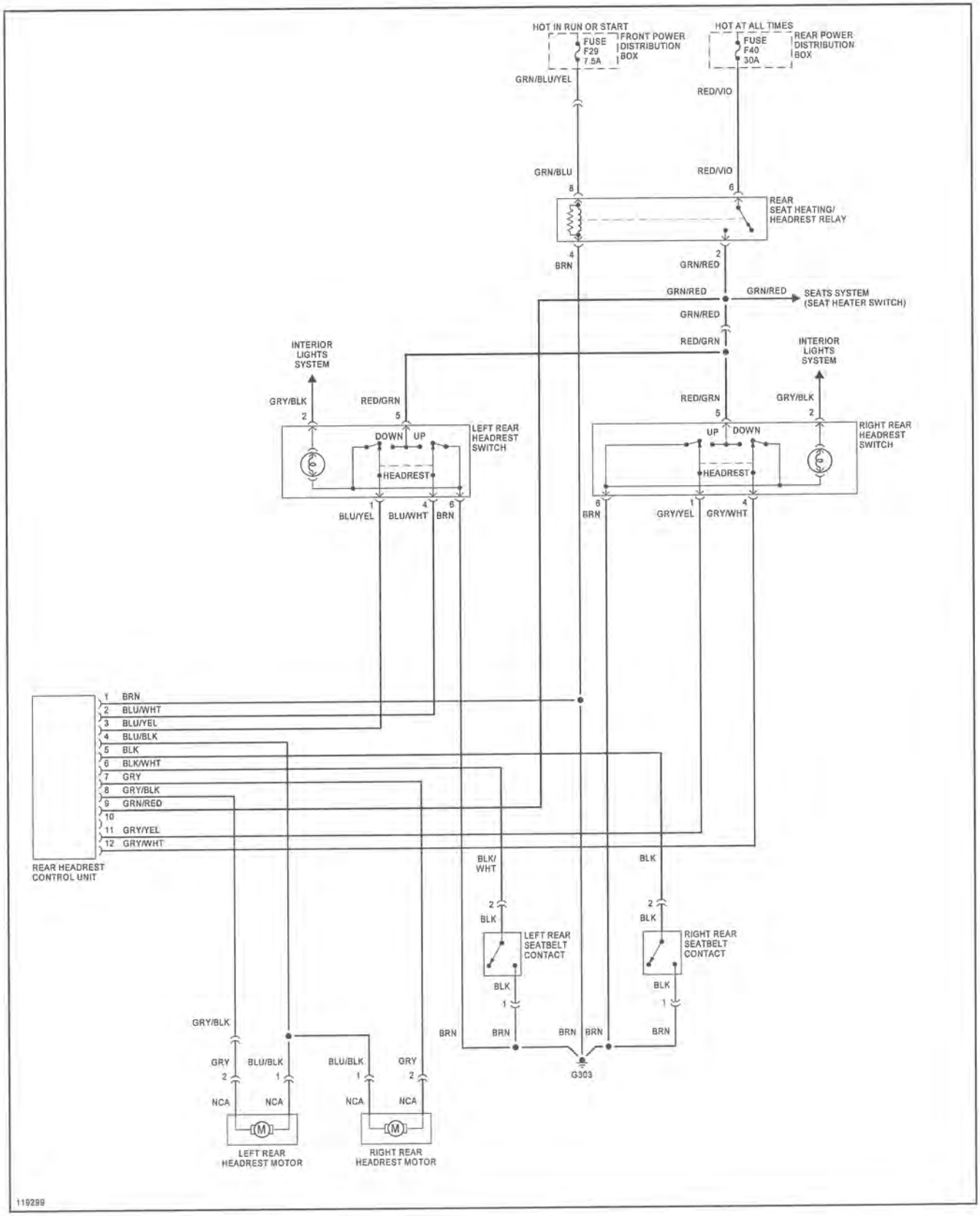
Power Seats

1991-94 Rear Power Seat/Headrest Circuit



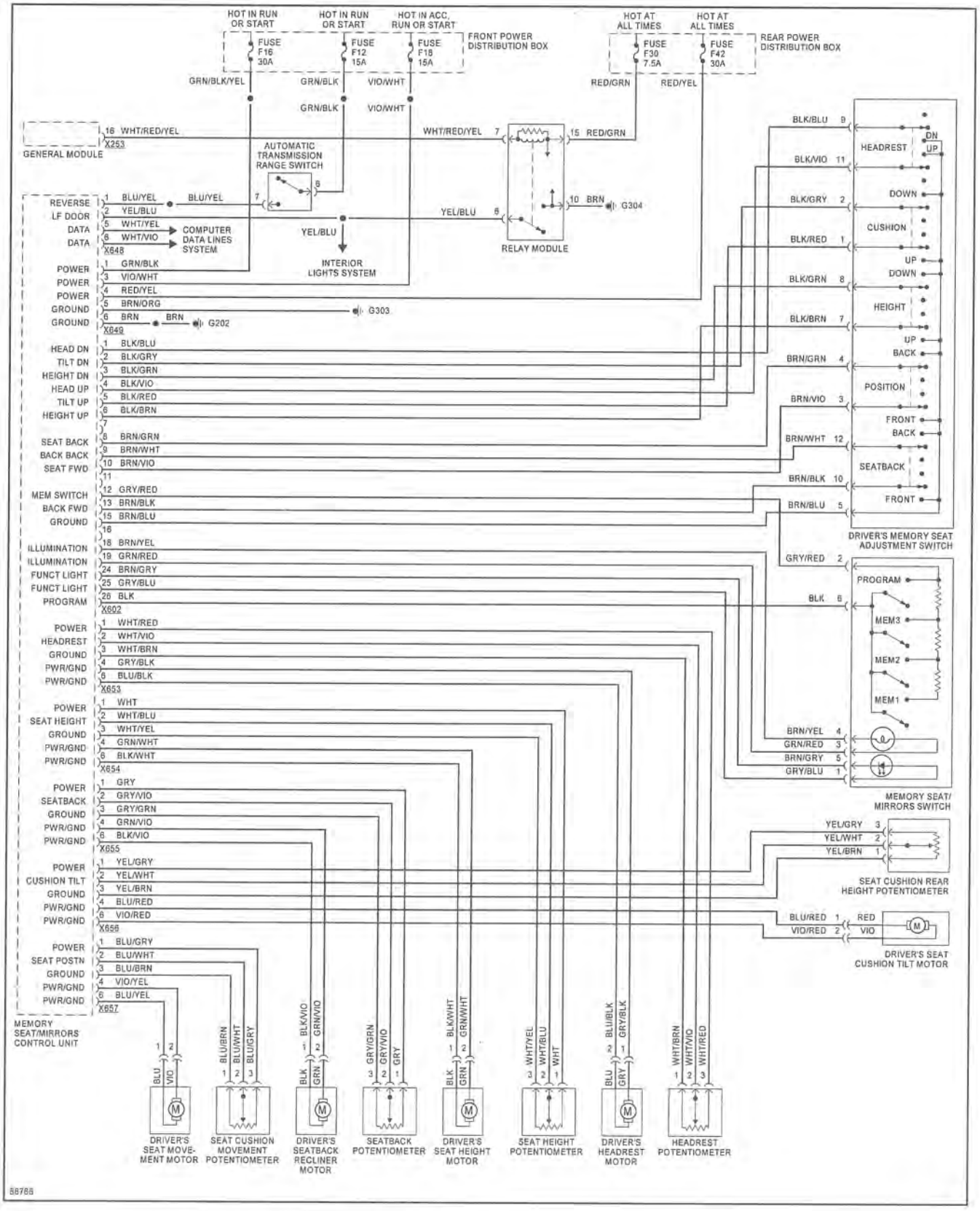
Power Seats

Rear Power Headrest



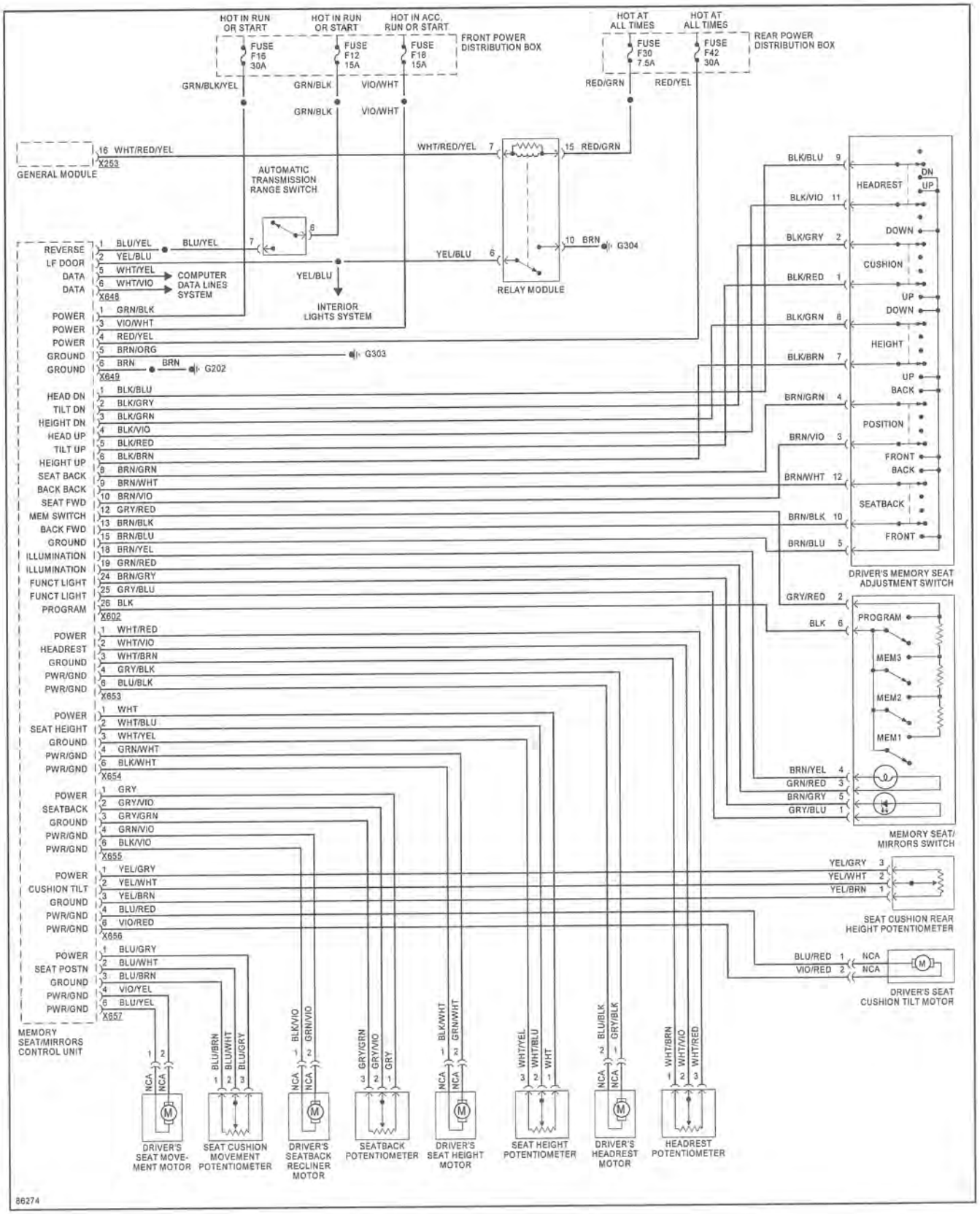
Memory Seats

1988



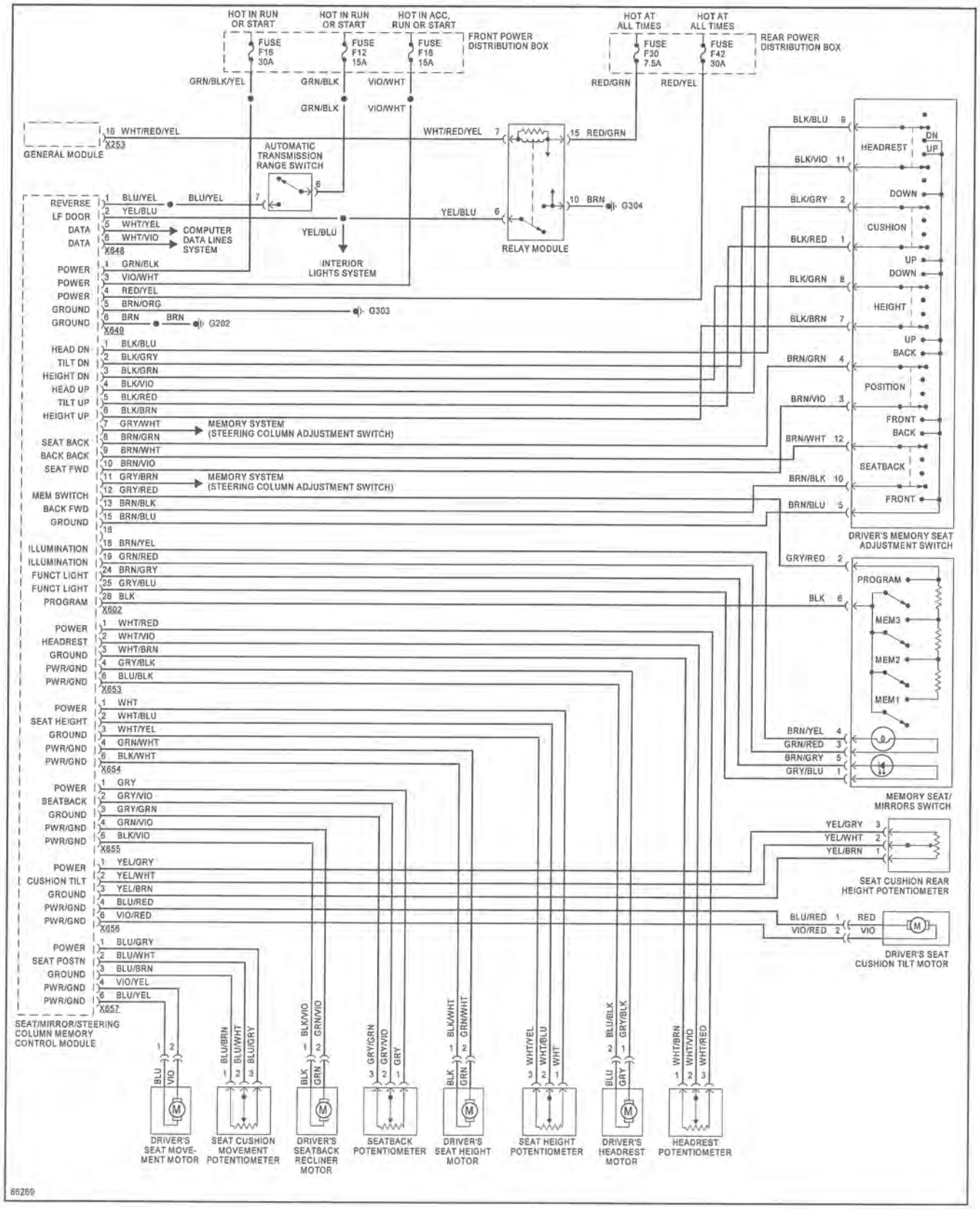
Memory Seats

1989-90



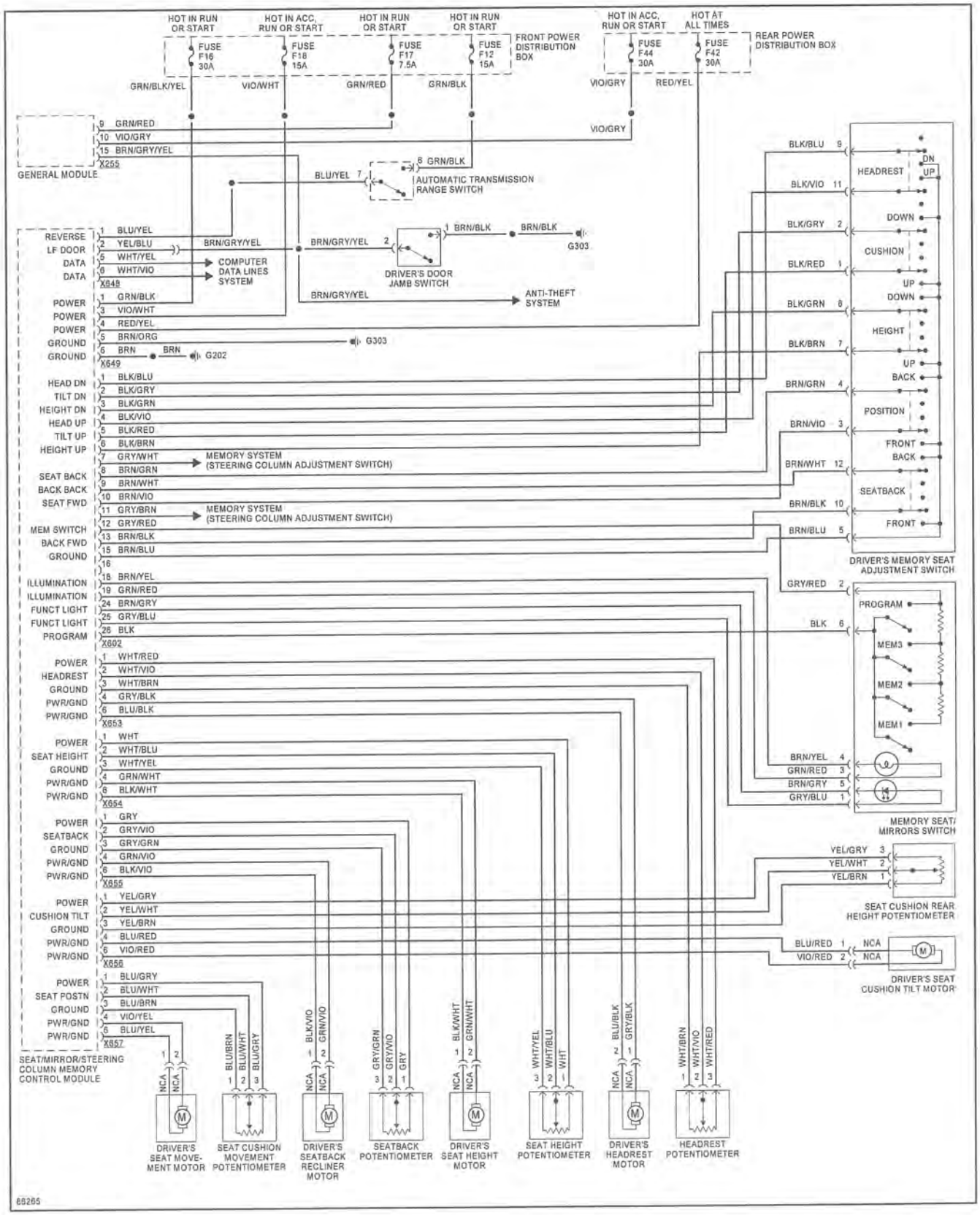
Memory Seats

1991



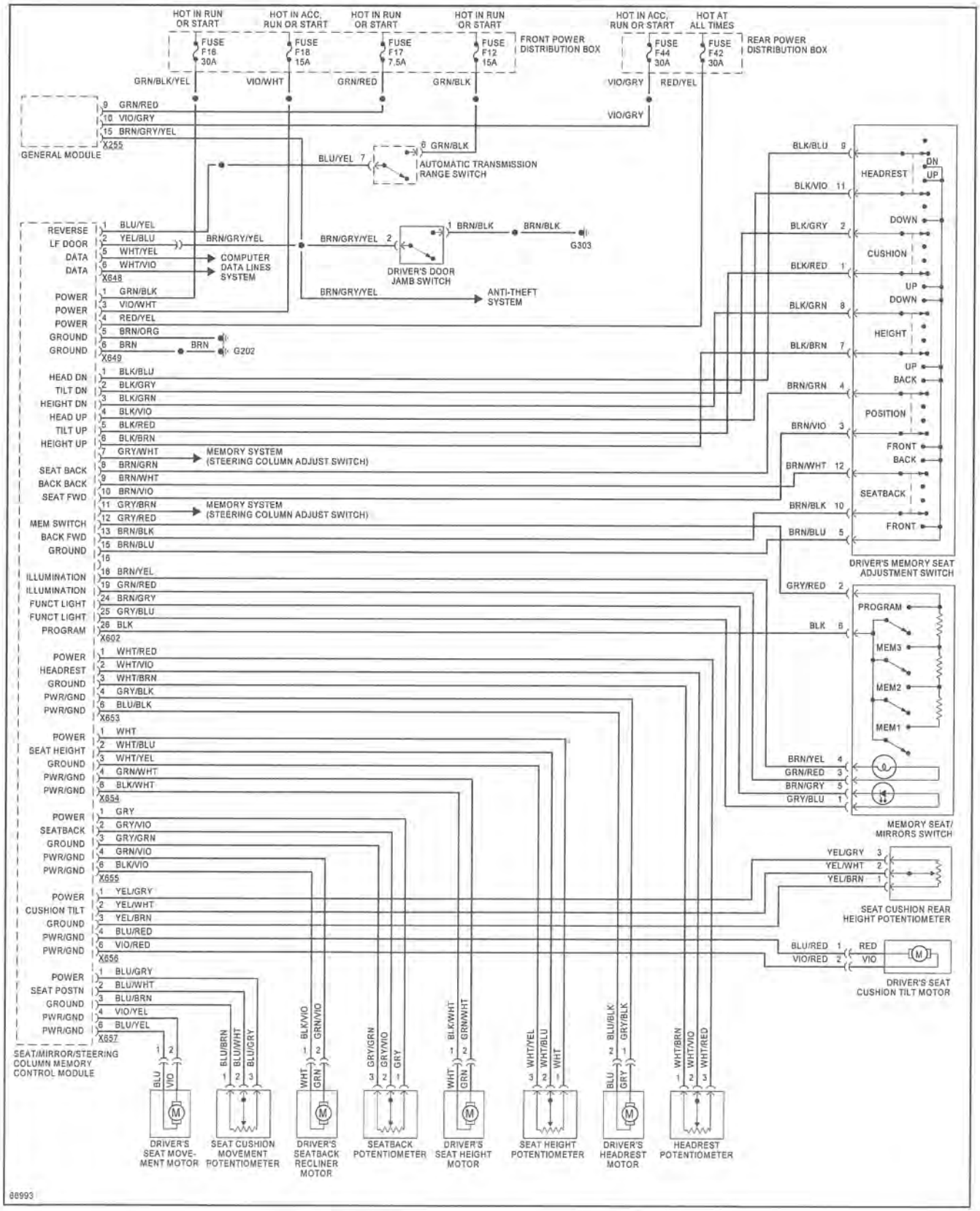
Memory Seats

1992



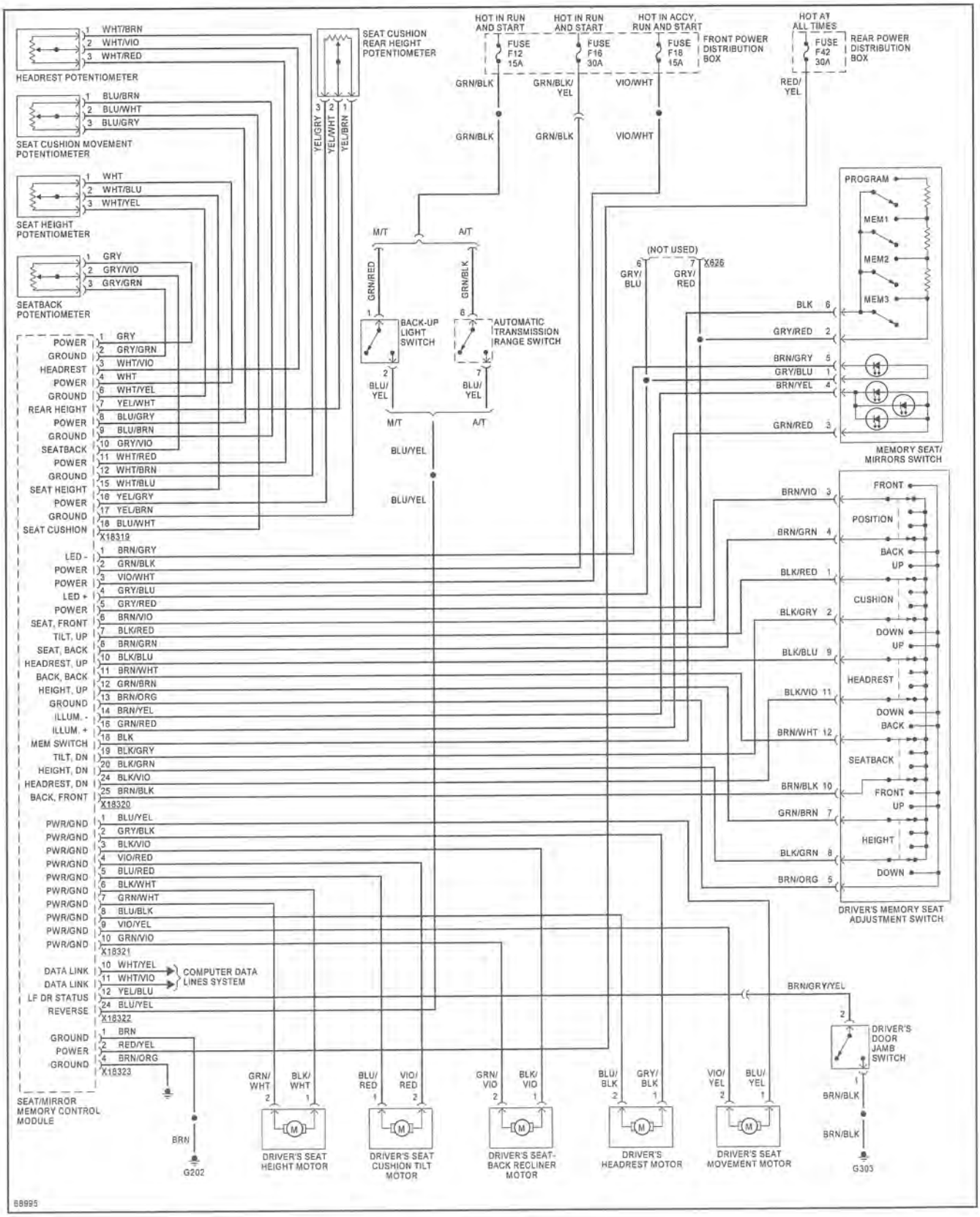
Memory Seats

1993 Early Production



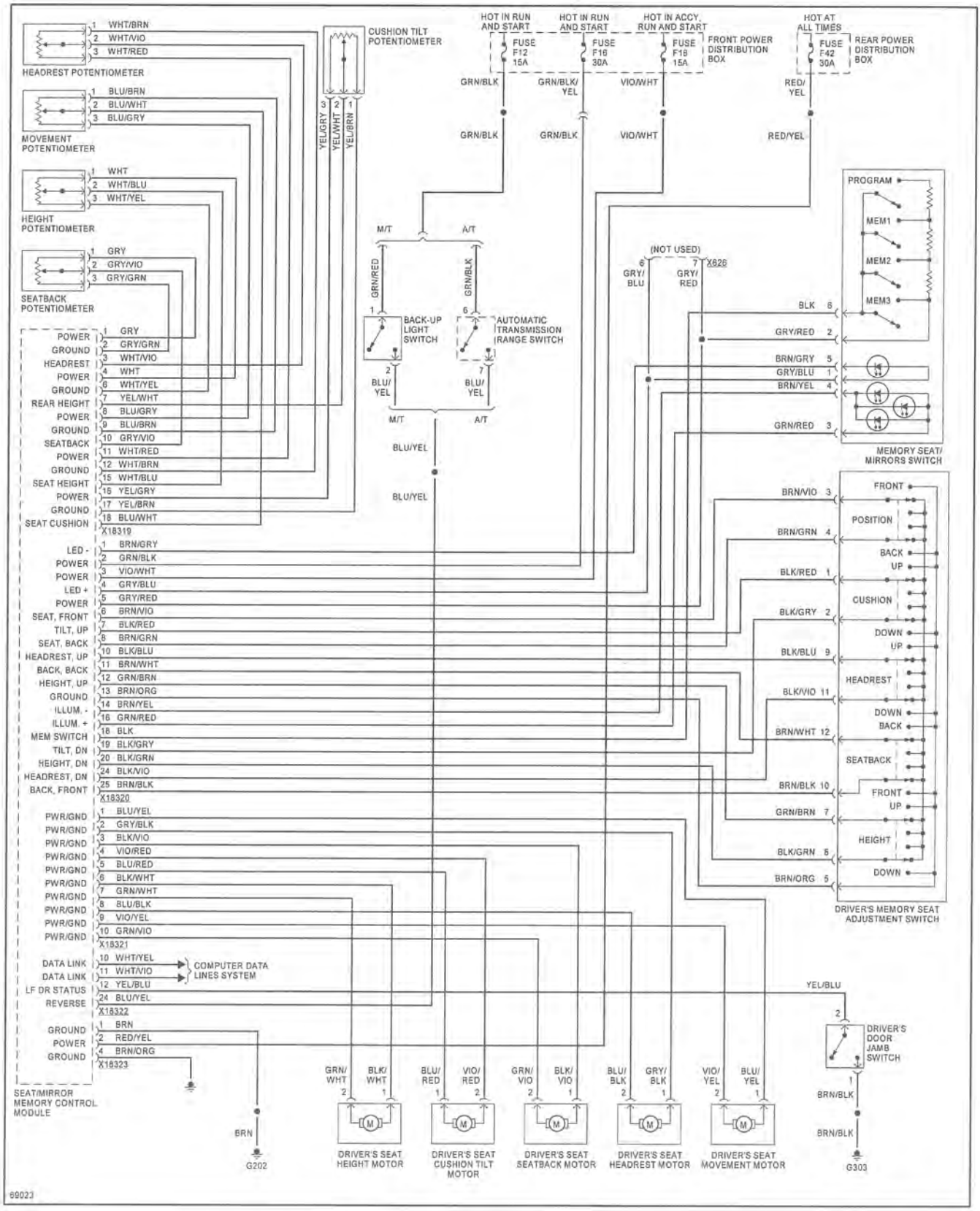
Memory Seats

1993 Late Production



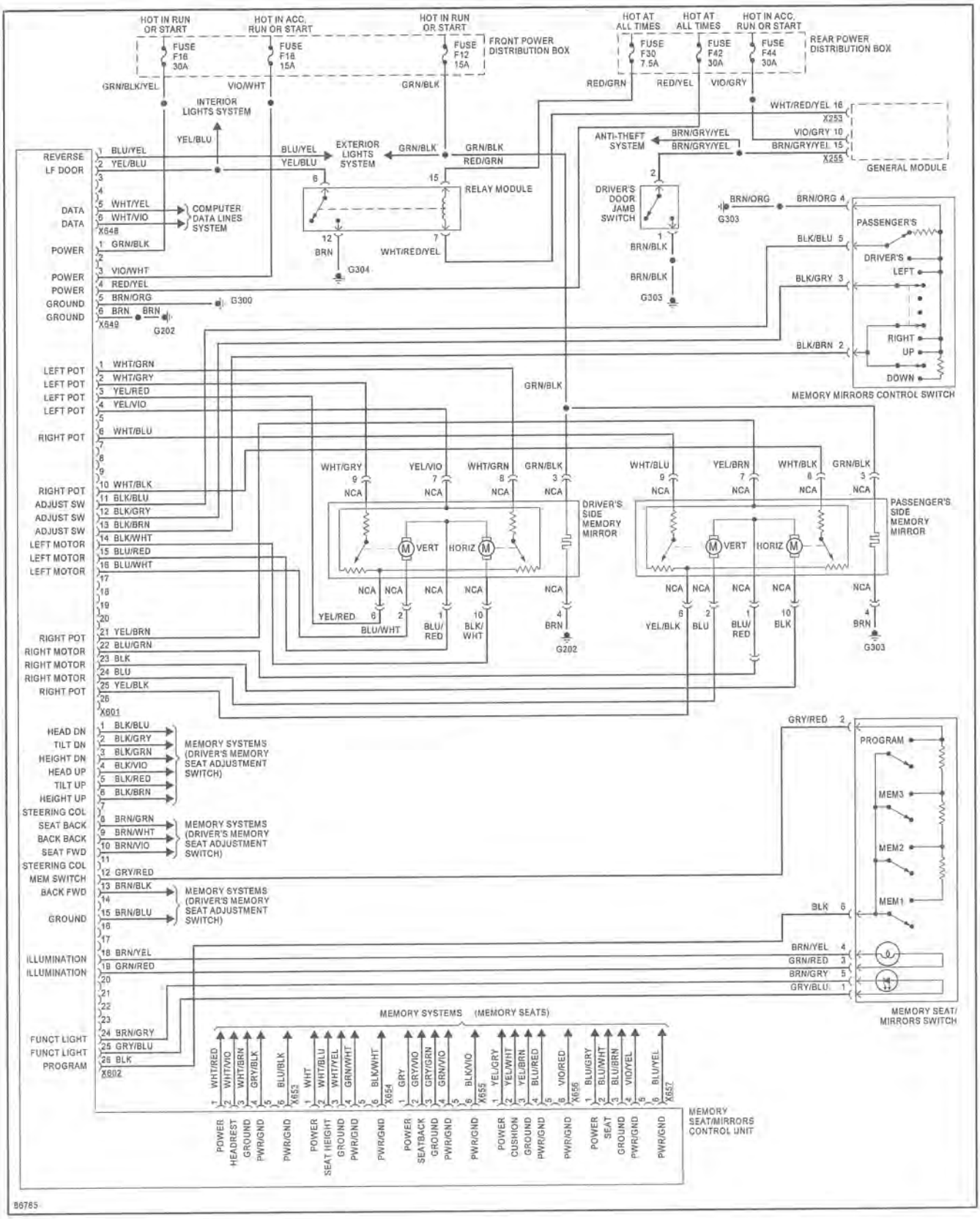
Memory Seats

1994



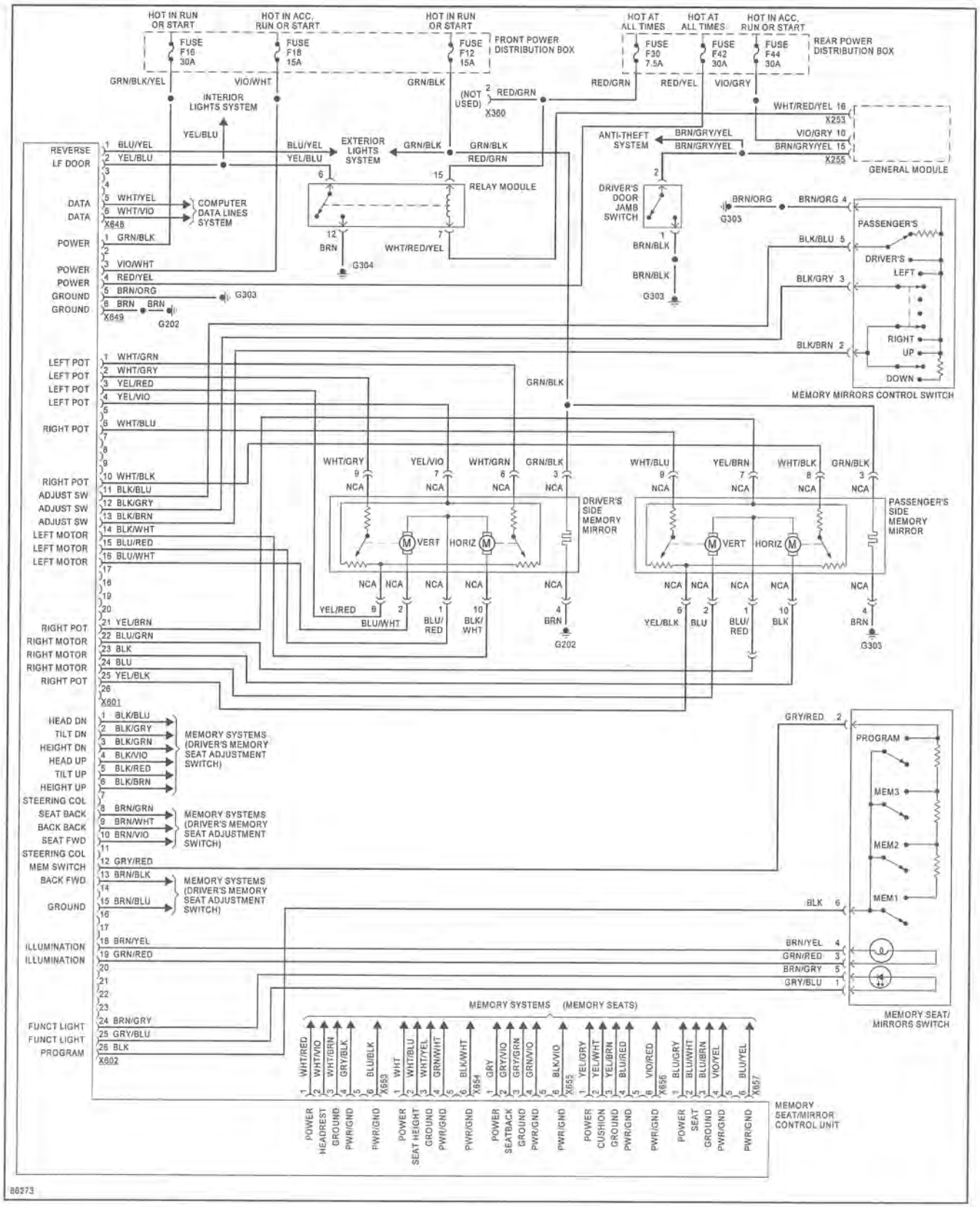
Memory Mirrors

1988



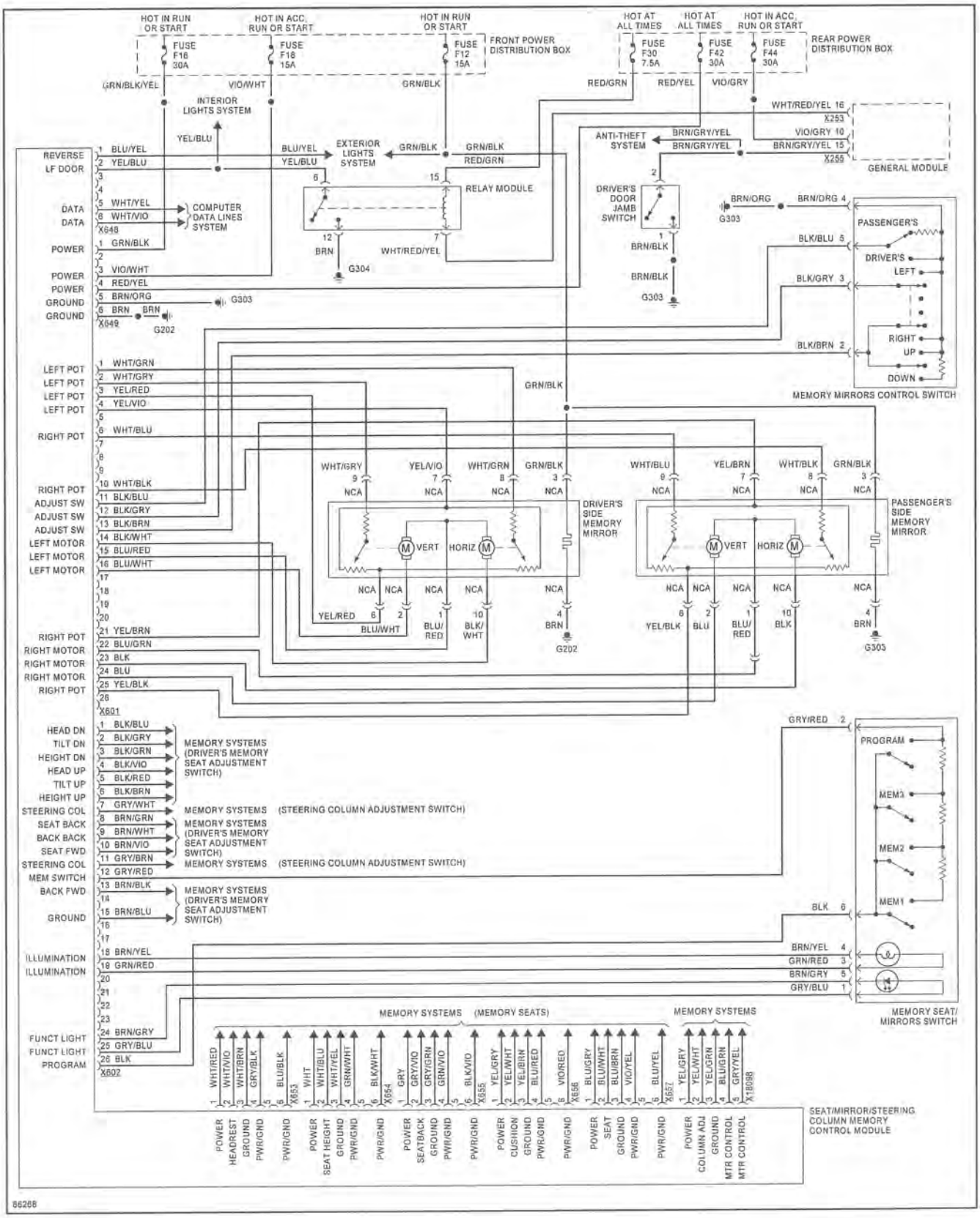
Memory Mirrors

1989-90



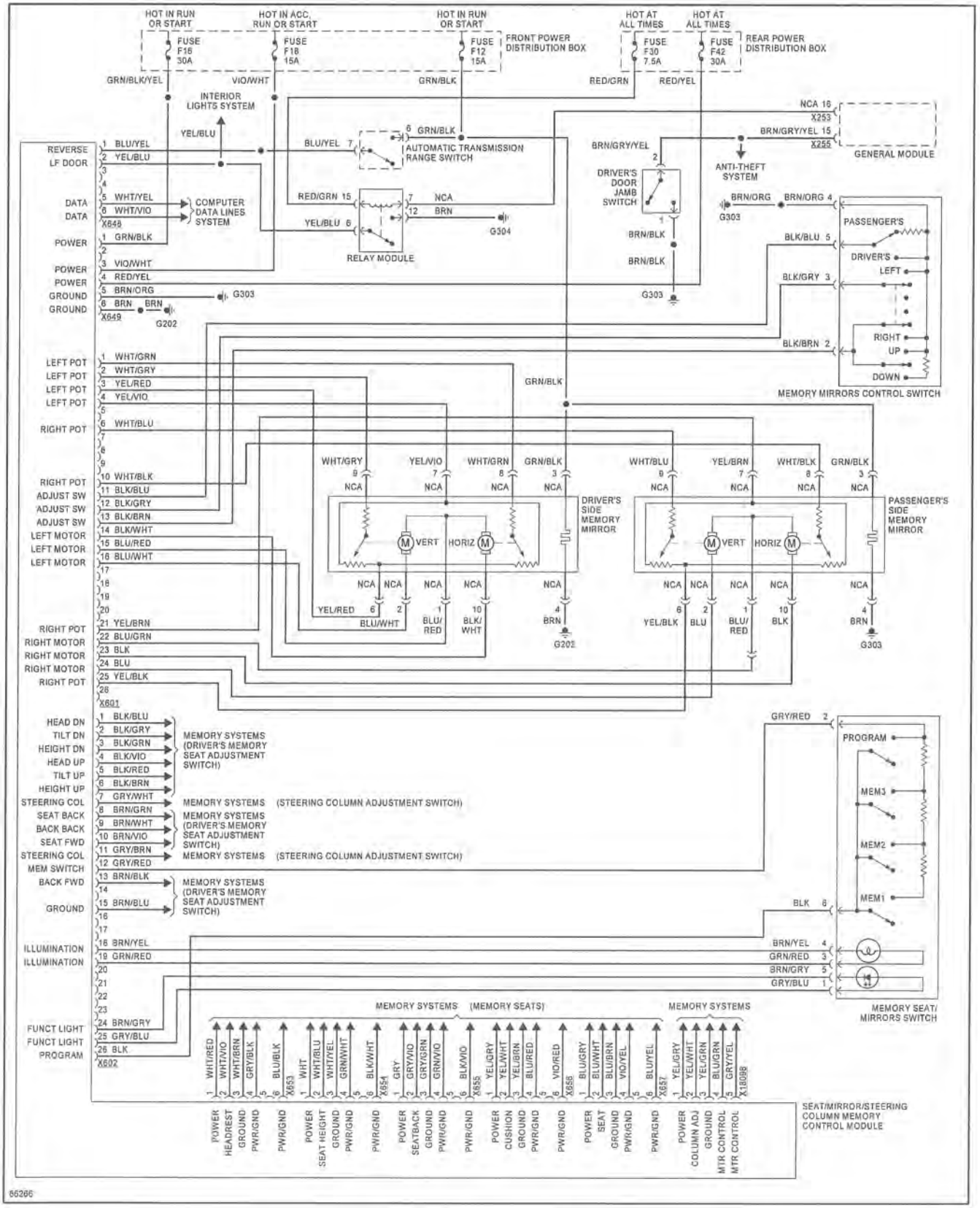
Memory Mirrors

1991



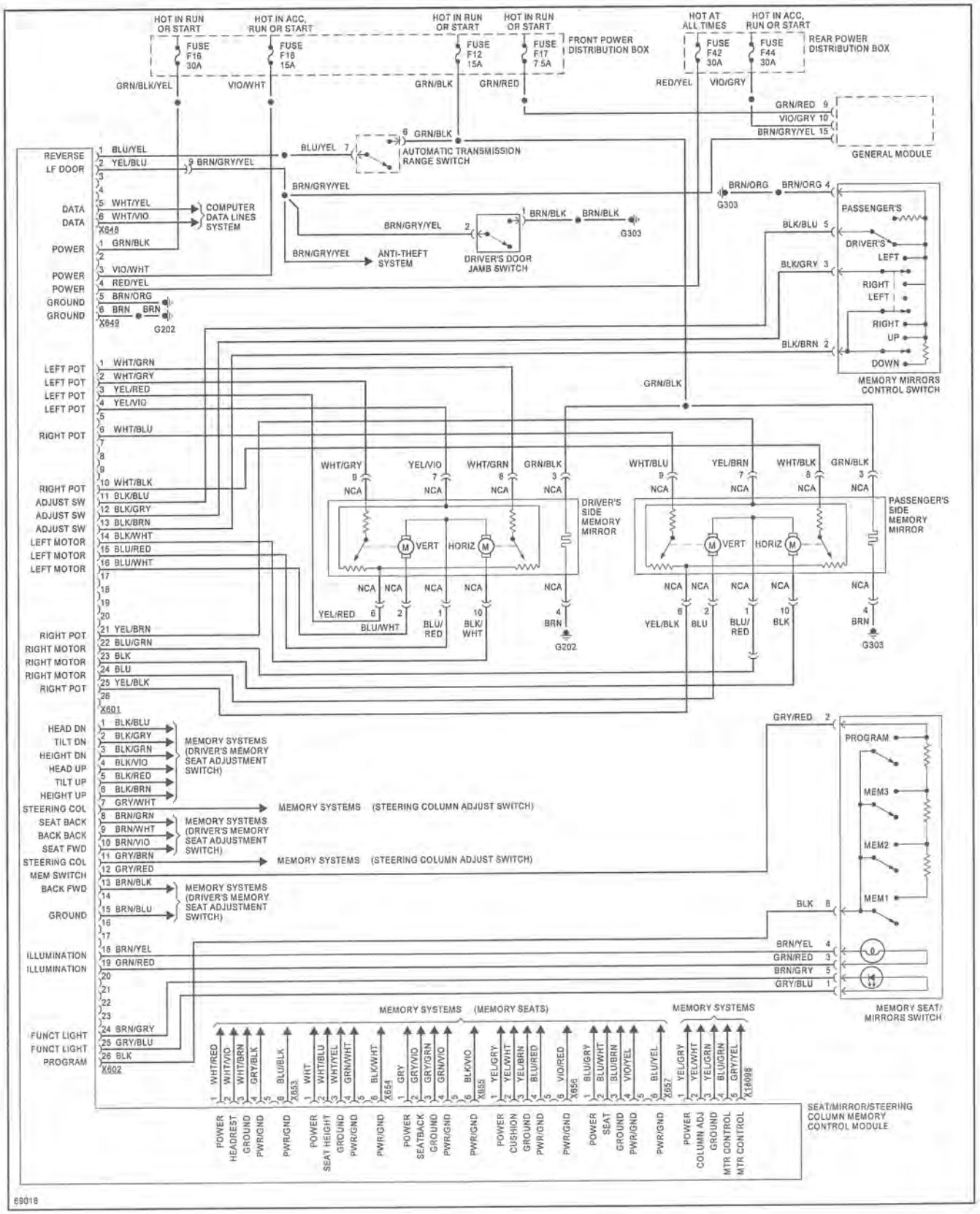
Memory Mirrors

1992



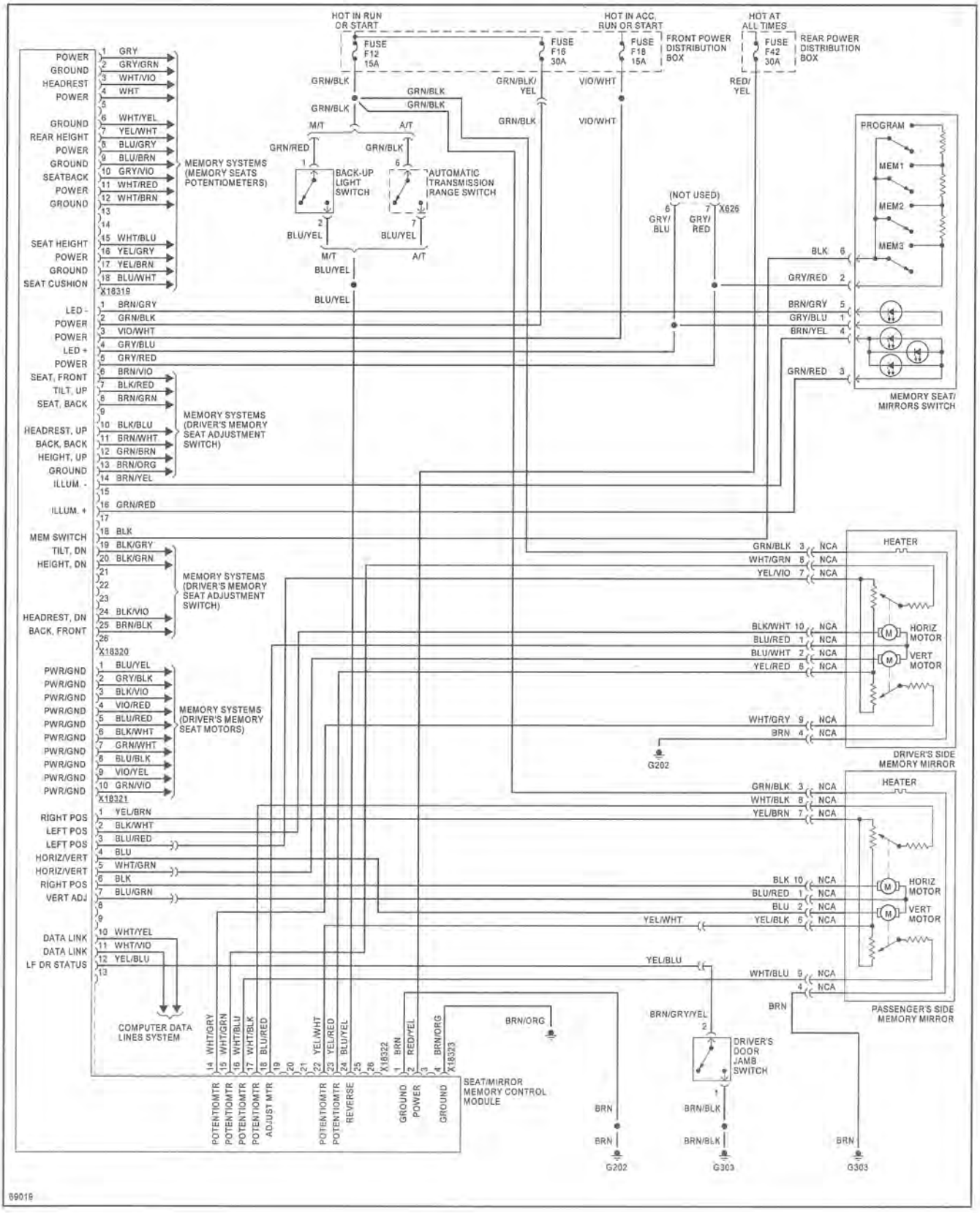
Memory Mirrors

1993 Early Production



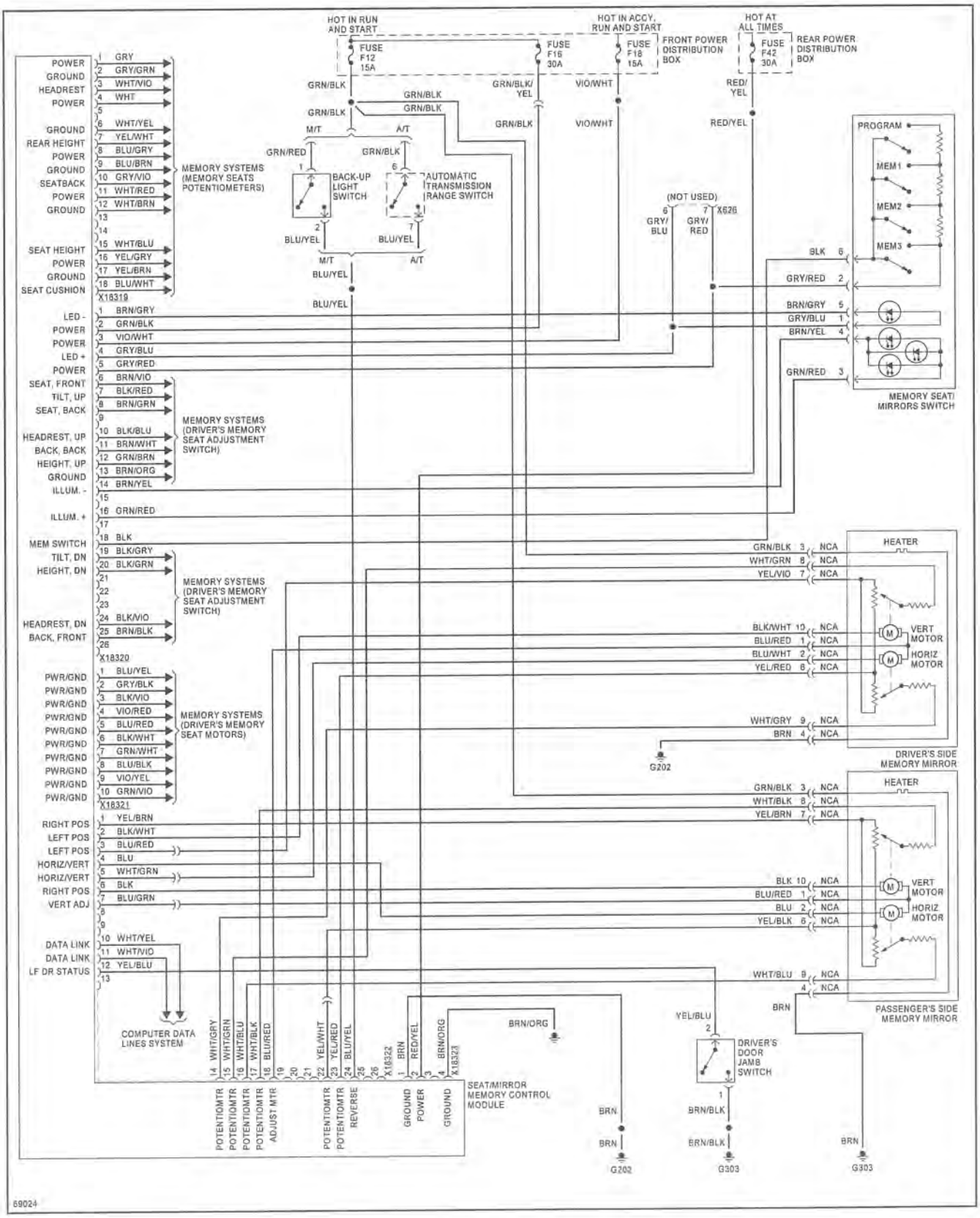
Memory Mirrors

1993 Late Production

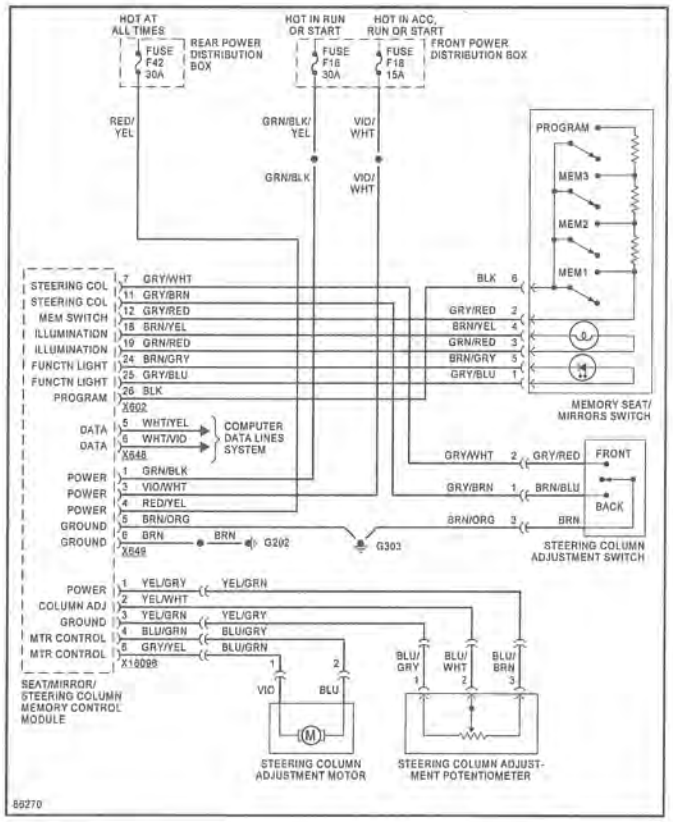


Memory Mirrors

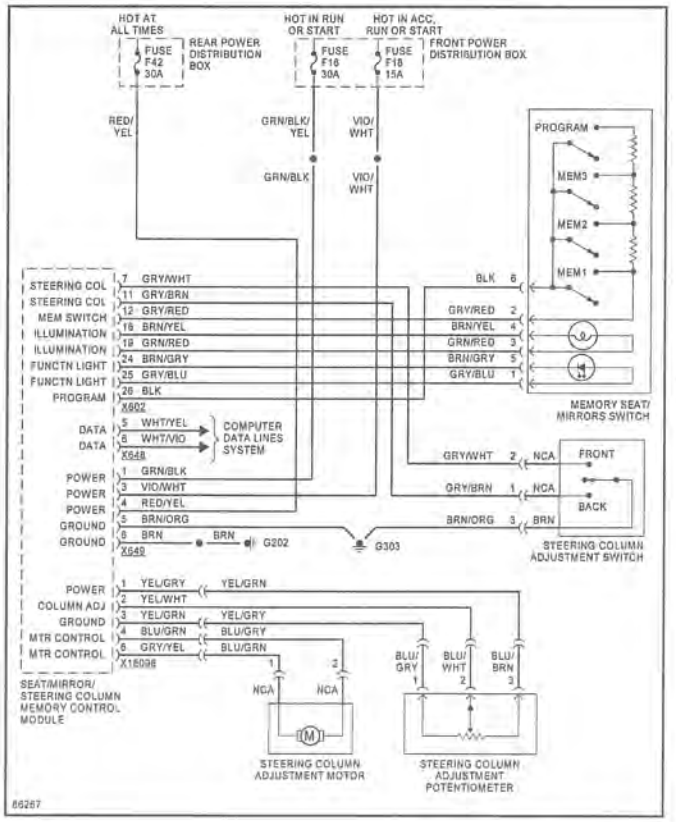
1994



Memory Steering Column

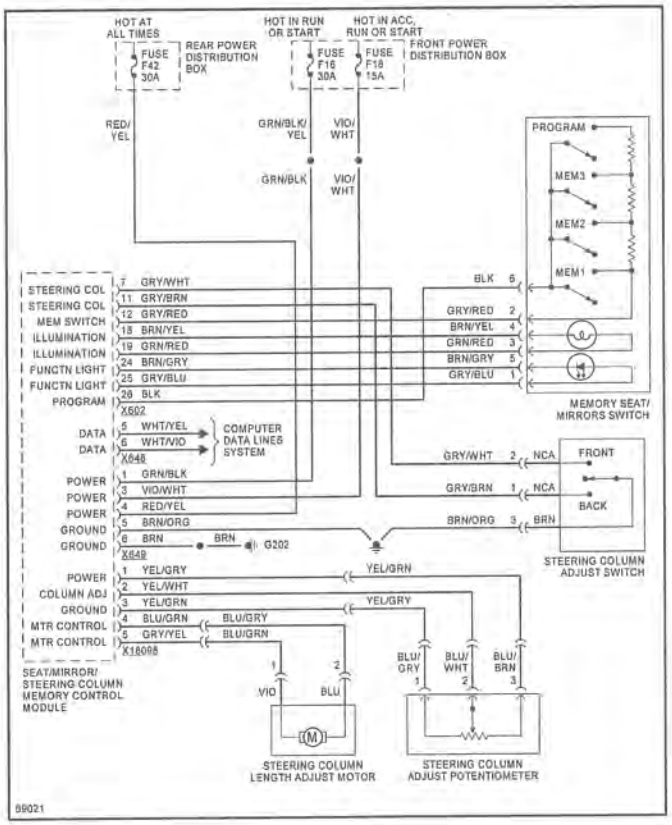


1991

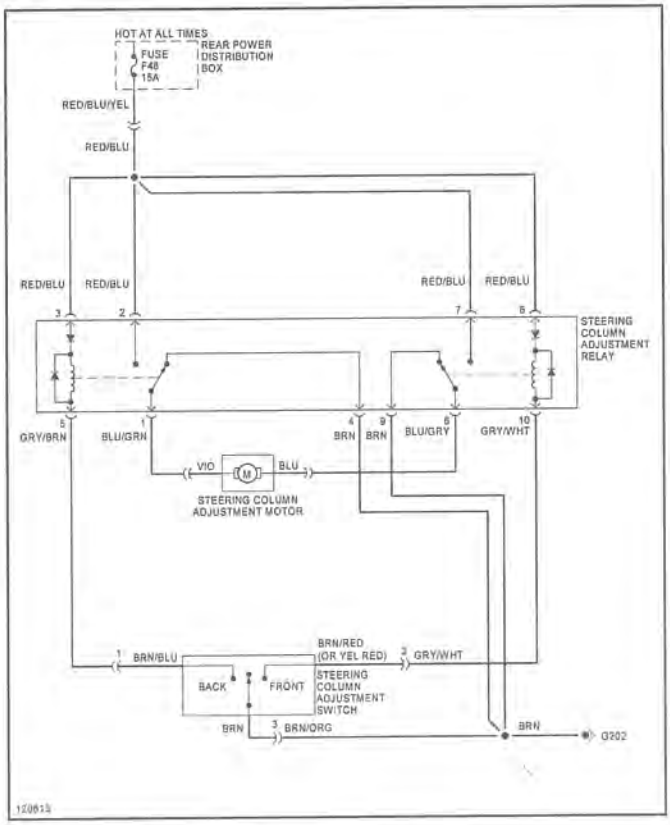


1992

Memory Steering Column

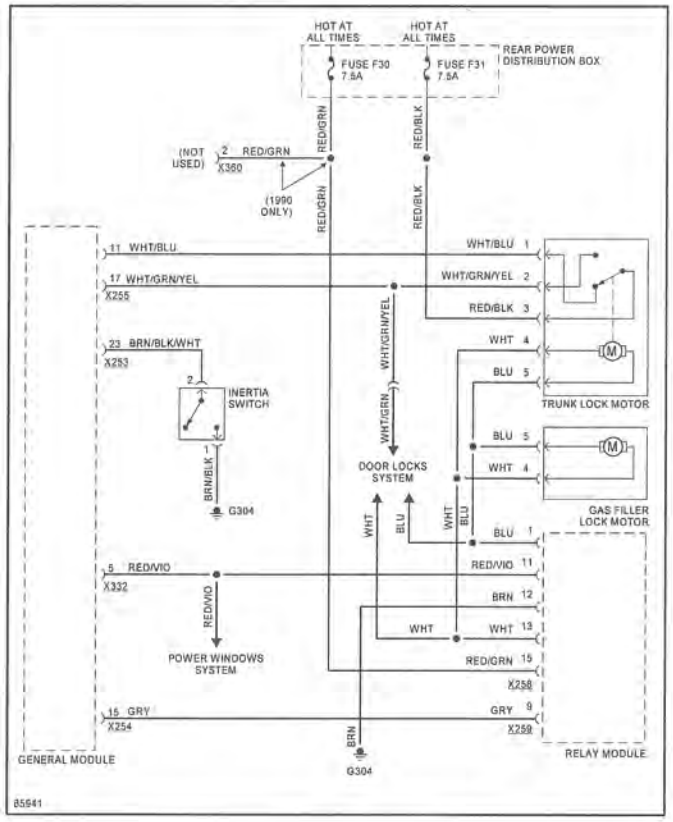


1993-94

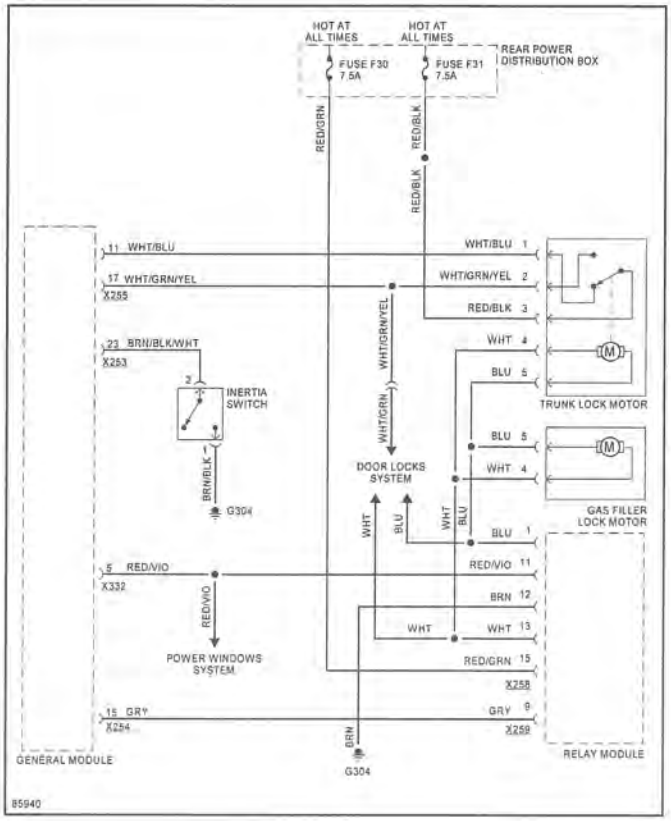


Steering Column Power Adjustment

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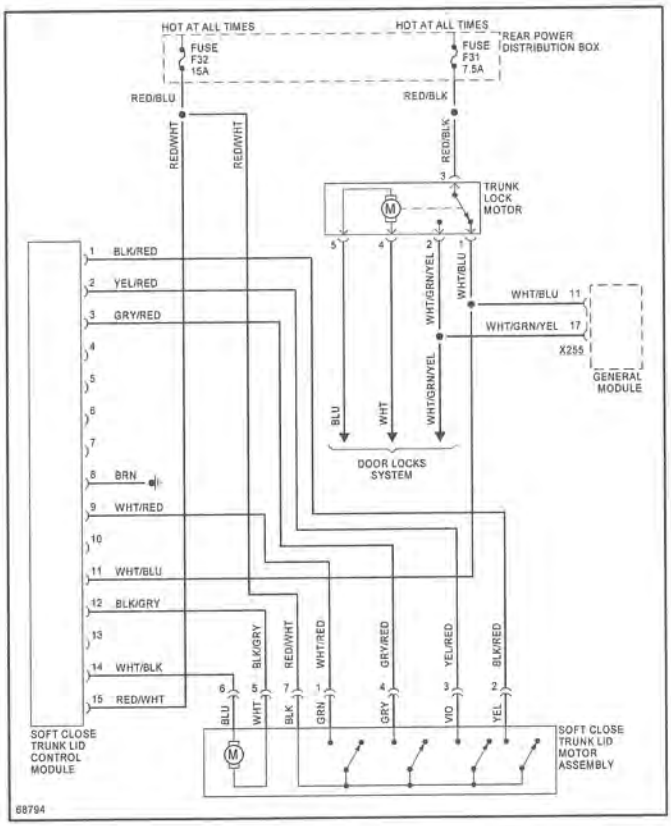


1990-92 Trunk & Fuel Door Release



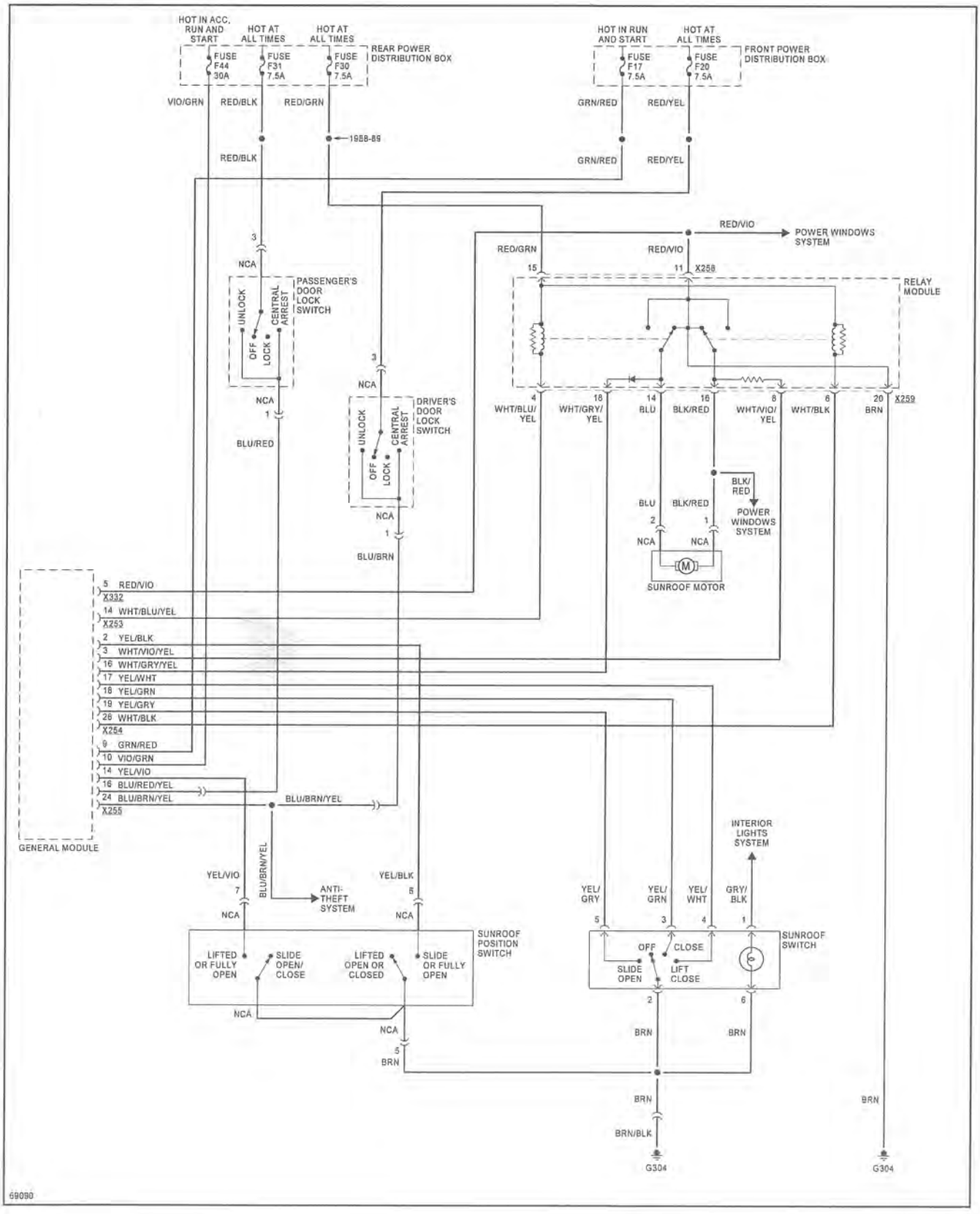
1993-94 Trunk & Fuel Door Release

Soft Close Trunk Lid

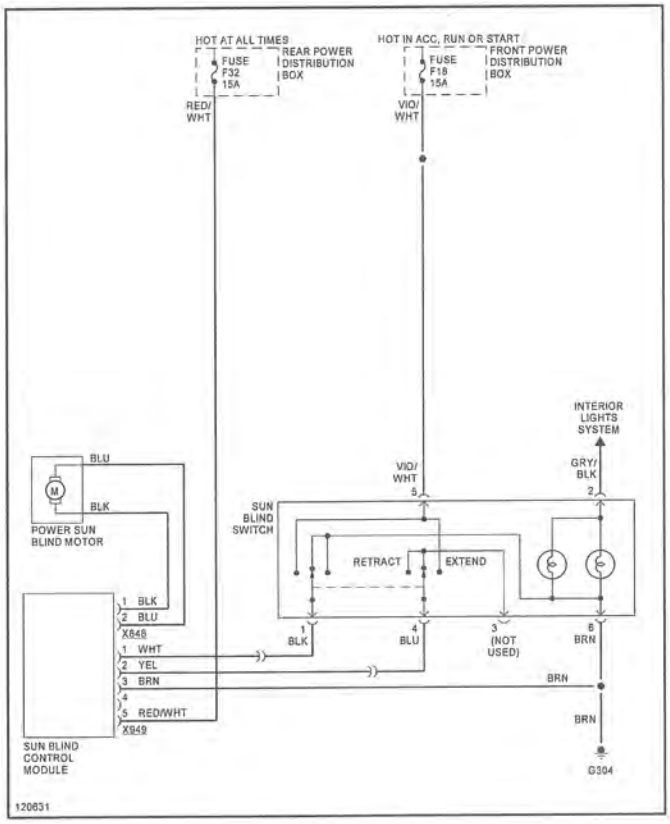


1993-94

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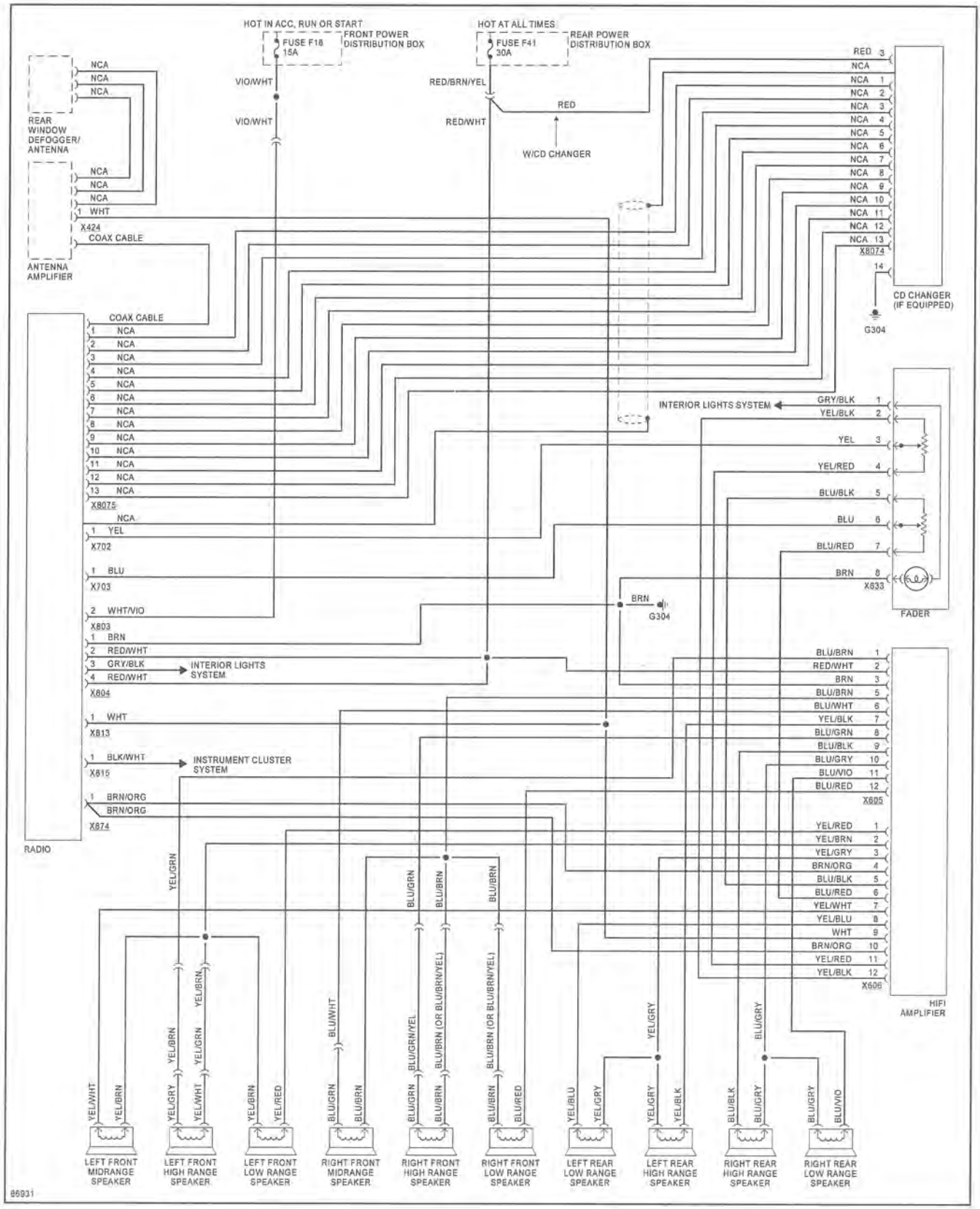


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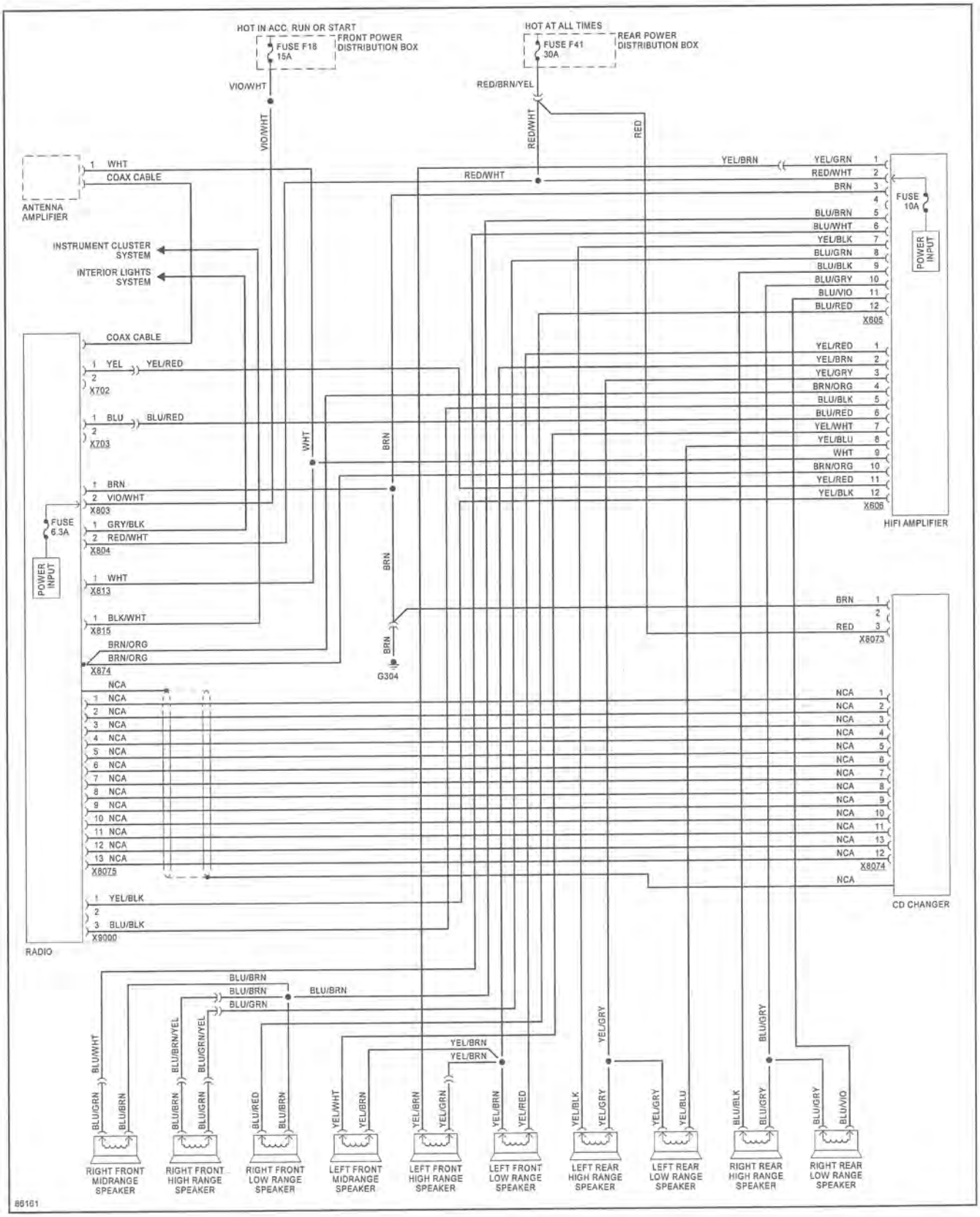
Radio/Cassette/CD/Speakers

1988-89



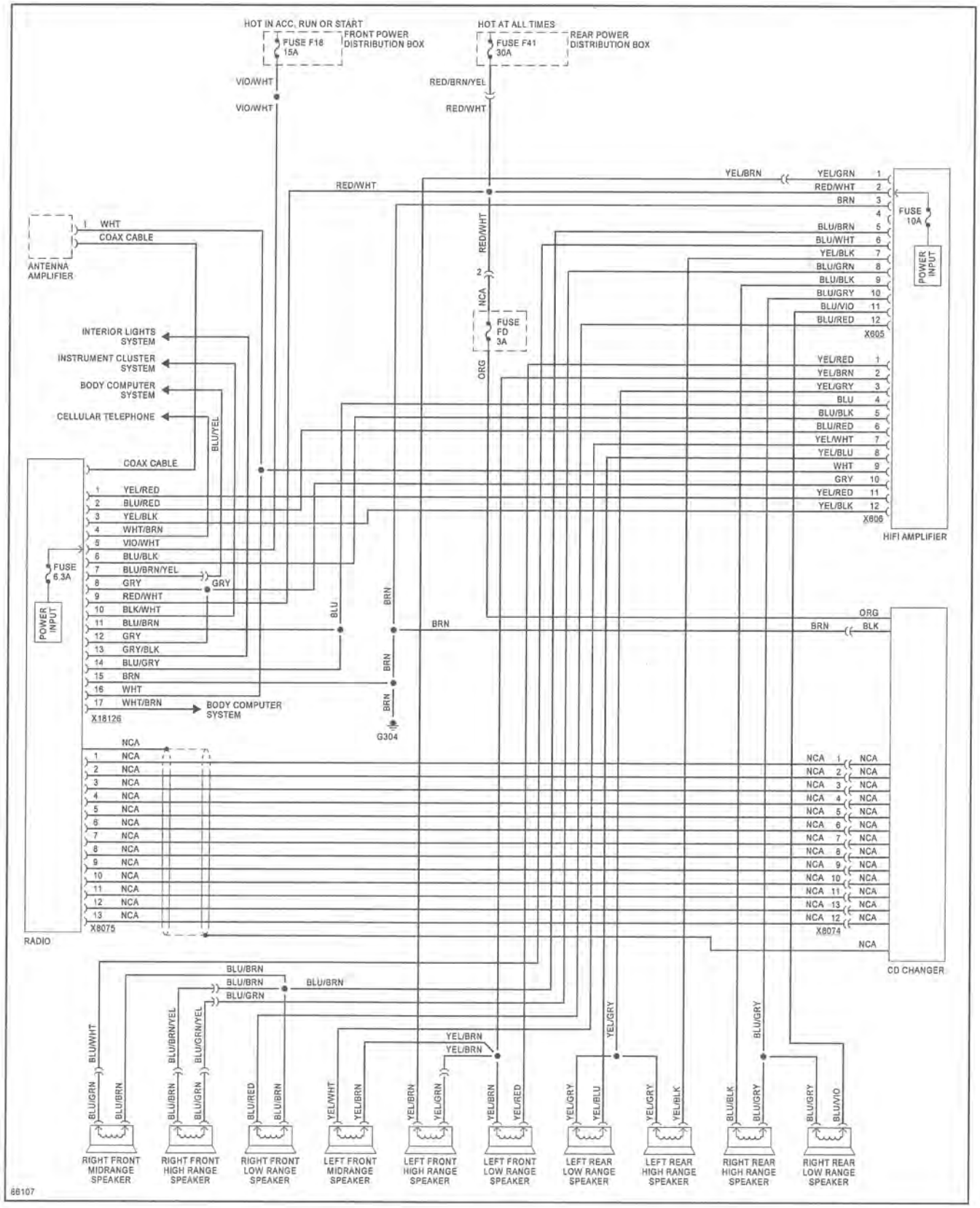
Radio/Cassette/CD/Speakers

1990



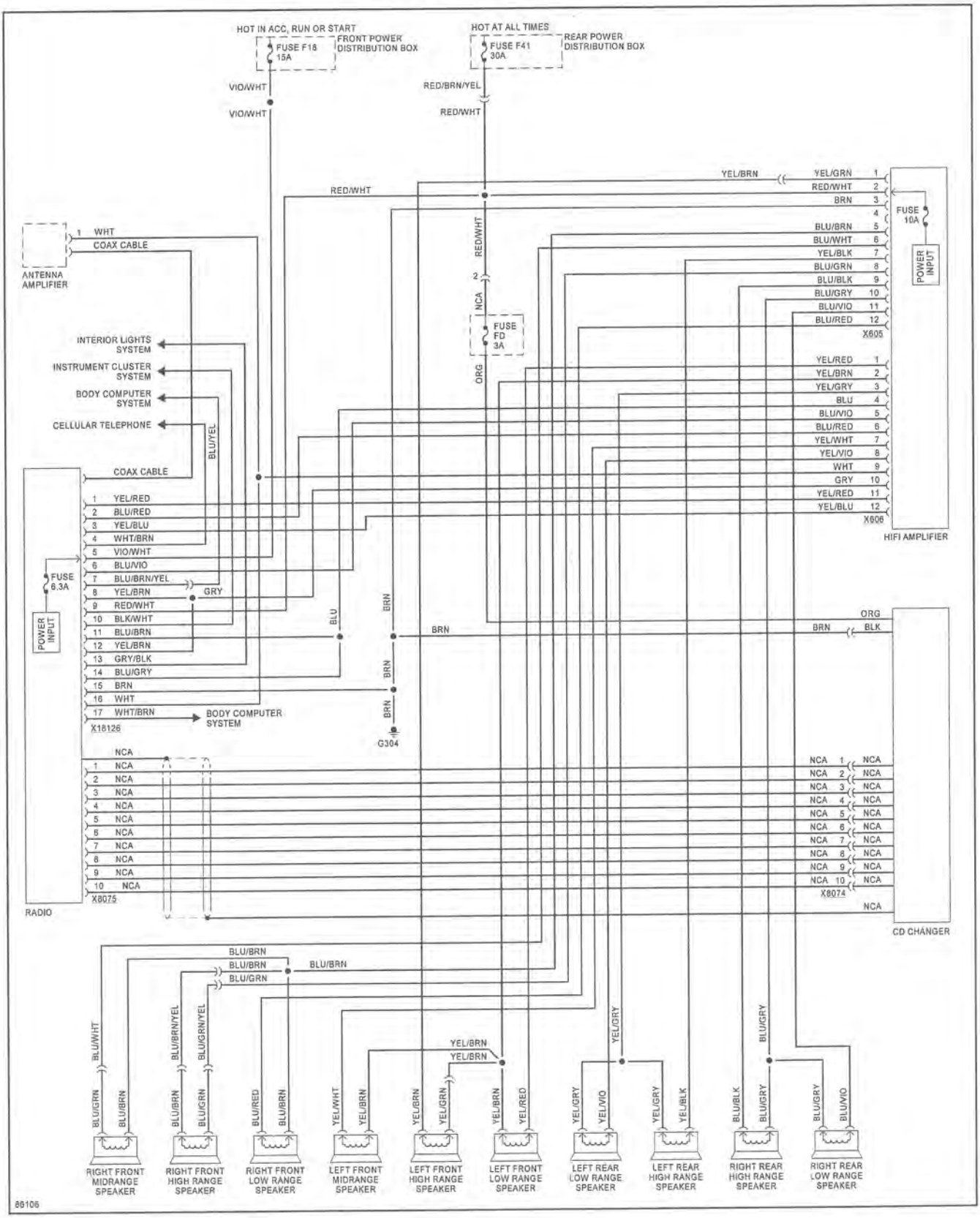
Radio/Cassette/CD/Speakers

1991



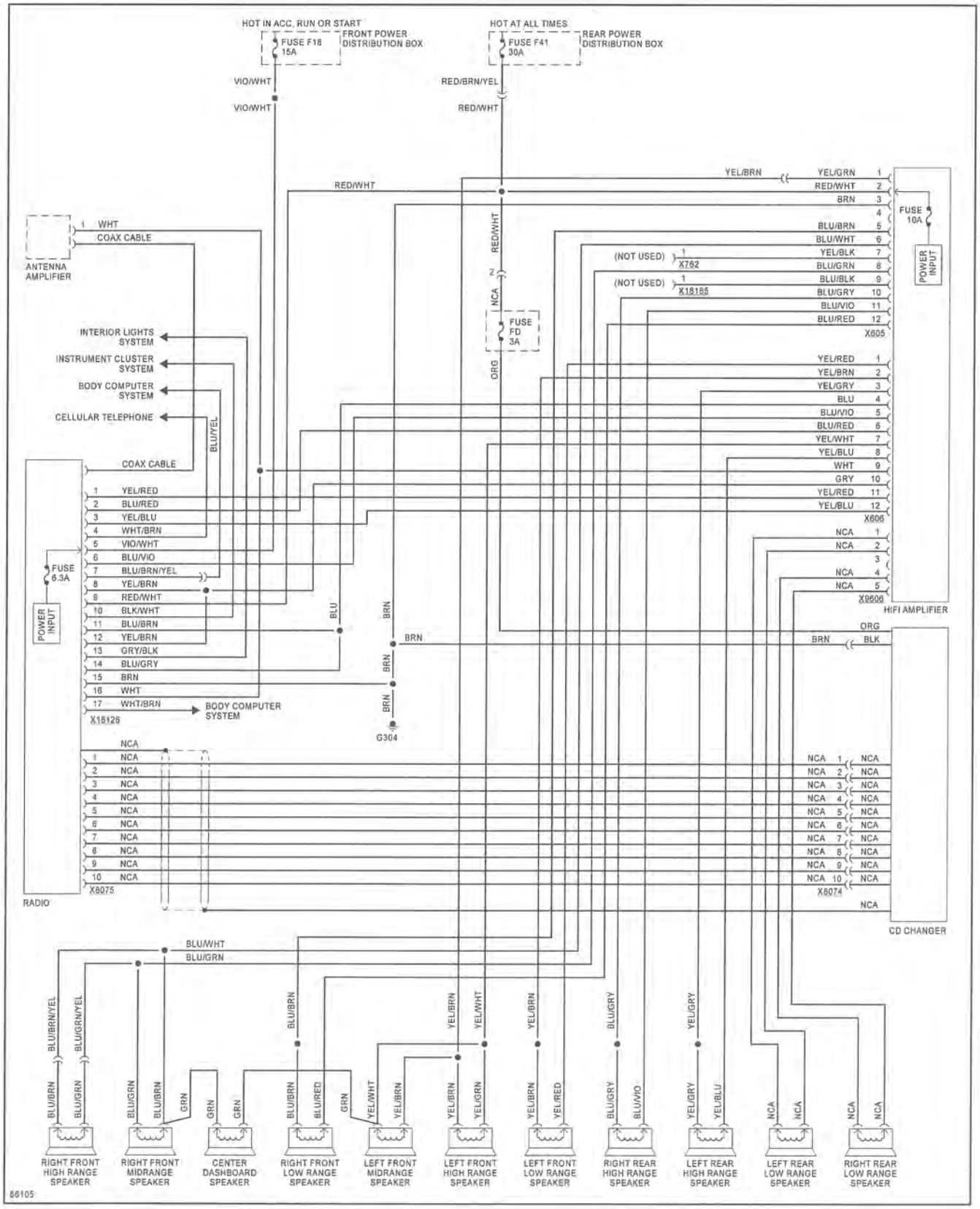
Radio/Cassette/CD/Speakers

1992 735i & 735iL



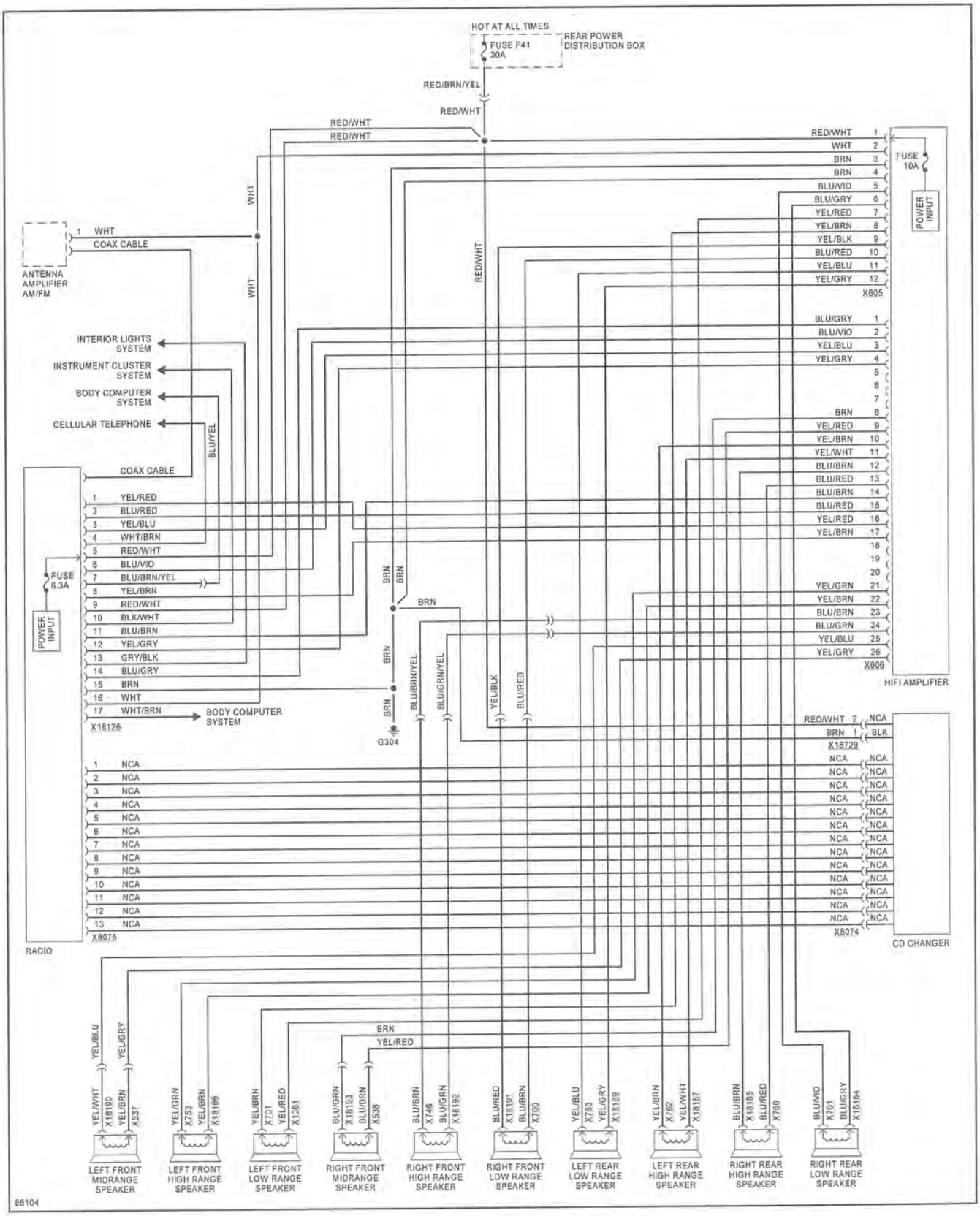
Radio/Cassette/CD/Speakers

1992 750iL



Radio/Cassette/CD/Speakers

1993-94



WARNING

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WARNING

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Your common sense, good judgement, and general alertness are crucial to safe and successful service work. Before attempting any work on your BMW, read the warnings and cautions on page vii and the copyright page at the front of the manual. Review these warnings and cautions each time you prepare to work on your BMW. Please also read any warnings and cautions that accompany the procedures in the manual.

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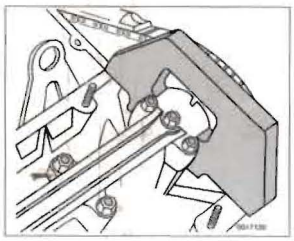


This Bentley Manual is a comprehensive source of service information, technical specifications, and wiring schematics specifically for BMW 7 Series (E28) cars from 1988 through 1994. The aim throughout this manual has been simplicity, clarity and completeness, with practical explanations, step-by-step procedures and accurate specifications. Whether you're a professional technician or a do-it-yourself BMW owner, this manual will help you understand, maintain, and repair your E32 7 Series.

Though the do-it-yourself BMW owner will find this manual indispensable as a source of detailed maintenance and repair information, the BMW owner who has no intention of working on his or her car will find that reading and owning this manual will make it possible to discuss repairs more intelligently with a professional technician.



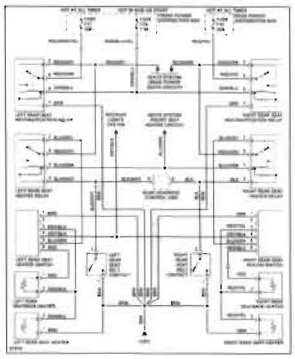
See how to perform routine maintenance procedures, such as checking brake pad thickness.
020 Maintenance



Detailed descriptions of engine repair procedures, including timing chain setup and adjustment.
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Quickly locate electronic modules, relays and fuses.
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Electrical wiring diagrams for models covered in this manual.
Electrical Wiring Diagrams

Features:

- Maintenance procedures for everything from brake fluid changes to resetting the Service Indicator. This manual tells you what to do and how and when to do it.
- Engine service, repair, and reconditioning, including valve clearance adjustments for 6-cylinder (M30) engine and camshaft timing chain setup and adjustment for V8 (M60) and V12 (M70) engines.
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- Suspension and brake system maintenance, troubleshooting, adjustment and repair, including ABS, traction control (ASC/ASC+T), self leveling suspension (LAD), and electronic damping control (EDC III).
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