

121 Battery, Starter, Alternator

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GENERAL

This repair group covers the battery, alternator, starter and associated components of the electrical system.

See also:

- **020 Maintenance** for accessory belt replacement and routine battery service.
- **600 Electrical System-General** for bus system information, power reset procedure and general electrical troubleshooting
- **721 Airbag System (SRS)** for battery safety terminal (BST)
- **ECL Electrical Component Locations**
- **ELE Electrical Wiring Diagrams**

Engine electrical system

The alternator and starter are wired directly to the battery. To prevent accidental shorts that might blow a fuse or damage wires and electrical components, disconnect the negative (-) battery cable before working on the electrical system.

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Troubleshooting

Different versions of alternators, starters and batteries are used in 5 Series models. Replace components according to the original equipment specifications.

Troubleshooting

Basic battery, starter and charging system troubleshooting information is in **Table a**.

Table a. Battery, starter and charging system troubleshooting

Symptom	Probable cause	Corrective action
Engine does not crank.	Fault in car access system (CAS).	Try another ignition key. If problem persists, contact your authorized BMW dealer.
Engine cranks slowly or not at all, solenoid clicks when starter is operated.	Battery cables loose, dirty or corroded.	Clean or replace cables. See 020 Maintenance .
	Battery discharged.	Charge battery and test. Replace if necessary.
	Battery to body ground cable in trunk loose, dirty or corroded	Inspect ground cable. Clean, tighten or replace if necessary.
	Poor connection at starter motor terminal X6512.	Check connections at starter motor.
	Starter motor or solenoid faulty.	Test starter.
Battery does not stay charged more than a few days.	Short circuit draining battery. (parasitic draw)	Test for excessive current drain with everything electrical off.
	Short driving trips and high electrical drain on charging system does not allow battery to recharge.	Evaluate driving style. Where possible, reduce electrical consumption when making short trips.
	Engine accessory belt loose, worn or damaged.	Inspect or replace accessory belt. See 020 Maintenance .
	Battery faulty.	Test battery and replace if necessary.
	Battery cables loose, dirty or corroded.	Clean or replace cables. See 020 Maintenance .
	Alternator faulty.	Test alternator.

Warnings and Cautions

WARNING—

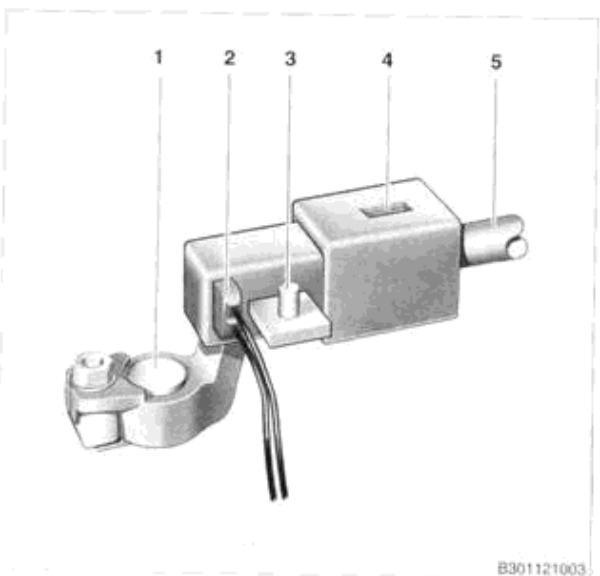
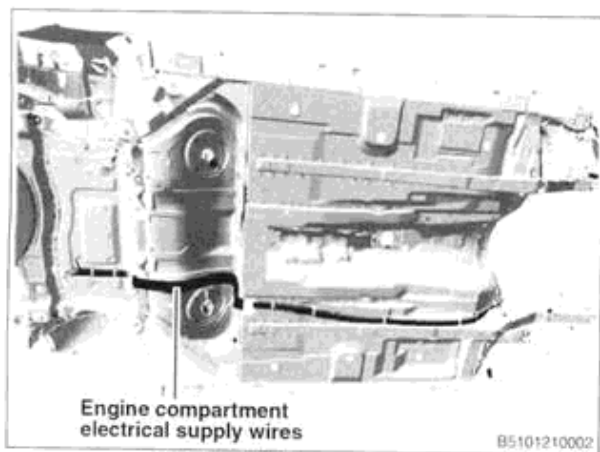
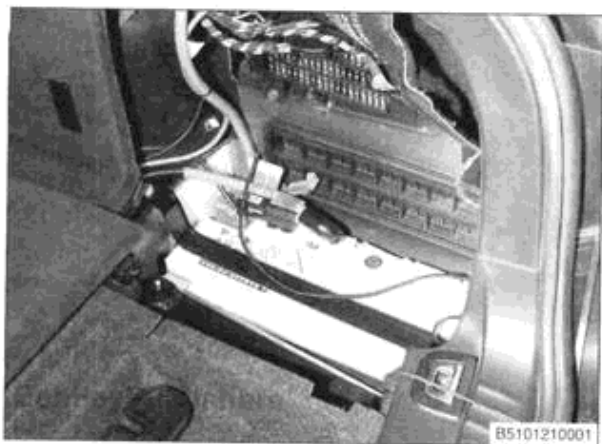
- Wear goggles, rubber gloves and a rubber apron when working around the battery or battery acid (electrolyte).
- Battery acid contains sulfuric acid and can cause skin irritation and burning. If acid is spilled on your skin or clothing, flush the area at once with large quantities of water. If electrolyte gets into your eyes, flush them with large quantities of clean water for several minutes and call a physician.
- A battery that is being charged or is fully charged gives off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.
- Battery lead and battery acid are both hazardous materials. When disposing of an old battery, follow federal, state and local regulations on hazardous waste disposal.

CAUTION—

- Use a digital multimeter when testing automotive electrical components.
- If a repair procedure specifies disconnecting the battery, follow the instruction for safety reasons.
- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.
- Disconnecting the battery cables may erase fault codes stored in ECM memory.
- Using a conventional battery charger to jump start the vehicle may damage electronic control modules. Use an electronic vehicle power supply or another 12-volt battery for jump-starting. Jump starting is covered in **020 Maintenance**.
- Disconnect the negative (–) battery cable first and reconnect it last. Cover the battery post with an insulating material whenever the cable is removed.
- Do not disconnect battery, alternator or starter wires while the engine is running.
- Do not reverse the battery cables. Even a momentary wrong connection can damage the alternator or other electrical components.
- Do not depend on insulation color to tell battery positive and negative cables apart. Label cables before removing.
- Power windows and sunroof may fail to function properly after disconnecting and reconnecting the battery. Reinitialize windows and sunroof. See **Battery reconnection notes** in this repair group.
- Do not make any additional connections at the negative terminal of the battery.
- Do not modify the battery ground cable.
- Do not make any connections between the intelligent battery sensor (IBS) and the sensor screw.
- Do not use force when disconnecting the ground terminal from the battery.
- Do not pull at the ground cable.
- Do not use the IBS as a pivot point to lever off the ground terminal.
- Do not use the connections of the IBS as a lever.
- Use a torque wrench when reinstalling the battery ground cable.
- Do not release or tighten the IBS screw (screw with Torx head).
- To avoid electrochemical corrosion to engine components made of aluminum-magnesium alloy, do not use steel fasteners. Use aluminum fasteners only. Use a magnet to identify aluminum fasteners.
- Replace aluminum fasteners each time they are loosened.
- Follow torque instructions, including angle of rotation specifications, when installing aluminum fasteners.

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Battery basics



BATTERY

Battery basics

The wet-cell lead-acid battery is rated by ampere / hours (Ah) and cold cranking amps (CCA) listed on the battery.

Battery location and connections

- ▶ The battery is mounted in the right side of the trunk or cargo compartment, underneath the floor trim.

For rear power distribution panel details, see **ECL Electrical Component Locations**.

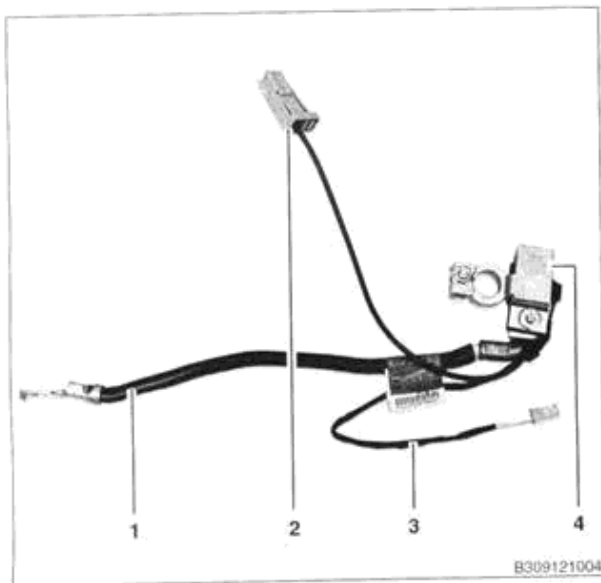
- ▶ Underneath the vehicle at the battery box are two power transfer points for the two cables that run to the engine compartment.
 - One cable goes to the jump start terminal in the engine compartment and then connects to the starter and alternator.
 - The second cable is used to supply power to engine electronics (DME and Valvetronic).
 - The power cables are routed in a protected area underneath the body of the vehicle.

Battery safety terminal (BST)

1. Positive battery terminal (B+)
2. BST igniter connector
3. B+ to rear power distribution box (A46)
4. BST cover retaining clip
5. B+ to starter and alternator

The battery safety terminal (BST) is controlled by the multiple restraint system (MRS) control module. The system disconnects electrical power to the engine compartment in case of a significant crash. MRS fires an encapsulated pyrotechnic device in the positive (+) battery terminal that disconnects power to the engine compartment but maintains power to the exterior lights and interior of the vehicle.

See also **721 Airbag System (SRS)**.



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Intelligent battery sensor (IBS)

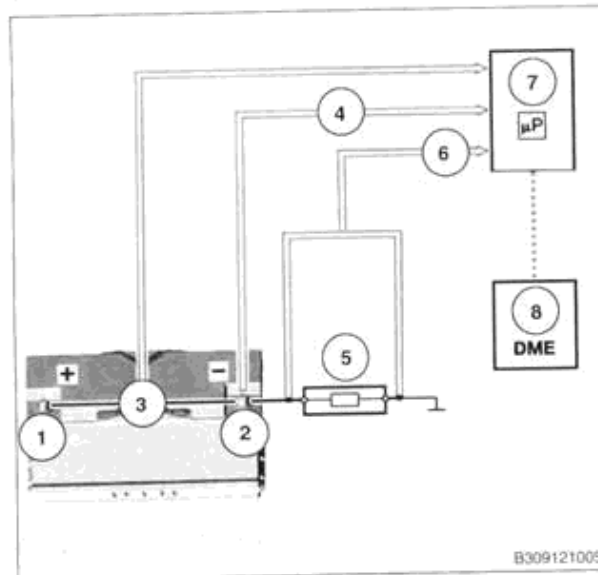
Intelligent battery sensor (IBS) is connected to the negative battery terminal.

1. Battery ground cable
2. B+ connection to IBS
3. Bit-serial data (BSD) interface
4. Intelligent battery sensor (IBS)

The IBS is sensitive to mechanical stress and strain. See **Warnings and Cautions** in this repair group.

Replace IBS as a complete unit with the battery ground cable. The ground cable serves as a heat sink for the IBS.

If IBS is replaced, allow vehicle to rest unused at least 3 hours. Only then can the new IBS determine battery status.

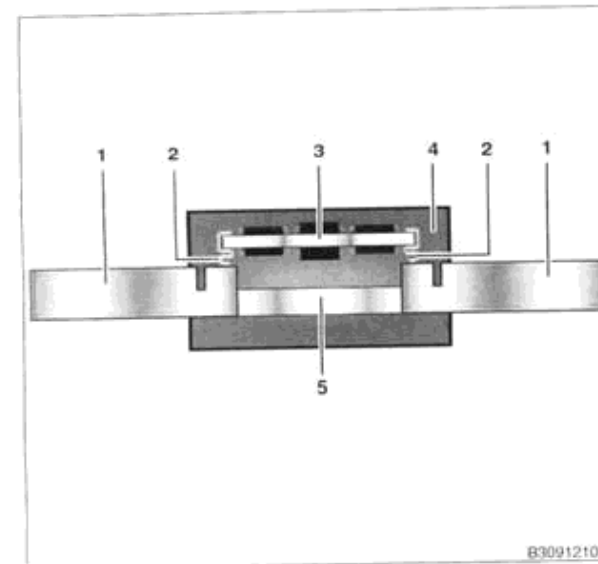


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The IBS microprocessor monitors and measures battery conditions such as:

- Terminal voltage via measurement from B+ to ground
- Charge / discharge current via integrated shunt resistor
- Temperature of battery acid via integrated temperature sensor

1. B+ battery positive terminal
2. Battery ground terminal
3. Voltage measurement
4. Temperature measurement
5. Integrated shunt resistor
6. Current measurement
7. IBS microprocessor
8. Engine control module (ECM)



B309121007

IBS components:

1. Copper plate
2. Gull wing tabs
3. PC board with evaluation electronics
4. Housing
5. Manganin copper alloy resistor maintains constant temperature regardless of current flow, used to measure current flow.

IBS evaluation function

IBS electronics continuously measure the following values under all vehicle operating conditions:

- Voltage (6 v to 16.5 v)
- Starting current (0 A to 1000 A)
- Charging current (20 A to 200 A)
- Temperature (-40°C to 105°C or -40°F to 221°F)
- Parasitic draw or closed circuit current (0 A to 10 A)

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Intelligent battery sensor (IBS)

When the vehicle is stationary, the IBS is programmed to wake up every 40 seconds and makes battery condition measurements within approx. 50 ms in order to save power. The measured values, communicated to the engine control module (ECM) via binary serial data (BSD) interface, are used to calculate the following:

- State of charge (SoC) shows the current charge of the battery. SoC is used during key OFF periods to insure that the battery maintains a sufficient charge to start the engine at least one more time.
- State of health (SoH) tracks the history of the battery in the vehicle. Charge / discharge cycles and times are monitored. SoH helps the ECM determine correct battery charging rates and anticipated battery life. Internal resistance of the battery is calculated by IBS from current and voltage drop during engine start. These values are used by the ECM to calculate the SoH of the battery.

Software contained in the IBS microprocessor utilizes the measured values to calculate battery SoC during vehicle sleep mode and compares this information with that received from the ECM pertaining to the battery SoC / SoH during the period between engine OFF and deactivation of the DME main relay.

Battery data is stored every 2 hours over a 6 hour time frame, providing three snapshots of battery SoC information. The stored information / snapshot data is overwritten every 6 hours. Whenever the ignition is activated, IBS updates the ECM with the current closed circuit histogram / battery status information. The ECM evaluates the new data and, if a parasitic draw (closed-circuit current draw) is identified, a fault is stored in fault memory.

IBS diagnosis

A fault code is stored in the ECM when the IBS is defective. The ECM boosts idle speed in order to sufficiently charge the battery.

The IBS can only be diagnosed through the ECM. The self-diagnosis function checks the voltage, current, temperature, terminal 15 wake up signal as well as system errors in the IBS.

Voltage measurement

If IBS is shorted to ground, ECM fault code displays "Voltage Fault DME ON". The IBS is unable to wake up the ECM.

If IBS is shorted to B+, ECM fault code displays "Voltage Fault, DME not ON". The vehicle does NOT enter sleep mode.

Current measurement

Current measurement is a dynamic process. If an implausible current flow value is detected, ECM fault code displays "Current Fault".

IBS wake-up

The IBS constantly monitors battery SoC, even when the vehicle is asleep. A wake-up signal is sent to the ECM if the SoC falls below a predetermined threshold. Upon wake-up, the ECM switches OFF auxiliary electrical loads in order to preserve battery charge.

IBS wakes up the vehicle once during a key-off cycle. Once awakened, the vehicle returns to sleep mode.

Wake-up signal faults

The IBS detects wake-up line faults under the following conditions:

- ECM switched ON.
- Ignition switched ON (voltage high at IBS).
- Terminal 15 running via alternator output at BSD.

If voltages at IBS terminal 15 and terminal 15 via the BSD are not equal, a fault is indicated either in the BSD line or the IBS.

Battery, testing

BMW batteries are rated as follows:

- **Ah rating** is determined by the average amount of current the battery can deliver over time without dropping below a specified voltage.
- **CCA rating** is determined by the battery's ability to deliver starting current at 0° F (-18° C) without dropping below a specified voltage.

Battery testing determines battery condition and state of charge. Before testing the battery, check that the battery cables are tight and free of corrosion.

Electronic battery testing

- ◀ Electronic battery testers such as Midtronics® MCR 717 are recommended for testing all battery types.

Hydrometer testing

On conventional or low-maintenance batteries, check the specific gravity of the electrolyte using a hydrometer. The more dense the concentration of sulfuric acid in the electrolyte, the higher the state of charge.

Before hydrometer testing, load the battery with 15 amperes for one minute. If the battery is installed in the vehicle, this can be done by switching the headlights ON for about one minute without the engine running. The state of battery charge based on specific gravity values are in **Table b**.

Note that electrolyte temperature affects hydrometer reading. Check the electrolyte temperature with a thermometer. Add 0.004 to the hydrometer reading for every 6° C (10° F) that the electrolyte is above 27° C (80° F). Subtract 0.004 from the reading for every 6° C (10° F) that the electrolyte is below 27° C (80° F).



Table b. Specific gravity of battery electrolyte at 27° C (80° F)

Specific gravity	State of charge
1.265	Fully charged
1.225	75% charged
1.190	50% charged
1.155	25% charged
1.120	Fully discharged

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Battery open-circuit voltage test

If the specific gravity is at or above 1.225 but the battery lacks power for starting, determine the battery's service condition with a load voltage test. See **Battery load voltage test** in this repair group.

If the average specific gravity of the six cells is below 1.225, charge battery and retest. See **Battery charging notes** in this repair group.

Battery open-circuit voltage test

- Before testing, load battery with 15 amperes for one minute with battery load-tester or switch headlights ON for about one minute without engine running. Connect digital voltmeter across battery terminals. Open-circuit voltage levels are given in **Table c**.

Table c. Open-circuit voltage and battery charge	
Open-circuit voltage	State of charge
12.6 or more	Fully charged
12.4	75% charged
12.2	50% charged
12.0	25% charged
11.7 or less	Fully discharged

- If open-circuit voltage is OK but battery still lacks power for starting, perform a load voltage test. See **Battery load voltage test** in this repair group.
- If open-circuit voltage is below 12.4 volts, recharge battery and retest. See **Battery charging notes** in this repair group.

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 simultaneously measuring battery voltage. For the most accurate results, make sure the battery is fully charged. Disconnect battery cables before making the test. Replace the battery if the voltage is below that listed in **Table d**.

WARNING —

- Wear protective goggles and clothing when performing a load test.

Table d. Battery load test—minimum voltage	
Ambient temperature	Voltage*
27° C (80° F)	9.6
16° C (60° F)	9.5
4° C (40° F)	9.3
-7° C (20° F)	8.9
-18° C (0° F)	8.5
* Measure after applying a 200 amp load for 15 seconds.	

Battery parasitic draw, testing

If the vehicle battery is discharged for an unknown reason, perform the parasitic draw test designed to detect excessive current flow from the battery when everything in the vehicle is shut down. This is also known as a closed circuit current measurement.

- Check that battery voltage is 12 volts or higher. If lower, recharge battery.
- Remove negative cable and install battery isolation switch (OTC tool 7645 or equivalent).
- Close switch. Connect digital multimeter in series across switch. Set meter to milliamp (mA) scale.
- Turn trunk lock to locked position using screwdriver or similar (simulates trunk lid being closed).
- To simulate normal parasitic draw conditions: Switch ignition ON and activate all electrical consumers, including any accessories. Switch ignition OFF. Open and close driver's door (simulates somebody getting out). Lock car, arming alarm if installed. With exception of trunk, keep all other doors and lids closed.
- Open battery isolation switch and monitor current draw.
 - Vehicle without telematics (TCU): Wait 30 minutes.
 - Vehicle with telematics (TCU): Wait 60 - 70 minutes.
- Maximum allowable parasitic draw after waiting: Approx. 40 mA.
- If draw exceeds maximum allowable, find consumer(s) at fault by removing individual fuses and noting change in parasitic draw. Repair or replace component(s) found at fault.

Fuse locations and applications are in **ECL Electrical Component Locations**.

Battery charging notes

- Consistent, clean voltage is essential when charging the battery or maintaining battery charge while coding or programming control modules. A transformer-based battery charger is inadequate for this task. BMW recommends the use of a vehicle power supply instead of a battery charger.

A power supply is a constant voltage, high-amperage power station with electronically controlled functions. It insures clean DC voltage and eliminates AC. It also provides fast, efficient and safe battery charging. Once proper battery voltage is obtained, the power supply floats the charge to maintain that voltage.

Battery charging voltage

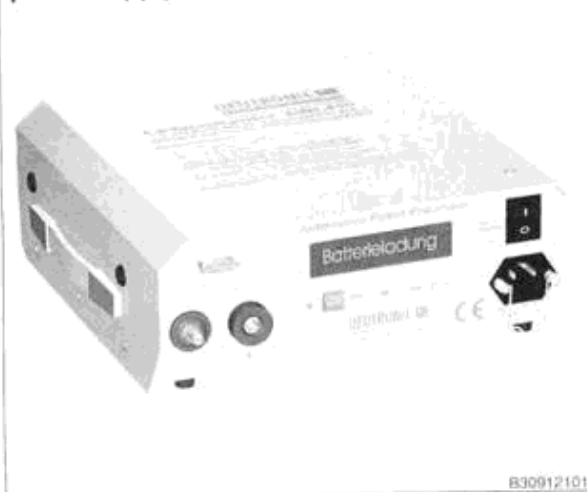
BMW recommendation	14.8 v
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Power supply units from different manufacturers are illustrated on next page.



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430-watt Deutronic power supply



B309121013

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Battery, charging

70-amp ACCTIVA Professional power supply



B309121014

- ⚠ If using a power supply, recharge battery without removing it. Otherwise, remove the battery from the trunk or cargo compartment during charging. See **Battery, removing and installing** in this repair group.

Prolonged charging with a conventional charger can cause battery electrolyte evaporation to a level that can damage. It is best to use a low-current charger (6 amperes or less) to prevent battery damage caused by overheating.

WARNING—

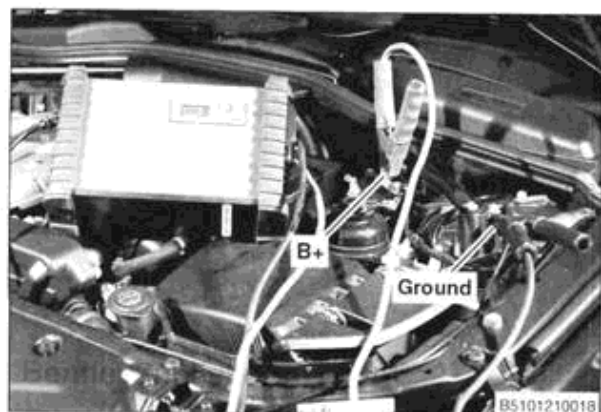
- Hydrogen gas given off by the battery during charging is explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.

CAUTION—

- Battery electrolyte (sulfuric acid) can damage the car. If electrolyte is spilled, clean the area with a solution of baking soda and water.
- Allow a frozen battery to thaw before attempting to recharge it.
- Do not exceed 16.5 charging voltage at the battery.

Battery, charging

- ⚠ Connect vehicle power supply charger to engine compartment B+ and ground. Follow manufacturer's instructions for setting charging voltage.



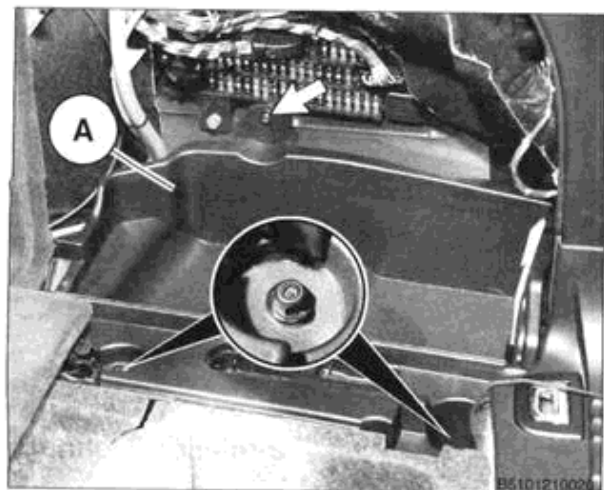
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Battery, removing and installing

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 Warnings and Cautions**.

- Switch ignition OFF.
- Working in trunk or cargo compartment, open battery compartment.
- Sports Wagon: Remove cargo compartment floor panel. See **513 Interior Trim**.
- ⚠ Sports Wagon: Remove screw (arrow) securing plastic storage shelf (A). Remove plastic storage shelf fasteners (inset) and remove plastic storage shelf.



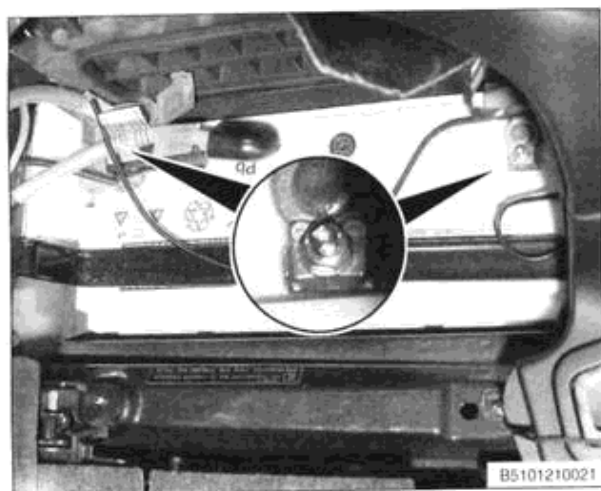
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Battery, Starter, Alternator 121-11

Battery, removing and installing



- Working at top of battery, remove protective bracket mounting fasteners (**arrows**) and lift off bracket.



- Working at top of battery:

- Unlock battery safety terminal plastic cover and loosen battery cable fasteners (**inset**).
- Disconnect negative cable first.
- Carefully lift positive cable, negative cable and intelligent battery sensor off battery and lay aside.

CAUTION—

- Do not damage intelligent battery sensor (IBS), which is attached to ground cable. See **Warnings and Cautions** in this repair group.

- Disconnect battery vent hose at side of battery, if applicable.
- Lift battery out of trunk or cargo compartment.
- Clean away corrosion in and around battery tray and on cables ends.
- When reinstalling battery, reconnect negative cable last.

Tightening torques

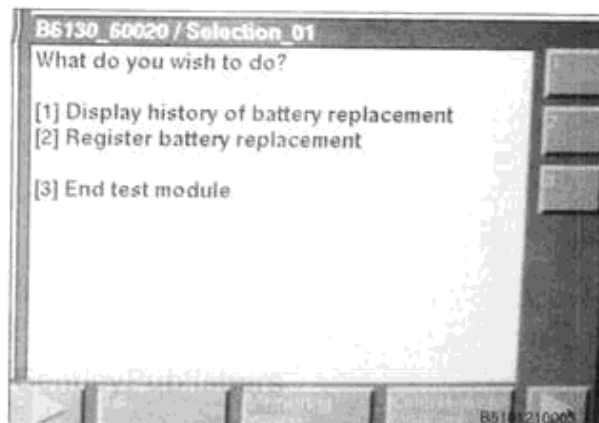
Battery post pinch bolt	
• M6	5 Nm (44 in-lb)
• M8	15 Nm (11 ft-lb)

Once the battery is reinstalled, the following steps are necessary:

- If higher rating battery is installed, recode CAS with correct battery specifications.
- Register battery. See **Replacement battery registration** in this repair group.
- Follow **Battery reconnection notes** in this repair group.

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Replacement battery registration



Replacement battery registration

- After fitting a new battery, connect BMW scan tool and run service function "Register battery replacement" to notify vehicle power management (software in the engine electronics and intelligent battery sensor) that a new battery is fitted in the vehicle.

Without new battery registration, CAS and vehicle power management does not run properly and this can lead for example: reduction or deactivation of individual consumer functions.

During battery registration, the following operations are performed:

- Current mileage is stored.
- Stored values from old battery (charge status, current, voltage, temperature, etc.) are deleted.
- Power management is initialized.

Battery reconnection notes

In addition to **Warnings and Cautions** in this repair group and in **001 Warnings and Cautions**, observe the following whenever the battery is disconnected or accidentally discharged and then reconnected.

Clock

- Reset.

Radio

- Enter presets.

Steering angle sensor

AFS (active front steering) only:

- Adjust using BMW scan tool.

Active front steering

- Initializing and commissioning, See **320 Steering and Wheel Alignment**.

Active stabilizer

- Commissioning, See **300 Suspension, Steering and Brakes—General**.

Automatic tailgate

- Setting readiness, See **412 Trunk Lid, Tailgate**.

Power window regulator motors

Initialize as follows:

- Switch ignition ON and open window completely.
- Hold switch in Open one-touch operation position and hold for 15 to 25 seconds.



- Release window button, then hold switch in Close direction.

The window fully opens and then closes. Initialization is completed once the window has closed.

- Check to make sure one-touch control, anti-trapping and comfort functions are active.

See **512 Door Windows** for additional information.

Sunroof

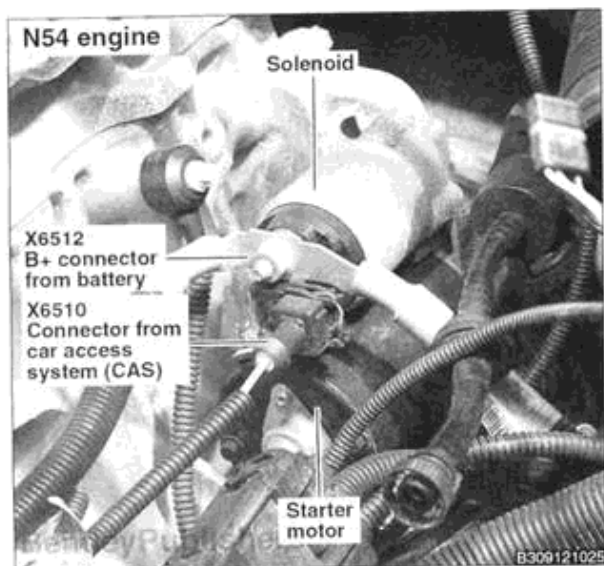
Initialize as follows (if applicable):

- Switch ignition ON and press and hold sunroof switch in Raised direction (**arrow**).
- After sunroof reaches Raised position, keep switch pressed for approx. 15 seconds longer.
- Initialization is complete when sunroof attempts briefly to lift again.

Compass in interior mirror

Calibration (if applicable):

- Switch ignition ON
- Using thin bladed screwdriver or equivalent tool, press push button at base of mirror until C appears in compass display (**oval**).
- Drive vehicle 2 - 3 times in a circle at approx. 10 mph.
- Calibration is complete when direction display appears.



STARTER

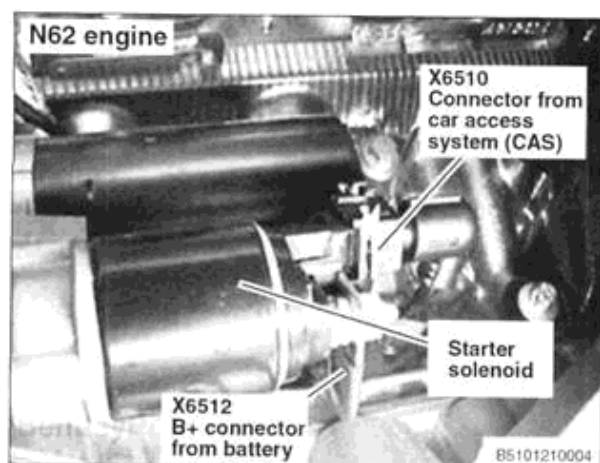
Starter troubleshooting

- M54, N52, N54 engine: Starter is bolted to engine bell housing under intake manifold. Starter wiring connects to solenoid, above starter, as follows:

- Large wire (X6512 or B+ connector) is direct battery voltage.
- Smaller wire (X6510) operates starter solenoid via ignition switch and car access system (CAS).

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CAS module, removing and installing



- N62 engine: Starter is bolted to engine bell housing under right exhaust manifold. Starter wiring connects to solenoid, above starter, as follows:
 - Large wire (X6512 or B+ connector) is direct battery voltage.
 - Smaller wire (X6510) operates starter solenoid via ignition switch and car access system (CAS).
- If starter and solenoid click repeatedly without starting vehicle:
 - Check battery state of charge.
 - Inspect battery and starter cables, terminals and ground connections for good contact. In particular, make sure ground connections between battery, body and engine are completely clean and tight.
 - If no faults are found, starter may be faulty and should be replaced.
- If starter fails to operate, check the following:
 - Car access system (CAS). Try another ignition key. If no faults can be found, check operation of CAS using a BMW scan tool. CAS replacement is covered in **CAS module, removing and installing** in this repair group.
 - Clutch switch module (manual transmission). Make sure clutch is pressed all the way to the floor. See **210 Clutch**.

NOTE —

- Automatic transmission neutral safety switch function is built into transmission mechatronics electronics. Failure of this function causes a no-start condition.
- Access to starter is difficult as it is under the intake manifold. If possible, check for battery voltage (12.6 volts) at B+ terminal (X6512).
- Check for battery voltage at terminal X6510 of starter motor with ignition in START position.
 - If voltage is not present, check wiring between CAS and starter terminal.
 - Check CAS and other inputs that disrupt power to solenoid. See **ELE Electrical Wiring Diagrams**.
 - If voltage is present and no other visible wiring faults can be found, problem is most likely in starter motor.

CAS module, removing and installing

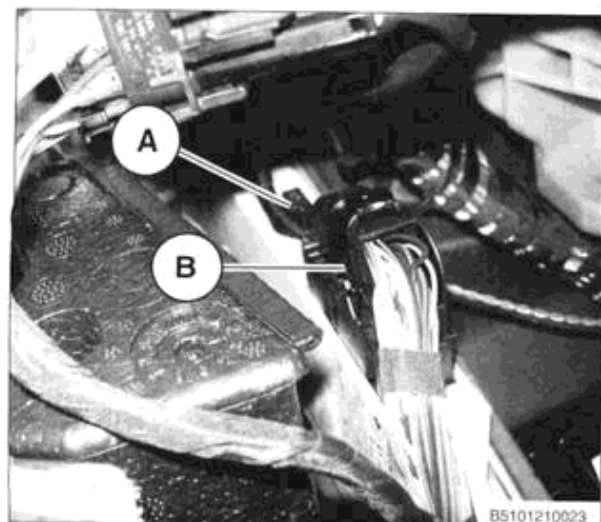
CAUTION—

- CAS module is static sensitive. Static discharge may damage it permanently. Handle using static prevention equipment and techniques. See **600 Electrical System-General**.

- Remove left side dashboard lower trim (pedal cluster trim). See **513 Interior Trim**.



- Working to left of steering column:
 - Detach ribbon harness (A) from CAS module.
 - Detach harness connector (B) from CAS module.



Battery, Starter, Alternator 121-15

Starter, removing and installing (M54 engine)



- Remove module mounting screw (**arrow**) and withdraw module to left and down to remove from dashboard.
- Inspect ribbon cable and replace if damaged. (Ribbon cable connects CAS to ignition key slot and START / STOP button.)
- When installing, make sure CAS module guide fits correctly into mounting slot.
- After reassembly, carry out vehicle coding and programming. See **600 Electrical System-General**.

Starter, removing and installing (M54 engine)

The starter is removed from below. Access to starter bolts is difficult. Be sure to have the proper tools on hand before proceeding.

- Disconnect negative (–) battery cable.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Raise vehicle and support safely.

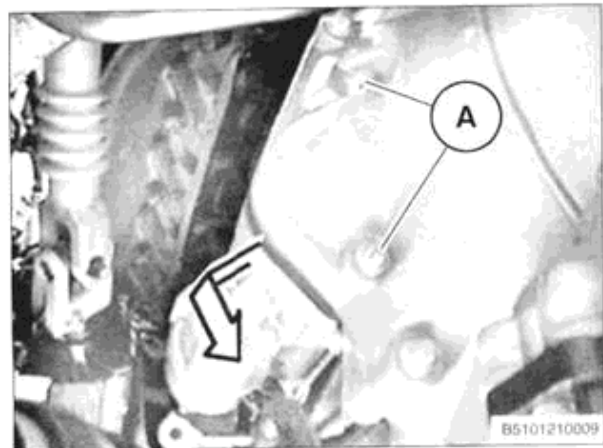
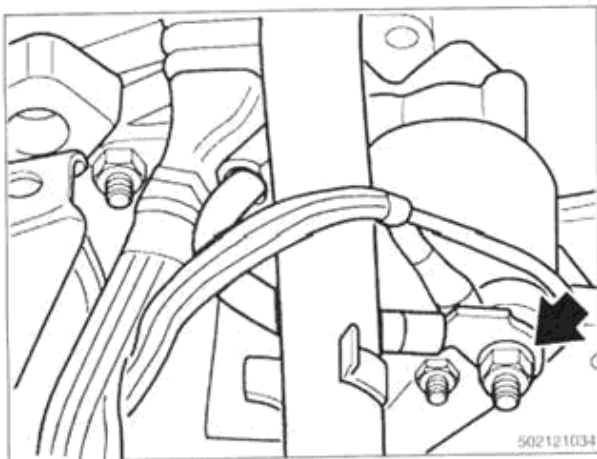
WARNING —

- 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 front suspension reinforcement plate.
- Working underneath car, disconnect battery positive (+) lead from starter (**arrow**).

NOTE —

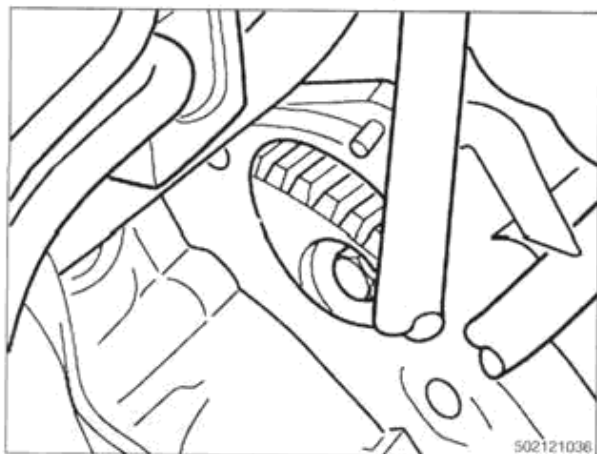
- Note routing for cables. Cable routing can vary. When reinstalling, make sure cables do not chafe.



- Using a long extension and universal joint from output end of transmission, remove bolts (**A**) fastening starter to transmission bell housing and engine block.
- Pull starter out of transmission bell housing in direction of **arrow** and detach remaining starter wiring.
- Remove starter from below.

121-16 Battery, Starter, Alternator

Starter, removing and installing (N52, N54 engine)



◀ Check starter pinion gear and flywheel teeth for damage.

— Installation is reverse of removal.

Tightening torques

Starter to transmission bell housing	45 Nm (33 ft-lb)
Wire terminals to starter	
• M5	5 Nm (44 in-lb)
• M6	7 Nm (62 in-lb)
• M8	13 Nm (10 ft-lb)

Starter, removing and installing (N52, N54 engine)

— Switch ignition OFF. Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

• Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

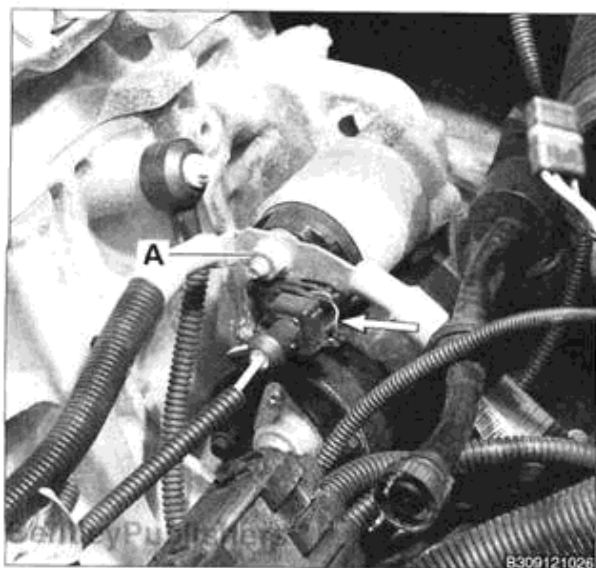
- Remove upper and lower cabin air microfilter housings. See **020 Maintenance**.
- Remove engine air filter housing and ducts. See **131, 132 Fuel Injection**.
- Remove ignition coil cover. See **020 Maintenance**.
- Remove intake manifold. See **131, 132 Fuel Injection**.

CAUTION—

• Do not detach fuel lines or injectors.

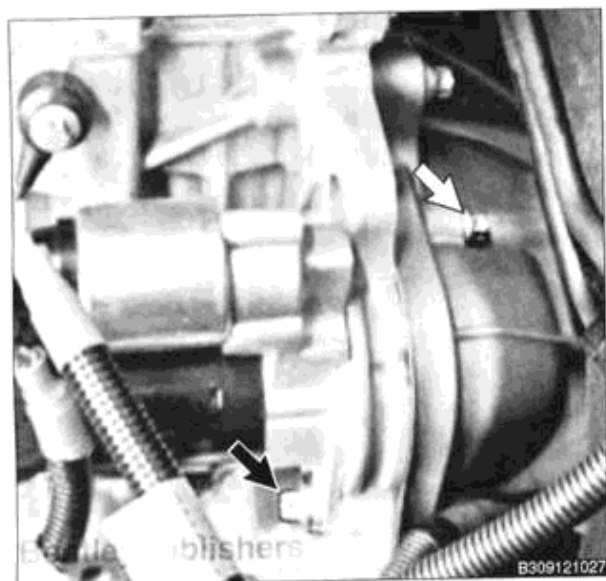
◀ Working at starter solenoid electrical connections:

- Remove fastener (A) and detach B+ cable from solenoid.
- Press in wire clip (arrow) to release solenoid wire connector.



Battery, Starter, Alternator 121-17

Starter, removing and installing (V8 engine)



- Remove starter mounting bolts (**arrows**). Discard aluminum bolts. (Aluminum bolt heads are not always marked with blue paint. Use a magnet to identify them.)
- Lift out starter motor.
- Before installing new starter, rotate engine and inspect flywheel or torque plate gear teeth through starter hole. Replace if damaged. See **210 Clutch** or **240 Automatic Transmission**.
- Reinstall starter and reattach electrical connectors.

Tightening torques

B+ cable to starter (M8)	13 Nm (10 ft-lb)
Starter to bell housing (turbo)	38 Nm (28 ft-lb)
Starter to bell housing (non-turbo) (replace M10 aluminum bolts)	20 Nm (15 ft-lb) additional 180°
• Stage 1	
• Stage 2	

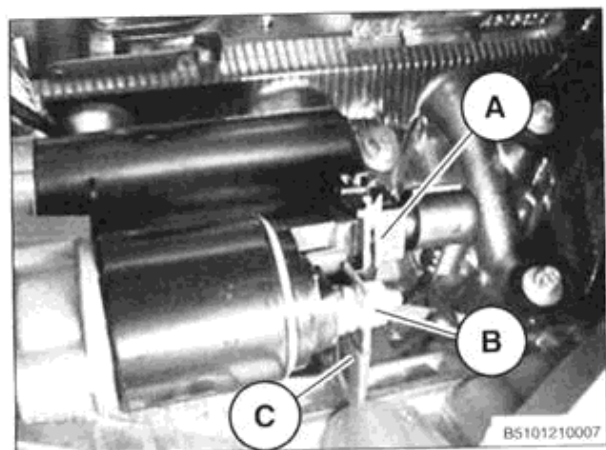
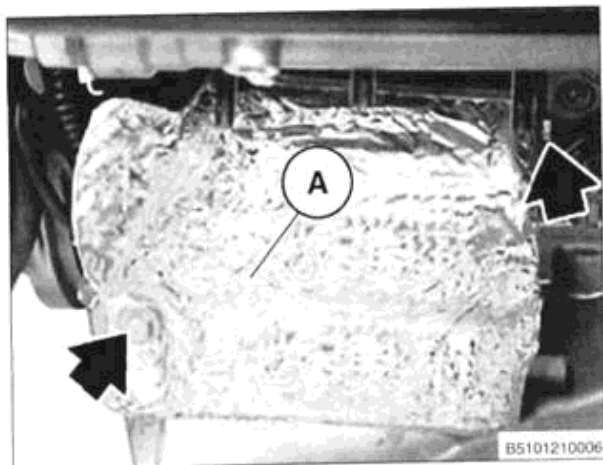
Starter, removing and installing (V8 engine)

- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

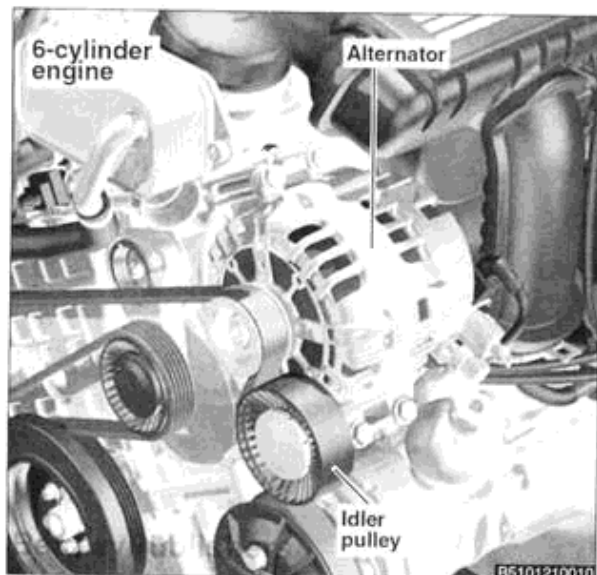
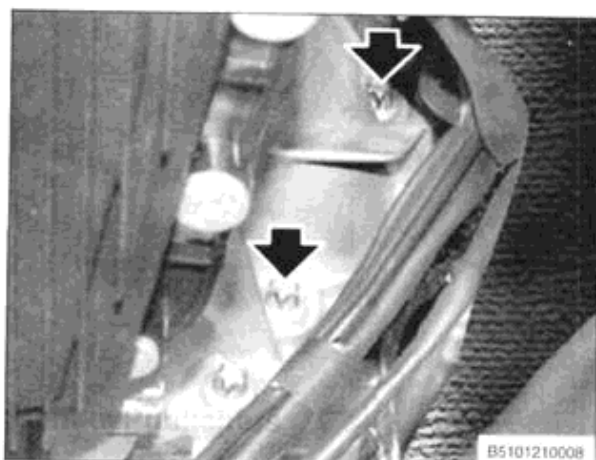
- Remove right side exhaust manifold. See **180 Exhaust System**.
- Remove starter heat shield fasteners (**arrows**) then remove heat shield (**A**).



- Disconnect electrical connector (**A**). Remove fastener (**B**) and remove starter cable (**C**).

121-18 Battery, Starter, Alternator

Alternator basics



➤ Remove starter mounting bolts (**arrows**).

— Lift out starter motor.

— Before installing new starter, rotate engine and inspect flywheel or torque plate gear teeth through starter hole. Replace if damaged. See **210 Clutch** or **240 Automatic Transmission**.

— Reinstall starter and reattach electrical connectors.

Tightening torques

B+ cable to starter (M8)	13 Nm (10 ft-lb)
Starter to bell housing (replace bolts)	45 Nm (33 ft-lb)
Starter heat shield	6 Nm (4.4 ft-lb)

ALTERNATOR AND CHARGING SYSTEM

Alternator basics

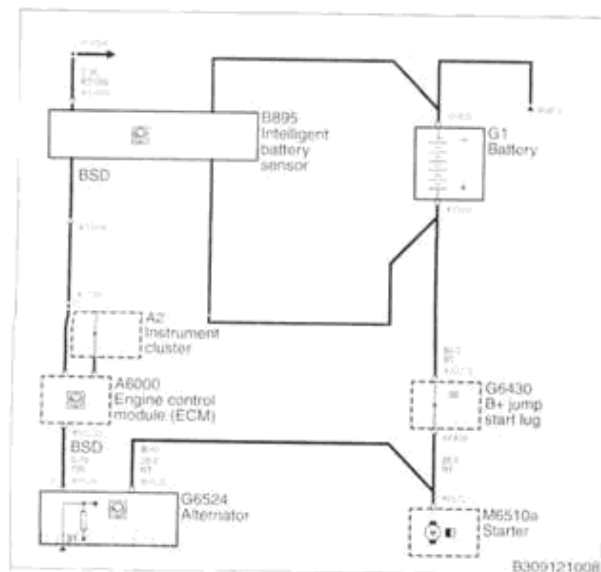
➤ The alternator is bolted to the left side of the engine block. It is driven by the engine accessory belt. Accessory belt replacement is covered in **020 Maintenance**.

Several versions of alternators are used in E60 vehicles. Be sure that the replacement alternator is correct for the application.

Alternator interface

➤ The alternator communicates with the engine control module (ECM) via bit-serial data (BSD) interface. This single wire connection allows the ECM to adapt its calculations and control data to alternator output. The ECM controls the following functions:

- Alternator activation and deactivation.
- Informing the voltage regulator of the nominal voltage value to be set.
- Alternator load response control.
- BSD line diagnosis.
- Alternator fault code storage.
- Charge indicator light activation in instrument cluster.



Charging system troubleshooting

Some charging system tests require 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. See **Table a** for general electrical component troubleshooting.

Before checking the alternator, make sure the battery is fully charged and capable of holding a charge. Check that the battery terminals are clean and tight and the engine accessory drive belt is properly tensioned and not severely worn. For drive belt service see **020 Maintenance**.

Charging system quick-check

- Use a digital multimeter to measure voltage across the battery terminals with ignition OFF and then again with engine running. Battery voltage should be about 12.6 volts with key OFF and between 13.2 and 14.5 volts with engine running.
- Run engine at about 2000 rpm and switch ON electrical loads (fans, lights, rear window defroster, and wipers). With all accessories on, battery voltage should be above 12.6 volts.

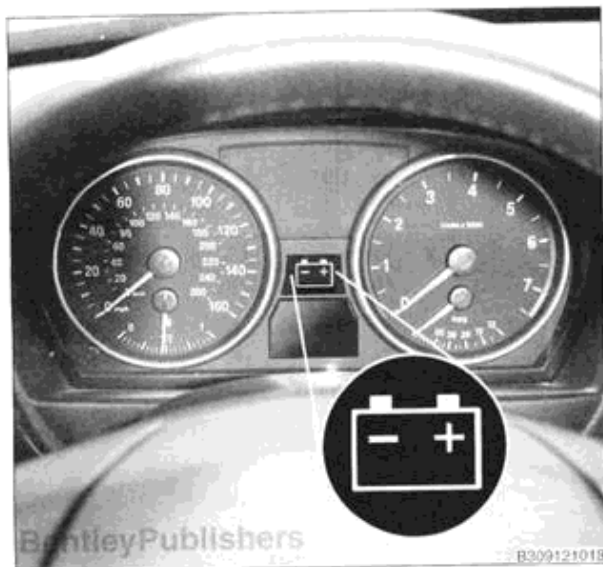
The regulated voltage (engine running, battery charged, accessories and lights OFF) is usually between 13.2 and 14.5, depending on temperature and operating conditions. If the voltage is higher than 14.8, the voltage regulator is most likely faulty.

Charging system, checking

CAUTION—

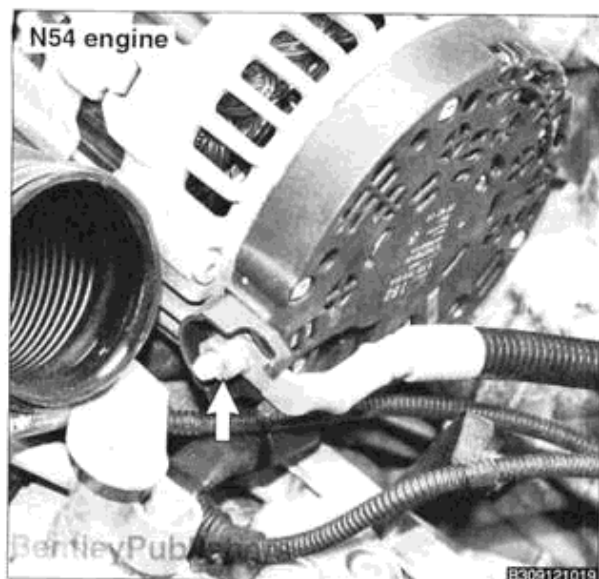
- Do not disconnect the battery while the engine is running. Damage to the alternator or engine electronic systems may result.
- Only use a digital multimeter when testing charging system components.

- ◀ Switch ignition ON. Check that battery warning light comes ON for self test. If warning light does not come ON, check for fault codes.

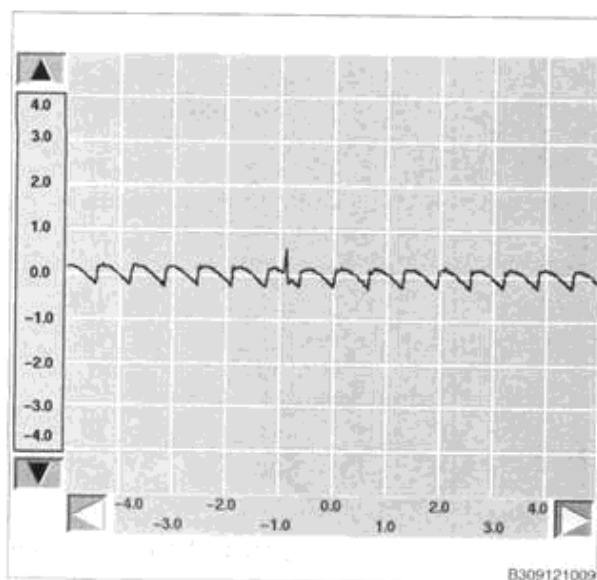


121-20 Battery, Starter, Alternator

Charging system, checking

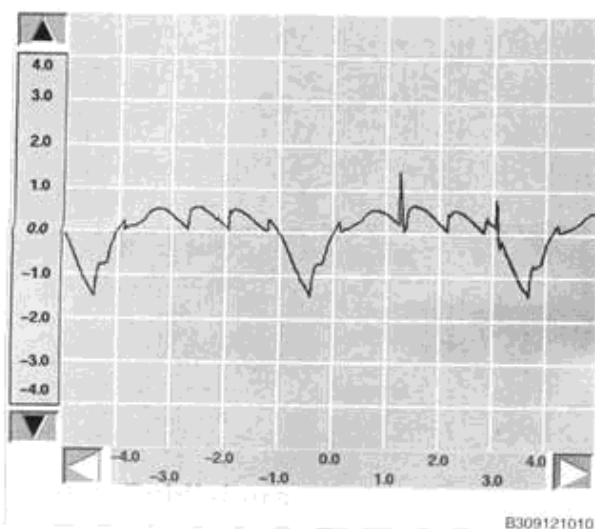


- Check for battery voltage at alternator terminal 30 (B+):
 - Pull off insulating cover at terminal 30 (**arrow**) at rear of alternator.
 - Connect voltmeter between terminal 30 and ground and check for battery voltage. If voltage is not present, check wiring for faults.
- Connect oscilloscope across battery terminals to check alternator function.



- Connecting oscilloscope:
 - Positive test lead of oscilloscope to positive battery terminal.
 - Negative test lead of oscilloscope to negative battery terminal
 - Set oscilloscope to A/C volts and a time base of 500ms.

➤ Normal alternator pattern.



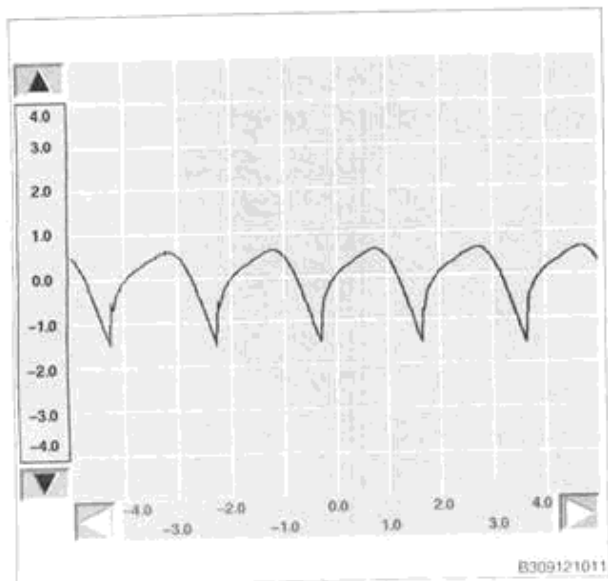
➤ Alternator with defective diode.

Battery, Starter, Alternator 121-21

Alternator, removing and installing (M54 engine)

◀ Alternator with broken winding.

- If test indicate a defective alternator, replace unit. Repair parts are not available for the alternator.



Alternator, removing and installing (M54 engine)

A replacement alternator should have the same rating as the original. Alternator manufacturer and ampere rating are normally marked on the alternator housing.

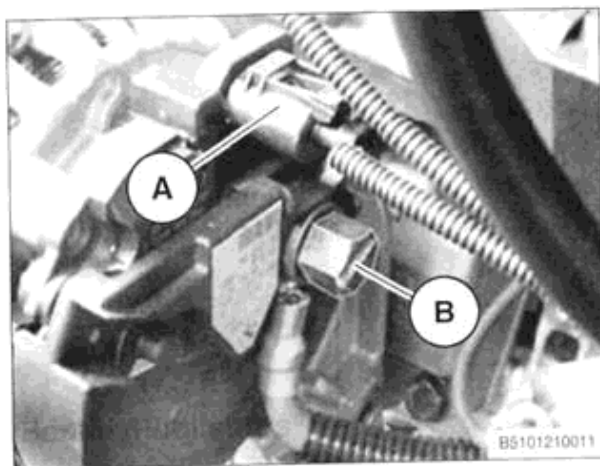
- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

- Remove air intake duct and filter housing. See 130 Fuel Injection.
- Remove engine accessory belt. See 020 Maintenance. Mark direction of rotation on belt before removing.

◀ Working at rear of alternator, remove electrical connector (A) and battery positive cable fastener (B).

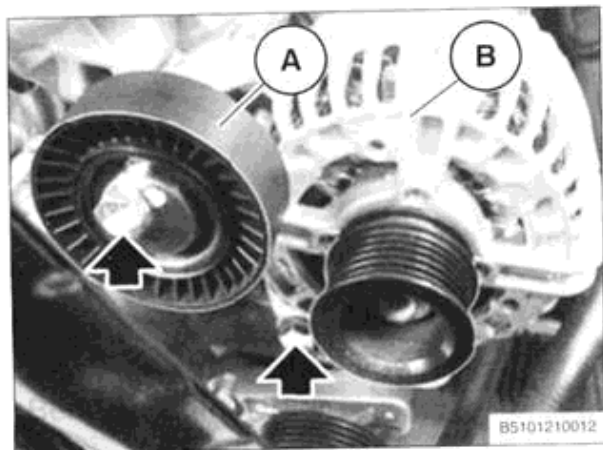


◀ Working at front of alternator (B), remove cover from idler pulley (A) and remove alternator fasteners (arrows).

- Rotate alternator forward and then up and out of engine compartment, using care to not damage radiator.

CAUTION—

- Protect radiator with heavy cardboard or sheet metal.



121-22 Battery, Starter, Alternator

Alternator, removing and installing (N52 engine)

- Installation is reverse of removal. Remember to:
 - Reinstall accessory belt using previously made direction-of-rotation marks.
 - Make sure accessory belt grooves engage pulleys correctly.

Tightening torques

Pulley to alternator	70 Nm (44 ft-lb)
Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)
Alternator to crankcase (M8)	21 Nm (15.4 ft-lb)

- After reconnecting battery, see **Battery reconnection notes** in this repair group.

Alternator, removing and installing (N52 engine)

- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove engine accessory belt. See **020 Maintenance**. Mark direction of rotation on belt before removing.
- Remove air intake duct and filter housing. See **131 Fuel Injection**.



Working at rear of alternator:

- Detach harness connector (A)
- Remove nut (B) and detach alternator cable.
- Remove alternator mounting bolts (arrows) and discard (aluminum bolts).
- Lift out alternator.



With alternator on work bench:

- Remove idler pulley (C) fastener plastic cover, if applicable.
- Remove idler pulley and transfer to new alternator.

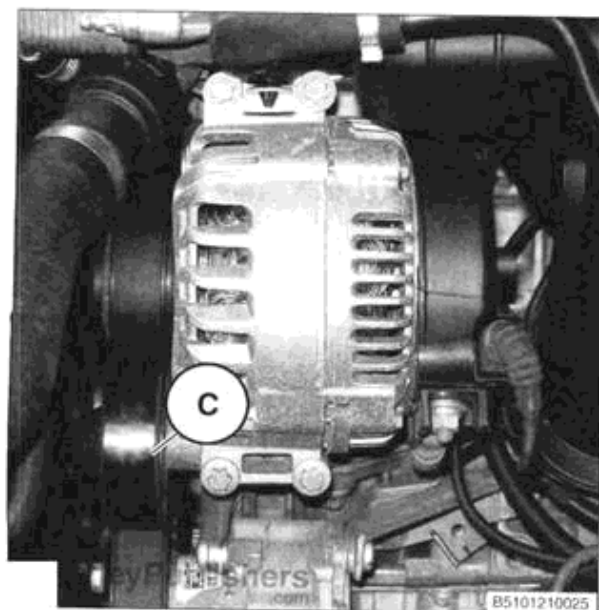
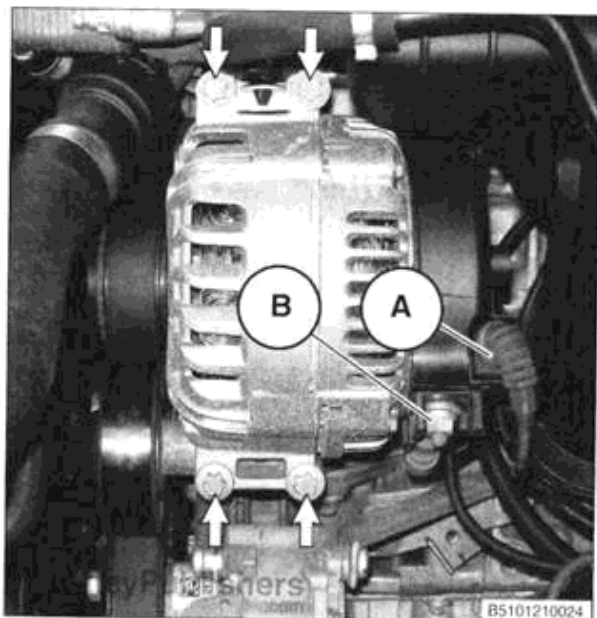
Tightening torques

Idler pulley to alternator housing	80 Nm (59 ft-lb)
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- Reinstall alternator using new aluminium bolts. Reattach electrical harnesses.

Tightening torques

Alternator cable to alternator (M8)	19 Nm (14 ft-lb)
Alternator to engine block (M8 x 82 mm aluminum bolts, replace with new)	
• Stage 1	10 Nm
• Stage 2	additional 180°



Battery, Starter, Alternator 121-23

Alternator, removing and installing (N54 engine)

- Reassemble front of engine. Remember to:
 - Reinstall accessory belt using previously made direction-of-rotation marks.
 - Make sure accessory belt grooves engage pulleys correctly.
 - After reconnecting battery, see **Battery reconnection notes** in this repair group.

Alternator, removing and installing (N54 engine)

- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

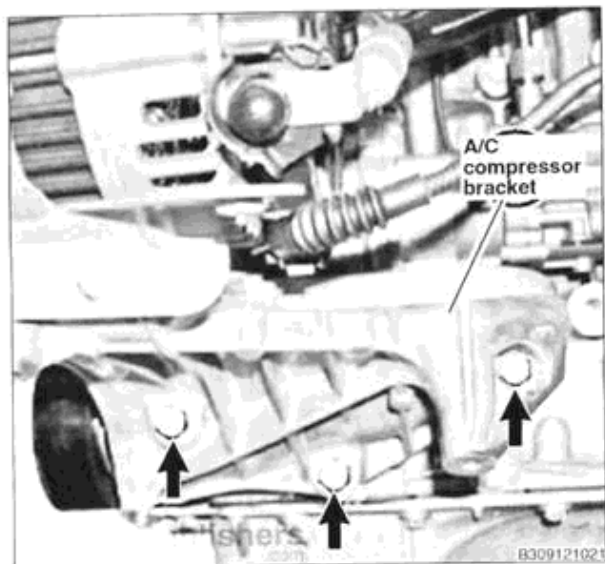
- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Raise vehicle and support safely.

WARNING—

- Make sure the vehicle 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 underneath engine compartment. See **020 Maintenance**.
- Remove electric fan cowl and fan. See **170 Radiator and Cooling System**.
- Remove engine accessory belt. See **020 Maintenance**. Mark direction of rotation on belt before removing.
- Remove air intake duct and filter housing. See **132 Fuel Injection**.
- Remove left side charge air duct. See **132 Fuel Injection**.
- Remove A/C compressor from mounting bracket and hang aside. See **640 Heating and Air-conditioning**. Do not detach A/C refrigerant lines.
- ◀ Loosen A/C compressor bracket bolts (arrows) a few turns. Do not remove bracket.



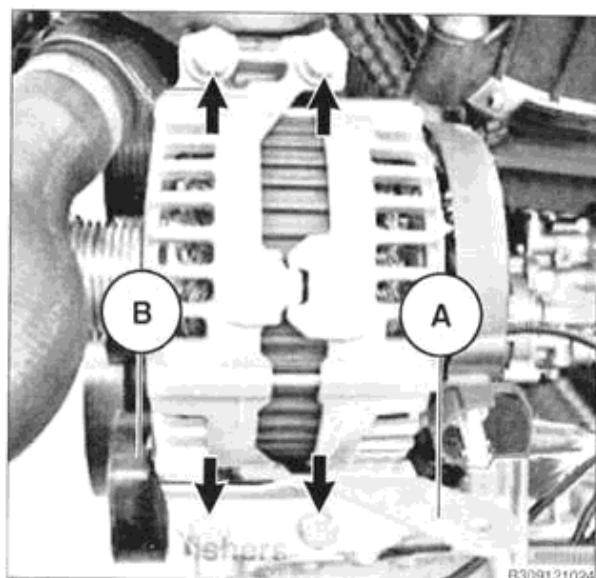
121-24 Battery, Starter, Alternator

Alternator, removing and installing (N54 engine)



Working at rear of alternator:

- Detach harness connector (A)
- Pull off plastic protective cover and remove nut (B) to detach alternator terminal 30 (B+) cable.



Working at left side of engine:

- Remove alternator mounting bolts (arrows).
- Lift out alternator with bracket (A).

With alternator on work bench:

- Remove idler pulley (B) fastener plastic cover, if applicable.
- Remove idler pulley and transfer to new alternator.

Tightening torques

Idler pulley to alternator housing	80 Nm (59 ft-lb)
------------------------------------	------------------

Reinstall alternator and reattach electrical harnesses.

Tightening torques

Alternator cable to alternator (M8)	19 Nm (14 ft-lb)
Alternator to engine block (M8)	19 Nm (14 ft-lb)

Tighten A/C compressor bracket bolts, then reinstall compressor.

Tightening torque

A/C compressor bracket to engine block	19 Nm (14 ft-lb)
--	------------------

Reassemble front of engine. Remember to:

- Reinstall accessory belt using previously made direction-of-rotation marks.
- Make sure accessory belt grooves engage pulleys correctly.
- After reconnecting battery, see **Battery reconnection notes** in this repair group.

Alternator, removing and installing (V8 engine)

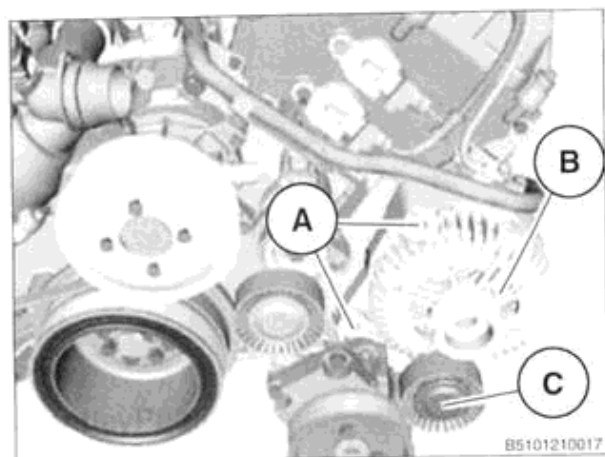
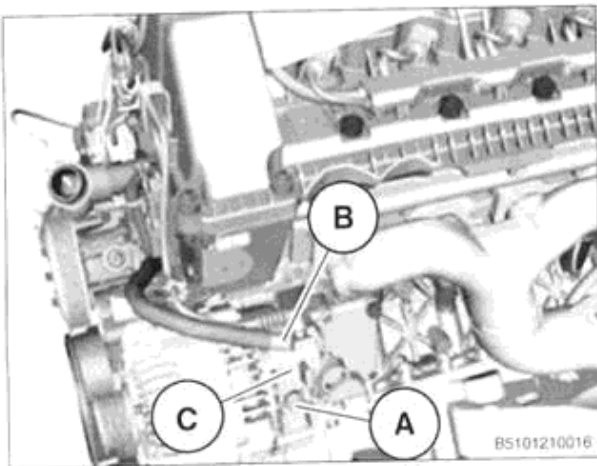
- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove air intake duct and filter housing. See **133 Fuel Injection**.
- Remove electric fan cowl and fan. See **170 Radiator and Cooling System**.
- Remove alternator drive belt. See **020 Maintenance**. Mark direction of rotation on belt before removing.

- ◀ Disconnect alternator electrical connector (B). Remove fastener (A) and alternator cable (C).



- ◀ Remove alternator fasteners (A) and lift out alternator (B).
 - Remove idler pulley (C) fastener plastic cover, if applicable.
 - Remove idler pulley and transfer to new alternator.
- Installation is reverse of removal.

Tightening torques

Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)
Idler pulley to alternator	45 Nm (33 ft-lb)
Drive pulley to alternator	70 Nm (51 ft-lb)
Alternator to crankcase	21 Nm (15.4 ft-lb)



