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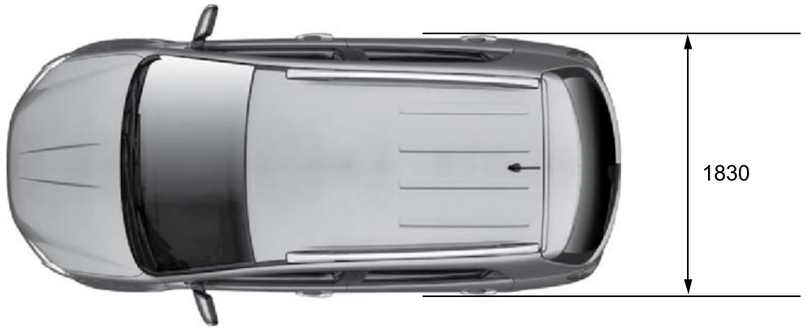
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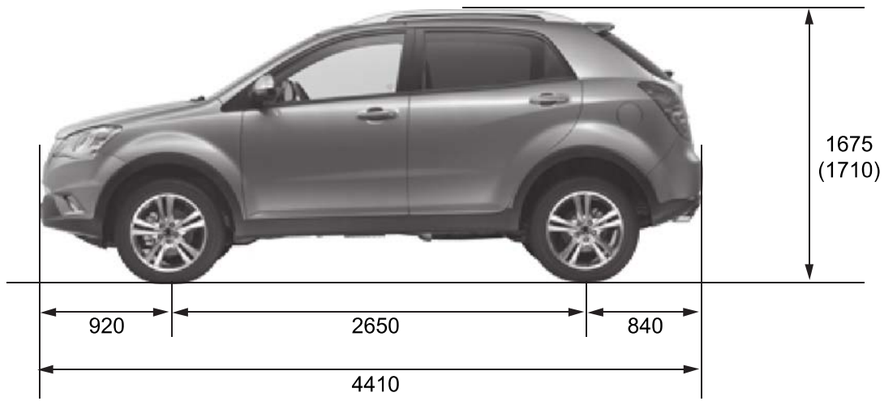
GENERAL INFORMATION

1. MAJOR DIMENSION

Top view



Side view



Front side	Rear view
	
1,555	1558

2. VEHICLE IDENTIFICATION

1) The engine number (671 950 0 2 5000001) is stamped on the lower area of cylinder block in exhaust manifold side.



2) The chassis number (KPTA0B1SSAP012345) is stamped on the right side in the engine compartment (passenger side).





3) The certification label is affixed on the bottom of driver side B-pillar. (30 psi)

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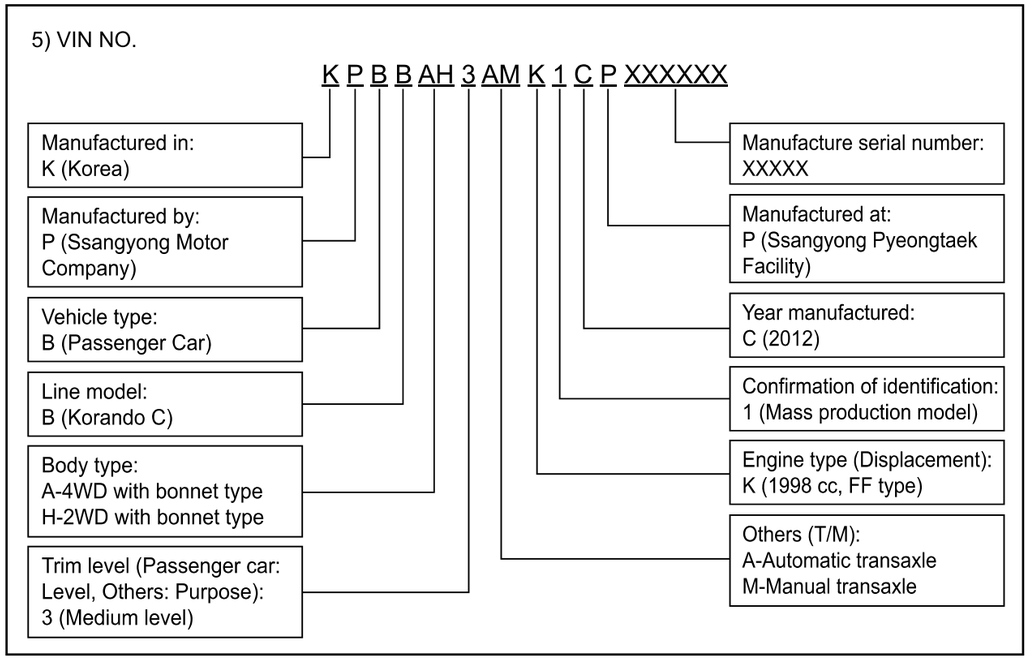
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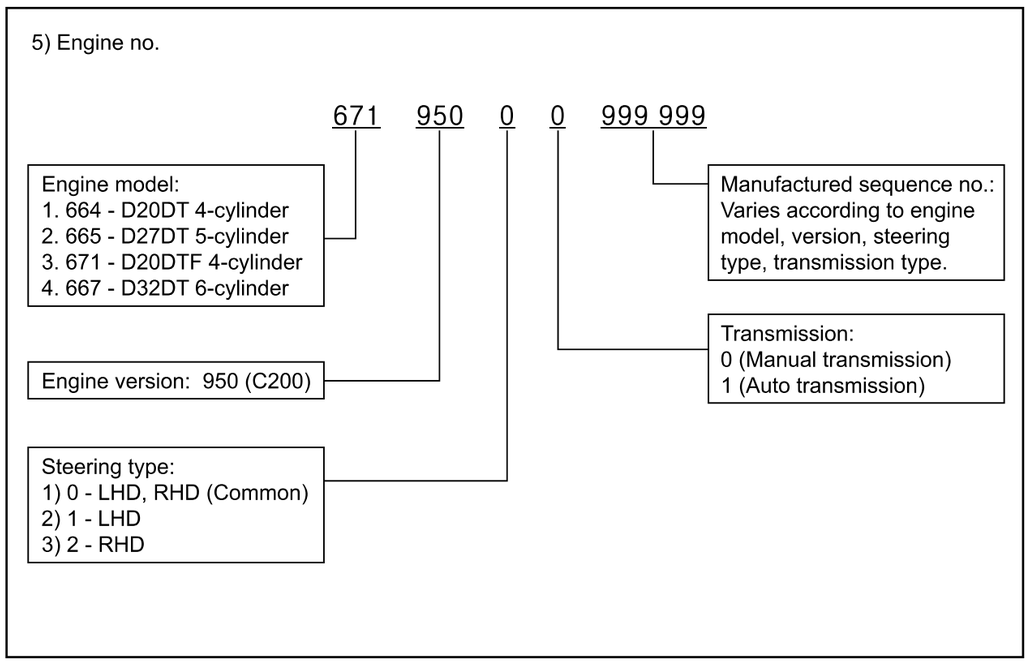
GROSS VEHICLE WEIGHT RATING	2260	KG
GROSS VEHICLE WEIGHT TRAILER WITH BRAKE	4260	KG
FRONT AXLE MAX WEIGHT RATING	1220	KG
REAR AXLE MAX WEIGHT RATING	1200	KG
BODY PAINT COLOR	WAA	
DATE OF MANUFACTURE		

Modification basis	
Application basis	
Affected VIN	

▶ **VIN number**



▶ **Engine number**



3. SPECIFICATION

* ( ) Optional

Descriptions			Diesel 2.0 Engine	Gasoline 2.0 Engine
General	Overall length (mm)		4410	←
	Overall width (mm)		1830	←
	Overall height (mm)		1675 (1710: including roof rack)	←
	Gross vehicle weight (kg)		4WD: 2260, 2WD: 2180	4WD: 2170, 2WD: 2100
	Curb vehicle weight (kg)	A/T	4WD: 1747, 2WD: 1665	-
		M/T	4WD: 1727, 2WD: 1645	4WD: 1673, 2WD: 1512
	Fuel		Diesel	Gasoline
	Fuel tank capacity (ℓ)		57	←
Engine	Engine		D20DTF	G20DF
	Number of cylinders/ Compression ratio		4 / 16.5:1	4 / 10.5:1
	Total displacement (cc)		1998	←
	Camshaft arrangement		DOHC	←
	Max. power	Normal power	175 ps / 4000 rpm	149 ps / 6000 rpm
		Low power	149 ps / 4000 rpm (149 ps / 3400 ~ 4000 rpm)	-
	Max. torque	Normal power	360 Nm / 2000 ~ 3000 rpm	191 Nm / 4000 rpm
		Low power	360 Nm / 2000 ~ 2500 rpm (360 Nm / 1500 ~ 2800 rpm)	-
	Idle speed	A/T	780 ± 20 rpm	-
		M/T	750 ± 20 rpm	700 ± 20 rpm
	Cooling system		Water-cooled / forced circulation	←
	Coolant capacity (ℓ)		8.5	←
	Lubrication type		Gear pump, forced circulation	←
	Max. oil capacity (ℓ) (when shipping)		6.0	←
	Turbocharger and cooling type		Turbocharger, water-cooled	←

* ( ) Optional

Descriptions			Diesel 2.0 Engine	Gasoline 2.0 Engine
Manual Transaxle	Operating type		Floor change type	←
	Gear ratio	1st	3.538 (3.385)	3.616
		2nd	1.909 (1.708)	1.957
		3rd	1.179 (1.033)	1.207
		4th	0.814 (0.786)	0.905
		5th	0.734 (0.730)	0.842
		6th	0.628 (0.595)	0.714
		Reverse	3.910 (3.747)	3.747
Automatic Transaxle	Model		Electronic 6-speed	-
	Operating type		Floor change type	-
	Gear ratio	1st	4.156	-
		2nd	2.375	-
		3rd	1.522	-
		4th	1.144	-
		5th	0.859	-
		6th	0.676	-
		Reverse	3.178	-
Transfer Case	Model		AWD	←
	Type		On demand type	←
Clutch (M/T)	Operating type		Hydraulic type	←
	Disc type		Dry single diaphragm type	←
Power Steering	Type		Rack and pinion (EPS, HPS)	←
	Steering angle	Inner	39.0°	←
		Outer	31.24°	←
Rear Axle	Drive shaft type	Rigid axle	2WD: Semi-floating type	←
		Independent suspension	4WD: Ball joint type	←
	Axle housing type		Build-up type	←

Descriptions			Diesel 2.0 Engine	Gasoline 2.0 Engine
Brake	Master cylinder type		Tandem type	←
	Booster type		Vacuum assisted booster type	←
	Brake type	Front wheel	Disc	←
		Rear wheel	Disc	←
	Parking brake		Mechanical type	←
Suspension	Front suspension		Macpherson + Coil spring	←
	Rear suspension		Multi link + Coil spring	←
Air Conditioner	Refrigerant (capacity)		R-134a (430 ± 30g)	←
Electrical	Battery type / Capacity (V-AH)		MF / 12 - 90	←
	Starter capacity (V-KW)		12 - 2.3	12 - 1.4
	Alternator capacity (V-A)		12V - 140A (EPS), 120A (HPS)	12V - 140A

Modification basis	
Application basis	
Affected VIN	

4. RECOMMENDED FLUIDS AND LUBRICANTS

Descriptions			Capacity	Specifications
Engine Oil	Diesel Engine	D20DTF	6.0 ℓ	Quality class: Ssangyong genuine engine oil (Approved by MB 229.51 SEA 5W30)
	Gasoline Engine	G20DF	4.5 ℓ	Quality class: Ssangyong genuine engine oil (Approved by MB 229.51 SEA 5W30 or API SN/GF-5 SAE 5W20)
Engine Coolant	Diesel Engine	D20DTF	8.5 ℓ	Ssangyong genuine coolant Anti-Freeze: SYC-1025 Anti-Freeze:Water = 50:50 ORGANIC ACID TYPE, COLOR:BLUE
	Gasoline Engine	G20DF	8.5 ℓ	
Automatic Transaxle Fluid			7.5 ℓ	Ssangyong genuine oil (FUCHS TITAN ATF 3292)
Manual Transaxle Fluid			1.6 ℓ	Ssangyong genuine oil (SAE 75W/85, API GL-4)
Transfer Case (PTU) Fluid		AWD	0.58 ℓ	Ssangyong genuine oil (IDEMITSU LW 80W/90)
Rear Axle Oil		AWD	0.7 ℓ	Ssangyong genuine oil (SAE 80W/90, API GL-5)
Brake / Clutch Fluid			As required	Ssangyong genuine oil (DOT4)
Power Steering Fluid			1.0 ℓ	Ssangyong genuine oil (ATF DEXRON II) * TOTAL FLUIDE DA (Extreme cold condition only)

WARNING

- Use only Ssangyong recommended fluids and lubricants.
- Do not mix any different types or brands of oils or fluids. This may cause damages.
- Keep the specified levels when adding or replacing the fluids.

5. SCHEDULED MAINTENANCE SERVICES

1) Diesel Engine(EU)

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner's responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
ENGINE CONTROL SYSTEM									
Drive belt	I	I	I	I	I	I	I	I	
* Engine oil & filter *1 (1)* (3)* (4)*	R	R	R	R	R	R	R	R	
	Shorten the service interval under severe conditions								
Cooling system hose & connections	I	I	I	I	I	I	I	I	
Engine coolant (3)* (4)	Change every 200000 km or 5 years. And, inspect and replenish if necessary.								
Fuel filter (1)*		R		R		R		R	
	Drain the water from fuel filter when the warning light comes on								
Fuel line & connections	I	I	I	I	I	I	I	I	
Air cleaner (2)*	R	R	R	R	R	R	R	R	
	Shorten the service interval under severe conditions								

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

*1 Check the engine oil level and leak every 3000 km (2000 miles) or before starting a long trip.

R- Replace or change.

(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, driving in dusty condition or sandy condition, pollutant area or off-road driving, frequently inspect the air cleaner, if necessary, change the air cleaner.

(3)* More frequent maintenance is required if under dusty driving condition.

(4)* Refer to "Recommended fluids, coolant and lubricants".

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transaxle oil (5)*				I			I		
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Power transfer unit oil (6)*		I	I	I	I	I	I	I	I
		Severe driving condition: Change every 60000 km							
Rear axle oil		Inspect every 20000 km, change every 100000 km (Frequnt check of oil leak)							
Automatic transaxle fluid (6)*		I	I	I	I	I	I	I	I
		Change every 60000 km under severe condition							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:

- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 3 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)

(6)* If vehicle is operated under severe condition: Shorten the service interval.

- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*		I	I	I	I	I	I	I	I
Drive shaft boots (8)*		I	I	I	I	I	I	I	I
Seat belts, buckles & anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch		Check frequently and adjust or replace if necessary							
Wheel bearing grease		I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*		I	I	I	I	I	I	I	I
Air conditioner filter (10)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(8)* After completion of off-road operation, the drive shaft boots should be inspected.

(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.

- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)* Severe Conditions in Air Conditioner Filter

- Pollutant area or off-road driving, extended air conditioner or heater operation

Modification basis	
Application basis	
Affected VIN	

2) Diesel Engine(General)

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner's responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
ENGINE CONTROL SYSTEM									
Drive belt		I	I	I	I	I	I	I	I
* Engine oil & filter *1 (1)* (3)* (4)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							
Cooling system hose & connections		I	I	I	I	I	I	I	I
Engine coolant (3)* (4)		Change every 200000 km or 5 years. And, inspect and replenish if necessary.							
Fuel filter (1)*				R			R		
		Drain the water from fuel filter when the warning light comes on							
Fuel line & connections		I	I	I	I	I	I	I	I
Air cleaner (2)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
*1 Check the engine oil level and leak every 3000 km (2000 miles) or before starting a long trip.
R- Replace or change.
(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, driving in dusty condition or sandy condition, pollutant area or off-road driving, frequently inspect the air cleaner, if necessary, change the air cleaner.
(3)* More frequent maintenance is required if under dusty driving condition.
(4)* Refer to "Recommended fluids, coolant and lubricants".

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transaxle oil (5)*					I				I
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Power transfer unit oil (6)*		I	I	I	I	I	I	I	I
		Severe driving condition: Change every 60000 km							
Rear axle oil		Inspect every 15000 km, change every 100000 km (Frequnt check of oil leak)							
Automatic transaxle fluid (6)*		Inspect every 15000 km or 12 month (But change every 60000 km under severe condition)							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
R- Replace or change.
(3)* Refer to "Recommended fluids and lubricants".
(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 4 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)
(6)* If vehicle is operated under severe condition: Shorten the service interval.
- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

MAINTENANCE ITEM / MAINTENANCE INTERVAL	Kilometers (miles) or time in months, whichever comes first							
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*		I	I	I	I	I	I	I	I
Drive shaft boots (8)*		I	I	I	I	I	I	I	I
Seat belts, buckles & anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch		Check frequently and adjust or replace if necessary							
Wheel bearing grease		I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*		I	I	I	I	I	I	I	I
Air conditioner filter (10)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:
I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
R- Replace or change.
(3)* Refer to “Recommended fluids and lubricants”.
(8)* After completion of off-road operation, the drive shaft boots should be inspected.
(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.
- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)*Severe Conditions in Air Conditioner Filter
- Pollutant area or off-road driving, extended air conditioner or heater operation

3) Gasoline Engine

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner’s responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE ITEM / MAINTENANCE INTERVAL	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
ENGINE CONTROL SYSTEM									
Drive belt		I	I	I	I	I	I	I	I
Engine oil & engine oil filter (1)* (3)* (Initial change: 10,000 km)		R**	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							
Cooling system hose & connections		I	I	I	I	I	I	I	I
Engine coolant (3)*		Change every 200,000 km or 5 years. And, inspect replenish if necessary.							
Fuel filter (2)*		Replace every 100,000 km (if using poor quality of fuel, replace every 30,000 km)							
Fuel line & connections		I	I	I	I	I	I	I	I
Air cleaner (2)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							
Ignition timing		I	I	I	I	I	I	I	I
Spark plugs (G20DF)		Change every 160,000 km or 5 years.							
Charcoal canister & vapor lines		-	-	I	-	-	I	-	-

Chart Symbols:
I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
R- Replace or change.
**- In order to secure engine long life and effective break-in, first oil (factory filled) would be recommended to drain with in 10,000 km.
(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, pollutant area or off-road driving, driving in dusty condition or sandy condition, frequently inspect the air cleaner, if necessary, change the air cleaner.
(3)* Refer to “Recommended fluids and lubricants”.

Modification basis	
Application basis	
Affected VIN	

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transaxle oil (5)*					I				I
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Power transfer unit oil (6)*		I	I	I	I	I	I	I	I
		Severe driving condition: Change every 60000 km							
Rear axle oil		Inspect every 15000 km, change every 100000 km (Frequnt check of oil leak)							
Automatic transaxle fluid (6)*		Inspect every 15000 km or 12 month (But change every 60000 km under severe condition)							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:
I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
R- Replace or change.
(3)* Refer to “Recommended fluids and lubricants”.
(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 4 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)
(6)* If vehicle is operated under severe condition: Shorten the service interval.
- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*		I	I	I	I	I	I	I	I
Drive shaft boots (8)*		I	I	I	I	I	I	I	I
Seat belts, buckles & anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch		Check frequently and adjust or replace if necessary							
Wheel bearing grease		I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*		I	I	I	I	I	I	I	I
Air conditioner filter (10)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

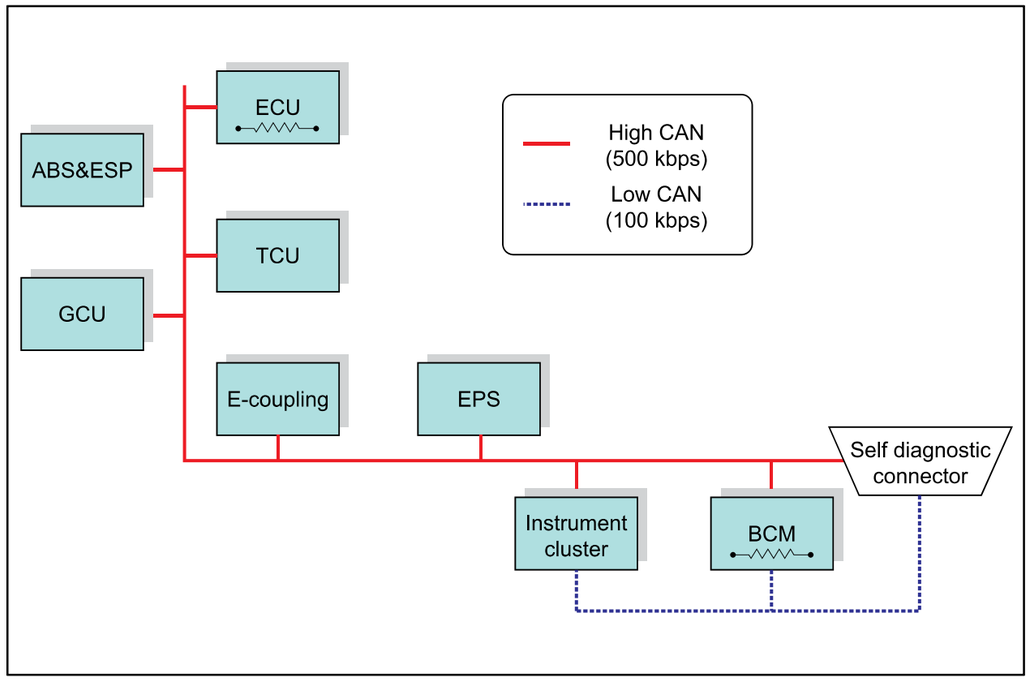
Chart Symbols:
I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
R- Replace or change.
(3)* Refer to “Recommended fluids and lubricants”.
(8)* After completion of off-road operation, the drive shaft boots should be inspected.
(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.
- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)* Severe Conditions in Air Conditioner Filter
- Pollutant area or off-road driving, extended air conditioner or heater operation

6. CAN COMMUNICATION CONFIGURATION

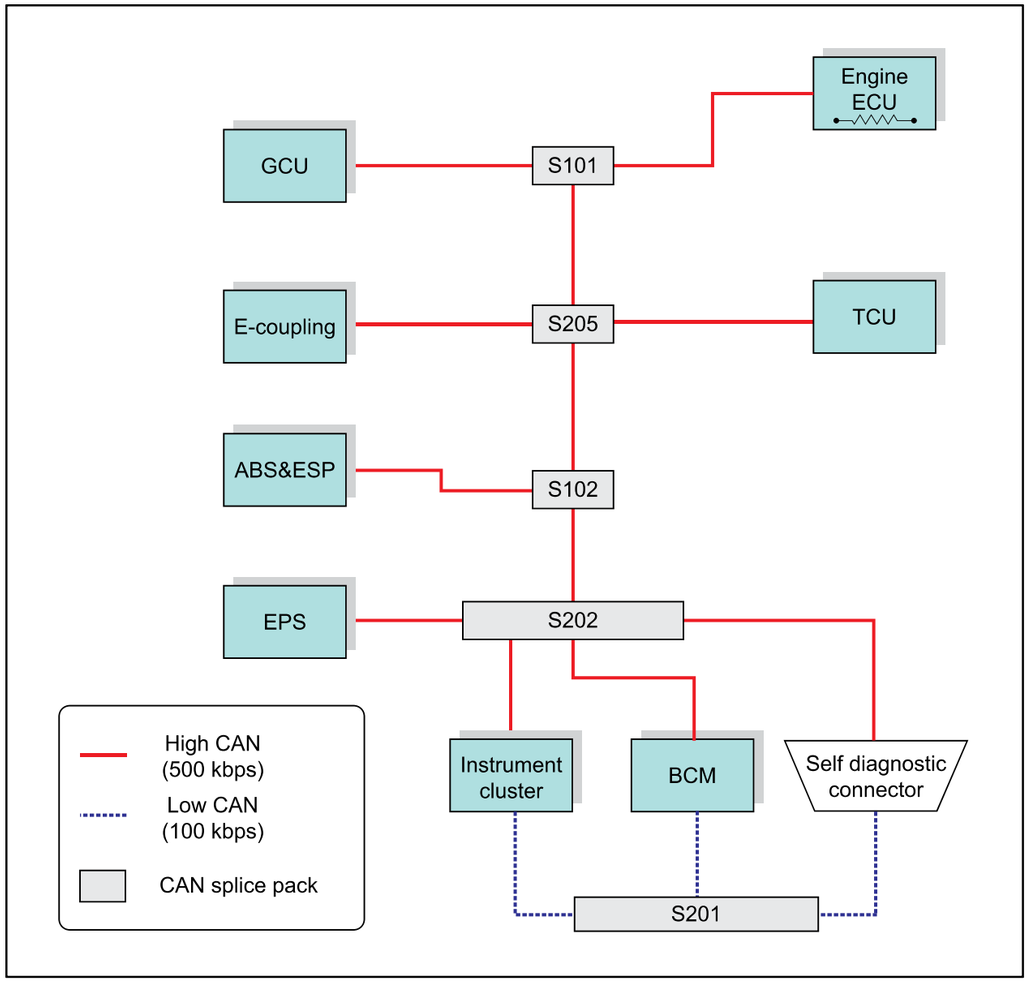
There are two types (P-CAN and B-CAN) of communication according to the communication speed.
The instrument cluster and BCM (Body Control Module) communicate through both P-CAN and B-CAN at the same time.

1) CAN Configurations (P-CAN/B-CAN)



Abbreviations	Meaning	Function
GCU	Glow Control Unit	Glow control unit
EPS	Electronic Power Steering Unit	Electrically driven power steering unit
BCM	Body Control Module	Body control module

2) CAN Communication Wiring Diagram



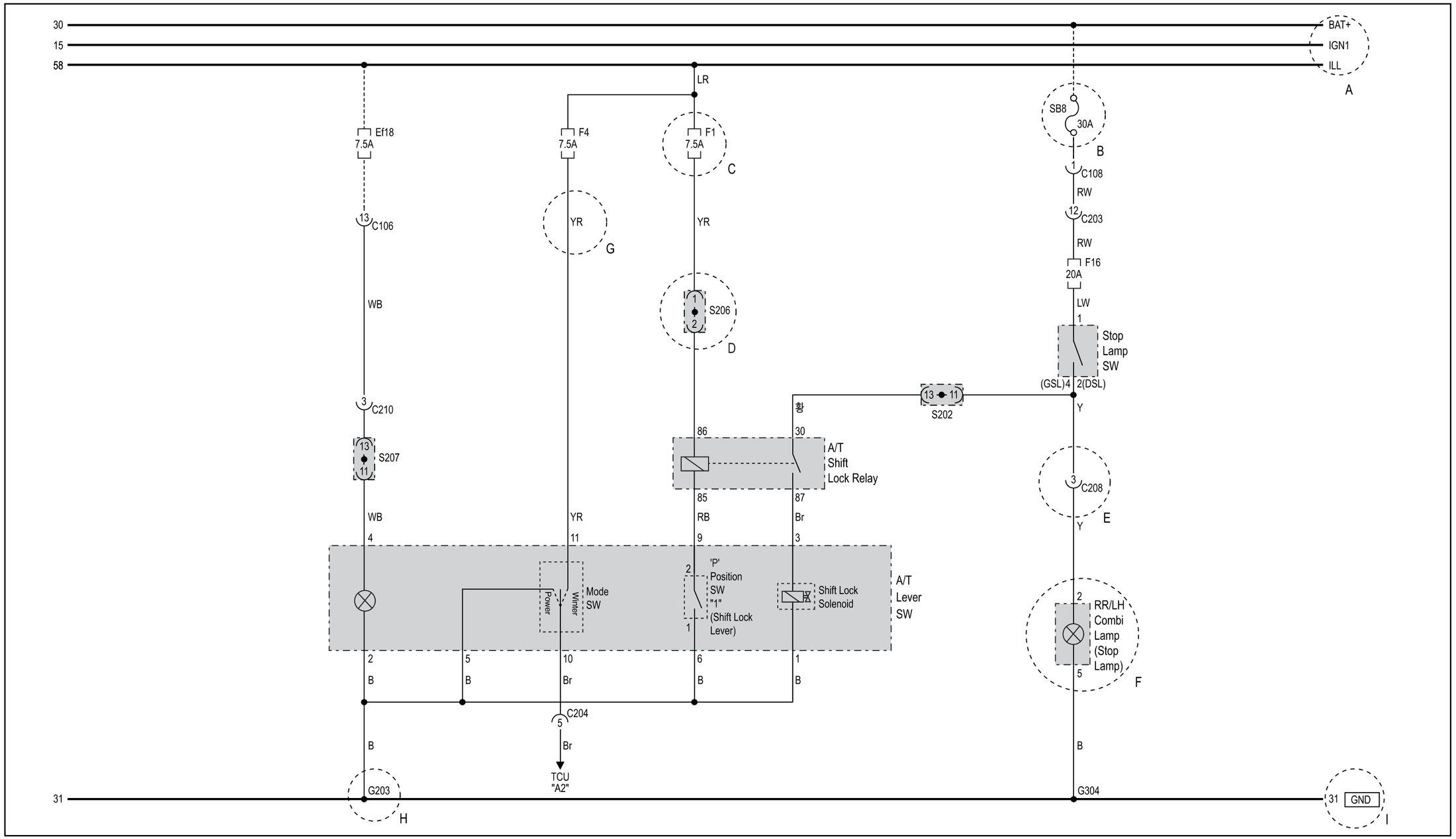
Splice pack	Wiring	Location
S101	Floor wiring (LH)	Under fuse and relay box in engine compartment
S102	Floor wiring (RH)	Inside of right fender
S202	Main wiring	Behind the instrument cluster (cowl cross member)
S204	Main wiring	Behind the instrument cluster (cowl cross member)
S205	Floor wiring (LH)	Under driver door scuff

Modification basis	
Application basis	
Affected VIN	

ELECTRIC DEVICE GENERAL INFORMATION

1. HOW TO READ ELECTRICAL WIRING DIAGRAM

(1) HOW TO READ ELECTRICAL WIRING DIAGRAM



(2) CONTENTS OF ELECTRICAL WIRING DIAGRAM(CIRCUIT)

Position	Emplanation
A	A top of horizontal line means Power supply and it is separated depending on condition of power supply. (For more information, please refer to the Function of power supply No.appendix)
B	This means Blow-slow Fuse No.8 in an Engine Room Fuse-Box and it is Main Fuse which supplies the power to each Fuse.
C	These mean both a Fuse No. and a Fuse location. And Ef 'means an Engine Room Fuse, F means an indoor Fuse. 7.5A means Fuse capacity.
D	"S" means Splice Pack and 206 'means Splice Pack Number.
E	"C" means Connector and '208' means Connector Number.
F	This means inner circuit and it is displayed one-point-center-line.
G	This means wiring color, so at the head of character Y means background color of wiring and the rear character R means middle color of wiring.
H	"G" means Ground and 203 'means Ground Number.
I	Below horizontal line means Ground. -Ground position (G101~G401) -B : Body Ground

(3) CIRCUIT IDENTIFICATION SYMBOL

Identification Symbol	Meaning
C	Connector
D	Diode
Ef	Fuse in Engine room Fuse & Relay Box
F	Indoor Fuse Box
G	Ground
S	Splice pack (Junction connector)
SB1 ~ SB10	Slow Blow Fuse (Engine room fuse & relay Box)

(4) FUNCTION OF POWER SUPPLY LINE(NUMBER)

Power supply NO.	Power supply condition
15	Battery Voltage (B+) Supply in Ignition Switch ON and ST (IGN 1)
15A	Battery Voltage (B+) Supply in Ignition Switch ON (IGN 2)
15C	Battery Voltage (B+) Supply in Ignition Switch ACC (ACC)
30	Battery Voltage (B+) Supply directly regardless of Ignition Switch
31	Ground Connnected to Battery(-)
50	Battery Voltage (B+) Supply in Ignition Switch ST
58	Battery Voltage (B+) Supply in Head Lamp Switch 1st and 2nd step(Illumination circuit)

(5) WIRING HARNESS COLOR IDENTIFICATION

Abbreviation	Color	Abbreviation	Color
Br	Brown	Sb	Sky Blue
G	Green	R	Red
V	Violet	L	Blue
P	Pink	Y	Yellow
W	White	Gr	Gray
O	Orange	B	Black
Lg	Light Green		

Modification basis	
Application basis	
Affected VIN	

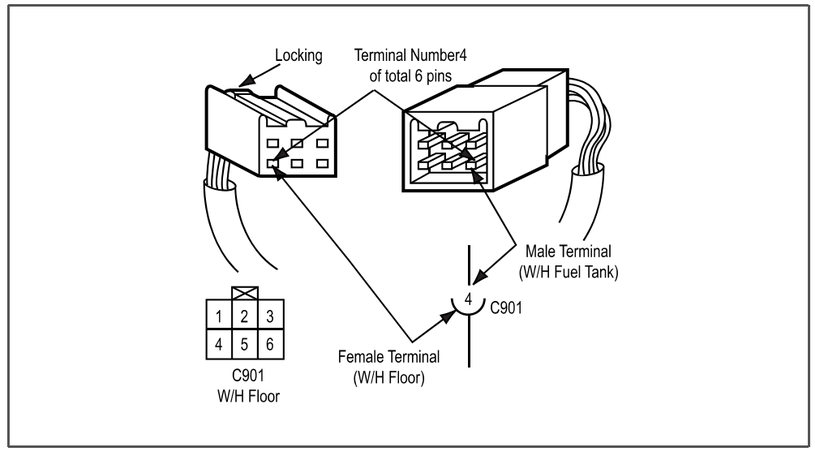
(6) ELECTRIC SYMBOLS

Items	Symbols	Items	Symbols
Resistance		Lamp	
Rheostat		Single Bulb	
Coil, Inductance		Double Bulb	
Condenser, Capacitor		Transistor : PNP type	
Ground, Earth		Transistor : NPN type	
Diode		~Meter, ~Gauge	
Zener Diode		Voltmeter	V
Photo Diode		Amperemeter	A
Light Emitting Diode		Switch	
Battery		Thermistor	
Disconnected Wire		Junction Point	
Fuse		Fusible Link	
Motor	M	Connector	No.
Speaker		Horn	

2. HOW TO CHECK TERMINAL NUMBER OF CONNECTOR

▶ Terminal number is given based on Female Terminal Male Connector

- ex) Terminal Number 4 of C901 connection



▶ Terminal number of Connector

- Generally, the Connector terminal number is given from left to right direction of Locking upper position through the Female Terminal.
- Exceptionally, Control unit such as Engine ECU, TCU and Instrument Cluster was used a specific number which marked on the draft.
- If a lot of connectors was connected to one parts, the connector was marked as A, B, C in front of terminal number.
- In case of terminal number was carved into connector or each parts, we will use the carved number exceptionally.

3. PART LOCATION ACCORDING TO CONNECTOR NUMBER

▶ **C : Symbol Character for Connector ex) C102**

Symbol Character	Description
C	Connector (Connecting part that connects two wiring harness)
D	Diode
G	Ground
S	Splice pack (Joint connector that connects various wiring harness)

▶ **1 : Connector location Number**



▶ **Connector Number according to locating Section**

Connector Number	Location
□1□□	Engine Compartment
□2□□	Instrument panel
□3□□	In Door
□4□□	Tail Gate
□9□□	Under Body

- In the locating section, the assignment for part number startsfrom left bottom and proceeds clockwise.
  In the fuse and relay box or the instrument panel, the partnumber is assigned from left top to light
- bottom.

▶ **02 : Connector Numbering Order**

Modification basis	
Application basis	
Affected VIN	

CONNECTOR/GROUND

1413-02/8210-00/8210-01/8211-01/8212-01/8212-02 /8213-03/8213-04/8213-06/8213-09/8213-108810-22/8810-23

WIRING HARNESS

8210-00 WIRING HARNESS, COMPONENTS LOCATION..... 2
8210-00 CONNECTOR, GROUND / SPLICE PACK..... 4

CONNECTOR/GROUND

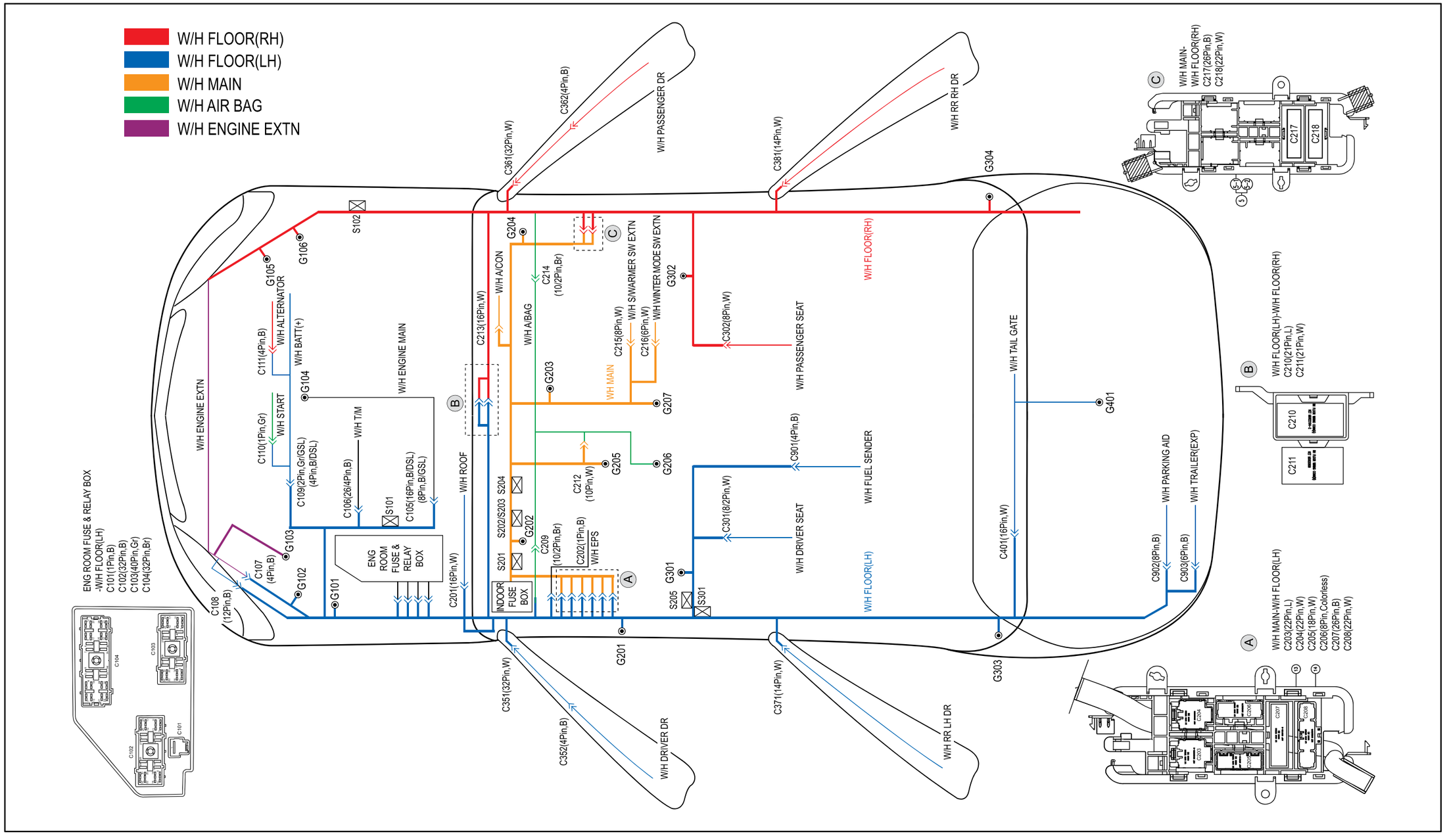
8210-01 W/H MAIN..... 11
8212-01 W/H FLOOR(LH)..... 13
8212-02 W/H FLOOR(RH)..... 15
1413-02 W/H ENGINE MAIN..... 16
8211-01 W/H ENGINE EXTN..... 17
8213-09 W/H ROOF..... 18
8810-22 W/H AIR BAG..... 19
8810-23 W/H AIR BAG EXTN..... 19
8213-03 W/H DRIVER DOOR..... 20
8213-04 W/H PASSENGER DOOR..... 20
8213-06 W/H REAR DOOR..... 21
8213-10 W/H TAIL GATE..... 21

WIRING HARNESS

S.G.N. 8210-00

WIRING HARNESS, COMPONENTS LOCATION

(1) WIRING HARNESS

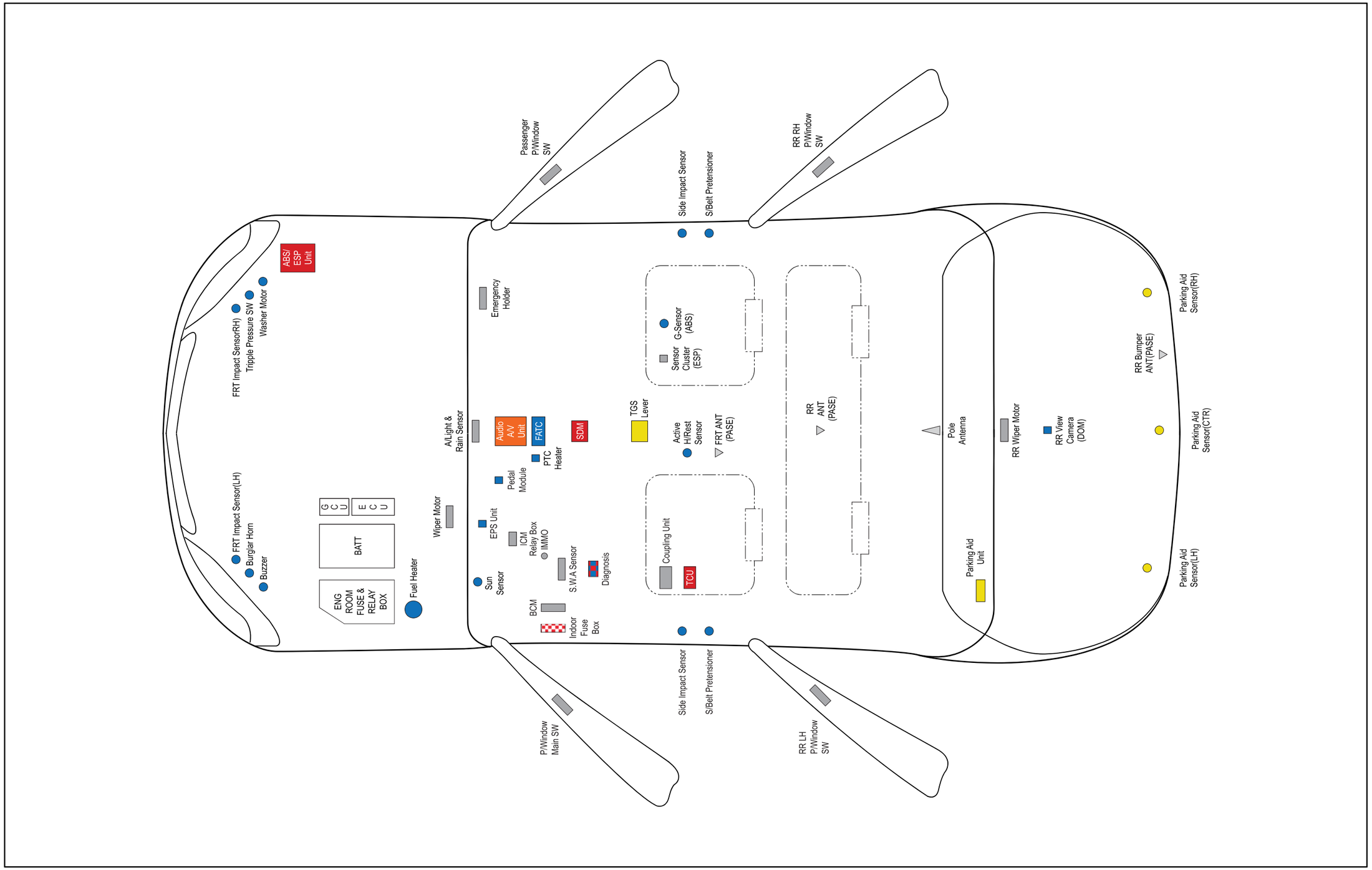


CONNECTOR/GROUND

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

(2) COMPONENTS LOCATION



S.G.N. 8210-00

CONNECTOR, GROUND / SPLICE PACK

(1) CONNECTOR, GROUND, SPLICE PACK

▶ CONNECTOR

Connector Number (Pin Number/Color)			Connecting Wiring Harness	Connector Position	Remark
C101	1	Black	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C102	32	Black	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C103	40	Gray	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C104	32	Brown	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C105	8	Black	W/H Floor(LH) - W/H Eng	Upper BATT Tray(Beside Fuel Heater)	GSL
	16	Black	W/H Floor(LH) - W/H Eng	Upper BATT Tray(Beside Fuel Heater)	DSL
C106	26	Black	W/H Floor(LH) - W/H T/M	Upper T/M(Under BATT Tray)	A/T
	4	Black	W/H Floor(LH) - W/H T/M	Upper T/M(Under BATT Tray)	M/T
C107	4	Black	W/H Floor(LH) - W/H Eng EXTN	Inside FRT Bumper(Behind LH Fog Lamp)	
C108	12	Black	W/H Floor(LH) - W/H Eng EXTN	Inside FRT Bumper(Behind LH Fog Lamp)	
C109	2	Gray	W/H Floor(LH) - W/H BATT(+)	Lower Air Cleaner Duct	GSL
	4	Black	W/H Floor(LH) - W/H BATT(+)	Lower Air Cleaner Duct	DSL
C110	1	Gray	W/H BATT(+) - Start Solenoid	Beside Starter Motor	
C111	4	Black	W/H BATT(+) - Alternator	Beside Alternator	
	2	Black	W/H BATT(+) - Alternator	Beside Alternator	LOW CO_2
C201	16	White	W/H Floor(LH) - W/H Roof	Upper Driver Cowl Side Connector Holder	
C202	1	Black	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	EPS
C203	22	Blue	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C204	22	White	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C205	18	White	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C206	8	Colorless	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C207	26	Black	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C208	22	White	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C209	10	Brown	W/H Air Bag - W/H Air Bag EXTN	Driver Cowl Side Connector Holder	Curtain/Side A/Bag
	2	Brown	W/H Air Bag - W/H Air Bag EXTN	Driver Cowl Side Connector Holder	
C210	21	Blue	W/H Floor(LH) - W/H Floor(RH)	Upper CTR Dash PNL	
C211	21	White	W/H Floor(LH) - W/H Floor(RH)	Upper CTR Dash PNL	
C212	10	White	W/H Main - W/H Air Bag	Inside I.P (Upper Driver LegRoom)	
C213	16	White	W/H Main - W/H Air Con	Inside I.P (Upper CTR Cowl Cross Member)	
C214	10	Brown	W/H Air Bag - W/H Air Bag EXTN	Passenger Cowl Side Connector Holder	Curtain/Side A/Bag
	2	Brown	W/H Air Bag - W/H Air Bag EXTN	Passenger Cowl Side Connector Holder	
C215	8	White	W/H Main - W/H Seat Warmer switch EXTN	Inside Console	A/T, M/T DLX
C216	6	White	W/H Main - W/H Winter Mode switch EXTN	Inside Console	A/T, DSL
C217	26	Black	W/H Main - W/H Floor(RH)	Passenger Cowl Side Connector Holder	
C218	22	White	W/H Main - W/H Floor(RH)	Passenger Cowl Side Connector Holder	
C301	8	White	W/H Floor(LH) - W/H Driver Seat	Under Driver Seat	S/Warmer, Active
	2	White	W/H Floor(LH) - W/H Driver Seat	Under Driver Seat	
C302	8	White	W/H Floor(RH) - W/H Passenger Seat	Under Passenger Seat	
C351	32	White	W/H Floor(LH) - W/H Driver DR	Under LH A Pillar	
C352	4	Black	W/H Driver DR - W/H Smart Key	Inside Driver DR	Smart Key
C361	32	White	W/H Floor(RH) - W/H Passenger DR	Under RH A Pillar	
C362	4	Black	W/H Passenger DR - W/H Smart Key	Inside Passenger DR	Smart Key
C371	14	White	W/H Floor(LH) - W/H RR LH DR	Under LH B Pillar	
C381	14	White	W/H Floor(RH) - W/H RR RH DR	Under RH B Pillar	
C401	16	White	W/H Floor(LH) - W/H Tail Gate	Upper Tail Gate LH	
C901	4	Black	W/H Floor(LH) - W/H Fuel Sender	FRT Fuel Tank	
C902	8	Black	W/H Floor(LH) - W/H RR Bumper	Under RR LH Bumper	PAS
C903	6	Black	W/H Floor(LH) - W/H Trailer	Under RR LH Bumper	

▶ GROUND

Connector Number	Connecting Wiring Harness	Connector Position	Remark
G101	W/H Floor(LH)	Behind LH Head Lamp	
G102	W/H Floor(LH)	Under BATT Tray	ECU
G103	W/H Eng EXTN	Under BATT Tray	
G104	W/H Eng Main	FRT Intake Valve	
G105	W/H Floor(RH)	Behind RH Head Lamp	
G106	W/H Floor(RH)	Beside ABS/ESP Unit	ABS/ESP
G201	W/H Floor(LH)	Under Driver Cowl Side Connector Holder	
G202	W/H Main	Backside Cluster(LH Cowl Cross Member)	AUDIO
G203	W/H Main	Backside Audio(CTR Cowl Cross Member)	
G204	W/H Main	Inside I.P(RH Glove Box)	
G205	W/H Main	Left Side I.P(Beside CTR Support BRKT)	PTC
G206	W/H Main	Left Under TGS Lever	AIR BAG
G207	W/H Main	Right Under TGS Lever	EPS
G301	W/H Floor(LH)	Under Driver Seat	
G302	W/H Floor(RH)	Under Passenger Seat	
G303	W/H Floor(LH)	Driver QTR PNL	
G304	W/H Floor(RH)	Passenger QTR PNL	
G401	W/H Tail Gate	CTR Under Tail Gate	

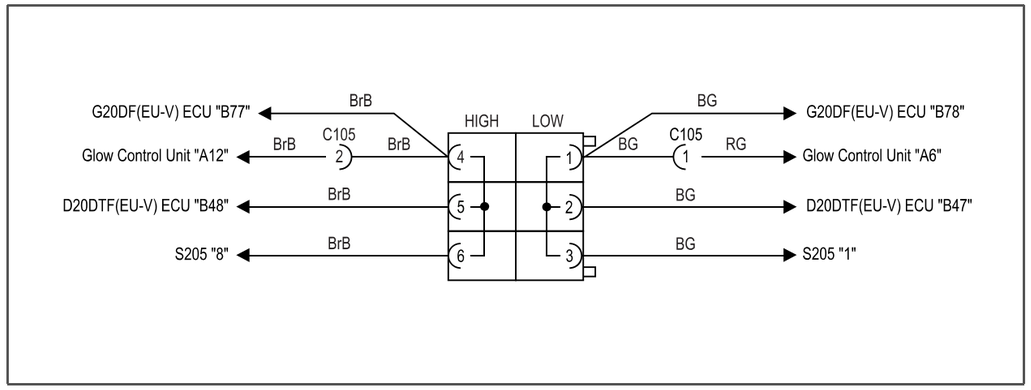
▶ SPLICE PACK

Connector Number (Pin Number/Color)		Connecting Wiring Harness	Connector Position	Remark
S101	6	W/H Floor(LH)	Under Eng Room Fuse & Relay Box	HS-CAN
S102	6	W/H Floor(RH)	Inside RH Fender	HS-CAN
S201	8	W/H Main	Backside Cluster(LH Cowl Cross Member)	LS-CAN
S202	20	W/H Main	Backside Cluster(LH Cowl Cross Member)	HS-CAN
S203	20	W/H Main	Backside Cluster(LH Cowl Cross Member)	ILL +
S204	20	W/H Main	Backside Cluster(Upper ICM Relay Box)	GND
S205	14	W/H Floor(LH)	Under Driver Seat	HS-CAN
S301	14	W/H Floor(LH)	Under Driver Seat	

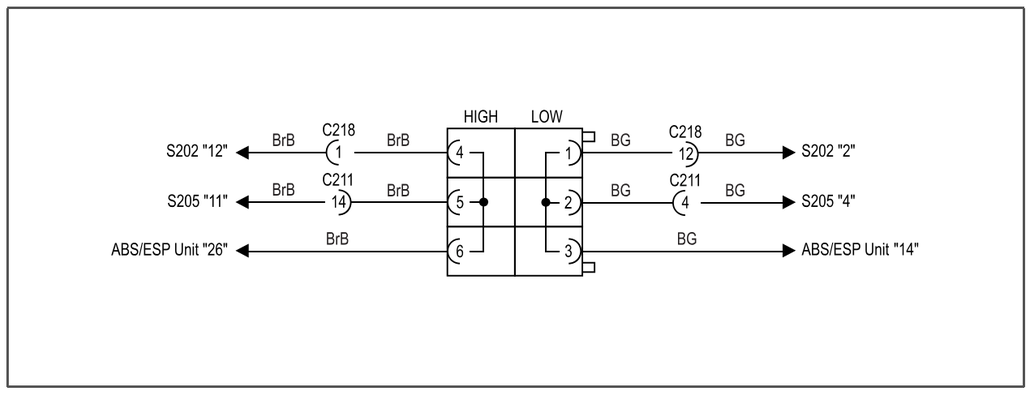
Modification basis	
Application basis	
Affected VIN	

(2) SPLICE PACK CIRCUIT

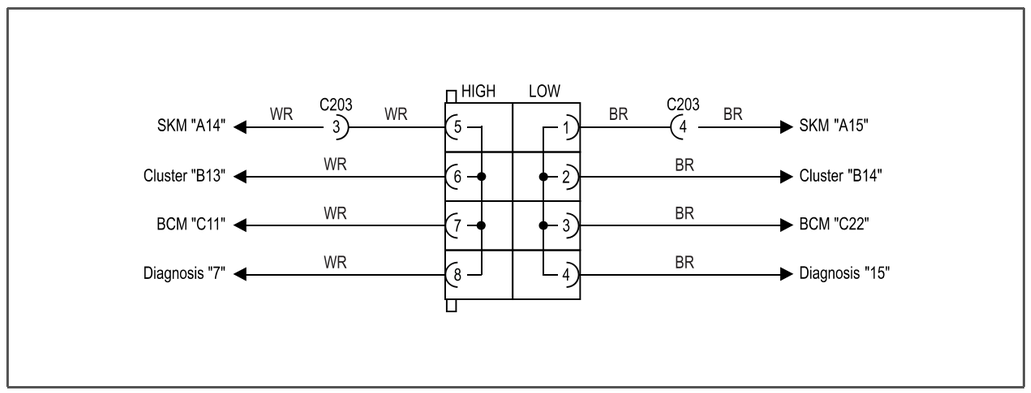
1) S101 (HS-CAN)



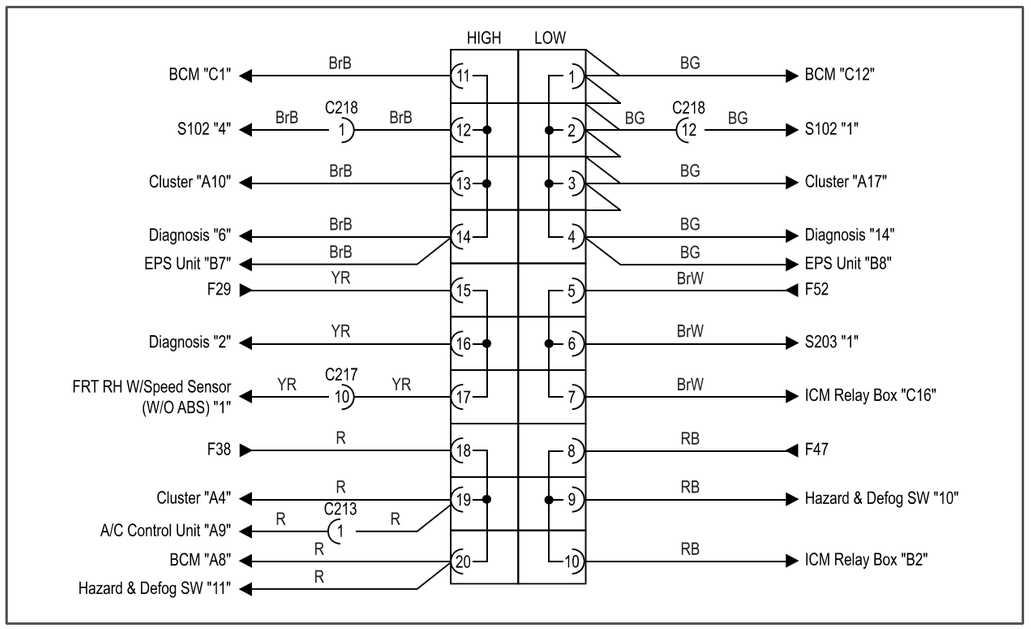
2) S102 (HS-CAN)



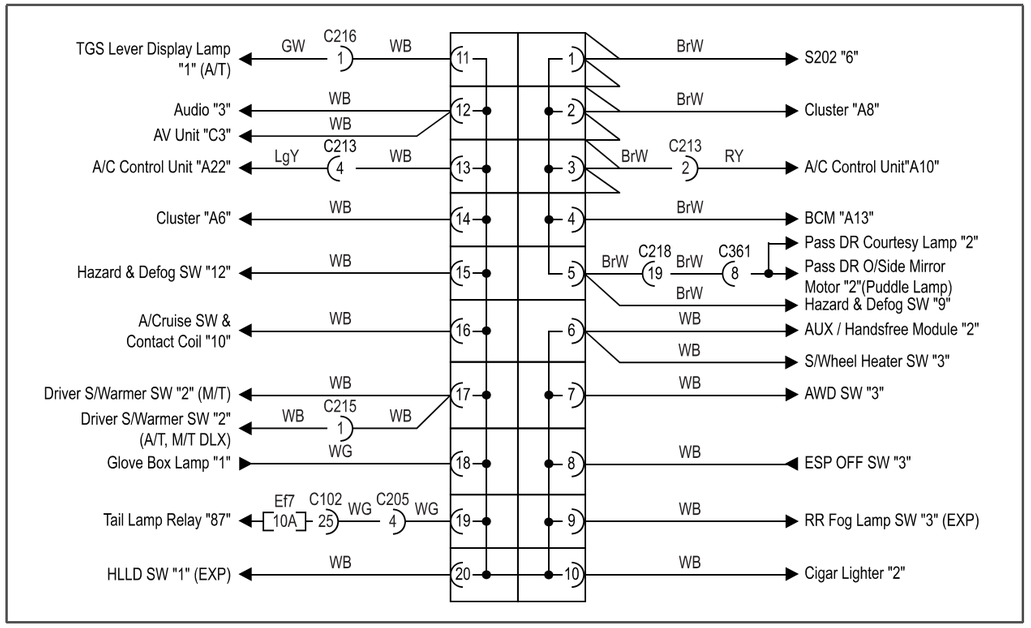
3) S201 (LS-CAN)



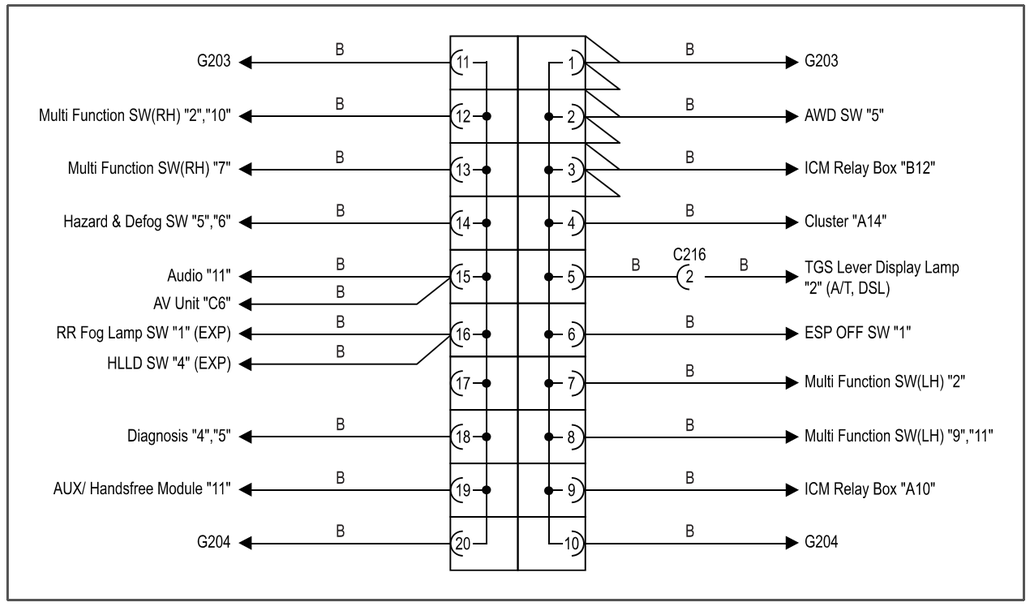
4) S202 (HS-CAN)



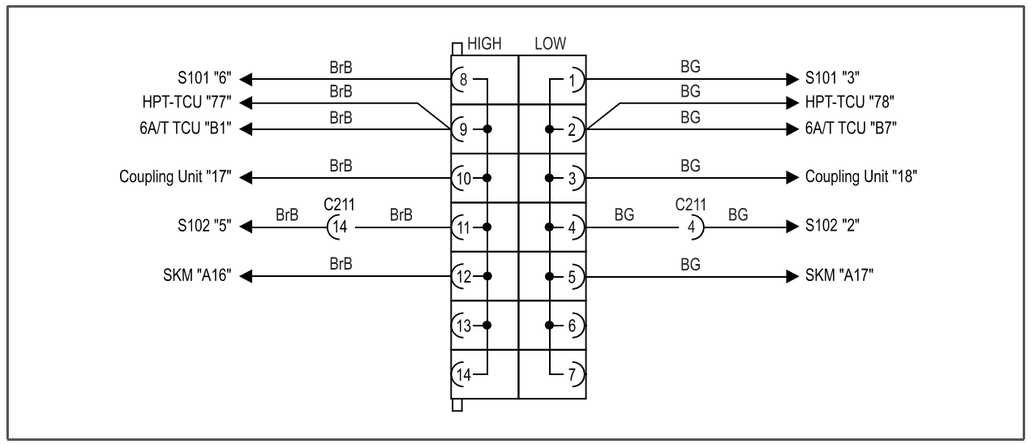
5) S203 (ILL+)



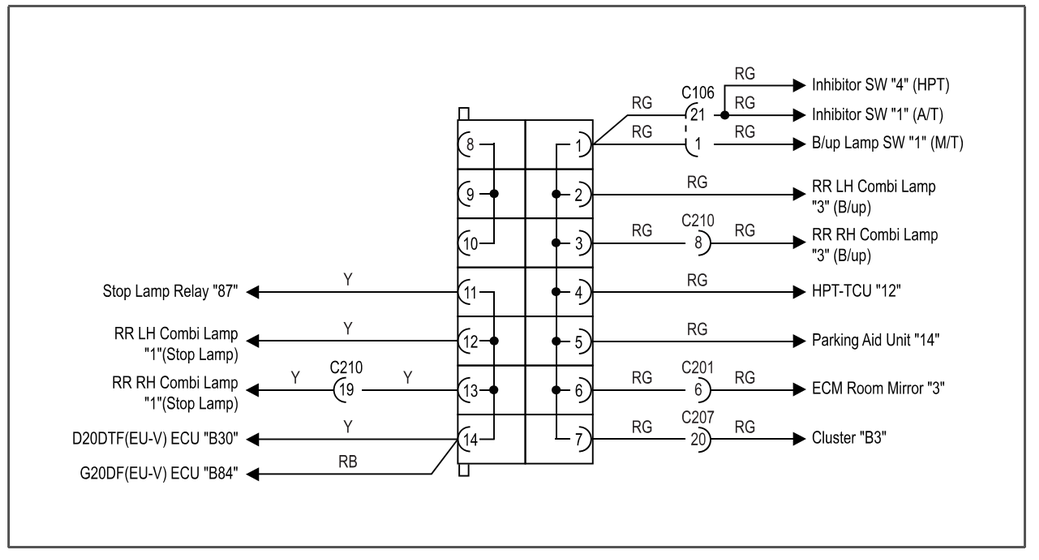
6) S204 (GND)



7) S205 (HS-CAN)

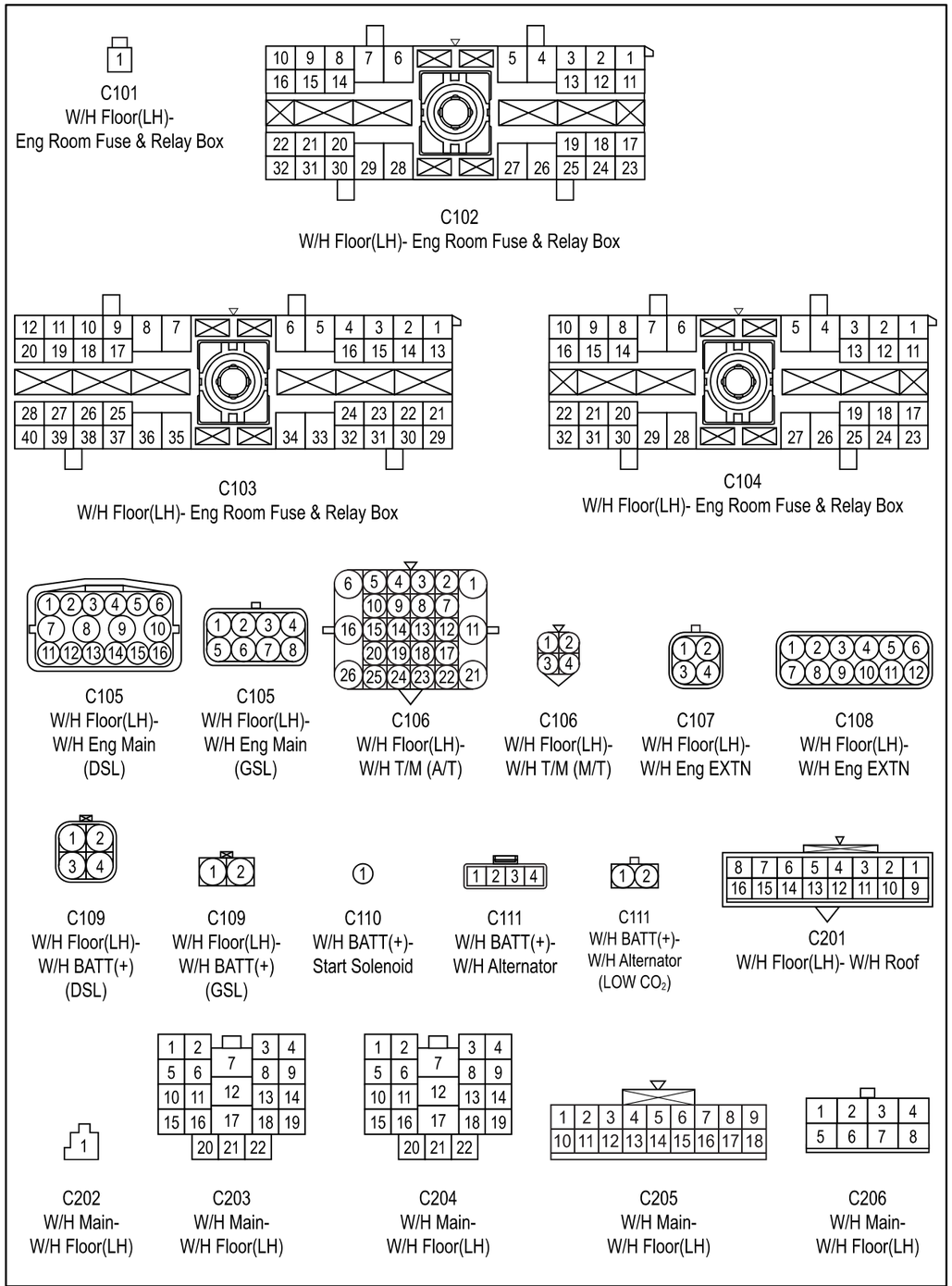


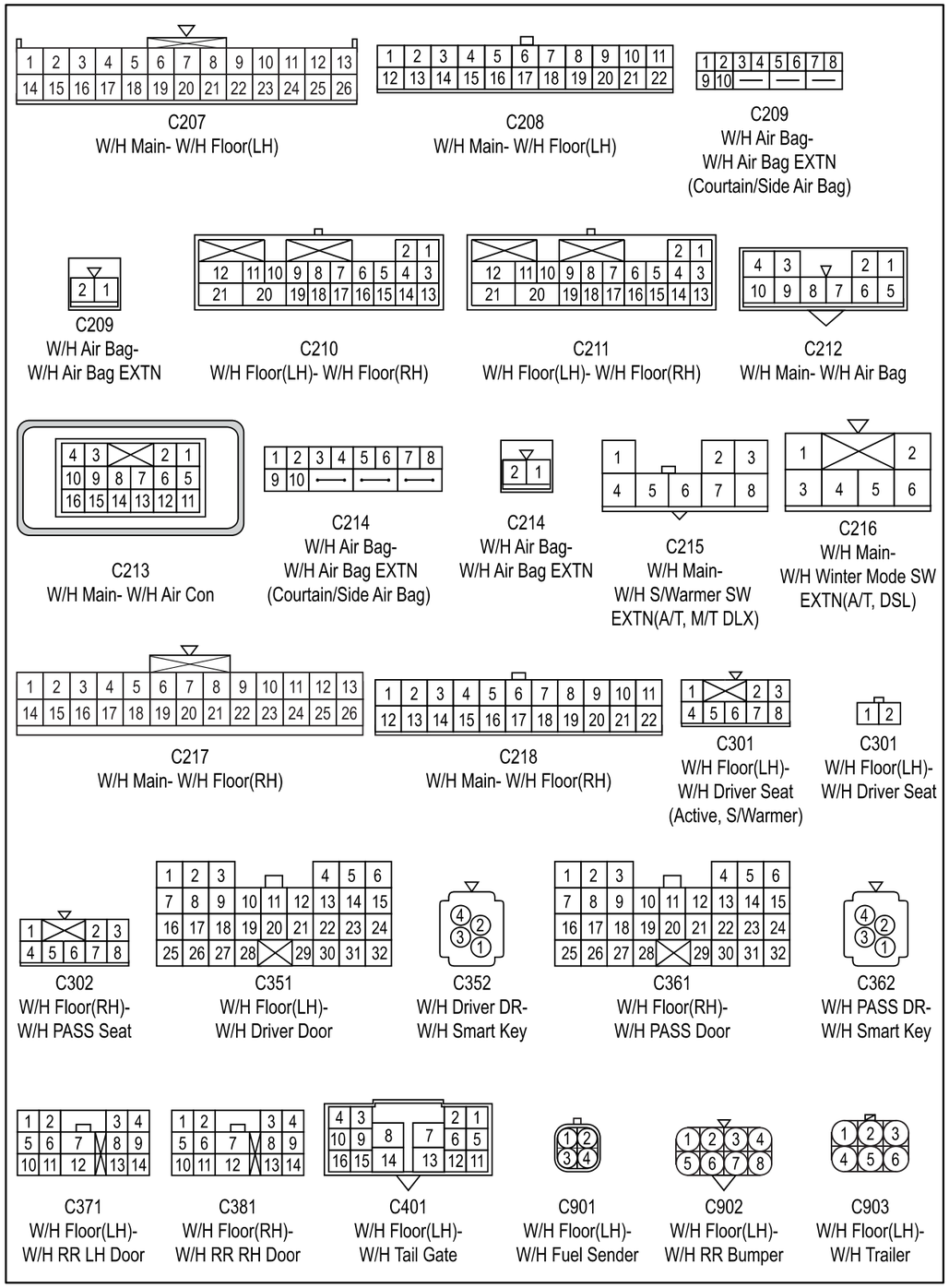
8) S301



Modification basis	
Application basis	
Affected VIN	

(3) WIRING CONNECTOR PARTS SHAPE / NUMBERING

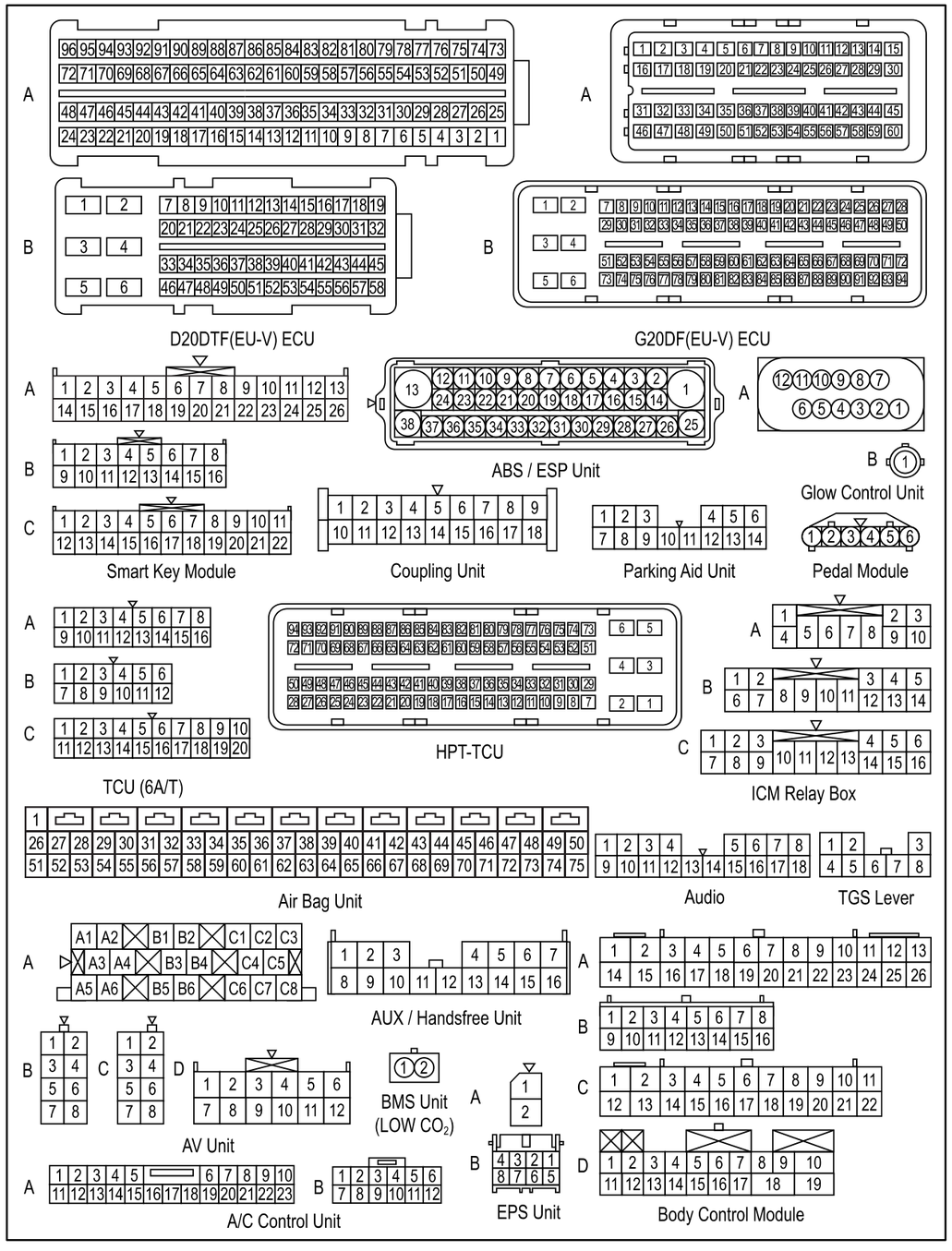




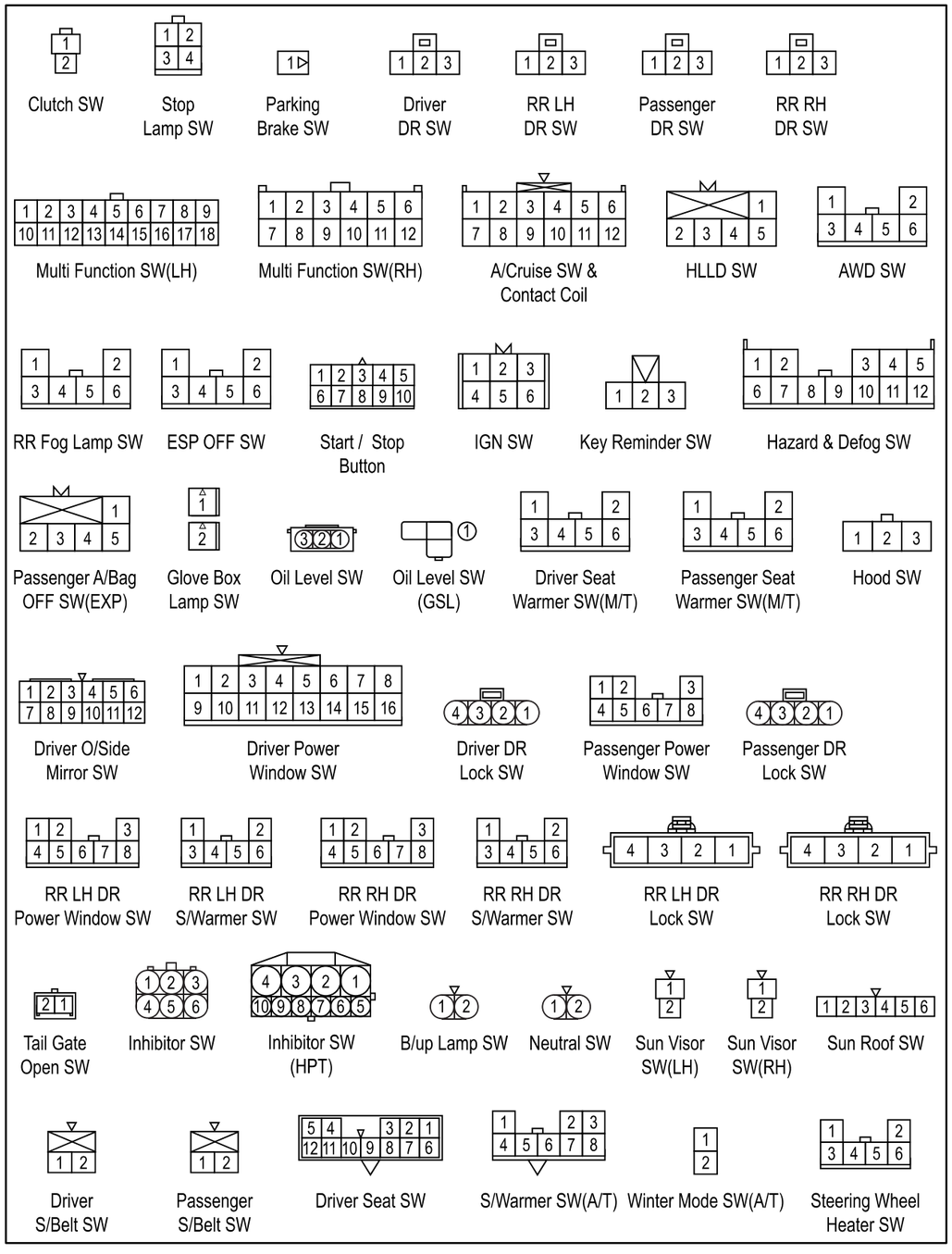
Modification basis	
Application basis	
Affected VIN	

(4) THE OTHERS PARTS SHAPE / NUMBERING

▶ UNIT PART

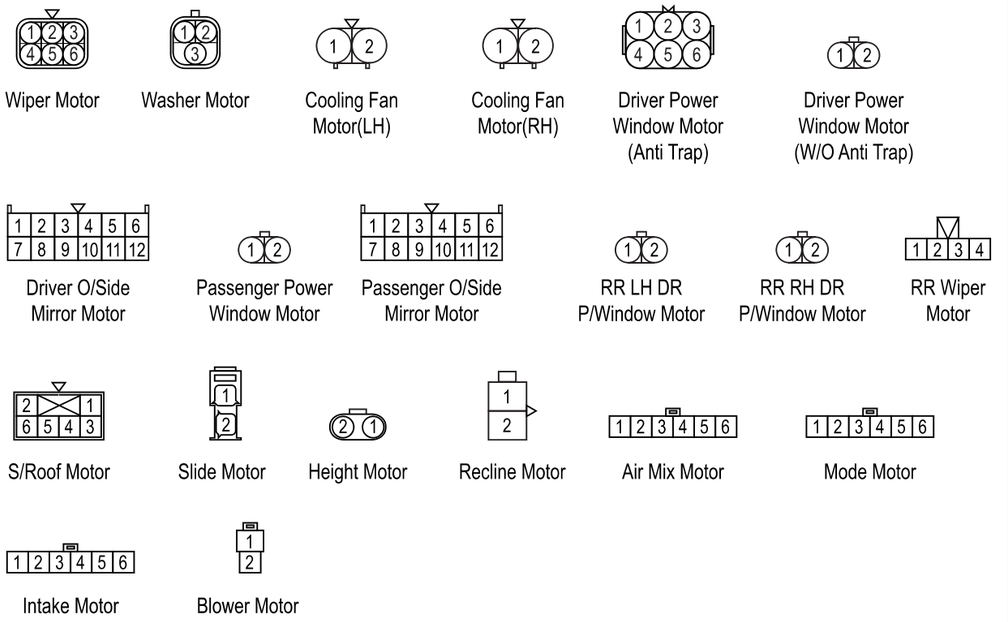


▶ SWITCH PART

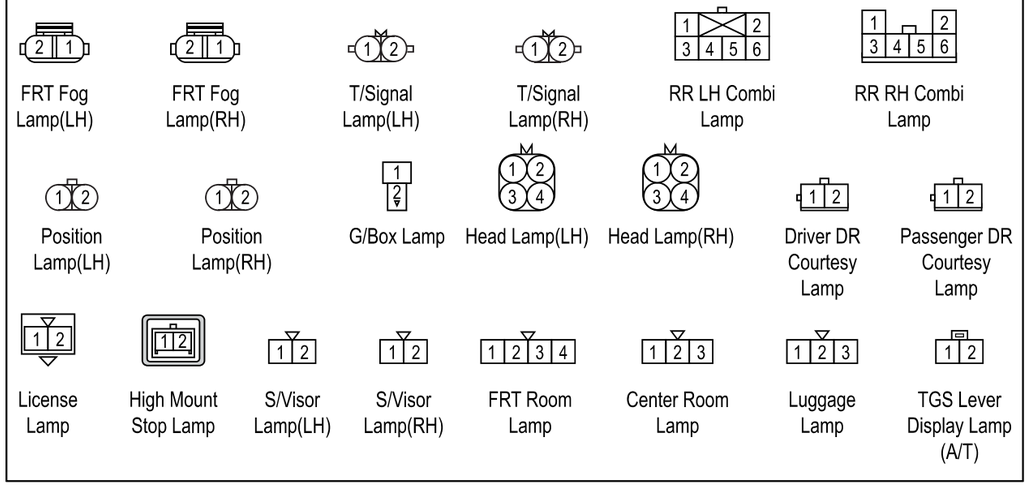


Modification basis	
Application basis	
Affected VIN	

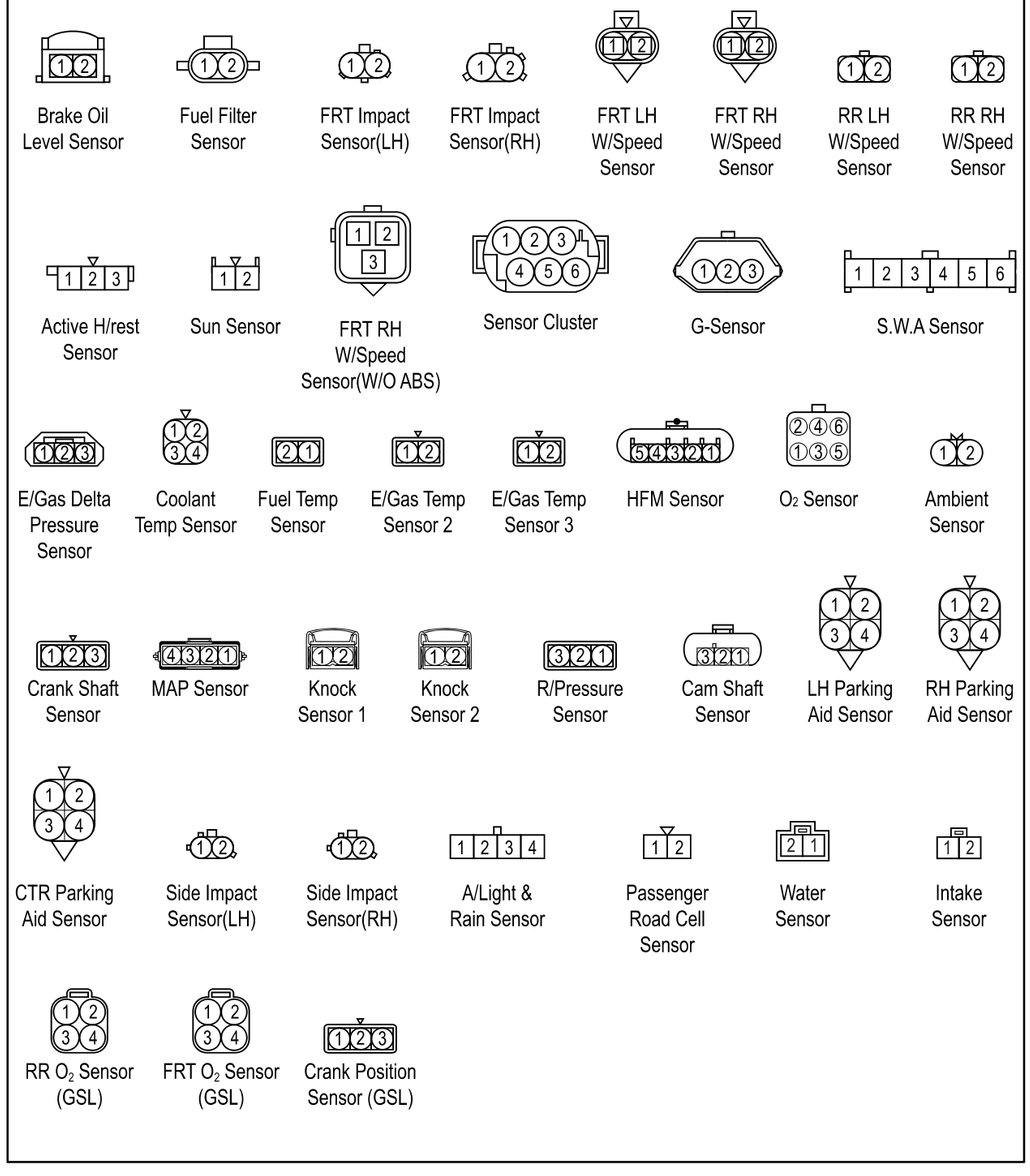
▶ MOTOR PART



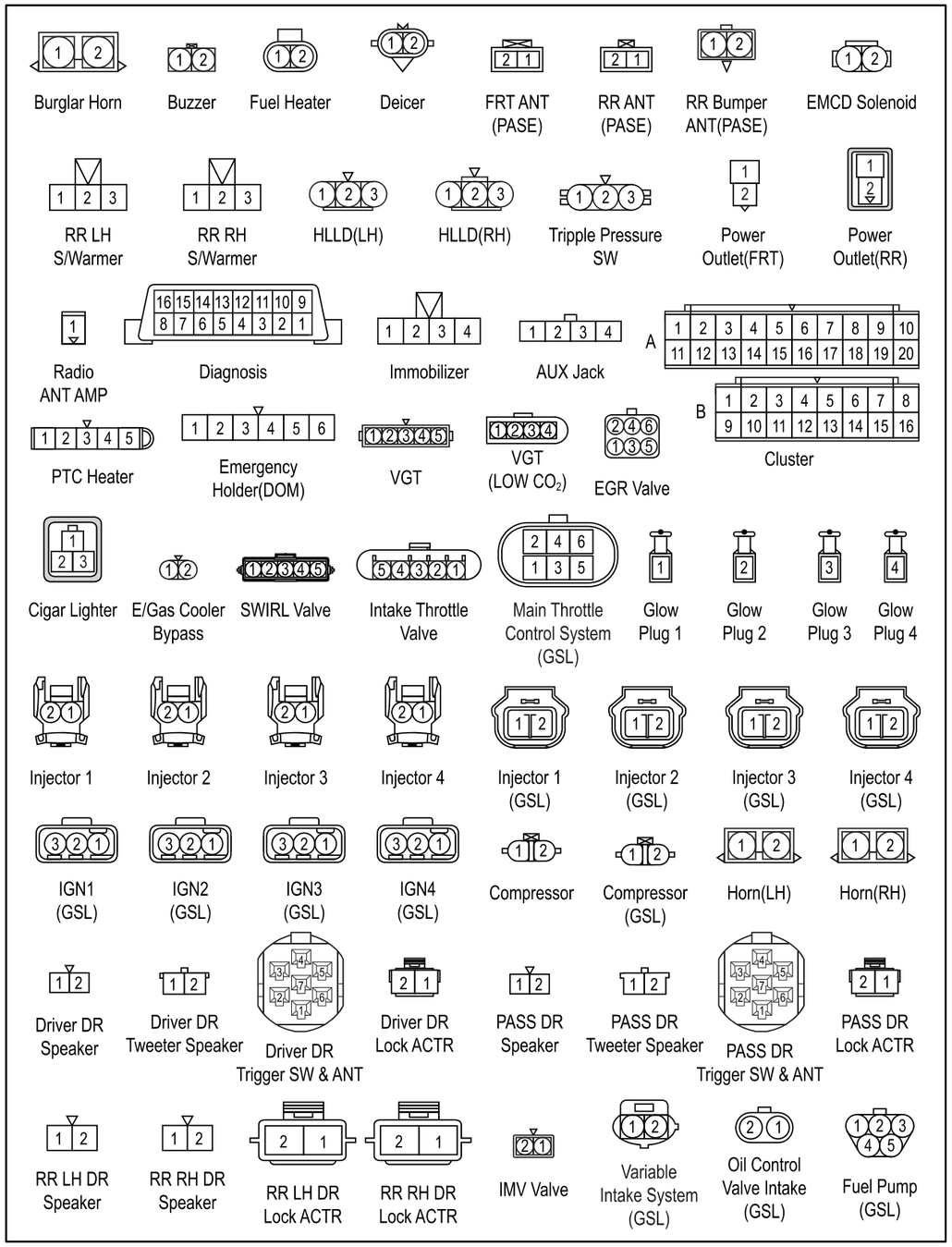
▶ LAMP PART

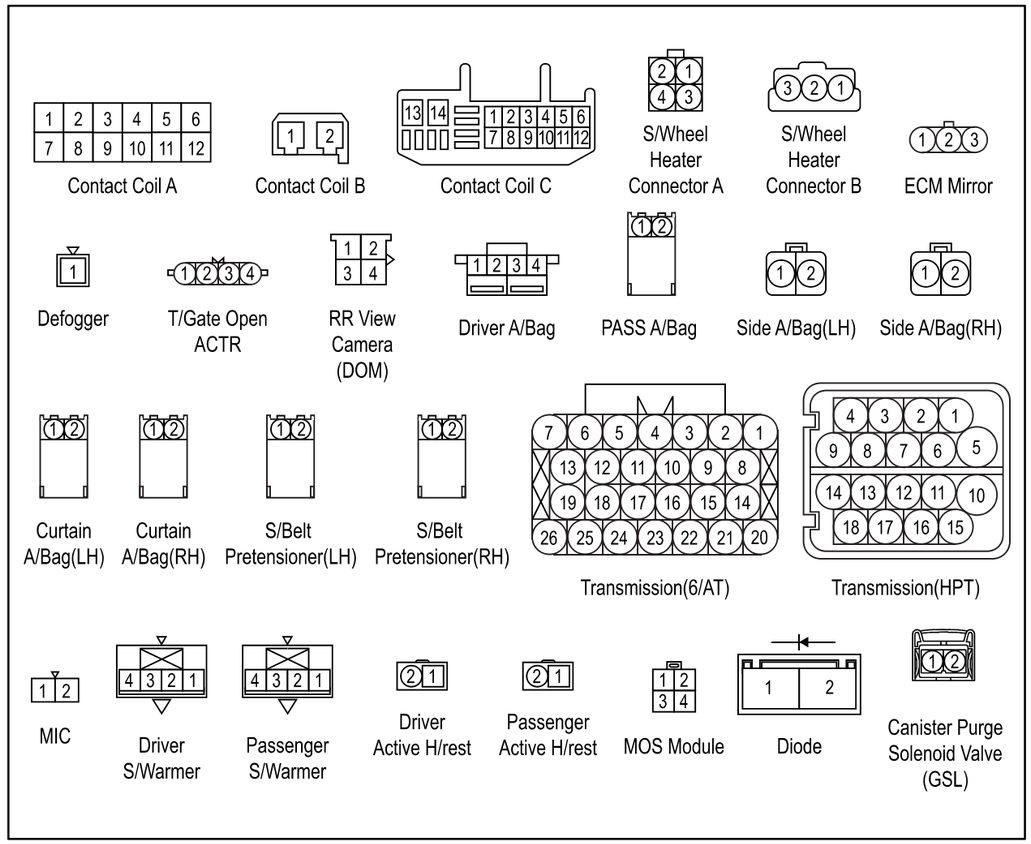


▶ SENSOR PART



▶ THE OTHER PART



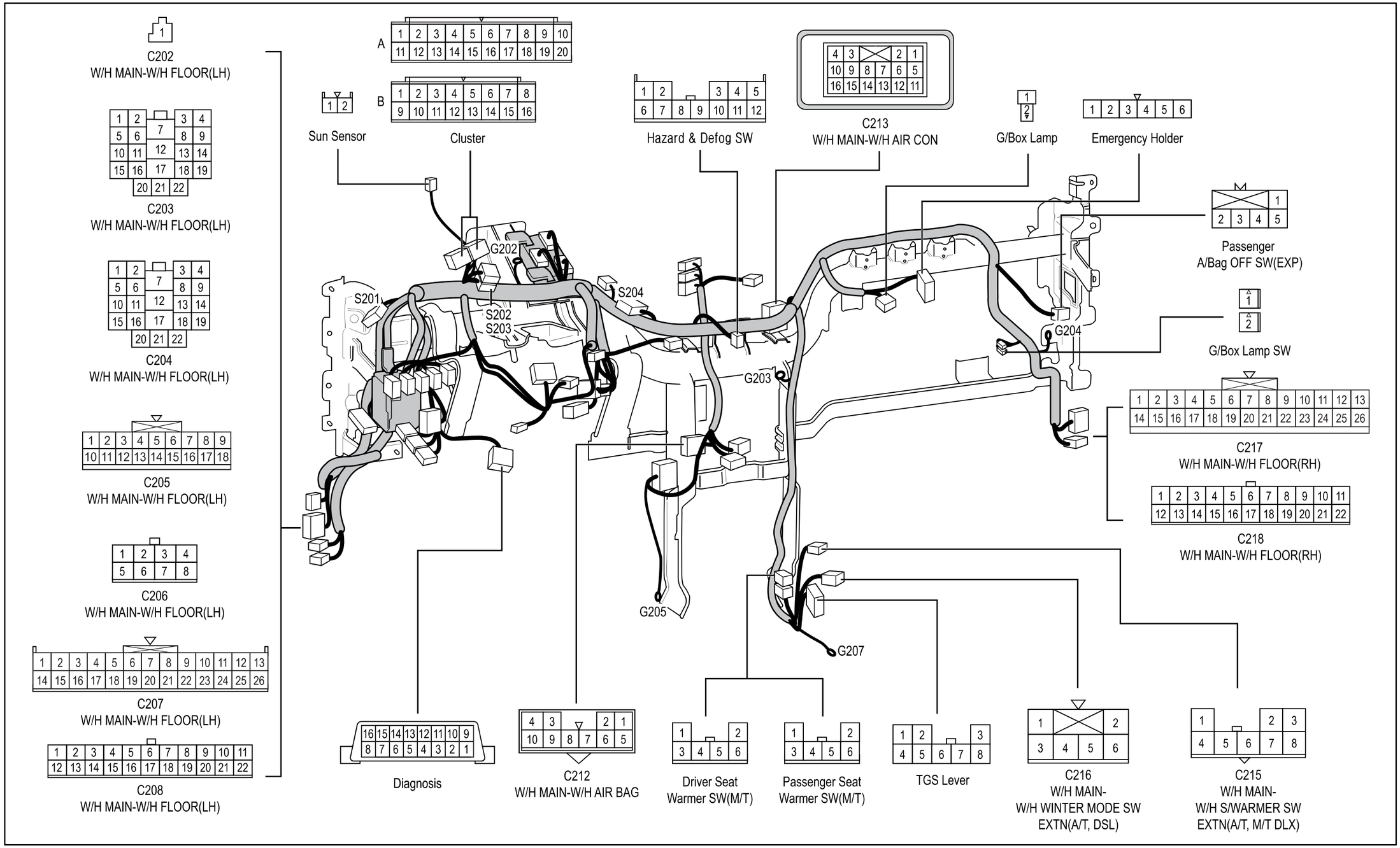


Modification basis	
Application basis	
Affected VIN	

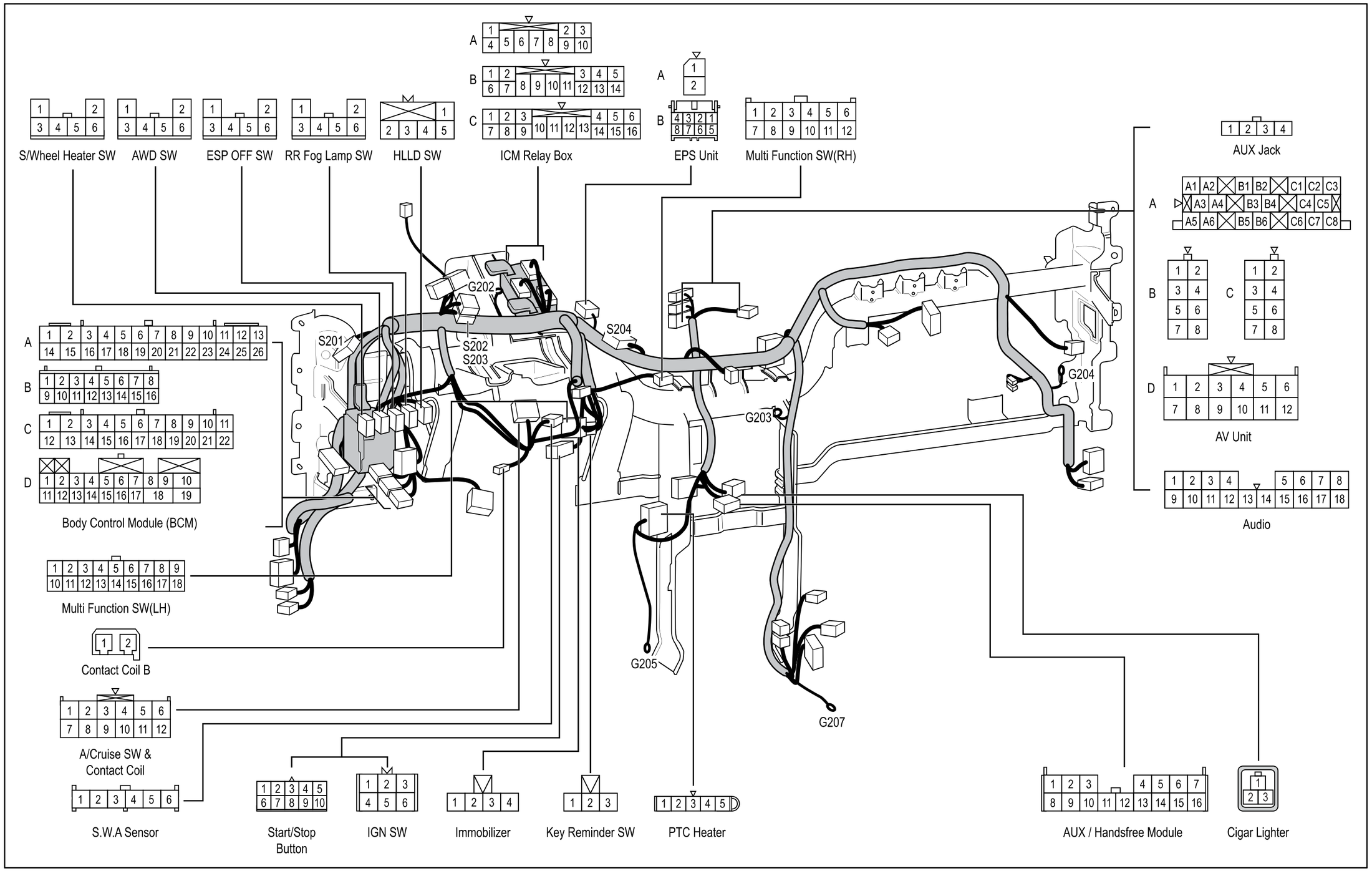
CONNECTOR/GROUND

S.G.N. 8210-01

W/H MAIN



Modification basis	
Application basis	
Affected VIN	



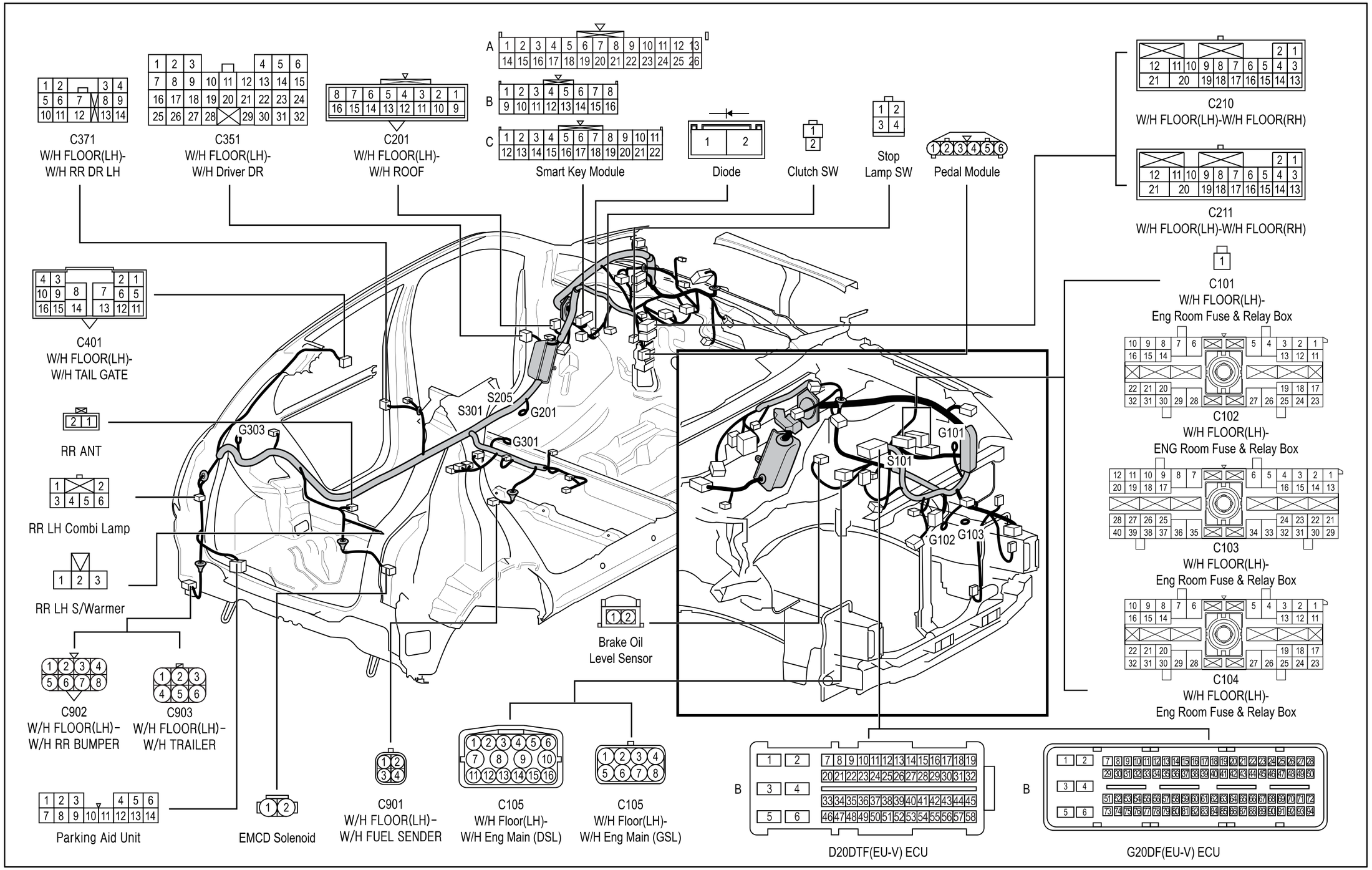
CONNECTOR/GROUND

KORANDO 2012.10

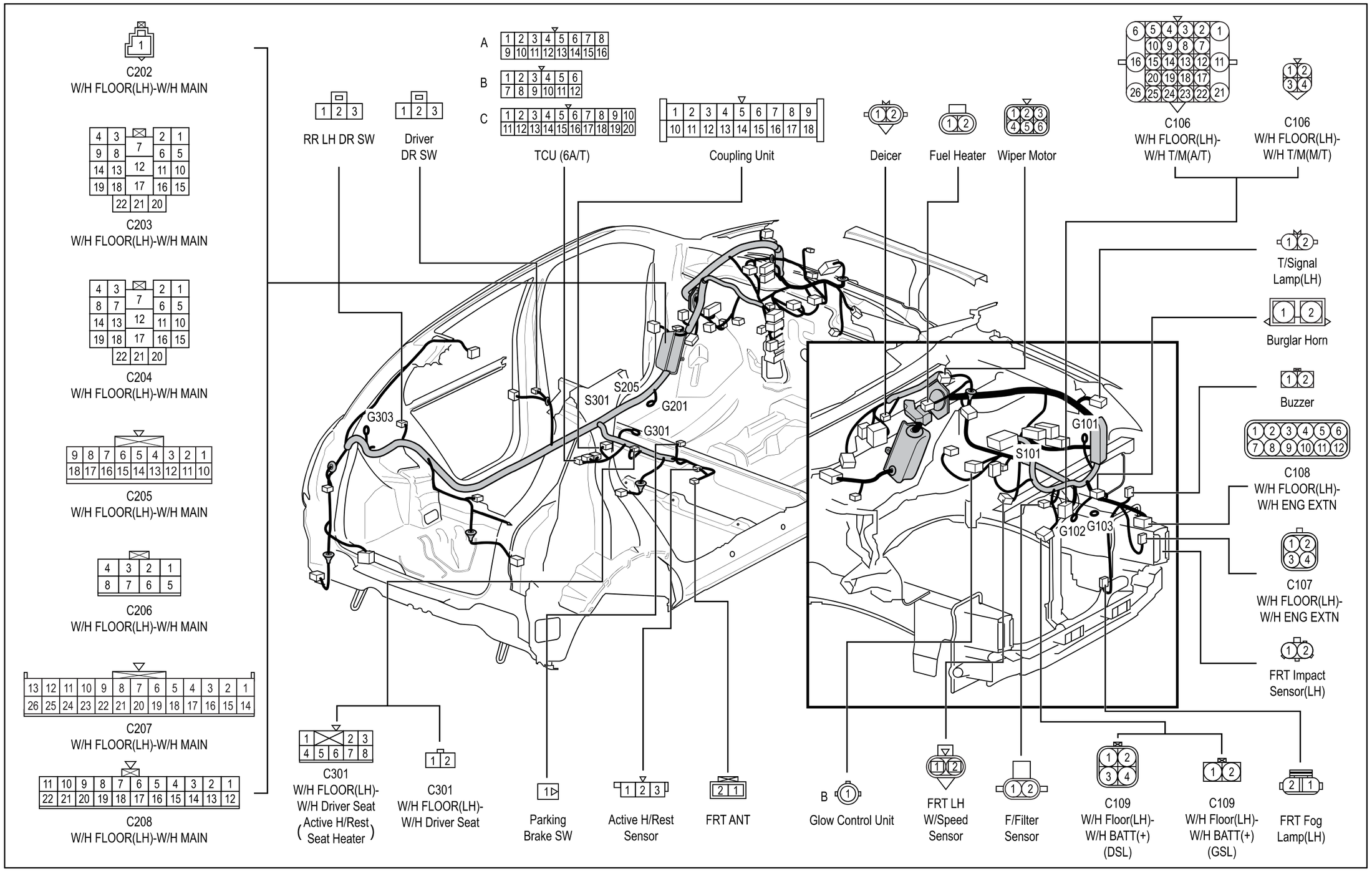
Modification basis	
Application basis	
Affected VIN	

S.G.N. 8212-01

W/H FLOOR(LH)



Modification basis	
Application basis	
Affected VIN	

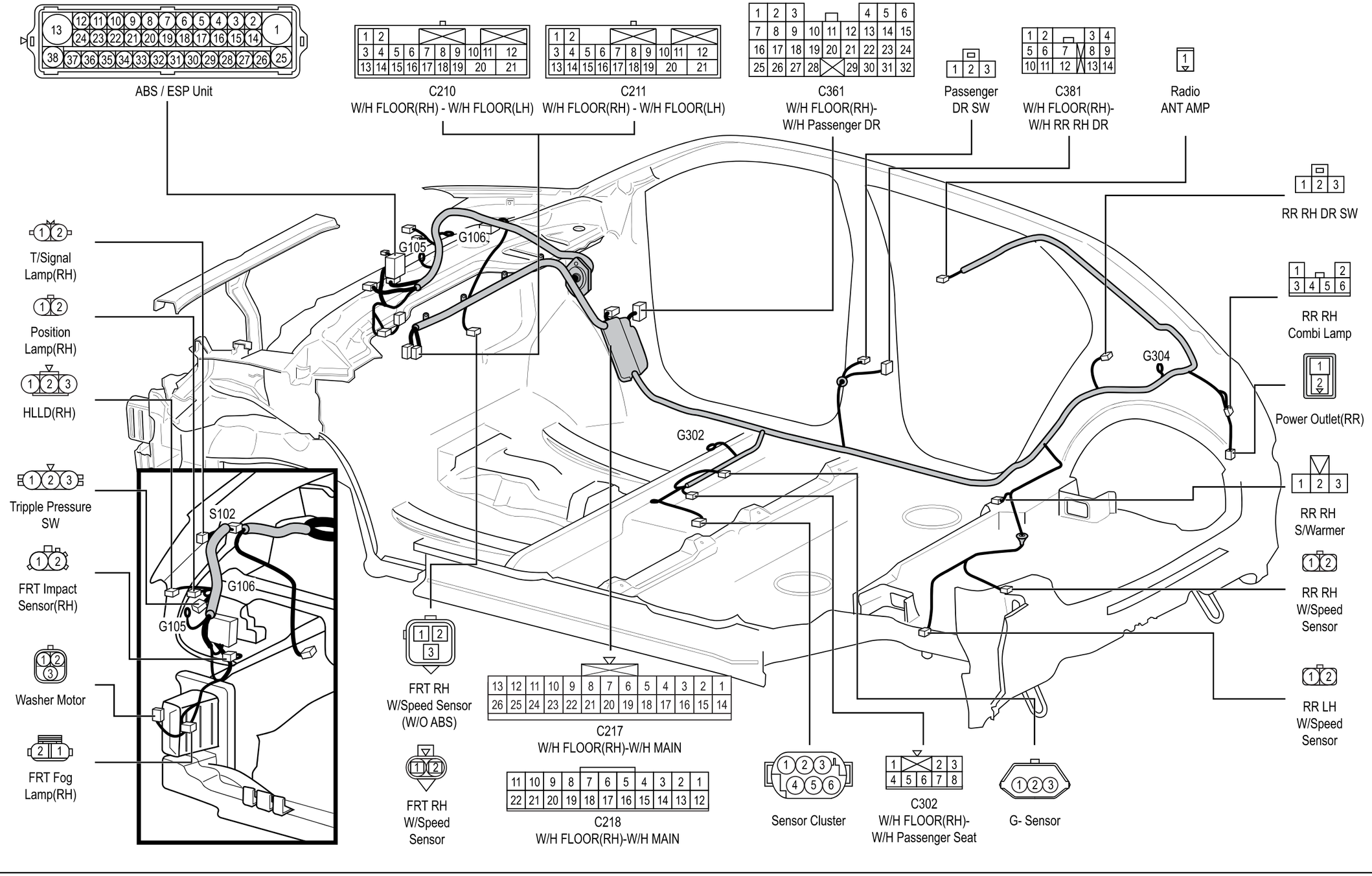


CONNECTOR/GROUND

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N.
8212-02 W/H FLOOR(RH)

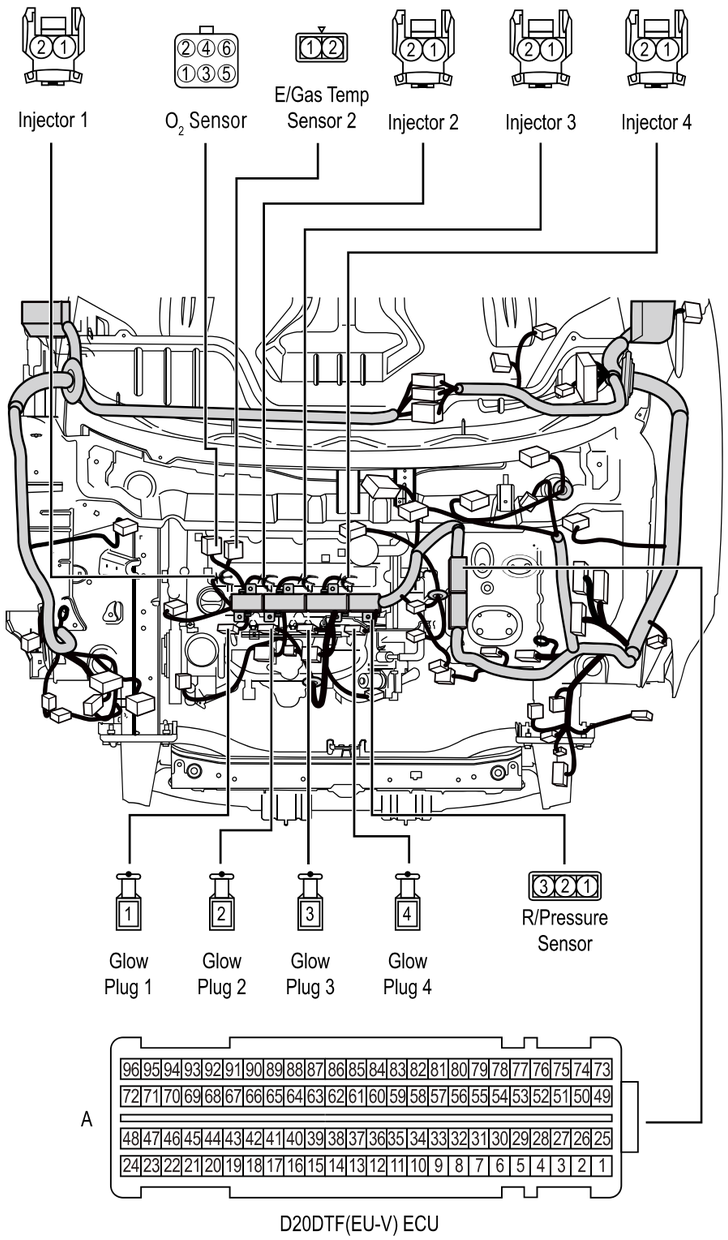


Modification basis	
Application basis	
Affected VIN	

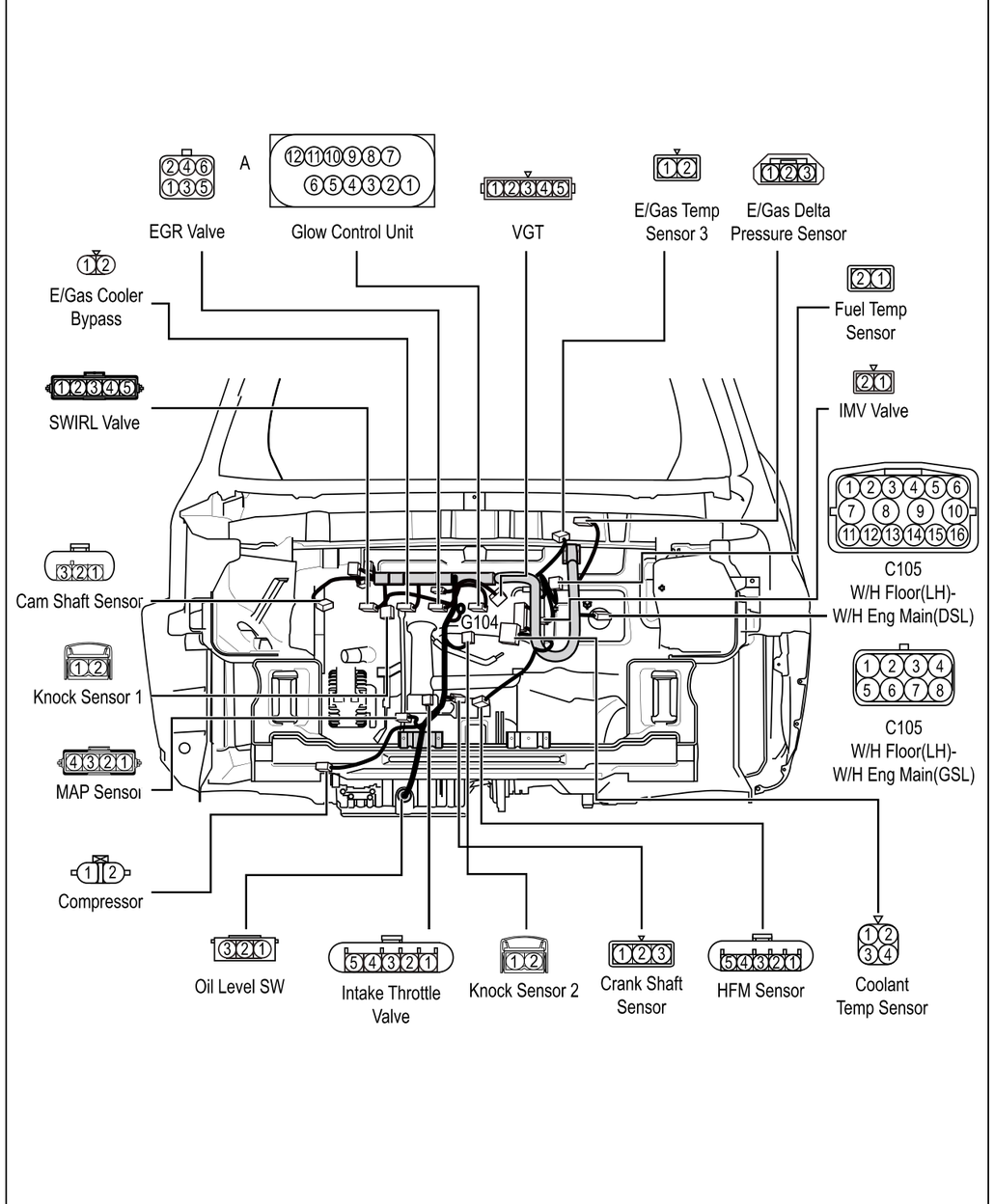
S.G.N. 1413-02

W/H ENGINE MAIN(DSL)

▶ TOP VIEW



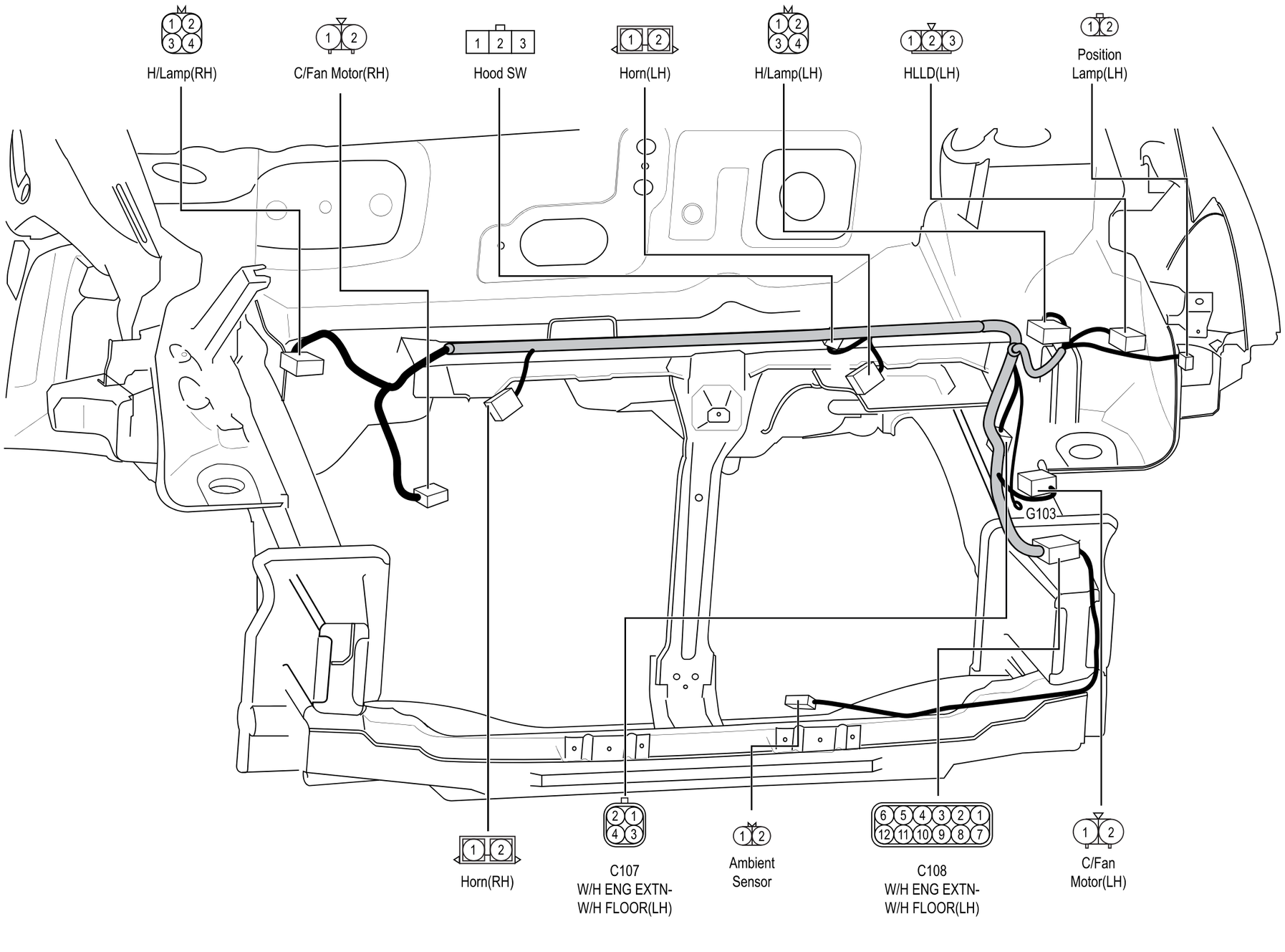
▶ FRONT VIEW



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8211-01

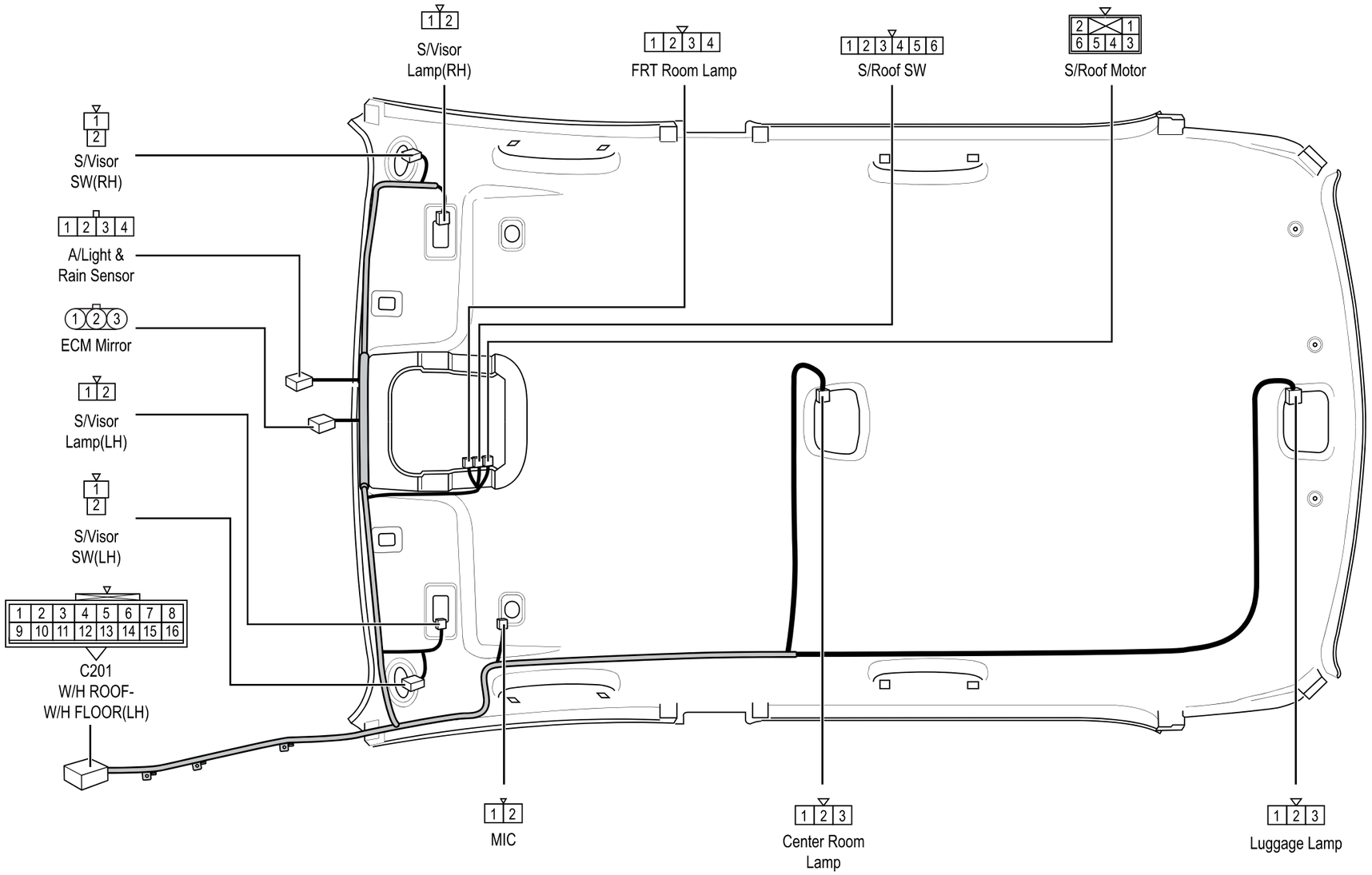
W/H ENGINE EXTN



Modification basis	
Application basis	
Affected VIN	

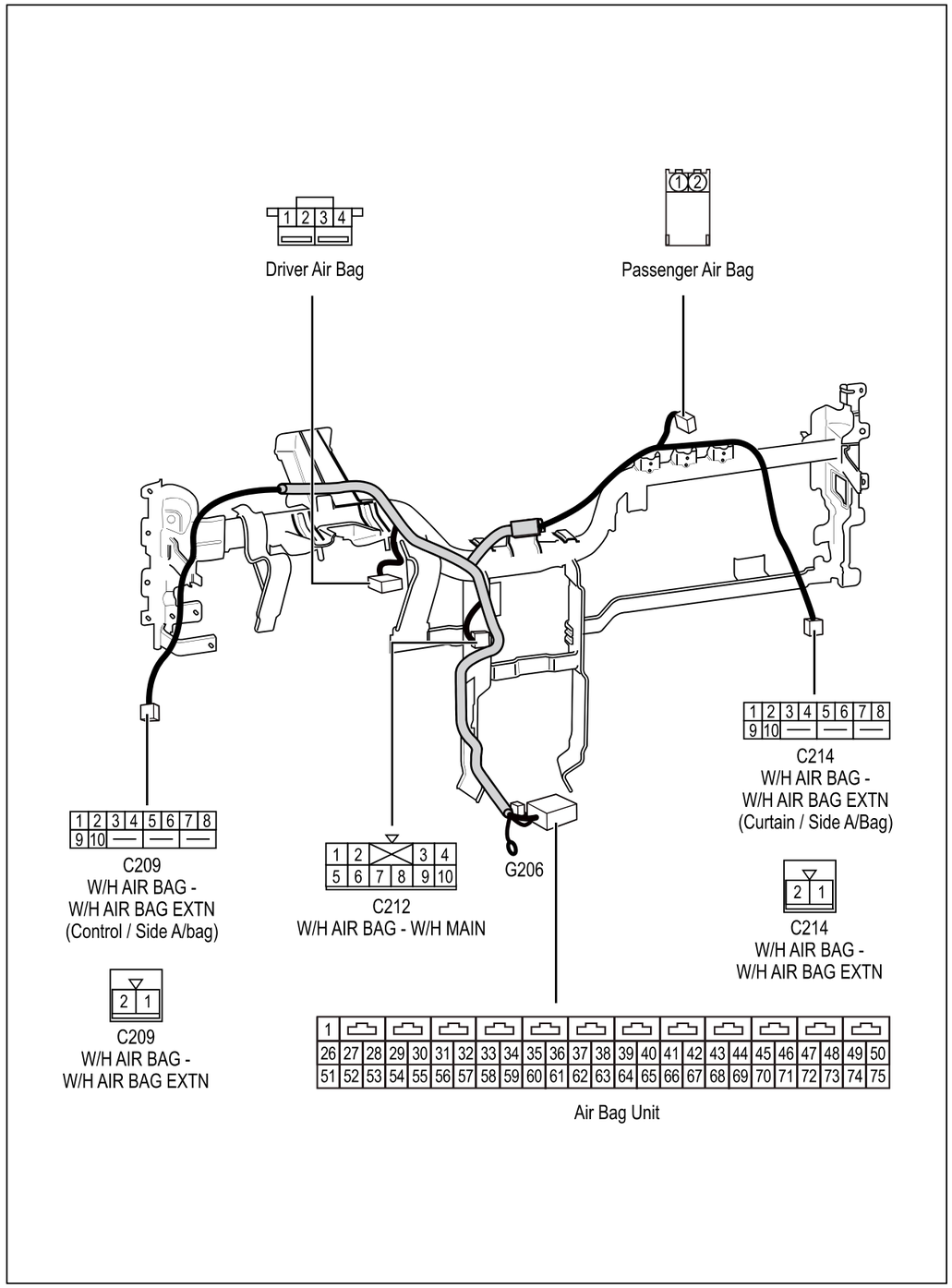
S.G.N. 8213-09

W/H ROOF

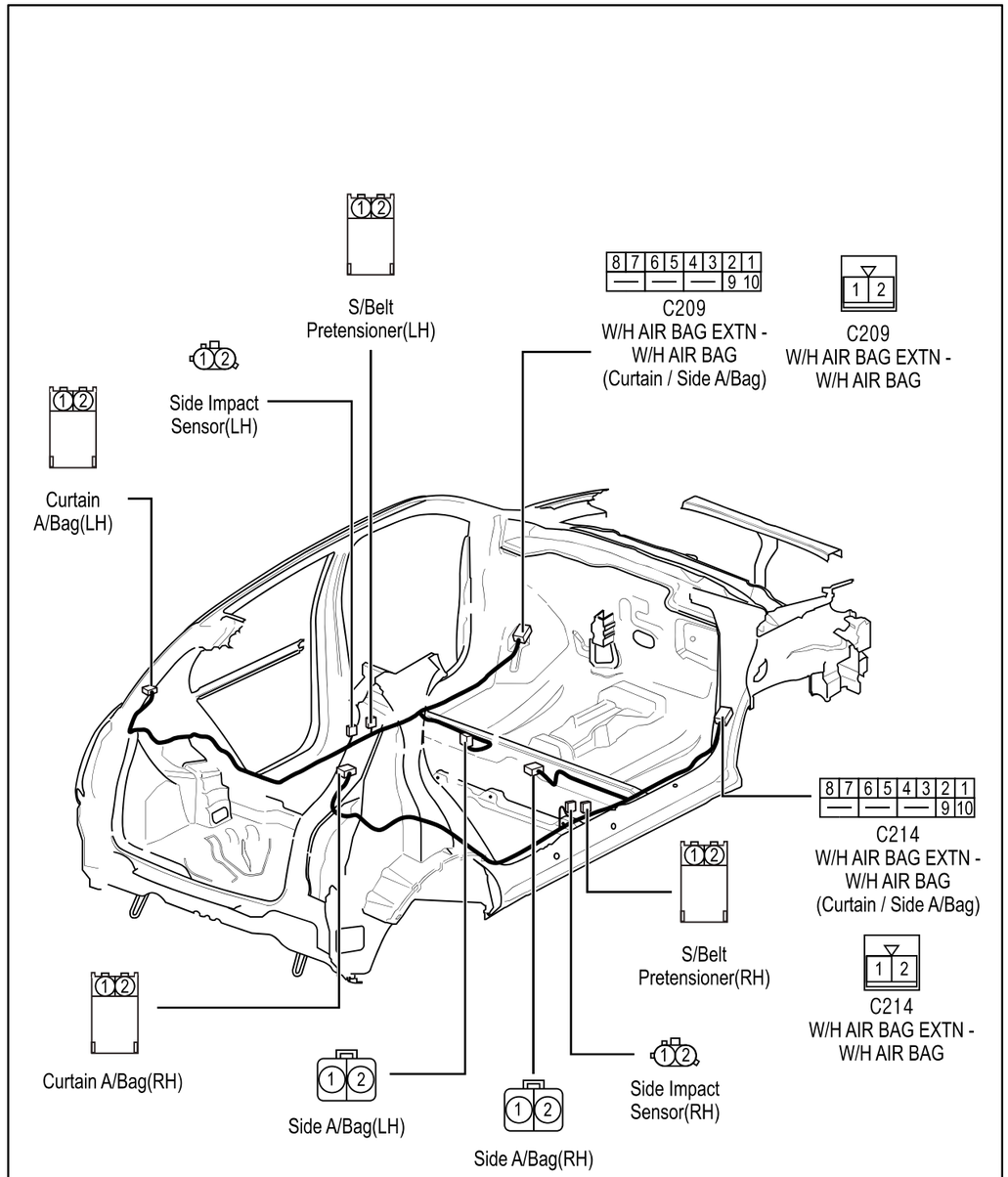


Modification basis	
Application basis	
Affected VIN	

S.G.N. 8810-22 W/H AIR BAG

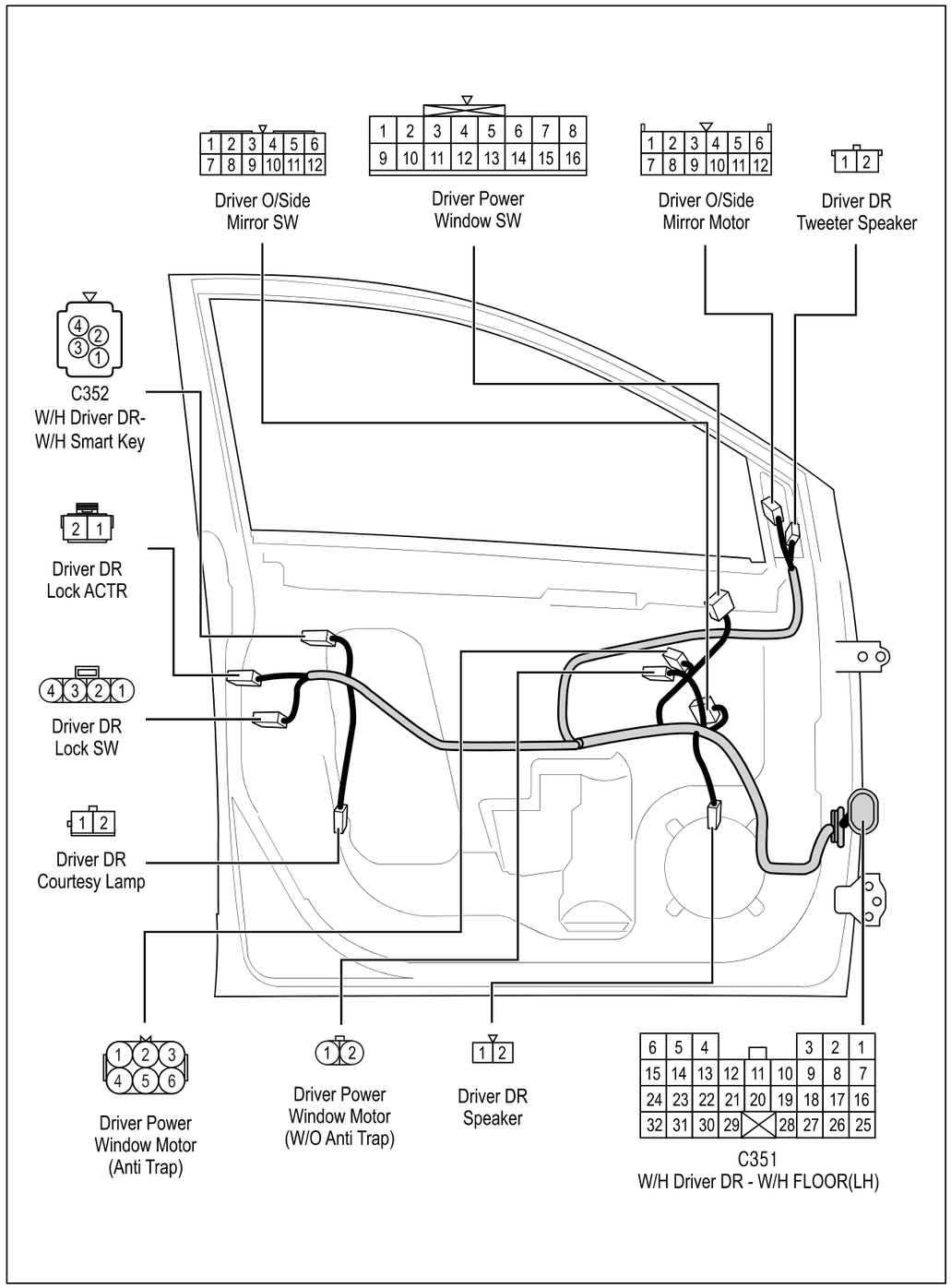


S.G.N. 8810-23 W/H AIR BAG EXTN

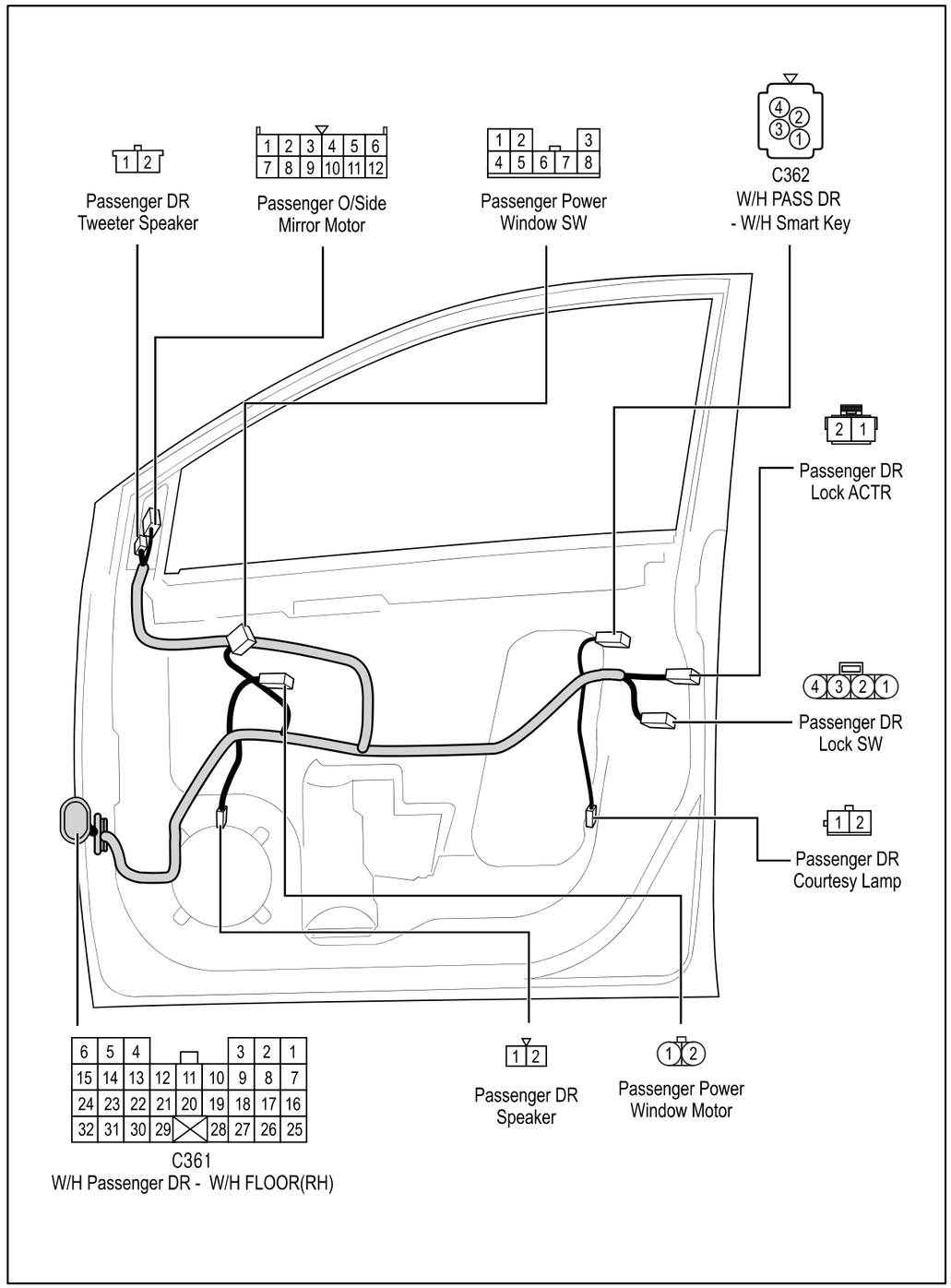


Modification basis	
Application basis	
Affected VIN	

S.G.N. 8213-03 W/H DRIVER DOOR



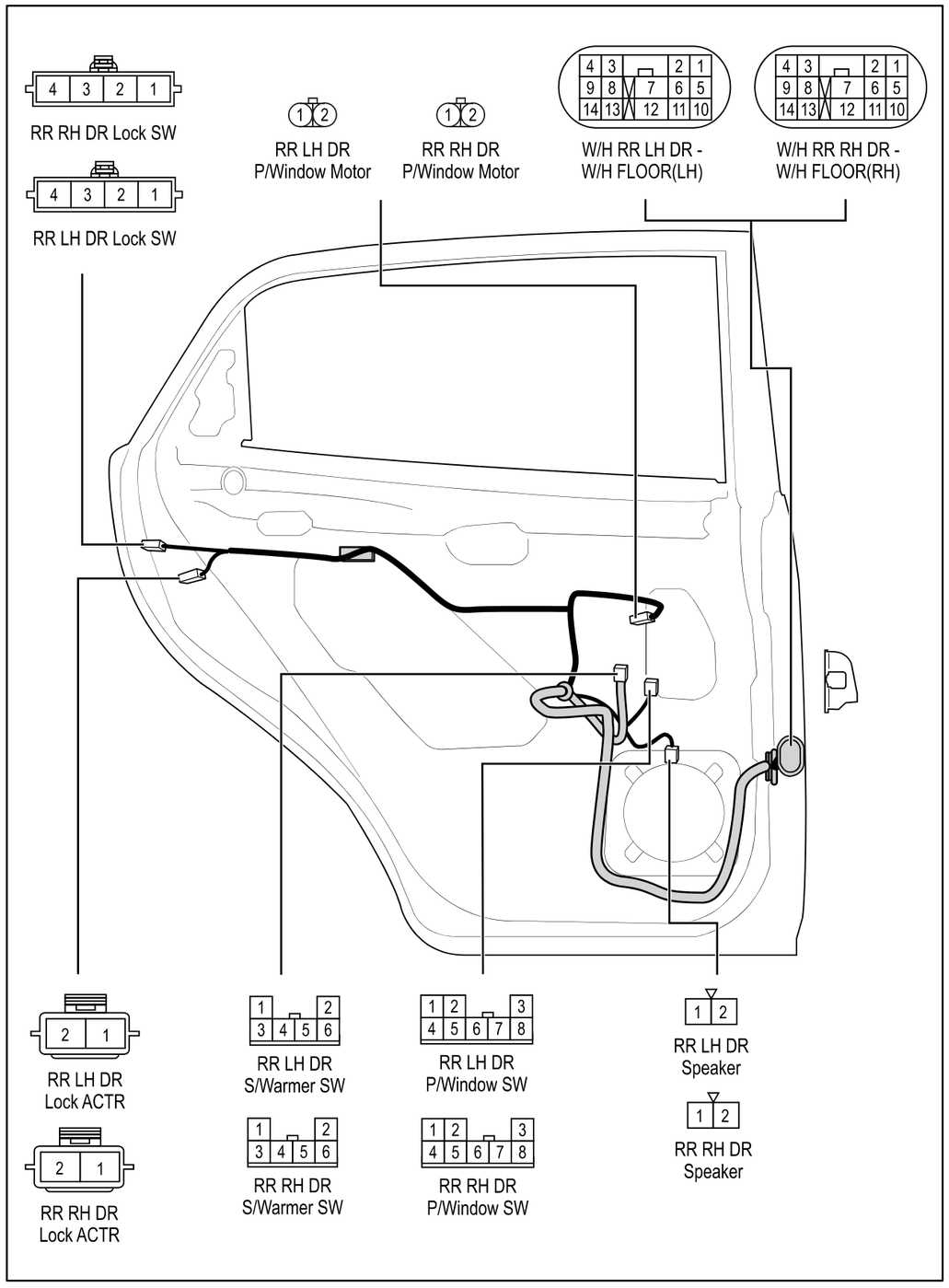
S.G.N. 8213-04 W/H PASSENGER DOOR



Modification basis	
Application basis	
Affected VIN	

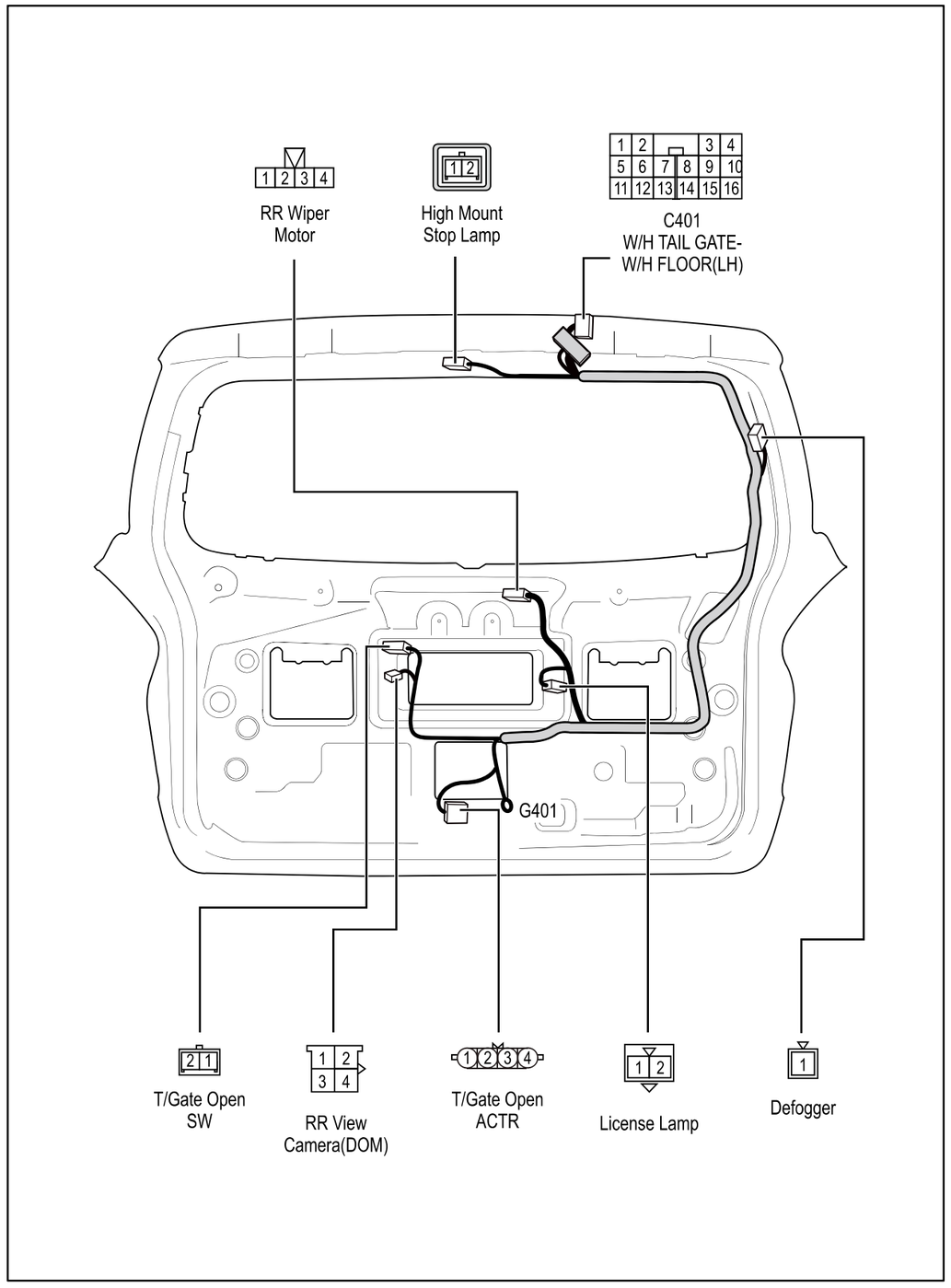
S.G.N. 8213-06

W/H REAR DOOR



S.G.N. 8213-10

W/H TAIL GATE



INDEX

FUSE

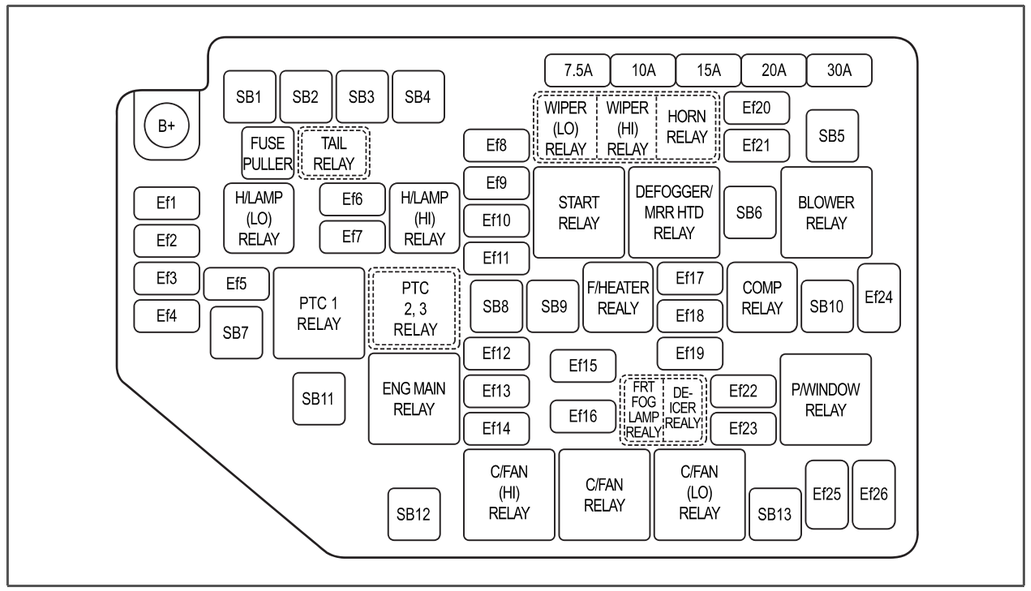
8210-00 ENGINE ROOM FUSE / RELAY BOX..... 2
8410-04 INDOOR FUSE BOX..... 9
8410-05 ICM RELAY BOX..... 14

FUSE

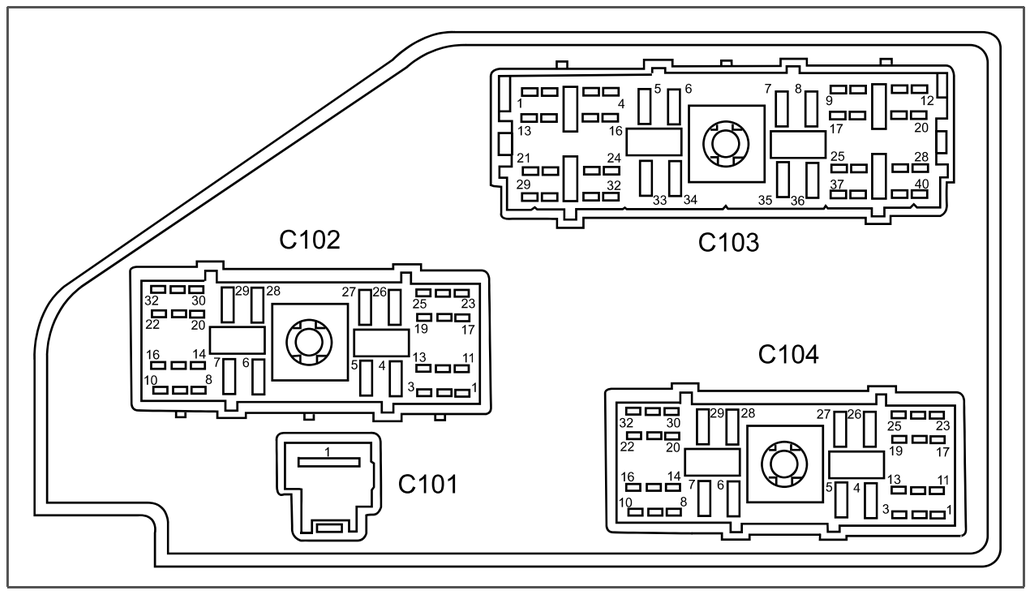
S.G.N. 8210-00

ENGINE ROOM FUSE / RELAY BOX

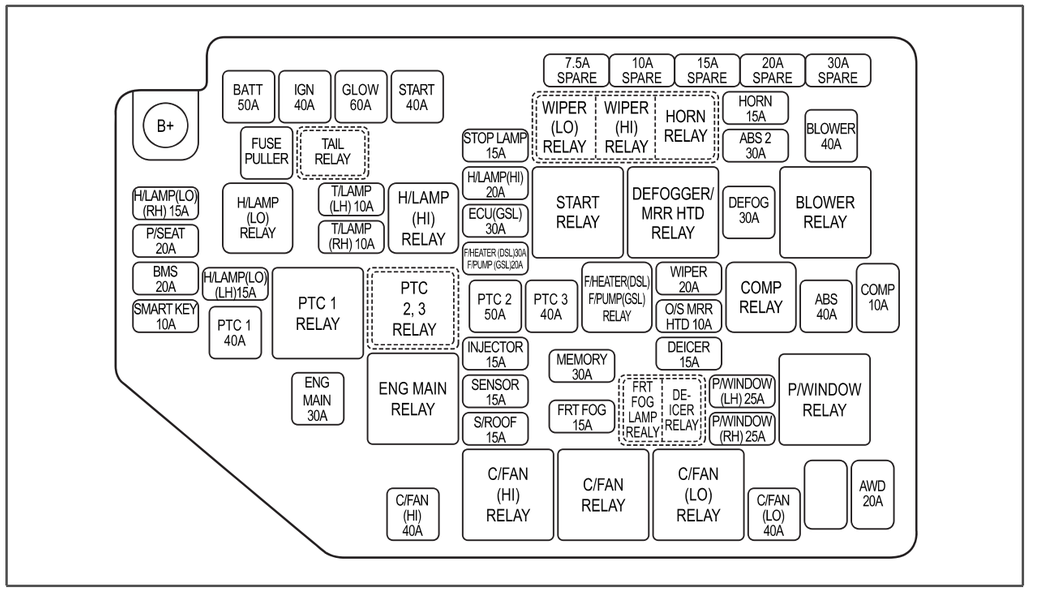
(1) ENGINE ROOM FUSE / RELAY BOX -TOP VIEW



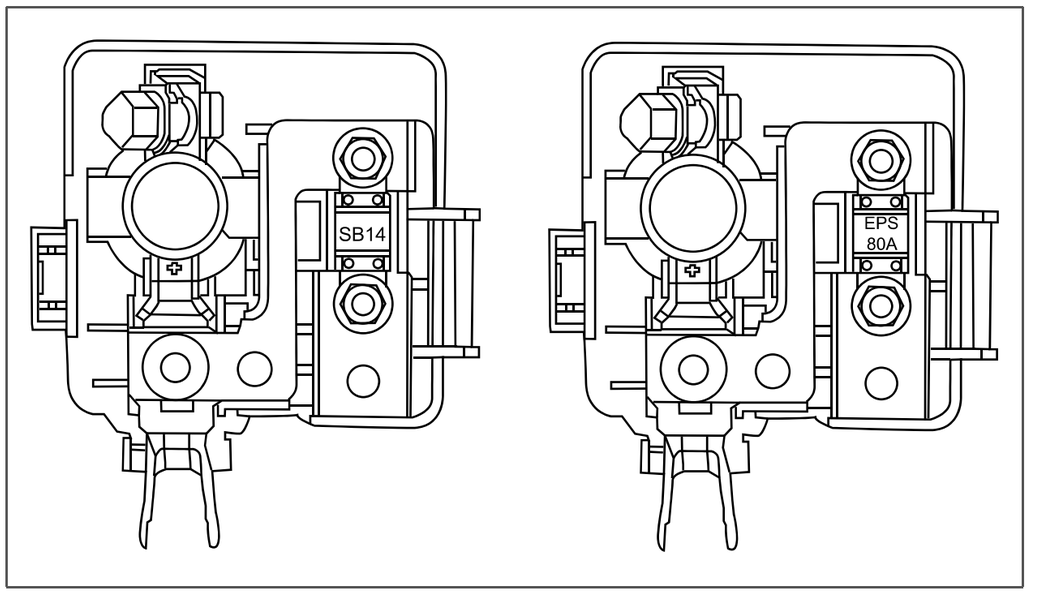
(2) ENG ROOM FUSE / RELAY BOX -UNDER VIEW



(3) ENGINE ROOM FUSE / RELAY BOX LOCATION



(4) BATTERY FUSE BOX LOCATION



Modification basis	
Application basis	
Affected VIN	

(5) USAGE OF FUSE IN ENGINE ROOM FUSE BOX

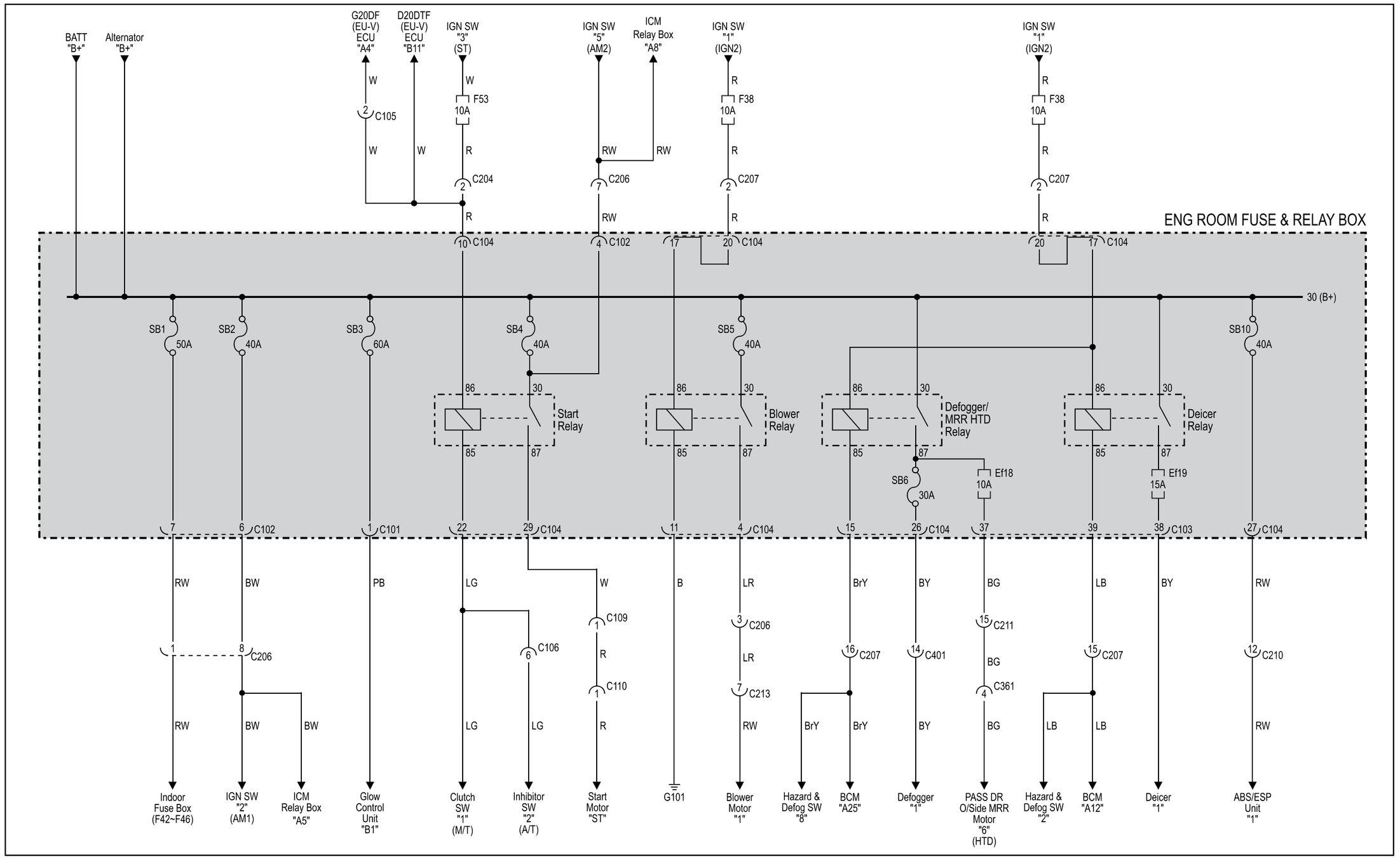
Fuse NO.	Capacity	Usage	Fuse NO.	Capacity	Usage
SB1	50A	BATT	Ef7	10A	Tail Lamp(RH)
SB2	40A	IGN SW	Ef8	15A	Stop Lamp
SB3	60A	Glow	Ef9	20A	Head Lamp(HI)
SB4	40A	Start	Ef10	15A	ECU(GSL)
SB5	40A	Blower	Ef11	30A/20A	Fuel Heater(DSL)/Fuel Pump(GSL)
SB6	30A	Defogger	Ef12	15A	Injector
SB7	40A	PTC 1	Ef13	15A	Sensor
SB8	50A	PTC 2	Ef14	15A	Sun Roof
SB9	40A	PTC 3	Ef15	30A	Memory
SB10	40A	ABS	Ef16	15A	FRT Fog Lamp
SB11	30A	ENG Main	Ef17	20A	Wiper
SB12	40A	Cooling Fan(HI)	Ef18	10A	O/Side Mirror HTD
SB13	40A	Cooling Fan(LO)	Ef19	15A	Deicer
SB14	80A	EPS	Ef20	15A	Horn
Ef1	15A	Head Lamp LO(RH)	Ef21	30A	ABS 2
Ef2	20A	Power Seat	Ef22	25A	Power Window(LH)
Ef3	20A	BMS Unit(LOW CO_2)/HPT-TCU	Ef23	25A	Power Window(RH)
Ef4	10A	Smart Key/HPT-TCU	Ef24	10A	Compressor
Ef5	15A	Head Lamp LO(LH)	Ef25	-	-
Ef6	10A	Tail Lamp(LH)	Ef26	20A	AWD

(6) ENGINE ROOM FUSE BOX CONNECTOR NUMBER

Connector NO.	Pin NO.	Connector Color
C101	1	Black
C102	32	Black
C103	40	Gray
C104	32	Brown

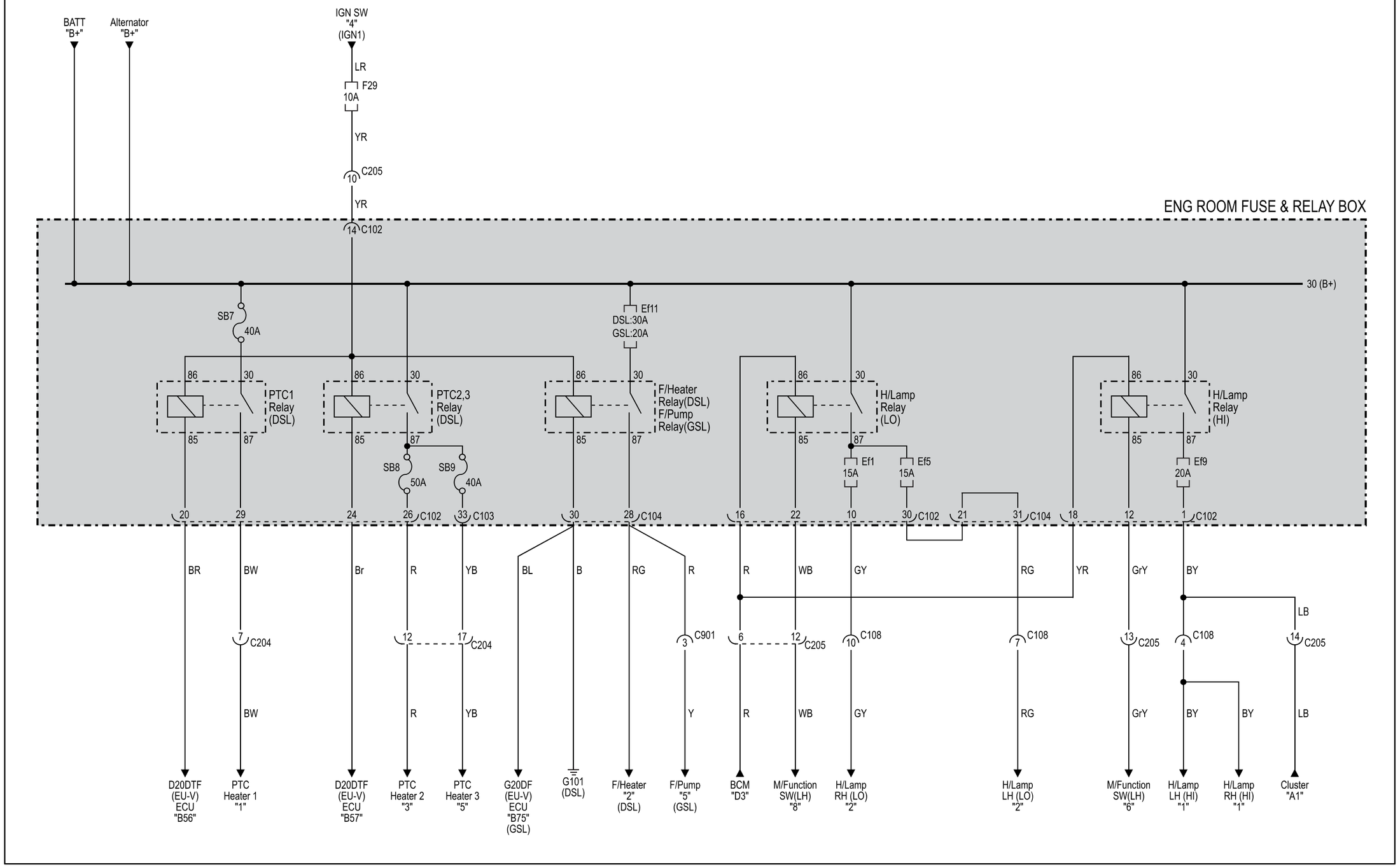
(7) ENGINE ROOM FUSE / RELAY BOX CIRCUIT

▶ **SB1~SB6, SB10, Ef18~Ef19, START RELAY, BLOWER RELAY, DEFOGGER RELAY, DEICER RELAY**



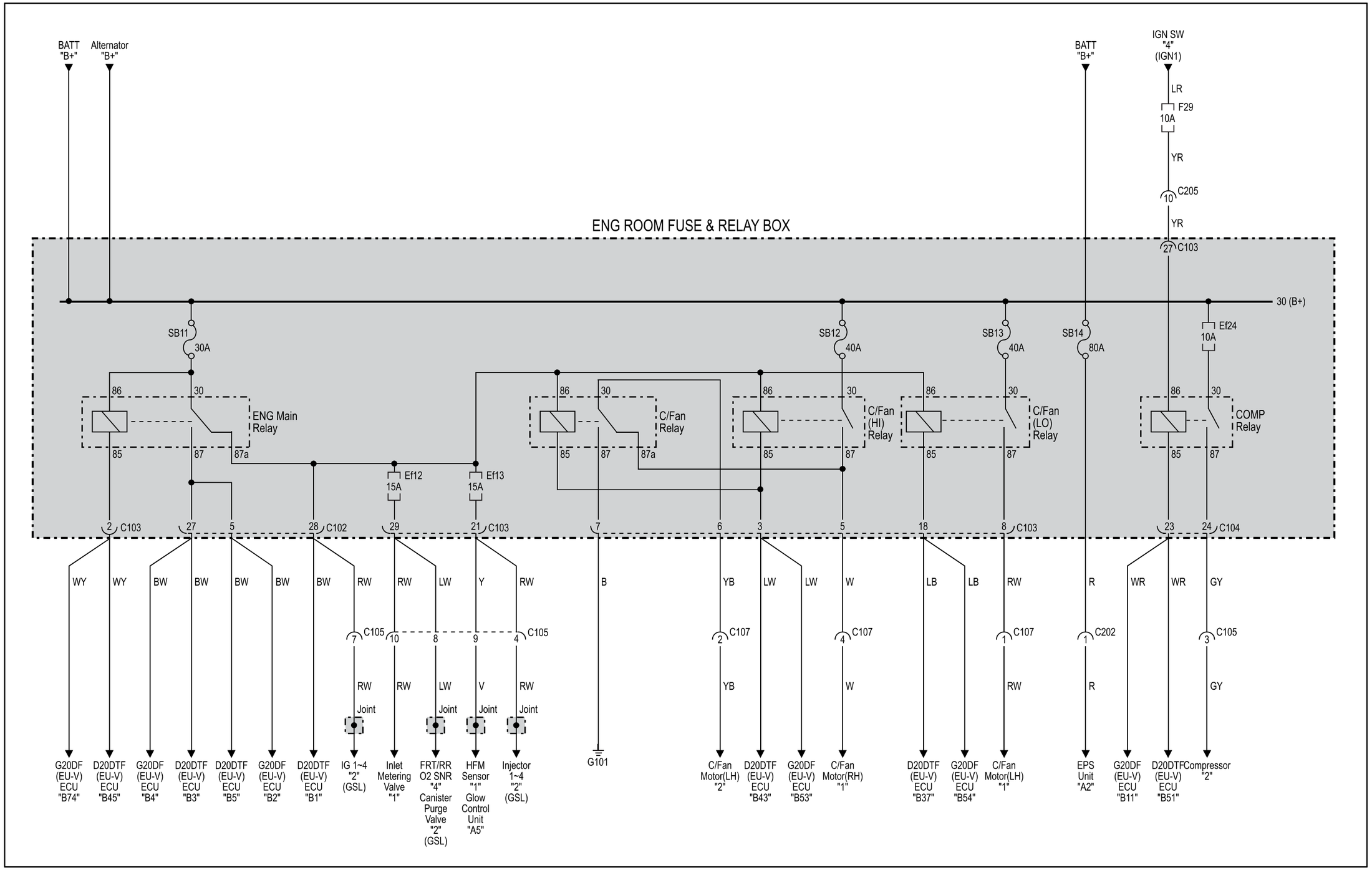
Modification basis	
Application basis	
Affected VIN	

▶ SB7~SB9, Ef1, Ef5, Ef9, Ef11, PTC RELAY, FUEL HEATER RELAY, HEAD LAMP RELAY(HI, LO)



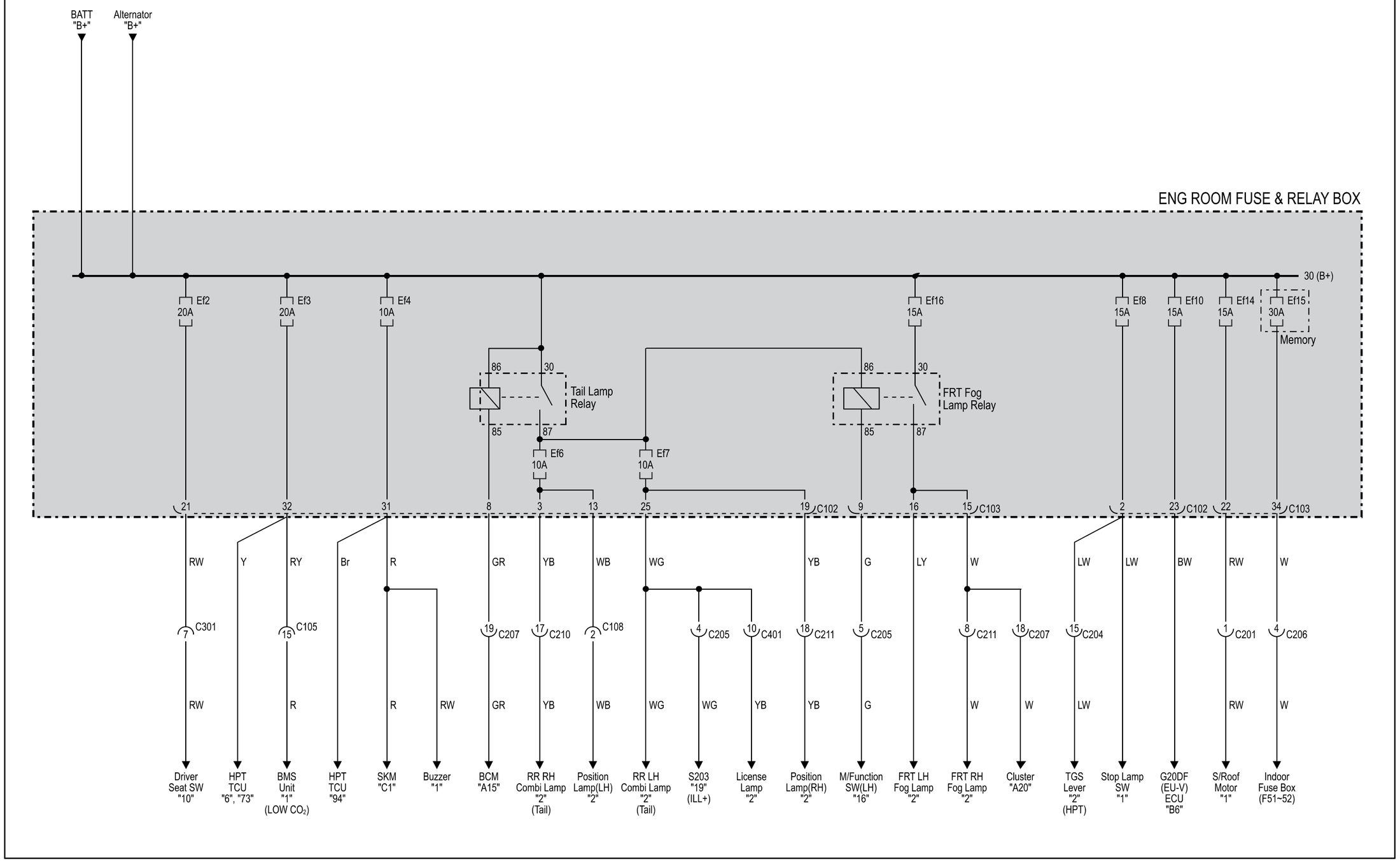
Modification basis	
Application basis	
Affected VIN	

▶ SB11~SB14, Ef12~Ef13, Ef24, ENG MAIN RELAY, C/FAN RELAY, C/FAN RELAY(HI, LO), COMP RELAY

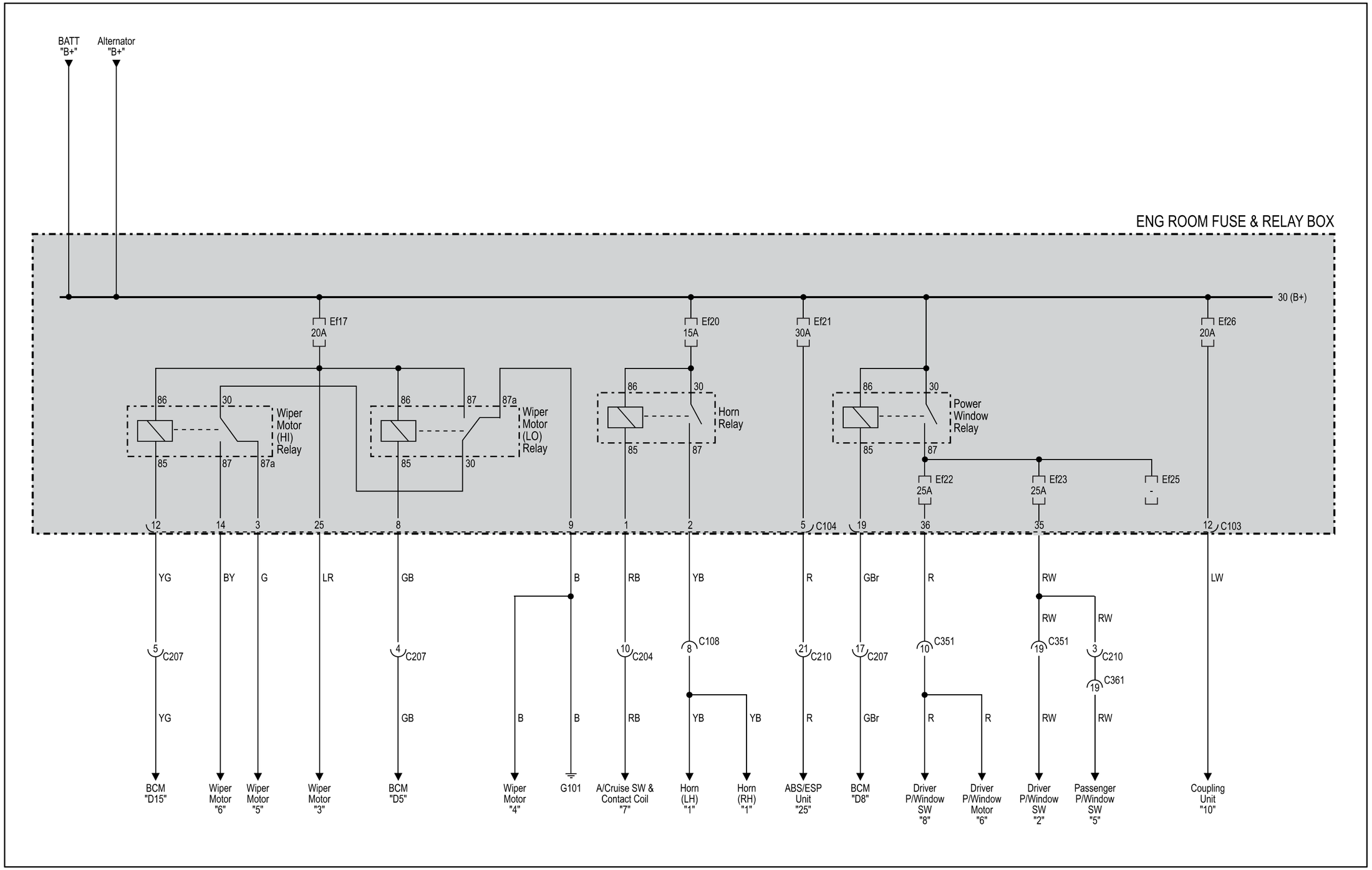


Modification basis	
Application basis	
Affected VIN	

▶ Ef2~Ef4, Ef6~Ef8, Ef10, Ef14~Ef16, TAIL LAMP RELAY, FRT FOG LAMP RELAY



▶ Ef17, Ef20~Ef23, Ef25~Ef26, WIPER MOTOR RELAY(HI, LO), HORN RELAY, POWER WINDOW RELAY



POWER DISTRIBUTION

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Modification basis	
Application basis	
Affected VIN	

S.G.N. 8410-04

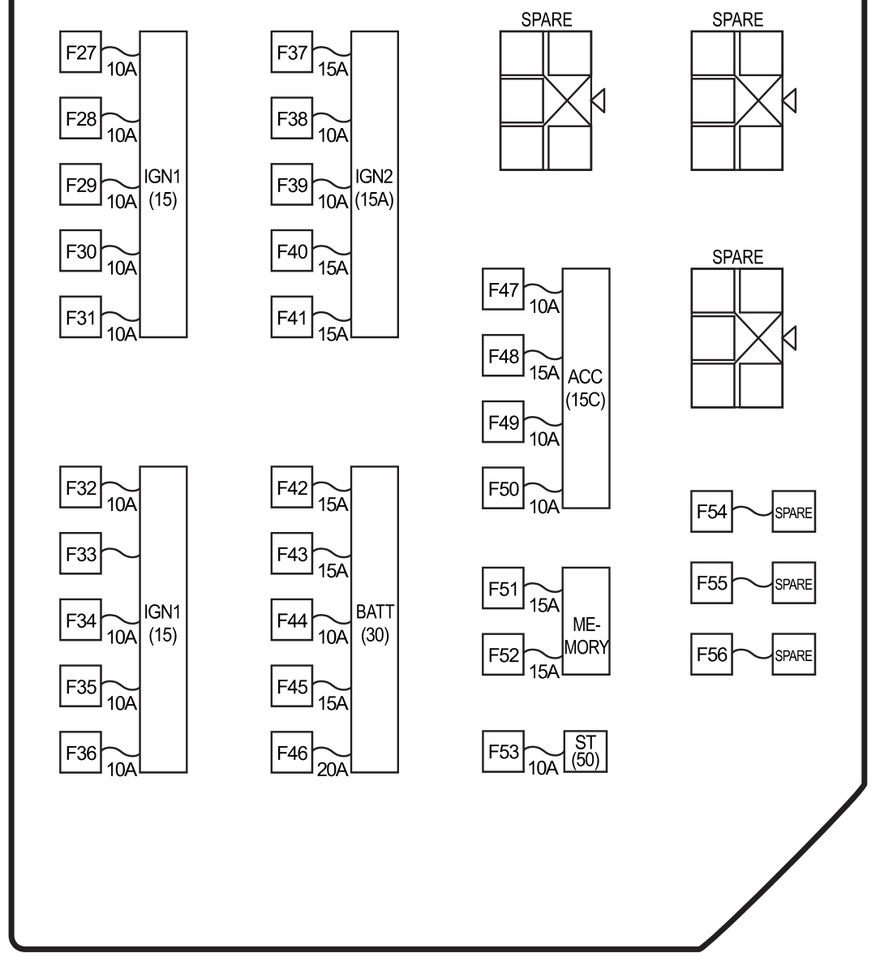
INDOOR FUSE BOX

(1) INDOOR FUSE BOX

NO.27 10A	AIR BAG	NO.37 15A	FRT SEAT WARMER	SAPRE		SAPRE			
NO.28 10A	CLUSTER BCM EPS	NO.38 10A	AIR CON FRT/RR DEFOGGER ALTERNATOR						
NO.29 10A	*FUEL HTR DIAGNOSIS *PTC	NO.39 10A	REAR WIPER						
NO.30 10A	BACK UP LAMP BACK SONAR	NO.40 15A	RR SEAT WARMER	NO.47 10A	DIGITAL CLOCK O/SIDE MRR SUN ROOF HEAD REST	SAPRE			
NO.31 10A	TCU AWD	NO.41 15A	STEERING WHEEL HEATED	NO.48 15A	CIGAR LIGHT				
NO.32 10A	* ENG ECU	NO.42 15A	BCM (DOOR LOCK)	NO.49 10A	AUDIO				
NO.33	SPARE	NO.43 15A	BCM (HAZARD)	NO.50 10A	SMART KEY	NO.54	SAPRE		
NO.34 10A	ABS/ESP	NO.44 10A	DIAGNOSIS SMART KEY	NO.51 15A	AUDIO	NO.55	SAPRE		
NO.35 10A	HLLD ECM MRR	NO.45 15A	B/HORN MRR FOLD	NO.52 15A	INTERIOR LAMP BCM CLUSTER	NO.56	SAPRE		
NO.36 10A	SMART KEY	NO.46 20A	POWER OUTLET	NO.53 10A	START				

- PLEASE USE THE DESIGNATED FUSE AND RELAY.
- CONSULT OWNER'S MANUAL FOR FUSE & RELAY SERVISE.
- " * "DSL, " ** " GSL

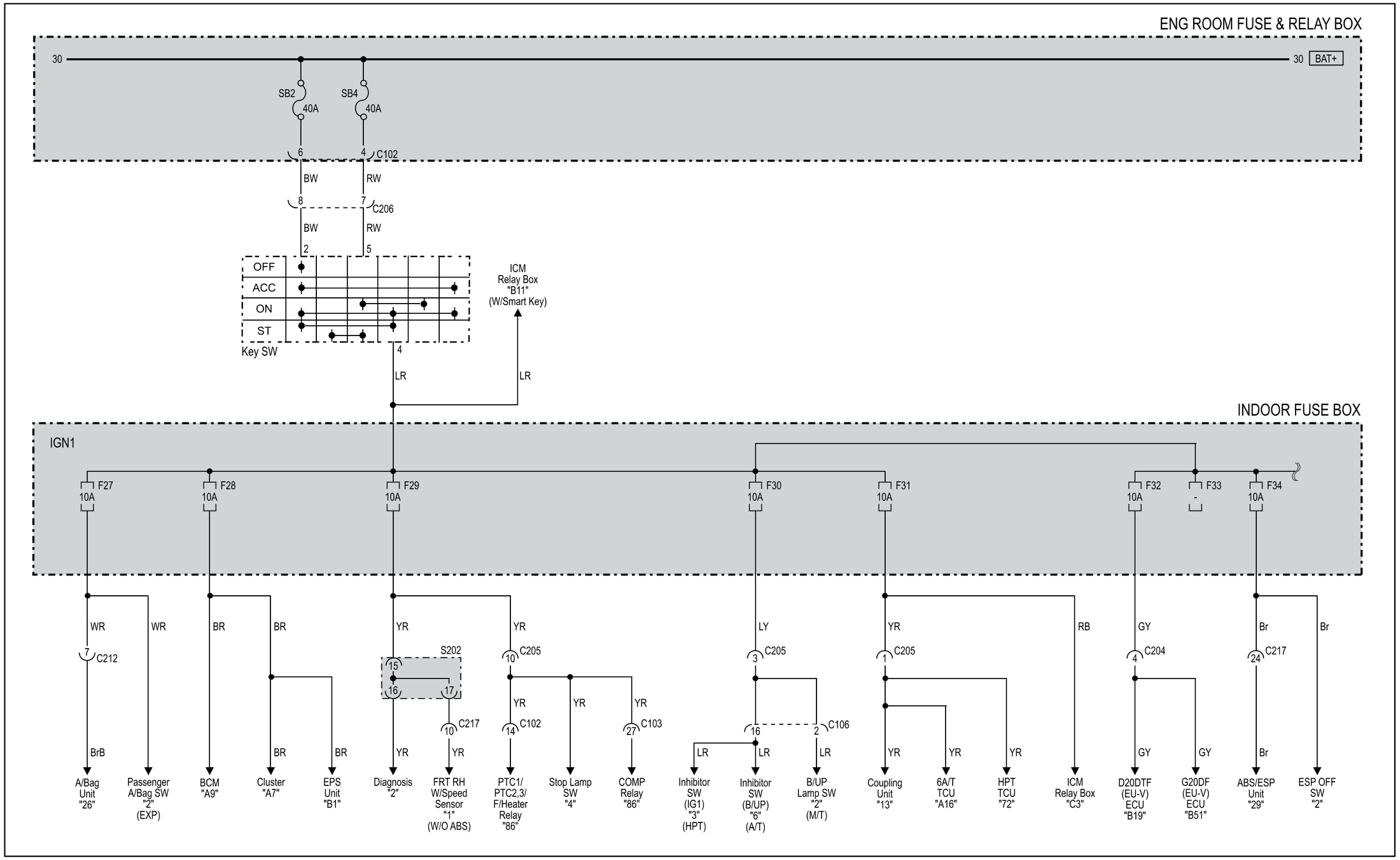
(2) POWER SUPPLY



Modification basis	
Application basis	
Affected VIN	

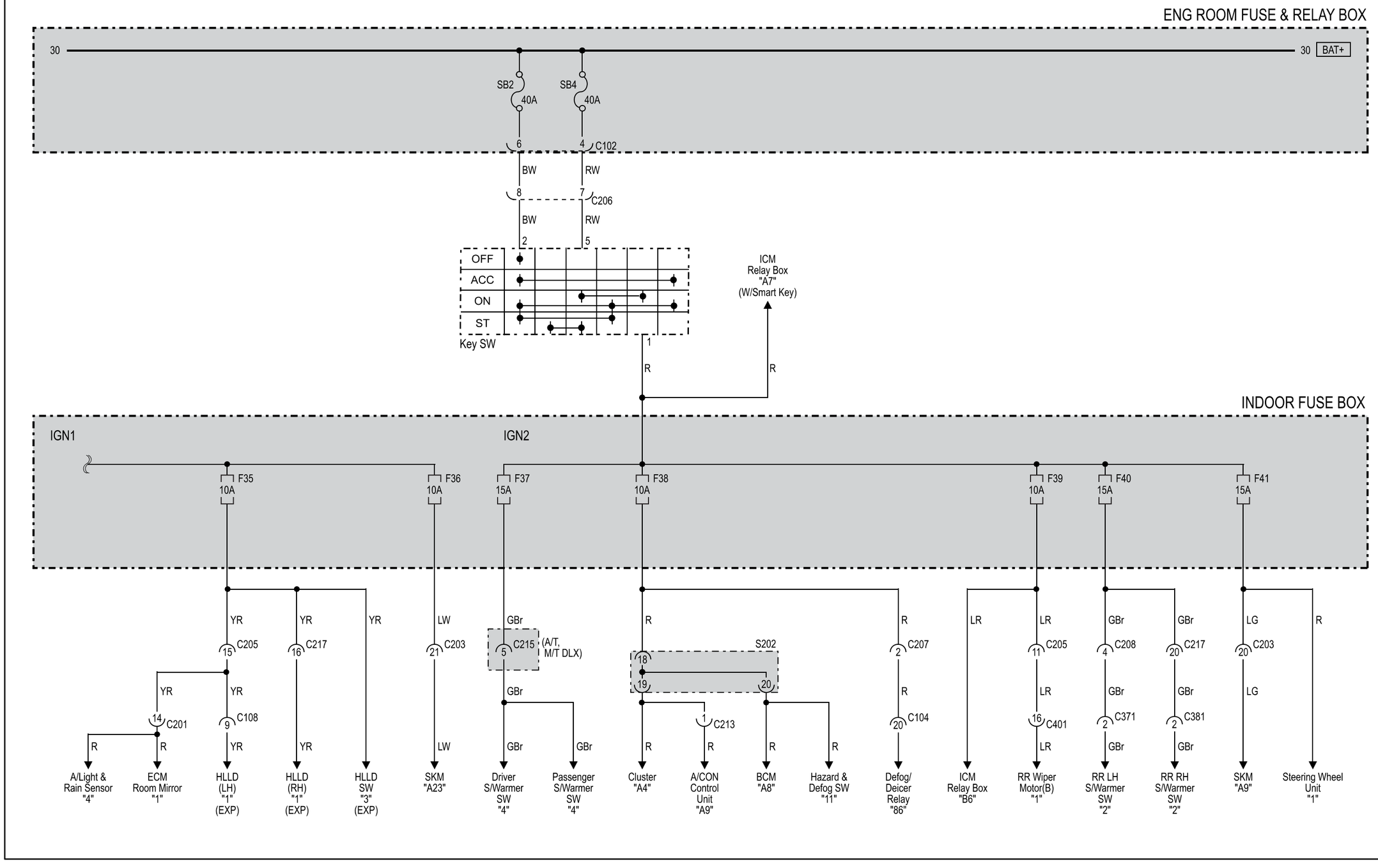
(3) INDOOR FUSE BOX CIRCUIT

▶ **F27~F34**



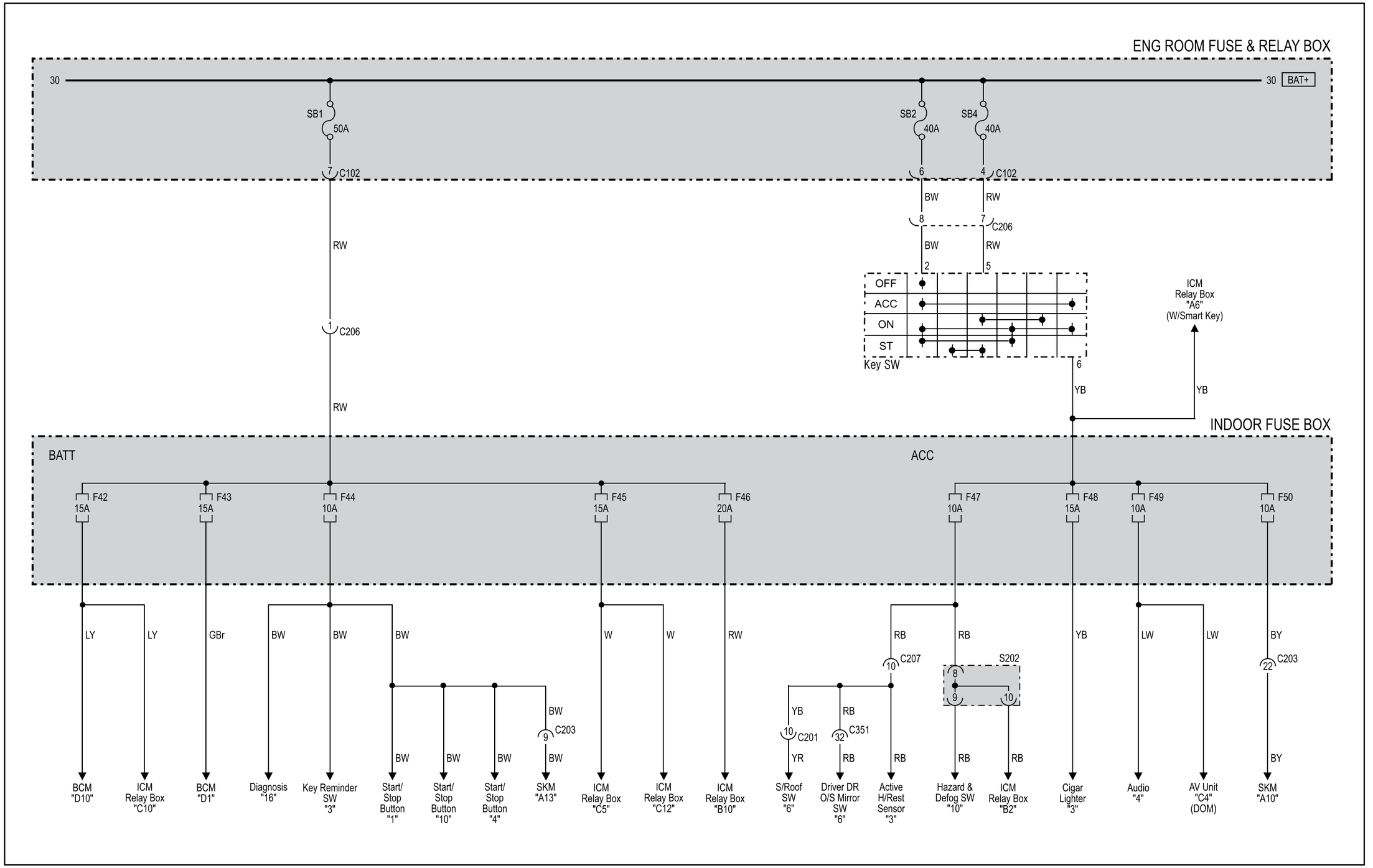
Modification basis	
Application basis	
Affected VIN	

▶ **F35~F41**



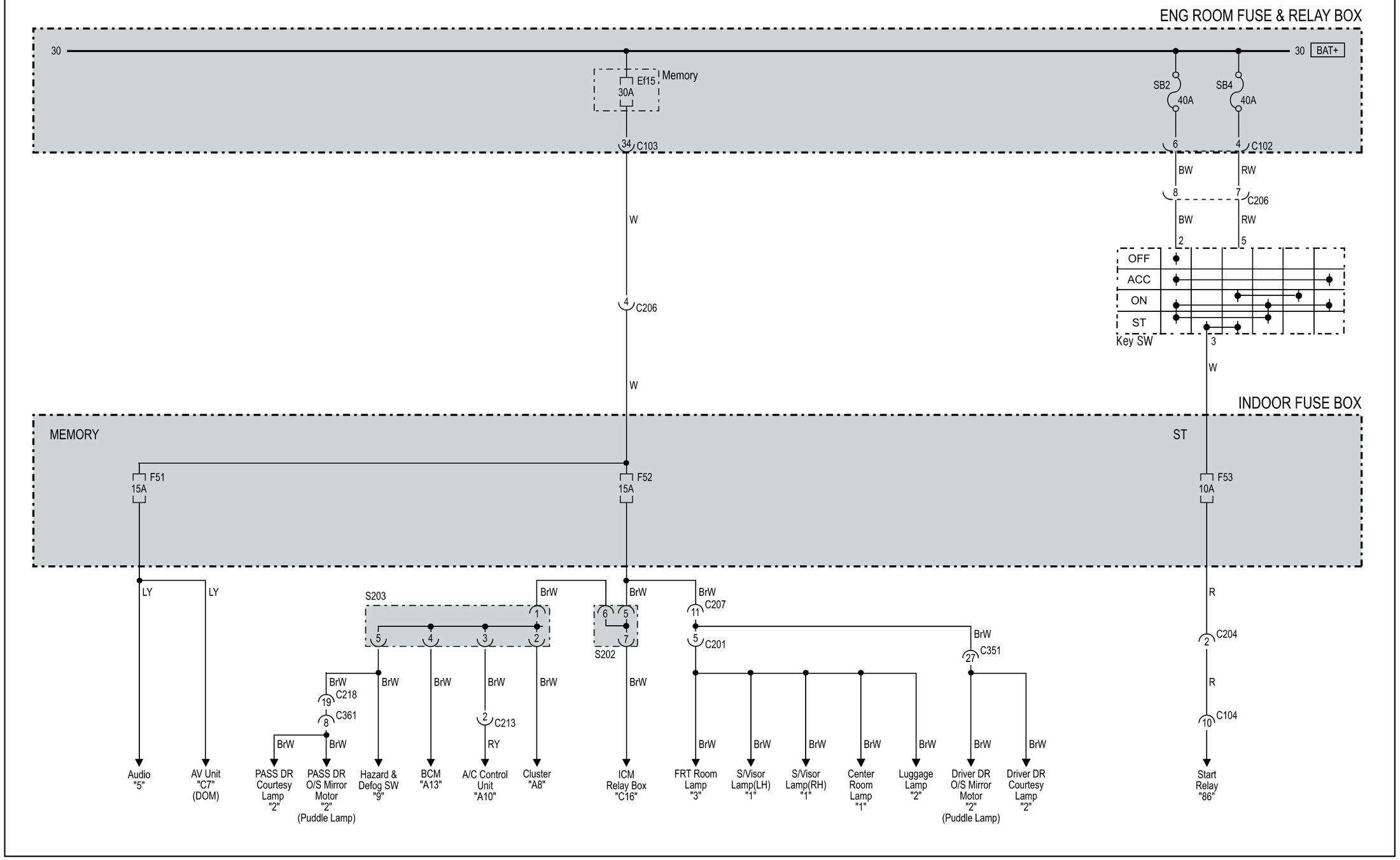
Modification basis	
Application basis	
Affected VIN	

▶ **F42~F50**



Modification basis	
Application basis	
Affected VIN	

▶ **F51~F53**

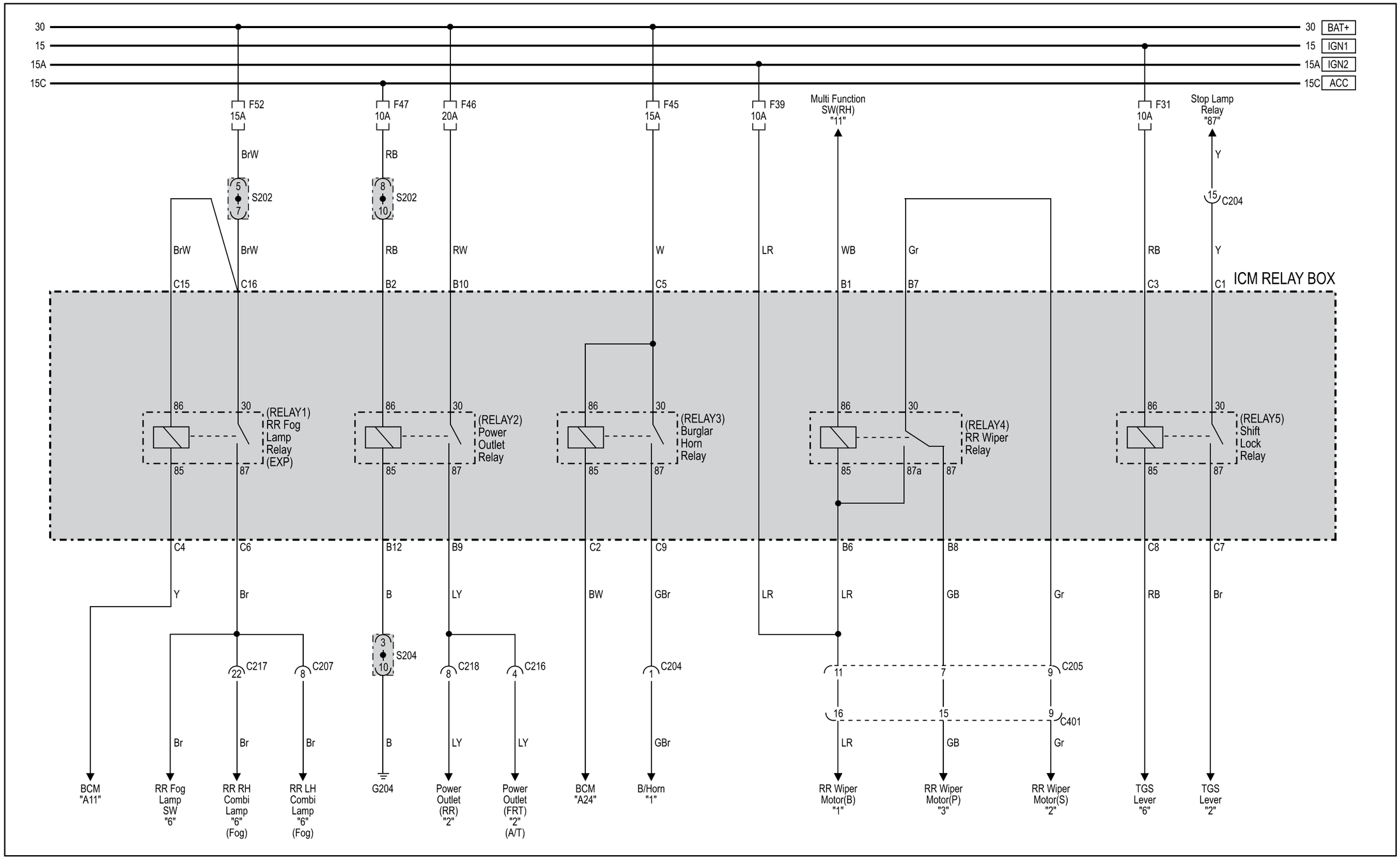


Modification basis	
Application basis	
Affected VIN	

S.G.N. 8410-05

ICM RELAY BOX

▶ RR FOG LAMP RELAY, POWER OUTLET RELAY, BURGLAR HORN RELAY, RR WIPER RELAY, SHIFT LOCK RELAY

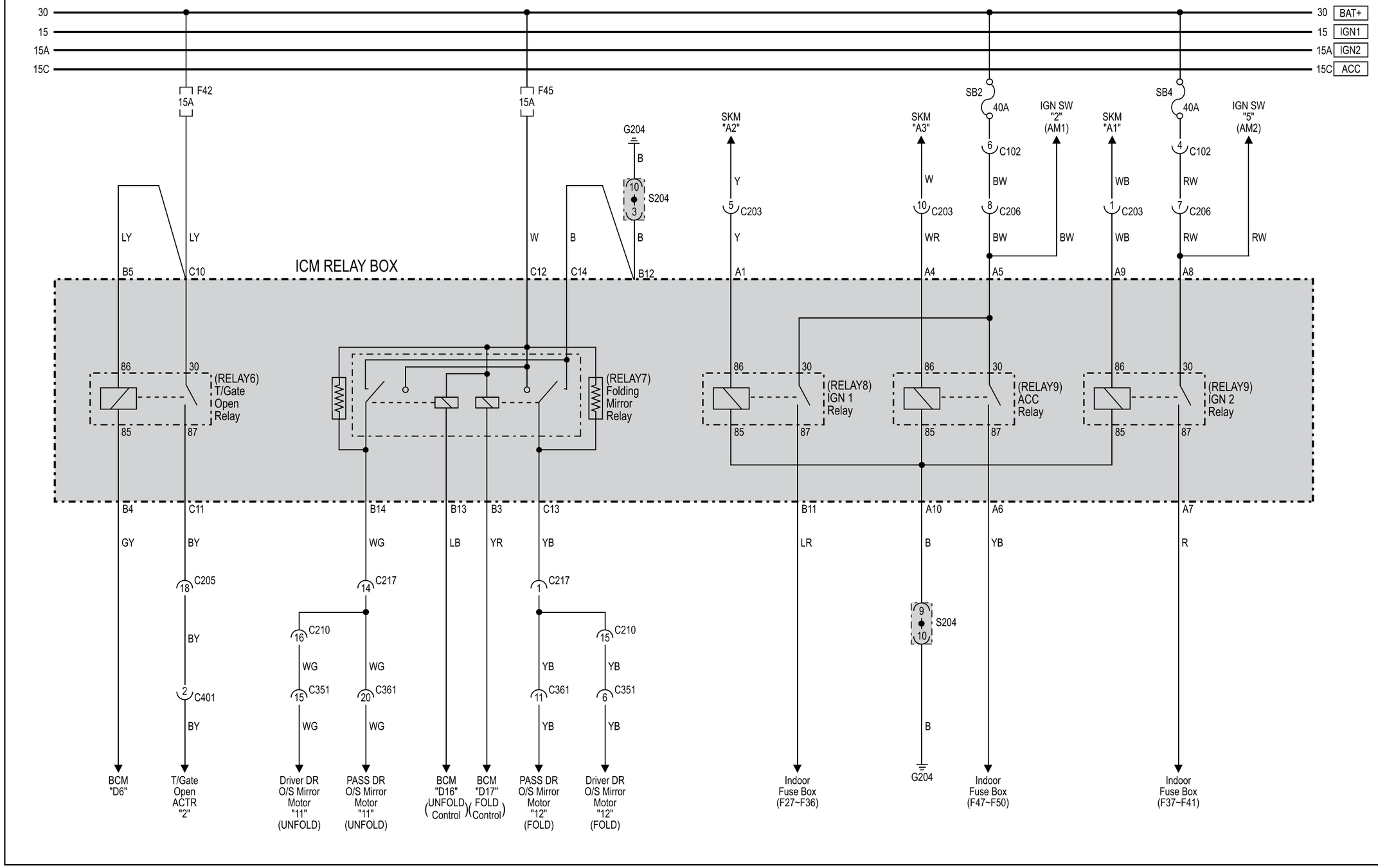


POWER DISTRIBUTION

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

▶ T/GATE OPEN RELAY, FOLDING MIRROR RELAY, IGN 1 RELAY, ACC RELAY, IGN 2 RELAY



Modification basis	
Application basis	
Affected VIN	

1461-01/2820-01/1491-01/1491-04/6810-15/8210-01/3110-01/3110-17/4892-01/8810-01/8010-01/8510-30/4610-04/7410-02/8510-48/8620-01/8510-05/8510-52/7810-01/8610-06/7632-16/7840-01/8710-03/7340-03/8310-01/8320-01/8310-01/8210-03/8310-10/4810-08/7770-02/8790-01/8930-03/8930-40/8930-01/6810-20/2112-02/8210-01/8712-03

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1491-01 ECU(D20DTF EU-V)..... 4
1491-04 ECU(G20DF EU-V)..... 6
6810-15 PTC HEATER/FUEL PUMP..... 8
8210-01 DIAGNOSIS CONNECTOR..... 9

CHASSIS

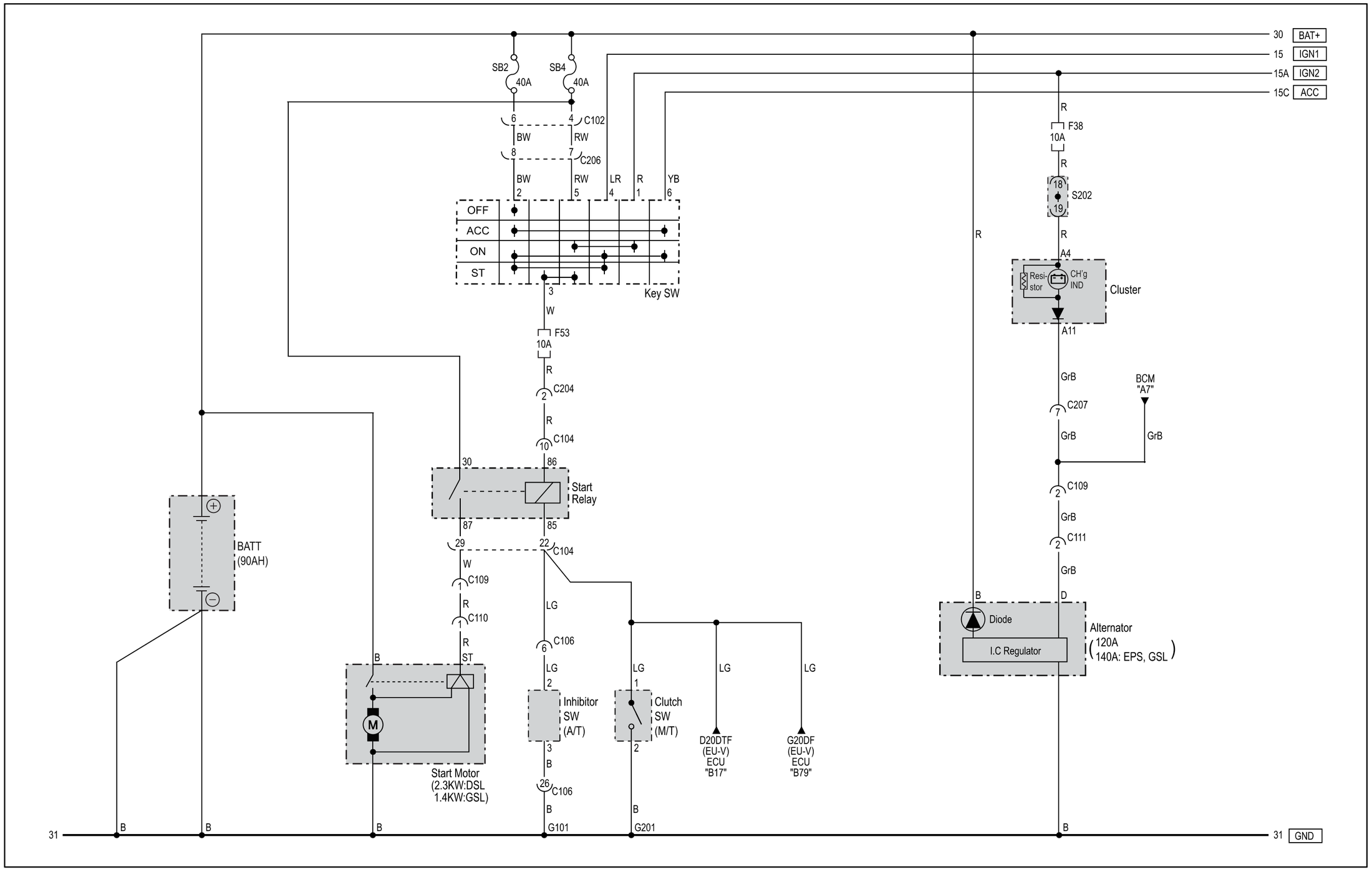
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3110-01 HPT-TCU..... 11
3110-17 AWD COUPLING UNIT..... 12
4892-01 ABS/ESP..... 13

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8510-30 STEERING WHEEL HEATING..... 16
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8510-05 POWER WINDOW..... 22
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7810-01 FRT(RR) WIPER / WASHER..... 24
8610-06 HORN..... 25
7632-16 CIGAR LIGHTER / POWER OUTLET..... 26
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8710-03 DOOR LOCK CIRCUIT..... 28
7340-03 SUN ROOF..... 29
8310-01 HEAD LAMP..... 30
8310-01 HEAD LAMP LEVEL 'G DEVICE(EXP)..... 31
8320-01 TAIL LAMP..... 32
8310-01 TURN SIGNAL LAMP / HAZARD LAMP..... 33
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8210-01 CAN..... 45
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S.G.N. 1461-01

STARTING / CHARGING(W/O SMART KEY)



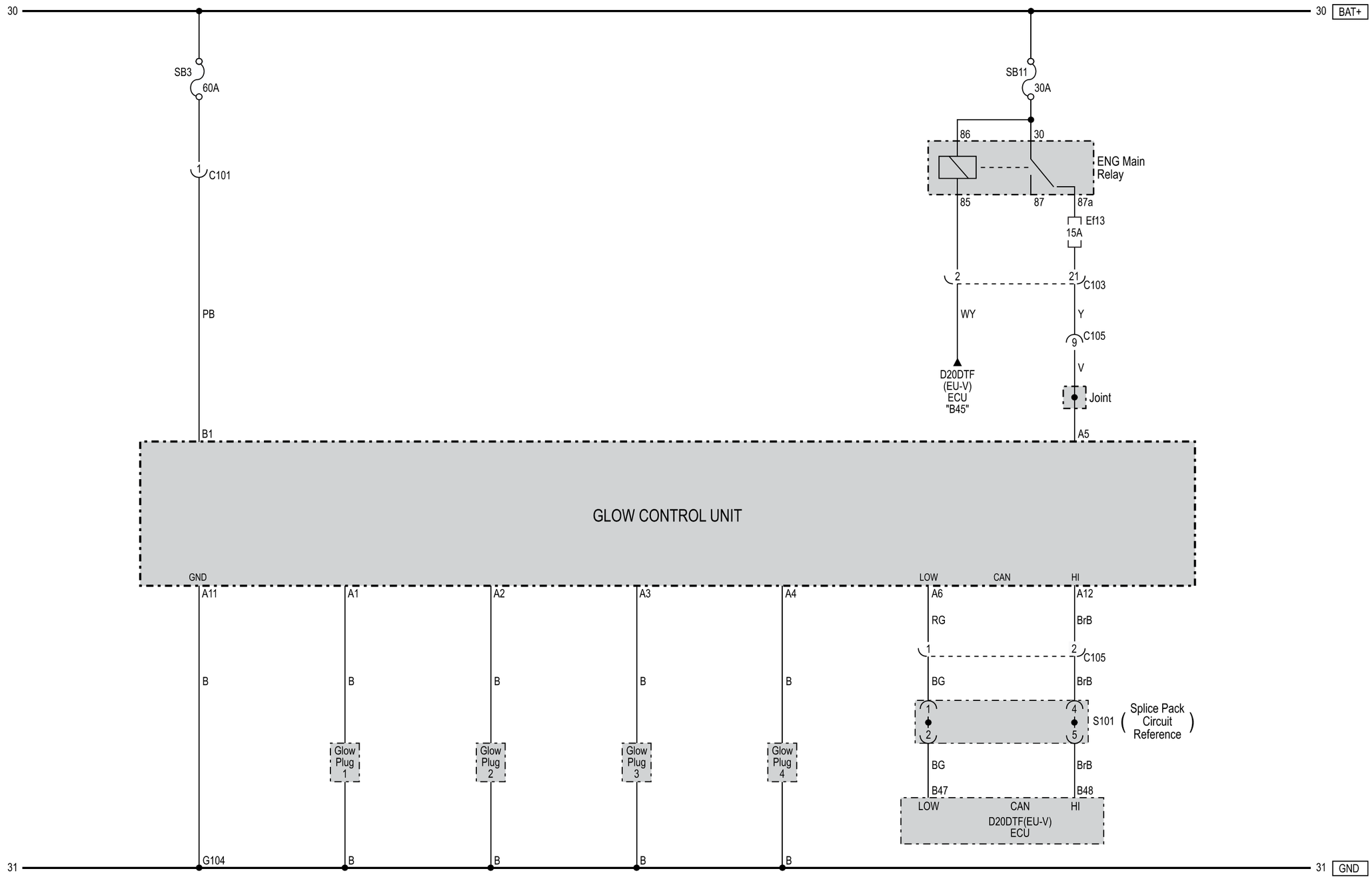
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 2820-01

GLOW CONTROL UNIT

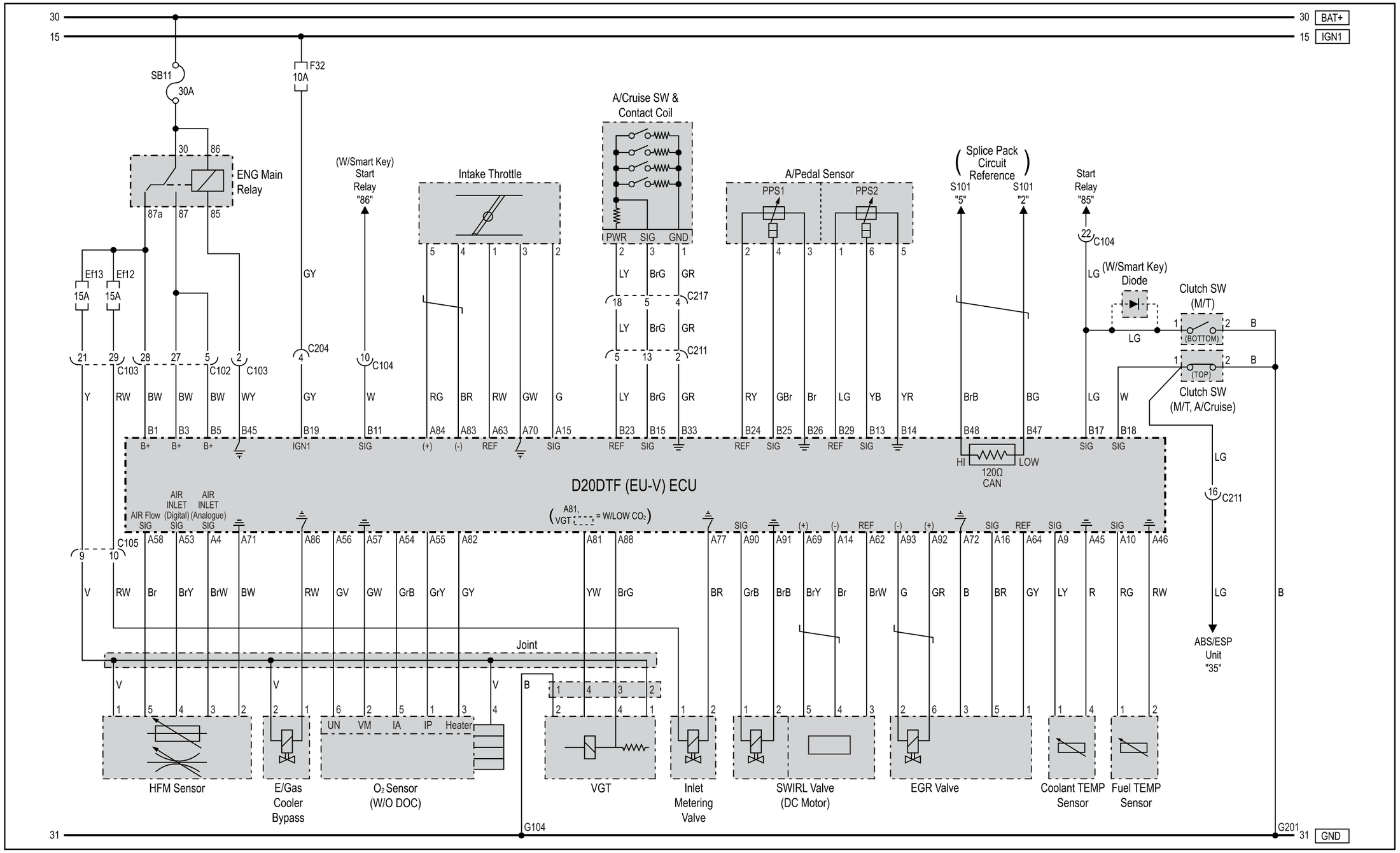


Modification basis	
Application basis	
Affected VIN	

S.G.N. 1491-01

ECU(D20DTF EU-V -ENGINE CONTROL UNIT)

(1) ENG MAIN RELAY, PEDAL MODULE, VALVE(THROTTLE, INLET METERING, EGR), SENSOR(HFM, O2, COOLANT TEMP, FUEL TEMP)

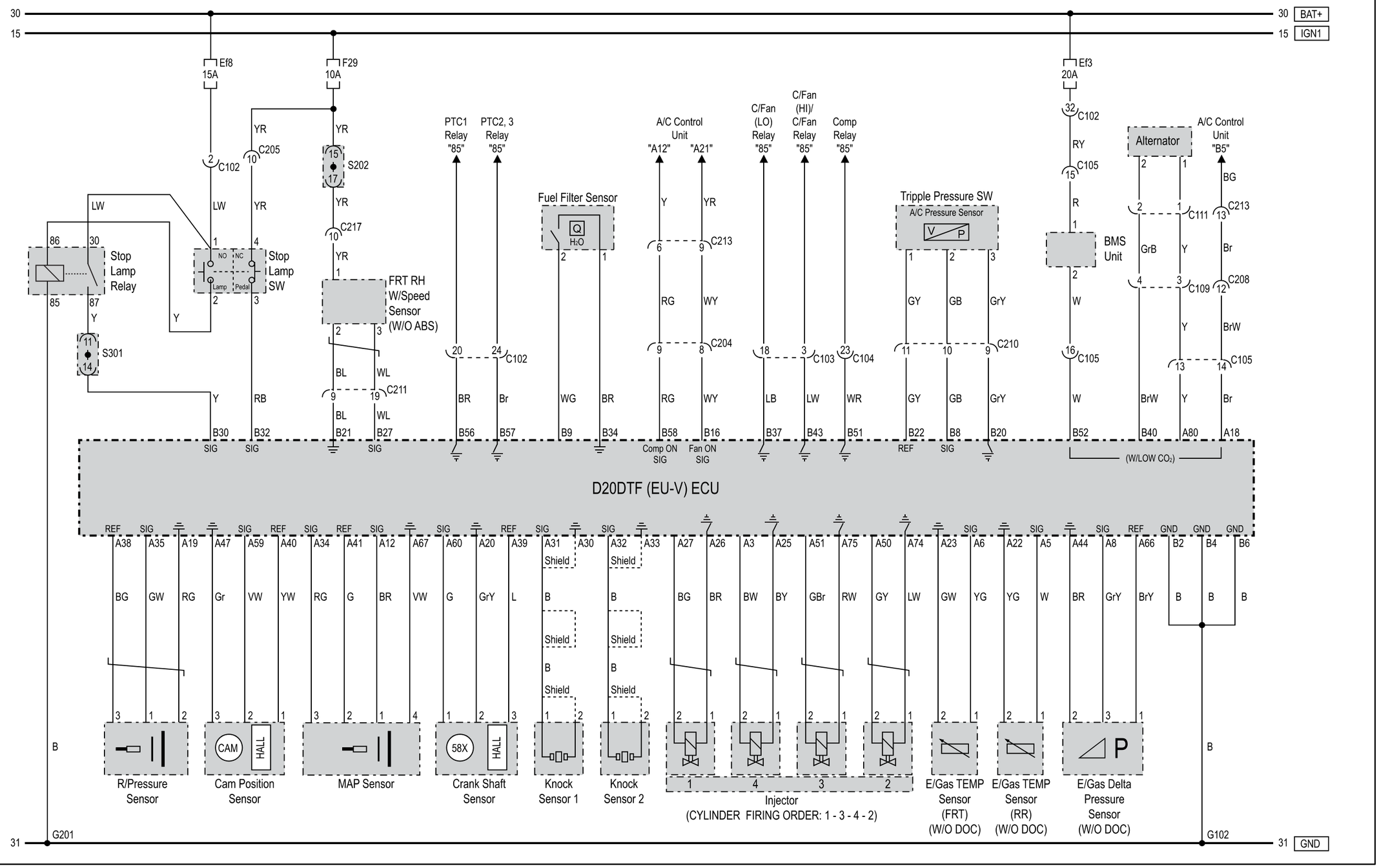


CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

(2) STOP LAMP, W/SPEED SENSOR, T/PRESSURE SW, INJECTOR, SENSOR(FUEL FILTER, R/PRESSURE, CAM POSITION, MAP, KNOCK, E/GAS TEMP)

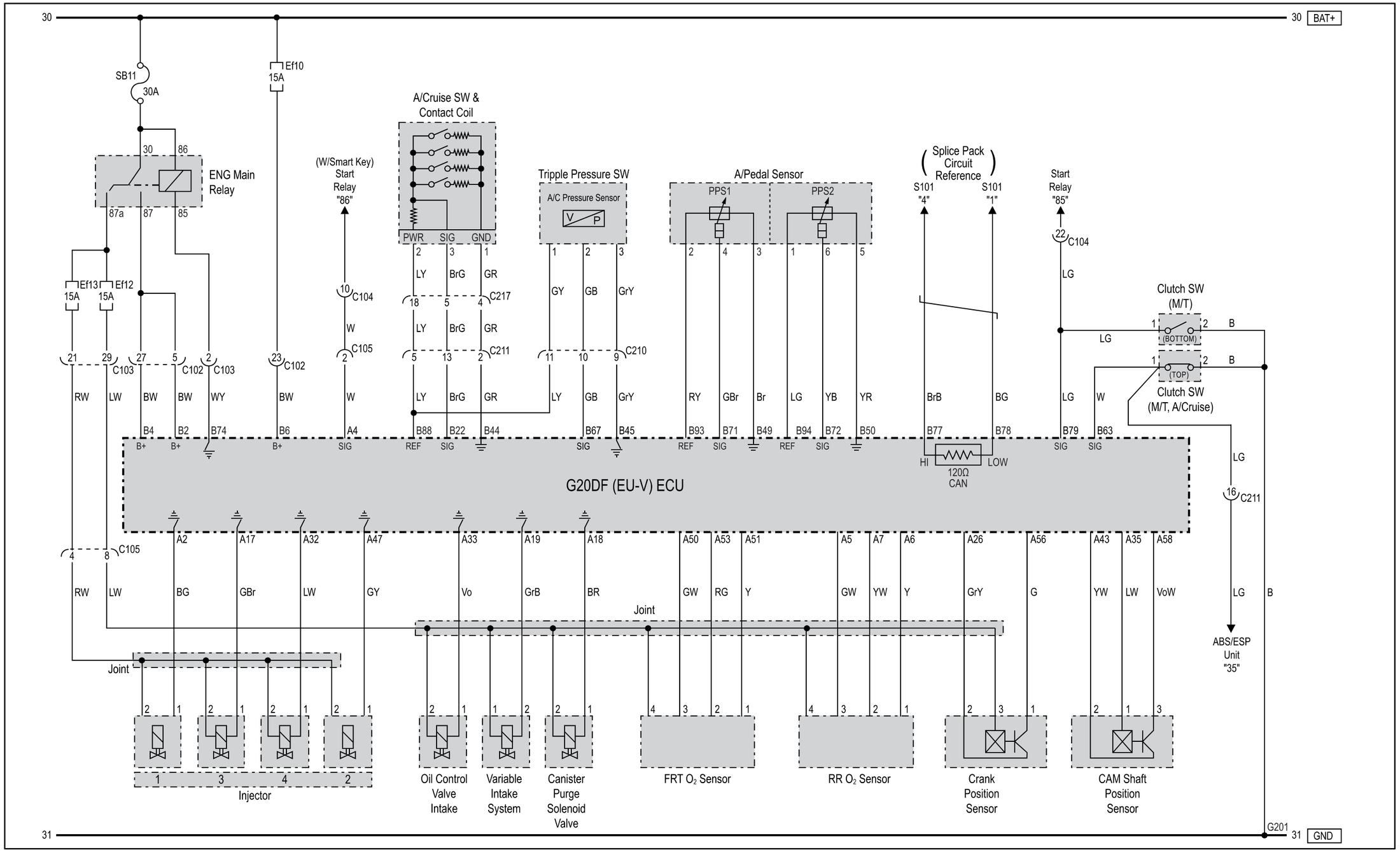


Modification basis	
Application basis	
Affected VIN	

S.G.N. 1491-04

ECU(G20DF EU-V -ENGINE CONTROL UNIT)

(1) ENG MAIN RELAY, PEDAL MODULE, INJECTOR, SENSOR(FRT/RR O2, CRANK POSITION, CAM SHAFT POSITION)

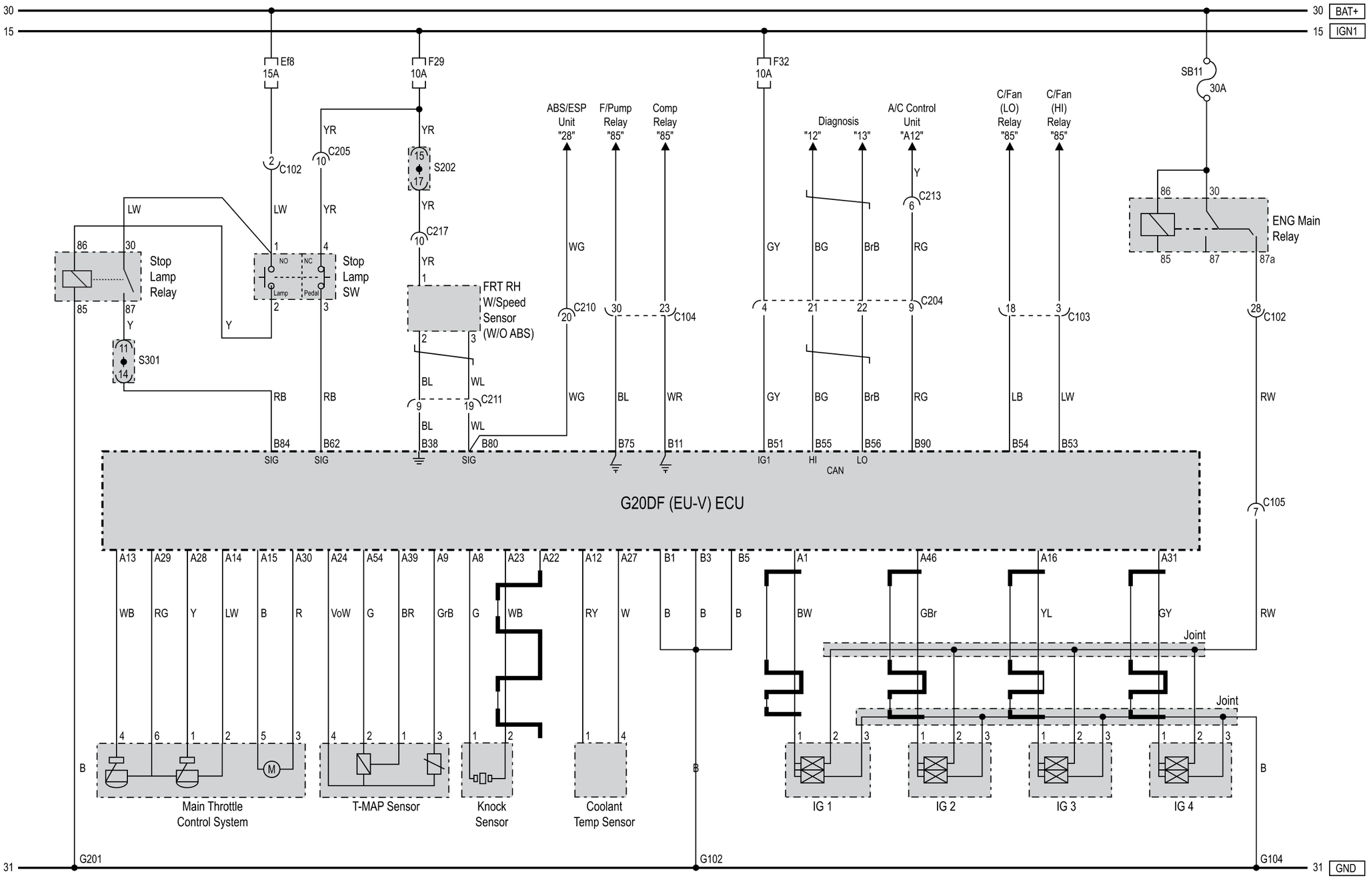


CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

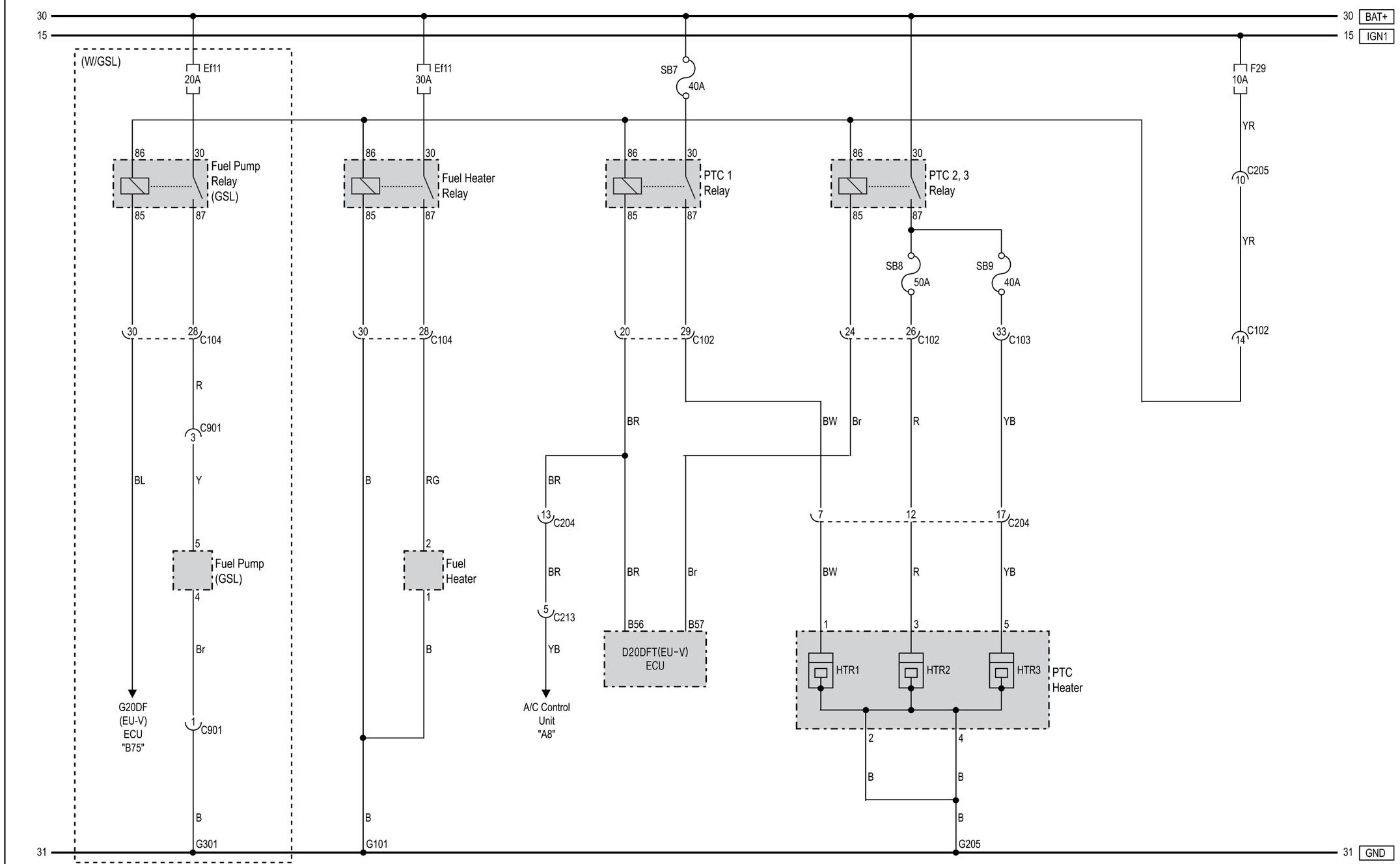
(2) STOP LAMP, W/SPEED SENSOR, THROTTLE CONTROL, IGN, SENSOR(T-MAP, KNOCK, COOLANT TEMP)



Modification basis	
Application basis	
Affected VIN	

CIRCUIT
KORANDO 2012.10

S.G.N.
6810-15 PTC HEATER, FUEL PUMP(GSL)



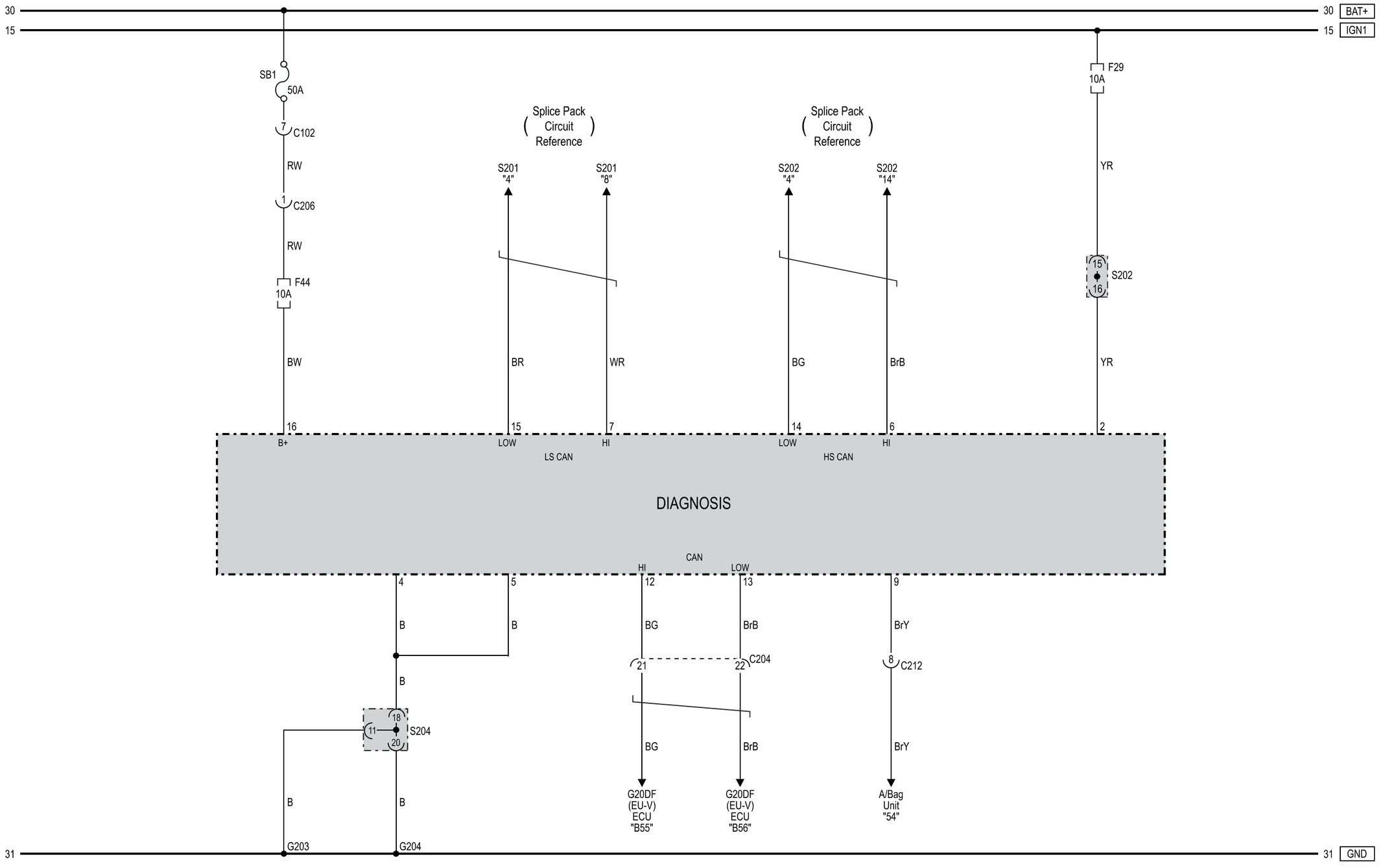
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8210-01

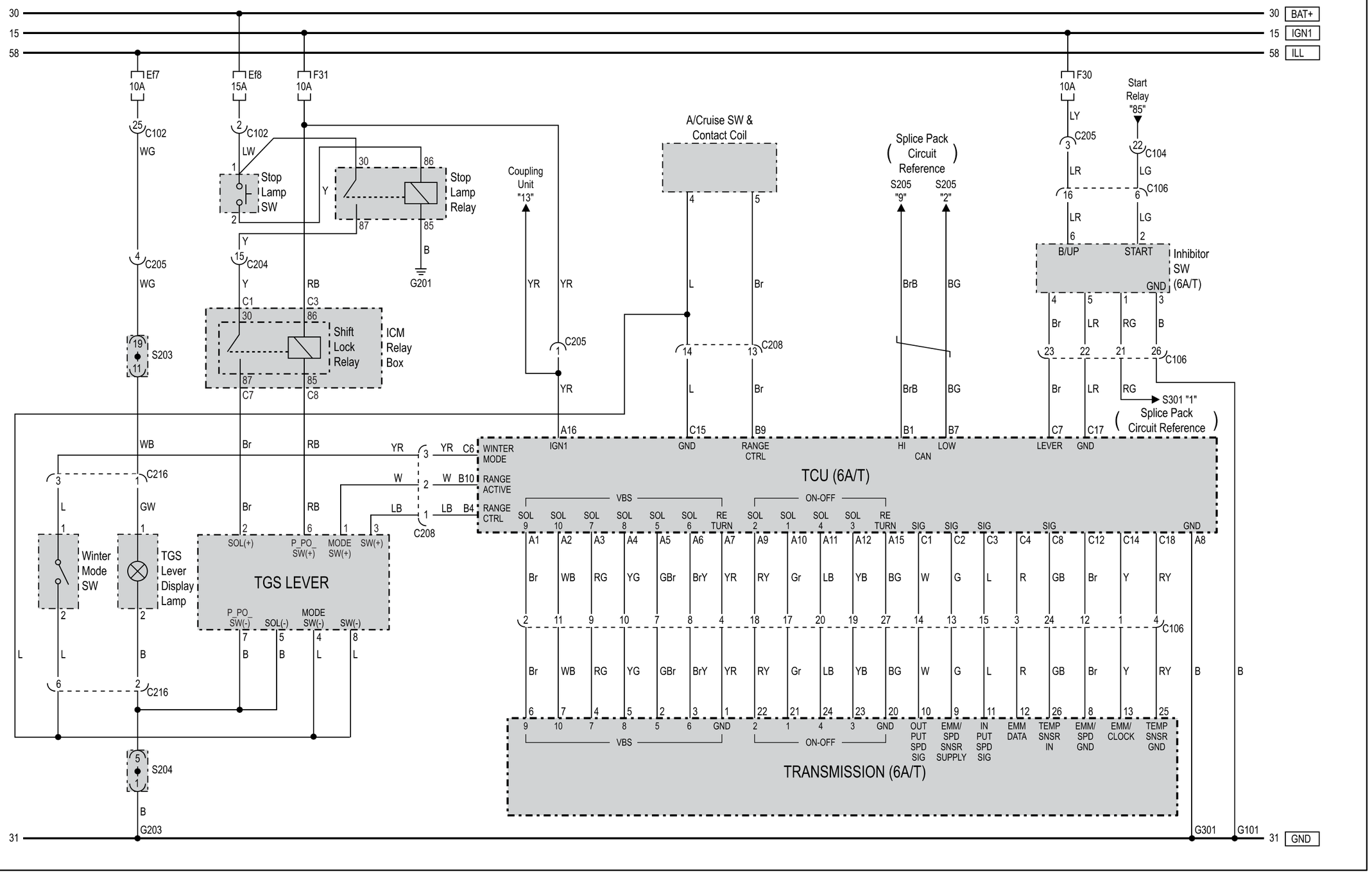
DIAGNOSIS CONNECTOR



Modification basis	
Application basis	
Affected VIN	

S.G.N. 3110-01

TCU(6-A/T)



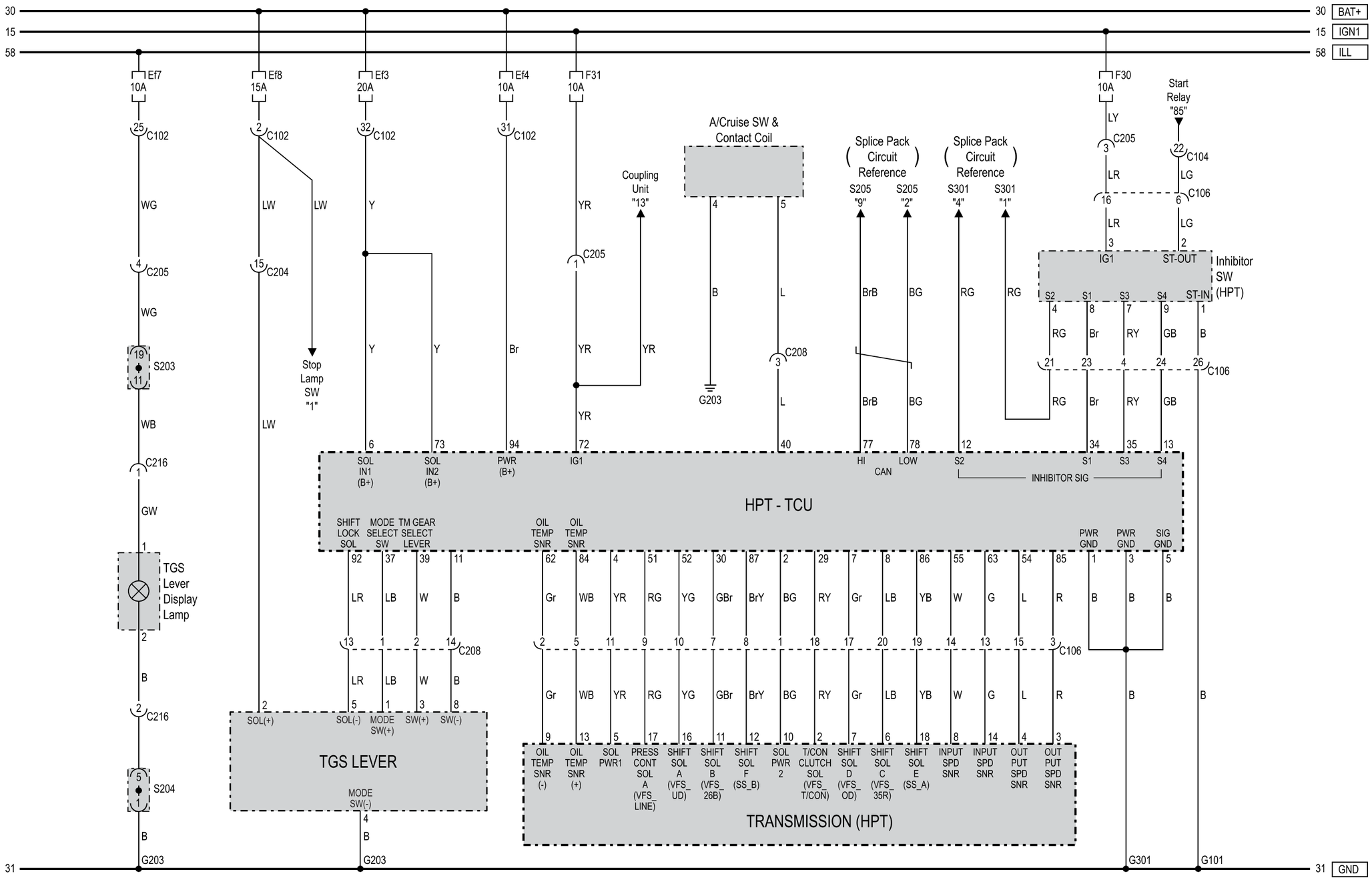
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 3110-01

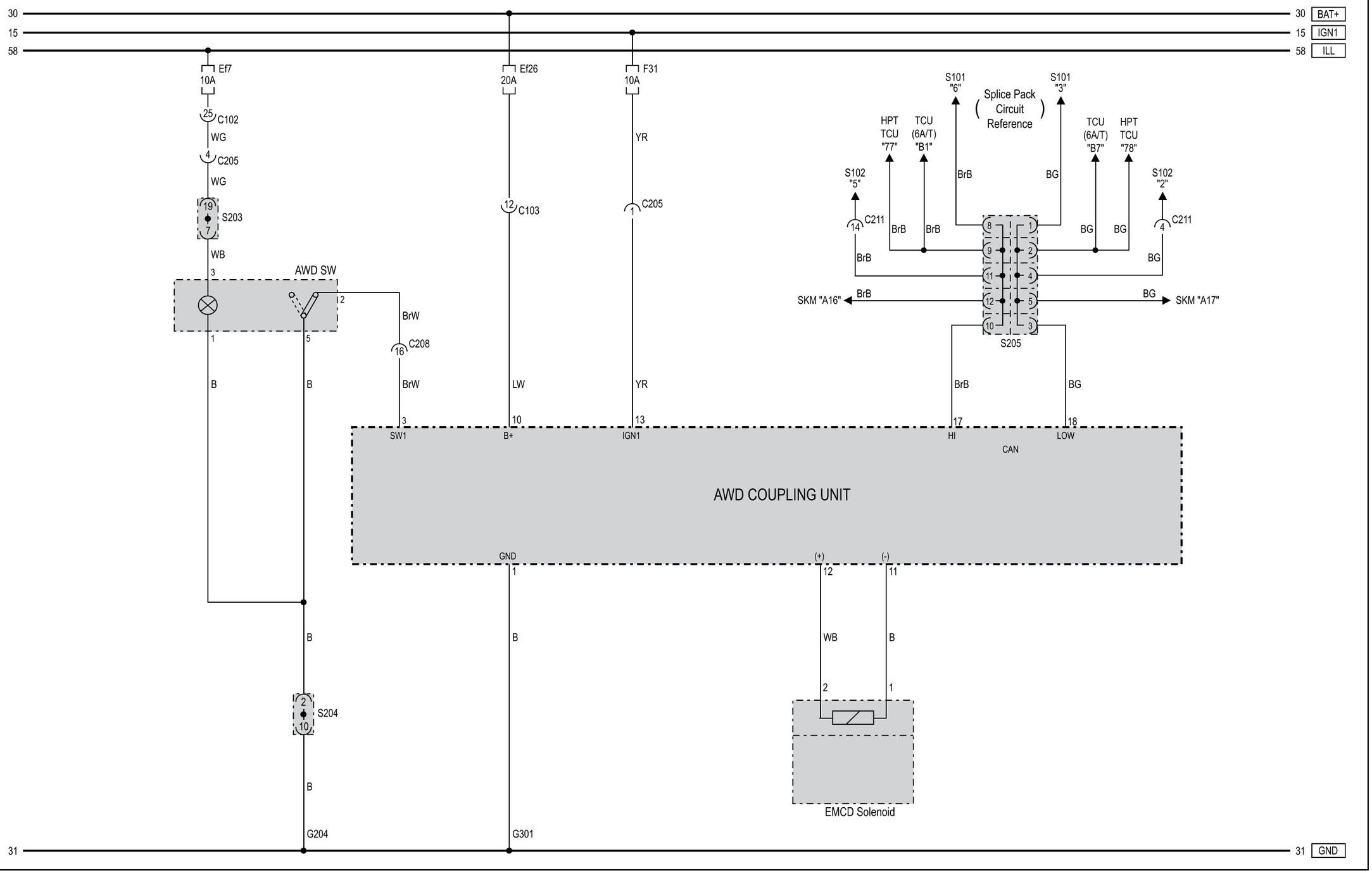
HPT-TCU



Modification basis	
Application basis	
Affected VIN	

S.G.N. 3110-17

AWD COUPLING UNIT



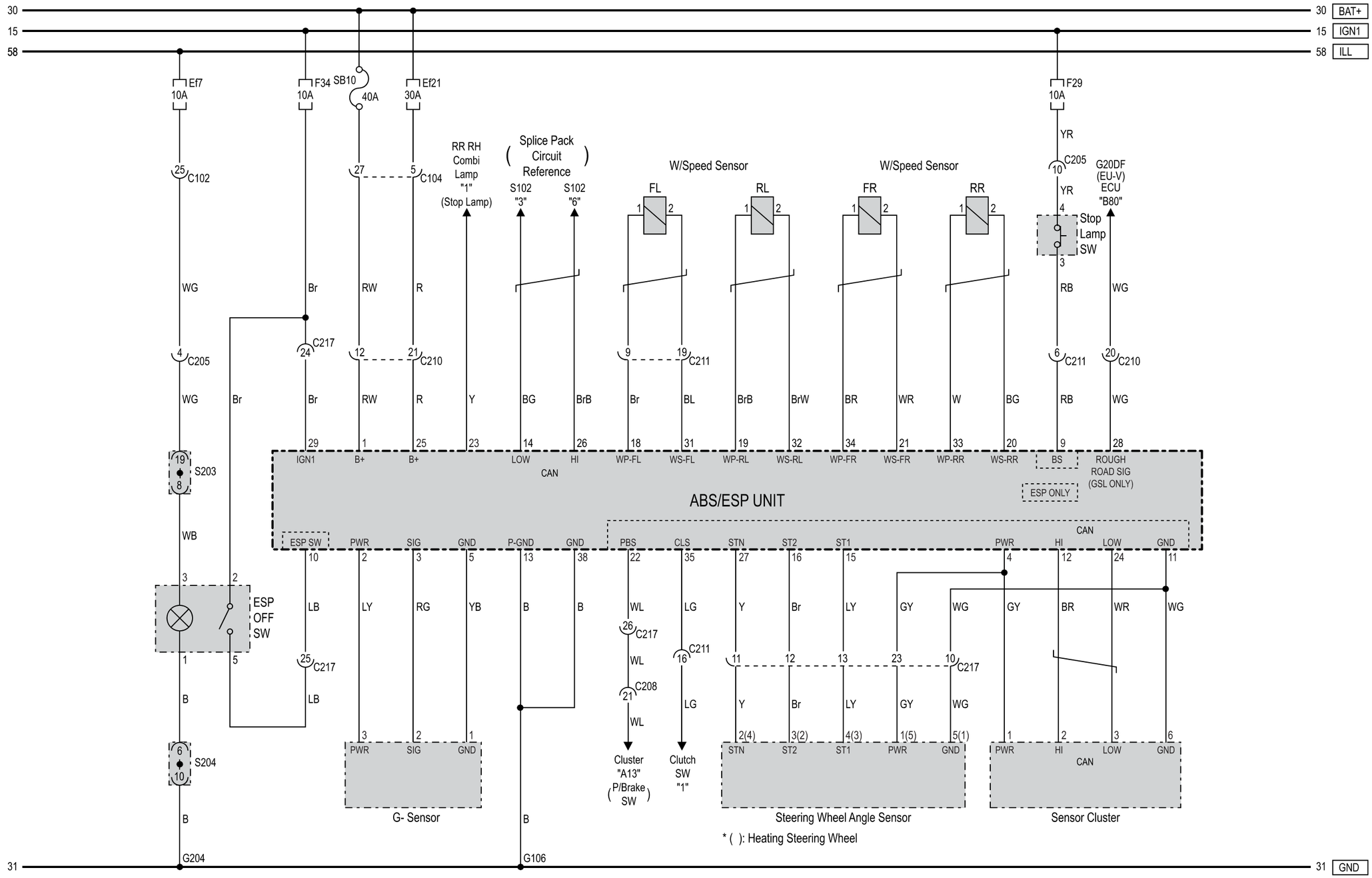
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 4892-01

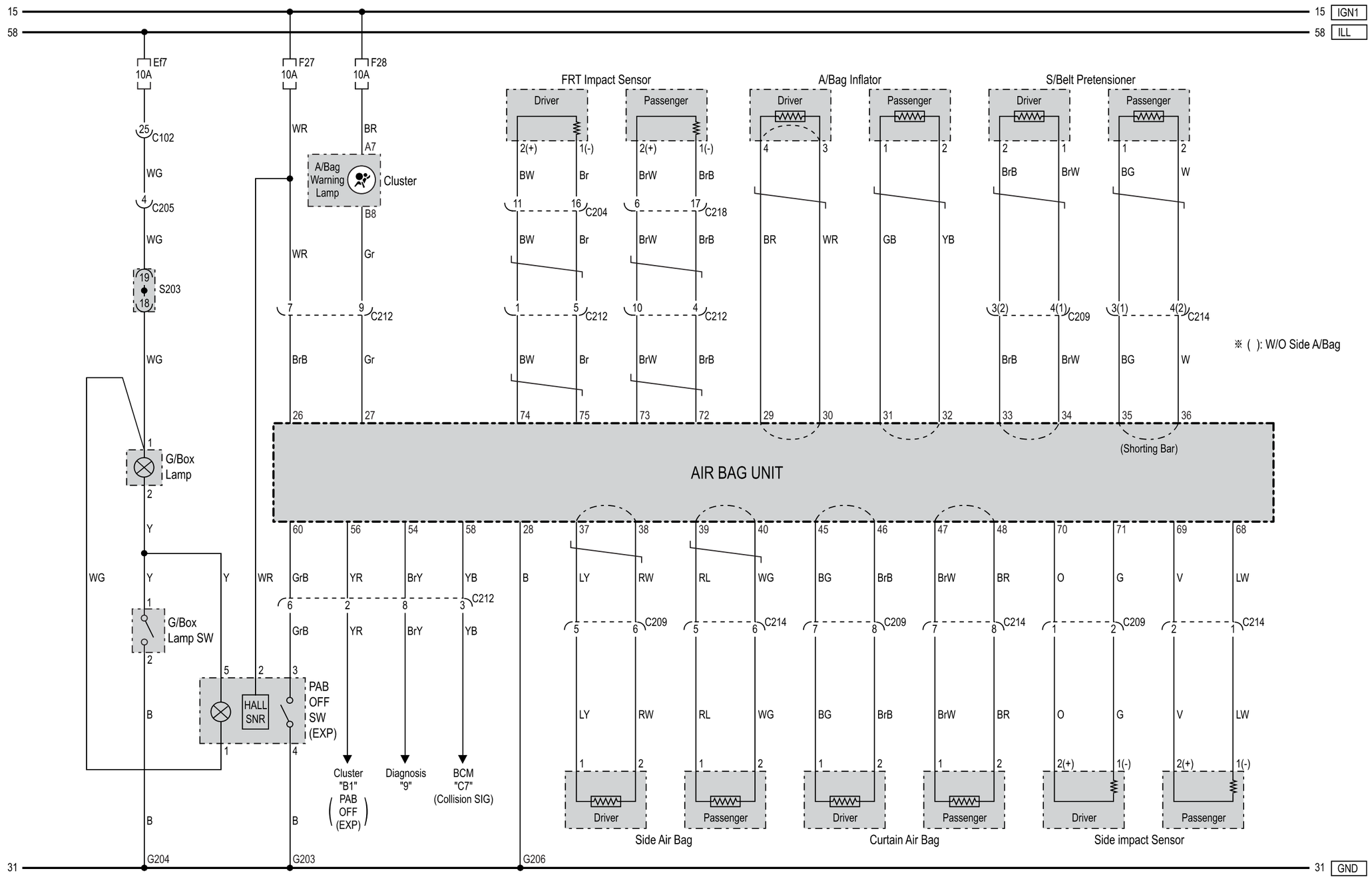
ABS/ESP



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8810-01

AIR BAG (DUAL/SIDE/CURTAIN) SYSTEM



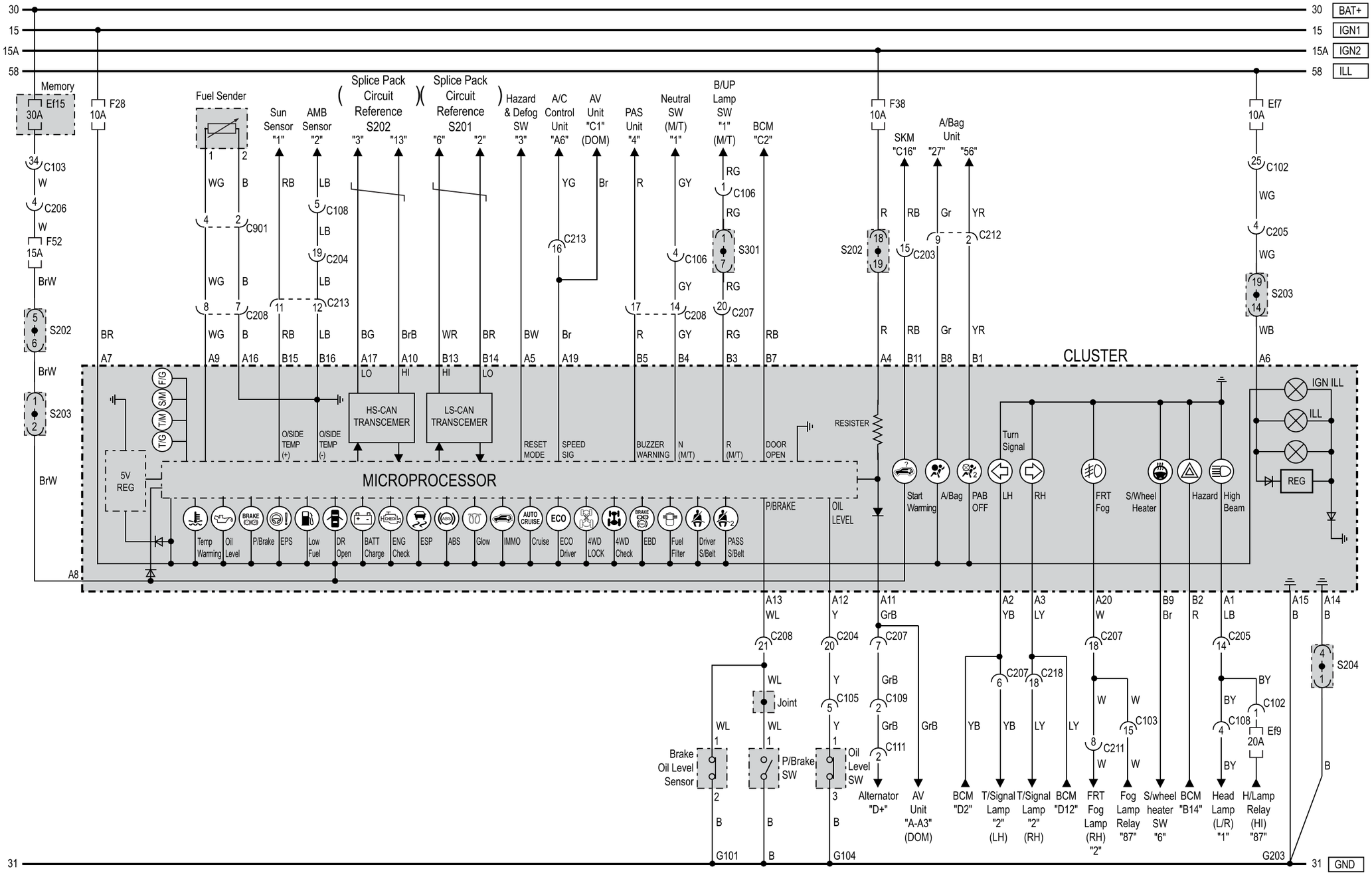
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8010-01

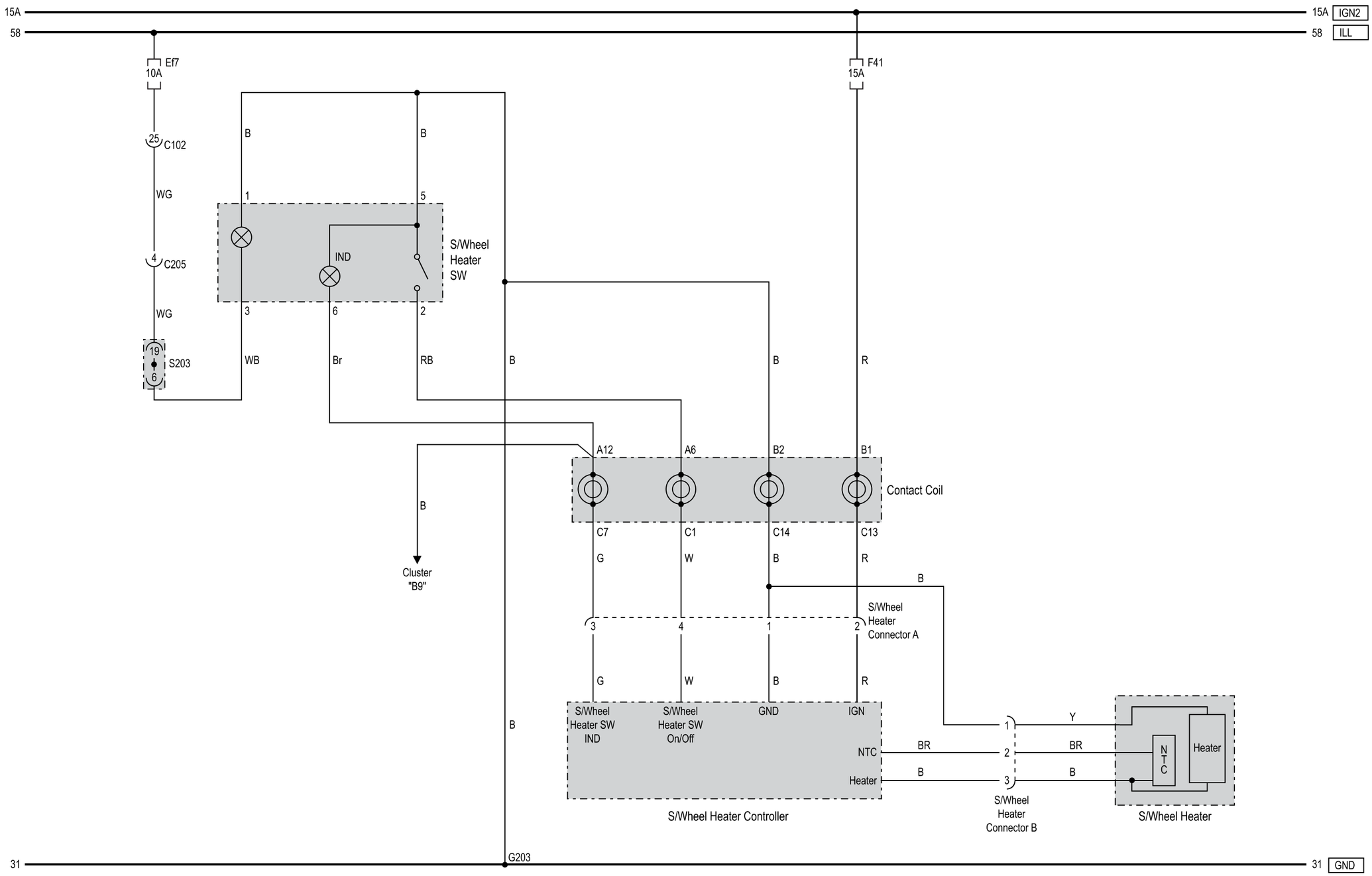
CLUSTER



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8510-30

STEERING WHEEL HEATING



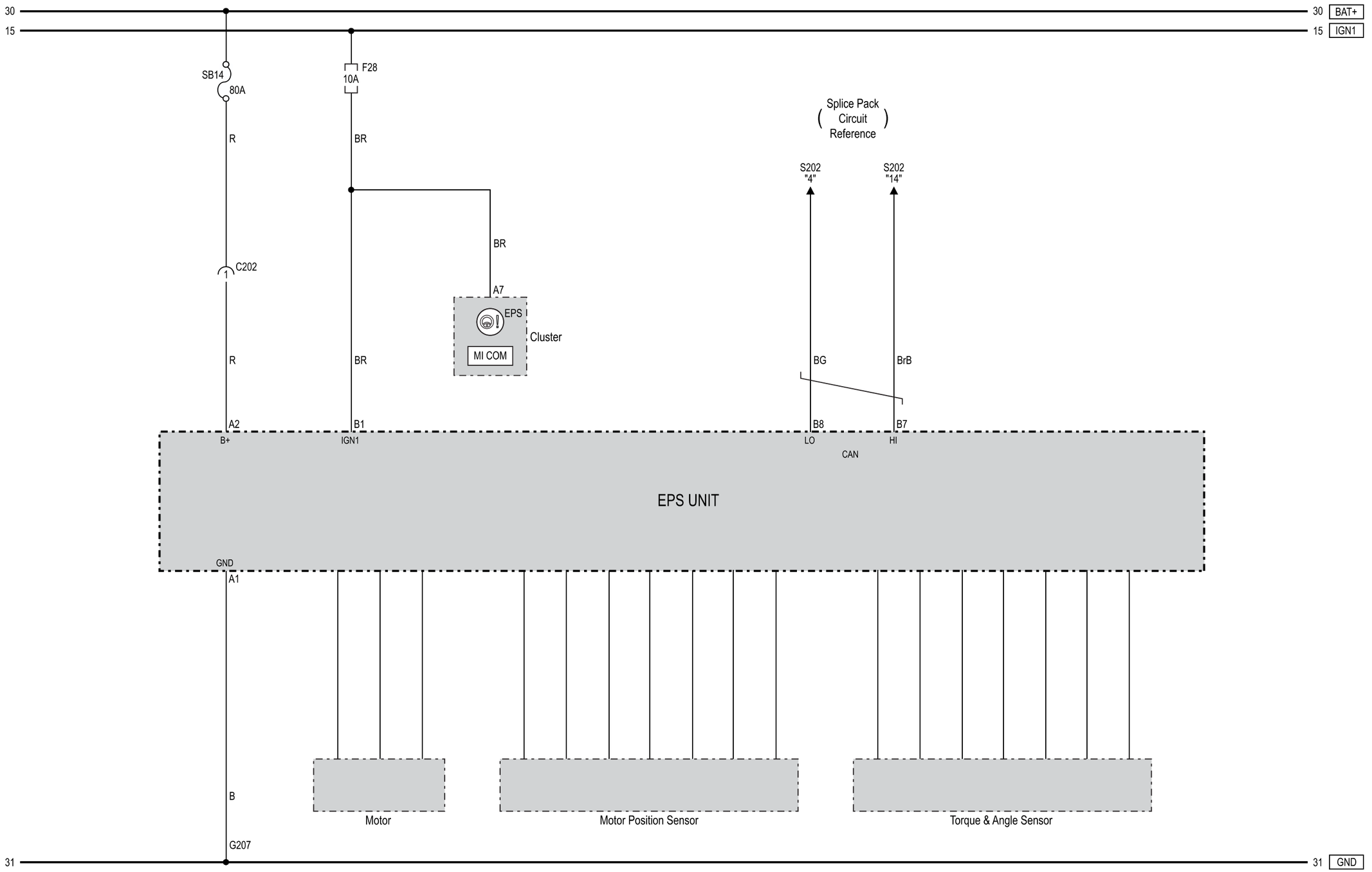
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

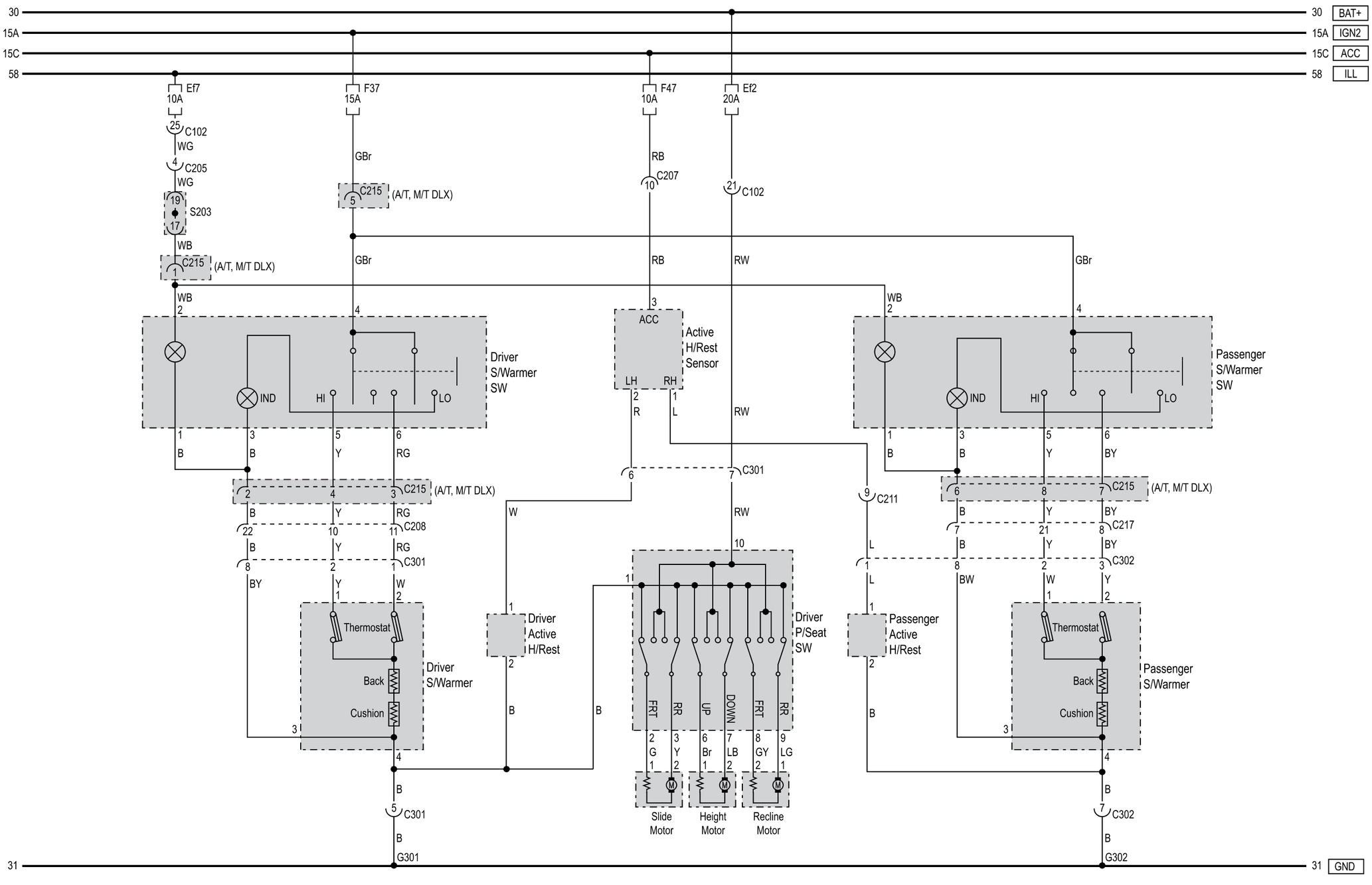
S.G.N. 4610-04

EPS



Modification basis	
Application basis	
Affected VIN	

S.G.N.
7410-02 POWER SEAT / FRT SEAT WARMER



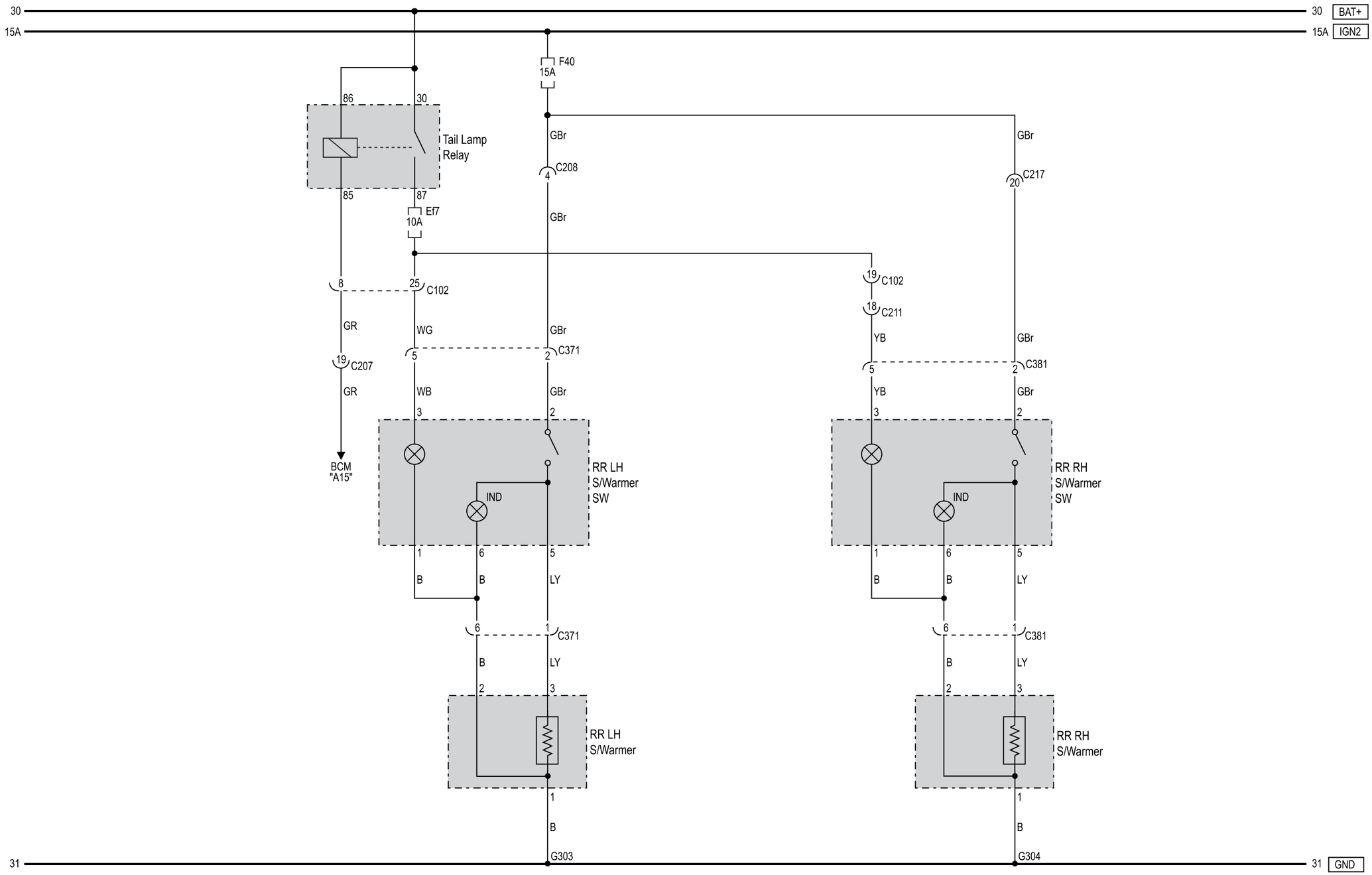
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8510-48

REAR SEAT WARMER

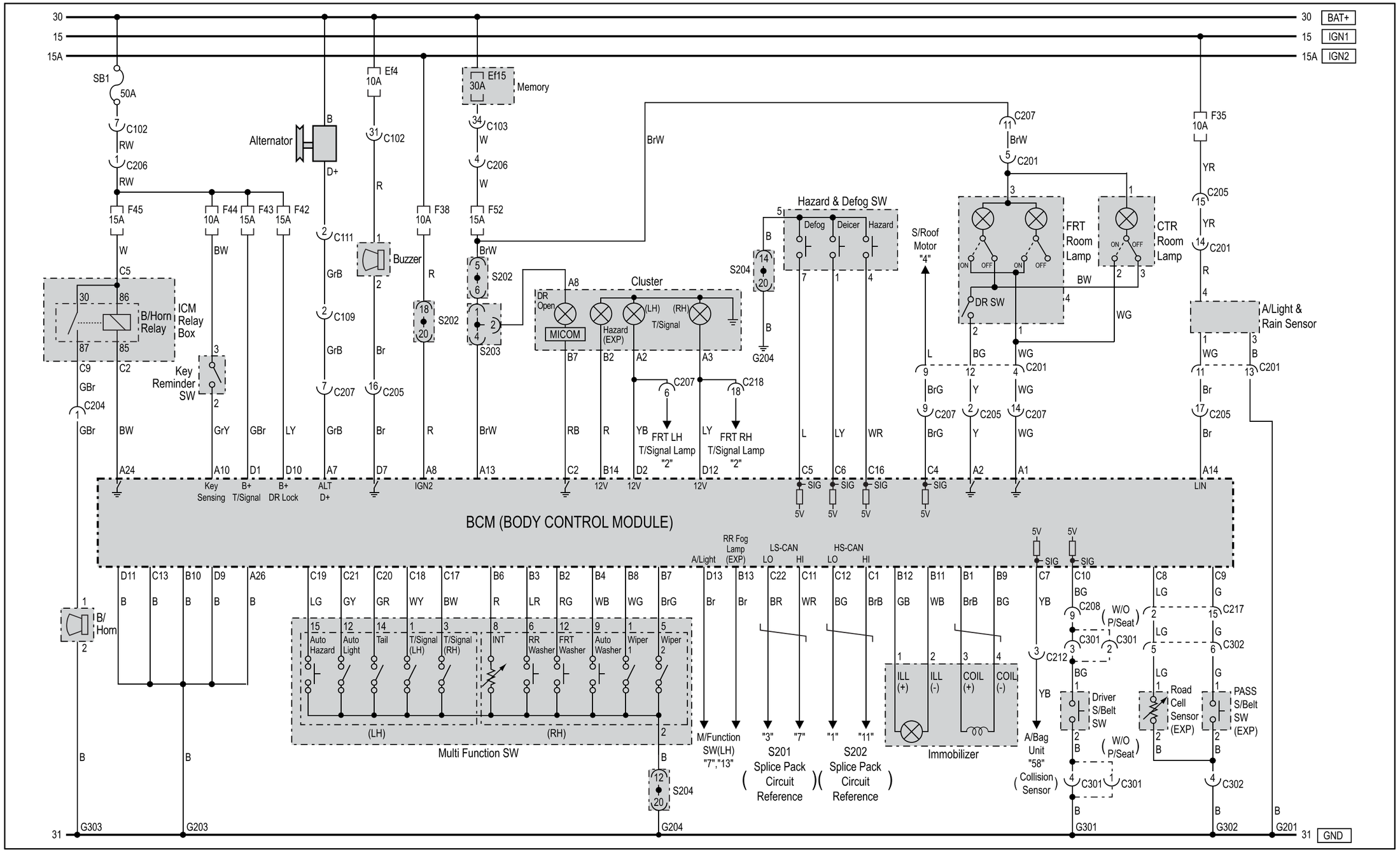


Modification basis	
Application basis	
Affected VIN	

S.G.N. 8620-01

BCM(BODY CONTROL MODULE)

(1) POWER/GROUND, B/HORN, BUZZER, CLUSTER, HAZARD, ROOM LAMP, M/FUNCTION SW, IMMO, A/LIGHT

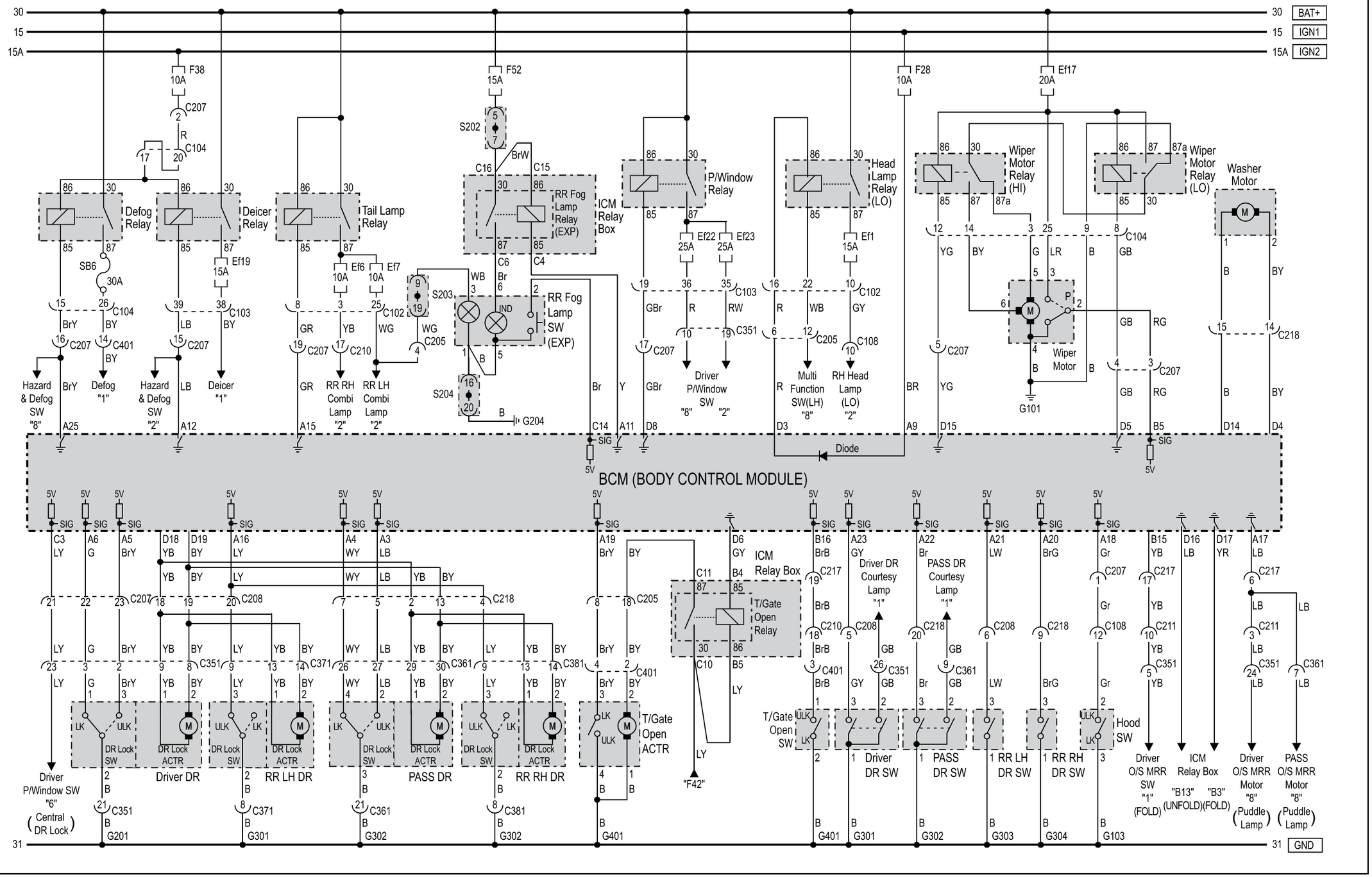


CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

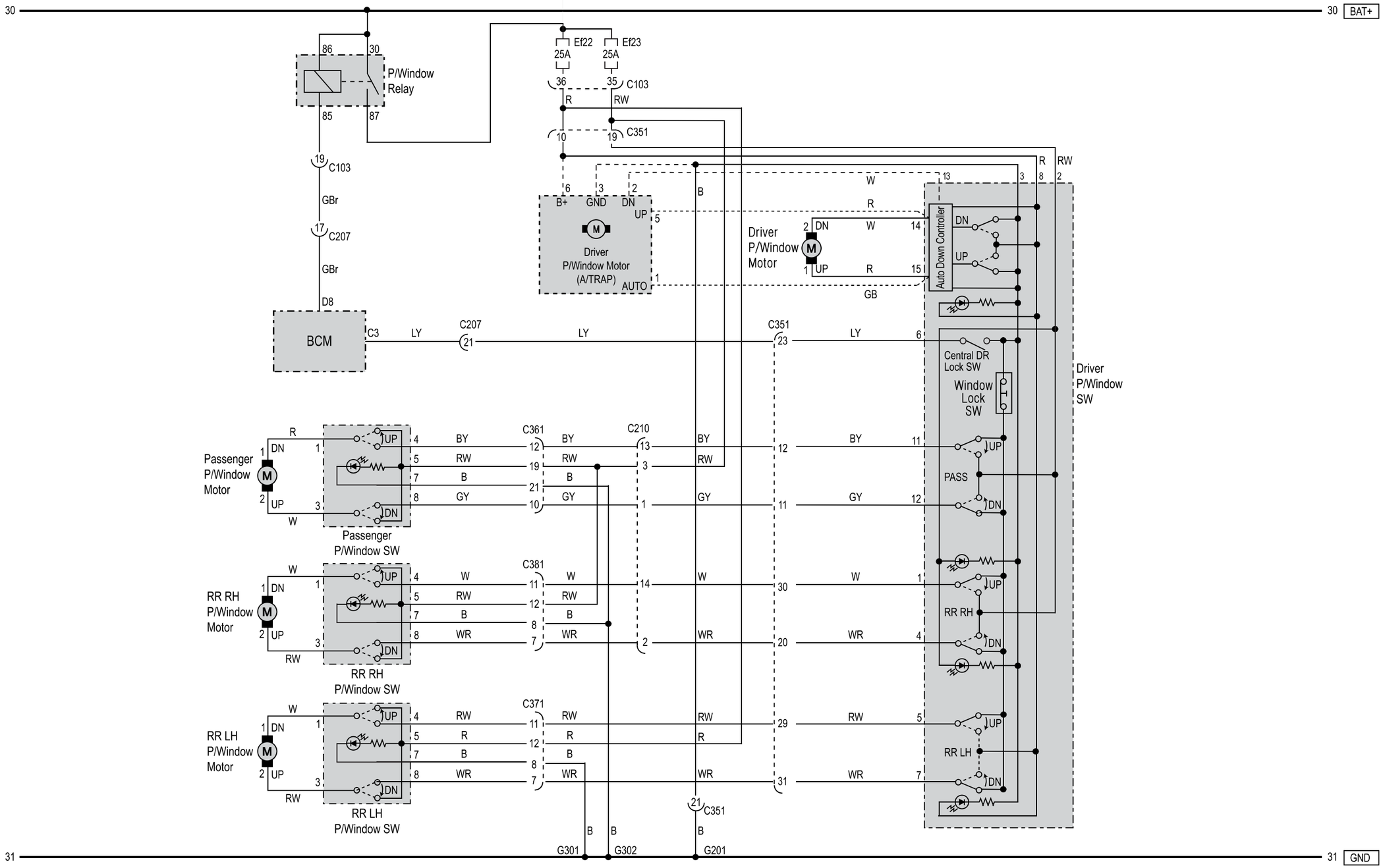
(2) DR LOCK, FOLDING, DEFOG/DEICER, P/WINDOW, WIPER/WASHER, DR SWITCH



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8510-05

POWER WINDOW



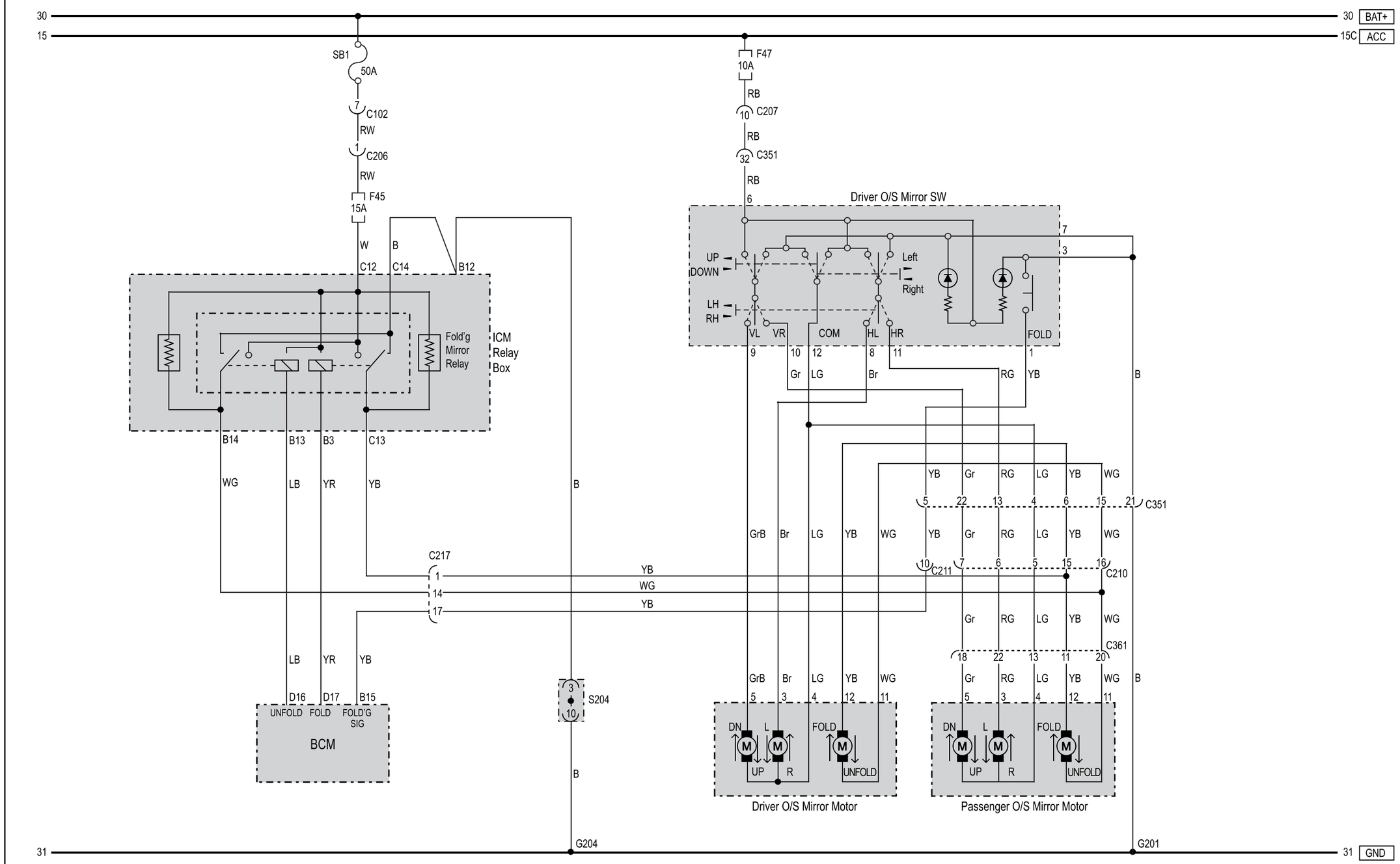
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8510-52

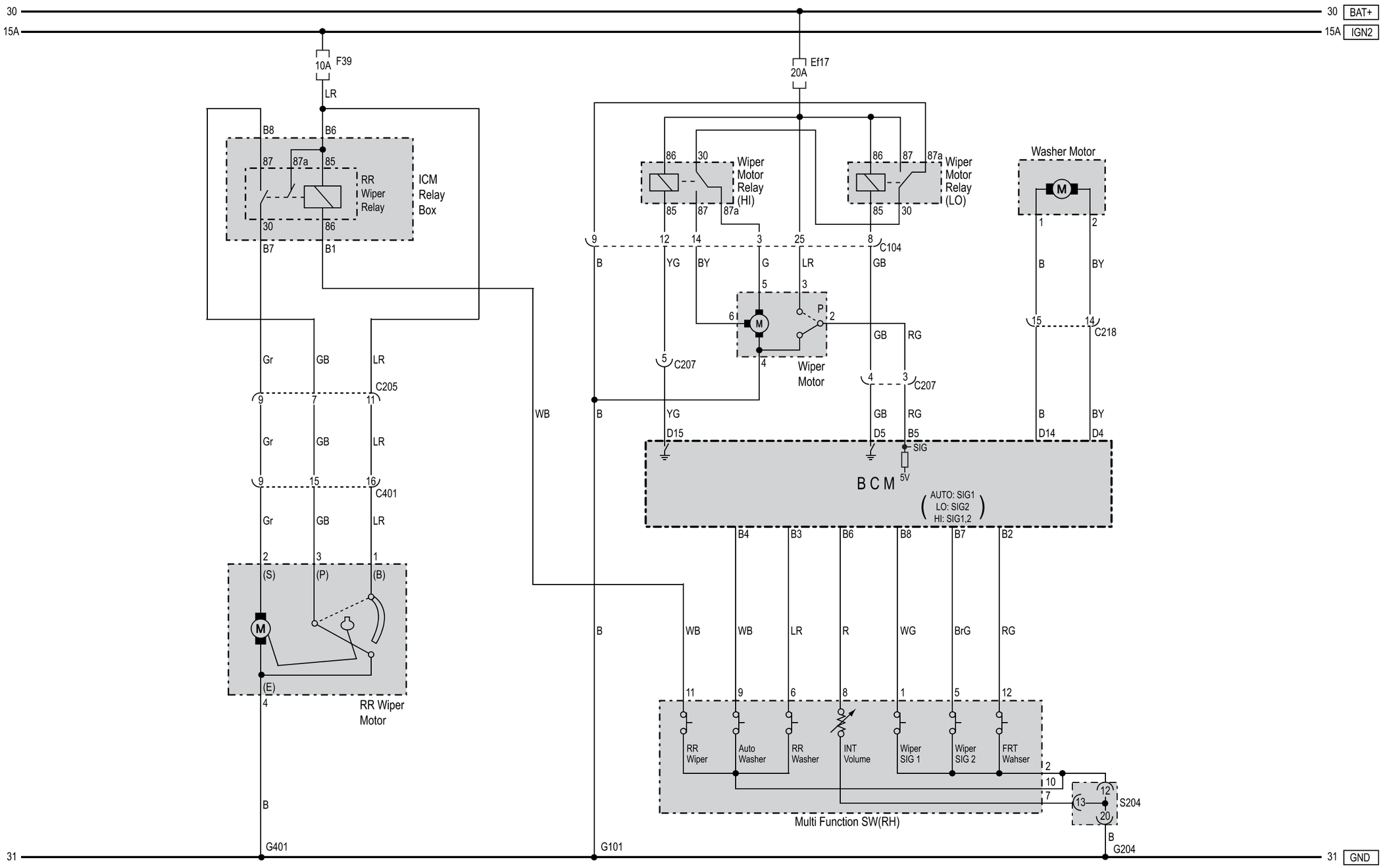
OUTSIDE MIRROR



Modification basis	
Application basis	
Affected VIN	

S.G.N. 7810-01

FRT(RR) WIPER / WASHER

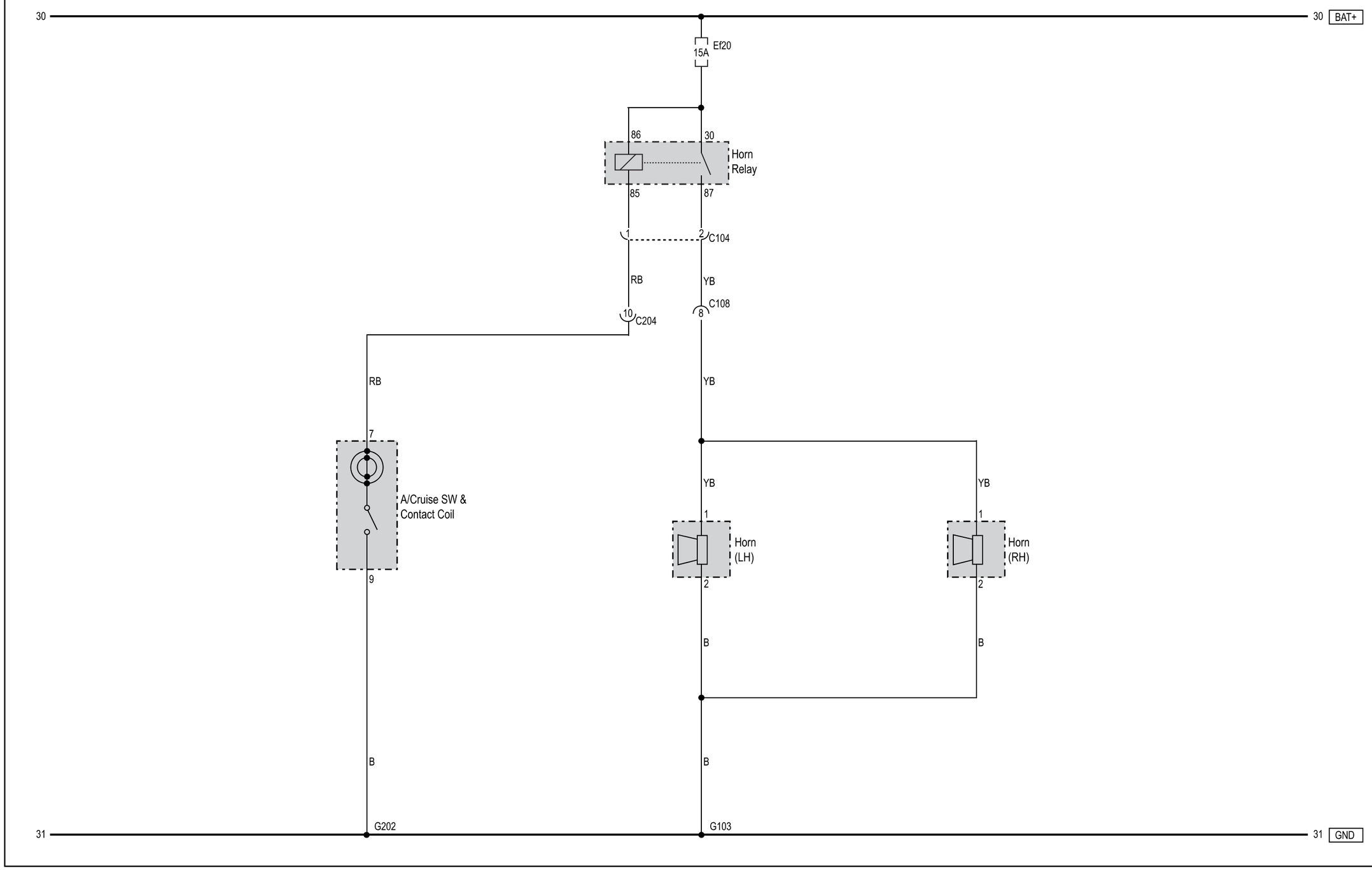


CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

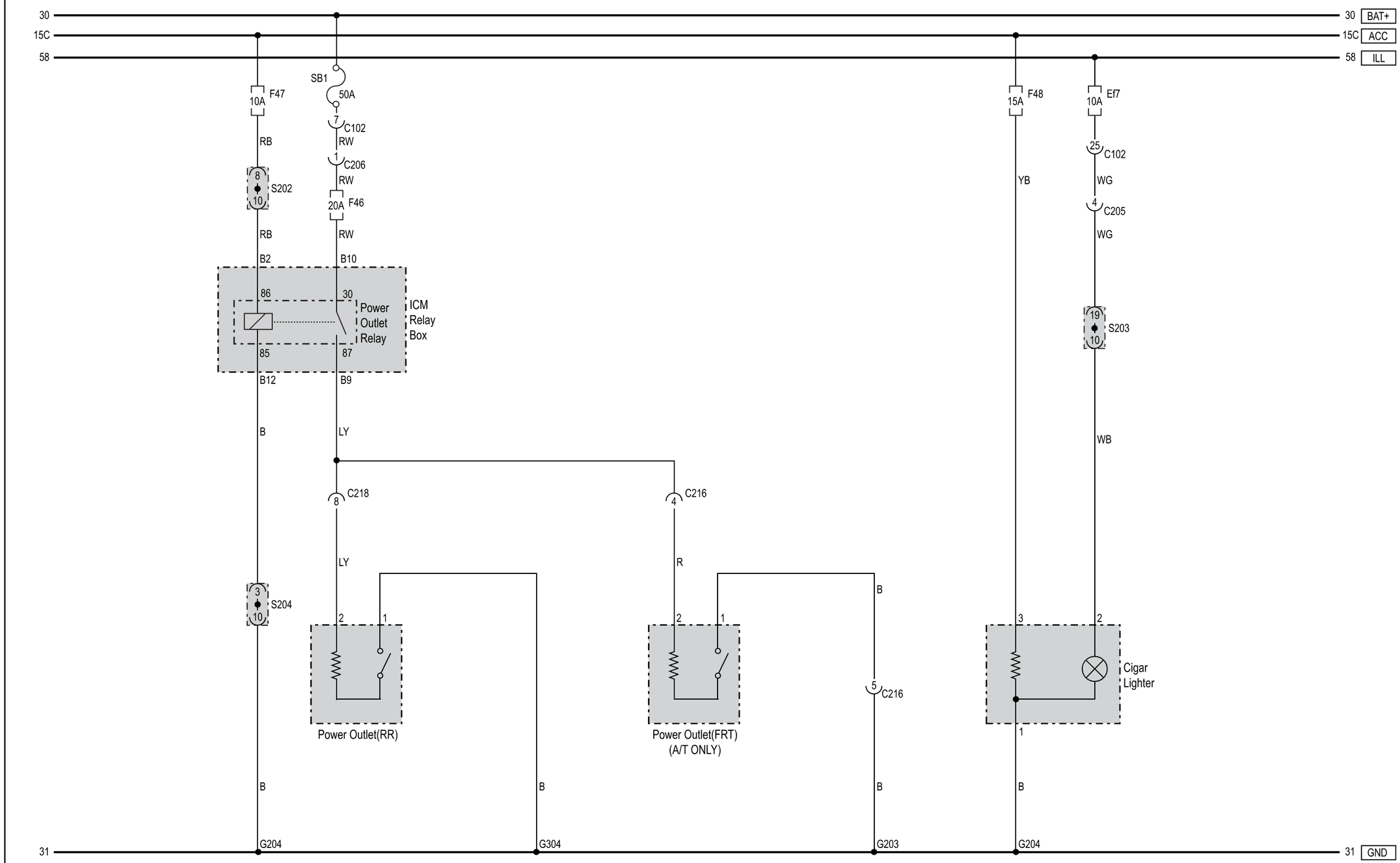
S.G.N.
8610-06 **HORN**



Modification basis	
Application basis	
Affected VIN	

S.G.N. 7632-16

CIGAR LIGHTER / POWER OUTLET



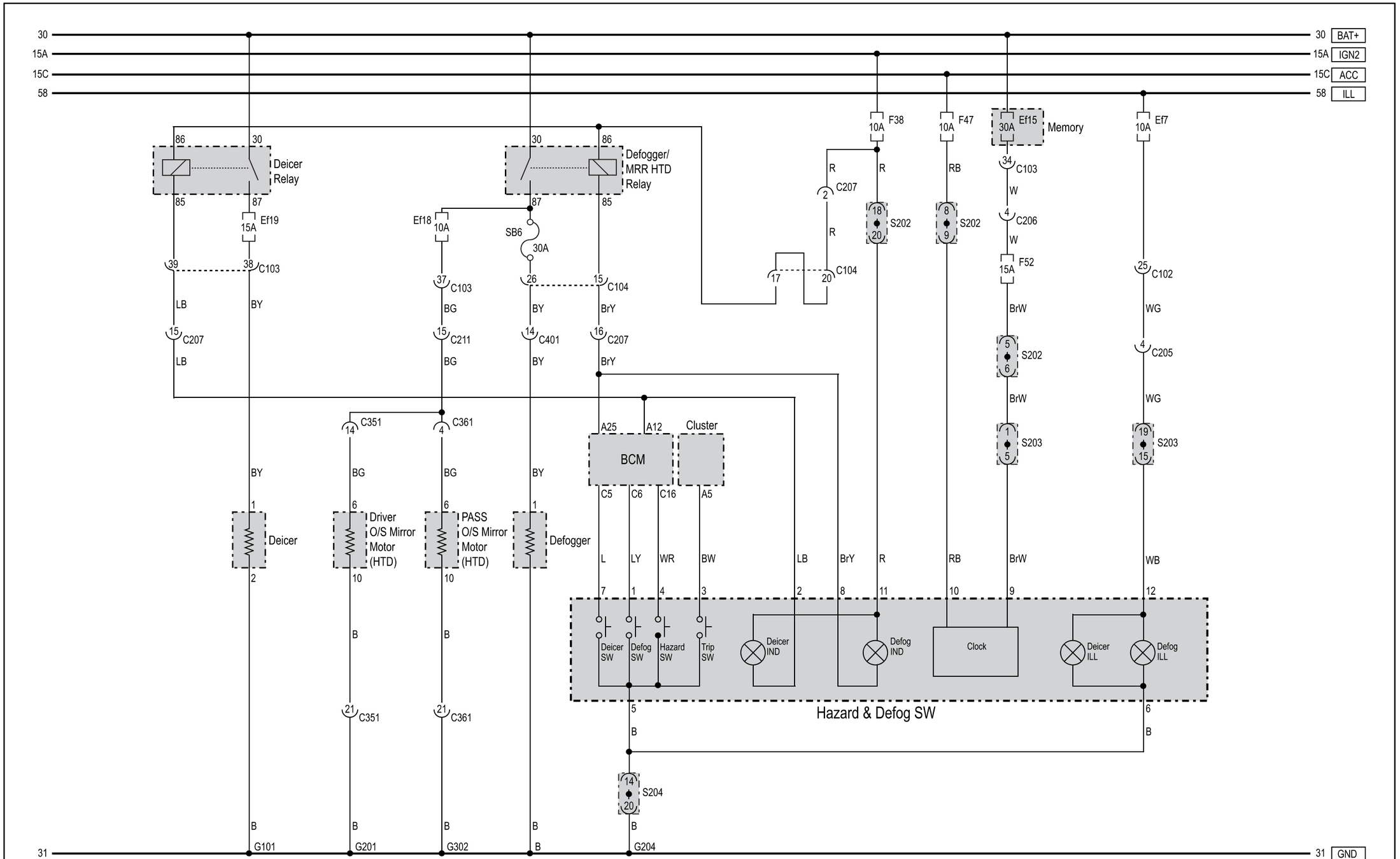
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 7840-01

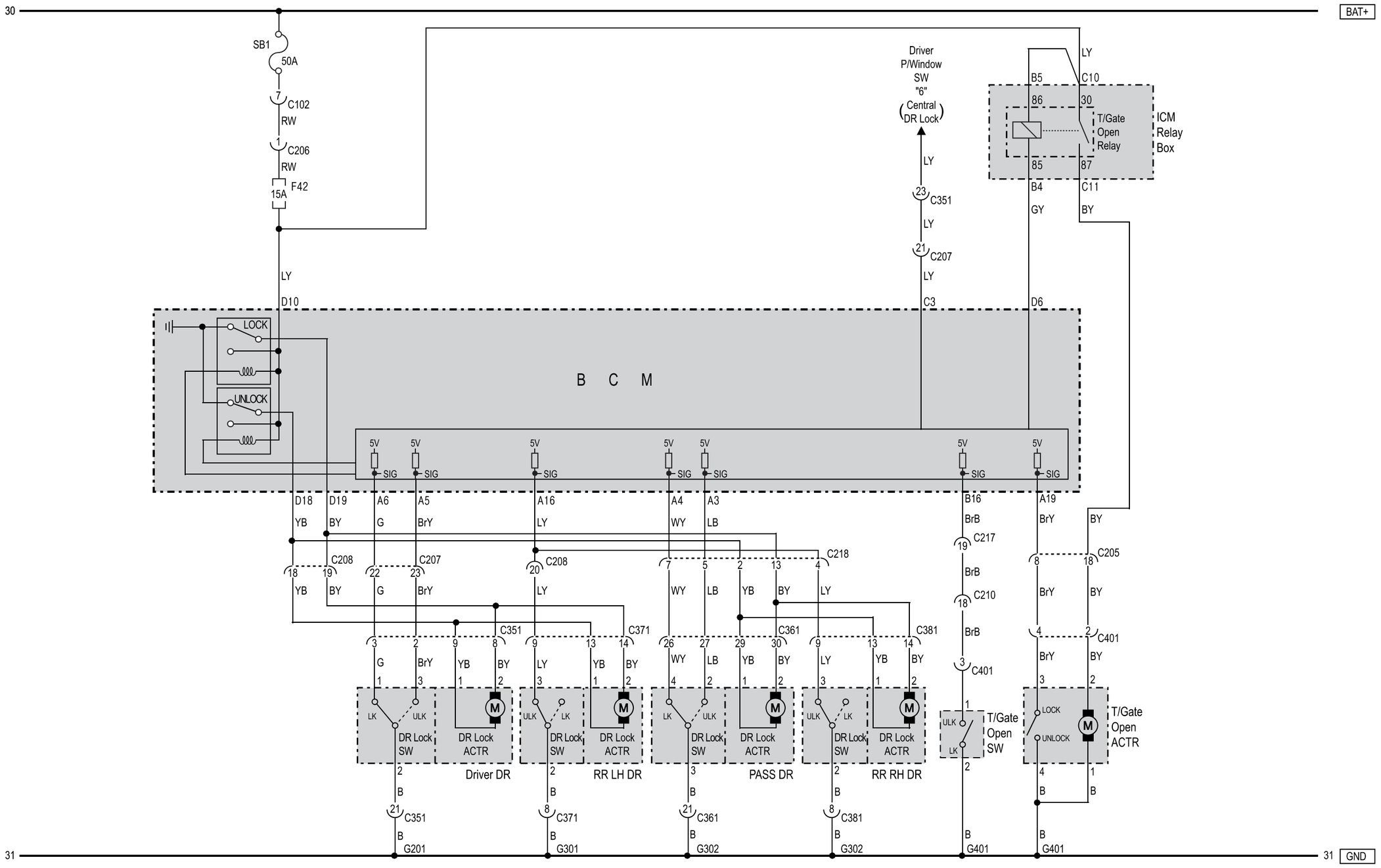
DEFOGGER / DEICER



Modification basis	
Application basis	
Affected VIN	

S.G.N.
8710-03

DOOR LOCK CIRCUIT



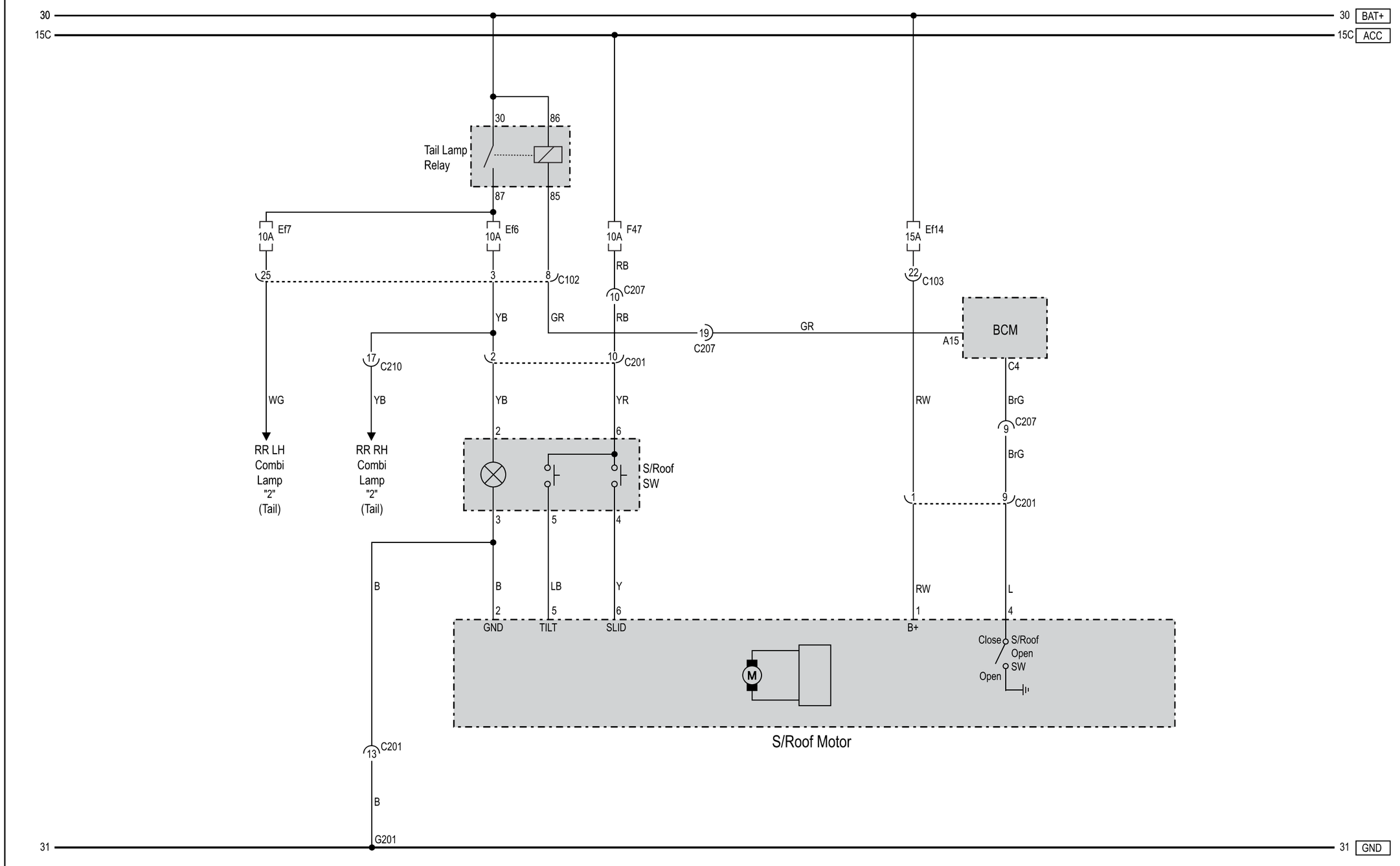
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 7340-03

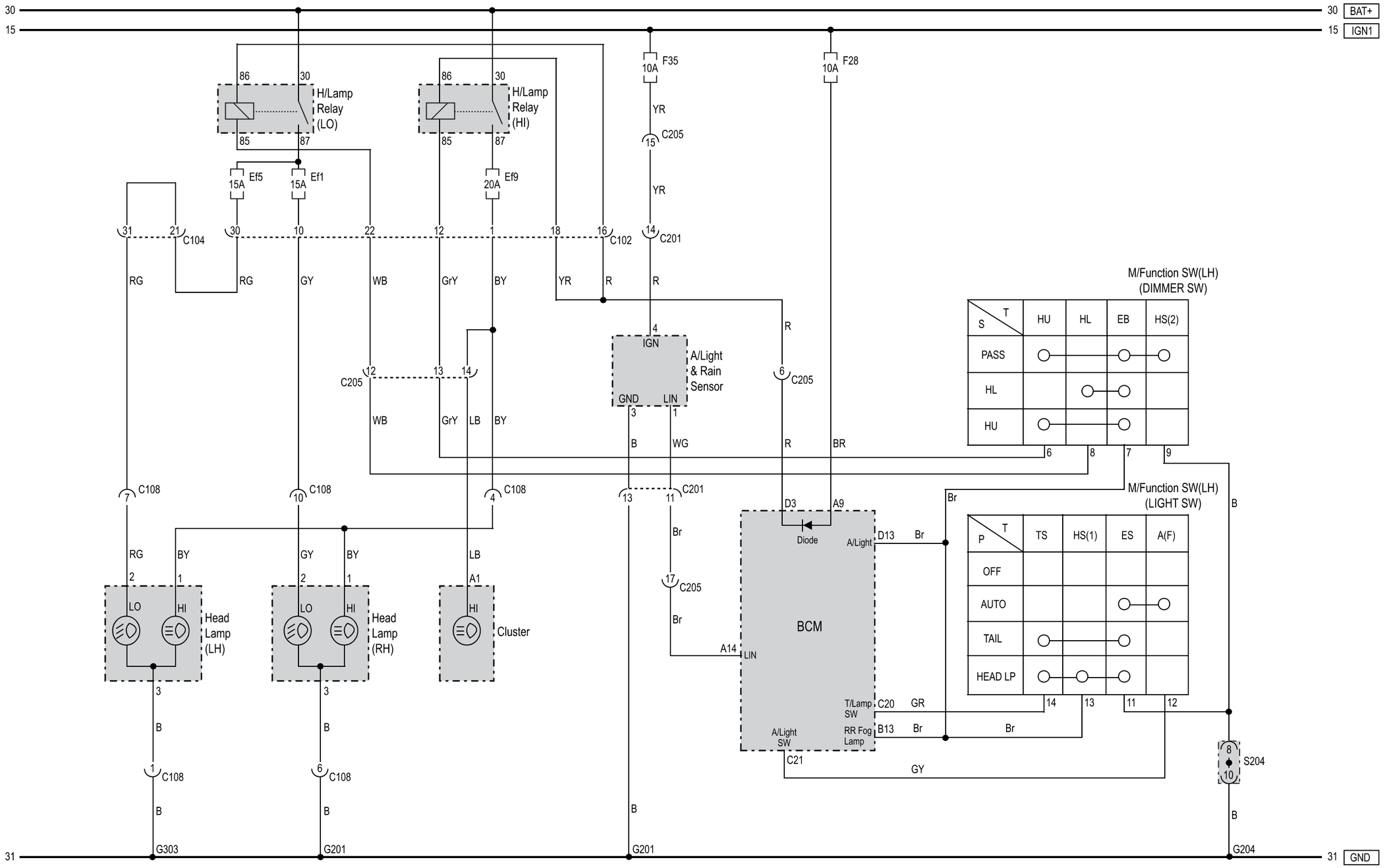
SUN ROOF



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8310-01

HEAD LAMP



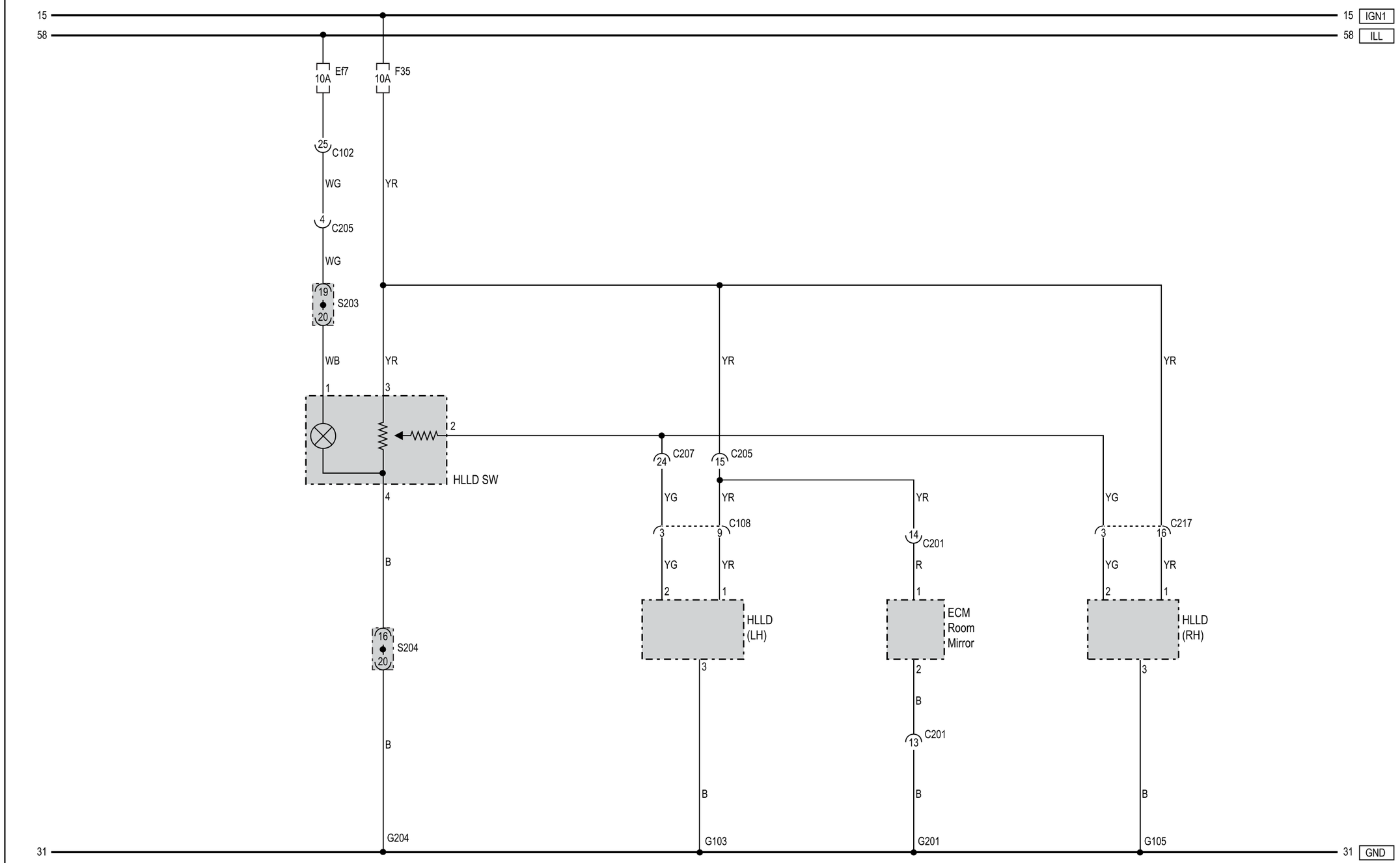
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8310-01

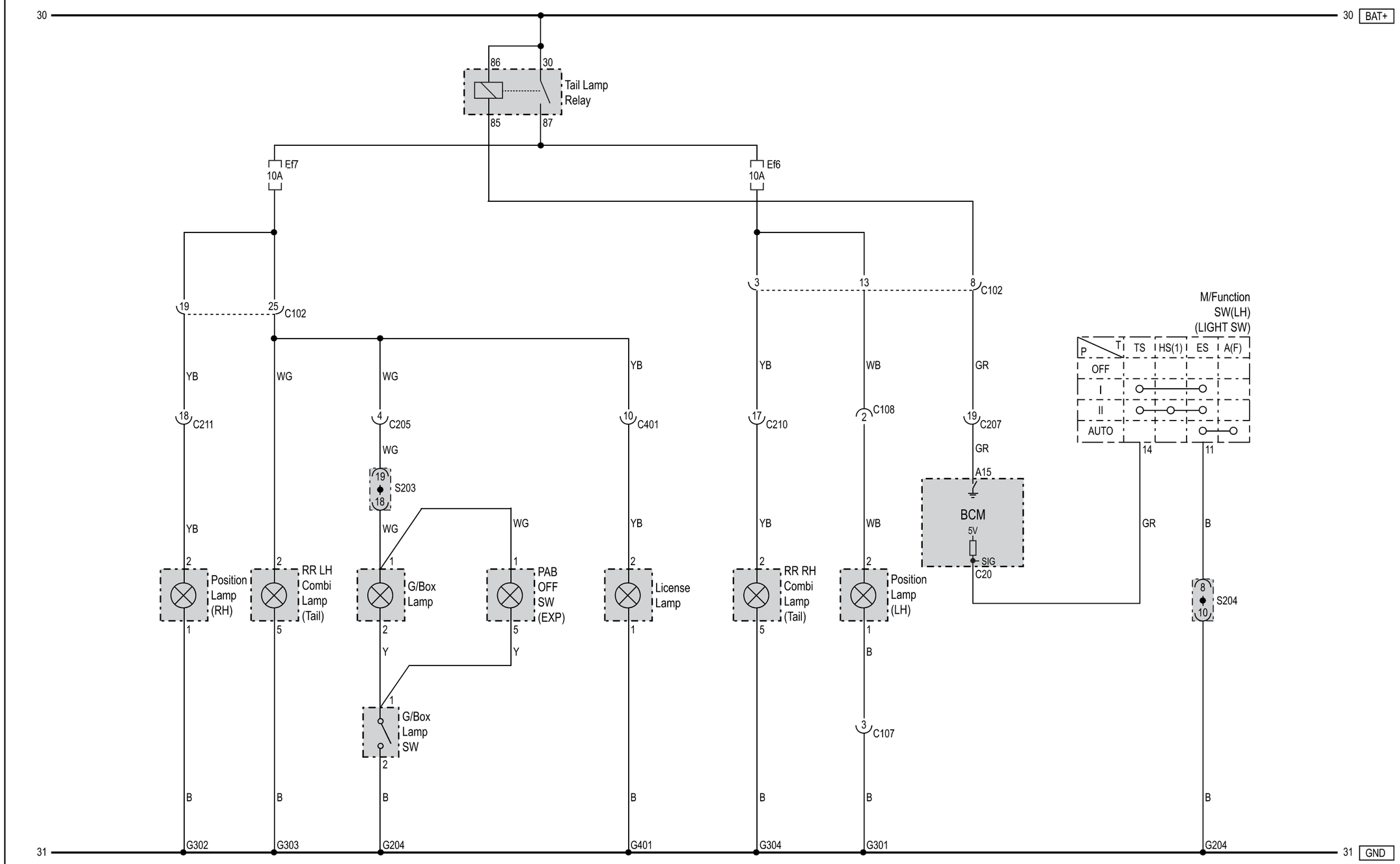
HEAD LAMP LEVEL' G DEVICE(EXP)



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8320-01

TAIL LAMP



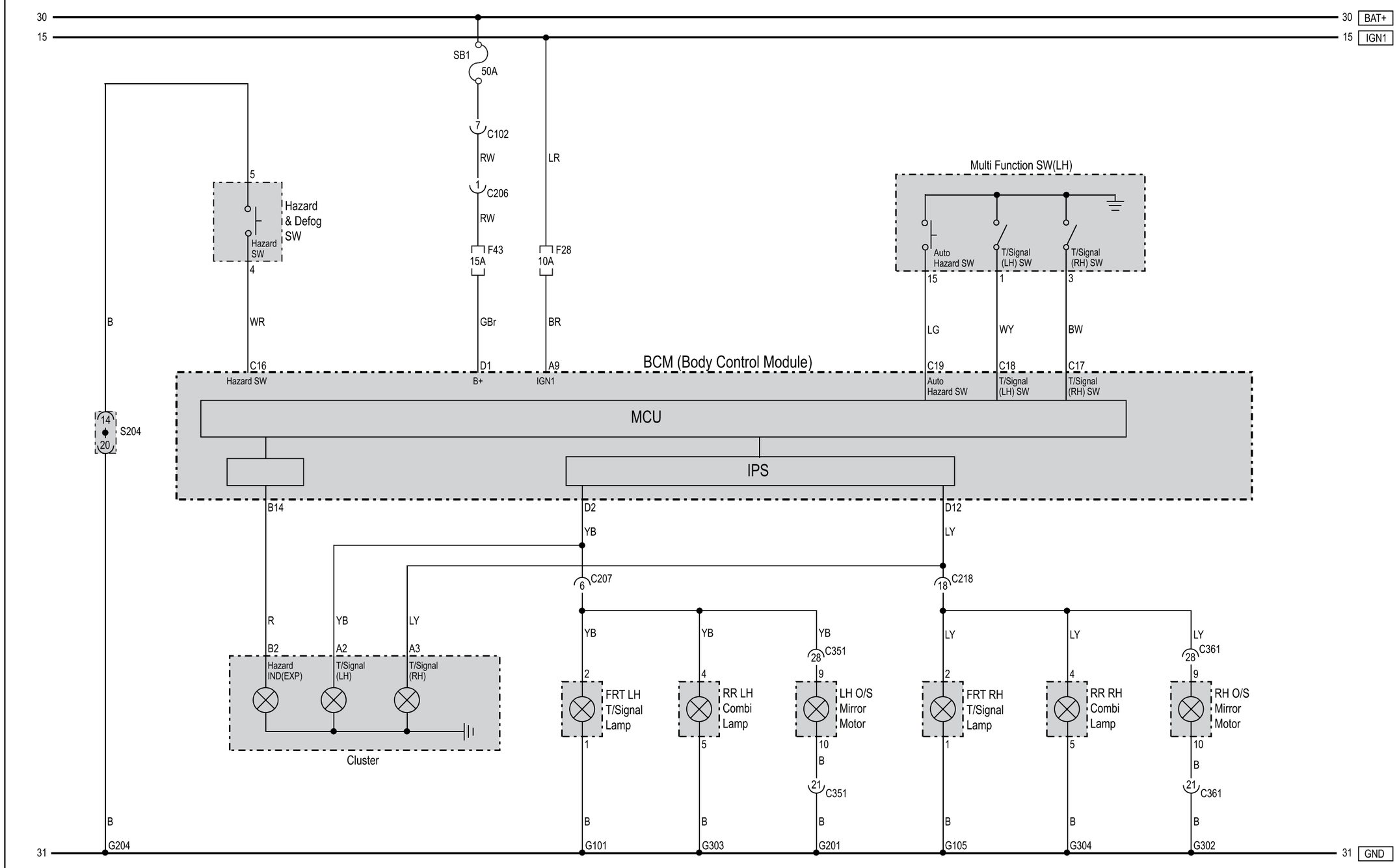
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8310-01

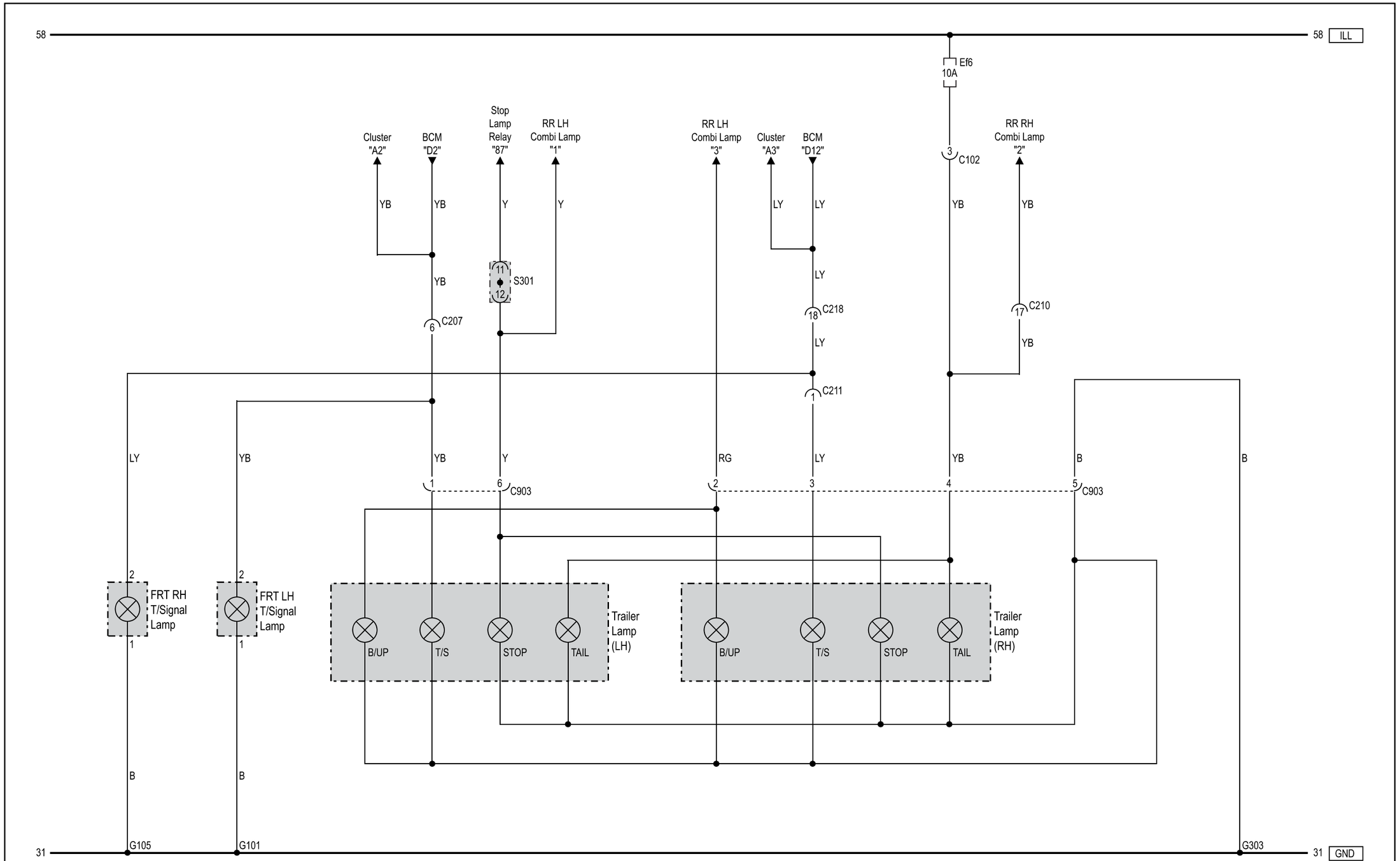
TURN SIGNAL LAMP / HAZARD LAMP



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8210-03

TRAILER LAMP(EXP)



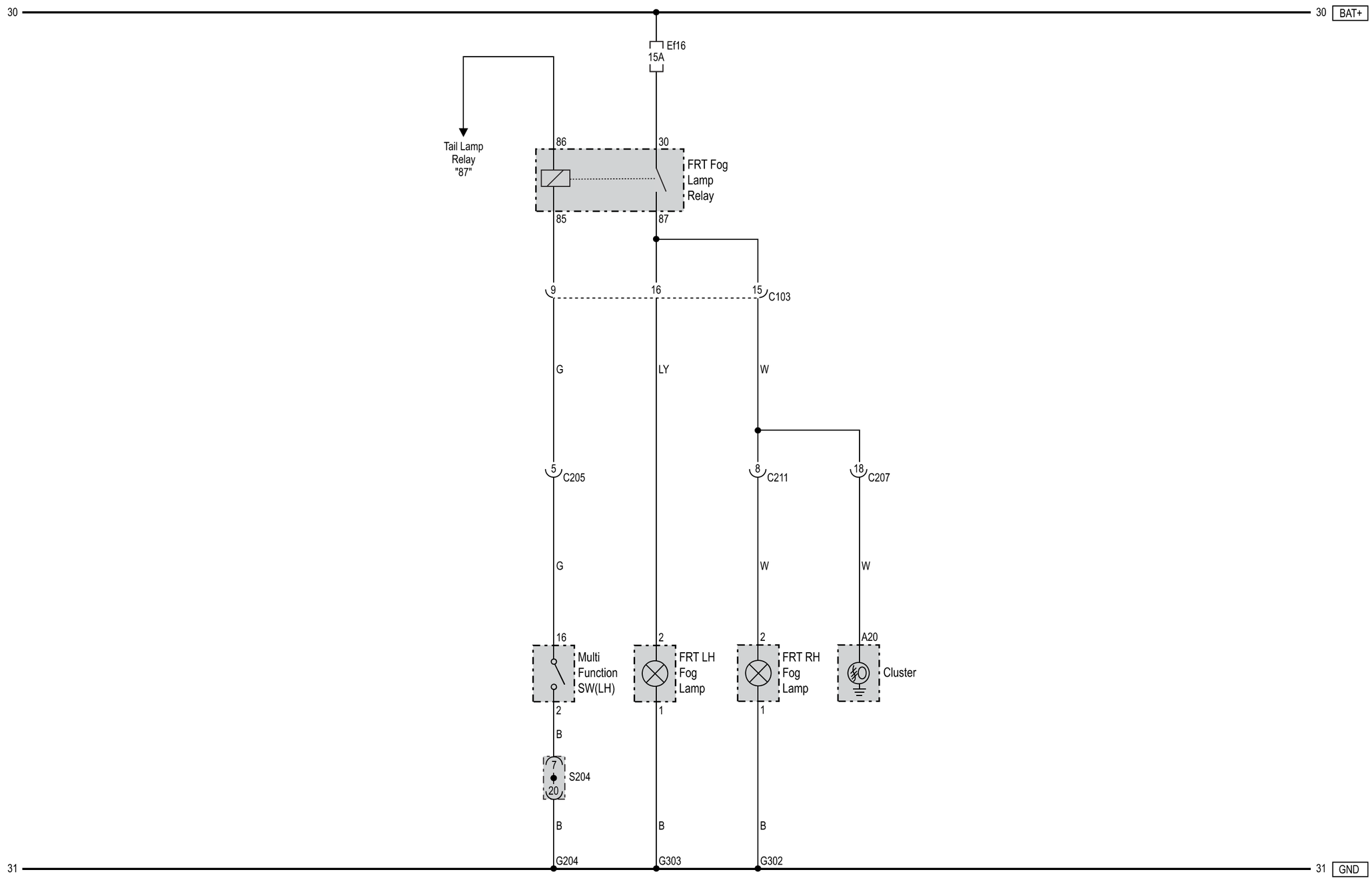
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N.
8310-10

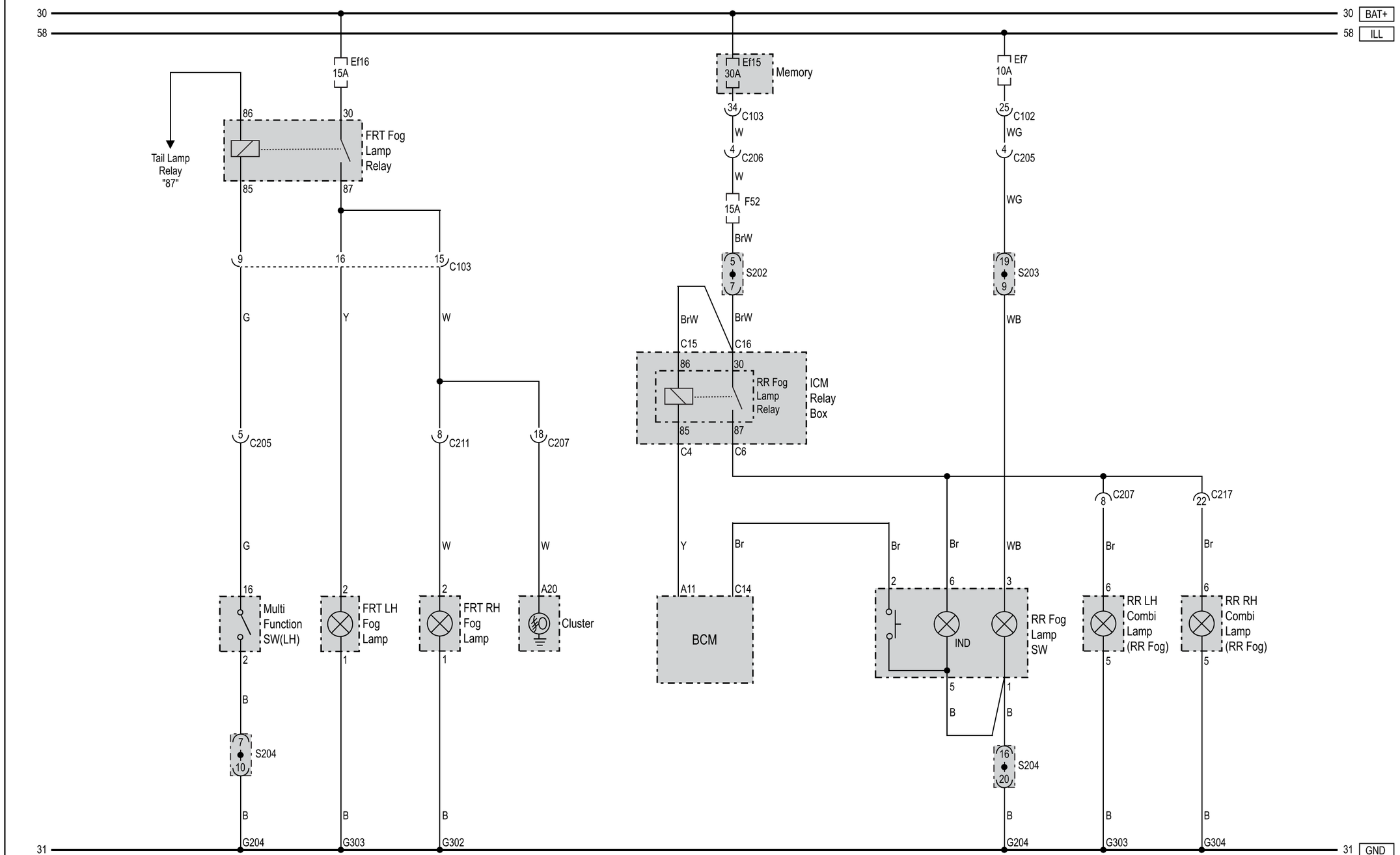
FRT FOG LAMP(DOM)



Modification basis	
Application basis	
Affected VIN	

S.G.N.
8310-10

FRT / RR FOG LAMP(EXP)



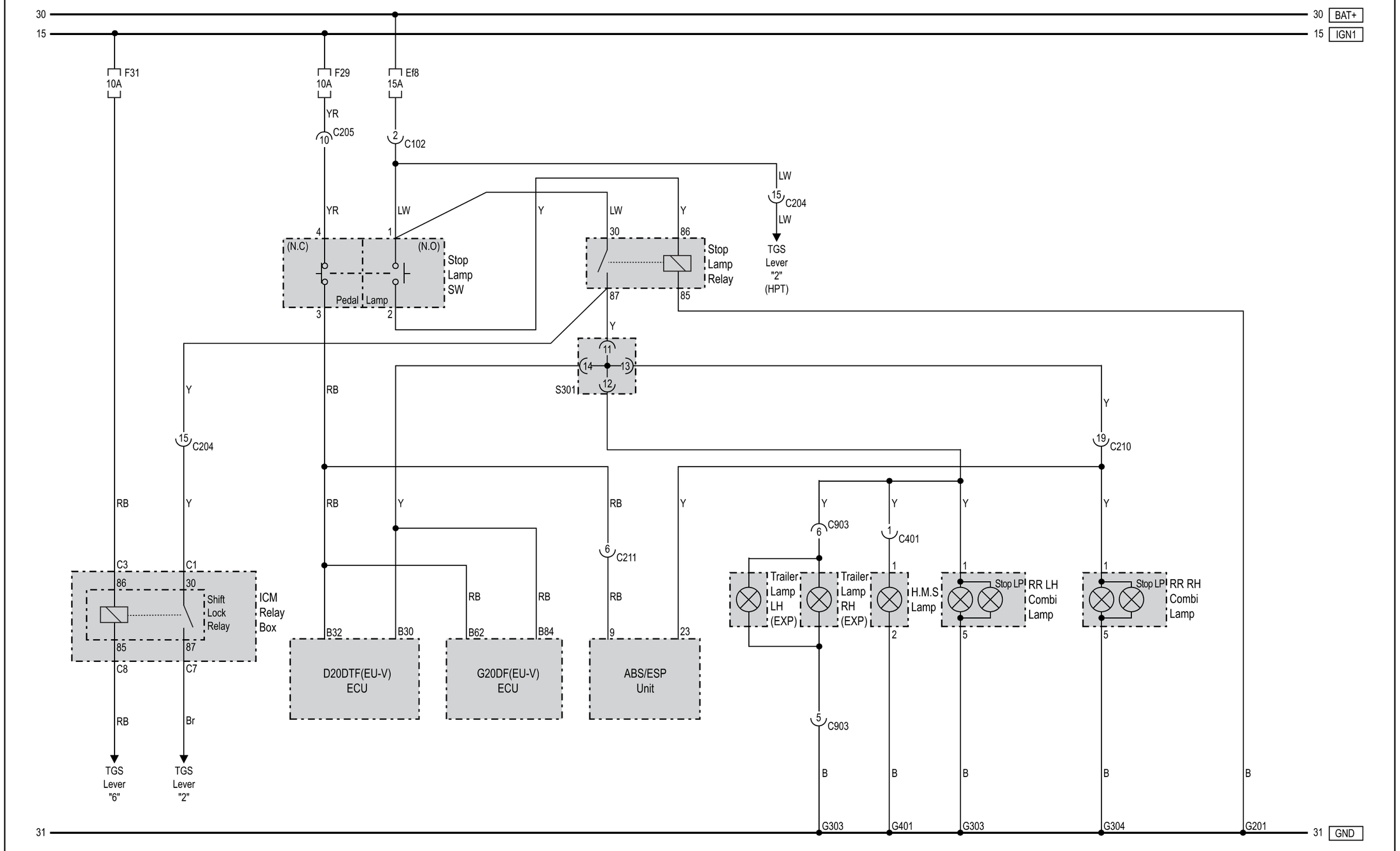
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 4810-08

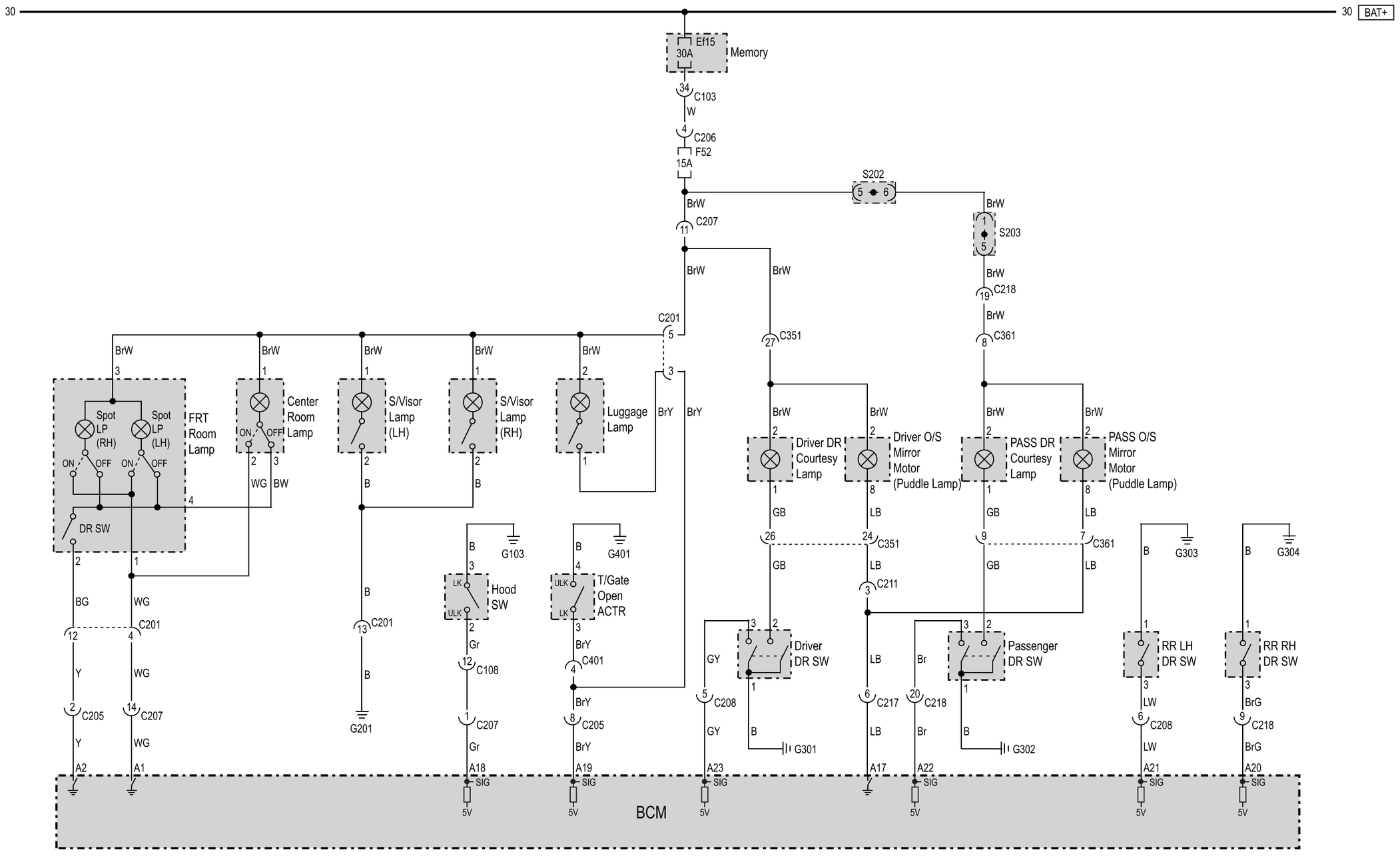
STOP LAMP



Modification basis	
Application basis	
Affected VIN	

S.G.N. 7770-02

INTERIOR / DOOR LAMP



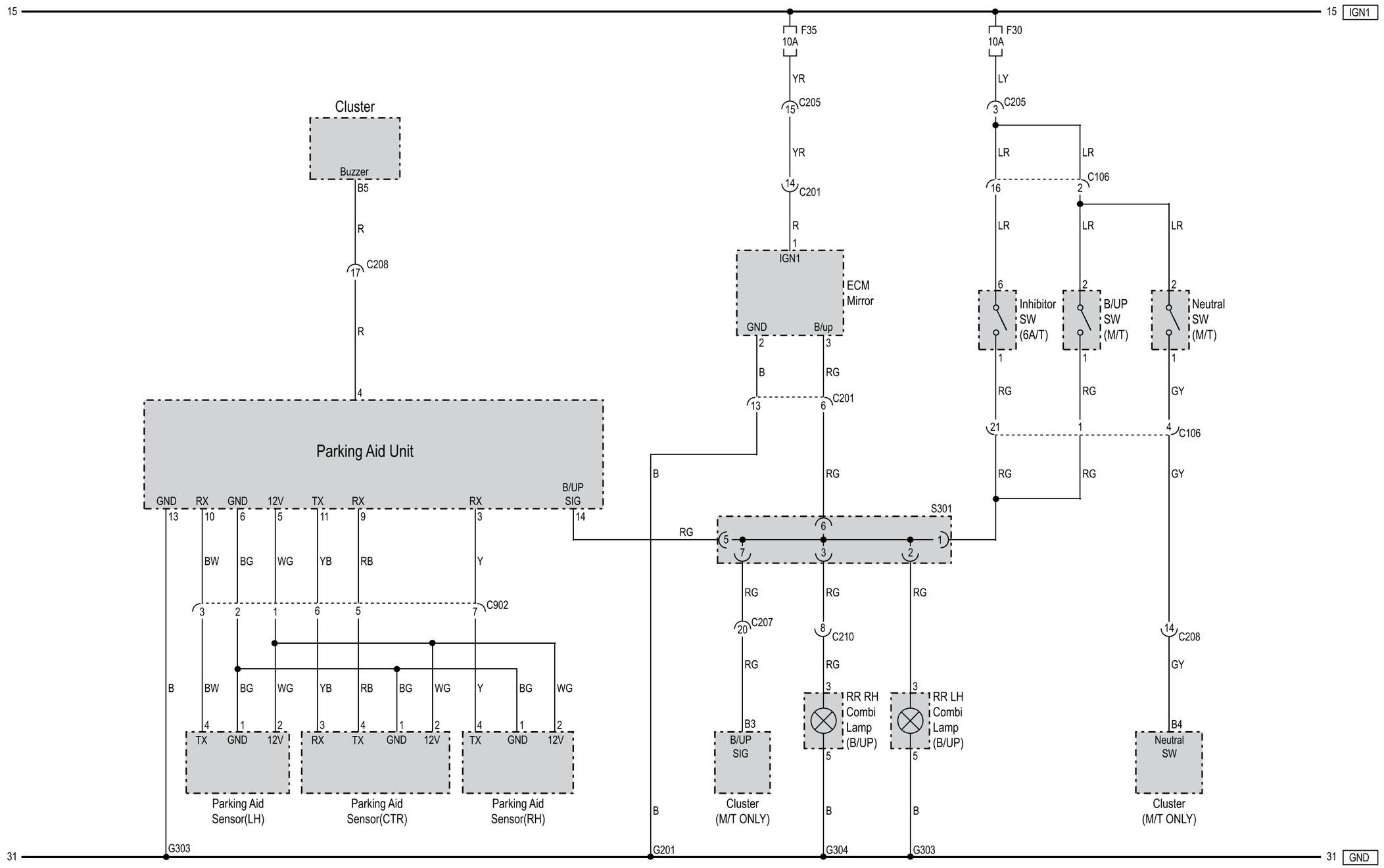
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8790-01

PARKING AID / BACK UP LAMP / ECM MIRROR

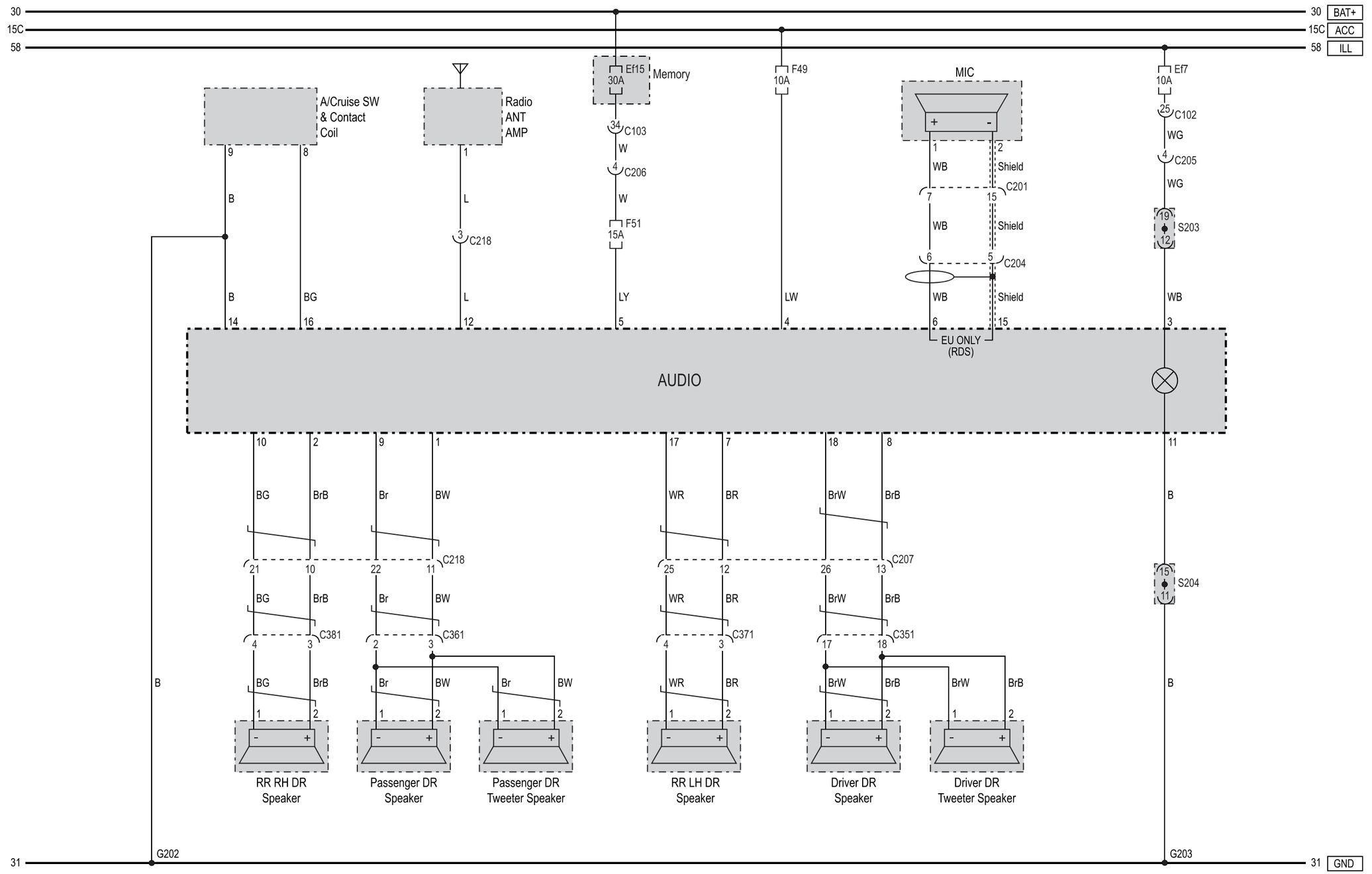


Modification basis	
Application basis	
Affected VIN	

CIRCUIT

KORANDO 2012.10

S.G.N.
8930-03 **AUDIO**



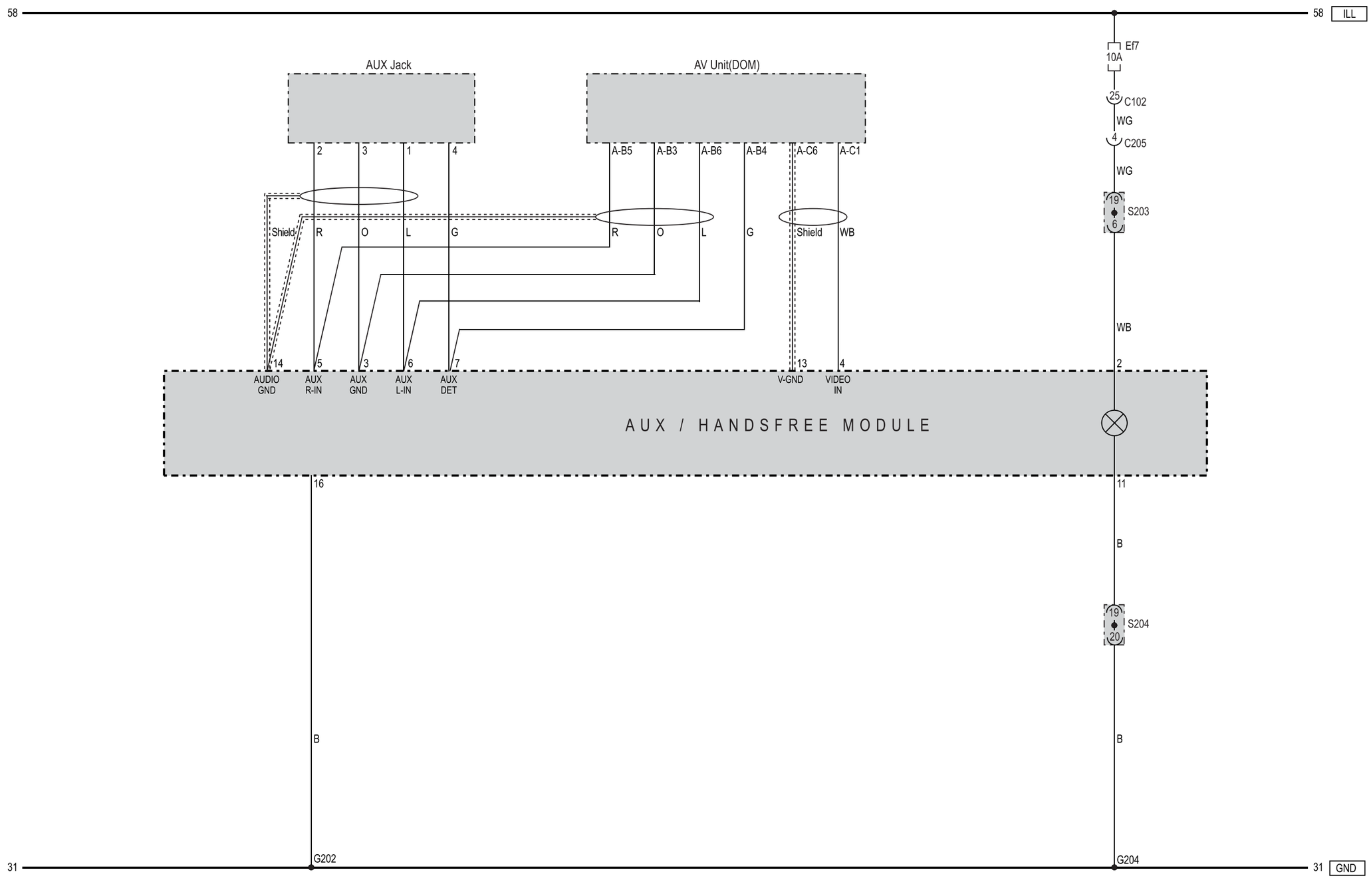
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8930-40

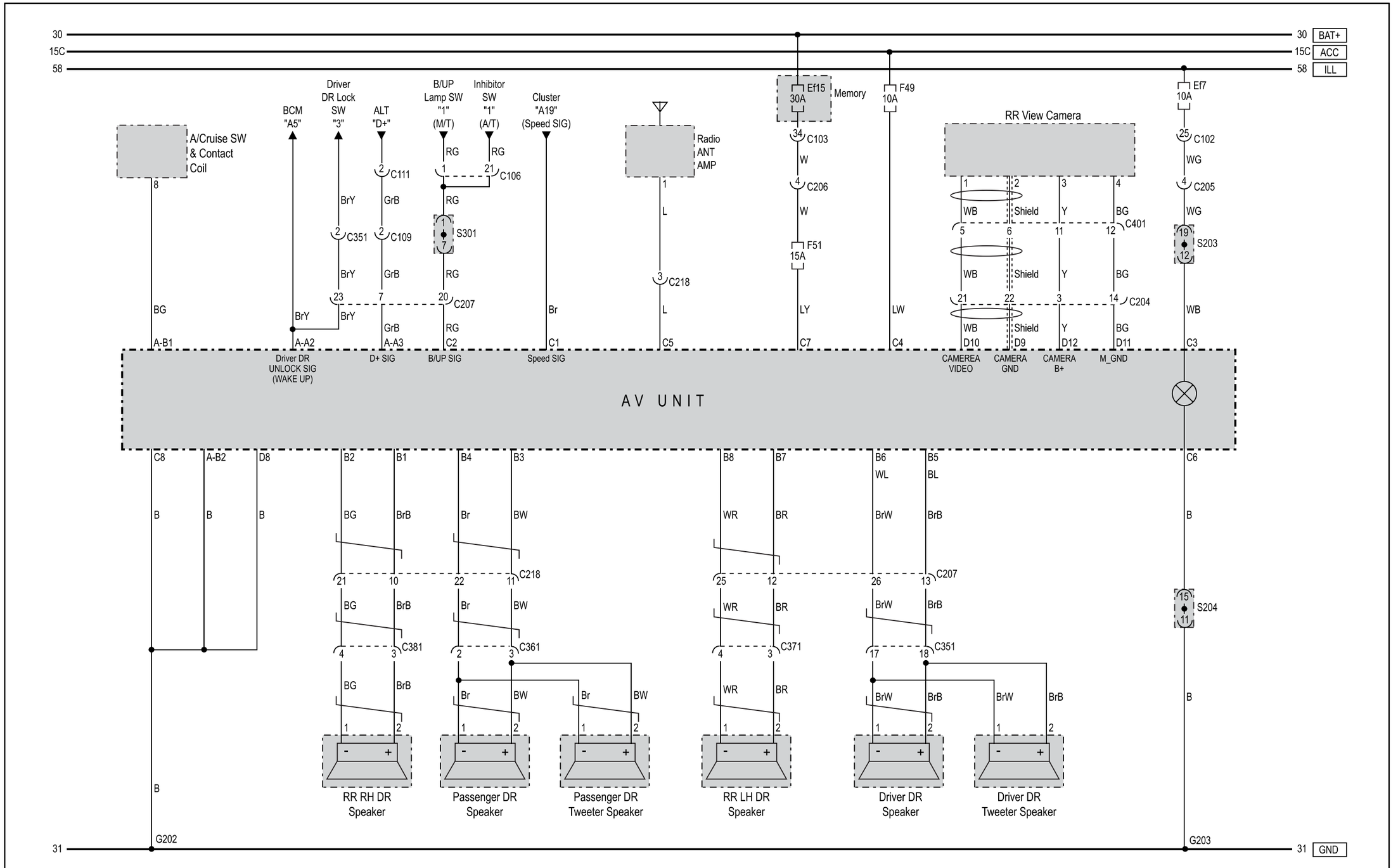
AUX / HANDSFREE MODULE



Modification basis	
Application basis	
Affected VIN	

S.G.N. 8930-01

AV SYSTEM



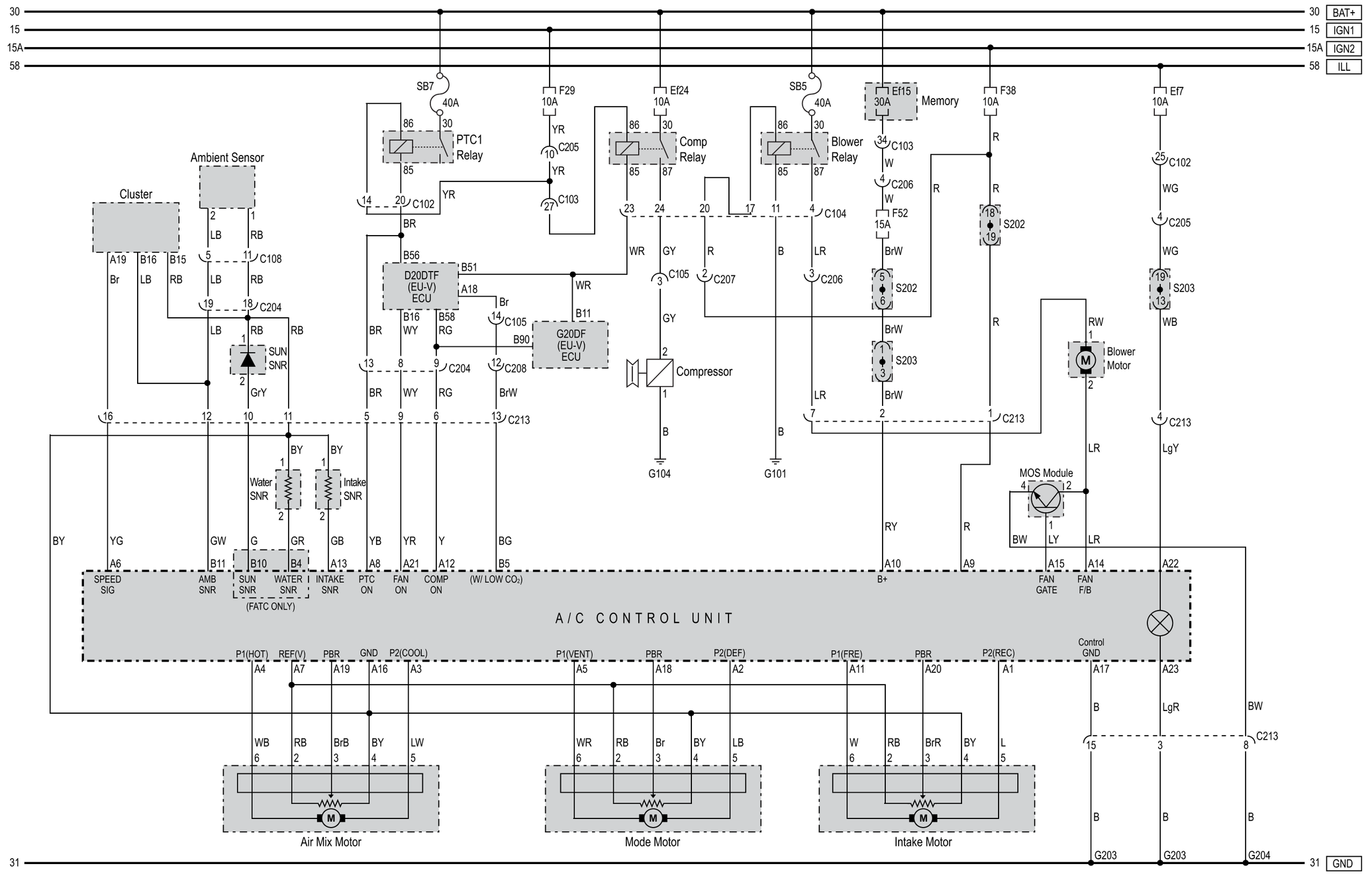
CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 6810-20

AIR CONDITIONER SYSTEM



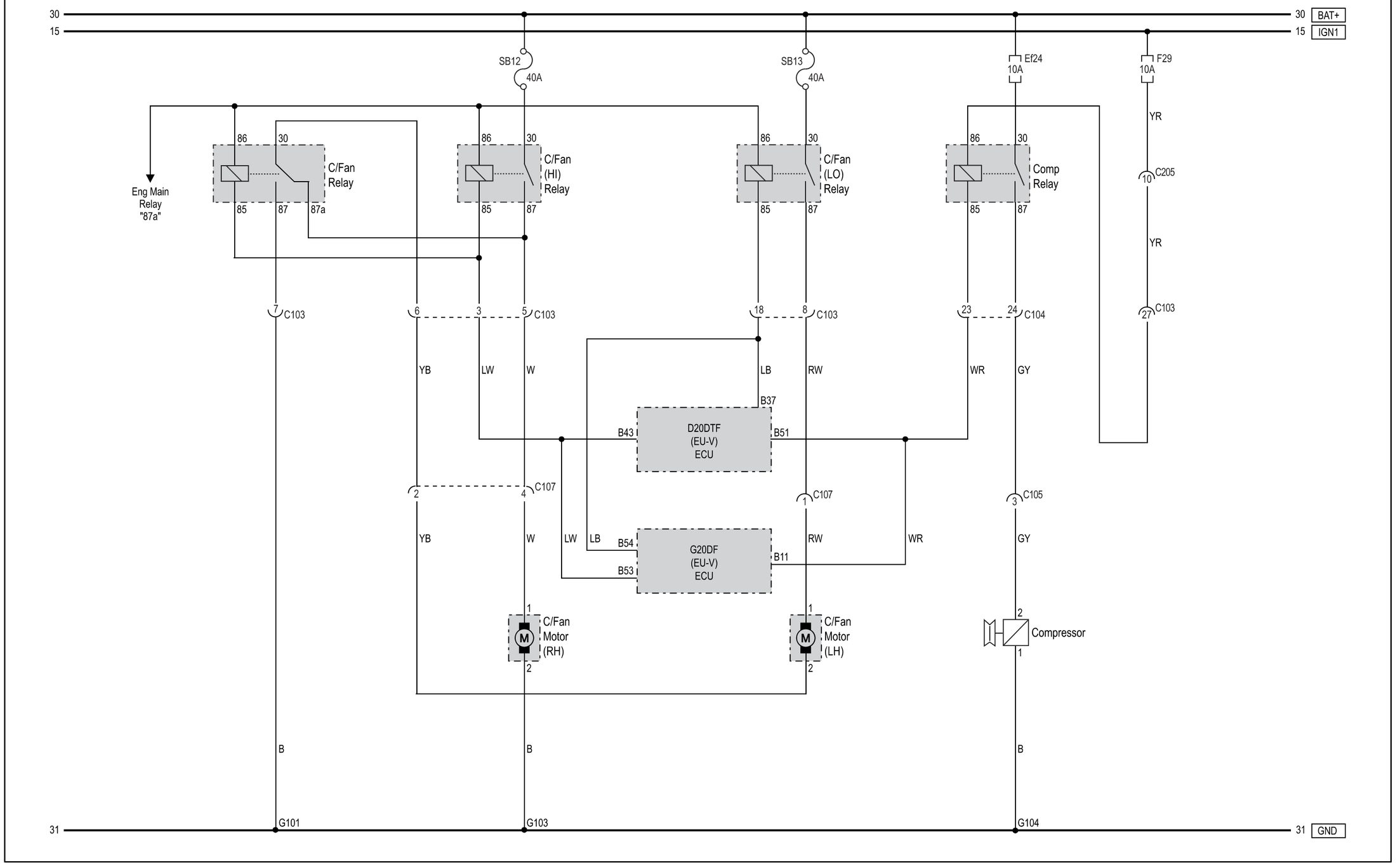
Modification basis	
Application basis	
Affected VIN	

CIRCUIT

KORANDO 2012.10

S.G.N. 2112-02

COOLING FAN SYSTEM



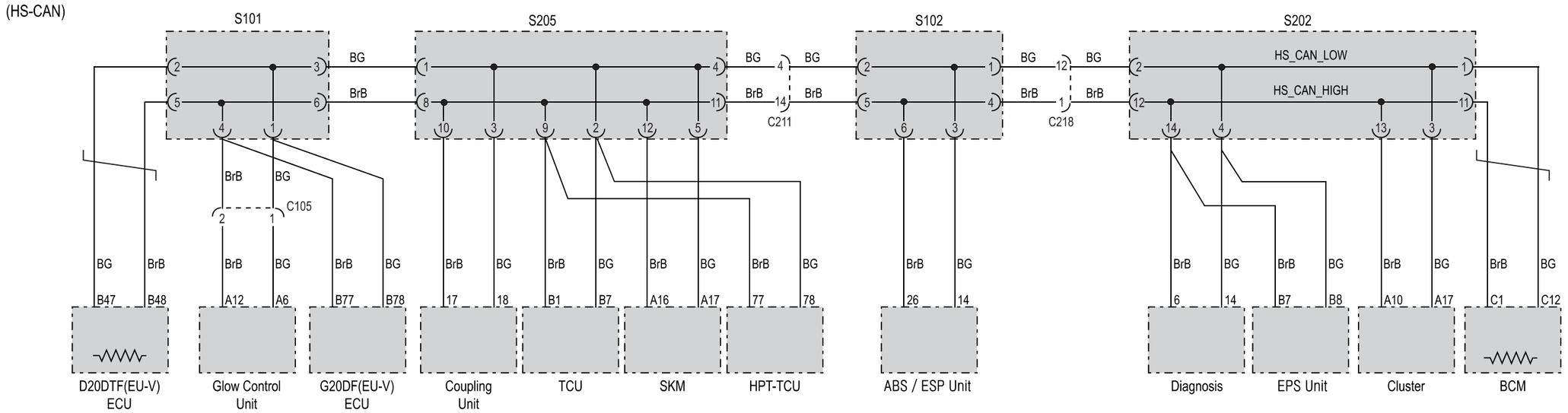
CIRCUIT

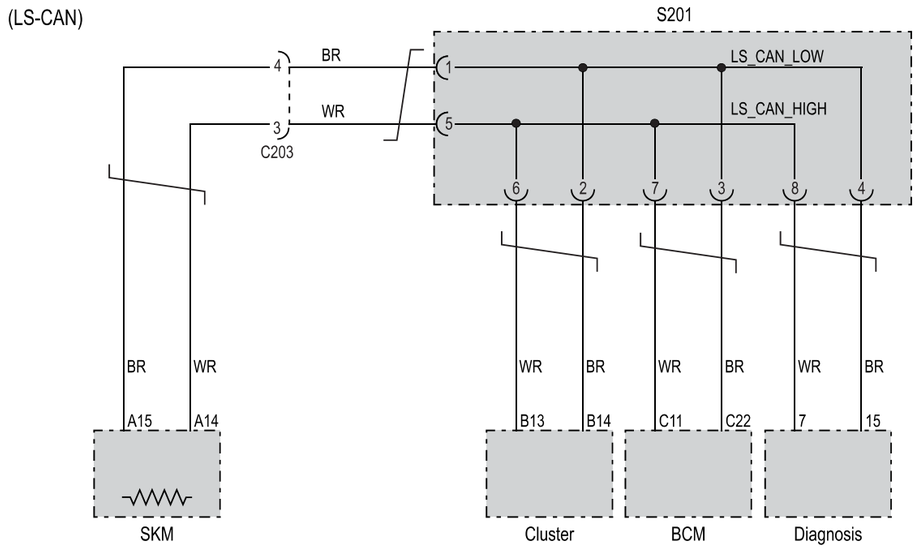
KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8210-01

CAN

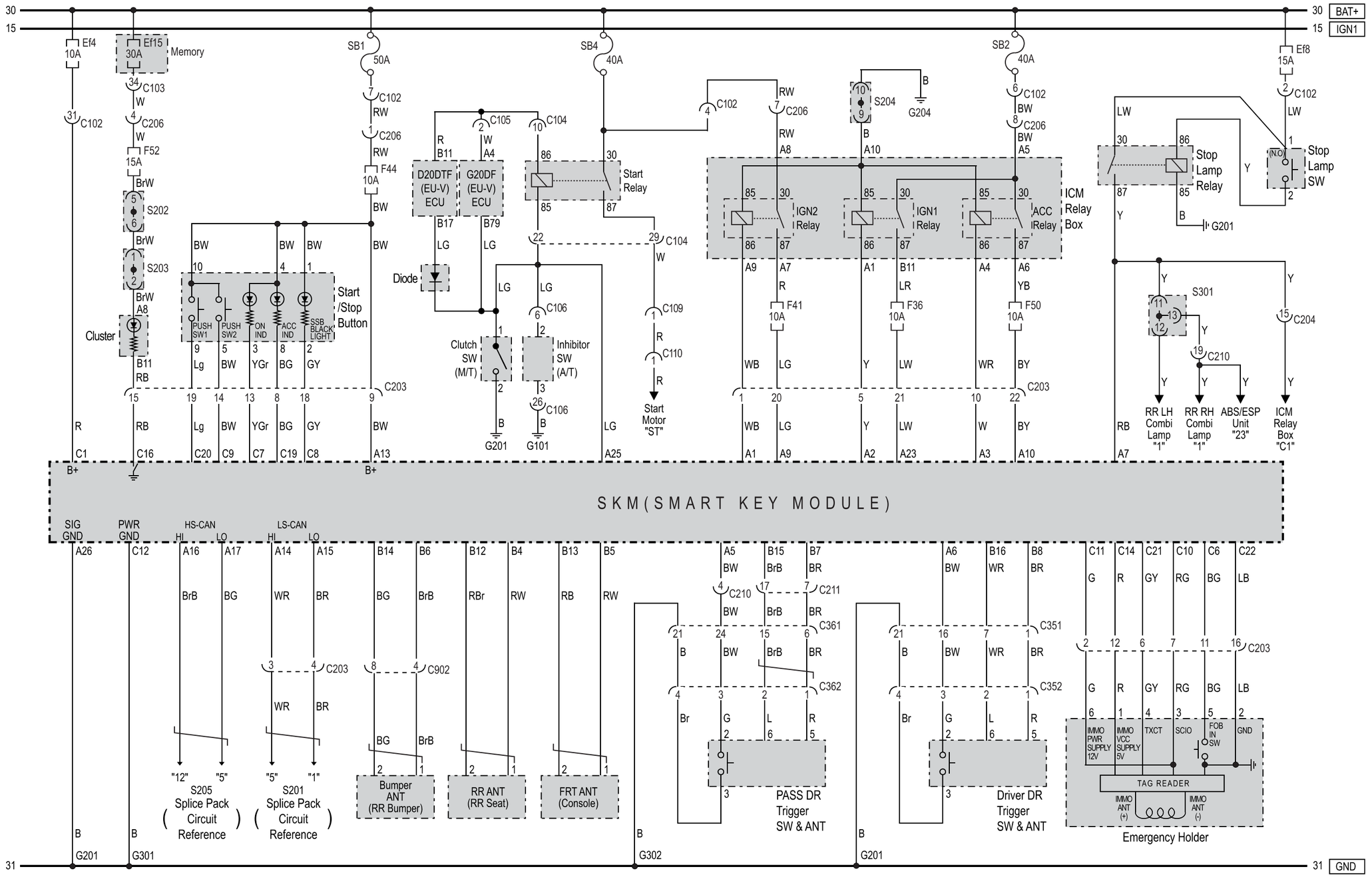




Modification basis	
Application basis	
Affected VIN	

S.G.N. 8712-03

SKM(SMART KEY MODULE)



CIRCUIT

KORANDO 2012.10

Modification basis	
Application basis	
Affected VIN	

NO DATA

NO DATA

ENGINE GENERAL

0000-00

GENERAL INFORMATION

1. LAYOUT

Front view



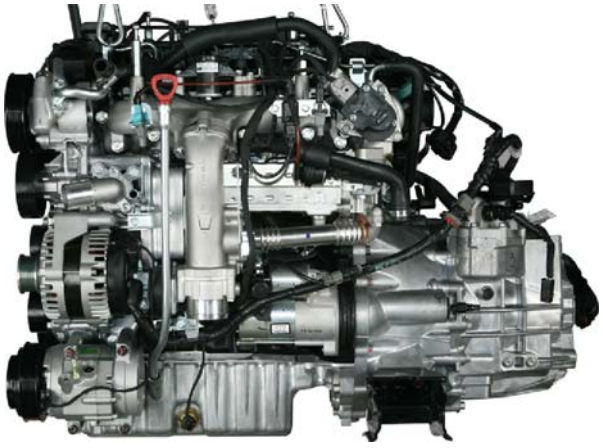
Rear view



Right side view



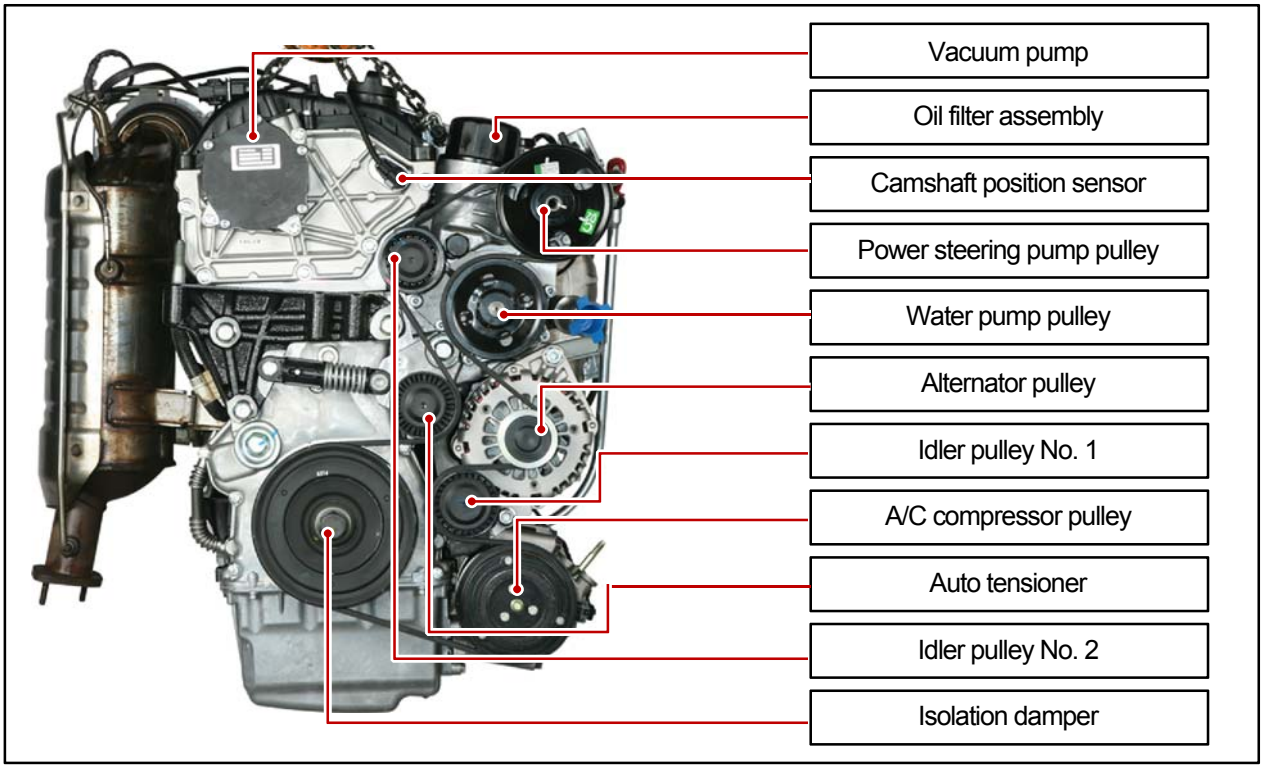
Left side view



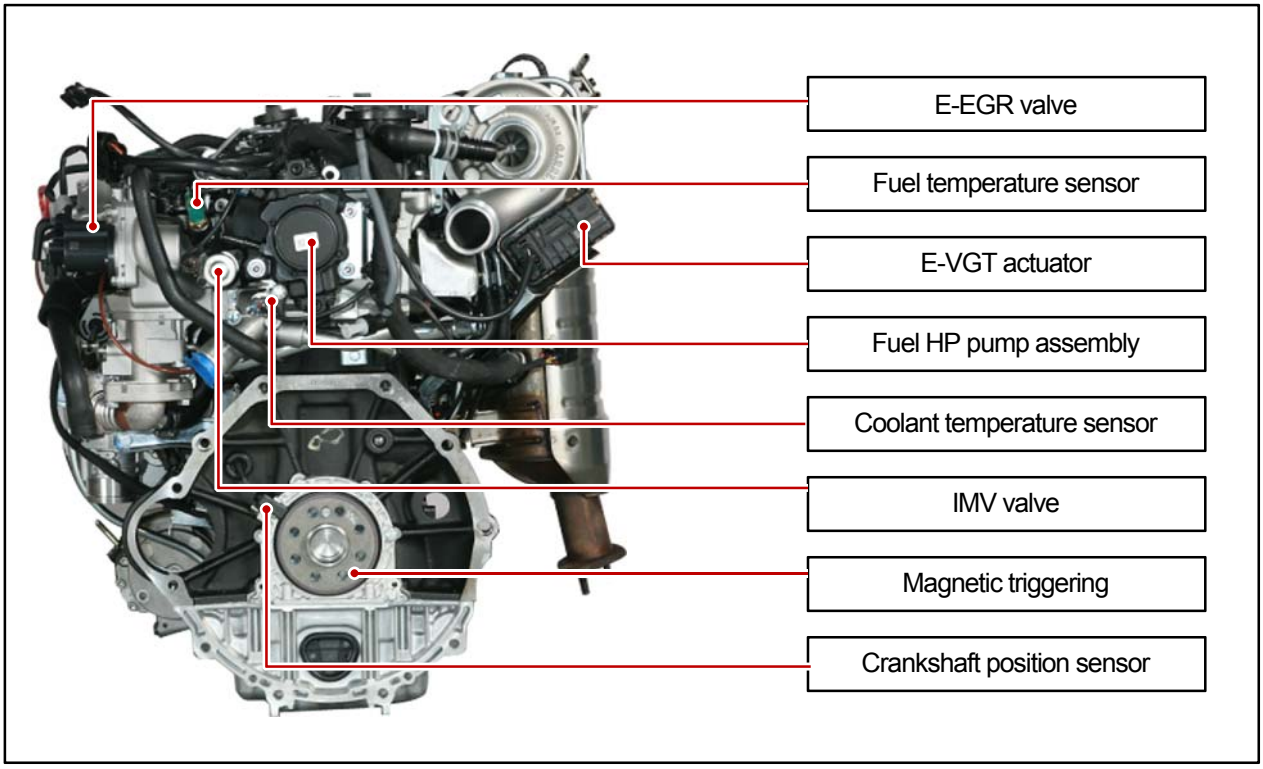
Modification basis	
Application basis	
Affected VIN	

2. MAJOR COMPONENTS

▶ **Front View**

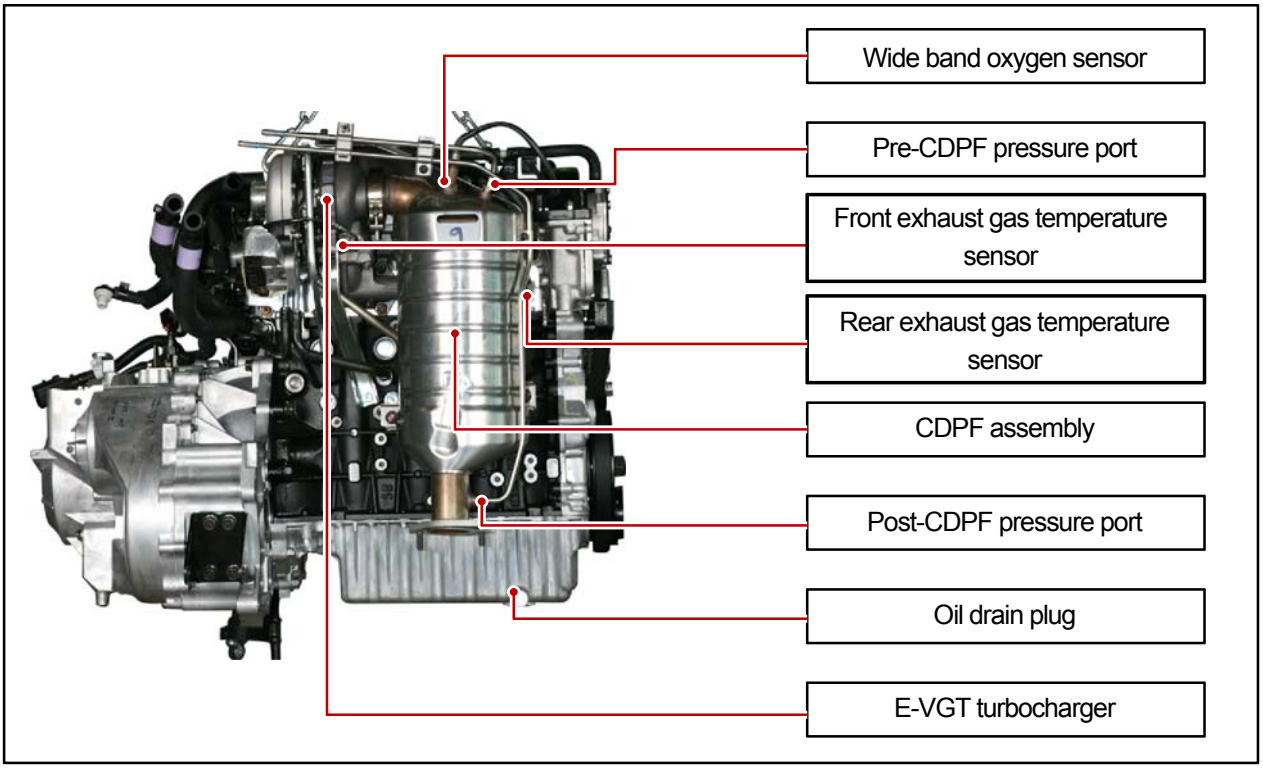


▶ **Rear View**

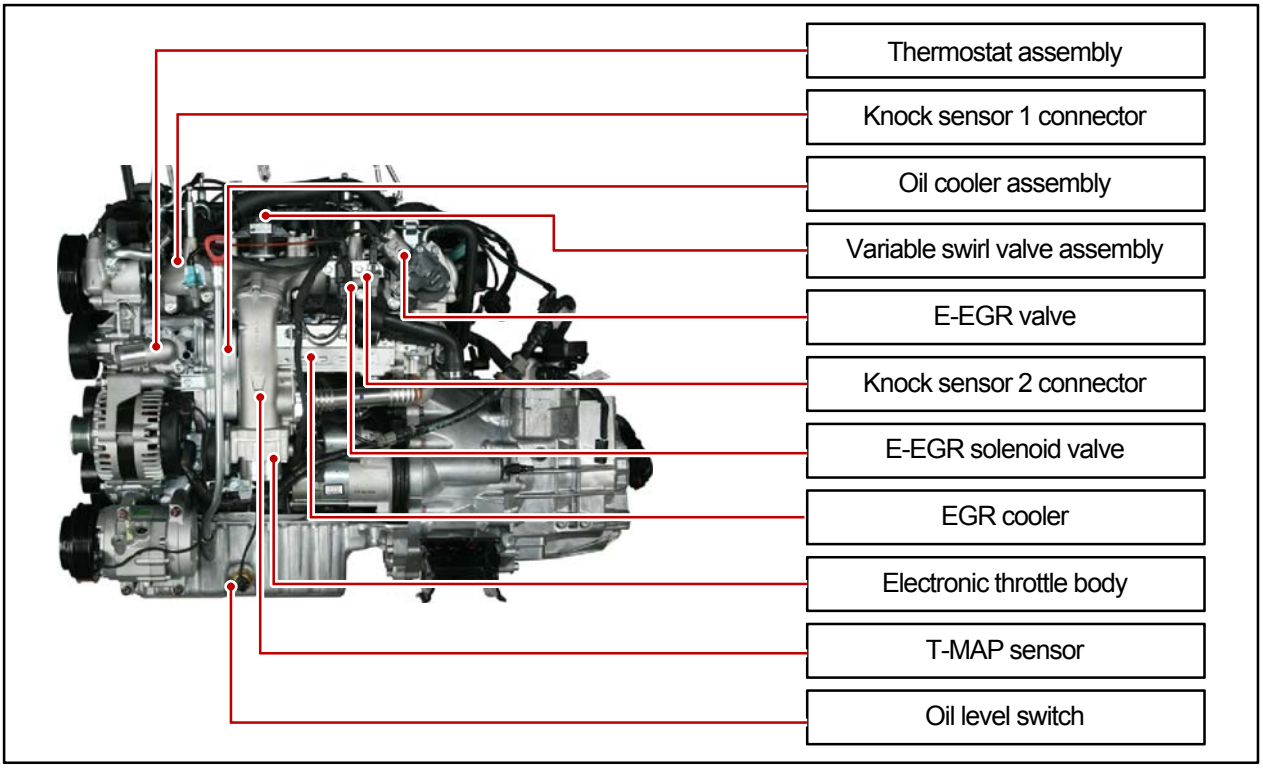


Modification basis	
Application basis	
Affected VIN	

▶ Right side View



▶ Left side View



Modification basis	
Application basis	
Affected VIN	

GENERAL INSTRUCTIONS

1. GUIDELINES FOR SERVICE WORKS

1) For Safety

To perform the service works easily ans safely, the service technicians must keep the proper working procedures and rules.
This manual provides the useful instructions to the service technicians so that they can perform the servive works with standard working process, skills, tips in time.
Please read this manual and follow the instructions carefully.

Signal words such as "CAUTION" and "NOTE" have special meanings.

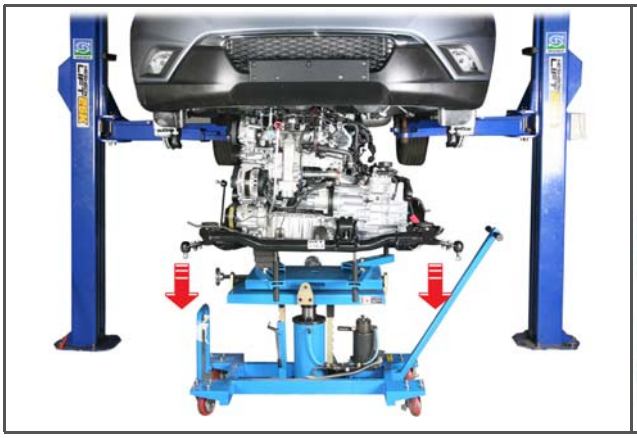
NOTE
indicates information to assist maintenance and instructions.

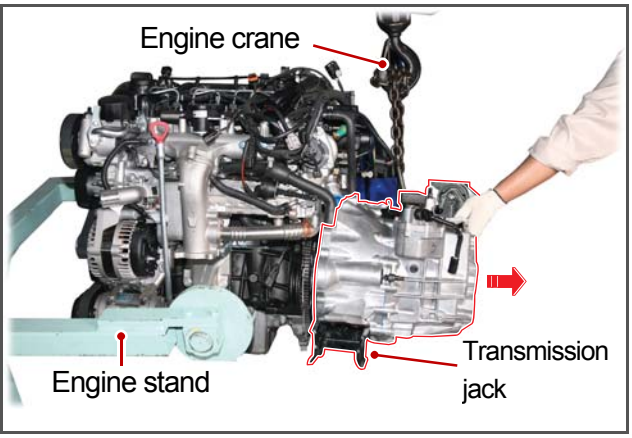
CAUTION
indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

However, above references and cautions cannot be inclusive measures, so should have habits of paying attentions and cautions based on common senses.

2) Equipment

- Korando is FF (Front Engine Front Drive) type vehicle, and engine and powertrain system are integrated into a module. Therefore, 2-post lift and general equipment are necessary when working
- on the engine and transmission.
  Major equipment: Engine and transmission jack, Engine stand, Engine crane, Transmission jack, Engine hanger





Modification basis	
Application basis	
Affected VIN	

Remove the engine and transaxle as a set.

- Korando is FF (Front Engine Front Drive) type vehicle, and engine and powertrain system are integrated into a module. Therefore, 2-post lift and general equipment are necessary when working on the engine and transmission.
- Major equipment: Engine and transmission jack, Engine stand, Engine crane, Transmission jack, Engine hanger

3) General Instructions

(1) Before lifting up the vehicle with a lift, correctly support the lifting points.
(2) When using a jack, park the vehicle on a level ground and place the wheel chocks under the tires. Position the jack under the frame and lift up the vehicle and then support with chassis stand before service work.
(3) Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
(4) If you have to work on vehicle, cover the seats and floor with protection covers to avoid any damage and contamination.
(5) Brake fluid and anti-freeze can damage the painted surface of body. So carefully handle them during service work.
(6) To improve the efficiency of service work, use only recommended and specified tools. Use only Ssangyong genuine spare parts.
(7) Never reuse the cotter pin, gasket, O-ring, oil seal, lock washer and self-locking nut. Replace them
(8) with new ones. If reused, normal functions cannot be maintained.
(9) Store the disassembled parts as a set based on disassembly order and unit.
(10) Pay particular attention not to miss or mix the fasteners.
(11) If necessary, especially for inspection, clean the removed parts completely.
(12) Apply the oil or grease on the running and sliding surfeces before installation. Use the specified
(13) sealant and gasket to prevent leakage if necessary.
(14) Tighten the fasteners with the specified tightening torque.
(15) As a final stage of service work, check if the serviced system is working properly and the problem has been eliminated clearly.

4) Basic Inspection

(1) Horn operation

- Listen for the horn sound when pressing the horn pad on the steering wheel.

(2) Brake operation

- Check if there is any abnormal noise, unusually long braking distance, or uneven braking force. If the brake warning lamp does not go out even after starting the engien or are flashing during driving, have the brake system checked immediately.
- Check the brake pipes and hoses for connection, oil leak, crack or interference after changing the position of tires. When replacing the tires, check the brake disc for surface condition and wear. Check the parking brake cable and brake operation. Shorten the checking interval if the parking
- brake is used frequently.

(3) Exhaust system

- Be aware to any changes in sound or smell from the exhaust system. These may be caused by leak or overheat. Have the exhaust system checked and repaired immediately.
- Inspect the exhaust system including catalytic converter. Inspect all the components and body frame near the exhaust system.

(4) Tires

- Unusual vibration of the steering wheel and seats or pulling to one side on the straight and level roads may indicates the uneven tire inflation pressure or poor wheel balance.

(5) Steering and suspension system

- Inspect the front and rear suspension and the steering system for damage, looseness or missing parts, signs of wear or lack of lubrication. Inspect the power steering line and the hoses for connection, leak, crack and chafing. Inspect the drive axle boot and seals for damage, tear or leak. Replace or repair the system if necessary.

(6) Engine oil

- Check the oil level when the engine is still warm and add the specified engine oil if necessary.

(7) Coolant

- Check the coolant level in the coolant reservoir, coolant conditions (contamination, foreign material), and hoses for damage and leak. Replace or add the Ssangyong genuine coolant, if needed.

(8) Engine drive belt

- Check all drive belts on the engine for wear, crack and looseness. Retighten or replace the belt, if needed.

Modification basis	
Application basis	
Affected VIN	

5) Guidelines on Engine Service

To prevent the personal injuries and vehicle damages that can be caused by mistakes during service and to provide the optimized performance and safety after service works, the service technicials must keep the basic cautions and service guidelines below. These could be easily forgotten during service works.

(1) Cautions before service works

- Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
- Make sure to clean the working area and to prepare the necessary tools before service works. Always place the ignition switch to OFF position if not required. Otherwise, there could be
- unexpected damage to electric devices or personal injuries due to short-circuit.
  To prevent the foreign material from entering into the fuel injection system, completely seal the inlets
- of HP pump, fuel hoses and high pressure pipes.
  To remoev the engine, use the dedicated equipments such as engine jack, transmission jack, engine
- stand and engine crane.

(2) Engine and accessories

Engine has a lot of precise components. The specified tightening torque and correct procedures should be kept during service works. And, the working area is always clean and well prepared.

- When disassembling the engine, related parts (bolts, gaskets, etc.) should be stored as a set.
- Clean the components completely with engine oil before assembling if needed.
- Fully drain the engine oil, coolant and fuel from the vehicle and seal the inlets with the plugs before removing the engine.
- All the interference should be eliminated before removing the engine.

(3) Electric devices

Extraordinary care should be taken when servicing the electric systems. Currently, the engine uses a lot of electric devices. Short circuit and poor contact may cause the low engine performance, incomplete combustion and other abnormalities.

- To prevent any damage to electric systems, make sure to disconnect the negative (-) cable from the battery and place the ignition switch to OFF position before servicing.
- Use only the specified parts with same ratings when replacing the electric devices. Check the grounds and connections for looseness.

(4) Fuel and lubrication system

- When working with the fuel or oil systems in enclosed area, always keep the working area well-ventilated and never allow anybody to smoke.
- Gaskets and seals on the fuel and oil systems should be replaced with new ones. All bolts and nuts should be tightened as specified.
- Make sure to check the connections for leak after installation.

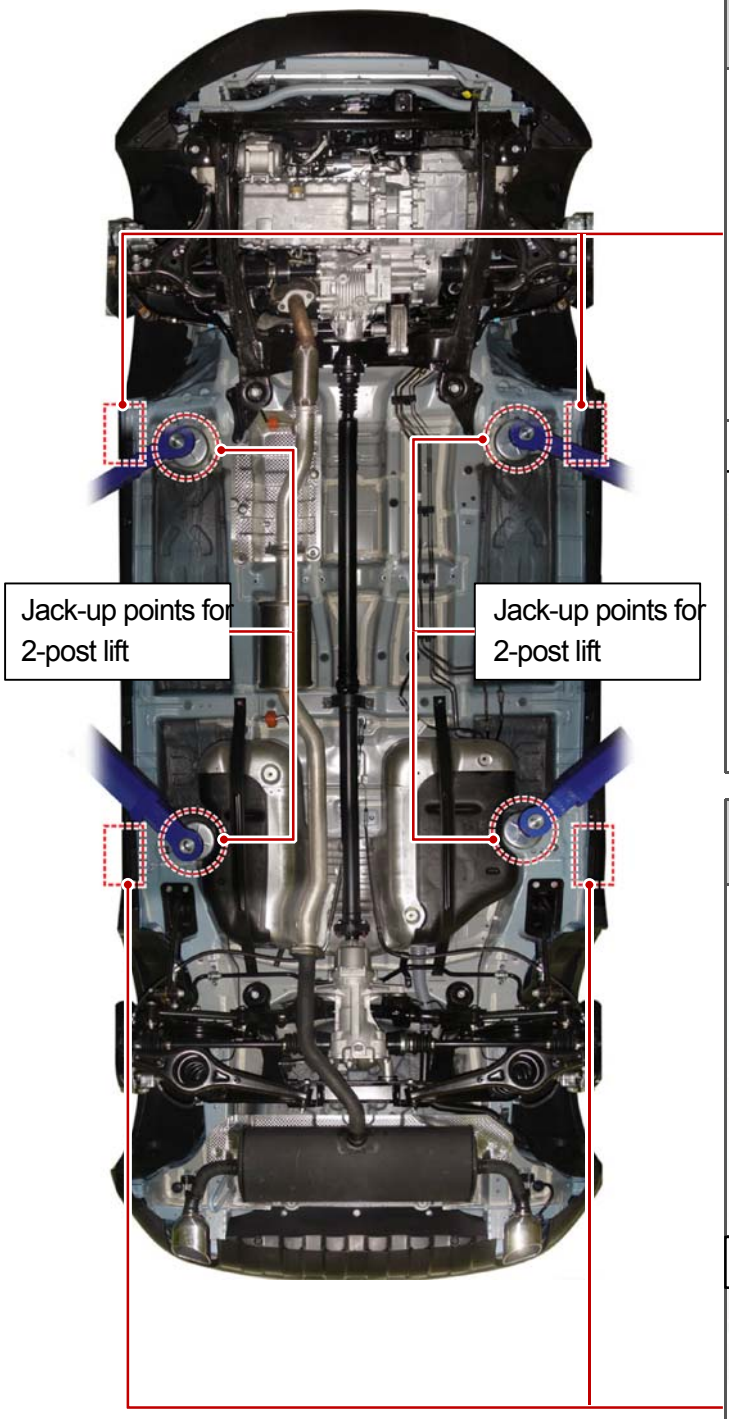
NOTE

1. If fine dust or foreign material enters into DI engine's fuel system, there can be serious damages between HP pump and injectors. So, be sure to cover removed fuel system components with cap and protect removed parts not to be contaminated with dirt. (Refer to cleanness in this manual while working on DI engine fuel system)
2. When working on the fuel line between priming pump and injector (including return line), always plug the openings with caps to prevent foreign materials or dust from entering to the openings and connections.
3. The HP fuel supply pipe (HP pump to fuel rail) and HP fuel pipe (Fuel rail to injector) should be replaced with new ones when removed.

Modification basis	
Application basis	
Affected VIN	

2. JACK-UP POINTS

▶ **Stand jack-up points and installation status (front side)**



Jack-up points and setup (front side)



Supporting



Jack-up points and setup (rear side)

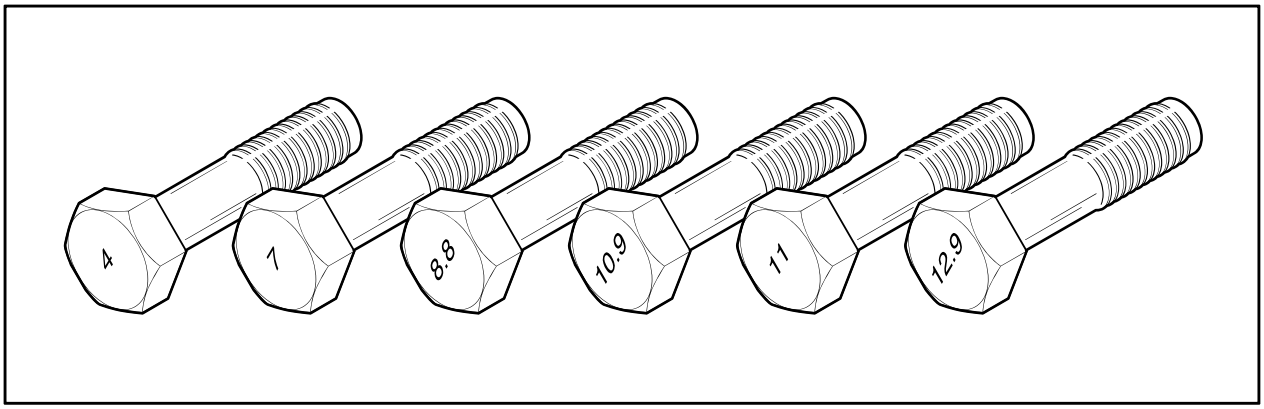


Supporting



3. STANDARD BOLTS SPECIFICATIONS

Bolt	Pitch	Tightening torque(kgf.cm)					
		Standard			Limit		
		4T	7T	9T	4T	7T	9T
M3	0.5	5	9	13	7	12	17
M4	0.7	12	20	30	16	27	40
M5	0.8	24	40	57	32	53	77
M6	1.0	41	68	99	55	91	130
M8	1.25	88	160	230	130	210	310
M10	1.25	190	330	470	260	430	620
	1.5	190	310	450	250	420	600
M12	1.25	350	580	840	460	770	1,100
	1.75	330	550	790	440	730	1,000
M14	1.5	550	910	1,300	730	1,200	1,900
M16	1.5	830	1,100	2,000	1,100	1,900	2,700
M18	1.5	1,200	2,000	2,900	1,600	2,700	3,800
M20	1.5	1,700	2,800	4,000	2,200	3,700	5,300
M22	1.5	2,300	3,800	5,400	3,000	5,000	7,200
M24	1.5	2,900	4,900	7,000	3,900	6,500	9,400
	2.0	2,800	4,700	6,800	3,800	6,300	9,100



1) Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2) Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max. allowable tightening torque if not required to do so. Determine extra proper tightening torque if tightens with washer or packing.
3) If tightens bolts on the below materials, be sure to determine the proper torque.
4)

- Aluminum alloy: Tighten to 80 % of above torque table.
- Plastics: Tighten to 20 % of above torque table.

Modification basis	
Application basis	
Affected VIN	

4. CODING AND SETUP

1) Engine Variant Coding

Unit	Selection	Description	
PTC auxiliary heater	NO	PTC auxiliary heater is the standard equipment in this vehicle. Select "YES".	
	YES		
Glow plug	Relay (K-Line)	AQGS is the standard equipment in this vehicle. Select "AQGS".	
	AQGS (CAN)		
Transmission	5-speed M/T	M/T: 6-speed M/T A/T: 6-speed A/T (DSI 6AT)	
	6-speed M/T		
	5-speed A/T (DC 5 AT)		
	7-speed A/T (DC 7 AT)		
	6-speed A/T (DSI 6 AT)		
Pressure sensor for A/C refrigerant	NO	Select the appropriate system.	
	Type		
Immobilizer	NO	Immobilizer is the standard equipment in this vehicle. Select "YES".	
	YES		
Vehicle speed signal to ECU	CAN	with ABS or ESP: Select "CAN"	
	WIRE		
Fan	2 relays	Select "2 relays".	
	PWM fan		
Auto cruise	NO	with Auto cruise system: Select "YES".	
	YES		
Engine level control	NO	Engine level control system is not available in this vehicle. Select "NO".	
	YES		
G-sensor	NO	with 2WD ABS and non-ABS: Select "NO" with 4WD ABS and ESP: Select "YES"	
	YES		
Smart key	NO	with Smart key: Select "YES".	
	YES		

D20DTF ENGINE ASSEMBLY

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification	Remark
Cylinder head	Height		131.9 to 132.1mm	
	Flatness		below 0.1mm	
	Valve protrusion	Intake Valve		
		Exhaust Valve		
	Flatness on manifold side	Intake manifold	0.08mm	
		Exhaust manifold	0.08mm	
Mass balance shaft (MBU)	Backlash		0.05 to 0.15mm	
Connecting rod	End play		0.5 to 1.5mm	
Camshaft	Axial end play	Intake	0.1 to 0.35mm	
		Exhaust	0.1 to 0.35mm	
Camshaft position sensor	Distance between Camshaft position sensor and sprocket		0.20 to 1.80mm	
Valve	Clearance between valve and piston	Intake	Approx. 0.7mm	
		Exhaust	Approx. 0.8mm	
	Valve recess	Intake	0.6 to 1.0mm	
		Exhaust	0.6 to 1.0mm	
Cylinder block	Piston protrusion		0.475 to 0.745mm	
Piston ring	TOP ring end gap		0.20 to 0.35mm	
	2nd ring end gap		0.35 to 0.50mm	
	3rd ring end gap		0.2 to 0.40mm	
	Offset		0.3mm	
Head gasket	Piston protrusion	0.475~0.540	1.2t	
		0.541~0.649	1.3t	
		0.650~0.745	1.4t	

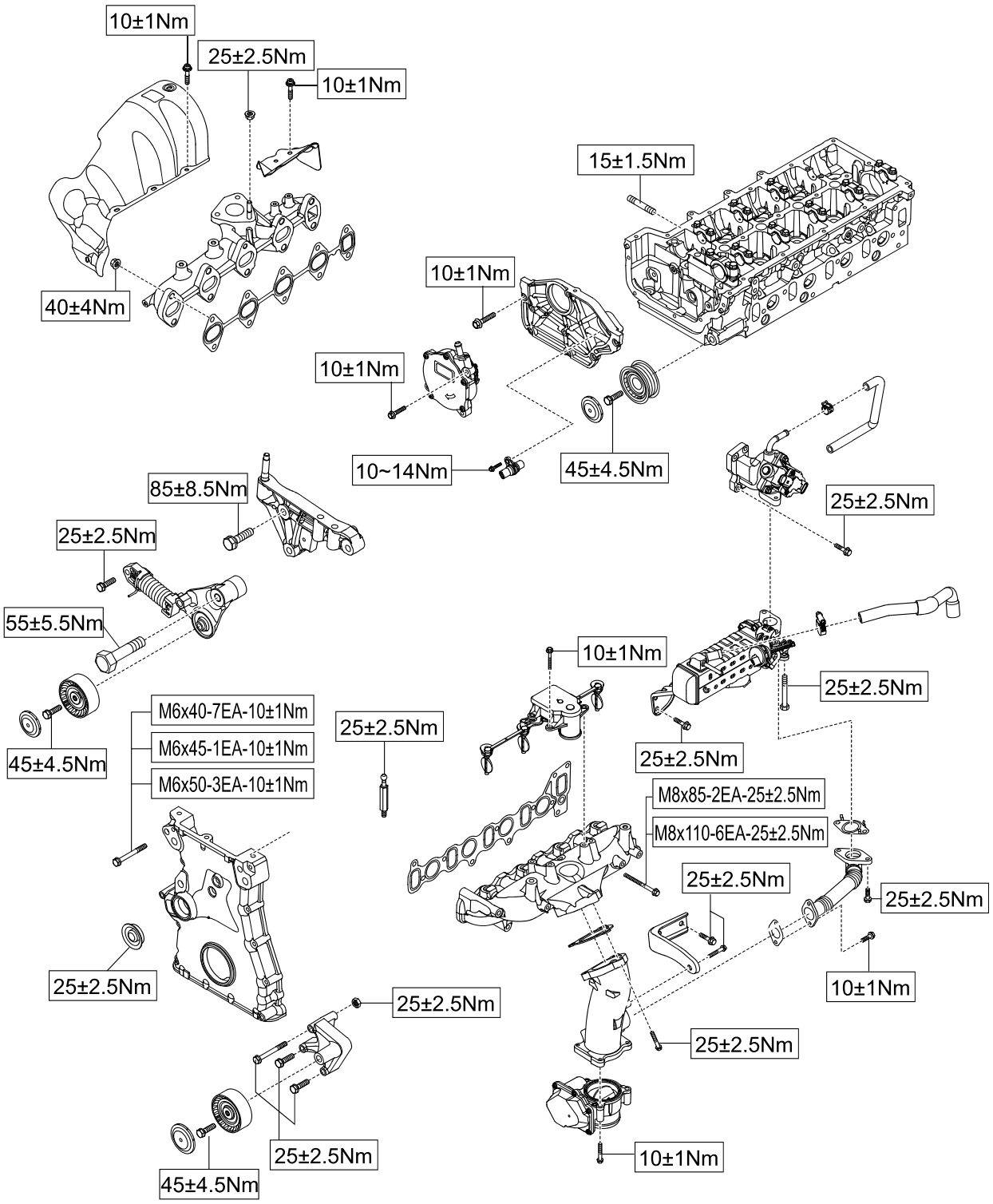
2. TIGHTENING TORQUE

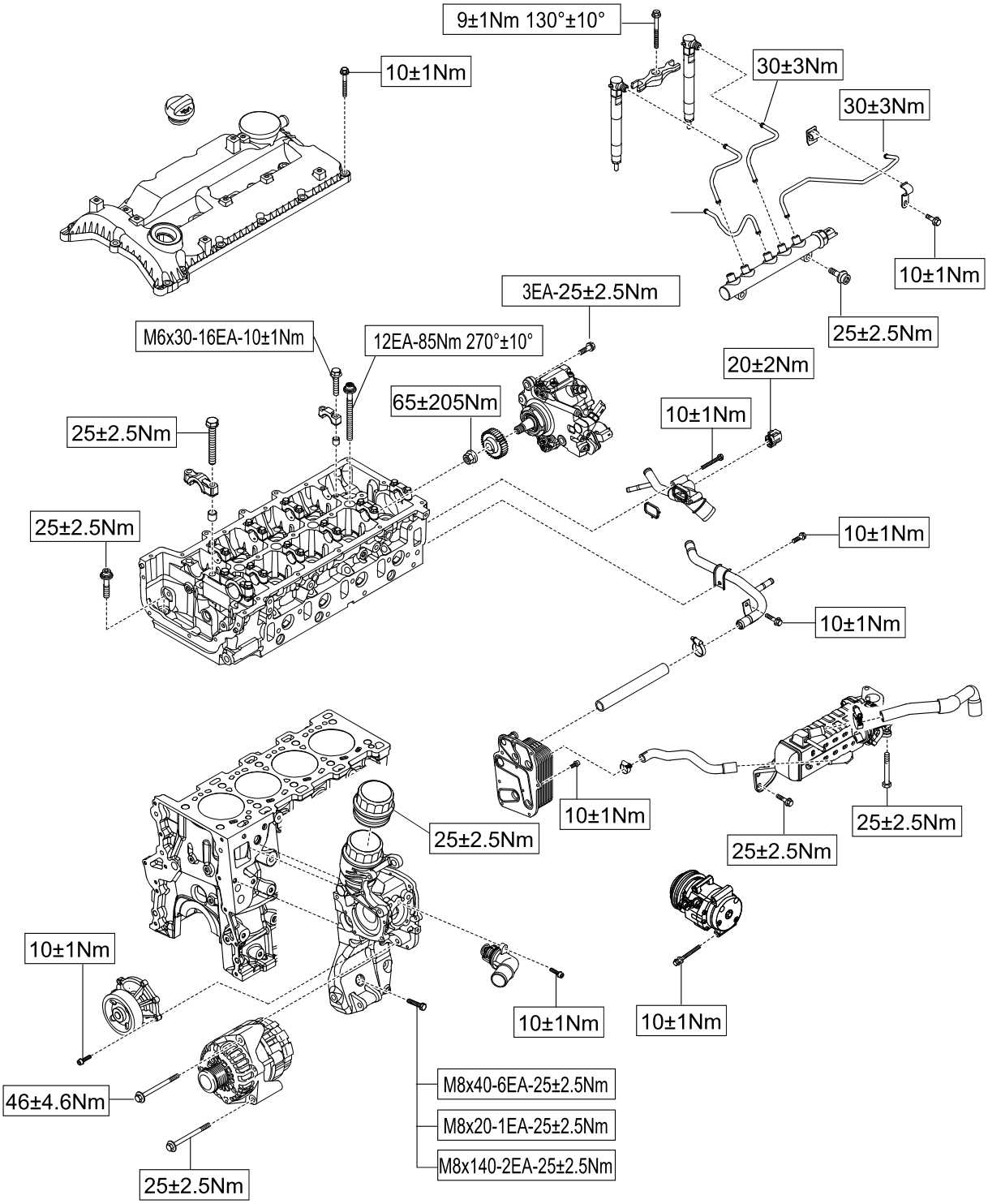
Component	Size	Quantity	Tightening torque (Nm)	Remark (Total torque)
Main bearing cap	M12×82	10	55 ± 5Nm, 180°	Not re-usable
Connecting rod cap	M9×52	8	40 ± 5Nm, 90° ± 10°	50~80Nm
Crankshaft rear cover	M6×20	6	10 ± 1Nm	-
Oil pump	M8×35	3	25 ± 2.5Nm	-
Flywheel	M10×22	8	45 ± 5Nm, 90° ± 10°	Not re-usable
Isolation damper center bolt	M18×50	1	200 ± 20Nm, 180° ± 20°	660~720Nm Not re-usable
Oil pan	M6×20	18	10 ± 1Nm	-
	M6×35	2	10 ± 1Nm	-
	M6×85	2	10 ± 1Nm	-
	M6×120	2	10 ± 1Nm	-
	M8×40	2	25 ± 2.5Nm	-
HP pump main nut	M14×1.5-8-1	1	650 ± 5Nm	-
HP pump mounting bolt	M8×55	3	25 ± 2.5Nm	-
Cylinder head	M13×150	12	85Nm 270° ± 10°	-
Camshaft cap	M6×30	16	10 ± 1Nm	-
	M8×60	4	25 ± 2.5Nm	-
Exhaust stud bolt		10	15 ± 1.5Nm	-
Exhaust sprocket bolt	M11×40	1	30 ± 3Nm	-
Chain tensioner screw plug	M38×1.5	1	25 ± 2.5Nm	-
Coolant temperature sensor		1	20 ± 2.0Nm	-
Belt auto tensioner	M8×30(LOW)	1	25 ± 2.5Nm	-
	M10×75(Upper)	1	55 ± 5.5Nm	-
Coolant pump	M6×50	7	10 ± 1.0Nm	-

Modification basis	
Application basis	
Affected VIN	

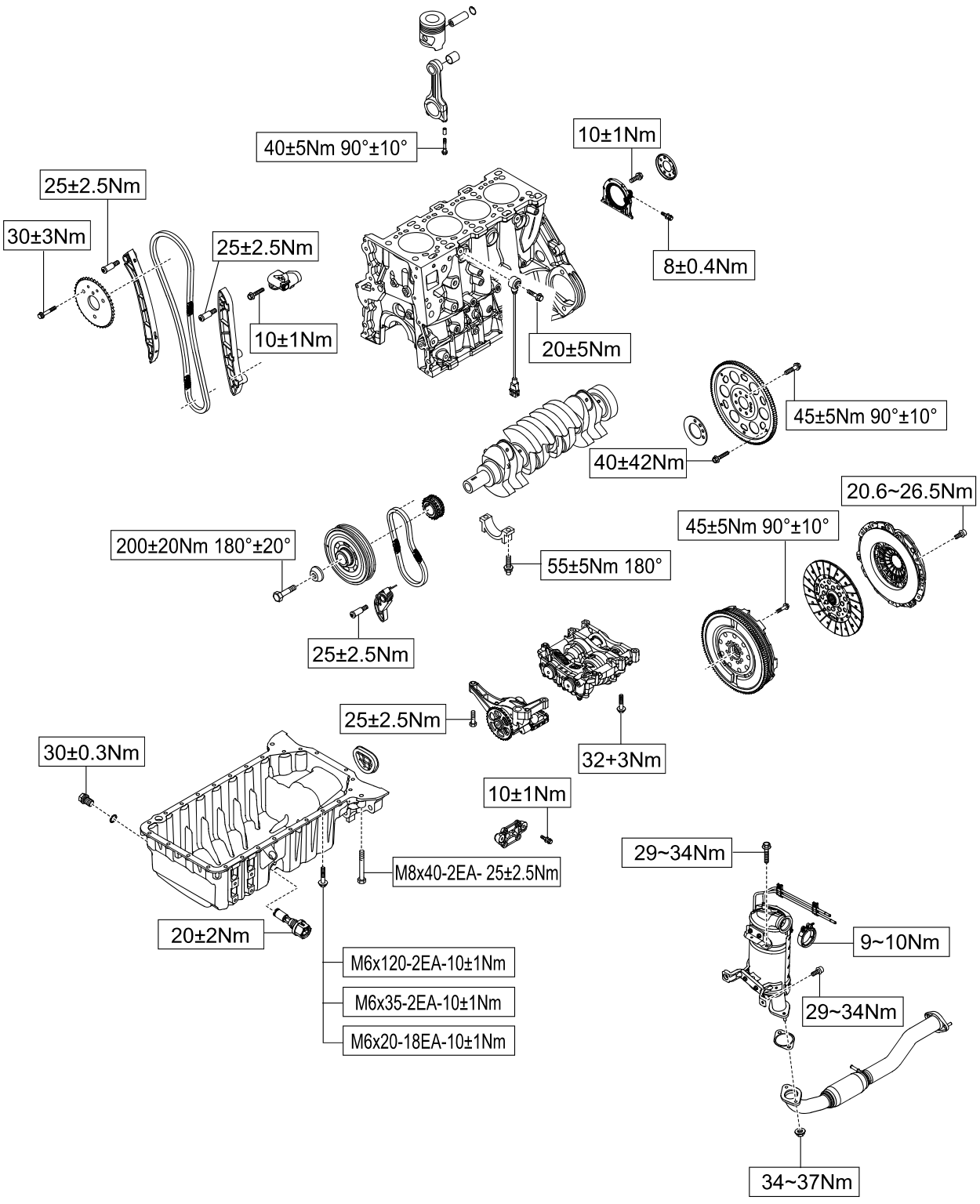
Component	Size	Quantity	Tightening torque (Nm)	Remark (Total torque)
Hot water inlet pipe	M6×12	2	10 ± 1Nm	-
Alternator	M10×90	1	25 ± 2.5Nm	Lower
	M10×116	1	46 ± 4.6Nm	Upper
A/C compressor	M8×85	4	25 ± 2.5Nm	-
A/C bracket	M6×25	4	10 ± 1Nm	-
Intake manifold	M8×35	2	25 ± 2.5Nm	-
	M8×110	6	25 ± 2.5Nm	-
Oil filter module	M8×40	6	25 ± 2.5Nm	-
	M8×20	1	25 ± 2.5Nm	-
	M8×140	2	25 ± 2.5Nm	-
Knock sensor	M8×28	2	20 ± 5Nm	-
Cam position sensor	M8×14	1	10 ~ 14Nm	-
T-MAP pressure sensor	M6×20	1	10 ± 1Nm	-
Exhaust manifold	M8	10	40 ± 4Nm	-
Turbocharger	M8	3	25 ± 2.5Nm	-
T/C support bracket bolt		1	25 ± 2.5Nm	-
T/C support bracket bolt	M8	1	25 ± 2.5Nm	-
T/C oil supply pipe	M6(block side)	1	10 ± 1.0Nm	-
	M6(turbo side)	1	17 ± 2.0Nm	-
T/C oil return pipe	M6×16 (turbo side)	2	10 ± 1Nm	-
	M6×16 (block side)	2	10 ± 1Nm	-
EGR valve	M8×22	3	25 ± 2.5Nm	-
EGR pipe bolt (Intake side)	M6×25	2	10 ± 1Nm	-
EGR pipe bolt (EGR cooler side)	M8×16	2	25 ± 2.5Nm	-

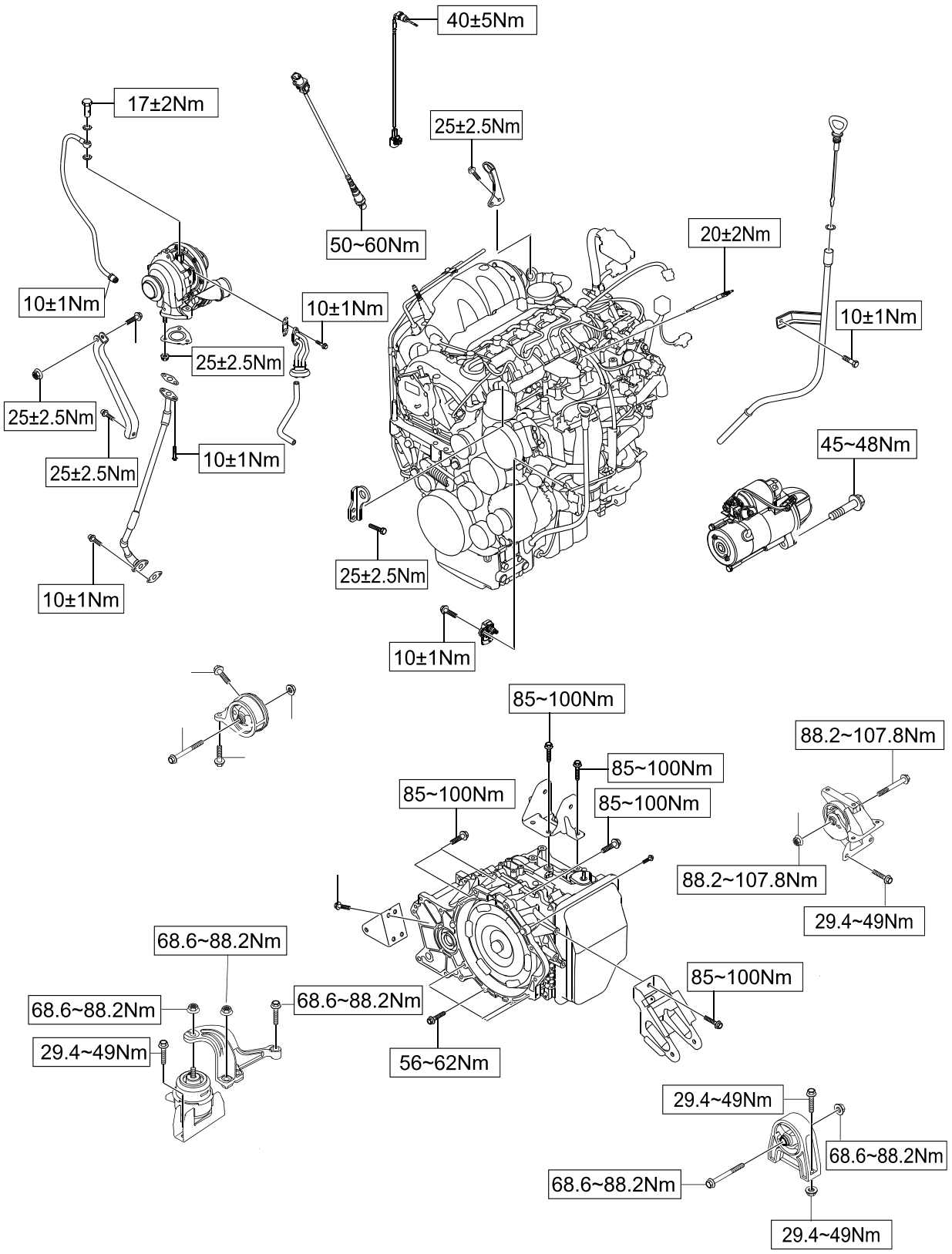
Component	Size	Quantity	Tightening torque (Nm)	Remark (Total torque)
Idle pulley/Tensioner pulley		1	45 ± 4.5Nm	-
Glow plug	M5	4	20 ± 2Nm	-
Vacuum pump	M8×25	3	10 ± 1Nm	-
Timing gear case cover	M6×40	7	10 ± 1Nm	-
	M6×45	1	10 ± 1Nm	-
	M6×50	3	10 ± 1Nm	-
Cylinder head cover	M6×35	21	10 ± 1Nm	-
Oil gauge tube	M6×16	1	10 ± 1Nm	-
Oil filter cap		1	25 ± 2.5Nm	-
Fuel rail	M8×35	2	25 ± 2.5Nm	-
Injector clamp bolt	M6×60	2	9 ± 1.0Nm 130° + 10°	-
High pressure pipe (between HP pump and fuel rail)	M17	1	30 ± 3Nm	-
High pressure pipe (between fuel rail and injector)	M17	4	30 ± 3Nm	-
Crank position sensor	M5×14	1	8 ± 0.4Nm	-
Main wiring	M6×16	5	10 ± 1Nm	-
Intake duct	M8x25	3	25 ± 2.5Nm	-
Power steering pump	M8×100	3	25 ± 2.5Nm	-
Mass balance shaft (MBU)	M8×45	6	30 ± 3Nm	-
Cylinder head front cover	M6×10	5	10 ± 1Nm	-


10±1Nm
25±2.5Nm
10±1Nm
40±4Nm
15±1.5Nm
10±1Nm
10±1Nm
10~14Nm
45±4.5Nm
85±8.5Nm
25±2.5Nm
55±5.5Nm
45±4.5Nm
M6x40-7EA-10±1Nm
M6x45-1EA-10±1Nm
M6x50-3EA-10±1Nm
25±2.5Nm
25±2.5Nm
10±1Nm
25±2.5Nm
25±2.5Nm
M8x85-2EA-25±2.5Nm
M8x110-6EA-25±2.5Nm
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25±2.5Nm
10±1Nm
25±2.5Nm
25±2.5Nm
25±2.5Nm
45±4.5Nm
10±1Nm



Modification basis	
Application basis	
Affected VIN	


40±5Nm 90°±10°
10±1Nm
8±0.4Nm
25±2.5Nm
30±3Nm
25±2.5Nm
10±1Nm
20±5Nm
45±5Nm 90°±10°
40±42Nm
20.6~26.5Nm
45±5Nm 90°±10°
200±20Nm 180°±20°
55±5Nm 180°
25±2.5Nm
25±2.5Nm
32+3Nm
30±0.3Nm
10±1Nm
M8x40-2EA- 25±2.5Nm
29~34Nm
9~10Nm
20±2Nm
M6x120-2EA-10±1Nm
M6x35-2EA-10±1Nm
M6x20-18EA-10±1Nm
29~34Nm
34~37Nm



Modification basis	
Application basis	
Affected VIN	

3. CHECK AND INSPECTION

1) Cylinder

(1) Compression pressure test

▶ **Specified value**

Compression ratio		16.5 : 1
Test condition		at normal operating temperature (80°C)
Compression pressure	**Standard**	32 bar
	Minimum	18 bar
Differential limit between cylinders		Maximum 3 bar

The compression pressure test is to check the conditions of internal components (piston, piston ring, intake and exhaust vale, cylinder head gasket). This test provides current engine operating status.

CAUTION
- Before cranking the engine, make sure that the test wiring, tools and persons are keeping away from moving components of engine (e.g., belt and cooling fan).
- Park the vehicle on the level ground and apply the parking brake.
- Do not allow anybody to be in front of the vehicle.

(2) Cylinder pressure leakage test

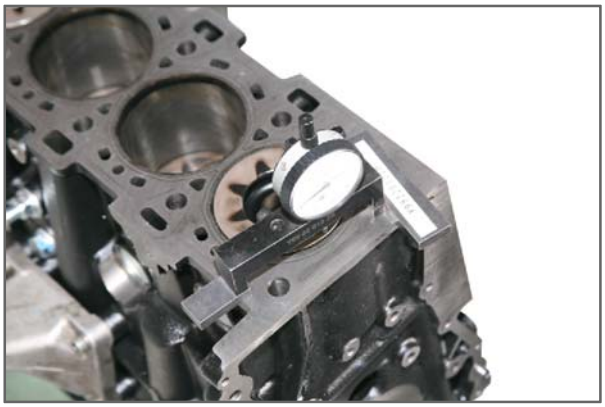
▶ **Specified value**

Test condition: normal engine operating temperature (80°C)	**Specified value**
Whole engine	below 25%
at valve and cylinder head gasket	below 10%
at piston ring	below 20%

If the measured value of the compression pressure test is not within the specifications, perform the cylinder pressure leakage test.

CAUTION
- Perform this test in the sequence of firing order.
- Do not test the cylinder pressure leakage with wet type test procedure. (do not inject the engine oil into the combustion chamber)

(3) Piston protrusion check



Position the piston at TDC and measure the piston protrusion from crank case mating surface.

Specified value	0.475 to 0.745mm

CAUTION

- Measure it at both ends of crankshaft.

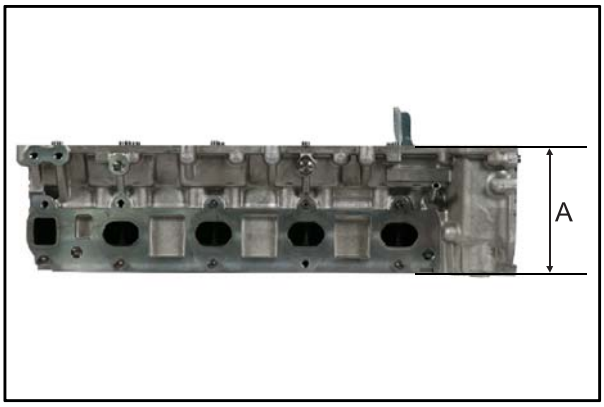
Modification basis	
Application basis	
Affected VIN	

2) Cylinder Head

(1) Cylinder head mating surface check

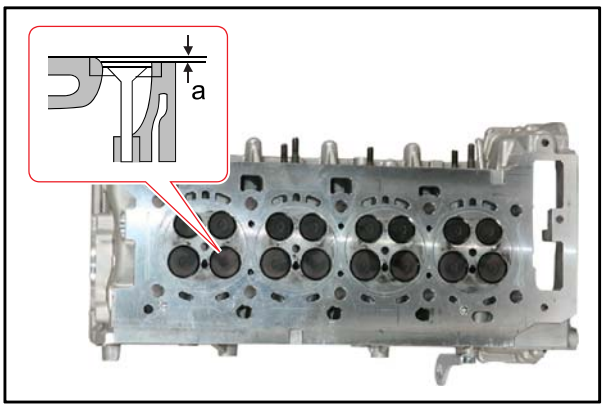
▶ **Specified value**

Total height "A"		131.9 to 132.1 mm
Minimum height after machining		131.9mm
Flatness	**Longitudinal direction**	0.1 / 150
	Transverse direction	0.15
Parallel deviation of cylinder head		below 0.1 mm
Peak-to valley of surface		Rmax7 Rz6.3
valve recess "a"	**Intake valve**	0.6 to 1.0 mm
	Exhaust valve	



1. Measure the cylinder head height "A".

CAUTION
- If the height is less than the limit, the cylinder head must be replaced.



2. Insert the valves into the valve guides and measure the recesses.

Valve recess “a"	0.6 to 1.0 mm

CAUTION
- If the measured value is out of the specified range, machine the valve seat as much as necessary until the specified value is achieved.

(2) Cylinder head pressure Leak test

Immerse the cylinder head with the pressure plate into warm water (approx. 60°C) and pressurize with compressed air to 2 bar.

4. GUIDELINES ON ENGINE SERVICE

To prevent personal injuries and vehicle damages that can be caused by mistakes during engine and unit inspection/repair and to secure optimum engine performance and safety after service works, basic cautions and service work guidelines that can be easily forgotten during engine service works are described in.

▶ **Cautions before service works**

- For safe and correct works, you must observe the working procedures and instructions in this manual. And, use the designated tools as follow:
  Engine stand / Heavy duty engine jack
- To prevent the engine from starting abruptly, do not allow anybody to get in the vehicle while servicing in engine compartment.
- Before work on engine and each electrical equipment, be sure to disconnect battery negative (-) terminal.
- Before service works, be sure to prepare the works by cleaning and aligning work areas.
- Do not allow the foreign material get into the fuel injection system.
- When removing the engine, use only the safety hook on engine and engine hanger. Do not support the bottom of oil pan with a jack.

▶ **Engine and accessories**

Engine has a lot of precise portions so tightening torque should be correct during disassembly/assembly and removal/installation and service work should be done in clean ways during disassembly/assembly. Maintaining working area clean and cautious service administration is essential element of service works while working on the engine and each section of the vehicle. So the mechanics should well aware of it.

- Completely drain the engine oil, coolant and fuel from engine before removal.
- Before disassembling/assembling the engine components, carefully read the working procedures in this manual.
- Make sure to keep the specified tightening torques during installation.
- Clean and properly lubricate the parts before reassembly.
- Carefully check that there are not any interference while servicing.

Modification basis	
Application basis	
Affected VIN	

▶ Fuel and lubrication system

- Do not allow the fluid and engine oil to make contact with the body paintwork and hoses.
- If work on the fluid system such as fuel and oil, working area should be well ventilated and smoking should be prohibited.
- Gasket or seal on the fuel/lubrication system should be replaced with new ones and bolts and nuts should be tightened as specified.
- After removal/installation works, be sure to check whether there is leak on the connecting section.

If fine dust or foreign material enters into DI engine's fuel system, there can be serious damages in HP pump and injectors. Thus, be sure to plug the inlets of removed fuel line components with cap and protect removed parts not to be contaminated with dirt. (Refer to cleanness in this manual while working on DI engine fuel system)

▶ Electrical equipment

Electric devices should be handled more carefully.
Currently, the engine has a lot of electric devices. there could be poor engine performance, incomplete combustion and other abnormal symptoms due to short circuit or poor contact.

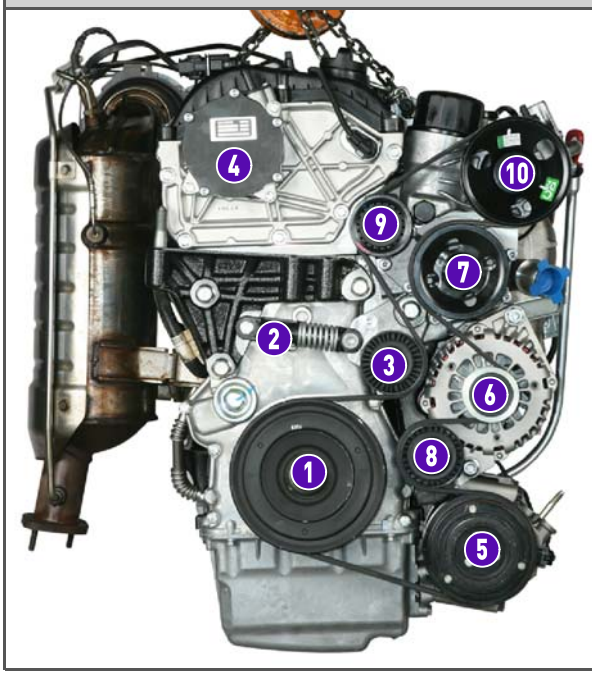
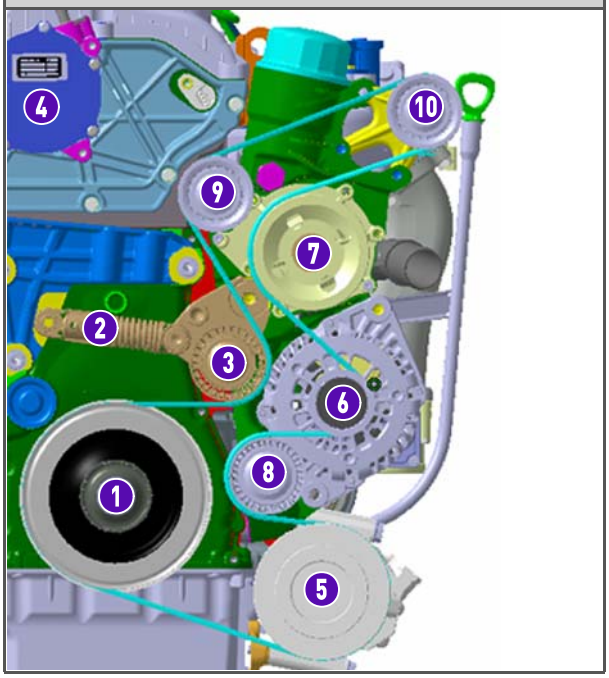
- Before work on engine and each electrical equipment, be sure to disconnect battery negative (-) terminal.
- When replacing the electric device, use only genuine part and check the conditions of connections and grounds. Loosened connection or ground make cause a fire and personal injury.

OVERVIEW AND OPERATING PROCESS

1. BELT SYSTEM

The belt system is a single belt drive system which uses single belt and has components on the oil filter housing as FEAD (Front End Accessories Drive) type.

▶ **Components**

with HPS (hydraulic power steering)	with EPS (electric power steering)
	

	HPS	EPS
1	Crankshaft pulley (DDU)	←
2	Auto tensioner	←
3	Tensioner pulley	←
4	Vacuum pulley	←
5	A/C compressor pulley	←
6	Alternator pulley	←
7	Water pump pulley	←
8	NO. 1 idler pulley	←
9	NO. 2 idler pulley	←
10	Power steering pump	-

Modification basis	
Application basis	
Affected VIN	

2. VACUUM PUMP

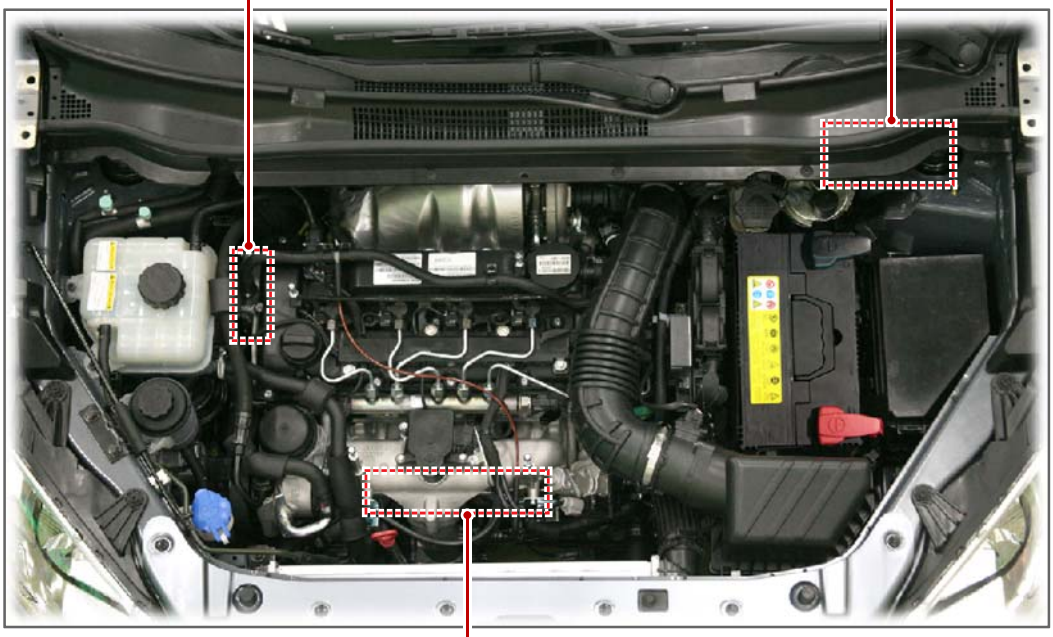
Vacuum pump generates the vacuum pressure and supplies it to EGR cooler bypass solenoid. This pump is single vane type and displacement is 210 cc/rev. The lubrication oil is supplied through the hole in hollow shaft.

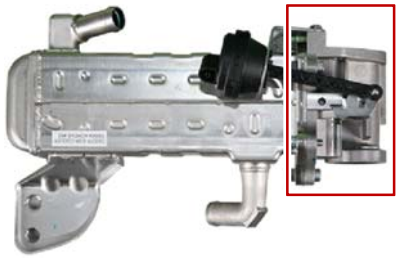
▶ Components

Vacuum pump	
	Pump capacity: 210 cc/rev Speed: 375 to 3,000 rpm Lubrication temperature: −40 to 155°C Oil: 5W30 Drive type: Driven by exhaust Camshaft sprocket

Brake booster





EGR cooler bypass valve	
	Exhaust gas goes to combustion chamber without through EGR cooler in engine cooled, and the valve is closed by vacuum pressure.

3. ENGINE MOUNTINGS

D20DTF engine mounting is 4-point mounting type and supports the engine and transaxle.
Front and rear mountings are rubber type and support the torque reaction. Left and right mountings support the power train rods and torque reaction. Additionally, left mounting is hydraulic type and supports the engine vibration.

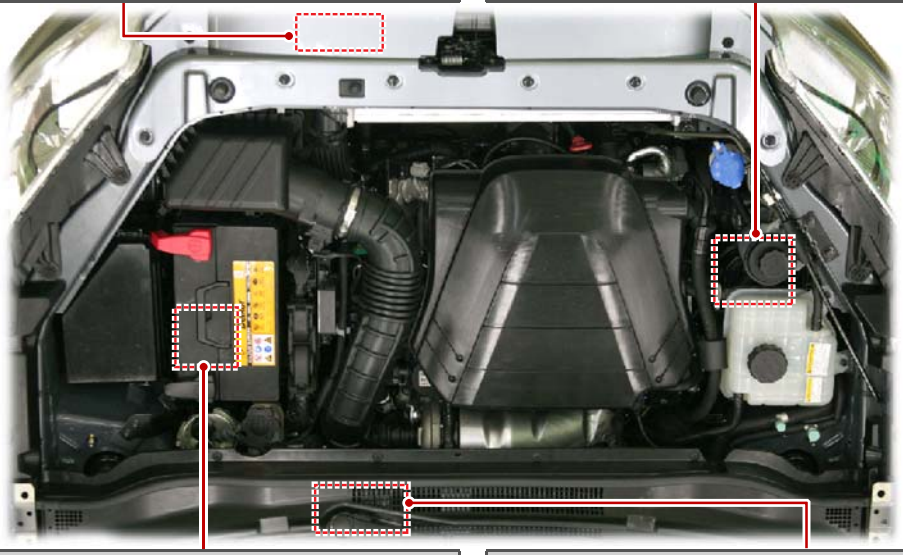
▶ **Components**

Front mounting assembly
Location: Front side of transfer axle housing and front side of sub frame

Location	Front mounting
	

Right mounting assembly
Location: Engine block side and body side member

Location	Front mounting
	



Left mounting assembly
Location: Upper side of transfer axle housing and body side member

Location	Front mounting
	

Rear mounting assembly
Location: Rear side of transfer axle housing and front side of sub frame

Location	Front mounting
	

Modification basis	
Application basis	
Affected VIN	

4. INTAKE/EXHAUST SYSTEM

1) Intake Manifold

Intake manifold is installed on the cylinder head with 8 bolts. The variable swirl valve is introduced to improve the EGR gas mixture and turbulence in combustion chamber and to decrease the exhaust gas.

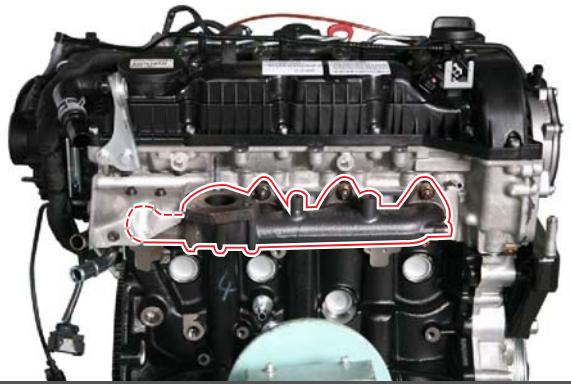
▶ **Components**

Intake manifold	
	

2) Exhaust Manifold

Exhaust manifold is installed on the cylinder head with 10 stud bolts and nuts. EGR port is integrated in cylinder head.

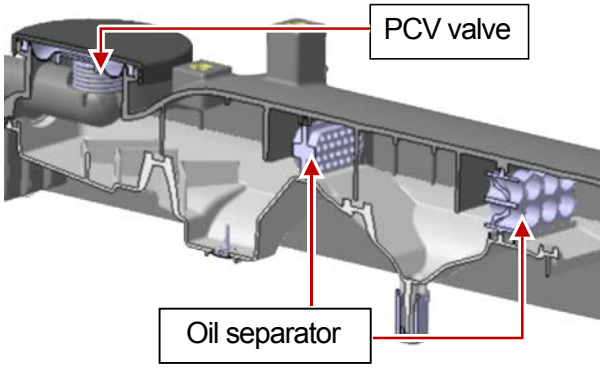
▶ **Components**

Exhaust manifold	
	

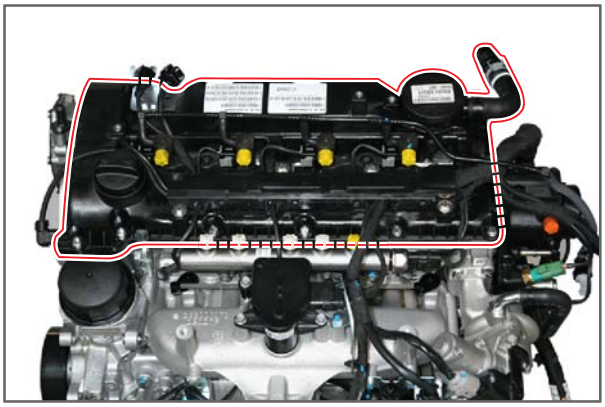
5. CYLINDER HEAD COVER AND OIL SEPARATOR

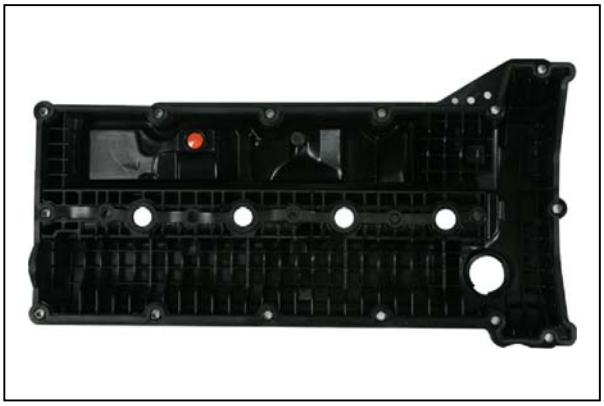
The cylinder head cover is made by high strength plastic to reduce the weight. The multi twist type oil separator improves the oil consumption.

▶ **Components**









Modification basis	
Application basis	
Affected VIN	

6. CYLINDER HEAD

Cylinder head contains cam position sensor, vacuum pump, intake manifold, exhaust manifold and valve assembly. Vacuum pump and the high pressure (HP) pump are driven by Camshaft and valves are install in vertical direction. This enables the compact layout in cylinder head assembly.





▶ Components

Finger follower & HLA

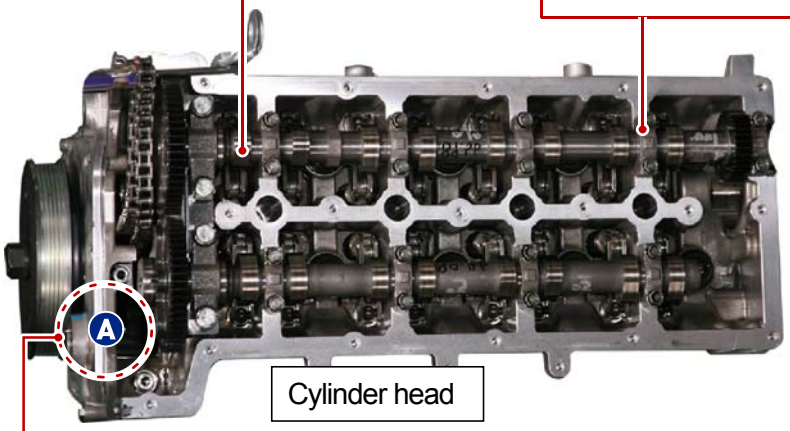


Intake/exhaust Camshafts



Camshaft sprocket





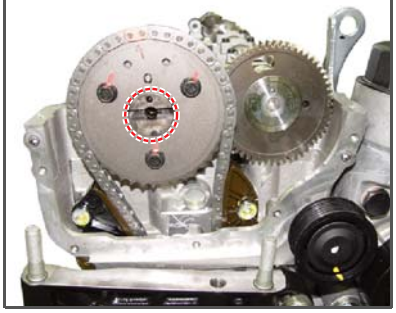
Camshaft position sensor



HP pump drive gear



Vacuum pump drive



Cylinder head gasket

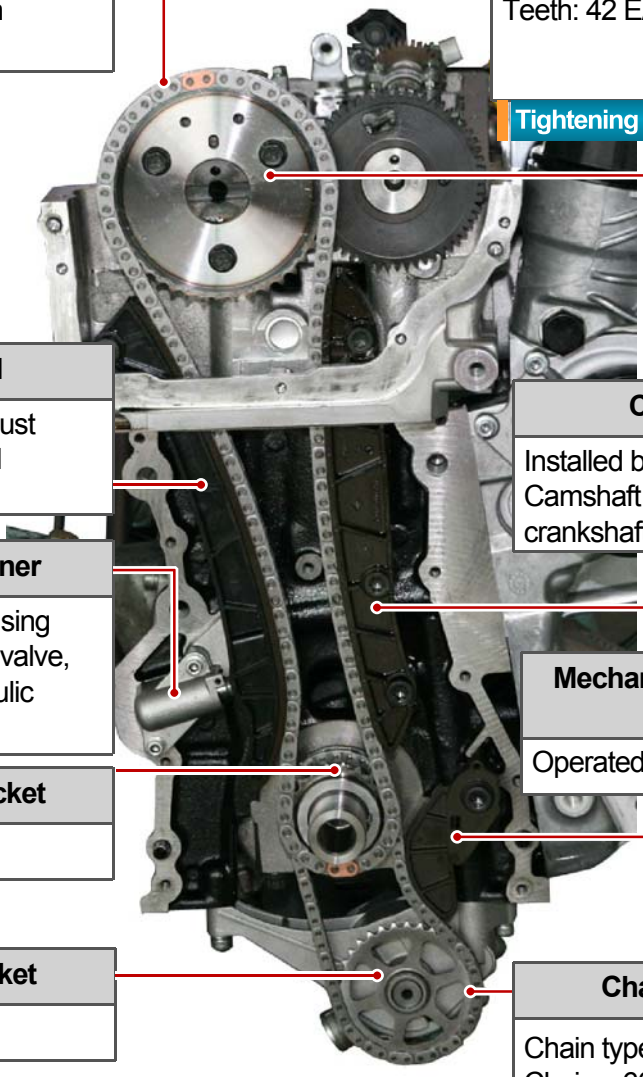


Modification basis	
Application basis	
Affected VIN	

7. CHAIN AND GEAR DRIVE SYSTEM

D20DTF engine uses single stage chain drive system. Timing chain drives the exhaust side and gear drive the intake side. Timing chain is single bush type. Upper chain drives HP pump connected to intake Camshaft by driving exhaust cam shift sprocke, and lower chain drives oil pump to lubricate the engine. And, MBU (Mass Balance shaft Unit) drive gear drives MBU.

▶ Components



Chain upper bush

Chain type: single bush
Chains: 112 EA

Exhaust Camshaft sprocket

Teeth: 42 EA

Tightening torque 30 ± 3Nm

Tensioner rail

Installed between exhaust Camshaft sprocket and crankshaft sprocket

Clamping rail

Installed between exhaust Camshaft sprocket and crankshaft sprocket

Hydraulic tensioner

Contains tensioner housing plug, spring and check valve, and operated by hydraulic pressure

Mechanical type tensioner

Operated by internal spring

Crankshaft sprocket

Teeth: 21 EA

Oil pump sprocket

Teeth: 20 EA

Chain lower bush

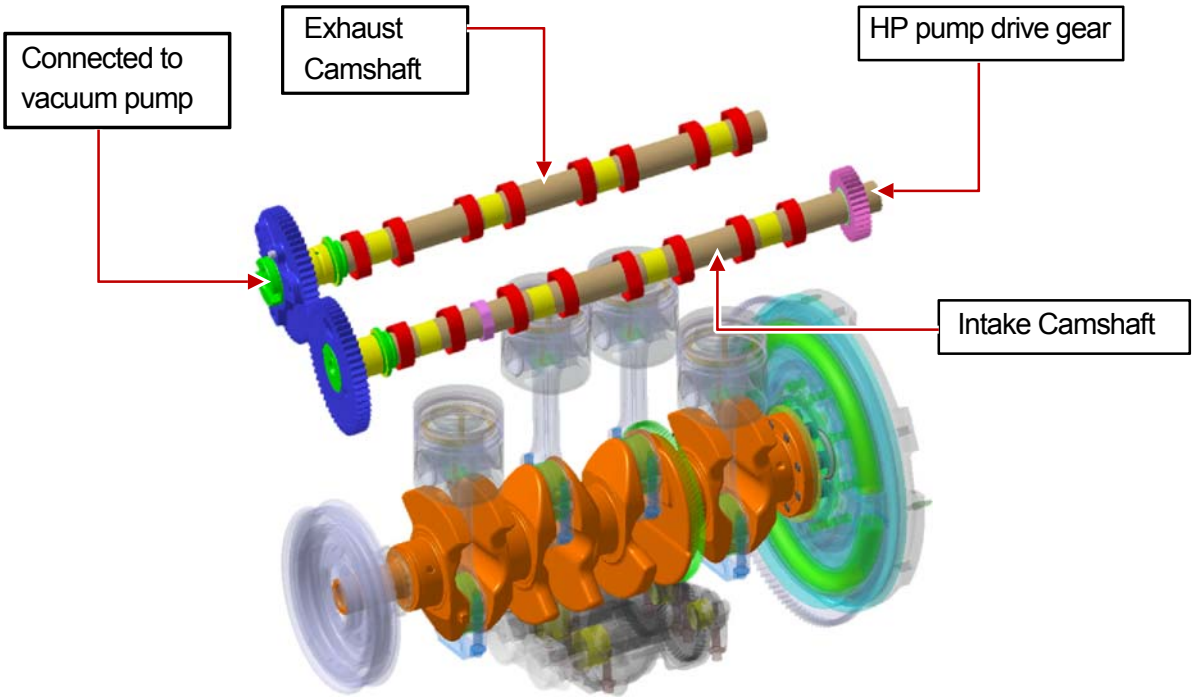
Chain type: single bush
Chains: 60 EA

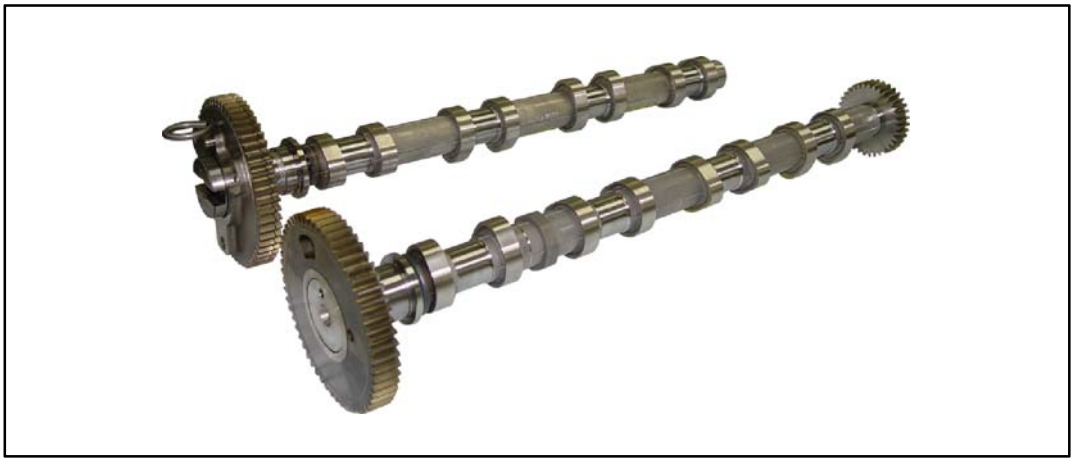
NOTE

The timing links (gold color) on the timing chain are aligned with the timing marks on the crankshaft sprocket and the camshaft sprocket whenever the crankshaft rotates 8 turns.

▶ Components

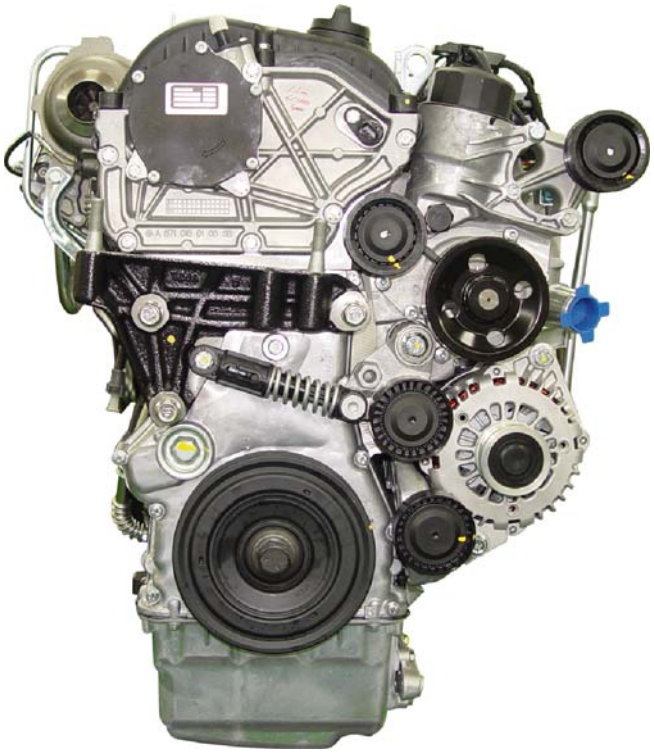
Intake/exhaust Camshaft assembly





Modification basis	
Application basis	
Affected VIN	

Timing gear cover case (TGCC)



TGCC



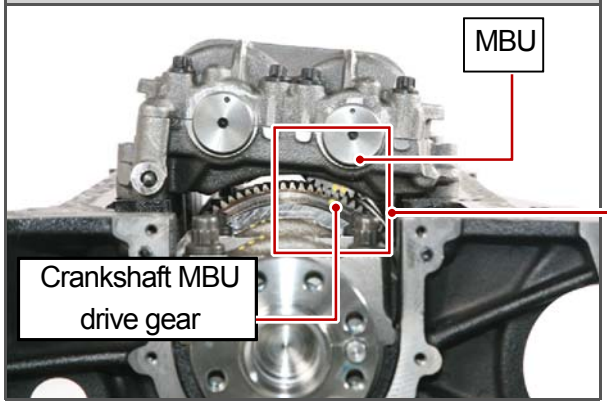
Oil seal

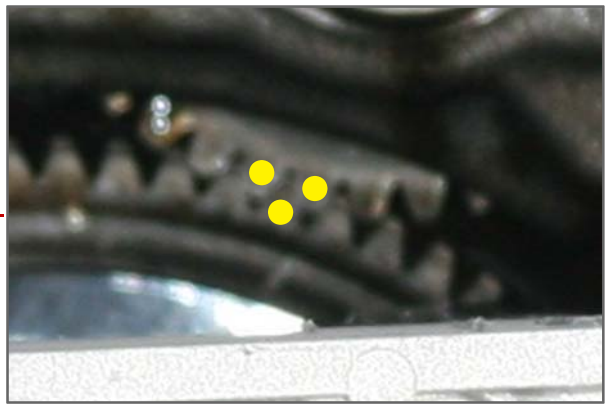


Screw plug

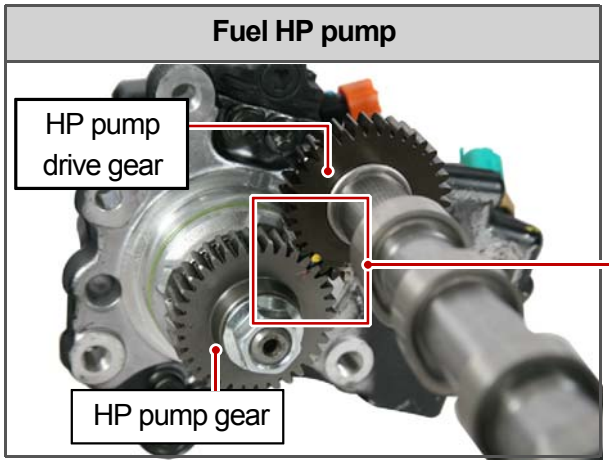


Mass Balance Unit (MBU)





Fuel HP pump



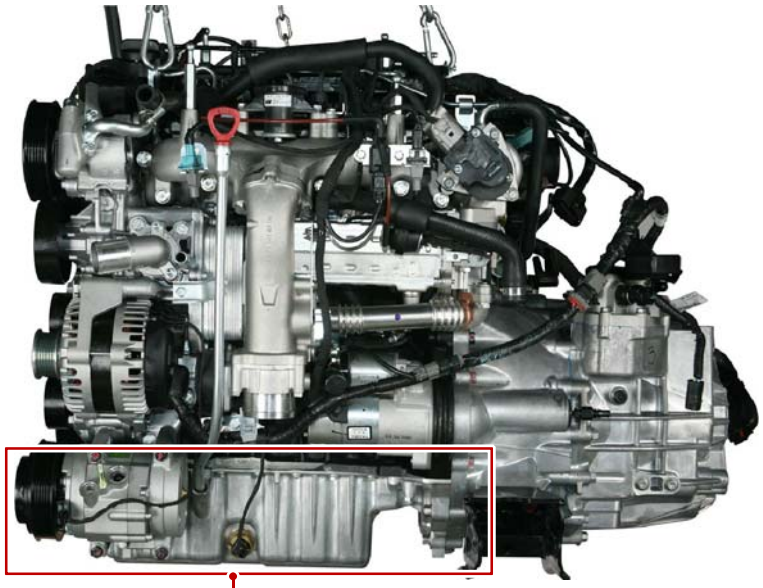


Modification basis	
Application basis	
Affected VIN	

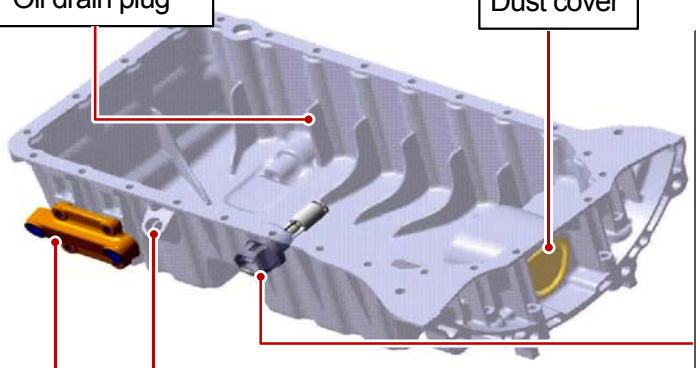
8. OIL PAN

The oil pan in D20DTF engine improves the noise and vibration. Especially, the oil drainage is very easier than before. The oil level sensor in oil pan monitors the oil level and turns on the oil level warning lamp on the meter cluster when the oil level goes down below the specified value. And, A/C compressor bracket and the oil dipstick tube are mounted on the oil pan.

▶ Components



Oil pan assembly



Oil level sensor

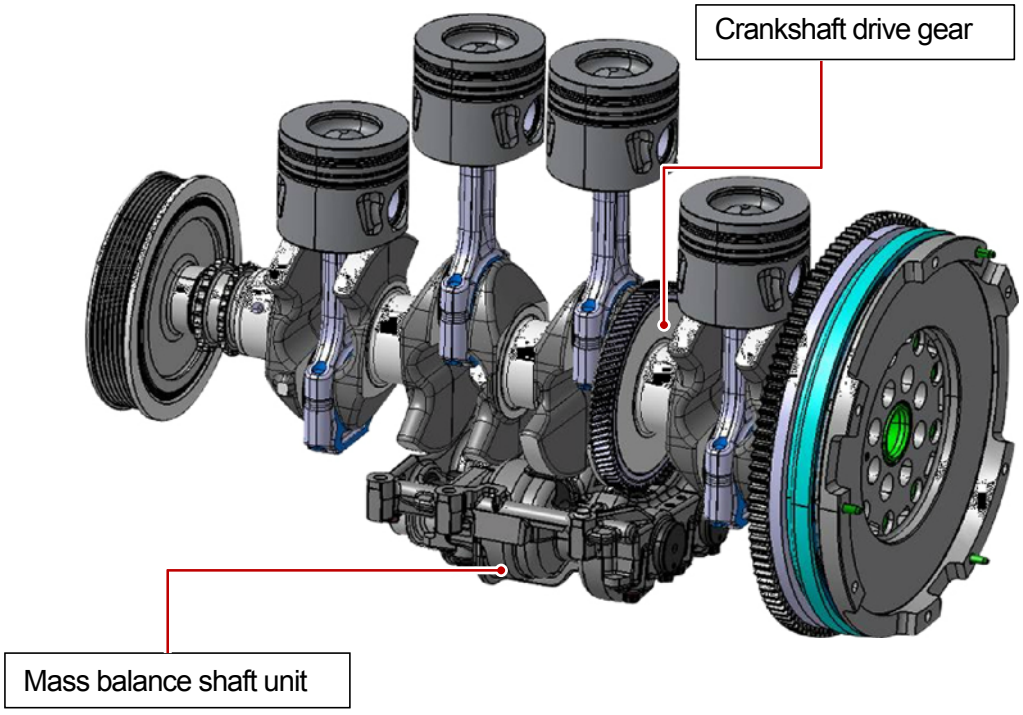


For details, refer to Chapter "Engine Control"

9. MASS BALANCE SHAFT UNIT (MBU)

The balance shaft in MBU (Mass Balance shaft Unit) improves the NVH performance by decreasing the unbalanced force.

▶ **Components**



Mass balance shaft unit

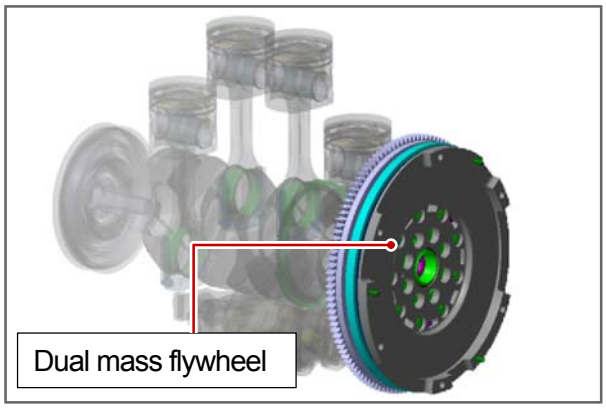

Modification basis	
Application basis	
Affected VIN	

10. FLYWHEEL AND DRIVE PLATE

1) DMF (Dual Mass Flywheel)

The dual mass flywheel, or DMF, eliminates excessive transmission gear rattle, reduces gear change/shift effort, and increases fuel economy. There is a friction ring located between the inner and outer flywheel that allows the inner and outer flywheel to slip. This feature is designed to alleviate any damage to the transmission when torque loads exceed the vehicle rating of the transmission. The friction ring is the weak spot in the system and can wear out if excessive engine torque loads are applied through it. The system also has a center support bearing that carries the load between the inner and outer flywheel, and is fitted with damper springs to absorb shocks.

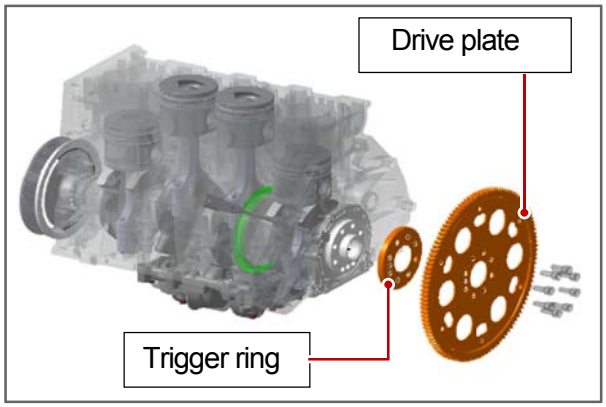
▶ **Components**



2) Drive Plate

Drive plate receives the power from the start motor when starting the engine. With this, the drive plate initially drives the power train system. And, it is connected to the torque converter to transfer the engine torque to the power train system.

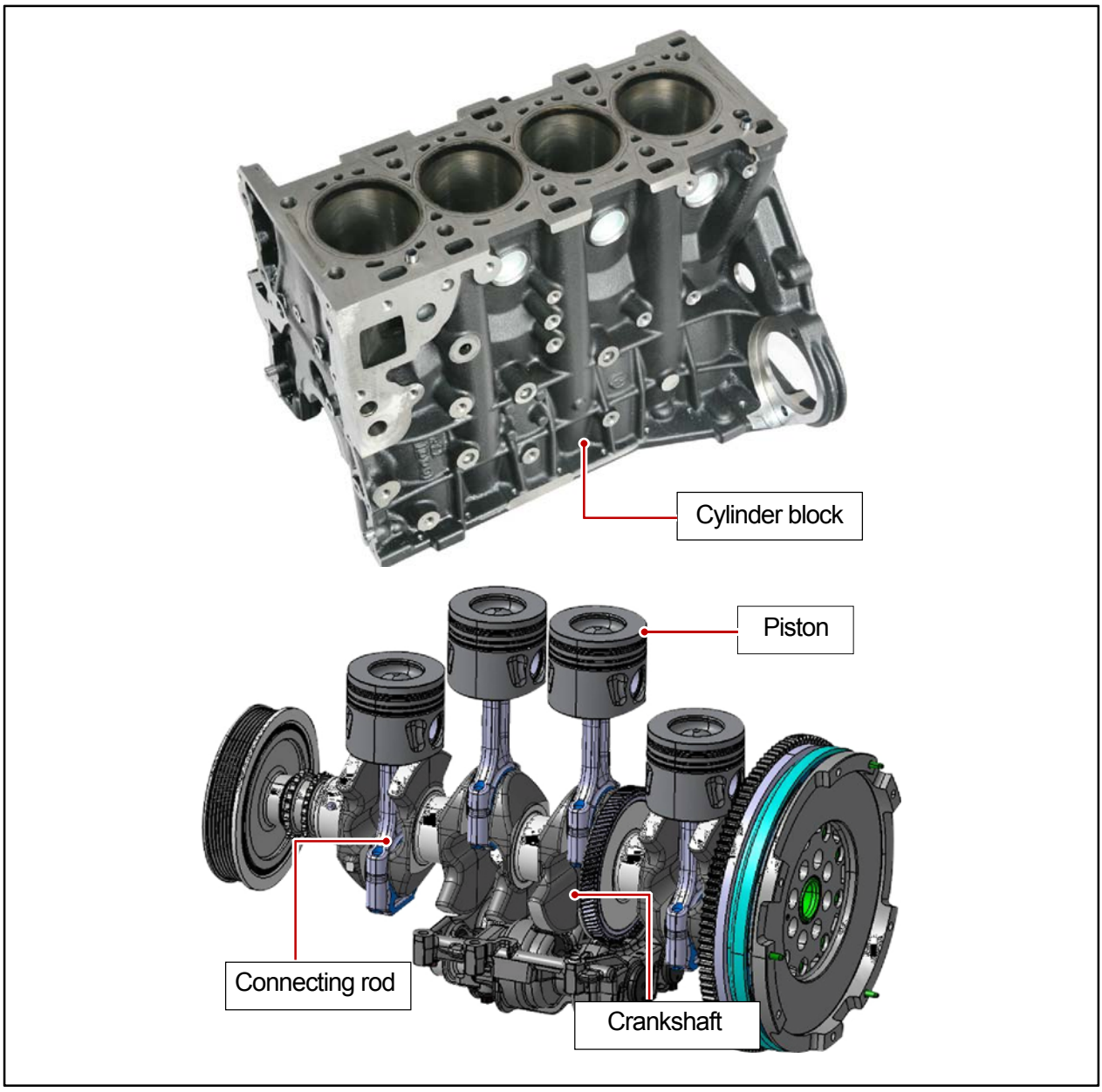
▶ **Components**



11. PISTON/CRANKSHAFT/CYLINDER BLOCK

This vehicle is FF driving type and the engine is installed in lateral direction. The crankshaft and the cylinder block convert the compression pressure to the rotating energy.

▶ **Components**



Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Description			Specification
Fuel			Diesel
Fuel filter	Type		Fuel heater + priming pump + water separator integrated type
	Filter type		Changeable filter element type
	Change interval	EU	every 40,000 km
		GEN	every 45,000 km
	Water accumulating capacity		200 cc
	Heater capacity		250W 13.5V
Injector	System pressure		1800 bar
High pressure fuel pump	Type		Eccentric cam/Plunger type
	Operating type		Gear driven type
	Normal operating temperature		−40 ~ 125℃
	Operating pressure		1800 bar
	Operating temperature		−30℃ ~ 120℃
Low pressure fuel pump	Type		Vane type
	Gear ratio (pump/engine)		0.5 : 1
	Pressure		6 bar
Fuel tank	Capacity		60 L
	Material		Plastic
	Fuel sender		Dual sender type

2. MAINTENANCE AND INSPECTION

1) Maintenance Procedures for DI Engine Fuel System

1. Always keep the workshop and lift clean (especially, from dust).
2. Always keep the tools clean (from oil or foreign materials).
3. Wear a clean vinyl apron to prevent the fuzz, dust and foreign materials from getting into fuel system. Wash your hands and do not wear working gloves.

NOTE

Follow the below procedures before starting service works for fuel system.

Carefully listen the symptoms and problems from customer.

↓

Visually check the leaks and vehicle appearance on the wiring harnesses and connectors in engine compartment.

↓

Perform the diagnosis proceee with SCAN tool

↓

Locate the fault. If the cause is from fuel system (from priming pump to injector, including return line), follow the step 1 through step 3 above.

↓

4. If the problem is from HP pump, fuel supply line or injector, prepare the clean special tools and sealing caps to perform the diagnosis for DI engine fuel system in this manual. At this point, thoroughly clean the related area in engine compartment.

CAUTION

Clean the engine compartment before starting service works.

Tool kit for high pressure line	Took kit for low pressure line
	

Modification basis	
Application basis	
Affected VIN	

5. Follow the job procedures. If you find a defective component, replace it with new one.

Disconnect the negative battery cable.

↓

Use special tools and torque wrench to perform the correct works.

Once disconnected, the fuel pipes between HP pump and fuel rail and between fuel rail and each injector should be replaced with new ones. The pipes should be tightened tospecified tightening torques during installation. Over or under torques out of specified range may cause damages and leaks at connections. Once installed, the pipes have been deformed according to the force during installation, therefore they are not reusable. The copper washer on injector should be replaced with new one. The injector holder bolt should be tightened to specified tightening torque as well. If not, the injection point may be deviated from correct position, and it may cause engine disorder.

Plug the disconnected parts with sealing caps, and remove the caps immediately before replacing the components.

6. Plug the removed components with clean and undamaged sealing caps and store it into the box to keep the conditions when it was installed.

Fuel filter assembly

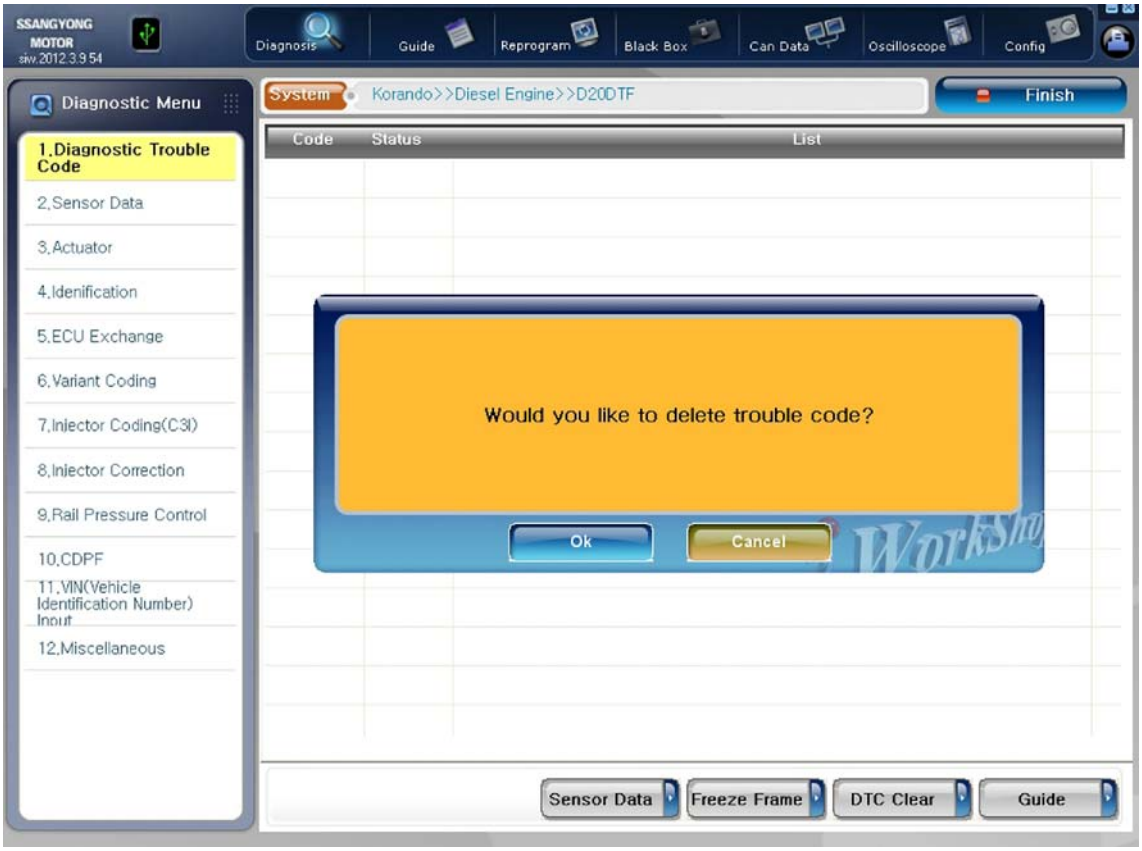


7. To supply the fuel to transfer line of HP pump press the priming pump until it becomes hard.

Priming pump cap



8. Check the installed components again and connect the negative battery cable. Start the engine and check the operating status.
9. With Scan Tool, check if there are current faults and erase the history faults.



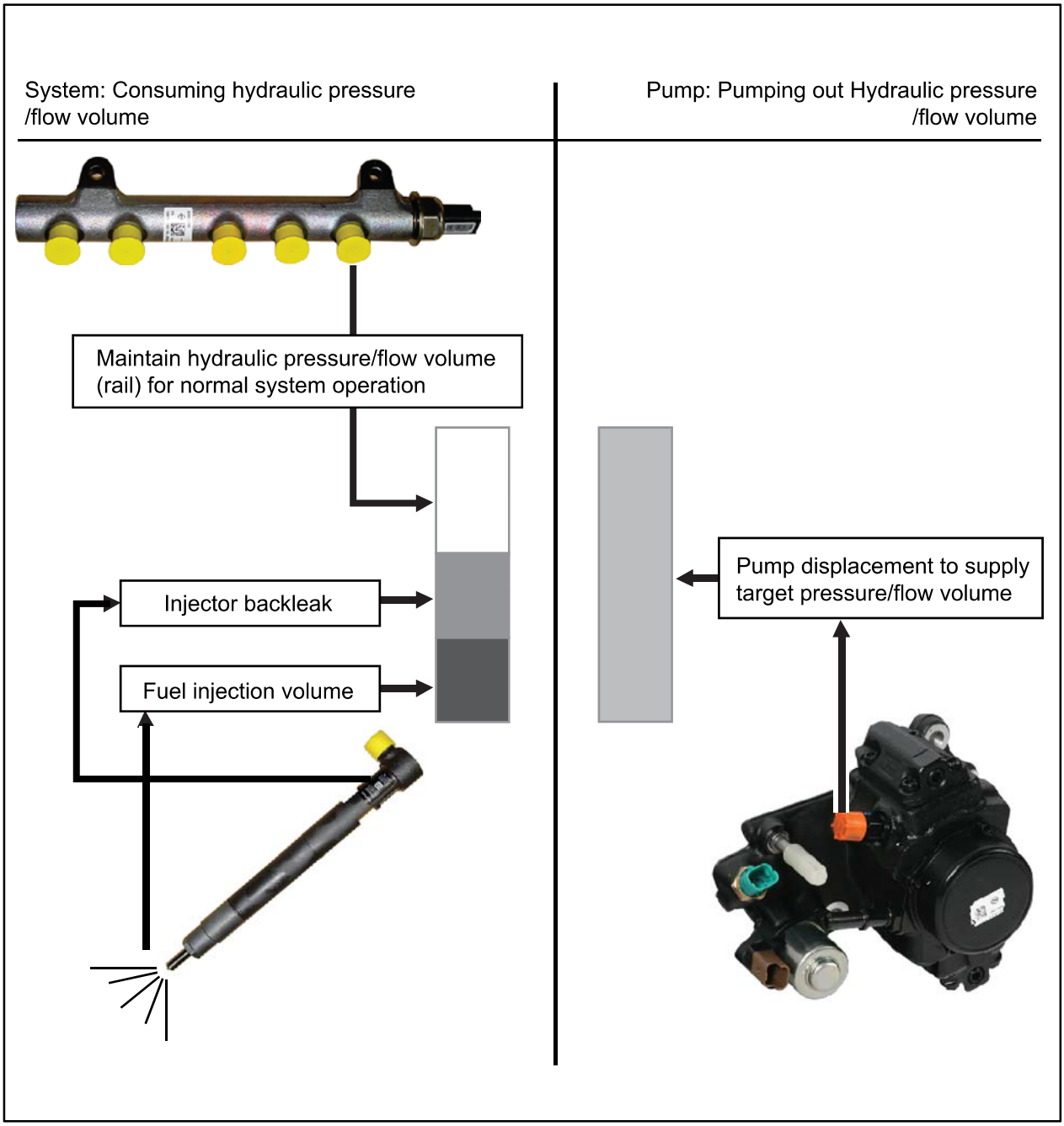
Modification basis	
Application basis	
Affected VIN	

2) Diagnostic Test for Engine Fuel System

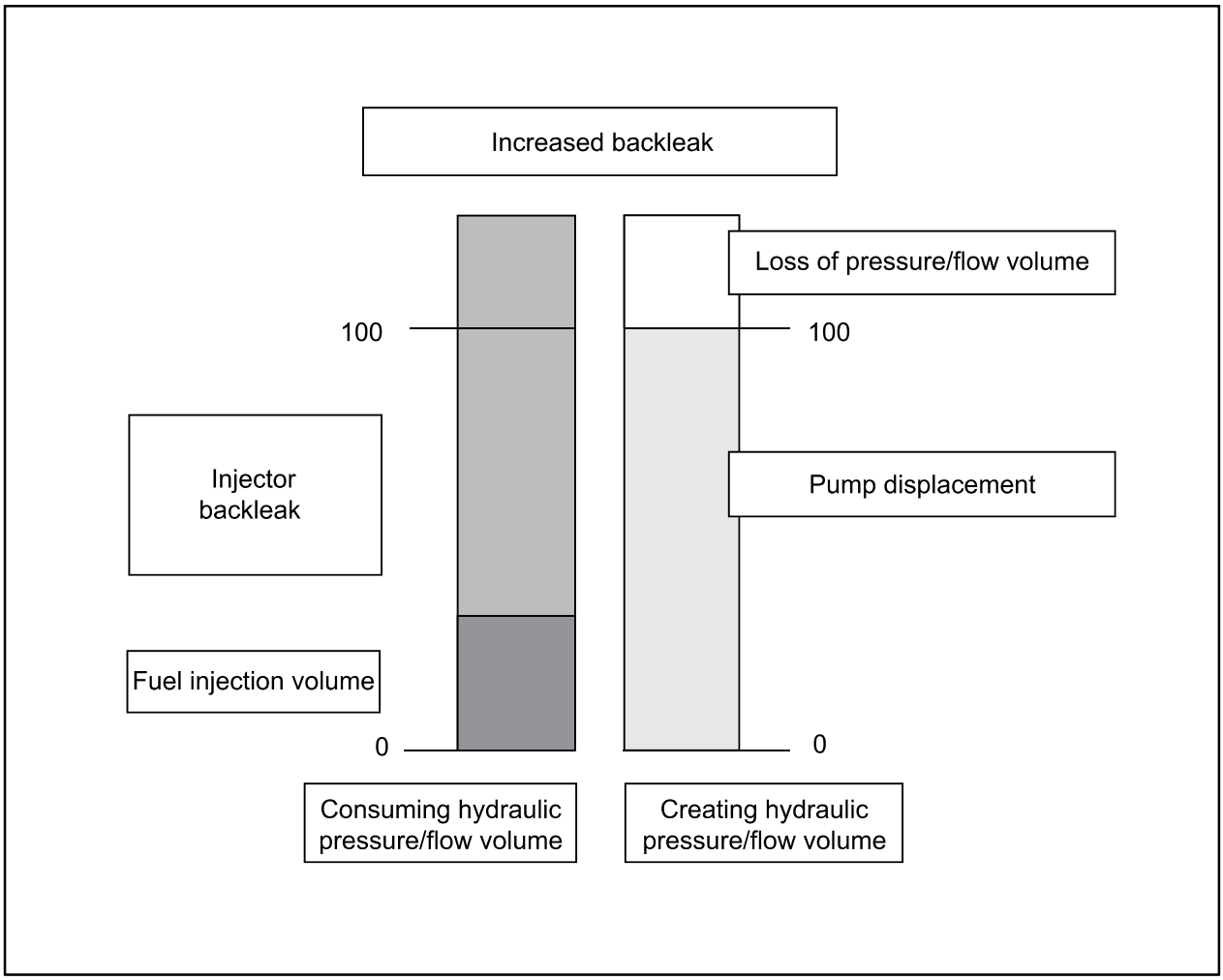
(1) Overview

If a DTC is displayed on the diagnostic device, check the low pressure- and high pressure fuel systems before removing the components.
To run the system properly, the electric system must be intact but for the DI engine, the fuel pressure should be measured also when there is a malfunction even after the diagnostic test with a diagnostic device.

(2) Hydraulic system



(3) Excessive backleak of injector



▶ **Excessive injector backleak**

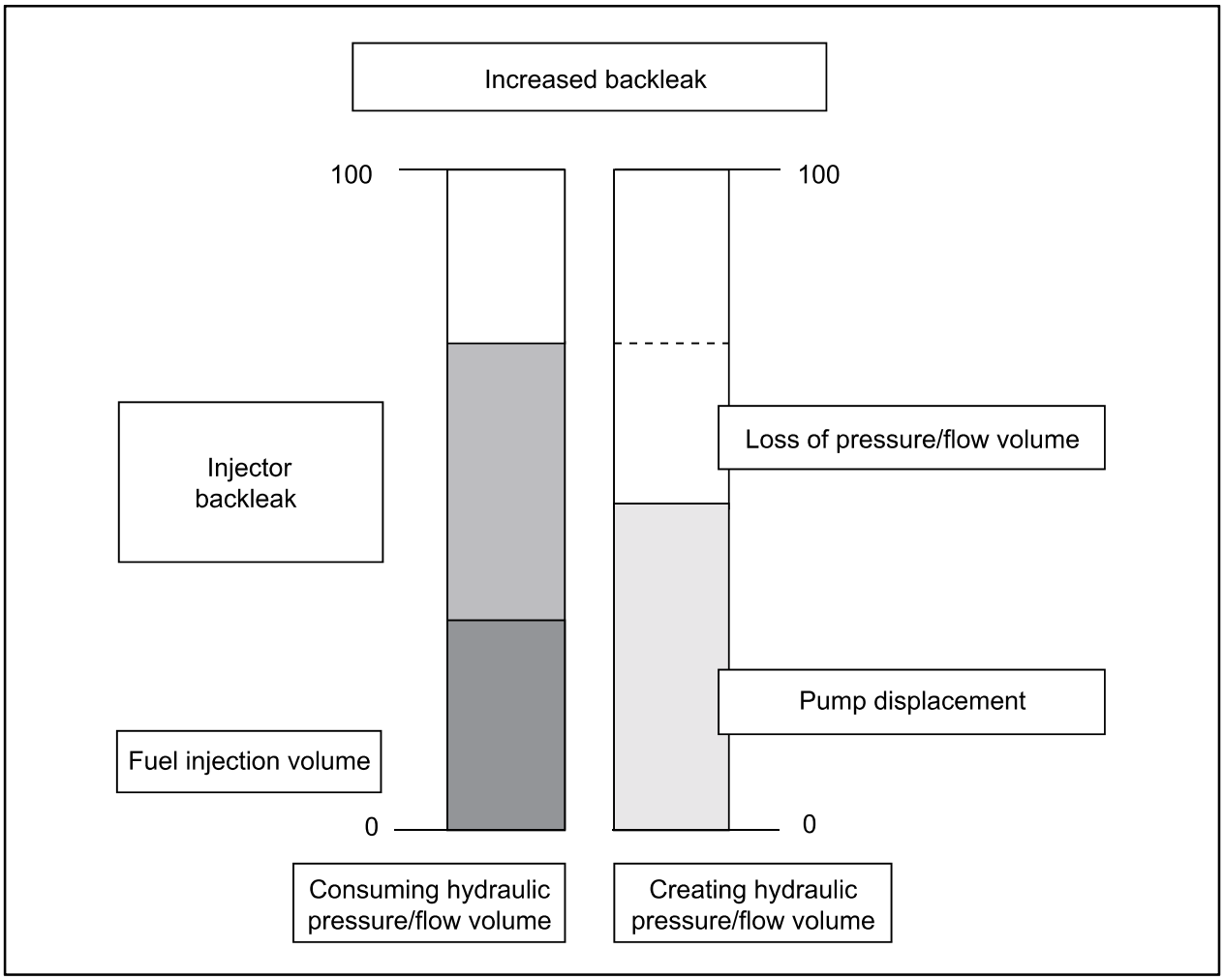
Occurs when the injector control valve is not sealed due to the entry of the foreign materials.

▶ **Example:**

- Entry of foreign materials
- Burned out and worn HP pump
- Mechanical damage inside the injector

Modification basis	
Application basis	
Affected VIN	

(4) Loss of pump pressure/flow



▶ **Loss of HP pump pressure/flow**

Faulty fuel supply line, or damaged or worn pump causes the lack of flow pressure and flow volume

▶ **Example:**

- Air in fuel supply line
- Excessive load on fuel supply line (←400 mBar)
- Burned out and mechanical worn pump
- High temperature of fuel supply (> 85℃)

3) Pressure Test for Fuel System in DI Engine

(1) Test device (Tool kit)

Tool kit for high pressure line

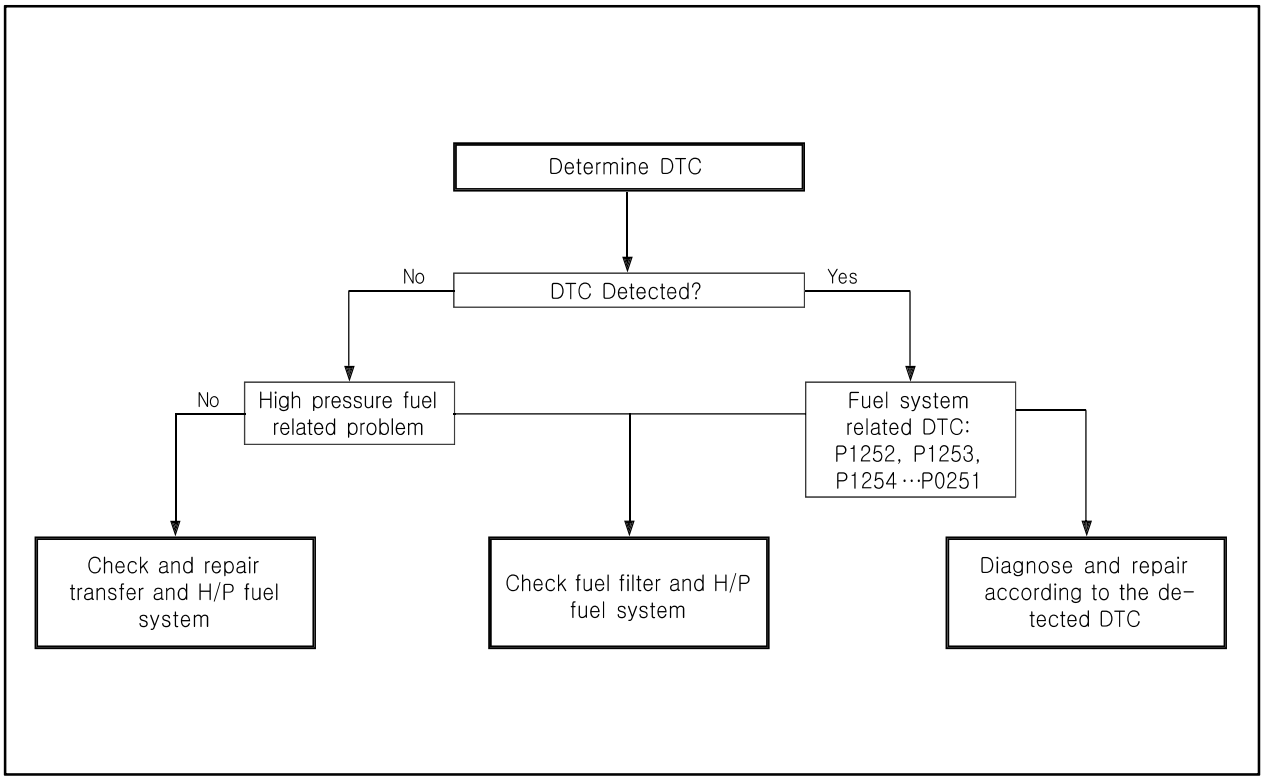
Tool kit for low pressure line


(2) Pre-inspection

- Connections in fuel supply line
- Fuel level in fuel tank
- Air in fuel supply line (air bubbles in fuel supply line or fuel)
- Fuel leaks from fuel supply line (low/high pressure line)
- Used the specified
- Fuel filter contamination

Modification basis	
Application basis	
Affected VIN	

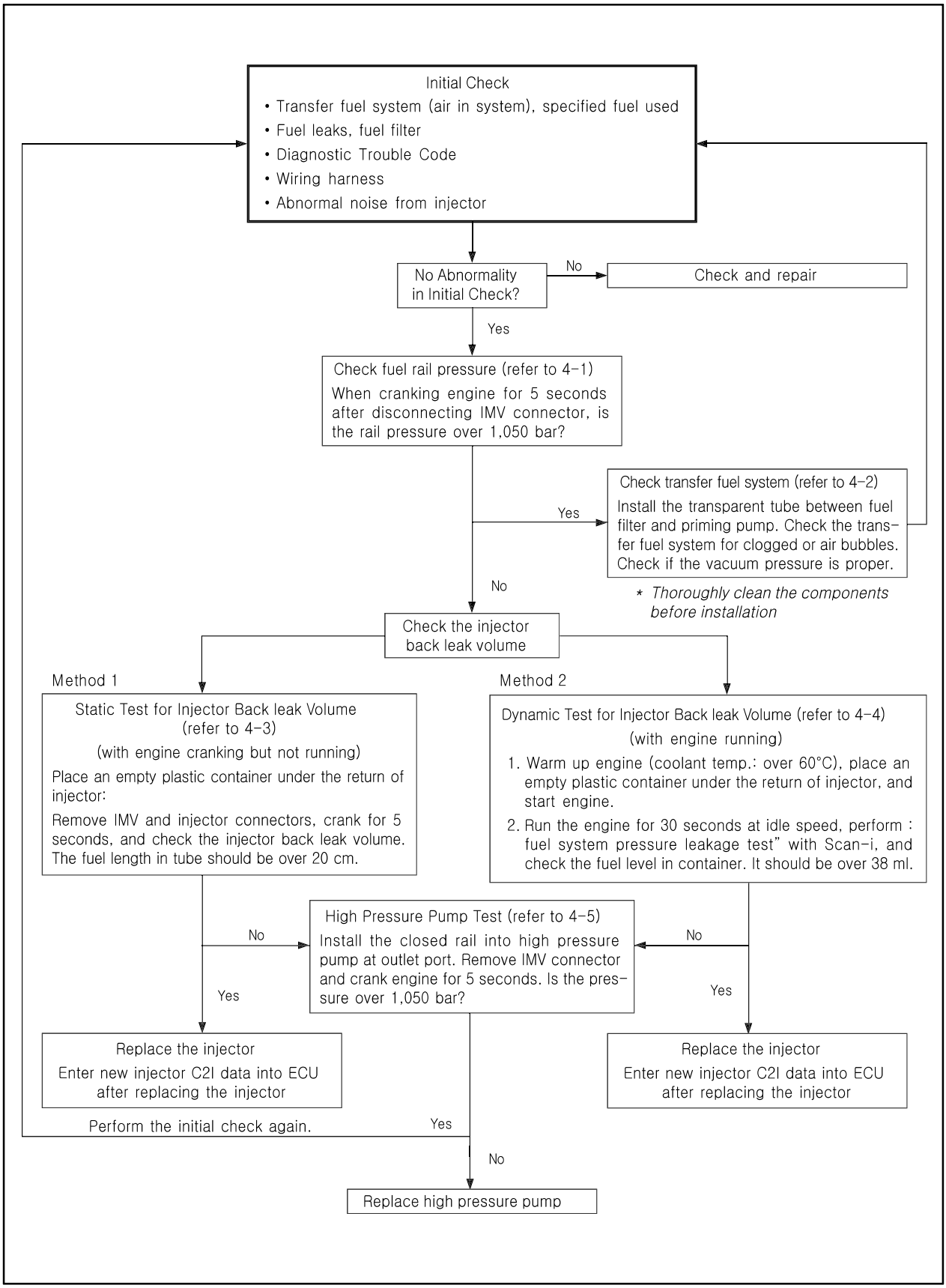
(3) DTC Check



CAUTION

If several DTCs are output simultaneously, check the electric wiring for open or short circuit.
Check the low pressure fuel system and fuel filter and confirm that there are no abnormalities. Carry out the high pressure fuel system check.

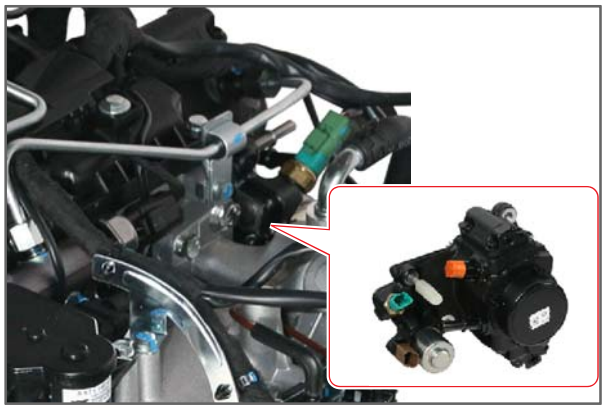
(4) Fuel System Check Procedure



Modification basis	
Application basis	
Affected VIN	

(5) High Pressure System Pressure Test

▶ **Fuel rail pressure test**



1. Disconnect the fuel rail pressure sensor connector and then IMV connector.



2. Connect the pressure tester to the fuel rail pressure sensor connector.



3. Crank the engine 2 times for 5 seconds.
   - Read the highest pressure value displayed on the tester display.
   - If the highest pressure value is 1,050 bar or less, refer to the section "Fuel System Check Process".

▶ How To Use Pressure Tester



1. Press the "TEST" button on the tester to check if the message "TEST?" is displayed. If the button is pressed again at 4 seconds
2. after starting engine cranking, the highest pressure is displayed on the tester.

NOTE

The fuel rail pressure value can be checked using a diagnostic device.

Modification basis	
Application basis	
Affected VIN	

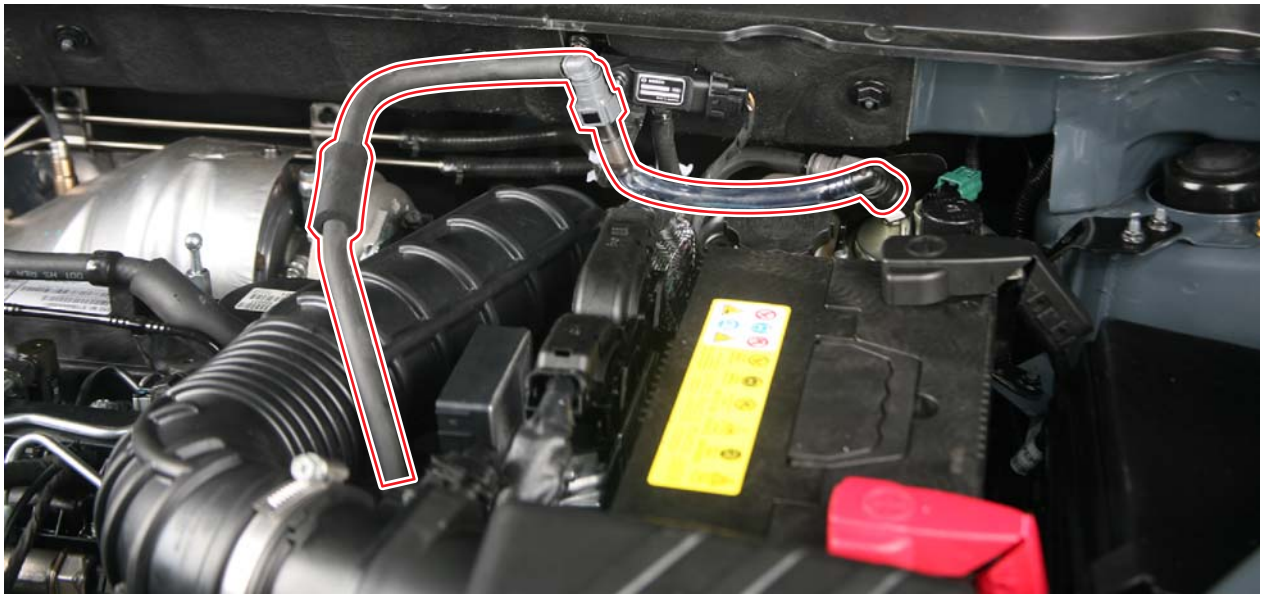
(6) Low Pressure System Pressure Test

▶ **Inspection procedure**



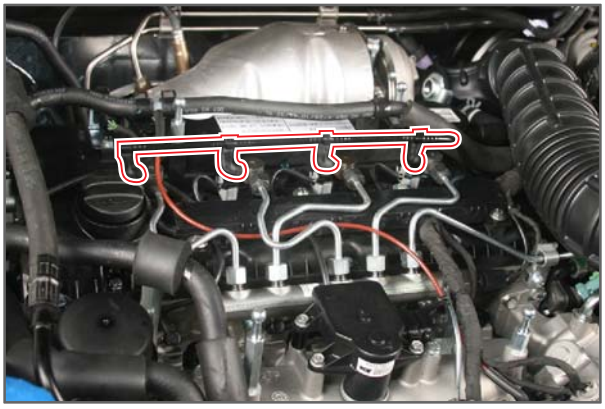
1. All wirings/connectors and fuel lines should be connected and the engine should work properly.
2. Prepare a special tool for low pressure test and clean it thoroughly to prevent foreign materials from entering.

3. Disconnect the key connector for fuel filter connection, and connect both connectors to the fuel filter and hose.



4. Start the engine and check visually for clogged low pressure fuel system, excessive air or air entry. If the fuel flow is not sufficient or air is in the fuel, repair the leak area.
5.

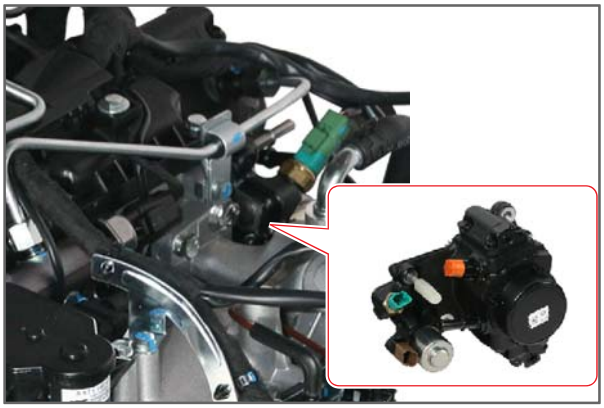
▶ Static test for backleak of injector



1. Disconnect the injector return hose and cover the openings with caps shaped screw (included in the special tool).



2. Connect the hose of the container for measuring backleak to the return nipple of the injector.
(prevent air entry to the low pressure line)



3. Disconnect the IMV connector of the high pressure pump and then fuel pressure sensor connector.

CAUTION
The connector of the injector can be easily contaminated. Always keep it clean.



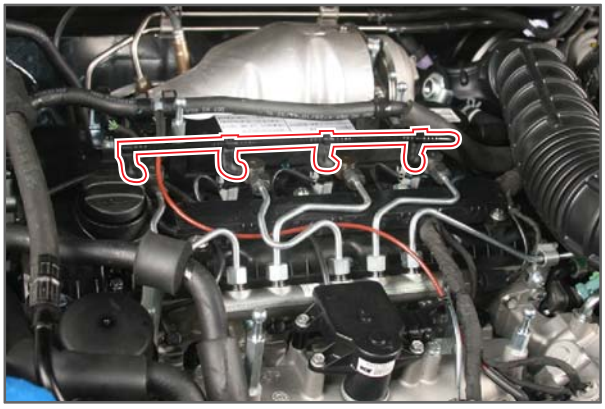
4. Crank the engine for 5 seconds.
5. Check the flow volume of injector backleak.

Flow volume of injector backleak	below 20 cm

NOTE
If the value is out of the specified range, replace the injector.

Modification basis	
Application basis	
Affected VIN	

▶ Dynamic test for backleak of injector



1. Warm up the engine so that the engine coolant temperature be over 80℃ and star
2. the engine again.
   Disconnect the injector return hose and cover the openings with caps shaped screw (included in the special tool).



3. Connect the hose of the container for measuring backleak to the return nipple of
4. the injector.
   Start the engine again and let the engine
5. idle for 30 seconds.
   Perform backleak test of fuel system with a diagnostic device after 30 seconds.

This test consists of 4 cycles, and the engine rpm reaches 3,500 rpm for 18 seconds in each cycle.



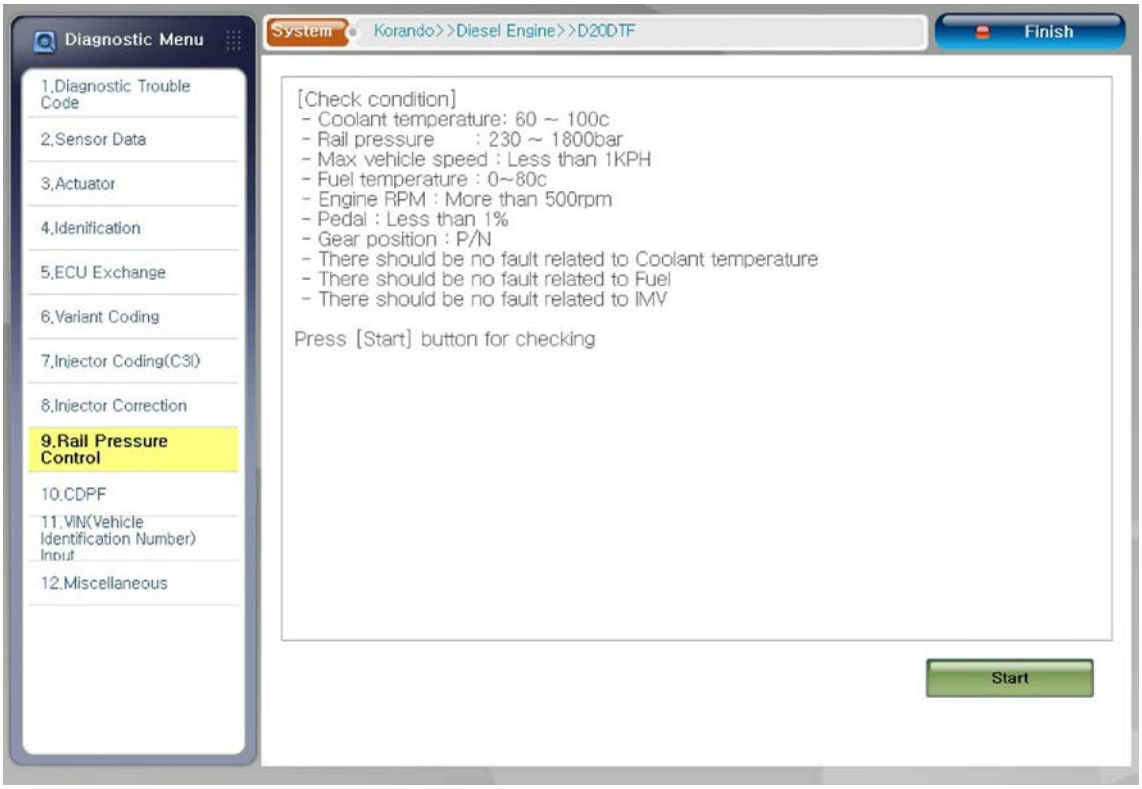
6. Check the amount of backleak collected into the container and confirm that it is within the specified range.

Specification	38 ml or less



▶ Pressure leak test in fuel system with scan tool

1. When the dynamic test for injector backleak is performed, this test should be done together with it. However, you can check the pressure leak from the fuel system only with this test.
2. To do this test, the coolant temperature should be over 60°C. Check the conditions of sensors and components in fuel system with scan tool.
3. Perform the diagnostic test as follows:
   - Select the "Vehicle Model" and go to "Diagnosis Mode".
   - Select "Pressure Leak Test in Fuel System" in "Diagnosis Menu".
   - If the conditions are OK, press "Start".



NOTE

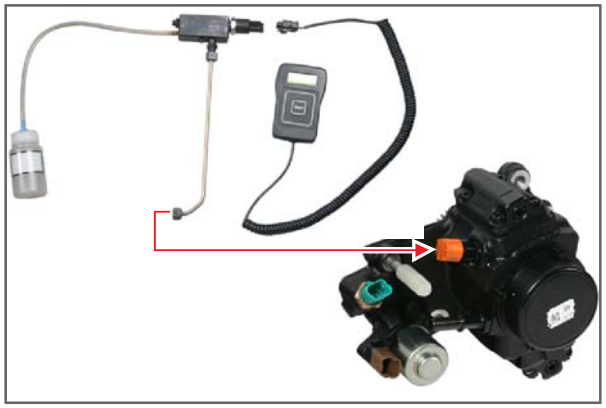
The pressure leak test procedure is performed in 4 cycles. The engine speed goes up to 3,500 rpm and down again four times for 18 seconds. If the system is OK, the "System OK" message will be displayed.

Modification basis	
Application basis	
Affected VIN	

▶ HP pump pressure test



1. Prepare a special tool for high pressure test and clean it thoroughly to prevent foreign materials from entering.



2. Disconnect the high pressure fuel supply pipe on the HP pump and install the close rail in the tool kit.

Tightening torque 30Nm

3. Connect the other end of the close rail to the fuel rail for test

Tightening torque 30Nm

4. Disconnect the return hose for HP pump and connect the clear hose and connect its the other end to the return port of the fuel rail for test.
5. Connect the digital tester connector to the sensor connector of the fuel rail for test.
6. Crank the engine 2 times for 5 seconds after removing the IMV connector and fuel rail pressure sensor connector.
7. Read the pressure value displayed on the tester display is within the specified range.



Specification	1,050 bar or more

3. CAUTIONS FOR DI ENGINE

1) Cautions for DI Engine

This chapter describes the cautions for DI engine equipped vehicle. This includes the water separation from engine, warning lights, symptoms when engine malfunctioning, causes and actions.

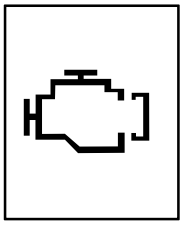
1. DI Engine

Comparatively conventional diesel engines, DI engine controls the fuel injection and timing electrically, delivers high power and reduces less emission.

2. System Safety Mode

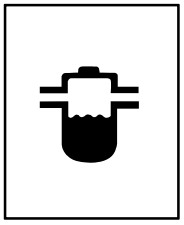
When a severe failure has been occurred in a vehicle, the system safety mode is activated to protect the system. It reduces the driving force, restricts the engine speed (rpm) and stops engine operation. Refer to "Diagnosis" section in this manual.

3. Engine CHECK Warning Lamp



The Engine CHECK warning lamp on the instrument cluster comes on when the fuel or major electronic systems of the engine are not working properly. As a result, the engine's power output may decrease or the engine may stall.

4. Water Separator Warning Lamp



When the water level inside water separator in fuel filter exceeds a certain level (approx. 45 cc), this warning light comes on and buzzer sounds.
Also, the driving force of the vehicle decreases (torque reduction). If these conditions occur, immediately drain the water from fuel filter.

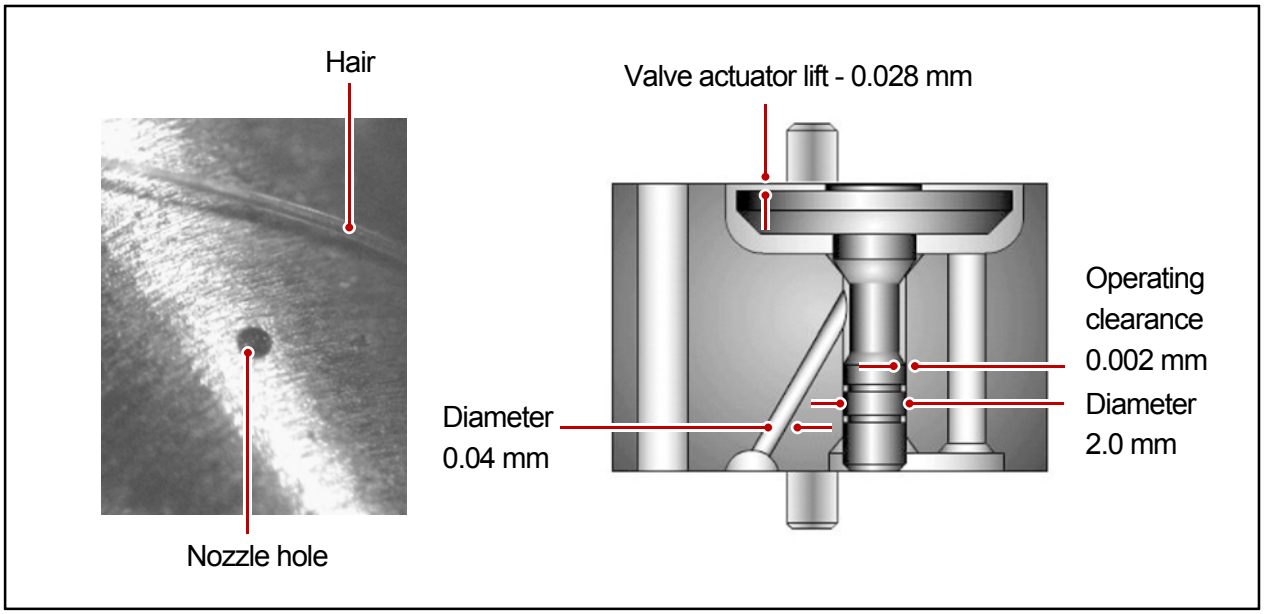
Modification basis	
Application basis	
Affected VIN	

2) Cleanness

(1) Cleanness of DI engine fuel system

▶ Cleanness of DI engine fuel system and service procedures

The fuel system for DI engine consists of transfer (low pressure) line and high pressure line.
Its highest pressure reaches over 1,600 bar.
Some components in injector and HP pump are machined at the micrometer 100 μm of preciseness.
The pressure regulation and injector operation are done by electric source from engine ECU.
Accordingly, if the internal valve is stuck due to foreign materials, injector remains open.
Even in this case, the HP pump still operates to supply high pressurized fuel. This increases the pressure to combustion chamber (over 250 bar) and may cause fatal damage to engine.
You can compare the thickness of injector nozzle hole and hair as shown in below figure (left side). The below figure shows the clearance between internal operating elements.



The core elements of fuel system has very high preciseness that is easily affected by dust or very small foreign material. Therefore, make sure to keep the preliminary works and job procedures in next pages. If not, lots of system problems and claims may arise.

(2) Di engine and its expected problems and remedies can be caused by water in fuel

▶ System supplement against paraffin separation

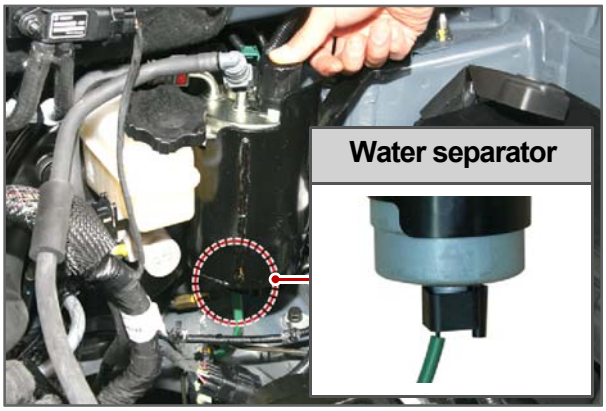
In case of Diesel fuel, paraffin, one of the elements, can be separated from fuel during winter and then can stick on the fuel filter blocking fuel flow and causing difficult starting finally. Oil companies supply summer fuel and winter fuel by differentiating mixing ratio of kerosene and other elements by region and season. However, above phenomenon can be happened if stations have poor facilities or sell improper fuel for the season. In case of DI engine, purity of fuel is very important factor to keep internal preciseness of HP pump and injector.
Accordingly, more dense mesh than conventional fuel filter is used. To prevent fuel filter internal clogging due to paraffin separation, SYMC is using fuel line that high pressure and temperature fuel injected by injector returns through fuel filter to have an effect of built-in heater (see fuel system).

▶ System supplement and remedy against water in fuel

As mentioned above, some gas stations supply fuel with excessive than specified water. In the conventional IDI engine, excessive water in the fuel only causes dropping engine power or engine hunting. However, fuel system in the DI engine consists of precise components so water in the fuel can cause malfunctions of HP pump due to poor lubrication of pump caused by poor coating film during high speed pumping and bacterization (under long period parking). To prevent problems can be caused by excessive water in fuel, water separator is installed inside of fuel filter. When fuel is passing filter, water that has relatively bigger specific gravity is accumulated on the bottom of the filter.

▶ Water drain from water separator

If water in the separator on the fuel filter exceeds a certain level, it will be supplied to HP pump with fuel, so the engine ECU turns on warning lamp on the meter cluster and buzzer if water level is higher than a certain level.
Due to engine layout, a customer cannot easily drain water from fuel filter directly, so if a customer checks in to change engine oil, be sure to perform water drain from fuel filter.

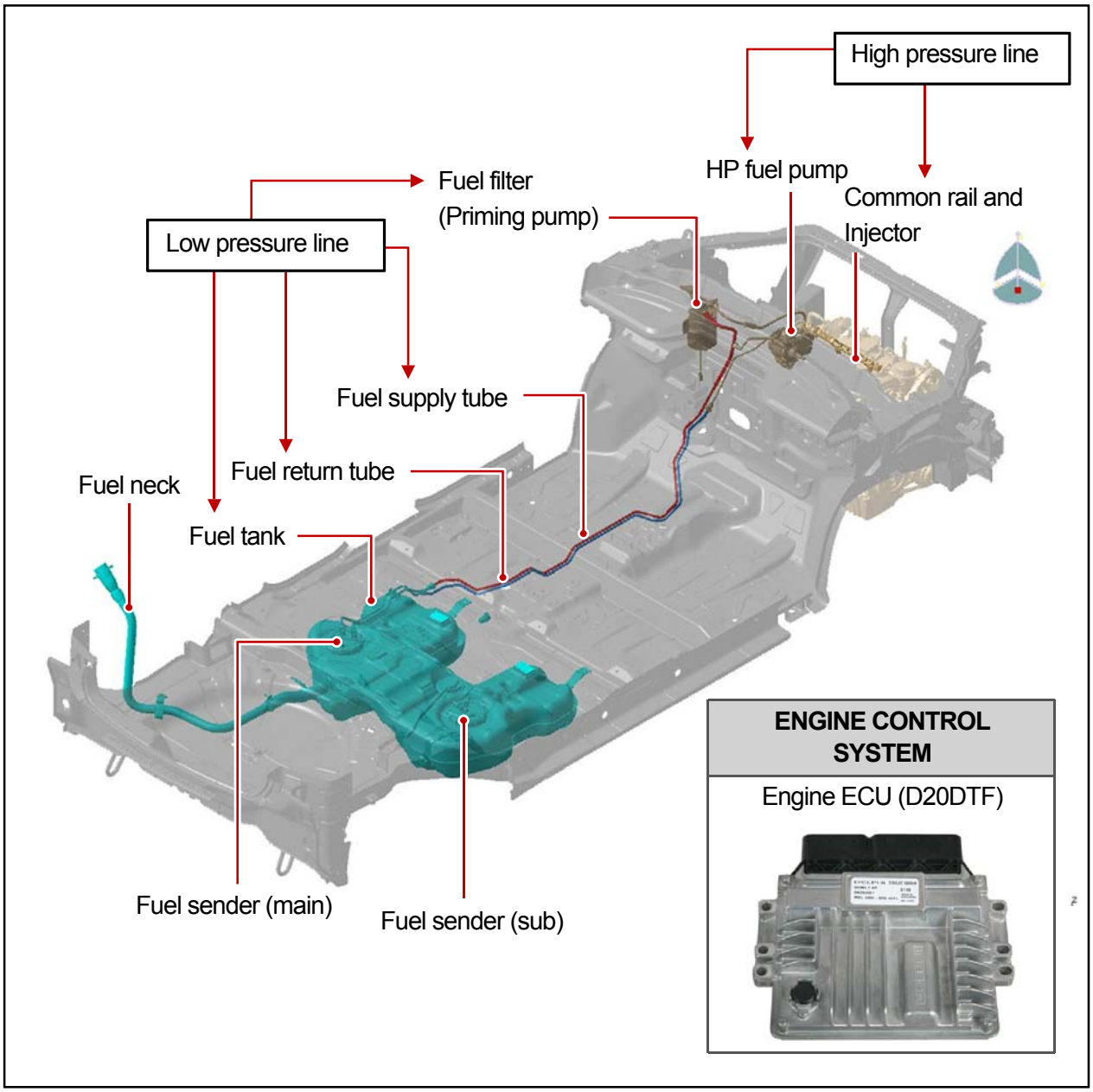


Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

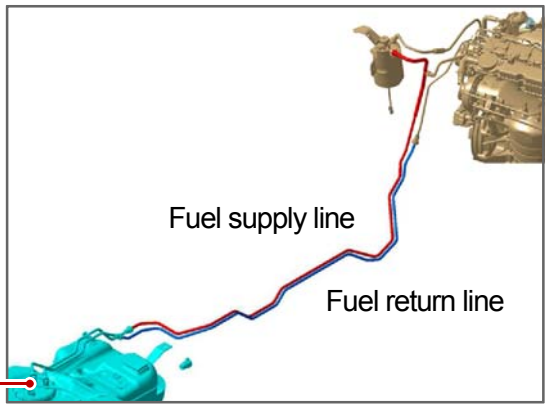
The components in the fuel system supply fuel and generate high pressure to inject fuel to each injector. They are controlled by the engine ECU.
The common rail fuel injection system consists of fuel tank, fuel line, low pressure line which supplies low pressure fuel to the low pressure pump (includes high pressure pump), high pressure line which connected to the injector and the engine control unit (ECU) which calculates the accelerator pedal position and controls the overall performance of vehicle based on the input signals from various sensors.



2. SYSTEM LAYOUT AND OPERATION

1) Layout

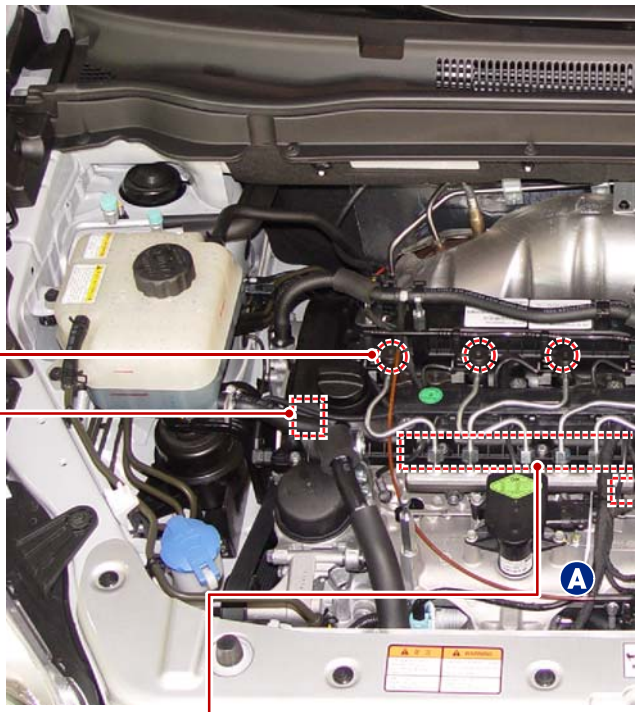
NOTE
For sensor and actuator control logic,
refer to Chapter "ENGINE CONTROL".



Fuel tank



Fuel metering by dual sender. Supply the fuel in main fuel tank and sub fuel tank through fuel inlet tube



Injector (C3I)



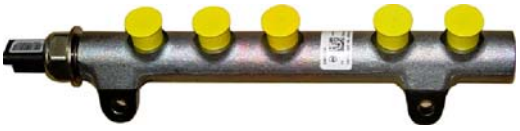
Pre-injection, main injection, after-injection by signals from ECU

Camshaft position sensor



Determines the injection order.

Fuel rail assembly



Relieves the pulsation.
Measures the fuel pressure.
Distributes the fuel to injectors.

Modification basis	
Application basis	
Affected VIN	

High pressure pump

Plunger type HP pump (1,800 bar)



Vane type transfer pump (6bar)

Generates the high pressurized fuel and supply it.

Accelerator pedal position sensor

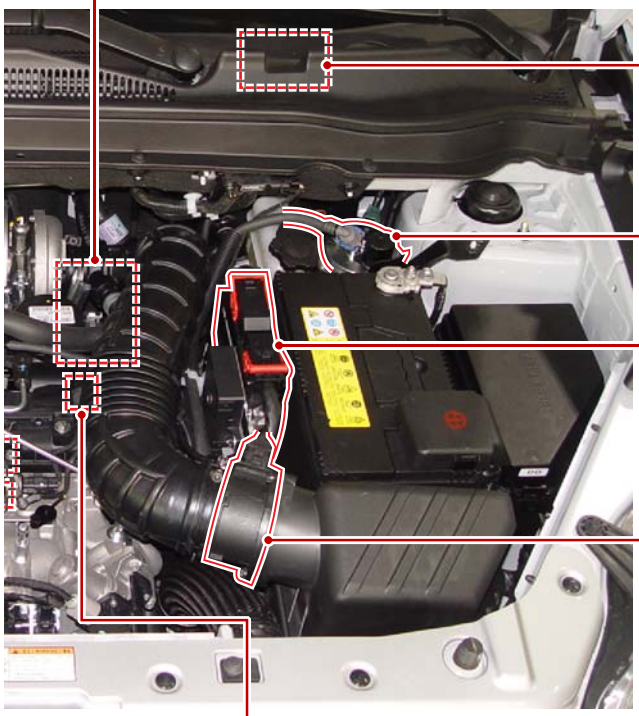


Detects driver's intention for speed up/down

Fuel filter assembly



Supply clean fuel/fuel heating/water separation by priming pump



Engine ECU (D20DTF)



Engine control by various signals

Crankshaft position sensor



Measuring engine rpm

T-MAP sensor



Measuring booster pressure and temperature

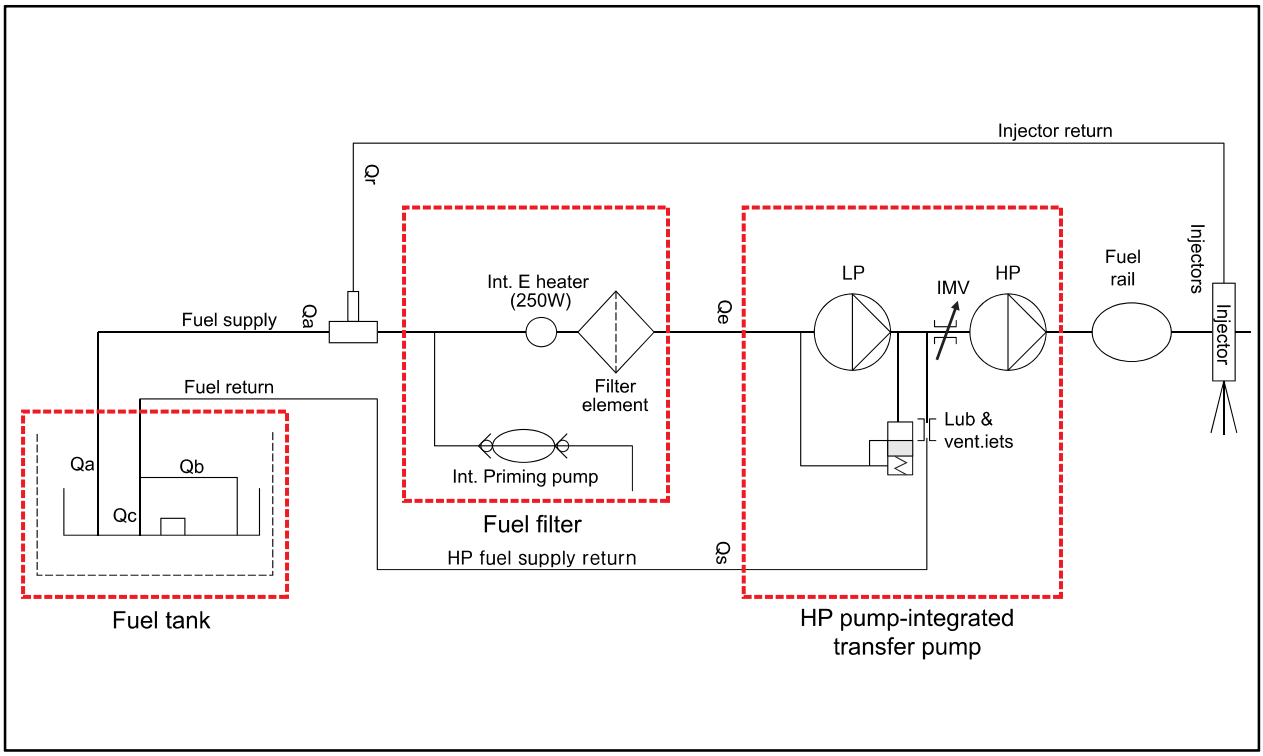
HFM



Measuring intake air mass and temperature

Modification basis	
Application basis	
Affected VIN	

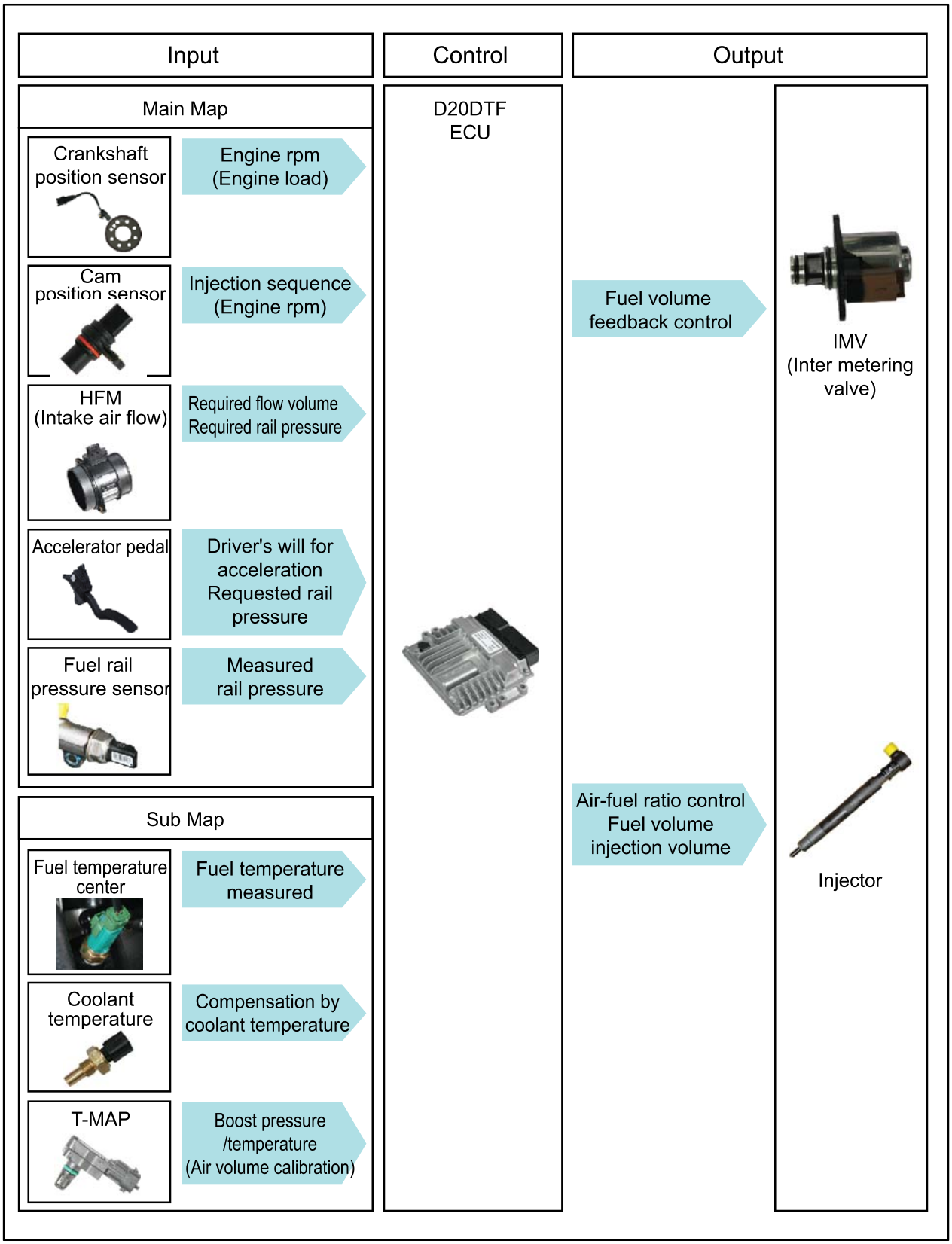
2) Fuel System Flow Diagram



The fuel from the fuel tank is supplied to the fuel heater of fuel filter/priming pump and then low pressure generated by the low pressure pump (built into HP pump) is transmitted to the HP pump.
The fuel pressure at the HP pump is controlled by the IMV valve, and the maximum allowed pressure is 1,800 bar. The compressed fuel at the fuel pump is delivered to the rail, and injected by the injectors according to the injection signals. The injection method is the same with the conventional method; Fuel return by backleak which operates the needle valve.
The major difference is that the fuel return line is connected to the fuel filter inlet port, not the HP pump venturi.
The pressure from the high pressure pump is increased to 1,800 bar from 1,600 bar, and the pump is now installed to the cylinder head (cylinder block for previous model). The fuel pressure is generated by the operation of intake camshaft and gears. The specifications for the IMV valve and the fuel temperature sensor are not changed.

Modification basis	
Application basis	
Affected VIN	

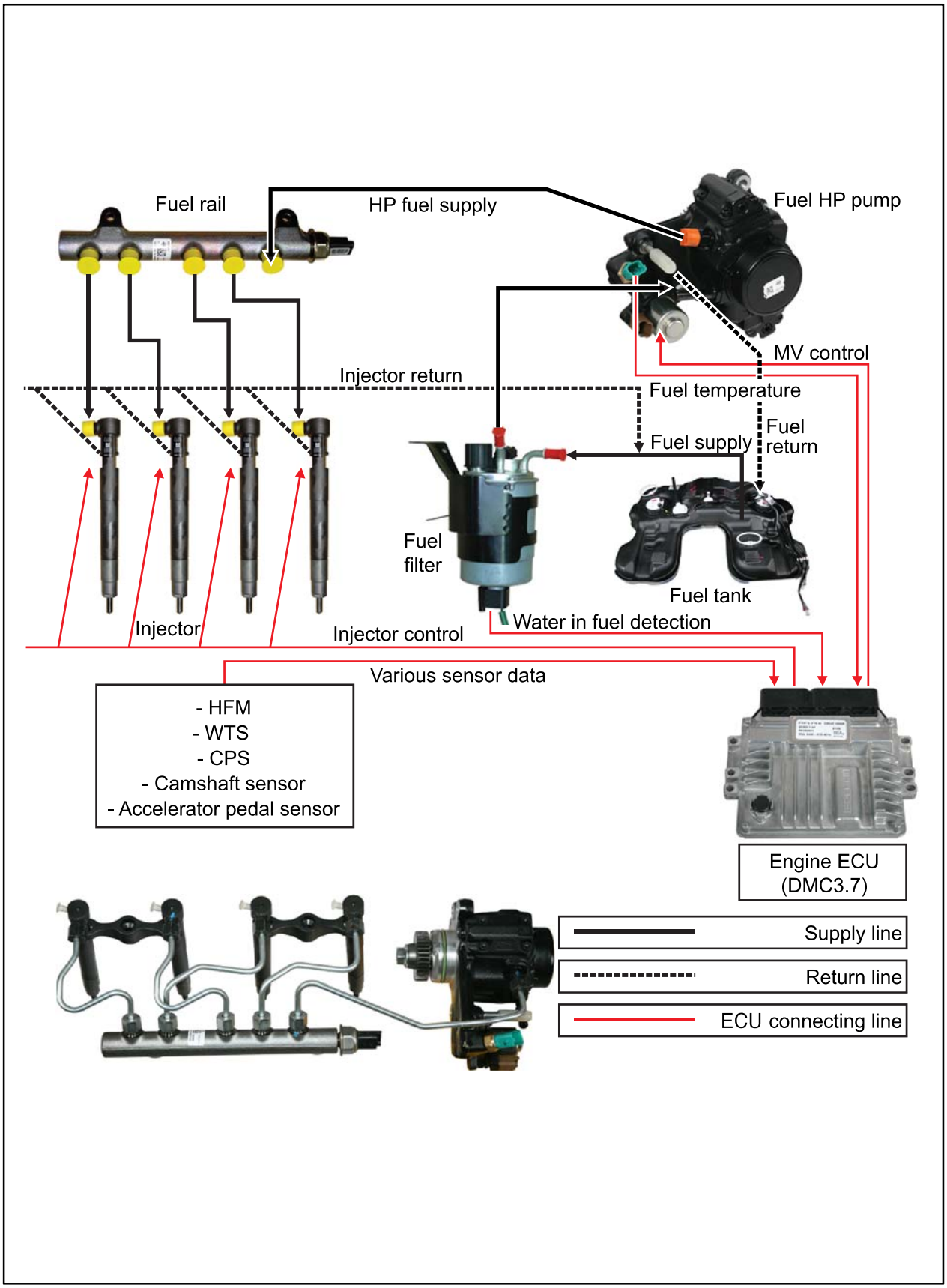
3) Input/Output devices



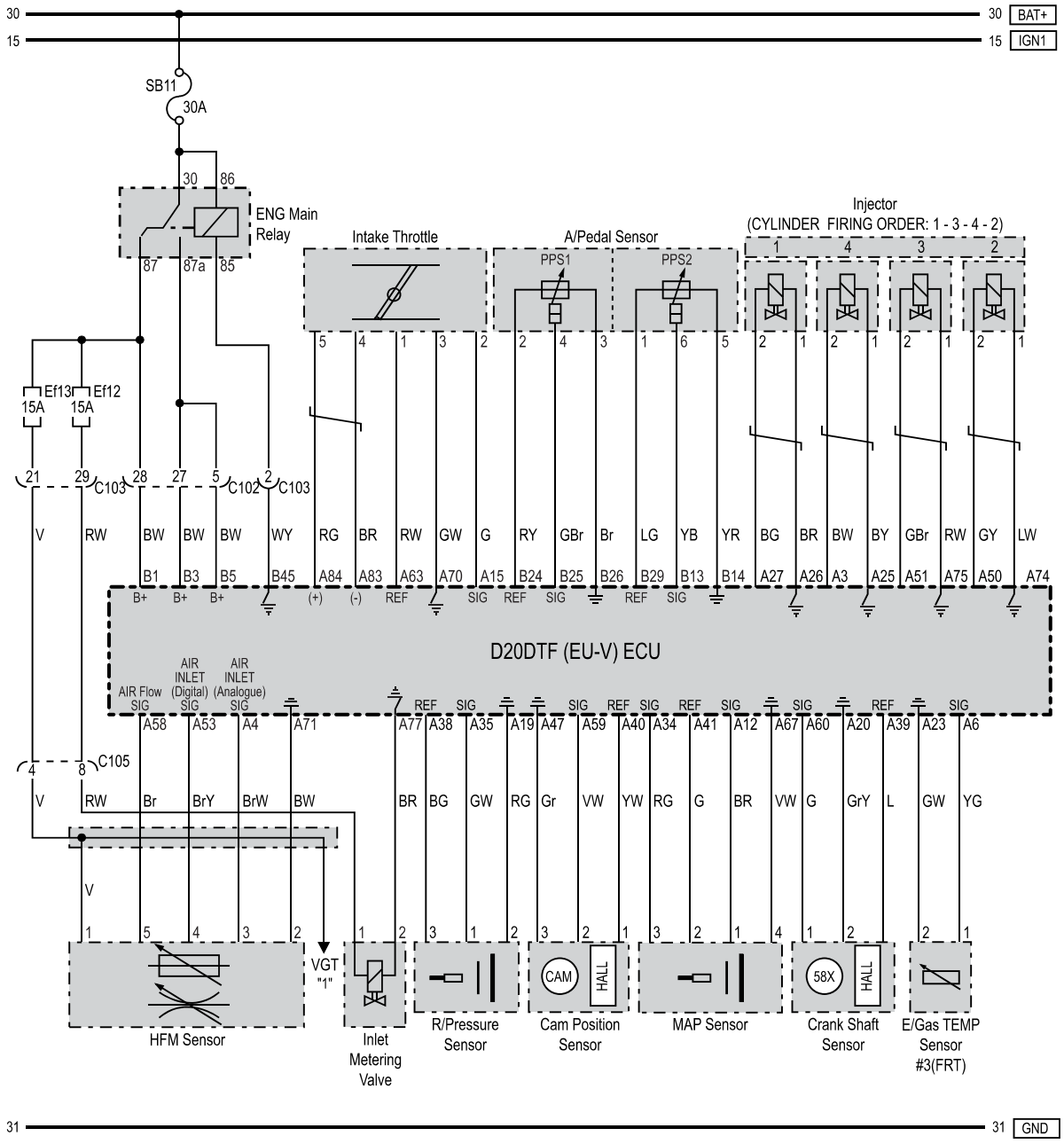
The engine ECU calculates the accelerator pedal based on the input signals from various sensors, and controls the overall operation of the vehicle.
The ECU receives the signals from various sensor through data line, and performs effective air-fuel ratio control based on these signals.
The crankshaft speed (position) sensor measures the engine speed, and the camshaft speed (position) sensor determines the order of injections, and the ECU detects the amount of the accelerator pedal depressed (driver's will) by receiving the electrical signals from the accelerator pedal sensor.
The mass air flow sensor detects the volume of intake air and sends the value to the ECU.
The major function of the ECU is controlling air-fuel ratio to reduce the emission level (EGR valve control) by detecting instantaneous air flow change with the signals from the mass air flow sensor.
Also, the ECU uses the signals from the coolant temperature & air temperature sensors, booster pressure sensor, atmospheric pressure sensor to: a) determine injection starting point and set value for pilot injection, and b) deal with various operations and variable conditions.

Modification basis	
Application basis	
Affected VIN	

4) Flow Diagram of Fuel Supply System



5) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

INTAKE SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Component	Item	Specification
Air cleaner element	Filter type	Dry, filter element
	Filter area	0.208 m²
	Service interval	EU: Change every 20,000 km (But, shorten the service interval under severe conditions)
		GEN: Change every 15,000 km (But, shorten the service interval under severe conditions)
Air cleaner assembly	Weight	1.13 kg
	Operating temperature	−30 ~ 100℃
	Capacity	6.5 L
Intercooler	Core material	Aluminum
	Size	510 x 110 x 70 (W x H x T)
	Core size	510 x 110 x 63 (W x H x T)
	Tank material	Plastic (Molding)
	Efficiency	80%

* Shorten the service interval under severe conditions such as driving on a dusty road or off-road.

2. INSPECTION

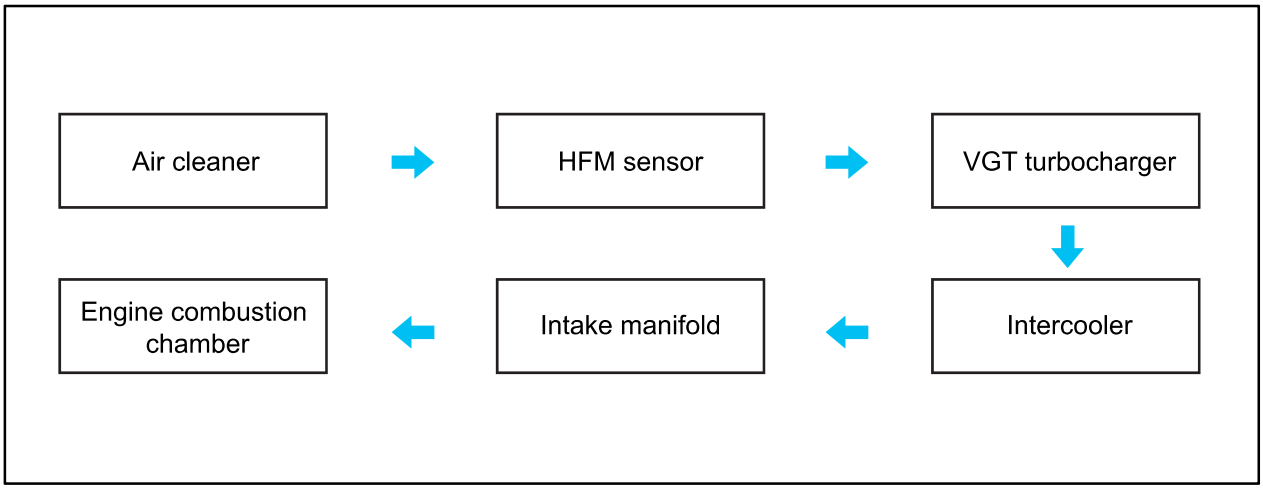
1) Troubleshooting

▶ **When Abnormal Noises are Heard from the Engine Room**

CAUTION

For the vehicle equipped with DI engine, if a learning noise occurs in each range or other noises occur, the major cause of it is a faulty turbocharger assembly. But an interference issue, poor tightness or loose in the intake and exhaust system also can cause those noises. This is mainly because the operator didn't follow the instruction exactly when reconnecting the intake hoses and pipes which were disconnected to check the system or replace the air cleaner. If the intake system is free of any faults, check the EGR and PCV oil separator connected to the intake system.
The figure may be different from the actual engine. Therefore, read thoroughly below before replacing the parts.

2) Abnormal Noise Caused by Poor Tightness of Intake System



When the DI engine is running, the air entered into the engine flows in the sequence as shown above. If high intake pressure is applied to the loose or damaged part, a whistling noise may occur, the intake air volume is measured incorrectly or the engine power is derated.

Modification basis	
Application basis	
Affected VIN	

3) Troubleshooting Sequence

The basic checks for intake system are as follows:

▶ Basic Checks for Intake System

Check if any abnormal noise occurs in each range while the vehicle is driven.

↓

Check if the engine warning lamp is illuminated or any DTC is displayed on the diagnostic device.

↓

Check the hoses for loose connections, or the clamps for deformation.

↓

Check tightness of the air cleaner housing by shaking it.

↓

Check the turbocharger and the intake/exhaust system for interferences in each range.

↓

Check the vacuum system and the hoses connected.

Make sure to replace or clean the air cleaner element periodically. Otherwise, engine will be derated or work abnormally because of low intake air volume.
Unlike the fuel system, which is a closed circuit, the intake system is an open circuit system. Therefore any malfunction may occur due to dust and dirt.
Most of the connections consist of hoses so the system cannot withstand high temperature and pressure. Also it can be deformed or loosened easily because it is a clamp mounting system. Thus, when checking the engine, basic inspections, such as tightened status check and visual inspection for hose, etc., should be carried out in advance.

▶ Other Checks for Intake System

Check the EGR system (vacuum circuit, electrical circuit of modulator, mechanical movements of EGR valve).

↓

Check the PCV oil separator.

If the intake system is free of any faults, check for EGR and PCV oil separator.

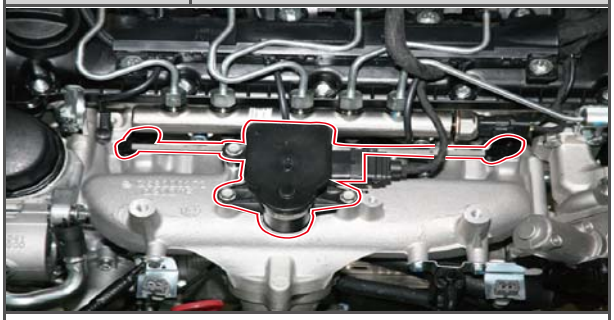
OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The intake system for D20DTF engine is equipped with an electric throttle body which includes a flap. This flap is controlled by an electrical signal to cut off the intake air entering to the engine when the ignition switch is turned off. To be sure to get the optimized swirl in intake manifold, the swirl valve and dual type port have been adopted. And, the improved HFM sensor has been adopted to control the intake air volume more precisely.

2. COMPONENTS

1719-02	Swirl control valve



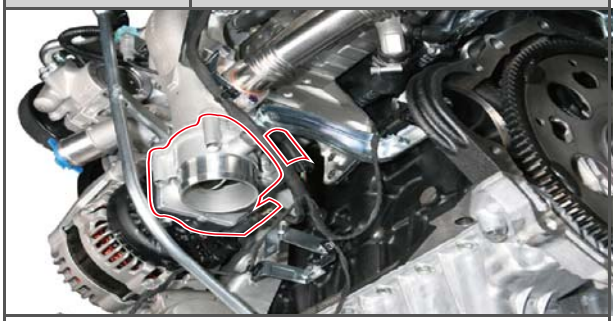
Operates variably in accordance with the engine load and rpm.
* For more information, refer to Chapter "Engine Control".

1719-01	Intake manifold

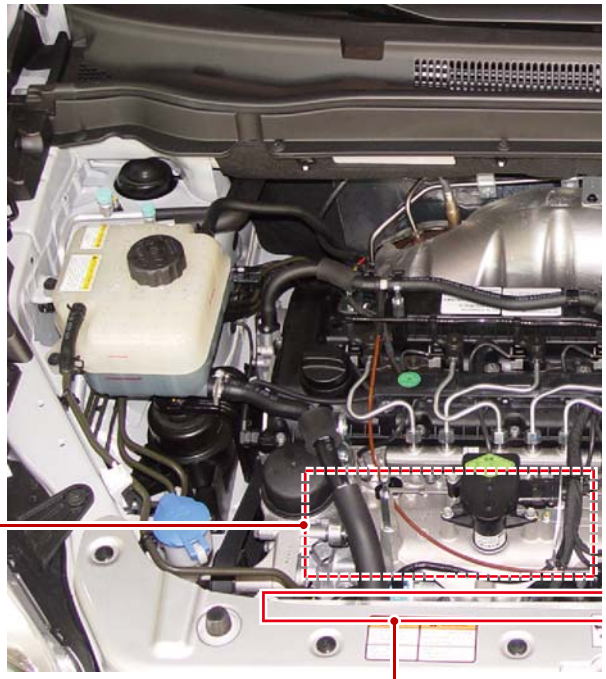


Passage for intake air during the operation of variable swirl valve

1719-16	Electric throttle body



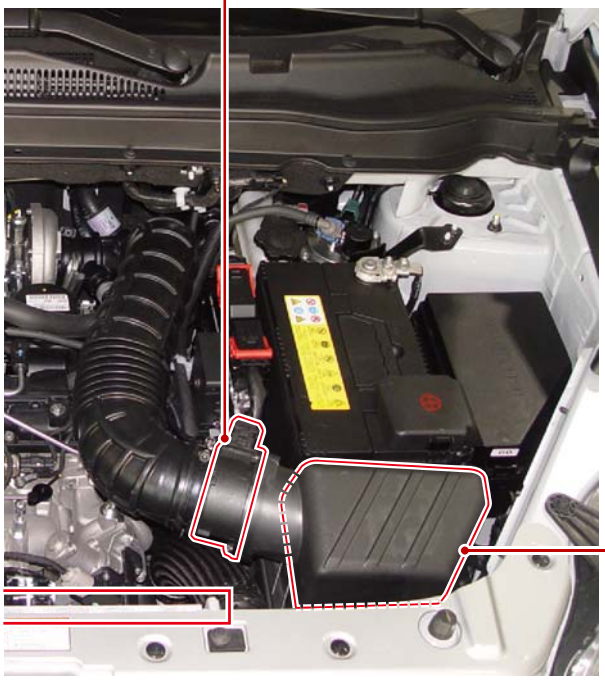
* For more information, refer to Chapter "Engine Control".



2330-01	Intercooler assembly



Modification basis	
Application basis	
Affected VIN	



2313-15	HFM (Hot Film Air-Mass) sensor

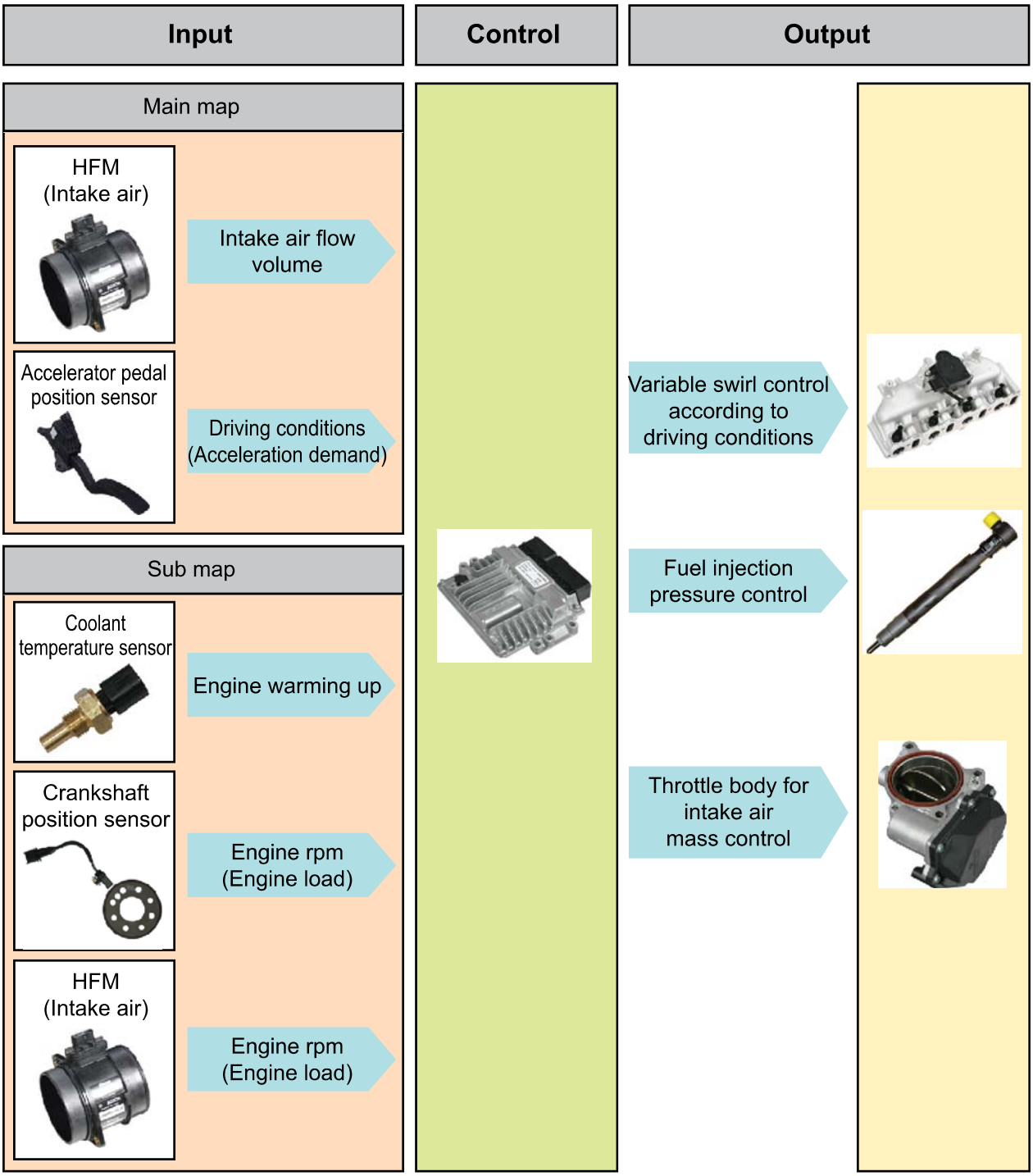


HFM sensor, version 6
* For more information, refer to Chapter "Engine Control".

2313-01	Air cleaner assembly and resonator

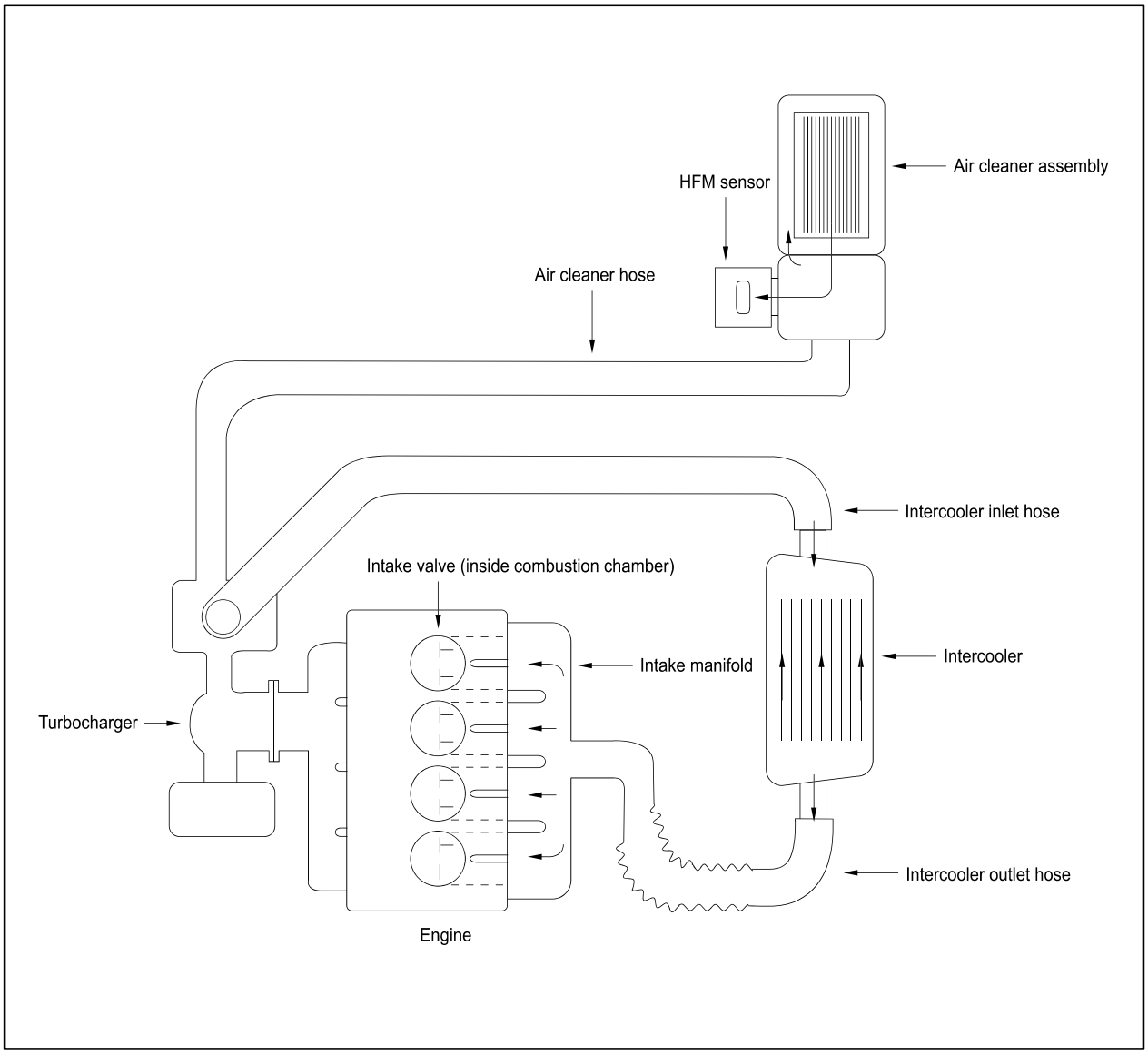


3. INPUT/OUTPUT OF INTAKE SYSTEM

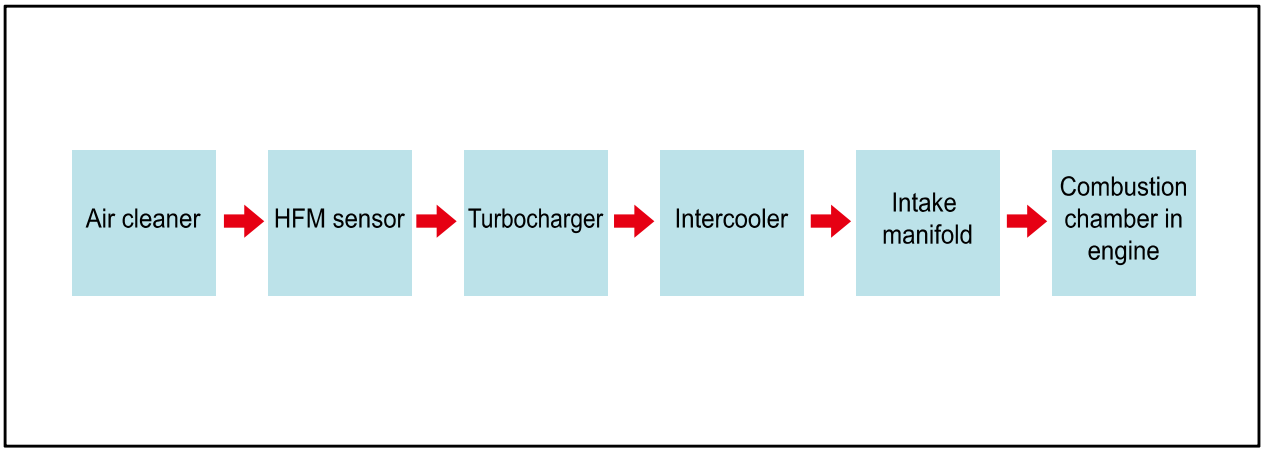


Modification basis	
Application basis	
Affected VIN	

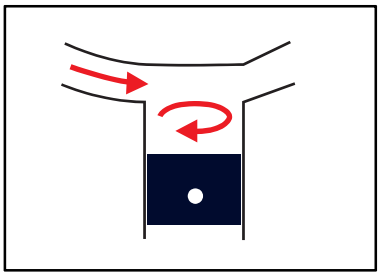
4. OPERATING PROCESS



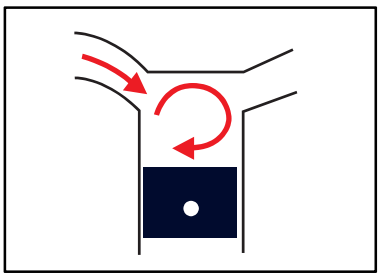
▶ Work Flow



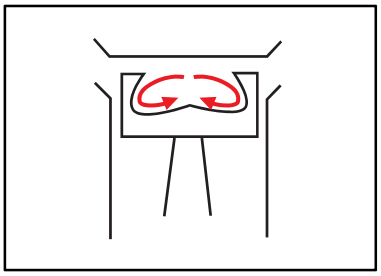
1) Types of swirl



Swirl: One cylinder has two intake air ports, one is set horizontally and the other one is set vertically. Swirl is the horizontal air flows in cylinder due to the horizontal intake air ports.



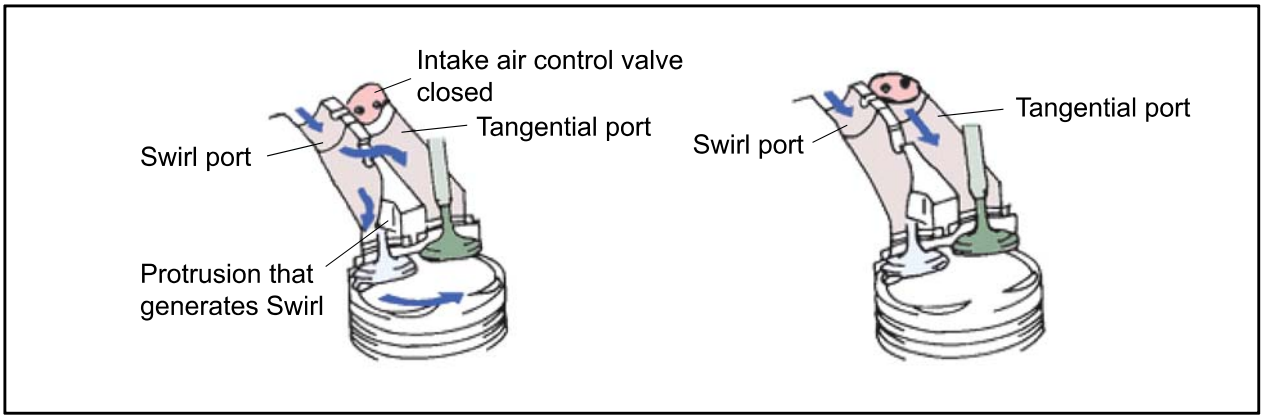
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



Squish: Squish is the air flows due to the piston head. Normally, this is appears at the final process of compression. In CRDi engine, the piston head creates the bowl type squish.

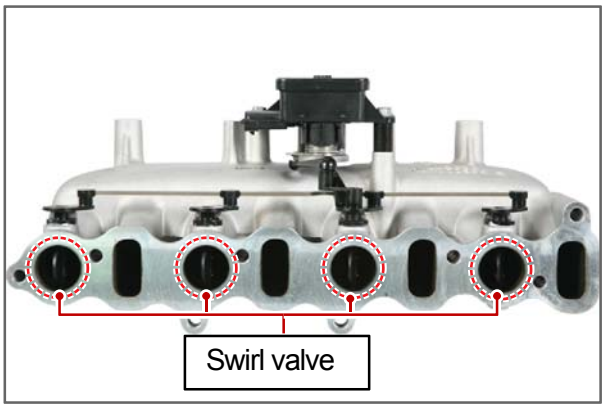
2) Swirl control

In DI type diesel engine, the liquefied fuel is injected into the cylinder directly. If the fuel is evenly distributed in short period, the combustion efficiency could be improved. To get this, there should be good air flow in cylinder. In general, there are two intake ports, swirl port and tangential port, in each cylinder. The swirl port generates the horizontal flow and the tangential port generates the longitudinal flow. In low/mid load range, the tabgential port is closed to increase the horizontal flow. Fast flow decreases the PM during combustion and increases the EGR ratio by better combustion efficiency.

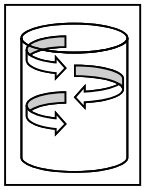


Modification basis	
Application basis	
Affected VIN	

Load	Engine speed	Swirl valve	Amount of swirl	Remarks
Low speed, Low load	below 3,000 rpm	Closed	Heavy	Increased EGR ratio, better air-fuel mixture (reduce exhaust gas)
High speed, High load	over 3,000 rpm	Open	Light	Increase charge efficiency, higher engine power



The variable swirl valve actuator operates when turning the ignition switch ON/OFF position to open/close the swirl valve. In this period, the soot will be removed and the learning for swirl valve position is performed.



NOTE

Swirl: This is the twisted (radial) air flow along the cylinder wall during the intake stroke. This stabilizes the combustion even in lean air-fuel mixture condition.

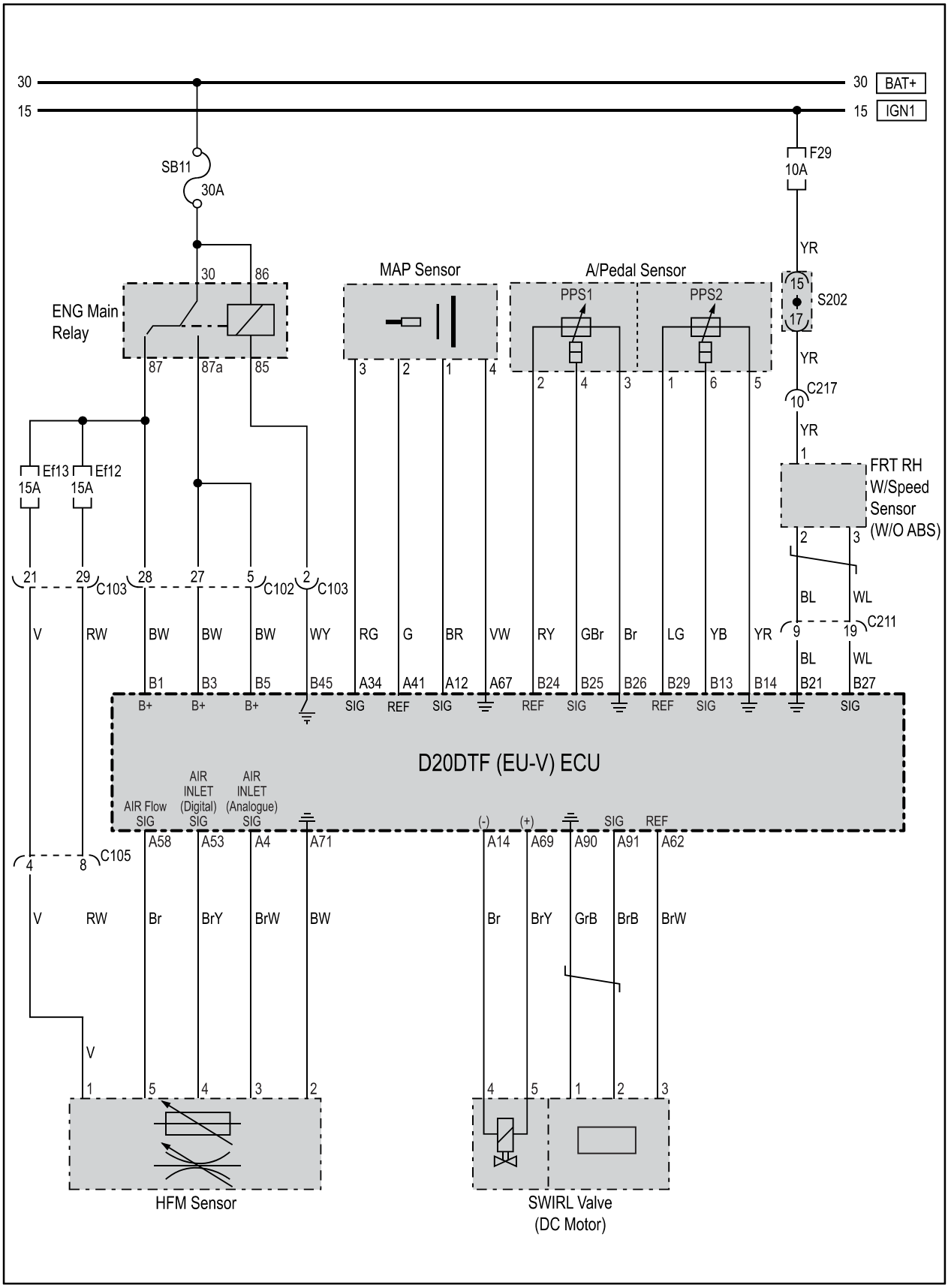
3) Features

- Swirl and air intake efficiency
  To generate the swirl, the intake port should be serpentine design. This makes the resistance in air flow. The resistance in air flow in engine high speed decreases the intake efficiency. Eventually, the engine power is also decreased, Thus, the swirl operation is deactivated in high speed range to increase the intake efficiency.
- Relationship between swirl and EGR
  To reduce Nox, it is essential to increase EGR ratio. However, if EGR ratio is too high, the PM also could be very higher. And, the exhaust gas should be evenly mixed with newly aspired air. Otherwise, PM and CO are dramatically increased in highly concentrated exhaust gas range and EGR ratio could not be increased beyond a certain limit. If the swirl valve operates in this moment, the limit of EGR ratio will be higher.

4) Relationship between swirl and fuel injection pressure

The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the injection angles might be overlapped. Therefore, the system may decreases the fuel injection pressure when the swirl is too strong.

5. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

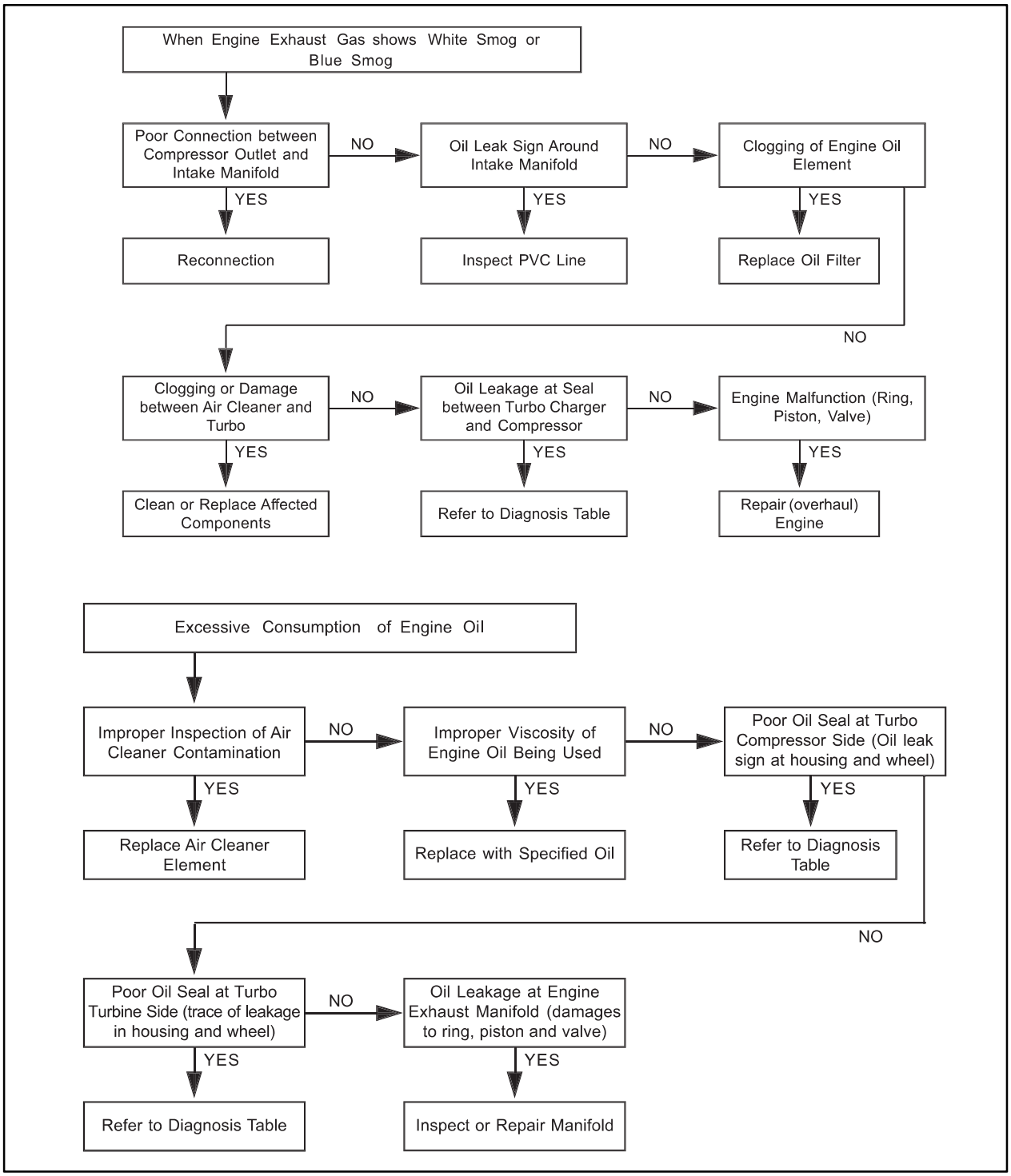
EXHAUST SYSTEM

0000-00

GENERAL INFORMATION

1. TROUBLESHOOTING

1) Work Flow



Modification basis	
Application basis	
Affected VIN	

2. CAUTIONS

- Do not park the vehicle on flammable materials, such as grass, leaves and carpet.
- Do not touch the catalyst or the exhaust gas ignition system when the engine is running.
- If a misfire occurs in the combustion chamber or the emission of pollutant exceeds the specified level, the catalyst can be damaged.
- When servicing or replacing components of the exhaust system, makes sure that the components are positioned at regular intervals from all other parts of the under body.
- Be careful not to damage the exhaust system when lifting the vehicle from its side.
- All components and body parts of the engine exhaust system should be inspected for crack, damage, air hole, part loss and incorrect mounting location. Also check for any deformation which can result in exhaust gas drawn into the vehicle.
- Make sure that the exhaust pipe is cooled down sufficiently before working on it because it is still hot right after the engine is stopped.
- Wear protective gloves when removing the exhaust pipe.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

This system purifies the exhaust gas generated by the combustion in the engine to reduce the pollutants and noise during that arise during combustion.

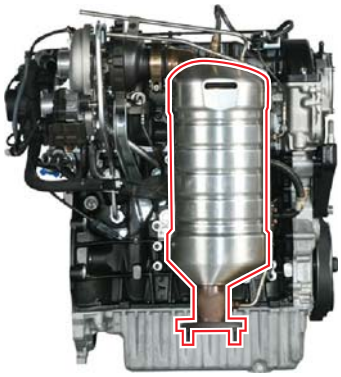
2. COMPONENT

Exhaust manifold

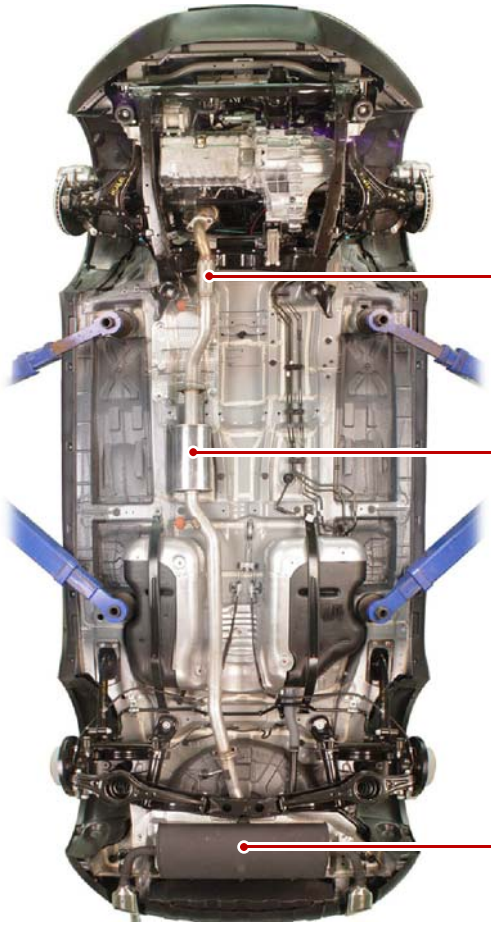




CDPF assembly



Fore details about the CDPF assembly, refer to Chapter "CDPF System".



No. 1 exhaust pipe



No. 2 exhaust pipe

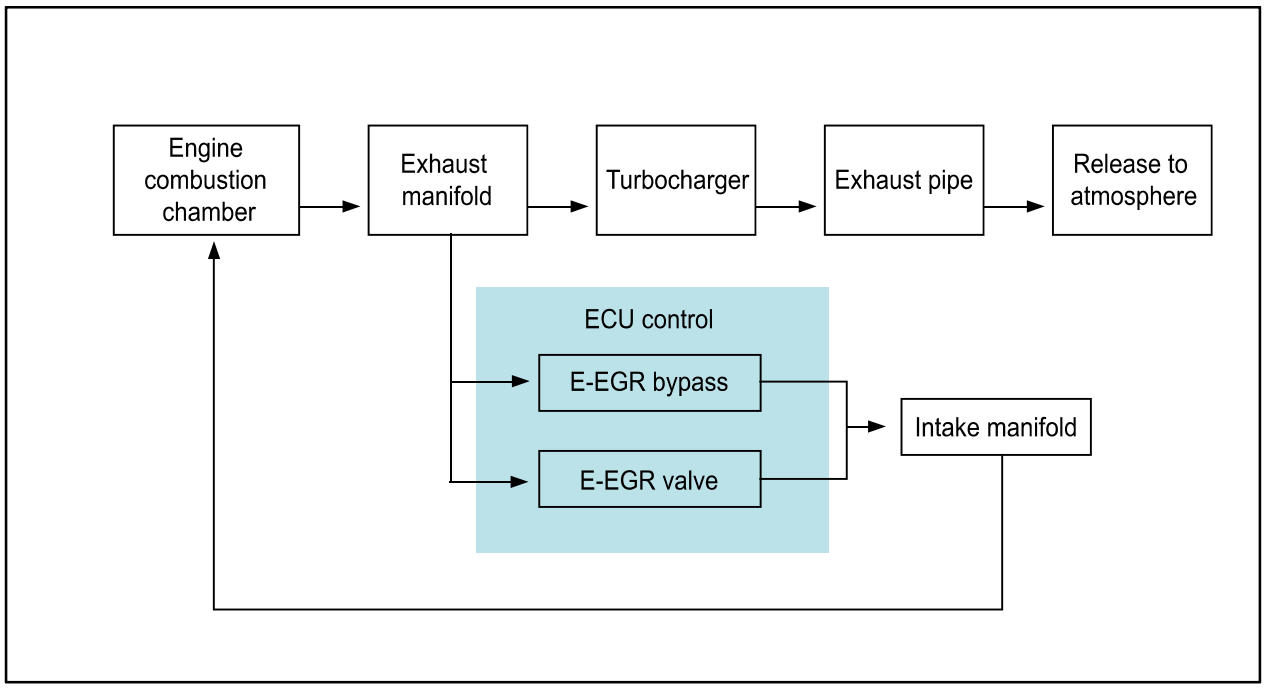


No.3 muffler pipe

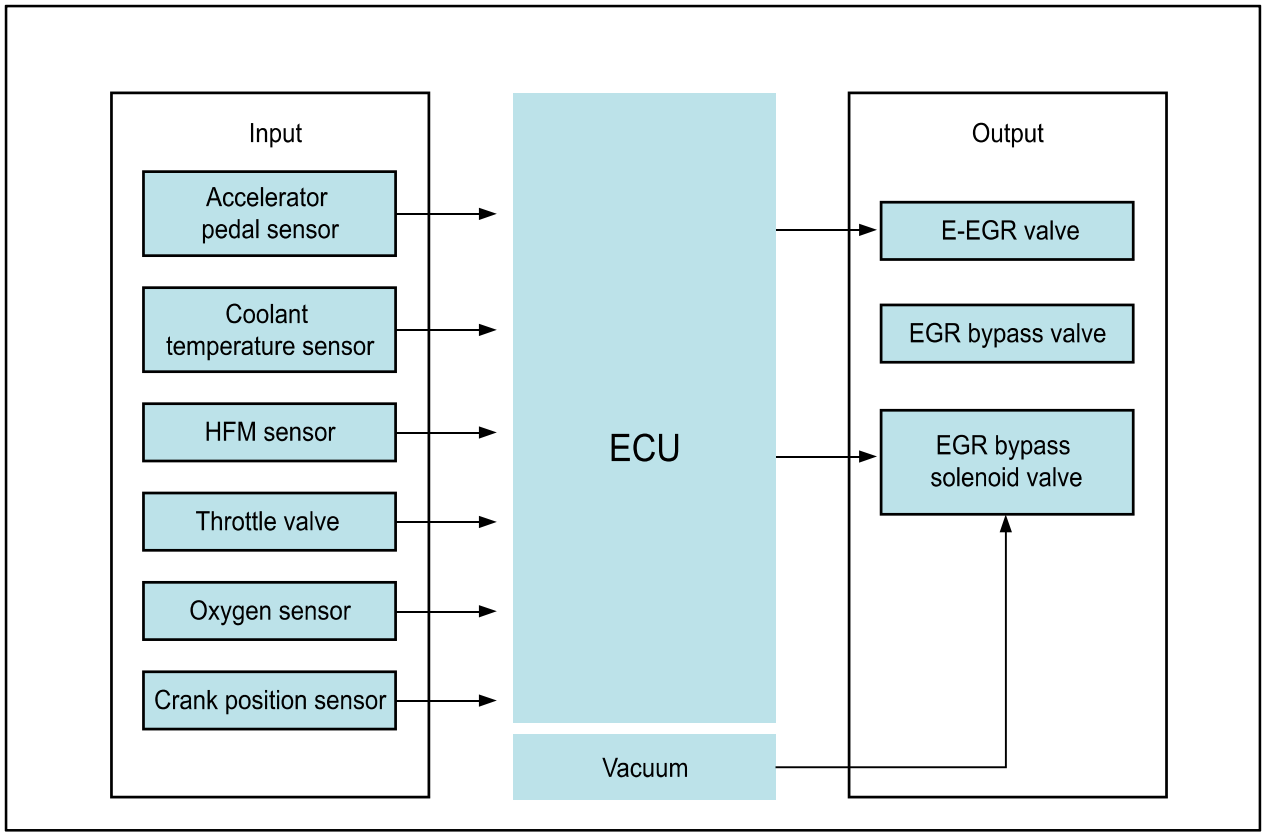


3. OPERATING PROCESS

1) Exhaust Gas Flow



2) Input & Output Devices



Modification basis	
Application basis	
Affected VIN	

TURBO SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Component	Item	Specification
Turbocharger	Max. expansion coefficient	5.0
	Max. turbine speed	215,000 rpm
	Max. temperature of turbine housing	800 ℃
	Weight	7.2 kg
E-Actuator	Operation duty cycle	300 Hz

2. INSPECTION

1) Cautions During Driving

The following lists cautions to take during test drive and on the turbocharger vehicle, which must be considered during the operation.

1. It's important not to drastically increase the engine rpm starting the engine. It could make rotation at excessive speed even before the journal bearing is lubricated and when the turbocharger rotates in poor oil supply condition, it could cause damage of bearing seizure within few seconds.
   If the engine is running radically after replacing the engine oil or oil filter brings poor oil supply
2. condition. To avoid this, it's necessary to start off after idling the engine for about 1 minute allowing oil to circulate to the turbocharger after the replacement.
   When the engine is stopped abruptly after driving at high speed, the turbocharger continues to rotate
3. in condition where the oil pressure is at '0'. In such condition, an oil film between the journal bearing and the housing shaft journal section gets broken and this causes abrasion of the journal bearing due to the rapid contact. The repeat of such condition significantly reduces life of the turbocharger. Therefore, the engine should be stopped possibly in the idle condition.

CAUTION

After string for long period of time during winter season or in the low temperature condition where the fluidity of engine oil declines, the engine, before being started, should be cranked to circulate oil and must drive after checking the oil pressure is in normal condition by idling the engine for few minutes.

Modification basis	
Application basis	
Affected VIN	

2) Inspection of Turbocharger

When problem occurs with the turbocharger, it could cause engine power decline, excessive discharge of exhaust gas, outbreak of abnormal noise and excessive consumption of oil.

1. On-board Inspection
   - Check the bolts and nuts foe looseness or missing
   - Check the intake and exhaust manifold for looseness or damage
   - Check the oil supply pipe and drain pipe for damages
   - Check the housing for crack and deterioration
2. Inspection of turbine

Remove the exhaust pipe at the opening of the turbine and check, with a lamp, the existence of interference of housing and wheel, oil leakage and contamination (at blade edge) of foreign materials.

- Interference: In case where the oil leak sign exists, even the small traces of interferences on the turbine wheel mean, most of times, that abrasion has occurred on the journal bearing. Must
- inspect after overhauling the turbocharger.
  Oil Leakage: Followings are the reasons for oil leakage condition

* Problems in engine: In case where the oil is smeared on inner wall section of the exhaust gas
* opening.
  Problems in turbocharger: In case where the oil is smeared on only at the exhaust gas outlet section.

CAUTION

Idling for long period of time can cause oil leakage to the turbine side due to low pressure of exhaust gas and the rotation speed of turbine wheel. Please note this is not a turbocharger problem.

- Oil Drain Pipe Defect
  In case where oil flow from the turbocharger sensor housing to the crank case is not smooth would become the reason for leakage as oil builds up within the center housing. Also, oil thickens (sludge) at high temperature and becomes the indirect reason of wheel hub section. In such case, clogging and damage of the oil drain pipe and the pressure of blow-by gas within the crank case must be inspected.
  Damages due to Foreign Materials
- When the foreign materials get into the system, it could induce inner damage as rotating balance of the turbocharger gets out of alignment.

3) Inspection of Turbine

Thoroughly check the followings.

CAUTION

Must absolutely not operate the turbocharger with the compressor outlet and inlet opened as it could damage the turbocharger or be hazardous during inspection.

- Interference: In case where is trace of interference or smallest damage on the compressor wheel means, most of times, that abrasion has occurred on the journal bearing. Must inspect after the overhaul.
- Oil Leakage: The reason for oil leakage at the compressor section is the air cleaner, clogged by substances such as dust, causes the compressor inlet negative pressure.

a. Rotating in high speed at no-load for extended period of time can cause oil leakage to the compressor section as oil pressure within the center housing gets higher than pressure within the compressor housing.
Overuse of engine break (especially in low gear) in down hill makes significantly low exhaust gas
b. energy compared to the time where great amount of air is required during idling conditions of the engine. Therefore, amount of air in the compressor inlet increases but the turbocharge pressure is not high, which makes negative pressure at the compressor section causing the oilleakage within the center housing.

CAUTION

No problem will occur with the turbocharger if above conditions are found in early stage but oil leaked over long period of time will solidify at each section causing to breakout secondary defects.

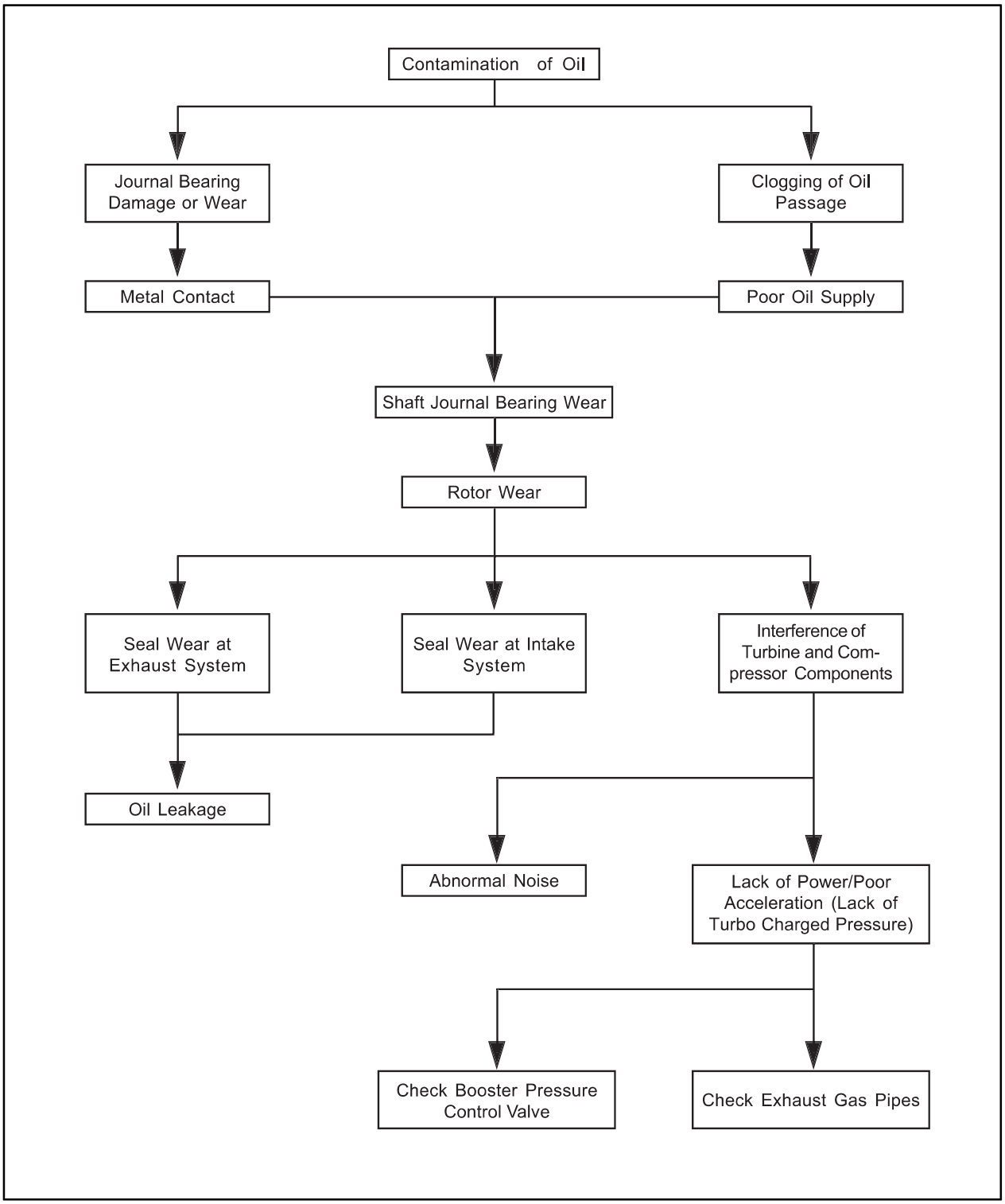
Damages by foreign materials: In case where the compressor wheel is damaged by foreign materials requires having an overhaul. At this time, it's necessary to check whether the foreign materials have contaminated intake/exhaust manifold or inside of engine.

Modification basis	
Application basis	
Affected VIN	

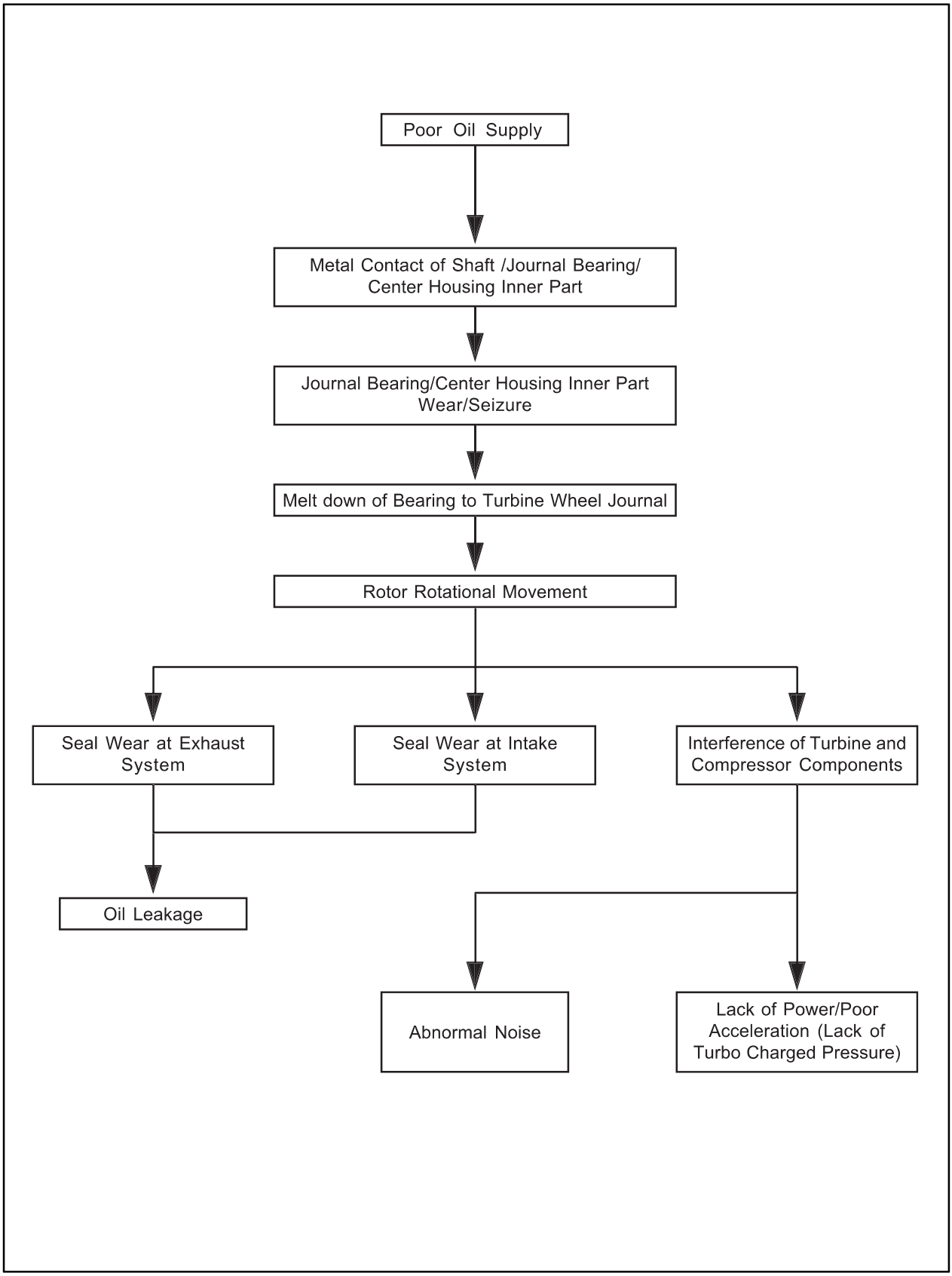
4) Possible Causes of Defect

The following tries to understand the defects that can occur with vehicle installed with the turbocharger and to manage the reasons of such defects.

1. In case where oil pan/oil pipe has been contaminated, oil filter is defected and where adhesive of gaskets has been contaminated into the oil line.

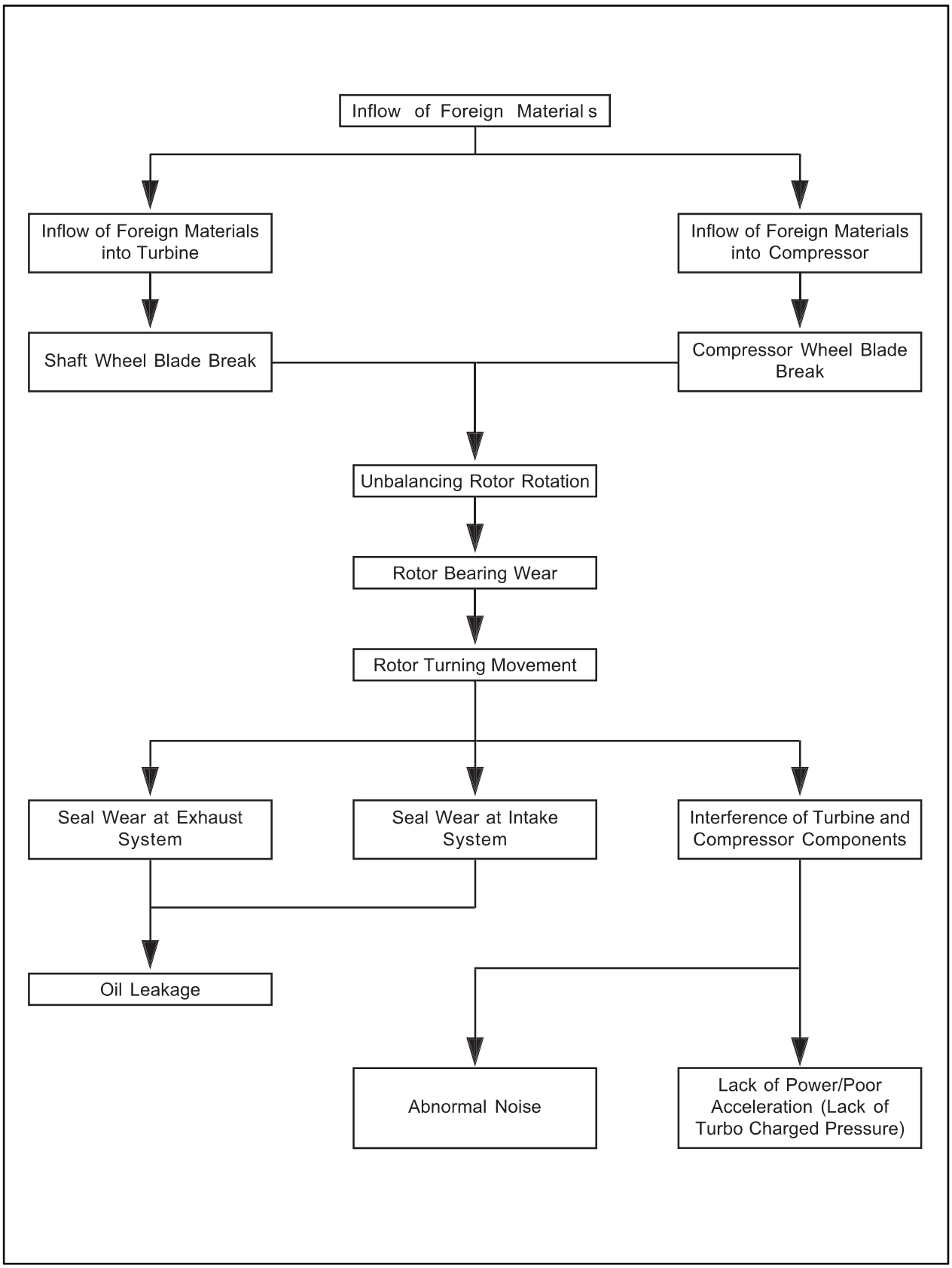


2. Oil Pump Defect: Rapid over-loaded driving after replacing oil filter and oil and clogging of oil line.

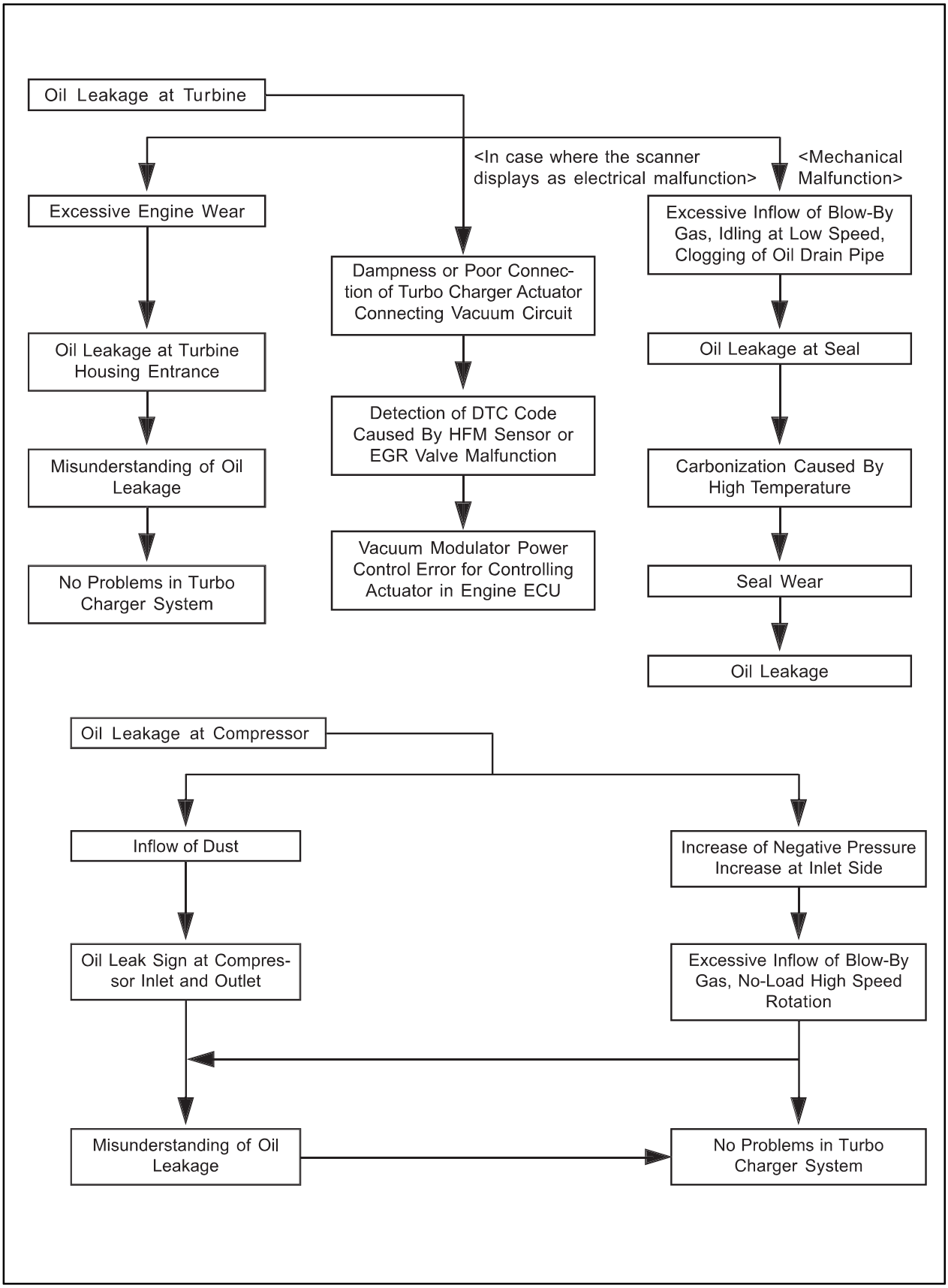


Modification basis	
Application basis	
Affected VIN	

3. Turbine Side: Inflow of foreign materials from engine
   Compressor Side: such as air filter, muffler and nut



4. Defects caused by reasons other than that of the turbocharger.



Modification basis	
Application basis	
Affected VIN	

3. TROUBLESHOOTING

The followings are cautions to take in handling defects of turbocharger, which must be fully aware of.

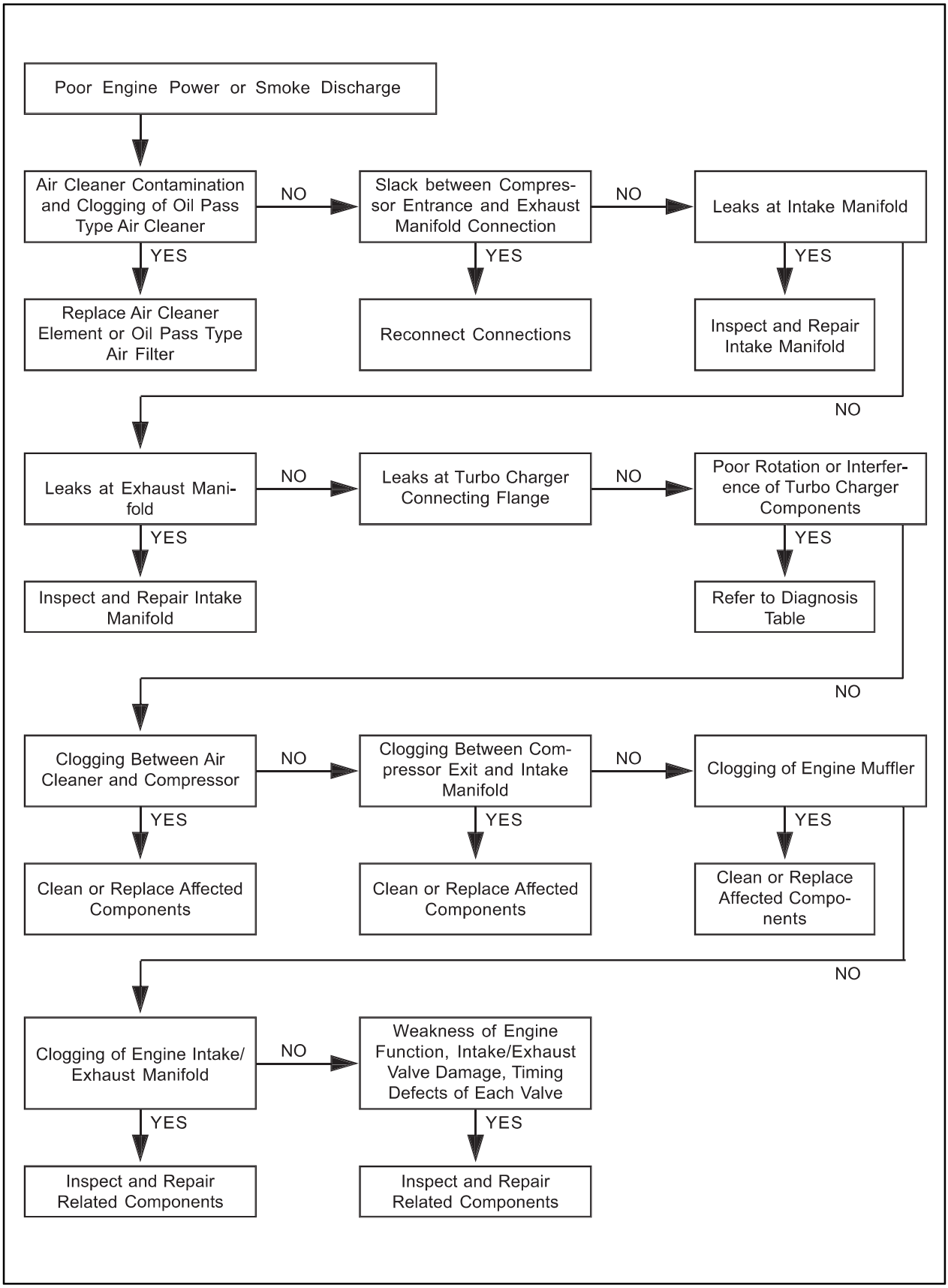
1) Cautions

1. After stopping the engine, check whether the bolts on pipe connecting section are loose as well as the connecting condition of vacuum port and modulator, which is connected to the actuator.
2. During idling of the engine, check for leakage in the connecting section of pipe (hoses and pipes, duct connections, after the turbocharger) by applying soap water. The leakage condition in the engine block and turbine housing opening can be determined by the occurrence of abnormal noise of exhaust.
3. By running the engine at idle speed, abnormal vibration and noise can be checked. Immediately stop the engine when abnormal vibration and noise is detected and make thorough inspection whether the turbocharger shaft wheel has any damages as well as checking the condition of connections between pipes.
   In case where the noise of engine is louder than usual, there is possibility of dampness
4. in the areas related with air cleaner and engine or engine block and turbocharger. And it could affect the smooth supply of engine oil and discharge.
   Check for damp condition in exhaust gas when there is sign of thermal discoloration or
5. discharge of carbon in connecting area of the duct.
   When the engine rotates or in case where there is change in noise level, check for
6. clogging of air cleaner or air cleaner duct or if there is any significant amount of dust in the compressor housing.
   During the inspection of center housing, inspect inside of the housing by removing the
7. oil drain pipe to check for sludge generation and its attachment condition at shaft area or turbine side.
   Inspect or replace the air cleaner when the compressor wheel is damaged by inflow of
8. foreign materials.
   Inspect both side of the turbocharger wheel after removing inlet and outlet pipe of the
9. turbocharger.
   - Is the rotation smooth when the rotor is rotated by hand?
   - Is the movement of bearing normal?
   - Inspect whether there has been any signs of interference between two wheels.

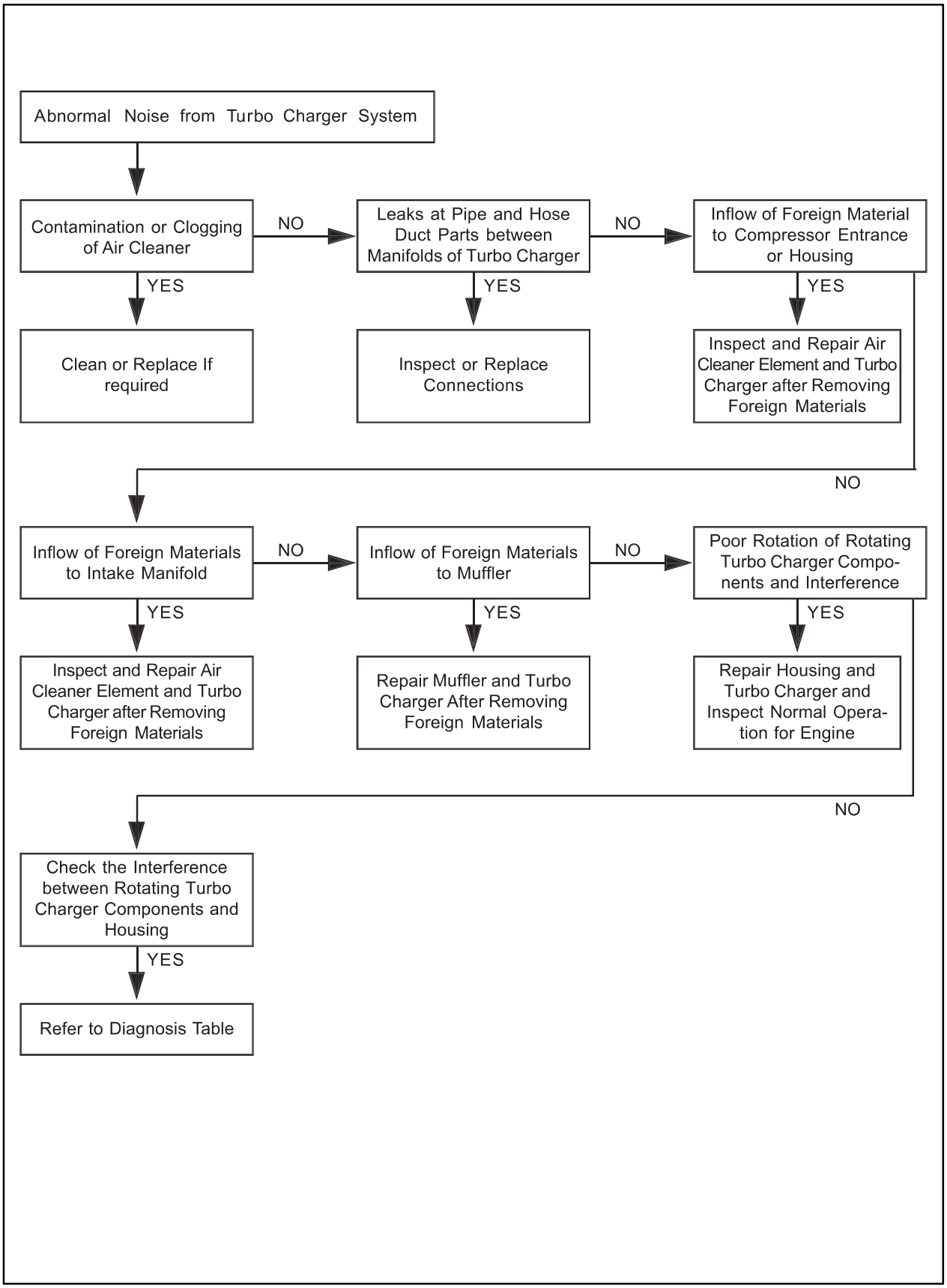
CAUTION

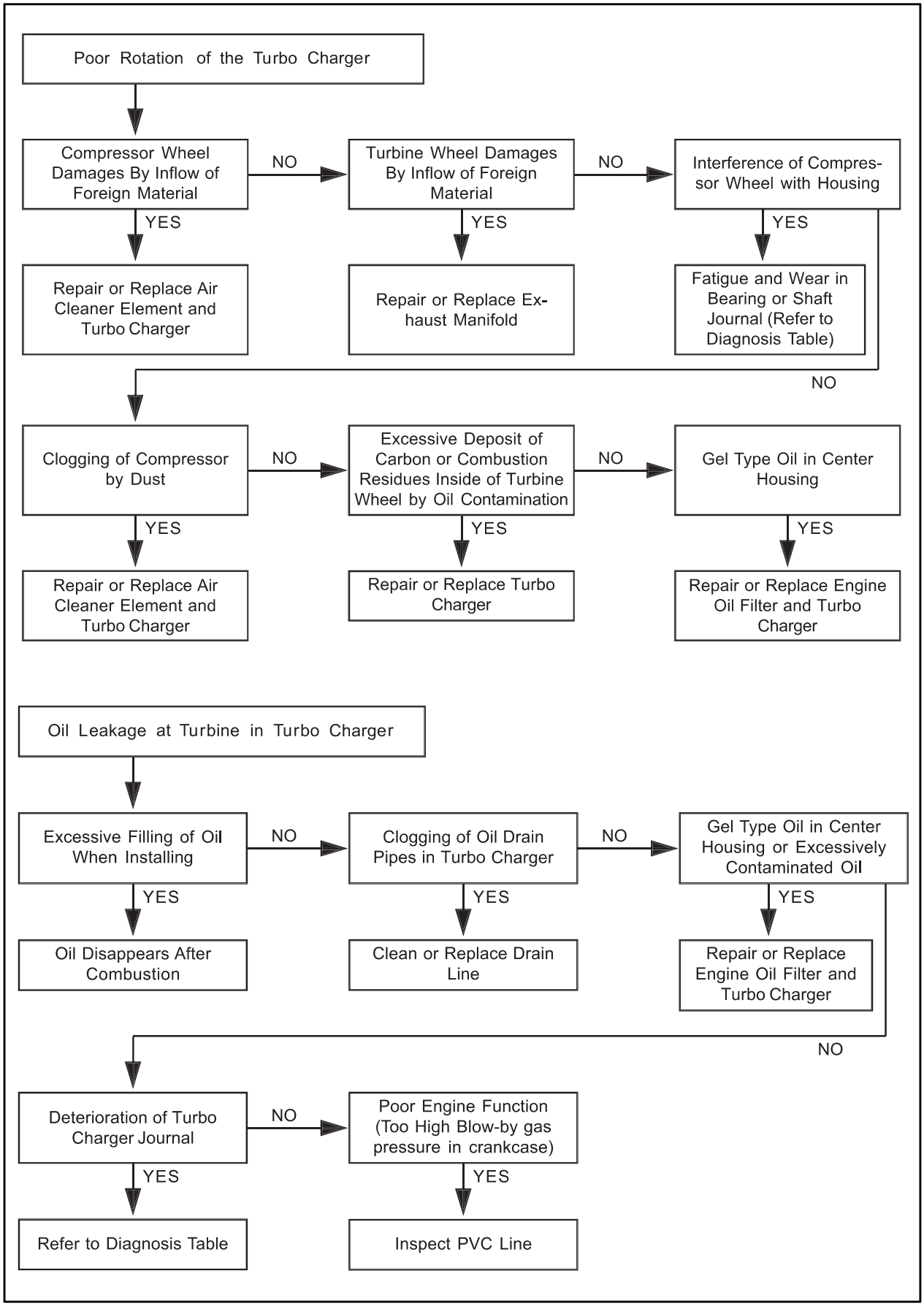
It's important not to drive the engine when the intake manifold hose has been removed.

2) Work Flow for Troubleshooting

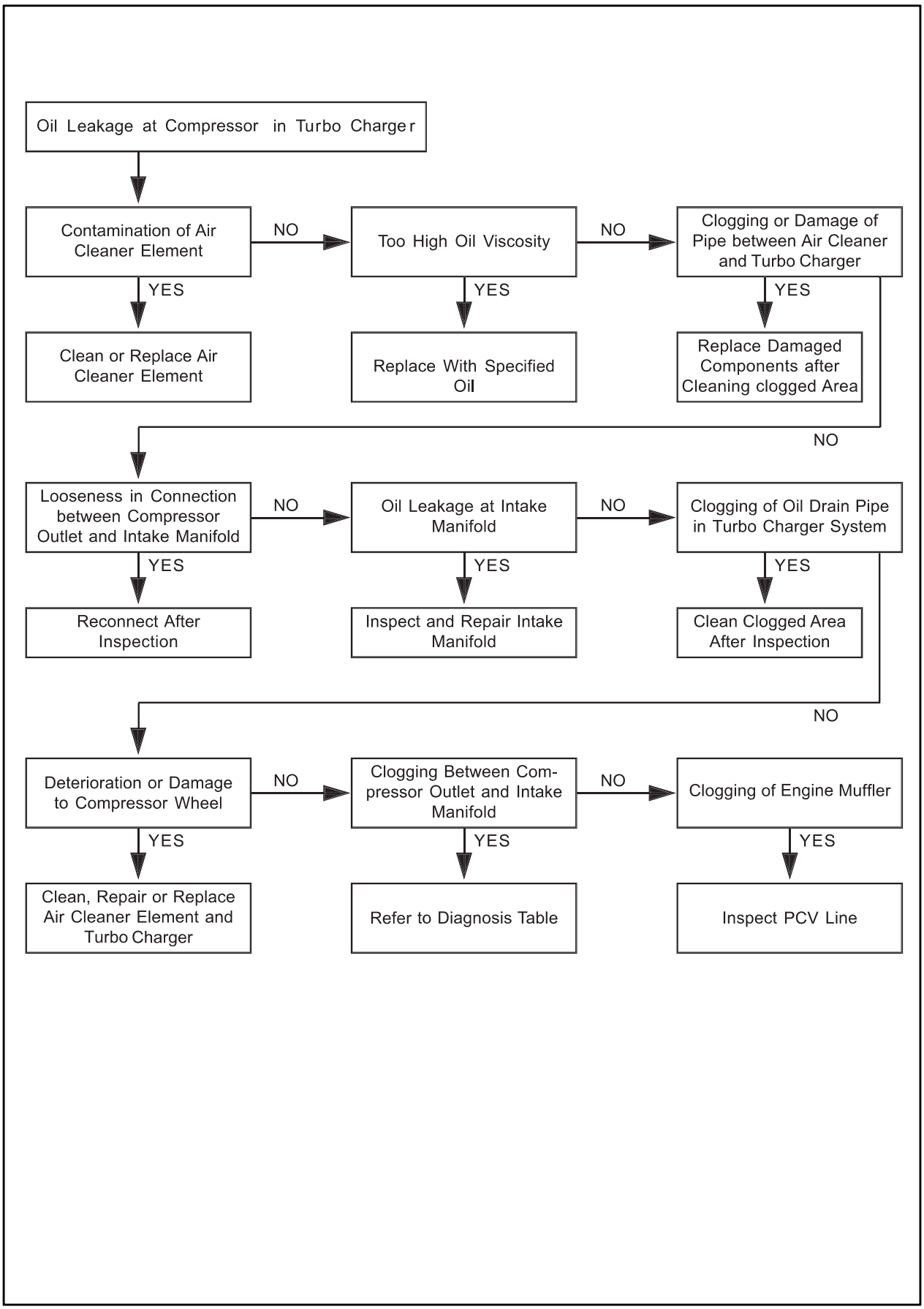


Modification basis	
Application basis	
Affected VIN	

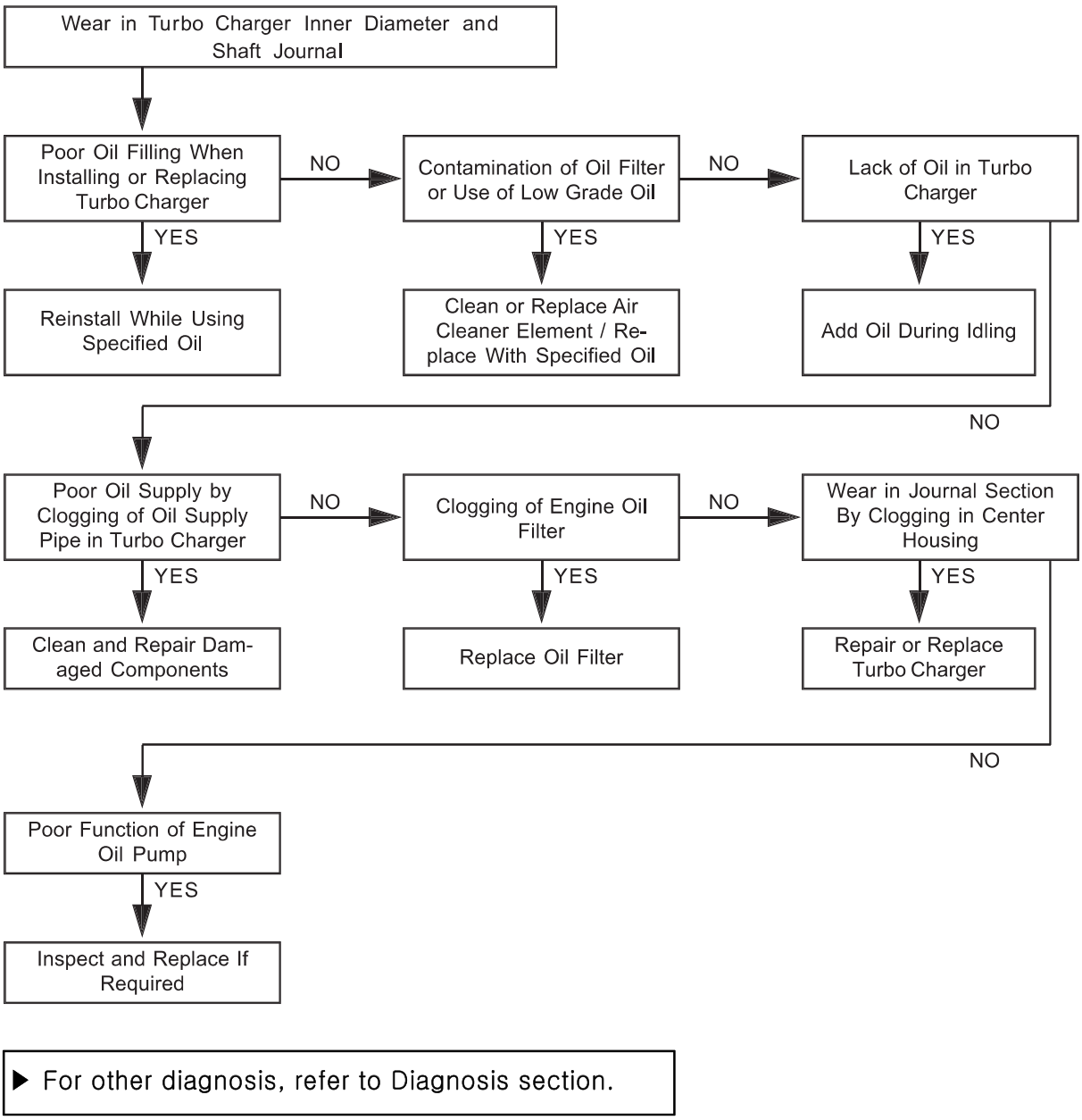

Abnormal Noise from Turbo Charger System
Contamination or Clogging of Air Cleaner
NO
Leaks at Pipe and Hose Duct Parts between Manifolds of Turbo Charger
NO
Inflow of Foreign Material to Compressor Entrance or Housing
YES
YES
YES
Clean or Replace If required
Inspect or Replace Connections
Inspect and Repair Air Cleaner Element and Turbo Charger after Removing Foreign Materials
NO
Inflow of Foreign Materials to Intake Manifold
NO
Inflow of Foreign Materials to Muffler
NO
Poor Rotation of Rotating Turbo Charger Components and Interference
YES
YES
YES
Inspect and Repair Air Cleaner Element and Turbo Charger after Removing Foreign Materials
Repair Muffler and Turbo Charger After Removing Foreign Materials
Repair Housing and Turbo Charger and Inspect Normal Operation for Engine
NO
Check the Interference between Rotating Turbo Charger Components and Housing
YES
Refer to Diagnosis Table



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	



▶ For other diagnosis, refer to Diagnosis section.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION OF E-VGT (Electric-Variable Geometry Turbine)

A turbocharger is a centrifugal compressor powered by a high speed turbine that is driven by an engine's exhaust gases. Its benefit lies with the compressor increasing the mass of air entering the engine (forced induction), thereby resulting in greater performance (for either, or both, power and efficiency). As the turbine, at exhaust end, is rotated by exhaust gas pressure the impeller, at intake end, gets rotated to send air around center of the impeller, being circumferentially accelerated by the centrifugal force, into the diffuser. The air, which has been introduced to the diffuser having a passage with big surface, transforms its speed energy into the pressure energy while being supplied to the cylinder improving the volume efficiency. Also, the exhaust efficiency improves as the exhaust turbine rotates. The turbocharger is often referred to as the exhaust turbine turbocharger.

Diffuser: With the meaning of spreading out it is a device that transforms fluid's speed energy into the pressure energy by enlarging the fluid's passage to slow down the flow.

The E-VGT system installed to the D20DTF engine variably controls the passages of the turbine housing to regulate the flow rate of the exhaust gas. The actuator of E-VGT is a DC motor actuator (E-Actuator) which controls more quickly and precisely than the previous vacuum type actuator.
The engine ECU controls the E-Actuator electronically as follows:

- At low speed: Narrows the flow passage for the exhaust gas, resulting in increasing the flow speed of the exhaust gas and running the turbine quickly and powerfully.
- At high speed: Expands the flow passage for the exhaust gas, resulting in increasing the mass flow of the exhaust gas and running the turbine more powerfully.

1) Features

(1) Performance (for EURO V)

1. Enhanced emission control: By temperature control with CDPF system

- Target temperature and airflow control

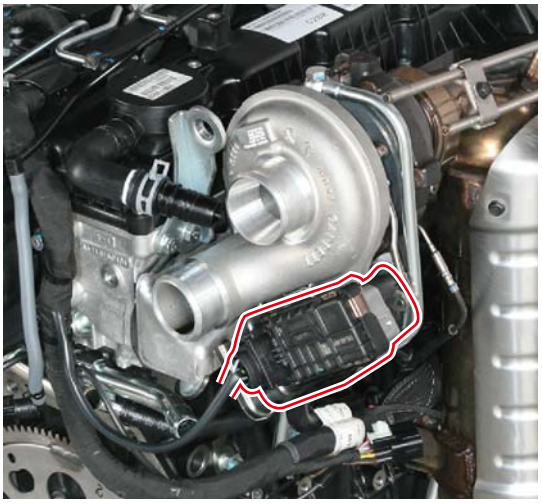
(2) E-Actuator (Electric-Actuator, Rotary type)

1. Optimizes the exhaust gas flow rate by controlling the vanes inside the turbine housing with the E-Actuator.

- Maximizes the intake air charging efficiency (Approx. 15%)

2. Has a faster response time than the conventional vacuum actuator

- Improved low speed torque, high speed power and fuel economy.
- Improved acceleration performance with rapid response time of vane



Features

- Folding and unfolding of the vane is controlled electrically
- Easy to get low speed air volume Rapid response time
- Electric control
-

Benefits

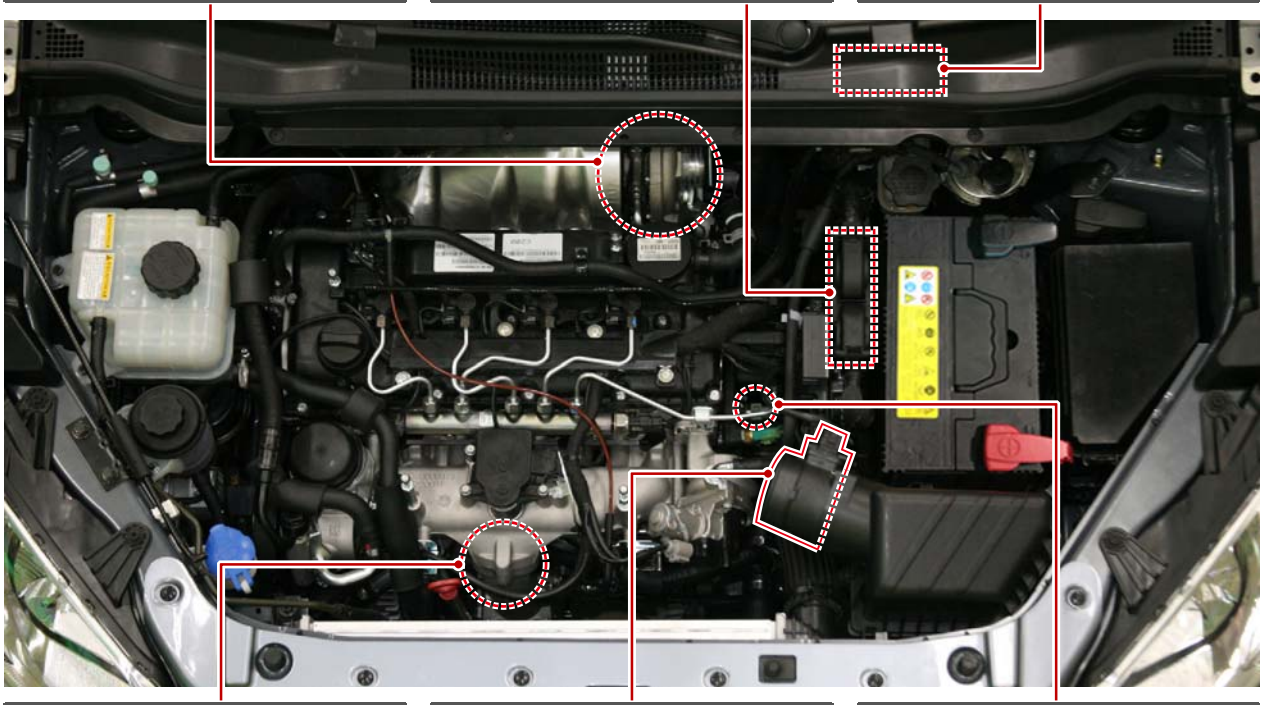
- Improved low speed torque Improved low speed torque and power
- Reduced exhaust gas
- Improved fuel consumption
- Improved acceleration performance

Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS

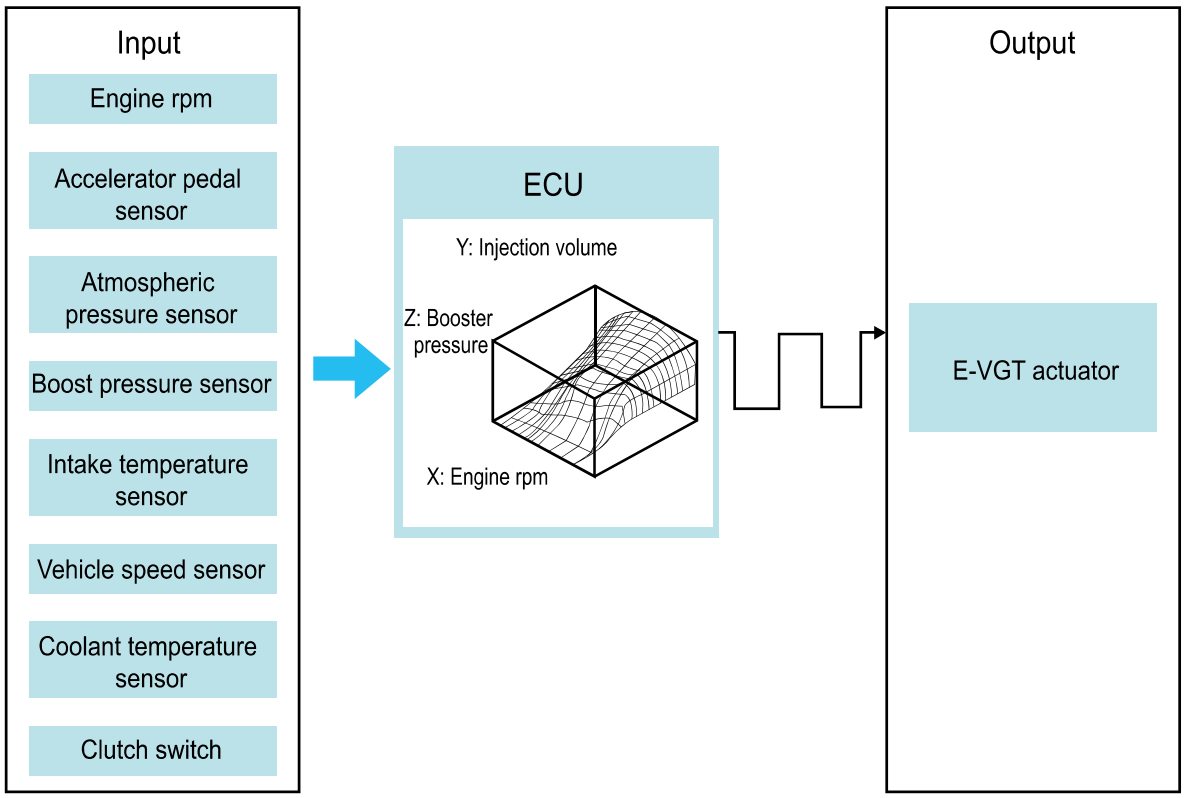
For more information about control logic, refer to Chapter "Engine Control".

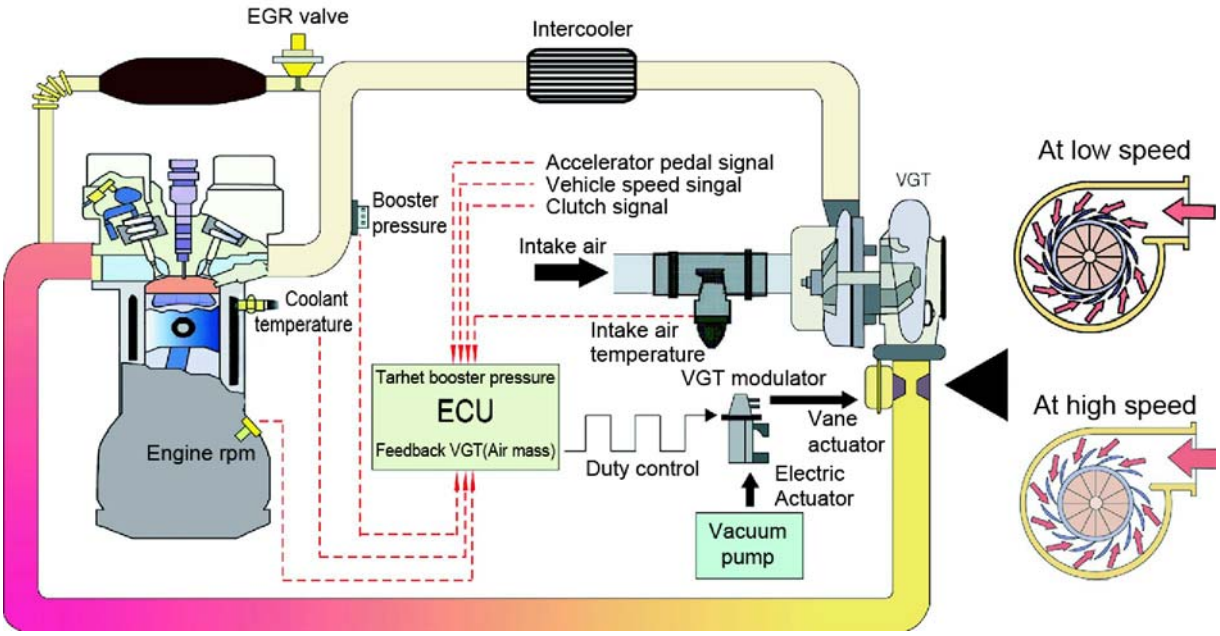
E-VGT turbocharger	Engine ECU (D20DTF)	Accelerator pedal position sensor
	 Atmospheric pressure, RPM signal	
Improves engine power	E-VGT duty control	Transfers accelerating demand to ECU



T-MAP sensor	HFM sensor	Coolant temperature sensor
		
Boost pressure and temperature	Improves the engine power	Operates the VGT according to engine warm-up

3. INPUT/OUTPUT DEVICES





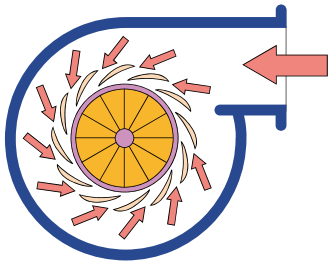
Modification basis	
Application basis	
Affected VIN	

4. OPERATING PRINCIPLES

The E-VGT is designed to get more improved engine power in all ranges by controlling the turbine as follows:

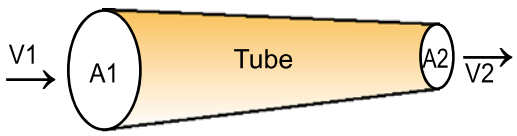
1) How it Works at Low Speed

Normal turbocharger cannot get the turbo effect because the amount of exhaust gas is not enough and the flow speed is slow in a low speed zone, but VGT allows the flow passage of exhaust to narrow, resulting in increasing the flow speed of exhaust gas and running the turbine quickly and powerfully. Therefore, as VGT can intake more air than normal turbocharger, it can give the benefit of the increased output even in a low speed zone.

Control range	Turbocharger driving mechanism	Control method	Effect	Improved performance
At low speed		Narrows the flow passage for the exhaust gas by folding the vanes	The flow rate is increased as the exhaust gas passes the narrow passage → Increased turbine & impeller speed, Increased compressive force	Improved low speed torque

※ **Basic principle at low speed**

At low speed, it utilizes the principle of venturi. For example, when air flows through the venturi tube, the flow speed is faster and the pressure is lower at the point "A". In this case, if the inner diameter of venturi is more narrowed, the flow speed is so much faster (refer to the equation).



V1 x A1 = V2 x A2 = Constant

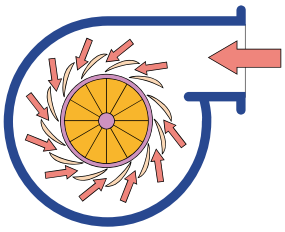
NOTE

Turbocharger lag

The turbocharger is at idle speed when there is no load or it is in the normal driving condition. During this period, the amount of exhaust gas passing through the turbine is not enough to turn the compressor wheel (impeller) fast. Therefore, the intake air is not compressed as needed. Because of this, it takes time for turbocharger to supply the additional power after the accelerator pedal is depressed. This is called "turbocharger lag".

2) How it Works at High Speed

In a high speed zone, the amount of exhaust gas increases and it is accompanied with a great force. Therefore, if the inner diameter of venturi is more widened, the turbine in the turbocharger by the releasing force of abundant exhaust gas can deliver a more increased energy to the compressor. The output will increase in submission to the increase of intake air volume.

Control range	Turbocharger driving mechanism	Control method	Effect	Improved performance
At high speed		Expands the flow passage for the exhaust gas by unfolding the vanes	The flow rate is increased due to the expanded passage→ Increased turbine & impeller speed, Increased compressive force	Improved maximum power

Modification basis	
Application basis	
Affected VIN	

LUBRICATION SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification	
Oil pump	Lubrication system	Gear pump, forced circulation	
	Type	Internal gear	
	Capacity	74 L at 4,000 rpm, 3 bar	
	Relief pressure	6.3 bar ± 0.3 bar	
Oil filter	Type	Fulle flow/Paper element	
Engine oil	Specified oil	Quality class: Ssangyong genuine engine oil (Total Quartz INEO ECS 5W 30, SK ZIC SY 5W 30 or oil Approved by MB 229. 51) SAE 5W30	
	Capacity	Min.: 4.5 L / Max.: 6.0 L	
	Service interval	EU	Change every 20000 km or 12 months (But, shorten the service interval under severe condition)
		General	Change every 15000 km or 12months (But, shorten the service interval under severe condition)
Oil injection nozzle	Type	Piston	
	Operating pressure	1.5 bar	
	Closing pressure	1.0 bar	
	Oil flow	4L/min	

CAUTION

The engine oil filter element should be changed at the same time with the engine oil.

- Regularly check the engine oil level and add the engine oil if necessary.
- Remember to check the engine oil level and shorten the cycle to replace the engine oil under severe driving conditions.

Severe Driving Condition

- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

2. MAINTENANCE

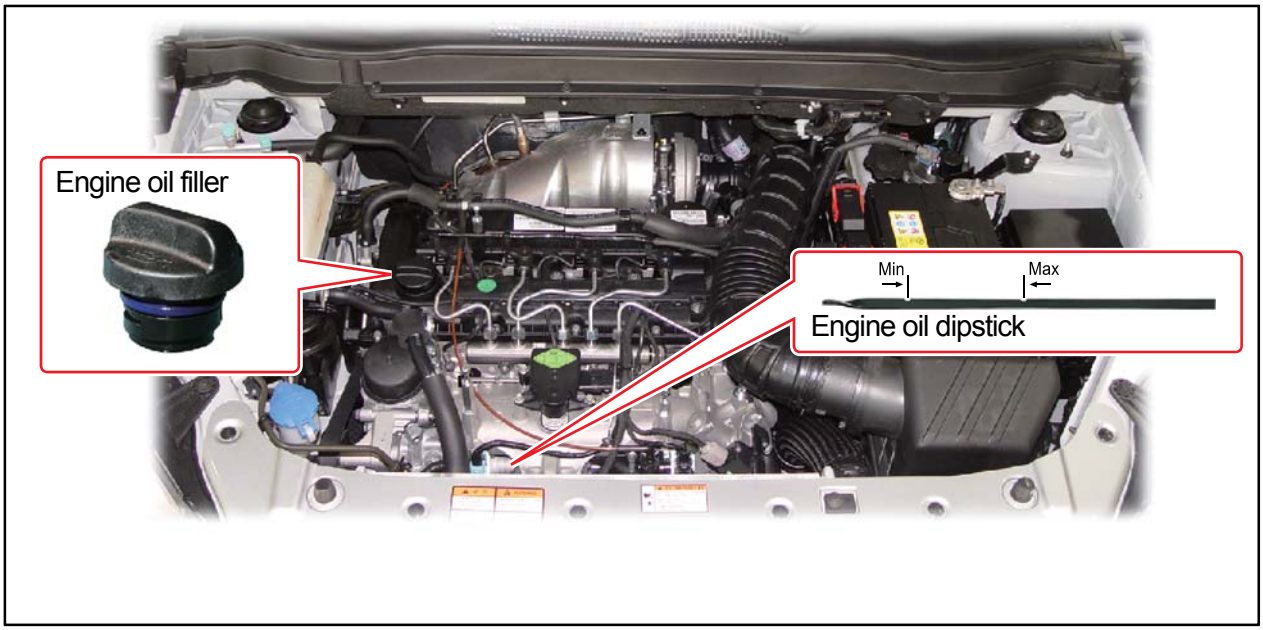
1) Level Check

Park the vehicle on a level ground and apply the parking brake. Stop the engine and wait more than 5 minutes.

- Pull out the dipstick and wipe it with a clean cloth. Reinsert it all the way.
- Pull out it again and check the oil level.
- The oil level should be between the maximum (Max) mark and minimum (Min) mark on the oil dipstick. Oil should be replenished before the level goes below the minimum mark.

WARNING

Operating vehicle with insufficient amount of oil can damage the engine. Make sure the engine oil level is correct and add oil if necessary.



2) Replenishment

If the level gets to the lower point, open the filler cap on top of the cylinder block and add the genuine oil without exceeding the level of the upper mark.
Recheck the oil level after 5 minutes.

CAUTION

- Regularly check the engine oil level and add Ssangyong genuine engine oil if necessary.
- Clean the dipstick with clean cloth so that any foreign materials cannot get into the engine.
- The oil should not go above the upper mark on the dipstick.
- The engine oil may be consumed more if the engine is new.

Modification basis	
Application basis	
Affected VIN	

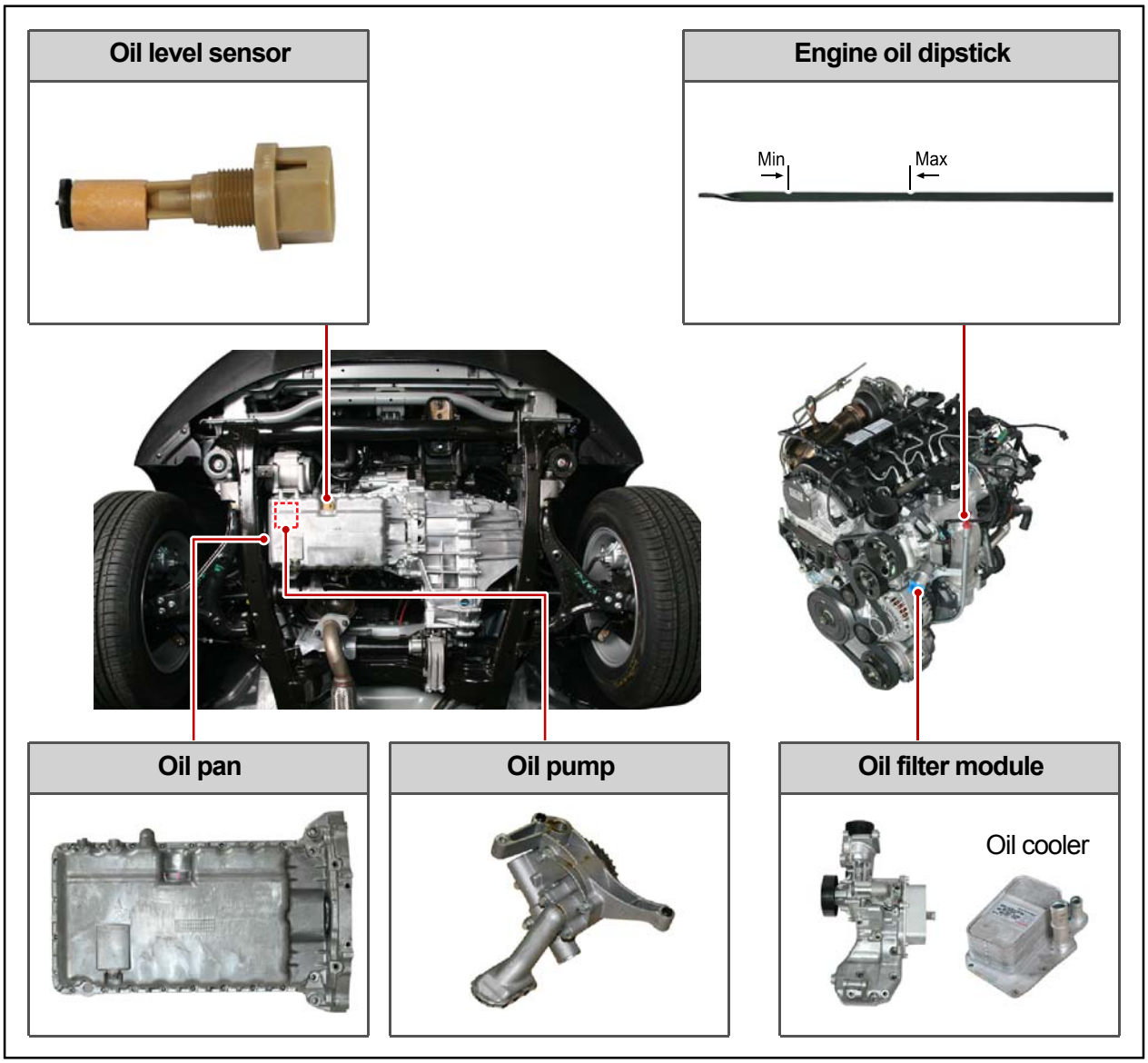
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

The lubrication system supplies oil to each lubrication section to prevent friction and wear and to remove heat from the friction part. As the engine runs, frictional heat is generated on each lubrication section. If this condition persists, the bearing can be burned and stuck.
In other words, it creates an oil film on each sliding surface to convert solid friction to liquid friction in order to minimize wear and prevent temperature increasing on the friction part.
For the D20DTF engine with no oil pressure switch, the engine ECU receives the low engine oil level signal from the oil level sensor and communicates with the instrument cluster through the CAN communication to turn on the warning lamp.

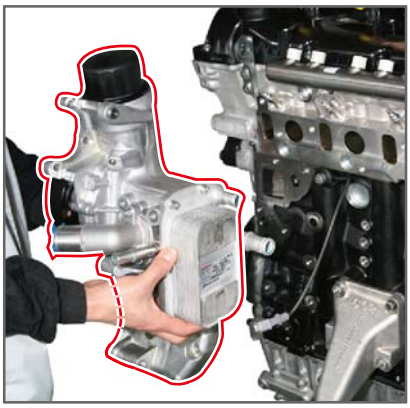
2) Component

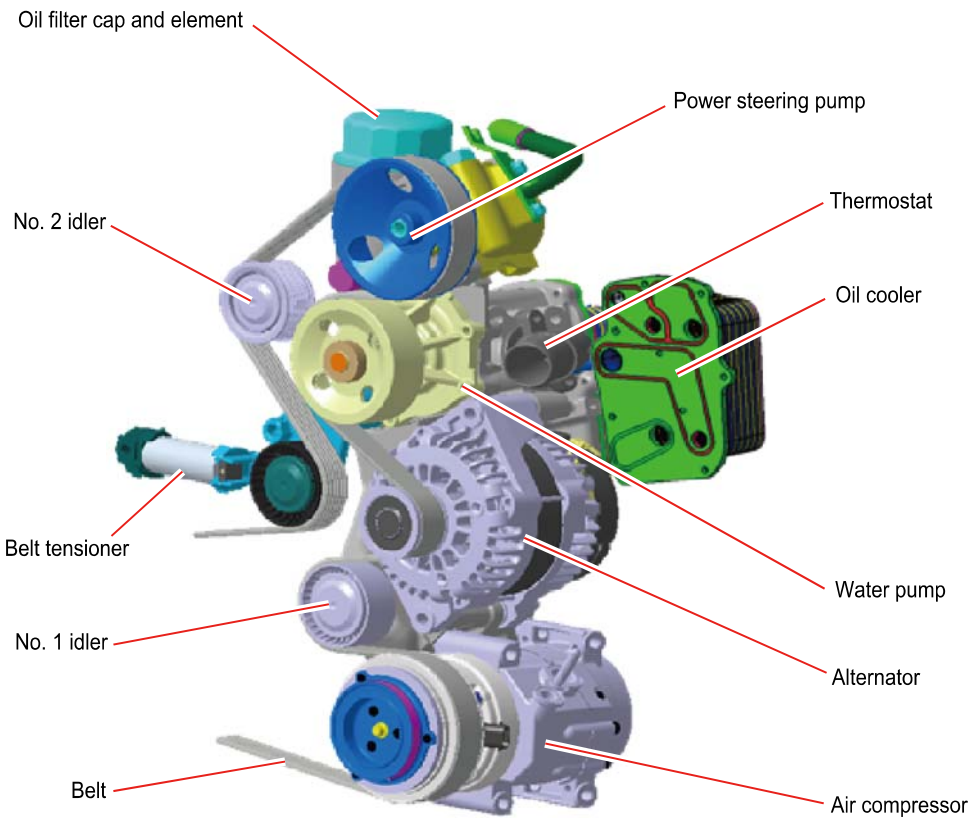


3) Oil Filter Module

The oil filter module consists of lubrication system, cooling system and some mechanical devices as below.

System	Components
Supplementary devices	Power steering pump (HPS), Alternator, A/C compressor
Belt drive	Belt tensioner, Idle pulley
Cooling	Water pump, Thermostat, Cooler housing and Pipes
Lubrication	Oil filter, Oil cooler (except coolant pipes)

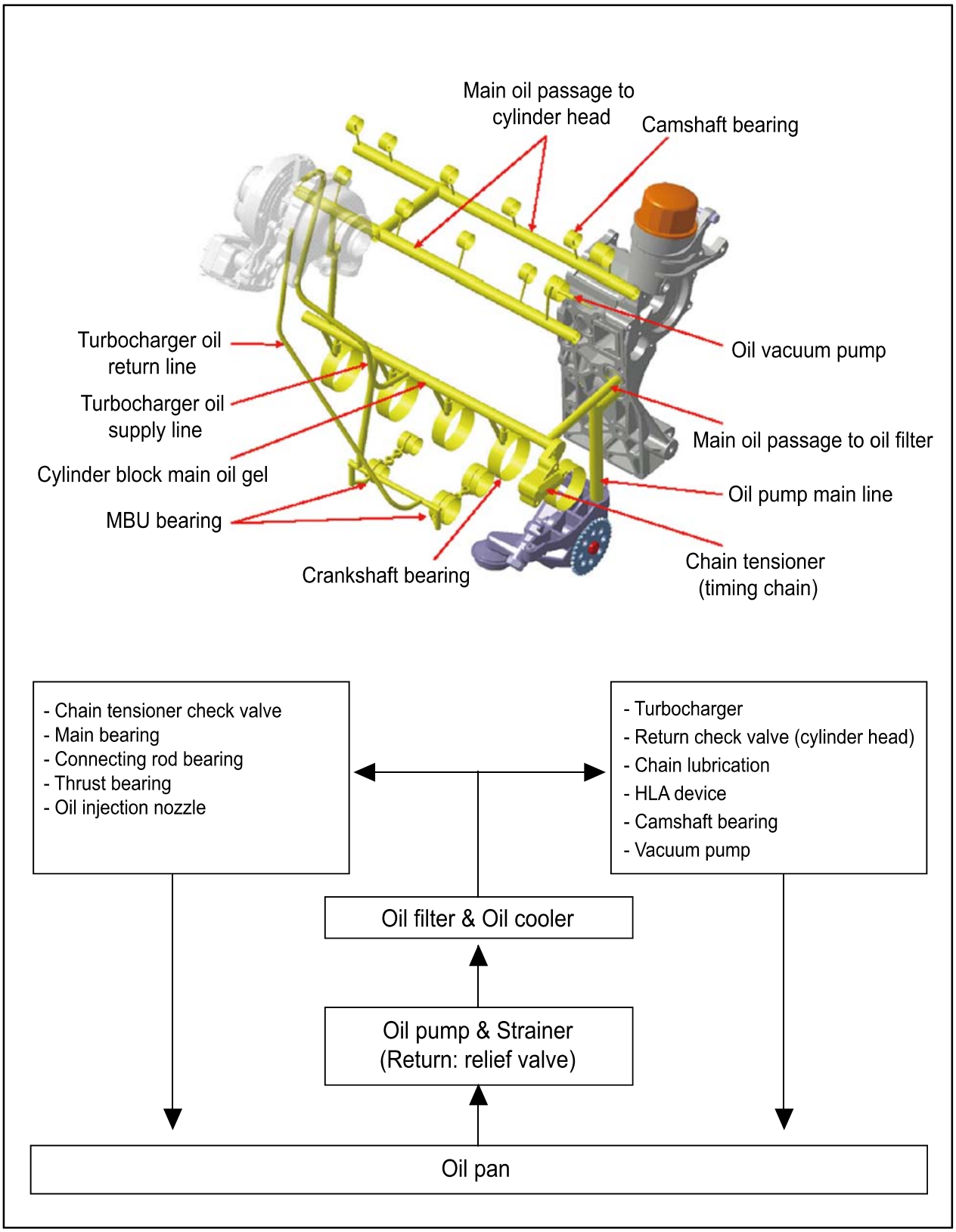




Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

1) Operation Flow



3. LUBRICATION

1)Anti-friction

The oil makes a thin film on the surface of sliding components to reduce the wear due to friction.

2)Cooling

The friction makes the heat on the components. The oil absorbs the heat and radiates it or cools it down.

3) Sealing

The piston ring on the piston seals the cylinder. The oil gets into the clearance in piston ring to secure the sealing for compression pressure and combustion gas.

4) Anti-corrosion

The oil generates the thin film on the surface of components to prevent the material from contacting with air, water and corrosive gas.

5) Cleaning

The oil transfers the residue of material due to friction, oxidized substance, and carbonized substance while circulating in the engine by oil pump.

Modification basis	
Application basis	
Affected VIN	

COOLING SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Cooling system	Type	Water cooling, forced circulation
Coolant	Capacity	11.3L
Radiator	Core size	740W X 380H X 27t (over 281,200㎟)
	Flow type	Cross flow
	Min. cooling capacity	over 68,000kcal/h
Antifreeze	Type	Long life coolant
	Mixing ratio (water:antifreeze)	50 : 50
Cooling fan module	Type	Electric
	Capacity	220W (Ø360) + 150W (Ø360)
	Control type	Series: low speed, Parallel: high speed
Coolant reservoir	Capacity	over 2.2L
	Circulation	Closed roof type
	Pressure cap	Screw type, 1.4bar
	Vacuum valve	Screw type, 1.4bar
Thermostat	Type	Wax pallet type
	Opening temperature	90℃
	Fully open temperature	100℃
	Valve lift	8mm

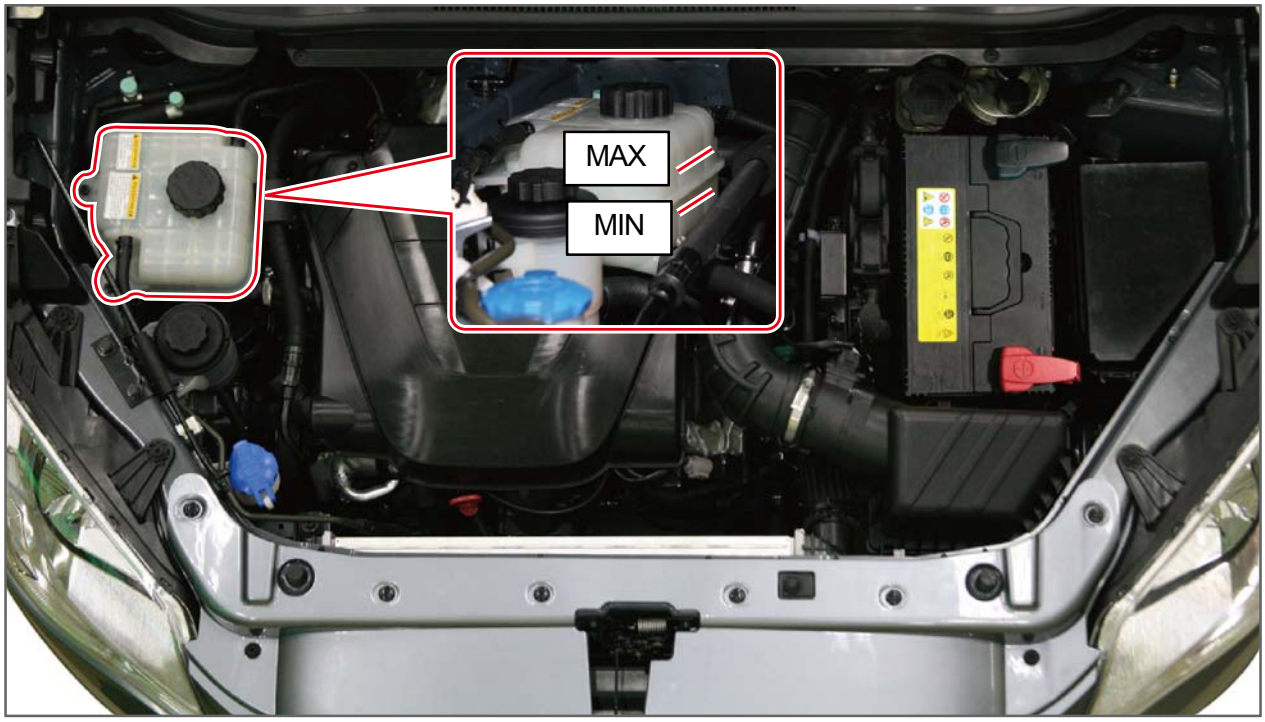
2. INSPECTION

Possible Cause		Action
Coolant level is too low	- Leak from the radiator - Leak from the auxiliary reservoir - Leak from the heater core	- Replace the radiator - Replace the auxiliary reservoir - Replace the heater
	- Leak from the coolant hose connections - Damaged coolant hose	- Reconnect the hose or replace the clamp - Replace the hose
	- Leak from the water pump gasket - Leak from the water pump internal seal	- Replace the gasket - Replace the water pump
	- Leak from the water inlet cap - Leak from the thermostat housing	- Replace the water inlet cap gasket - Replace the thermostat sealing
	- Incorrect tightening torque of the cylinder head bolts - Damaged cylinder head gasket	- Tighten the bolts to the specified torque - Replace the cylinder head gasket
Coolant temperature is too high	- Coolant leakage (Coolant level is low) - Improper coolant mixture ratio - Kinked coolant hose	- Add coolant - Check the coolant concentration (Anti-freeze) - Repair or replace the hose
	- Defective thermostat - Defective water pump - Defective radiator - Defective auxiliary reservoir or tank cap	- Replace the thermostat - Replace the water pump - Replace the radiator - Replace the auxiliary reservoir or tank cap
	- Cracks on the cylinder block or cylinder head - Clogged coolant passages in the cylinder block or cylinder head	- Replace cylinder block or cylinder head - Clean the coolant passage
	- Clogged radiator core	- Clean the radiator core
	- Improper operation of cooling fan	- Replace the cooling fan or repair the related circuit
	- Defective temperature sensor or faulty wiring	- Replace the sensor or repair the related wiring
Coolant temperature is too low	- Thermostat is stuck open	- Replace the thermostat
	- Improper operation of cooling fan	- Replace the cooling fan or repair the related circuit
	- Defective temperature sensor or faulty wiring	- Replace the sensor or repair the related wiring

Modification basis	
Application basis	
Affected VIN	

1) Coolant Level Check

1. Park the vehicle on level ground and apply the parking brake. Stop the engine and wait until it is cooled down.
2. The coolant level should be between the MAX and MIN mark on the coolant reservoir.
   Check the coolant level. If the level is below the "MIN" mark, immediately add coolant.



CAUTION

- Scalding hot coolant and steam could be blown out under pressure, which could cause serious injury. Never remove the coolant reservoir cap when the engine and radiator are hot.
  Avoid any direct contact of the coolant to the painted body of the vehicle.
-

2) Leak Test



1. Release the pressure in the system by loosening the pressure cap of the coolant reservoir slightly. Then, remove the pressure cap completely.

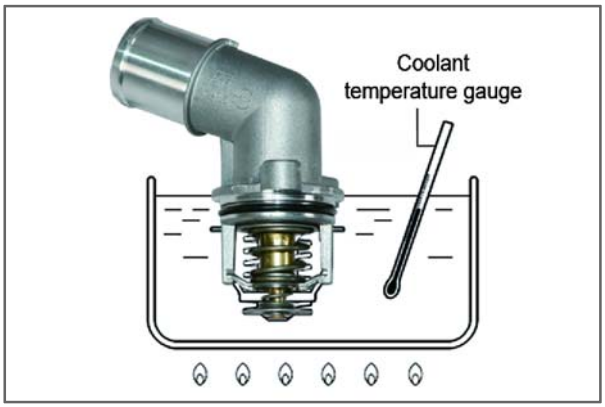
CAUTION

Never open the cap until the coolant temperature becomes under 90℃ to prevent any burn.



2. Add the coolant so that the coolant level is between MAX and MIN mark on the coolant auxiliary tank.
3. Connect the tester to the tank filler and apply pressure (1.4 bar).
4. Check all the coolant hoses, pipes and connections for leaks when the pressure of the tester drops, and replace or tighten, if necessary.

3) Thermostat



Immerse the thermostat into the water. Heat the water and check the valve opening temperature.

Valve opening temperature	90±2℃

Modification basis	
Application basis	
Affected VIN	

3. CAUTIONS

CAUTION

- If 100% of anti-freeze is added, the water pump vane can be damaged and thermal conductivity can be decreased resulting in poor circulation in the cooling system which leads to overheated engine.
- Use of non-recommended coolant could cause damage to the cooling system and overheating of the engine.
- Opening the coolant reservoir cap while the engine is running or hot can cause burns by hot steam or water.
- To open the coolant reservoir cap, wrap the cap with a wet towel or thick cloth after the engine is cooled down sufficiently.
- If cool water is added to the heated engine, the engine or radiator can be deformed.
- The anti-freeze in the coolant can damage the painted surface, so avoid the contact of the coolant to the painted body.
- The anti-freeze and water should be mixed in proper mixture ratio. Never add only water when adding coolant.
- If the anti-freeze content is too low, the coolant can be frozen while the engine can be overheated if anti-freeze content is too high.

OVERVIEW AND OPERATING PROCESS

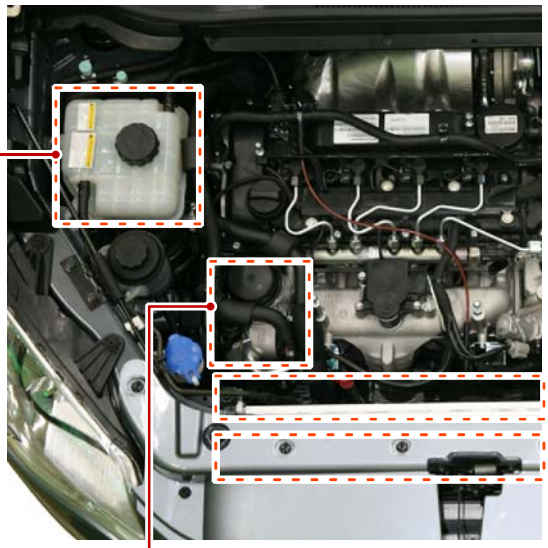
1. SYSTEM DESCRIPTION

1) Overview

Coolant reservoir



Long life coolant is used.



Water pump

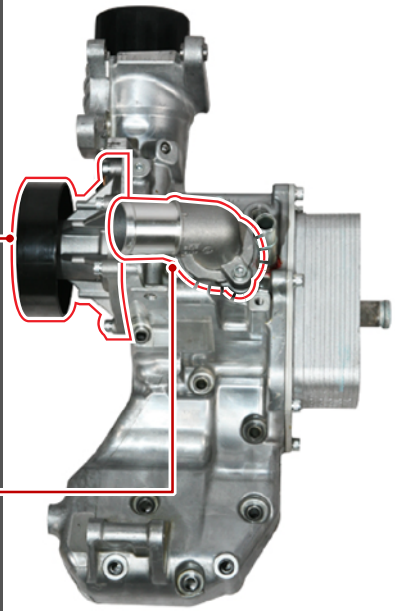


Water pump pulley



The water pump is driven by the engine drive belt and supplies the coolant to each area of the engine.

Oil filter module

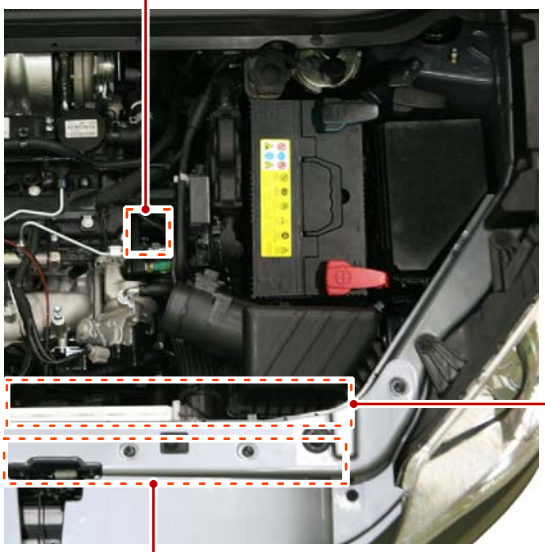


Thermostat



When the engine coolant reaches 90℃, the thermostat starts to open (fully open at 100℃) and lets the coolant flow to the radiator to maintain the engine temperature.

Modification basis	
Application basis	
Affected VIN	



Coolant temperature sensor



Measures the coolant temperature and sends the result to the engine ECU.

Electric fan



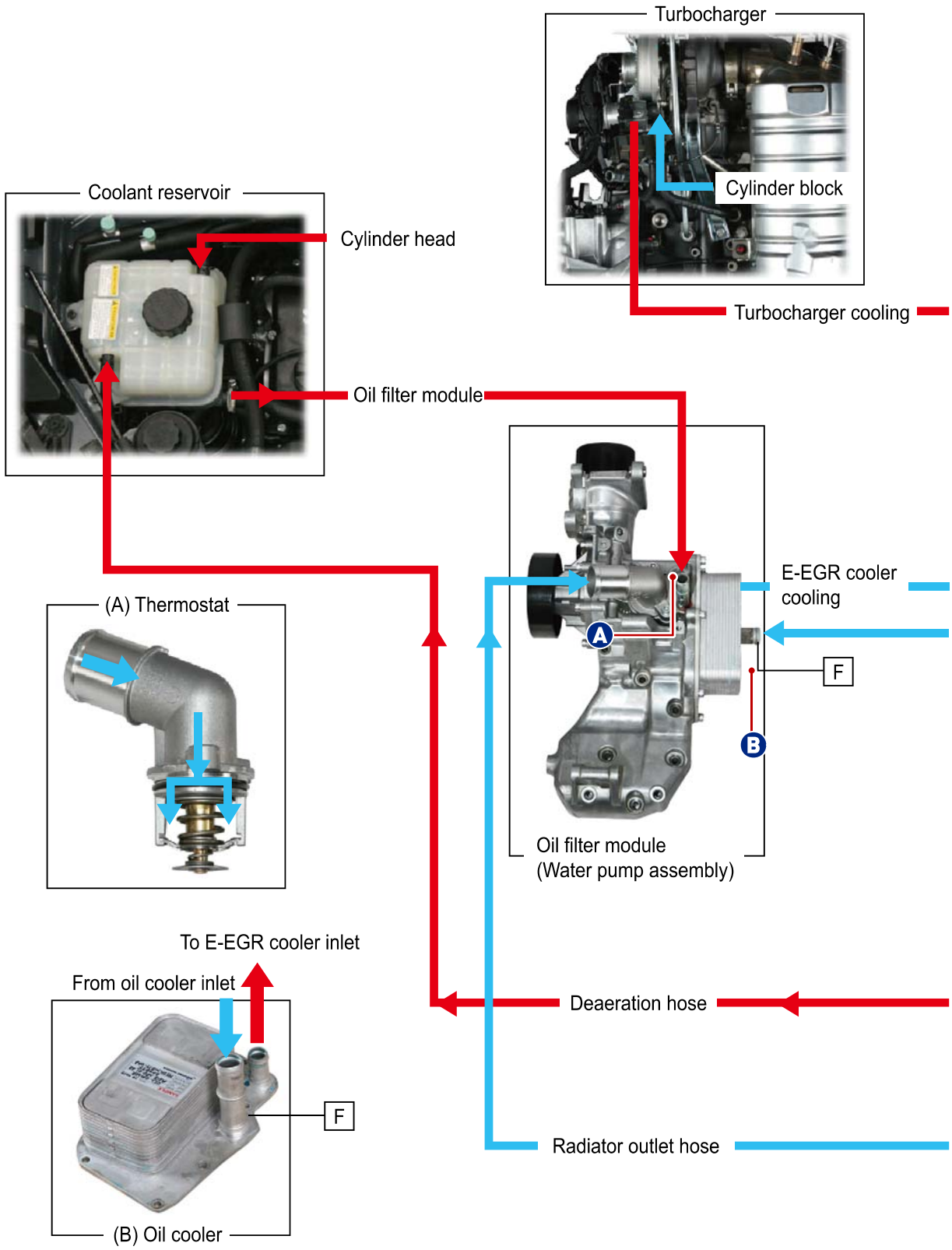
Circulates the fresh air forcibly to exchange heat with the radiator core fin.

Radiator

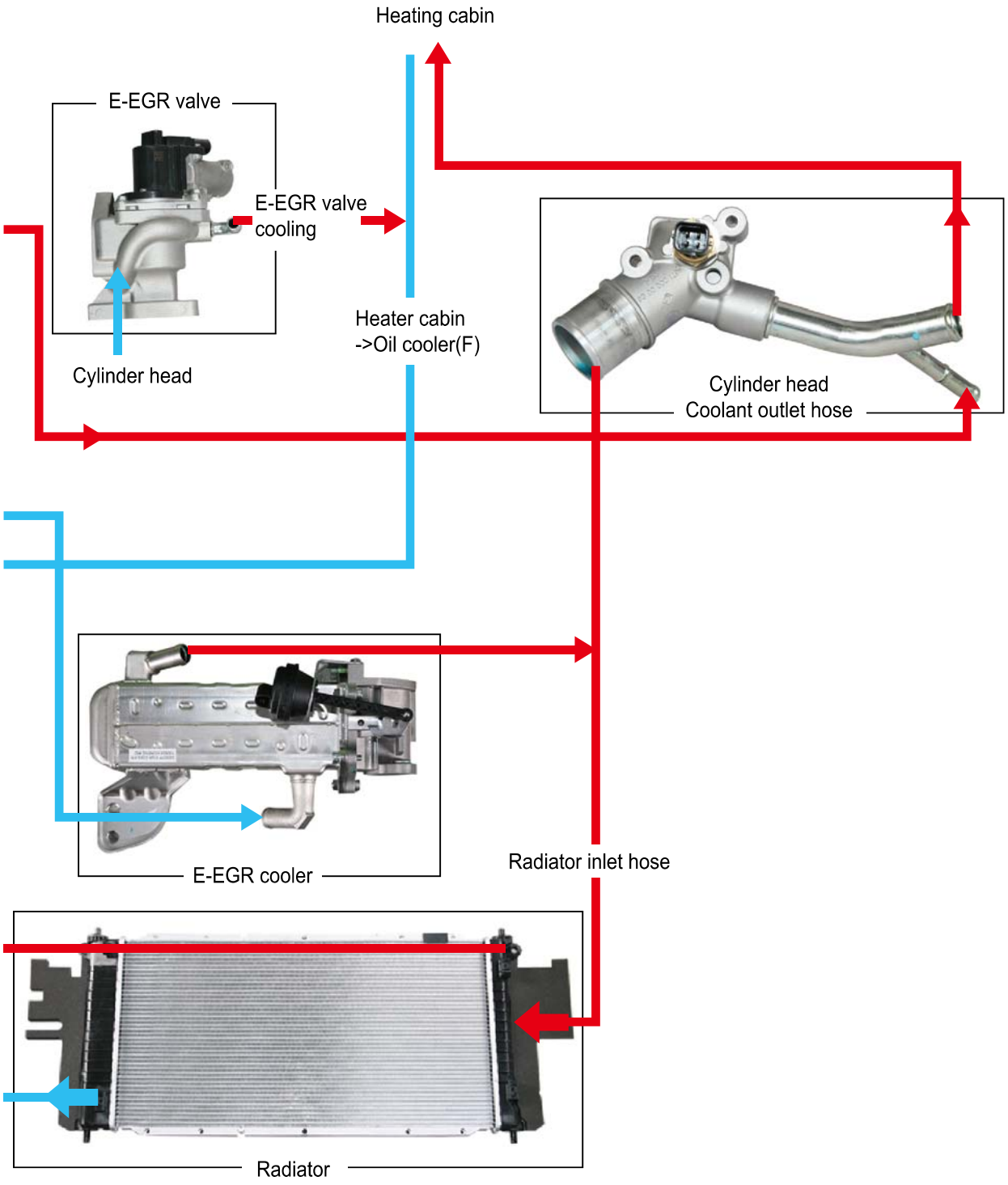


Releases heat through fins and cools down the hot coolant as the coolant passes through the tube of the radiator core.

3) System Layout



Modification basis	
Application basis	
Affected VIN	


Heating cabin
E-EGR valve
E-EGR valve
cooling
Heater cabin
->Oil cooler(F)
Cylinder head
Cylinder head
Coolant outlet hose
E-EGR cooler
Radiator inlet hose
Radiator

CHARGING SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Specification			HPS	EPS
Alternator	Crankshaft pulley : Alternator Pulley		1 : 2.94	
	Normal output (idling/2200 rpm)		70/120 A	70/140A
	Regulator voltage		14.6 V	←
	Brush	Length	12.5 mm	←
		Wear limit	7 mm	←
Battery	Type		MF	←
	Capacity		90AH	←

2. INSPECTION

1) Alternator Output Test

Item	How to check	DTC set value / Action
Output current	1. Disconnect the cable connected to the B terminal on the alternator. Connect one end of the ammeter to the B terminal and the other end to the cable connected to the B terminal. 2. Measure the maximum output value. (Maintain the engine speed between 2,500 and 3,000 rpm.) (Turn the headlamp and all the electrical switches on.)	- Pass: If the measured current is 45 A or higher. - Fail: If the measured current is less than 45 A. - Check the current of the B terminal.
B terminal current	1. Move the gear selector lever to the neutral position. 2. Maintain the engine speed at 2,500 rpm with the vehicle unloaded. (Turn all the electrical switches off.)	- Open circuit: If the measured current is 5 A or higher.
Rotor coil resistance	1. Disconnect the negative cable from the battery. 2. Remove the B terminal and turn off the ignition switch. 3. Measure the resistance between the L and F terminals with an ohmmeter.	- Pass: If the measured resistance is between 3 and 6 Ω. - Faulty rotor coil or slip ring: If the measured resistance is less than 3 Ω or greater than 6 Ω.
L terminal voltage	1. Connect the B terminal wiring. 2. Measure the voltage with the engine running.	- Specification: 12.5 V to 14.5 V - Faulty IC regulator or field coil: If the measured voltage is 14.5 V or higher.

CAUTION

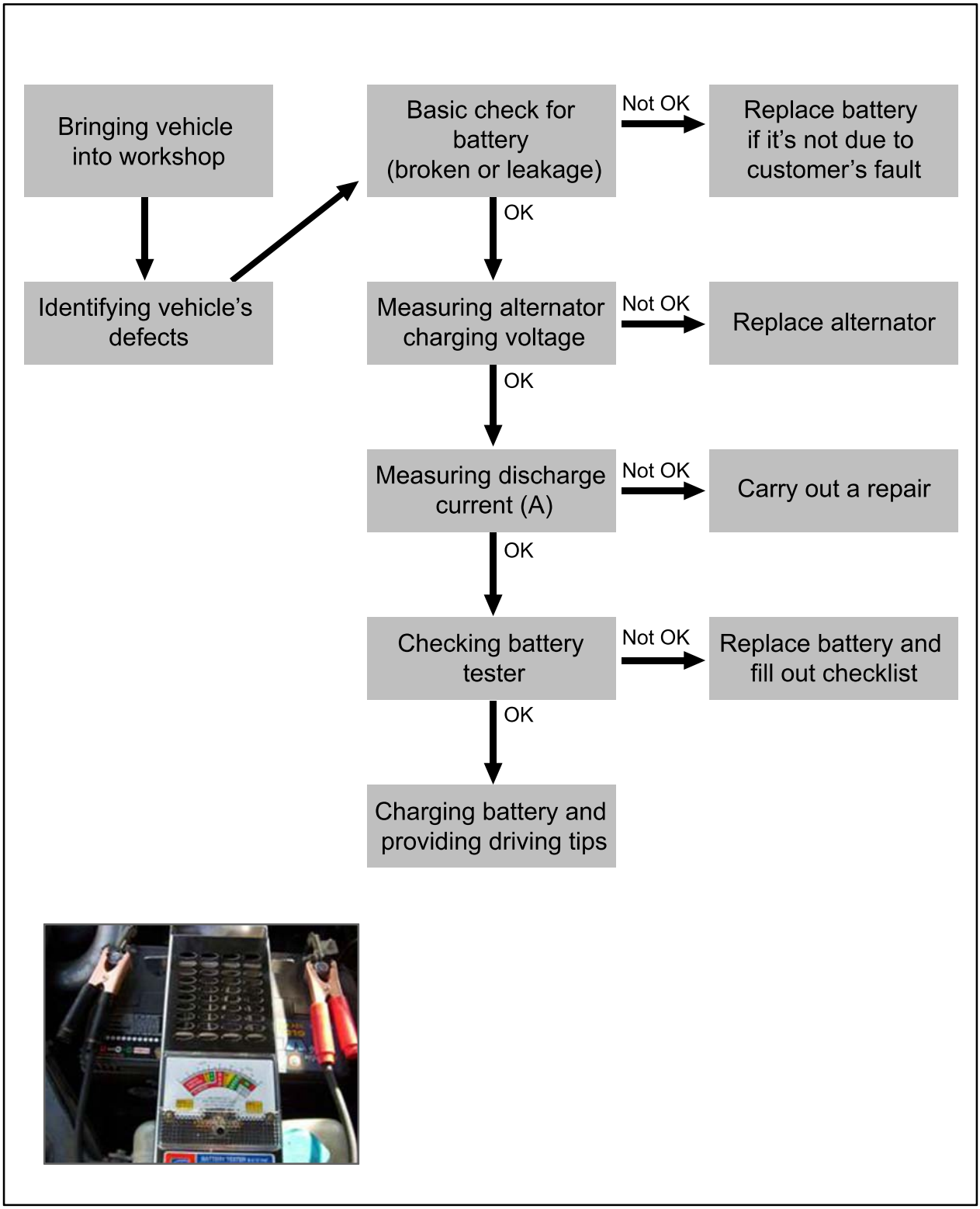
- Disconnect the negative battery cable.
- Connect the negative cable again after connecting the ammeter.

Modification basis	
Application basis	
Affected VIN	

2) Troubleshooting for Alternator

Item	Cause	Action
Overcharged battery	Defective alternator voltage regulator	Replace
	defective alternator detection wiring	Repair or replace
Discharged battery	Loose alternator drive belt	Adjust the belt tension or replace
	Poor connection of related circuit or open circuit	Retighten the loose connection or repair open circuit
	Defective alternator voltage regulator	Replace
	Terminated battery	Replace
	Defective ground	Repair
Charge warning lamp does not come on when turning on ignition switch with engine stopped	Defective alternator voltage regulator	Replace
	Open circuit in charge warning lamp, fuse or wiring	Replace or repair the charge warning lamp or fuse
	Defective ignition switch	Replace
	Defective ground of alternator circuit	Repair
Charge warning lamp does not go off after starting engine	Defective alternator voltage regulator	Replace
	Corroded or worn battery cable	Repair or replace
	Loose alternator drive belt	Adjust the belt tension or replace the belt
	Defective wiring harness	Repair or replace

3) Checking Battery



Modification basis	
Application basis	
Affected VIN	

(1) Checking

▶ **Using battery tester**

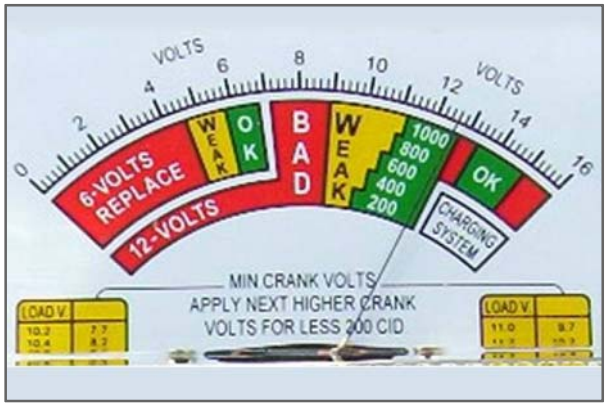
- PASS (11.0 V or more): Explain to the customer that the battery is reusable.
- Need to be charged (9.0 to 11.0 V): Charge the battery with a charger and reinstall it. Explain it to the customer.
- Need to be replaced (9.0 V or more): The battery should be replaced due to overdischarging.

(2) How to use battery tester



▶ **How it works and How to use it**

- Determine battery capacity by fixing current (load capacity) and time and varying voltage. Determine battery capacity based on the
- amount of voltage drop when discharging a fixed load capacity (120 A) for 5 seconds. Connect the tester to the battery and read the
- display while applying a load for 5 seconds.



▶ **How to read display**

- Red area (①): overdischarge or faulty battery
- Yellow area (②): Need to be charged (using a vehicle alternator and a battery charger)
- Green area (③): Normal
- Red area on the left-hand side of OK (④): Impossible to charge with an alternator
- Green area with OK (⑤): Normally charged
- Red area on the right-hand side of OK (⑥ Overcharged by an alternator

(3) Starting with jumper cable

If the battery is weak or terminated, the battery from another vehicle can be used with jumper cables to start the engine.

▶ **Connecting order**

1. The positive (+) terminal of the discharged battery
2. The positive (+) terminal of the booster battery
3. The negative (-) terminal of the booster battery
4. Connect one end of the other jumper cable to the body of the discharged vehicle, such as the engine block or a front towing hook.

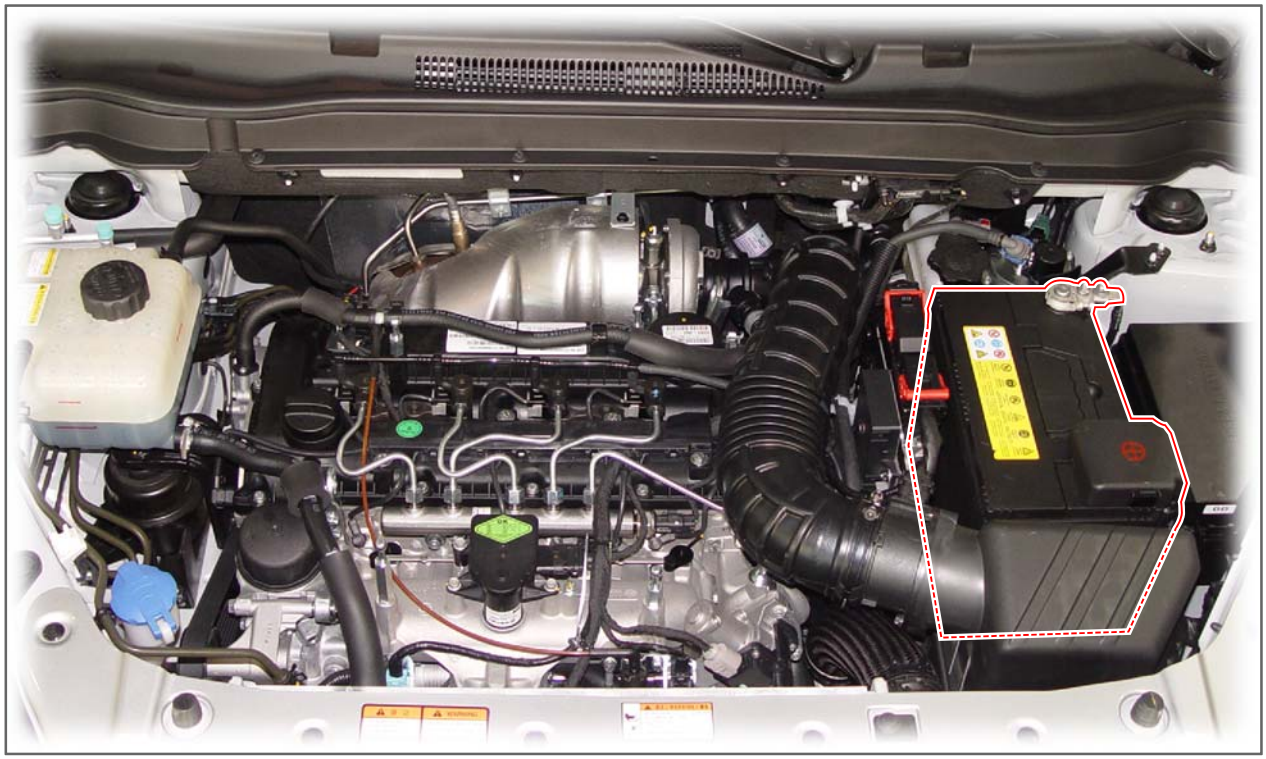
▶ **Starting**

1. Prepare a set of jumper cables.
2. Place another vehicle that has the same 12 V of power near to the discharged vehicle.
3. Switch off all electrical accessories for the discharged vehicle.
4. Apply the parking brake and shift the transaxle to the P position (automatic transaxle) or neutral (N) position (manual transaxle).
5. Connect the jumper cables.
6. Try to start the discharged vehicle while accelerating the engine rpm in the booster vehicle.
7. Attempt to start the engine with the discharged battery.
8. After starting the engine, carefully disconnect the jumper cables in the reverse sequence of connection.

Modification basis	
Application basis	
Affected VIN	

(4) Maintenance

If the charge warning lamp ( ) on the instrument cluster comes on while driving, there is a malfunction in the charge system including the battery. Therefore, carrying out the system check is needed.



- Make sure that the battery cables are firmly connected.
- If the terminals are corroded, clean them with a wire brush or sandpapers.
- Always disconnect the battery cables with the ignition key removed. When disconnecting the battery cables with the ignition key turned to ON or ACC position, several electric units can be damaged due to sudden voltage change.
- Check the battery for crack, damage or fluid leaks. Replace it if necessary.
- Wipe out the battery fluid on the battery surface using a rubber glove and a clean cloth wetted with soapy water.

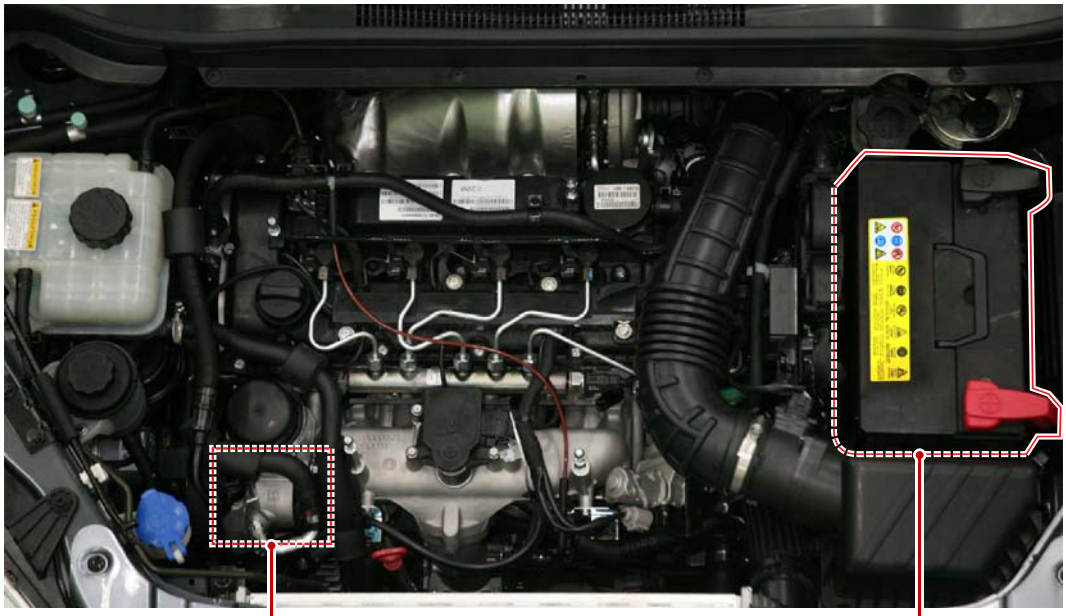
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

The charge system is designed to supply electrical energy to the vehicle while driving, and supplies a constant direct current voltage by converting mechanical rotational movement to electrical energy.
The voltage regulator on the back of the alternator controls the generated voltage in all rotating ranges and adjusts the system voltage according to the electric load and ambient temperature change.

2) System Layout (Locations)



Alternator	Battery
	
The alternator charges the battery and supplies power to each electric unit by converting the mechanical energy to the electrical energy.	It converts the chemical energy to the electrical energy and supplies power to the corresponding electric units when starting the engine.

Modification basis	
Application basis	
Affected VIN	

3) Charging

The alternator uses a new regulator which has three diodes. It consists of the delta stator, rectifier bridge, slip ring and brush.

▶ **Charging time according to vehicle conditions and environment**

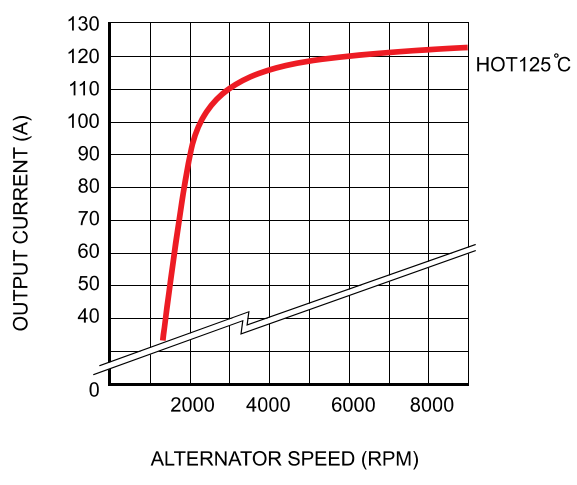


Specification: Charging a fully depleted high-capacity battery takes twice or more as long as charging a fully depleted battery for small vehicles.
Temperature: The lower the temperature is, the longer the time taken to charge the battery. When connecting the battery charger to the cold battery, the amount of current the battery can accept initially is very small. As the battery gets warmer, it can accept more current.

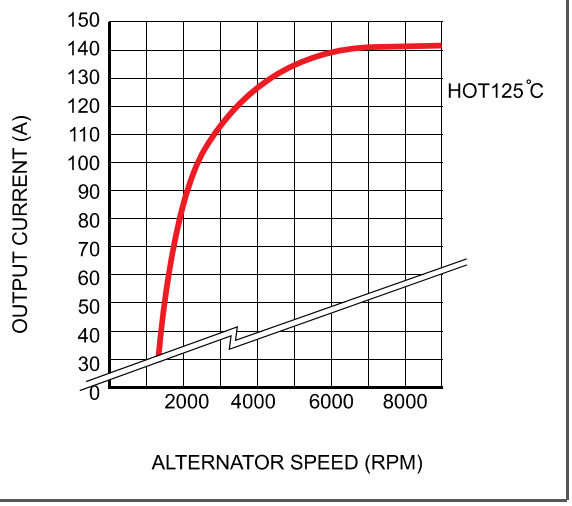
Charging capacity: Charging a battery with a low-capacity charger takes longer time than charging with a high-capacity charger.
Charging status: Charging a fully depleted battery takes twice or more as long as charging a half-depleted battery. Since the electrolyte in a fully depleted battery consists of nearly pure water and conductor, only a very small amount of current can be accepted by the battery initially. The charging current increases as the amount of acids in the electrolyte is increased by the charging current.

4) Output Characteristics

Alternator (120 A)

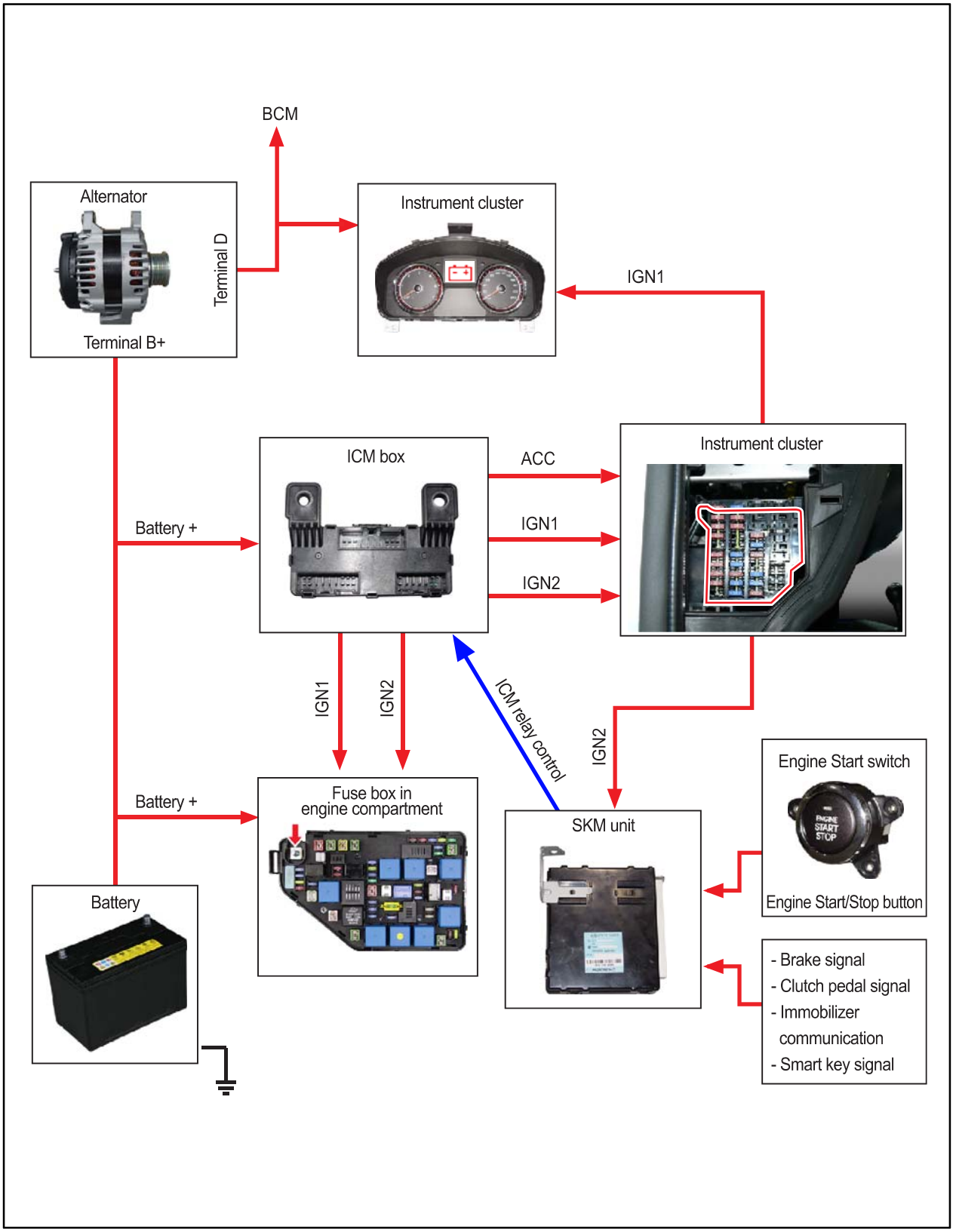


Alternator (140 A)



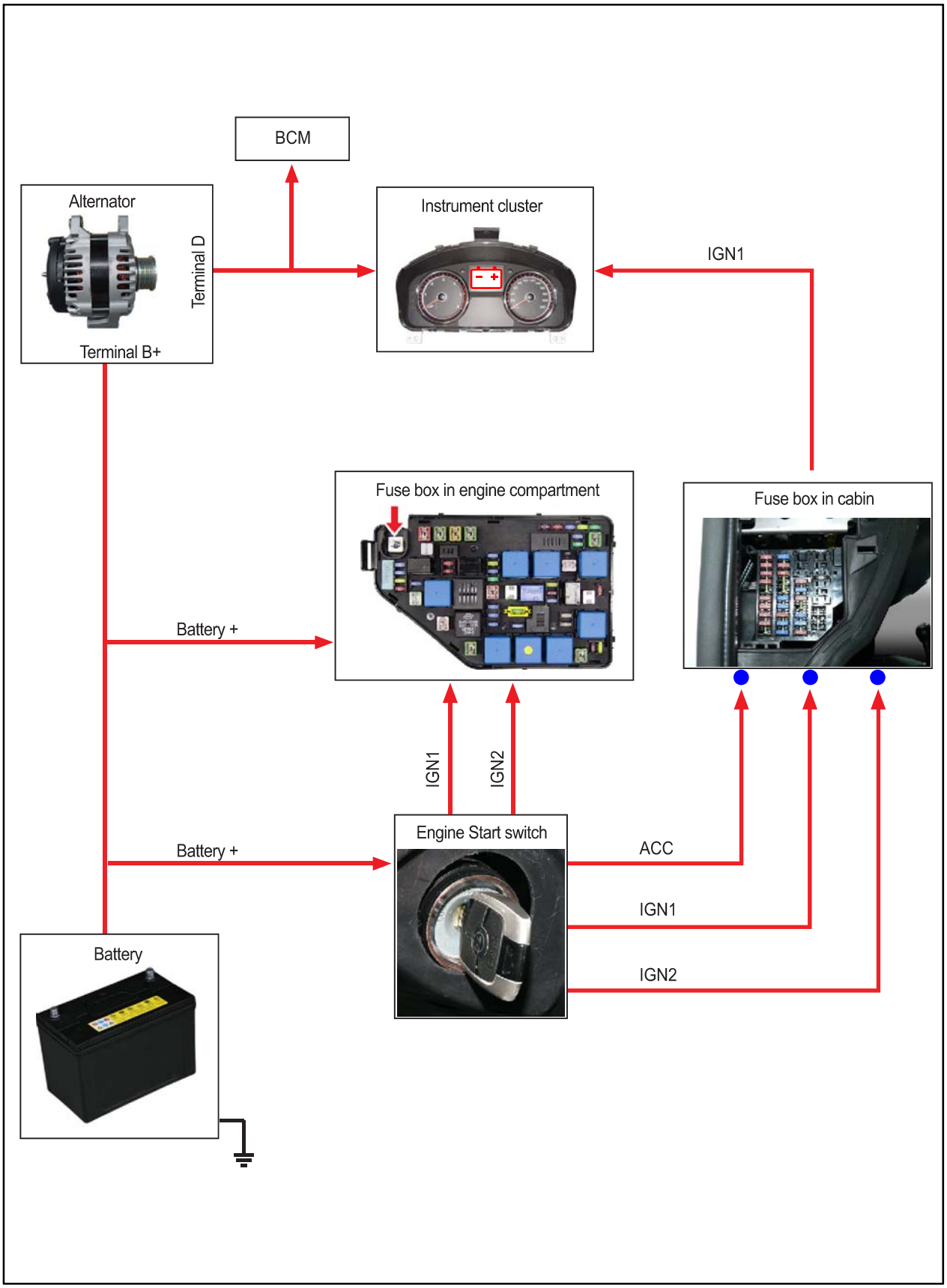
2. CHARGING OPERATION

1) With Smart Key System

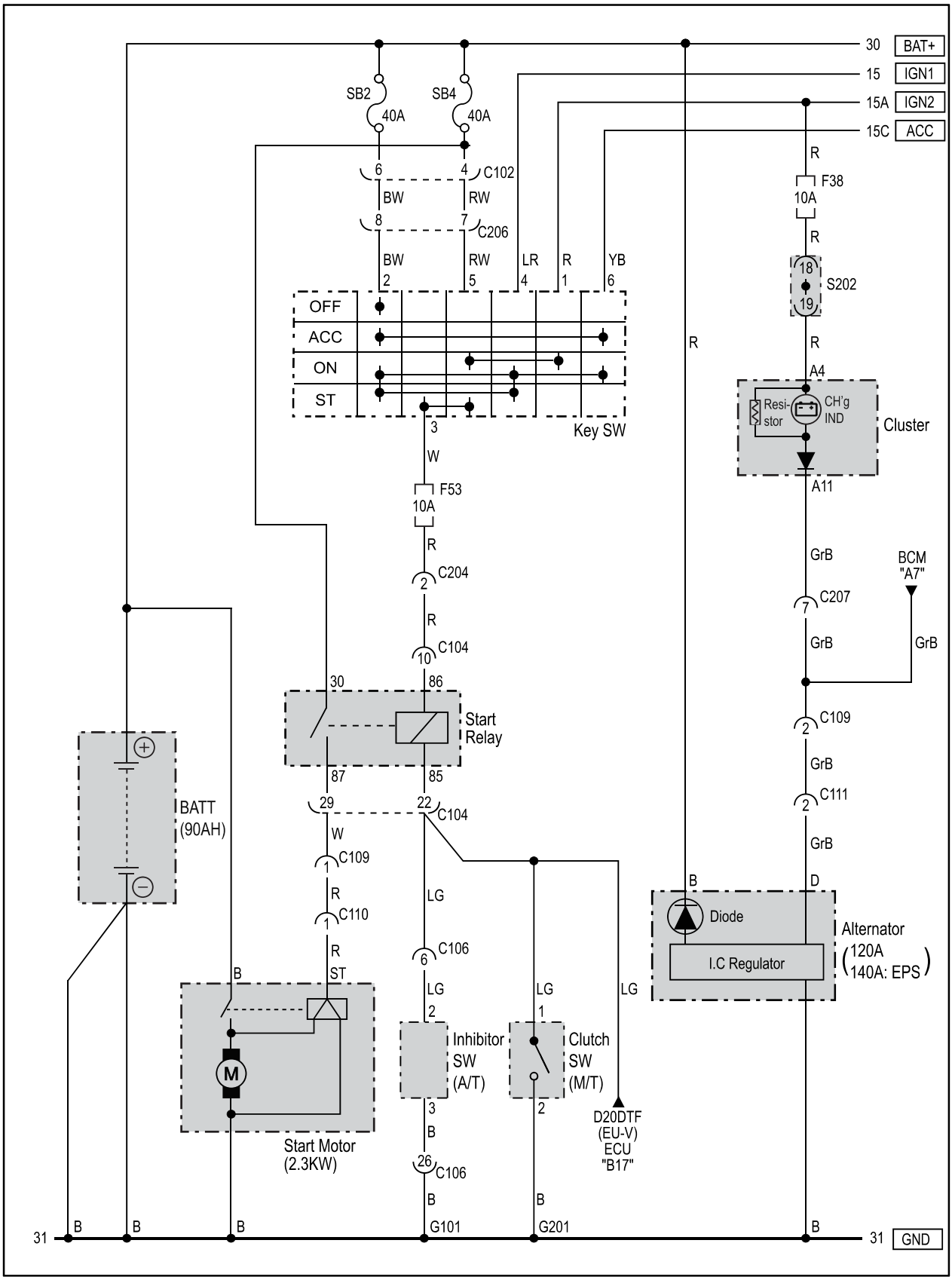


Modification basis	
Application basis	
Affected VIN	

2) Without SMART Key System



3. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

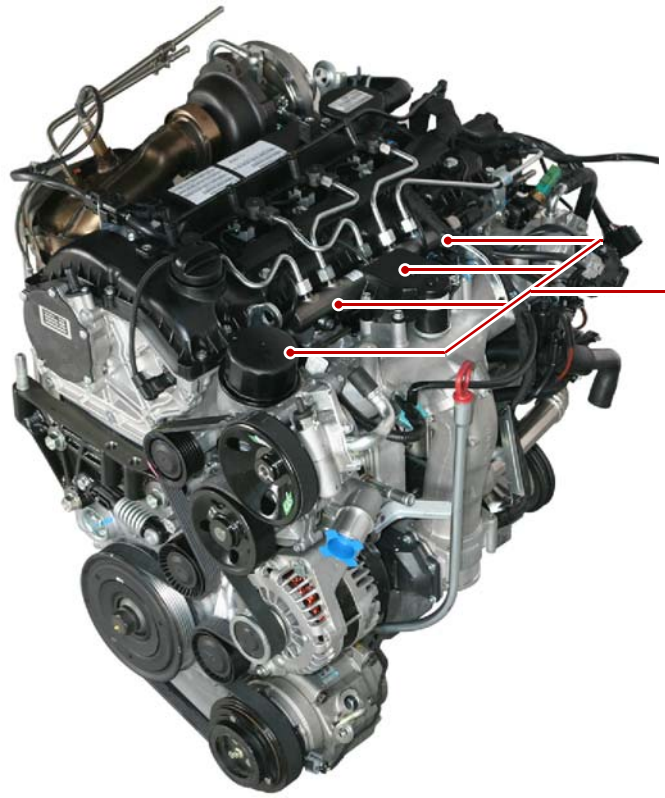
D20DTF PRE-HEATING 1413-00

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Glow plug	Rated voltage	4.4 V
	Maximum temperature	1100°C
	Operating temperature	1080 to 1100°C
Glow plug control unit	EMS operating voltage	6 to 16 V
	Operating temperature	−40°C to 110°C
	Dark current	Max. 1 mA

2. TIGHTENING TORQUE



Glow plug





GCU (Glow plug Control Unit)



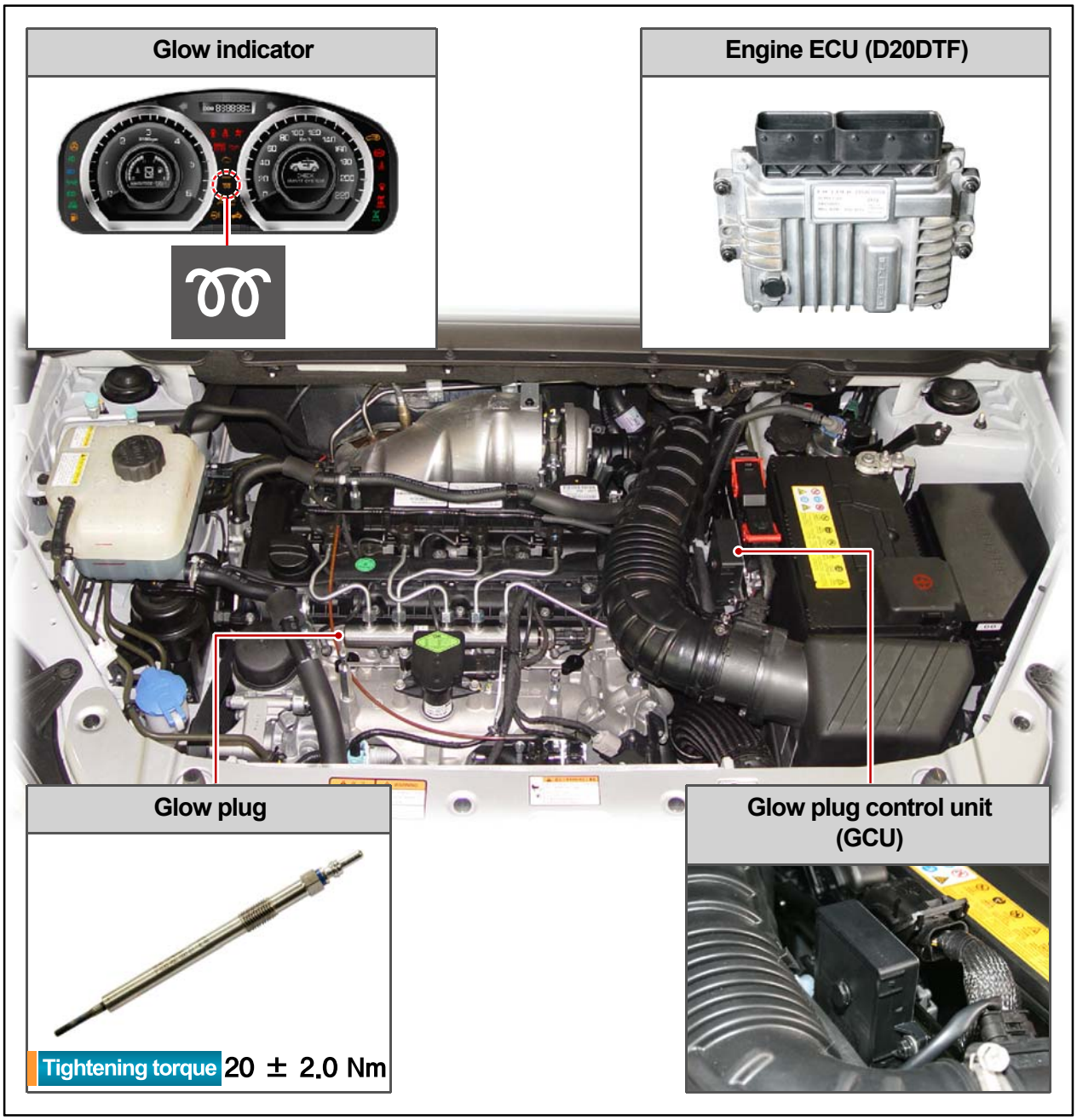
No.	Name	Tightening torque	
1	Glow plug	15 ± 1.5 Nm	
2	Glow plug control unit bolt	10 ± 1.0 Nm	

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

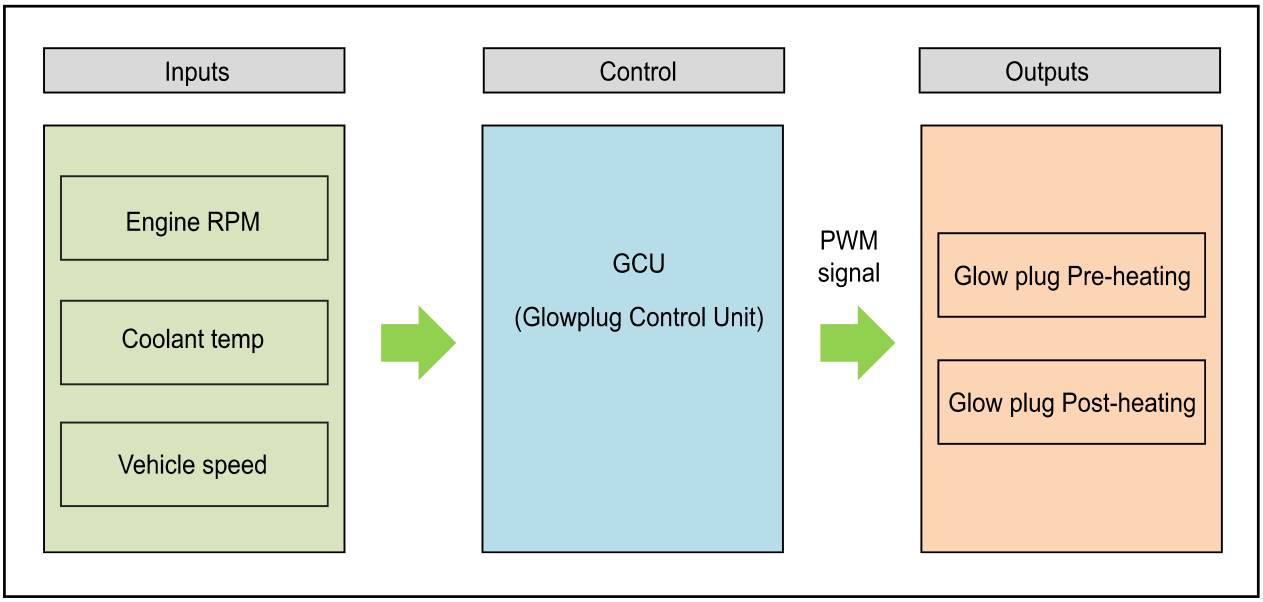
1. OVERVIEW

The pre-heating system for D20DTF engine has the glow plug to the cylinder head (combustion chamber), and improves the cold start performance and reduces the emission level.
The pre-heating resistor (air heater) is used to heat the intake air.
This enables the diesel fuel to be ignited in low temperature condition.
The ECU receives the information such as, engine rpm, coolant temperature, engine torque, etc., through CAN communication during pre-heating process; and the pre-heating control unit controls the pre-heating, heating during cranking and post-heating by the PWM control.

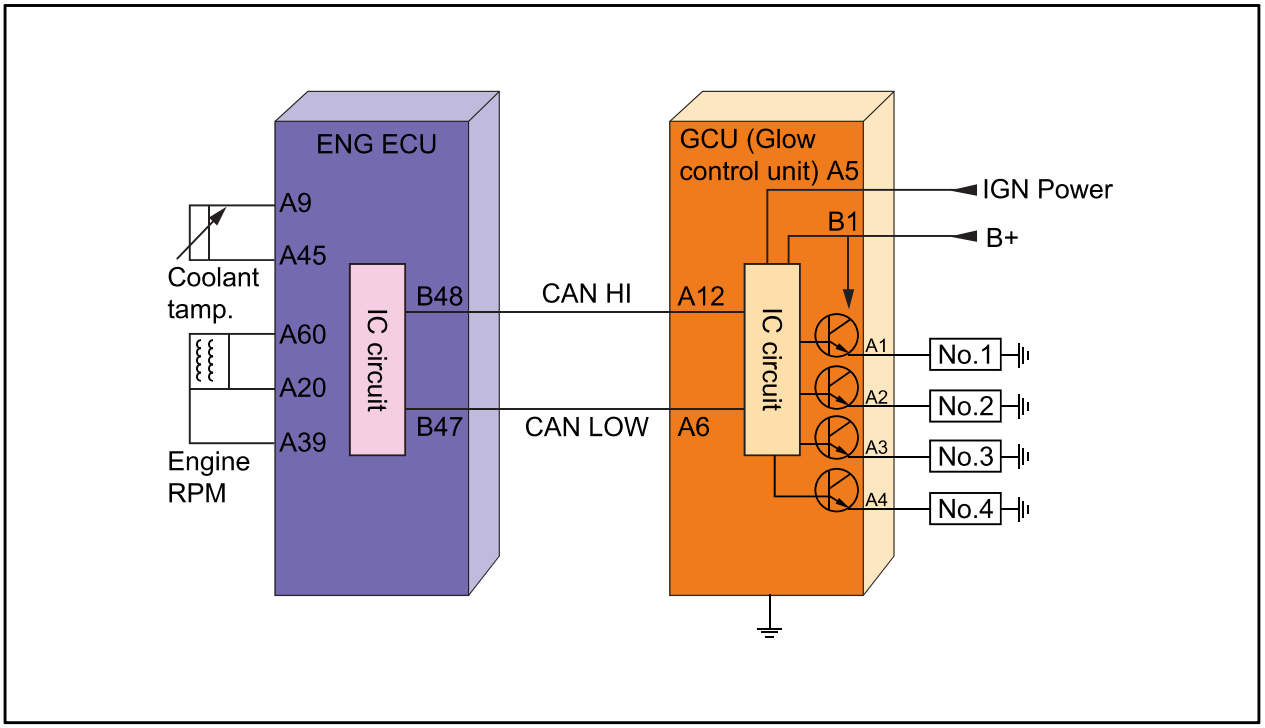


2. SYSTEM OPERATION

1) Input/Output Diagram of Glow Plug Control Unit



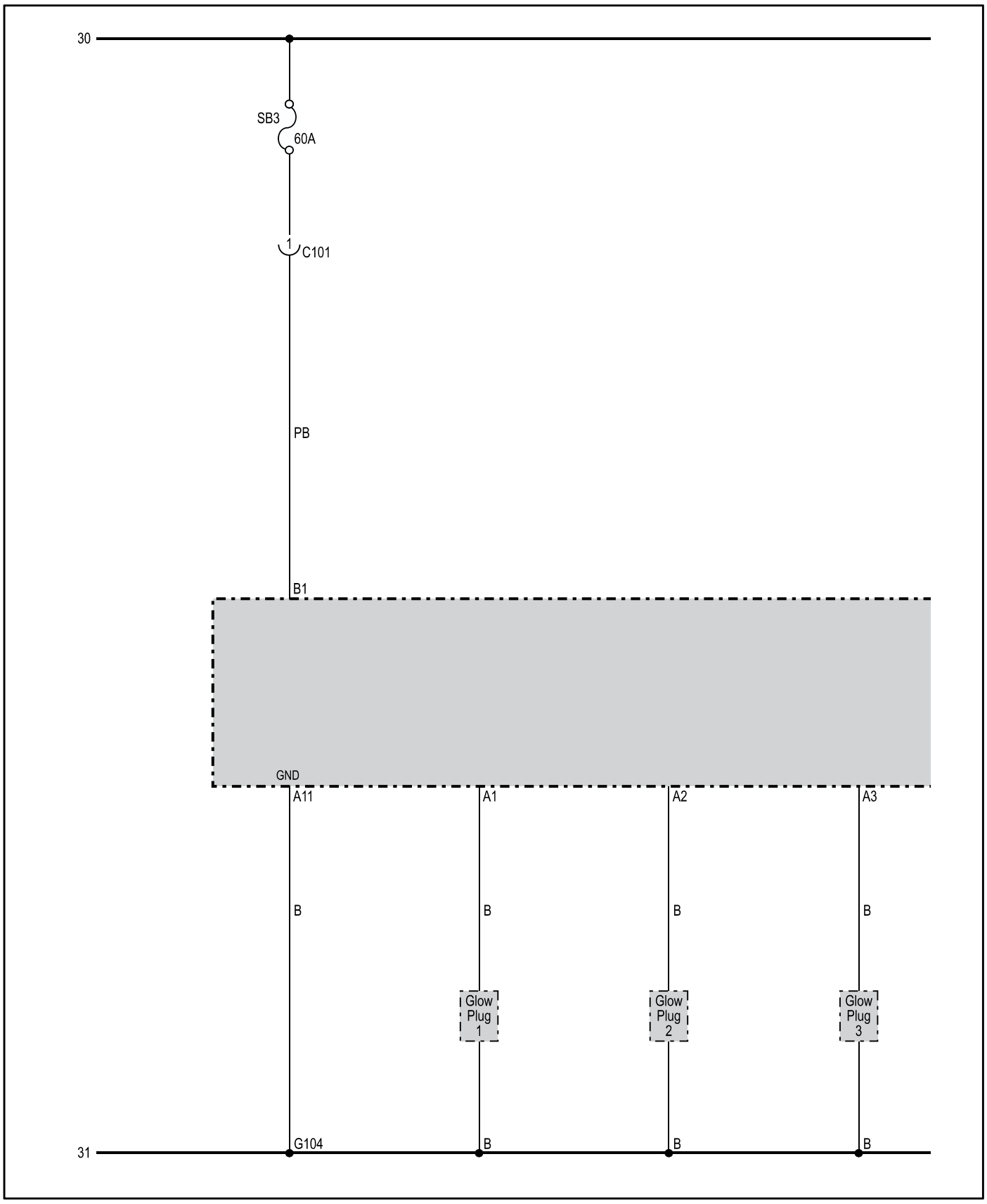
2) System Diagram



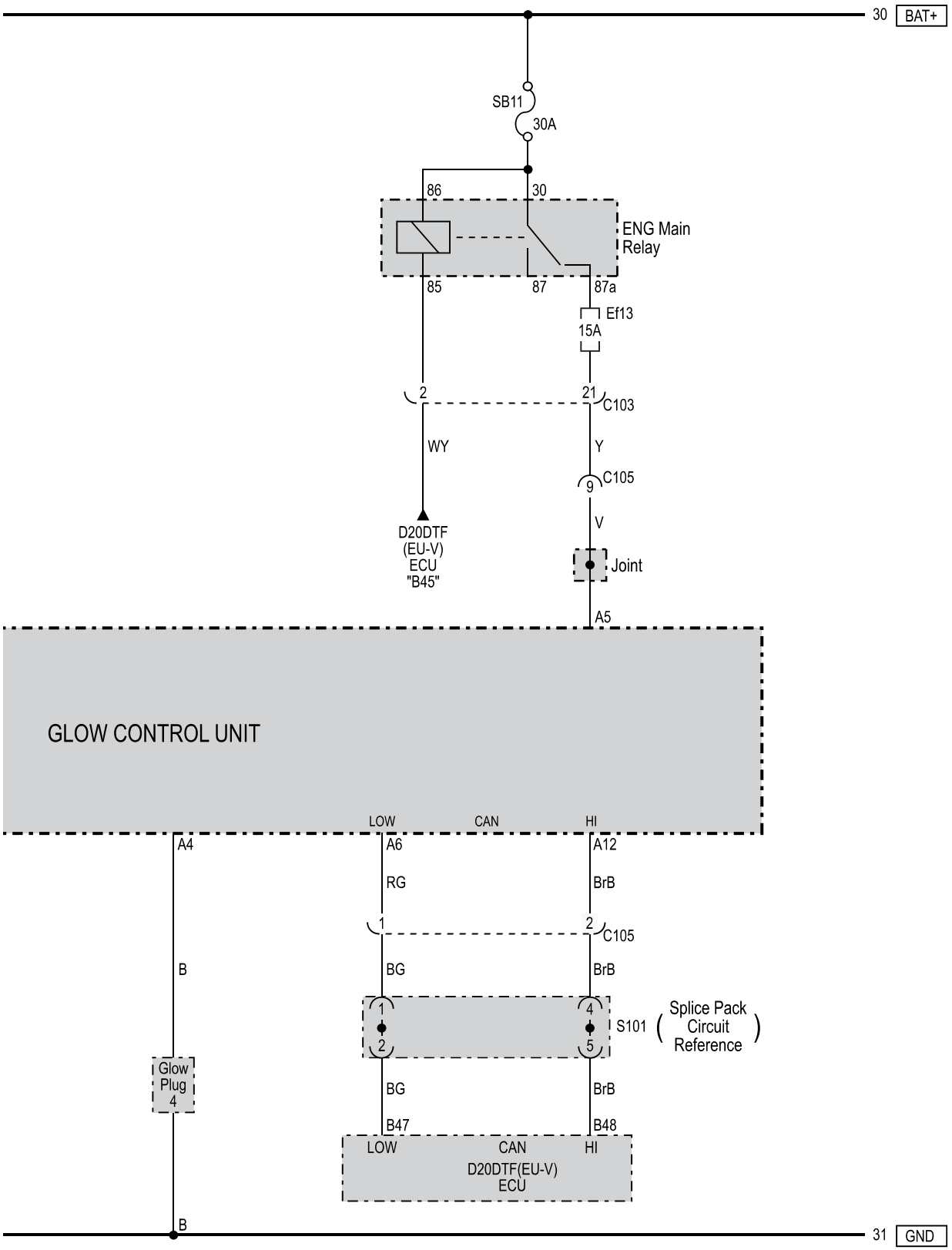
Modification basis	
Application basis	
Affected VIN	

Memo

3) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	


30 BAT+
SB11
30A
86
30
ENG Main Relay
85
87
87a
Ef13
15A
2
21
C103
WY
Y
C105
9
V
D20DTF (EU-V) ECU "B45"
Joint
A5
GLOW CONTROL UNIT
LOW
CAN
HI
A4
A6
A12
RG
BrB
1
2
C105
B
BG
BrB
1
2
4
5
S101
Splice Pack Circuit Reference
Glow Plug 4
BG
BrB
B47
B48
LOW
CAN
HI
D20DTF(EU-V) ECU
B
31 GND

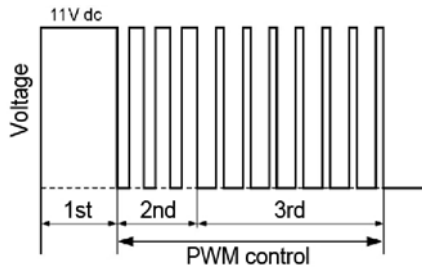
4) System Operation

Glow plug is installed in the cylinder head. It enhances the cold starting performance and reduces the exhaust gas during cold starting.
ECU receives the various signals such as engine rpm, coolant temperature and vehicle speed through CAN communication lines. GCU controls the pre-heating, cranking and post-heating operations and monitors the glow plug. If GCU detects a problem, it sends the result to ECU.

(1) Characteristics of temperature and current in AQGS

1. AQGS unit increases the glow plug temperature very rapidly (1,000°C in 2 seconds).
2. FET (similar to transistor) for each cylinder in AQGS unit pre-heats the glow plug.
3. If the glow plug temperature reaches to target temperature, the temperature is controlled by duty ratio.

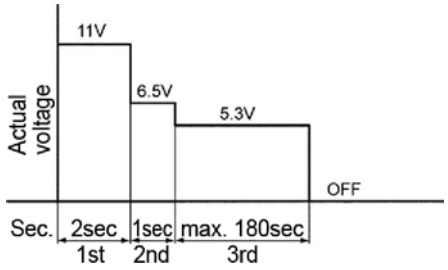
AQGS PWM Control



Frequency: 20~33Hz
PWM Control duty ratio
- 1st step: 100%
- 2nd step: 35%
- 3rd step: 23%

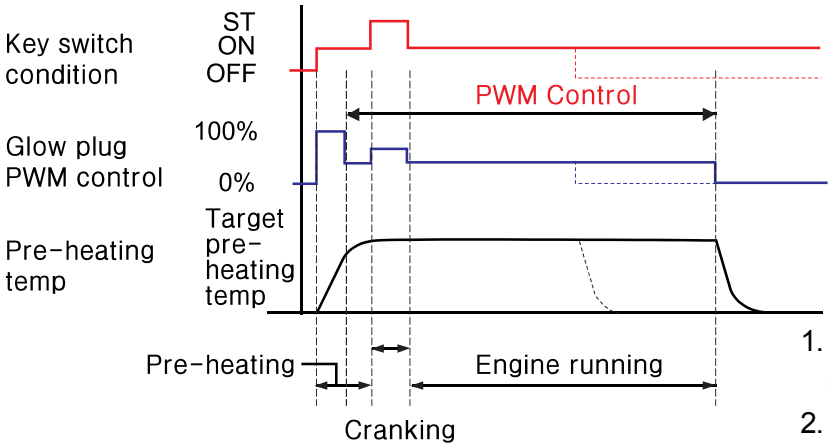
AQGS unit supplies the power to glow plug.

Actual voltage pattern



This shows the voltage and time supplied by AQGS by steps. As shown on the graph, the supplied voltage is decreased as the steps are continued. The 3rd step is to keep the temperature, not to raise it.

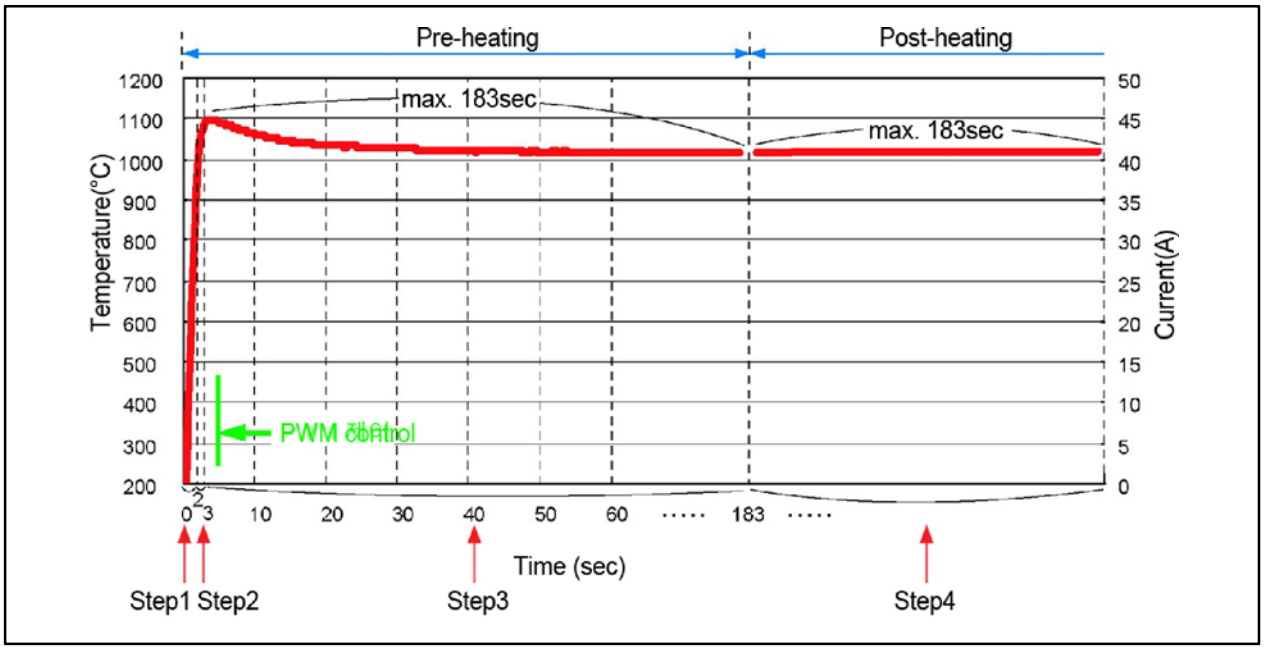
(2) Operation of AQGS



1. Duty control area:
   Between 5 and 100%
2. Frequency: 20 Hz
3. Duty ratio = $\frac{(\text{RMS voltage})^2}{(\text{Battery voltage})^2}$

Modification basis	
Application basis	
Affected VIN	

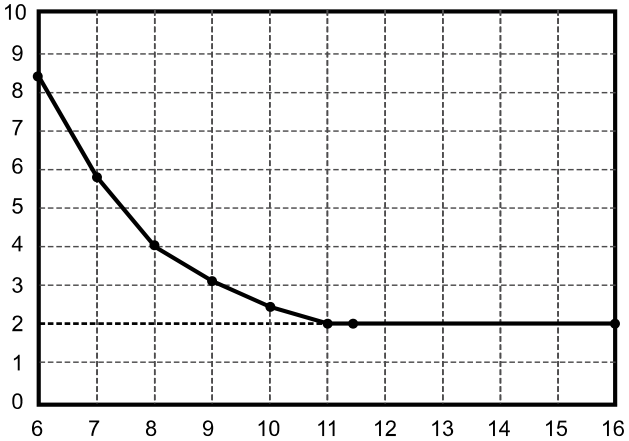
(3) Operating Steps



▶ Pre-Glow: Step 1

If normal communication with the ECU is established 2 seconds after the power is supplied to the IGN terminal from the battery, the GCU supplies the battery power to raise the temperature of the glow plug to 1000℃ by the preheating request from the engine ECU before starting.

- The time for pre-heating is controlled by the ECU.



Input voltage VB (V)	Pre-heating time T1 (sec)
6	8.27
7	5.8
8	4.1
9	3.15
10	2.4
11	1.95
≥ 11.5	1.9

- If the input voltage (VB) is 11.5 V or less, GCU supplies the battery voltage for preheating time (T1). If the input voltage (VB) is greater than 11.5 V, GCU supplies the voltage of 11.5 V for preheating time
- (T1).

NOTE

The preheating time may vary according to the conditions.

▶ **During cranking: Step 2 and step 3**

1. Step 2: If the ECU receives the cranking signal after pre-heating (step 1), the GCU supplies the voltage of 6.8 V for 1 sec to raise the temperature to 1,100℃.
2. Step 3: The GCU supplies the voltage of 5.1 V to keep the temperature at 1,000°C.
   * Under fixed temperature: The AQGS unit supplies power for 30 seconds (Step 1 + Step 3) if no cranking signal is received after the step 1.
   * During cranking: The step 3 is started after the step 2.

▶ **Post-glow: Step 4:**

The post-heating is for reducing HC/CO after the engine is started. If the time for post-heating exceeds 180 sec., the GCU unit cuts off the power to each glow plug even if there is preheating request from the engine ECU.

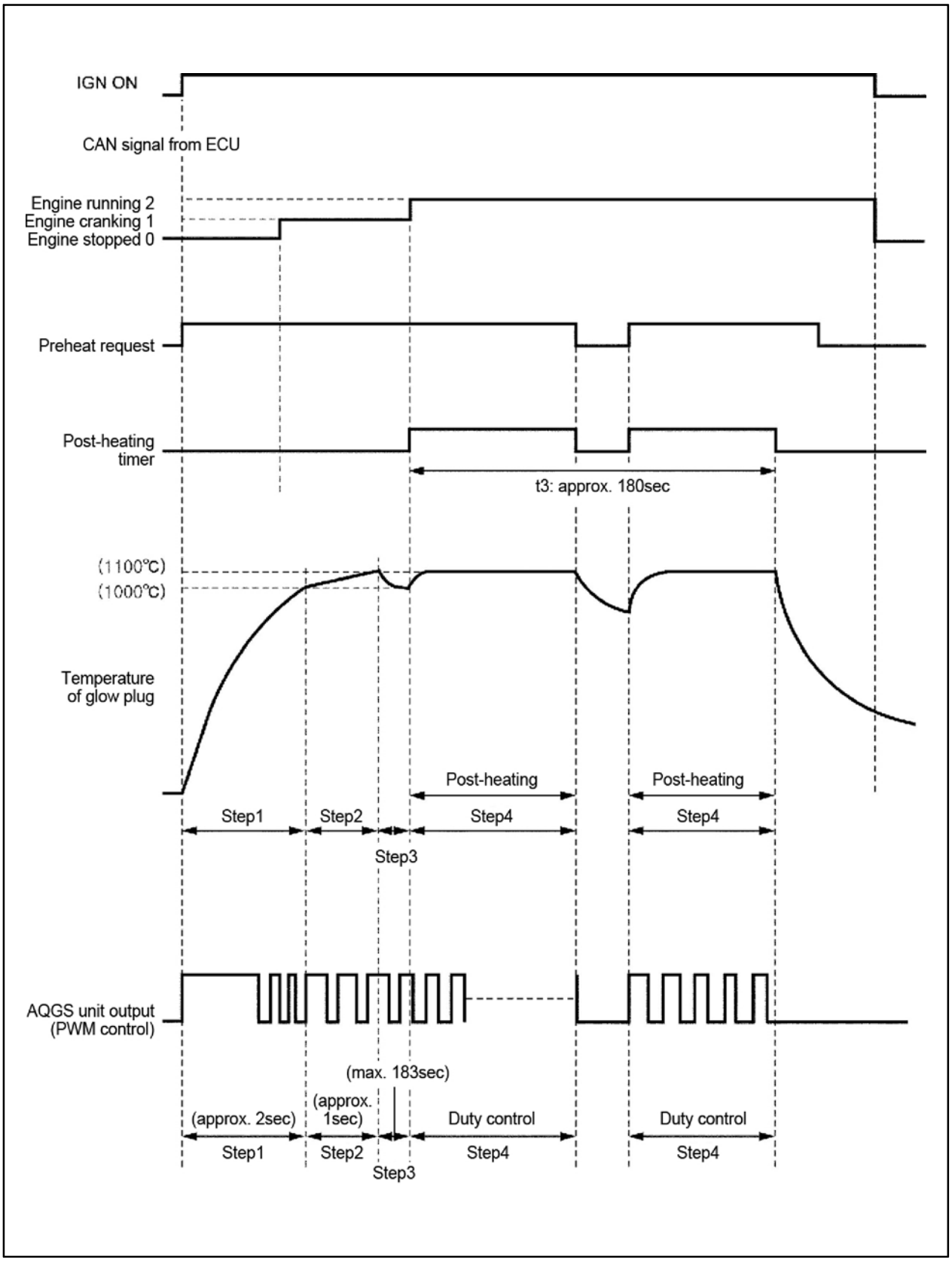
▶ **Emergency glow**

If no CAN signal is received for 4 seconds from the engine ECU after the IGN ON signal is input, the GCU performs emergency preheating (Step 3) for 30 seconds.

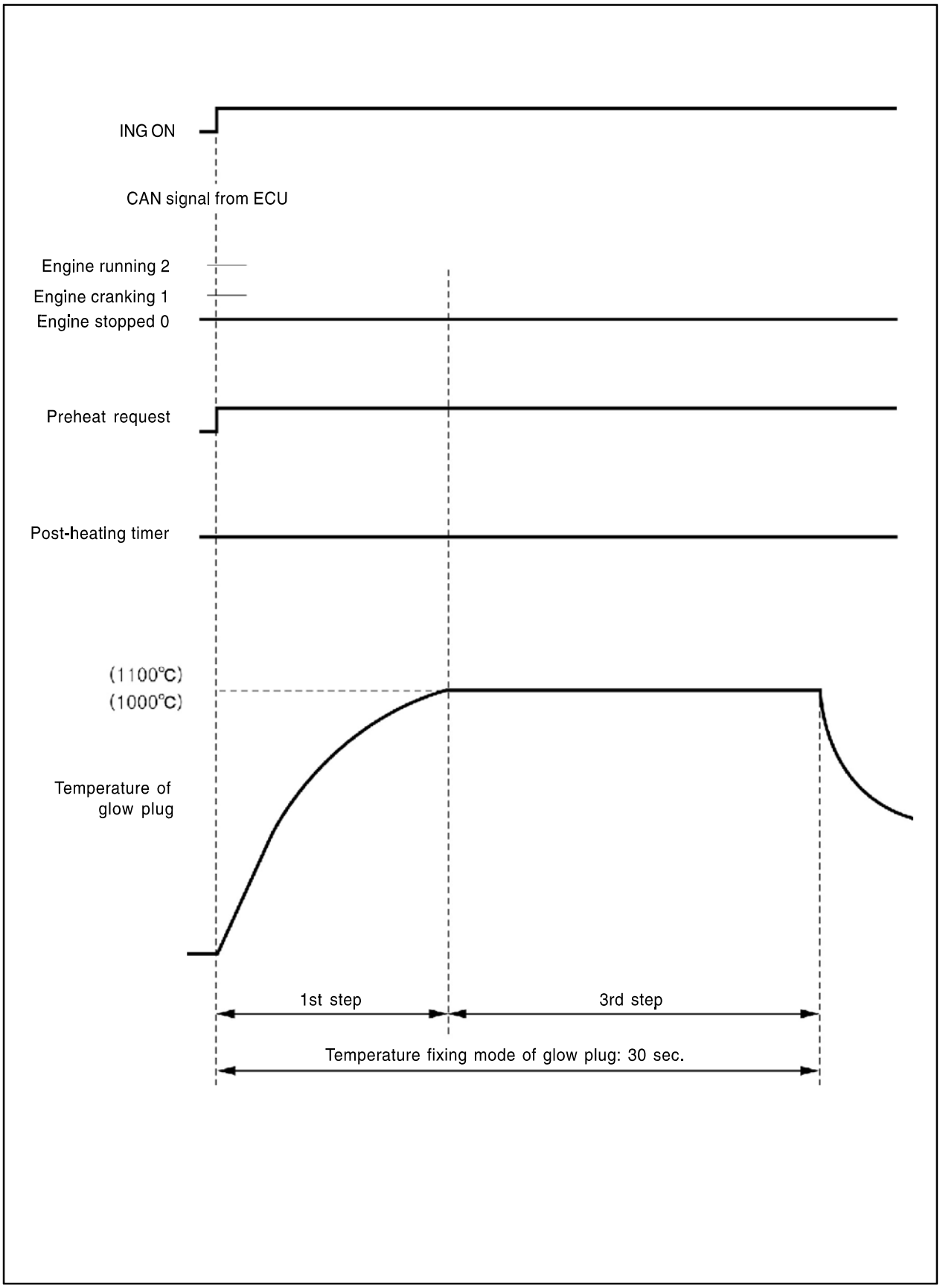
Modification basis	
Application basis	
Affected VIN	

▶ Normal operating mode

This shows the components of preheating system in the pre-heating and the post-heating steps.



▶ **When there is no engine cranking signal after turning the ignition key ON**



Modification basis	
Application basis	
Affected VIN	

STARTING SYSTEM

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Capacity	12V 2.3kW
Engagement	Meshed type
Rotating direction	Clockwise
Pinion gear manufacturing	Cooled forging
Solenoid operating voltage	Max. 8 V
Weight	2.5 kg
Bracket manufacturing	Aluminum die casting

2. TROUBLESHOOTING

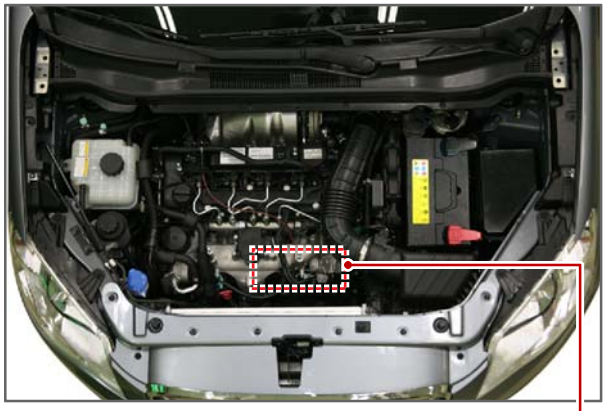
Problem	Possible Cause	Action
Engine will not crank	Low battery voltage	Charge or replace
	Loose, corroded or damaged battery cable	Repair or replace
	Faulty starter or open circuit	
	Faulty ignition switch or blown fuse	Repair or replace
	Poor engine ground	Repair
Engine cranks too slow	Low battery voltage	Charge or replace
	Loose, corroded or damaged battery cable	Repair or replace
	Faulty starter	
Starter does not stop	Faulty starter	
	Faulty ignition switch	Replace
Engine cranks normally, but does not start	Broken pinion gear or faulty starter	Replace the starter
	Broken flywheel ring gear	Replace
	Open circuit	Repair

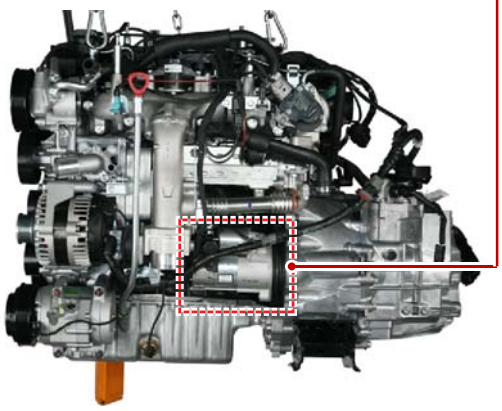
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

The starter (start motor) starts the engine with rotational power by converting the electric energy to the mechanical energy.
When the engine is cranking, the pinion gear meshes with the ring gear. If the ring gear overruns, the pinion gear clutch overruns to protect the pinion gear.

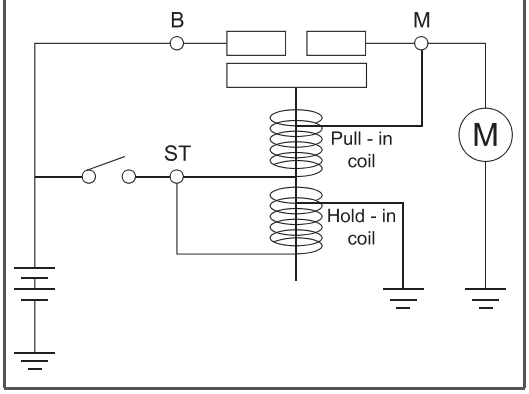
▶ System Configuration





Start motor assembly





2. OPERATING PROCESS

1) System Layout

(1) Engine start

1. SKM performs the authentication process for the SMART key and sends the engine start request to EMS if there is a normally coded SMART key when pressing the Engine Start/Stop button with the brake pedal depressed and gear shift lever in "P" or "N" position.
2. SKM sends the start request signal to PCAN network and the cranking request to BCAN network by "SMART key location" signal when receiving the engine start signal by Engine Start/Stop button.
3. SKM turns off the IGN2/ACC relay during cranking to shut down the electric loads.
4. SKM receives the starting status signal from EMS throug PCAN.
5. After cranking, SKM turns on the ACC/IGN2 relay and sends the power status signal of "IGN after started" through BCAN.
6. EMS starts to crank the engine after checking the pre-heating condition if it receives the engine cranking request 1 when pressing the Engine Start/Stop button. EMS starts to crank the engine immediately if it receives the engine cranking request 2 when pressing the Engine Start/Stop button.

   - Engine cranking request 1: when pressing the Engine Start/Stop button shortly in normal conditions
   - Engine cranking request 2: when pressing the Engine Start/Stop button again after first press or when pressing the Engine Start/Stp button for more than 3 seconds

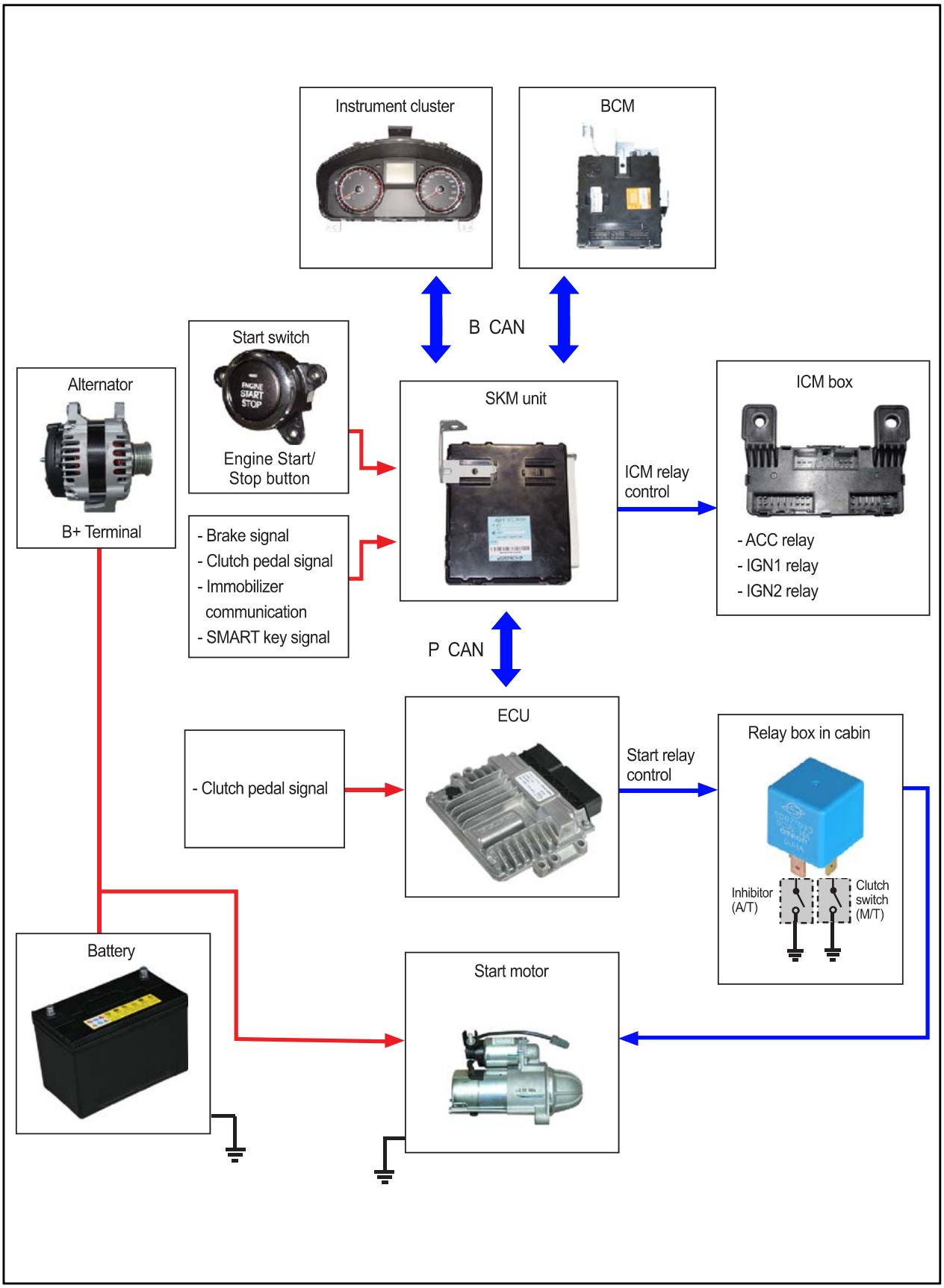
7. Engine start during driving
   - When pressing the Engine Start/Stop button with IGN ON, the engine start is requested if the vehicle speed is less than 10 km/h or no signal, the gear shift lever is in 'N" position and the brake switch is ON (no need authentication for 30 seconds).
   - When pressing the Engine Start/Stop button with IGN ON, the engine start is requested regardless of brake signal if the vehicle speed is over 10 km/h and the gear shift lever is in ' position (no need authentication for 30 seconds).

   * Except input of brake switch signal

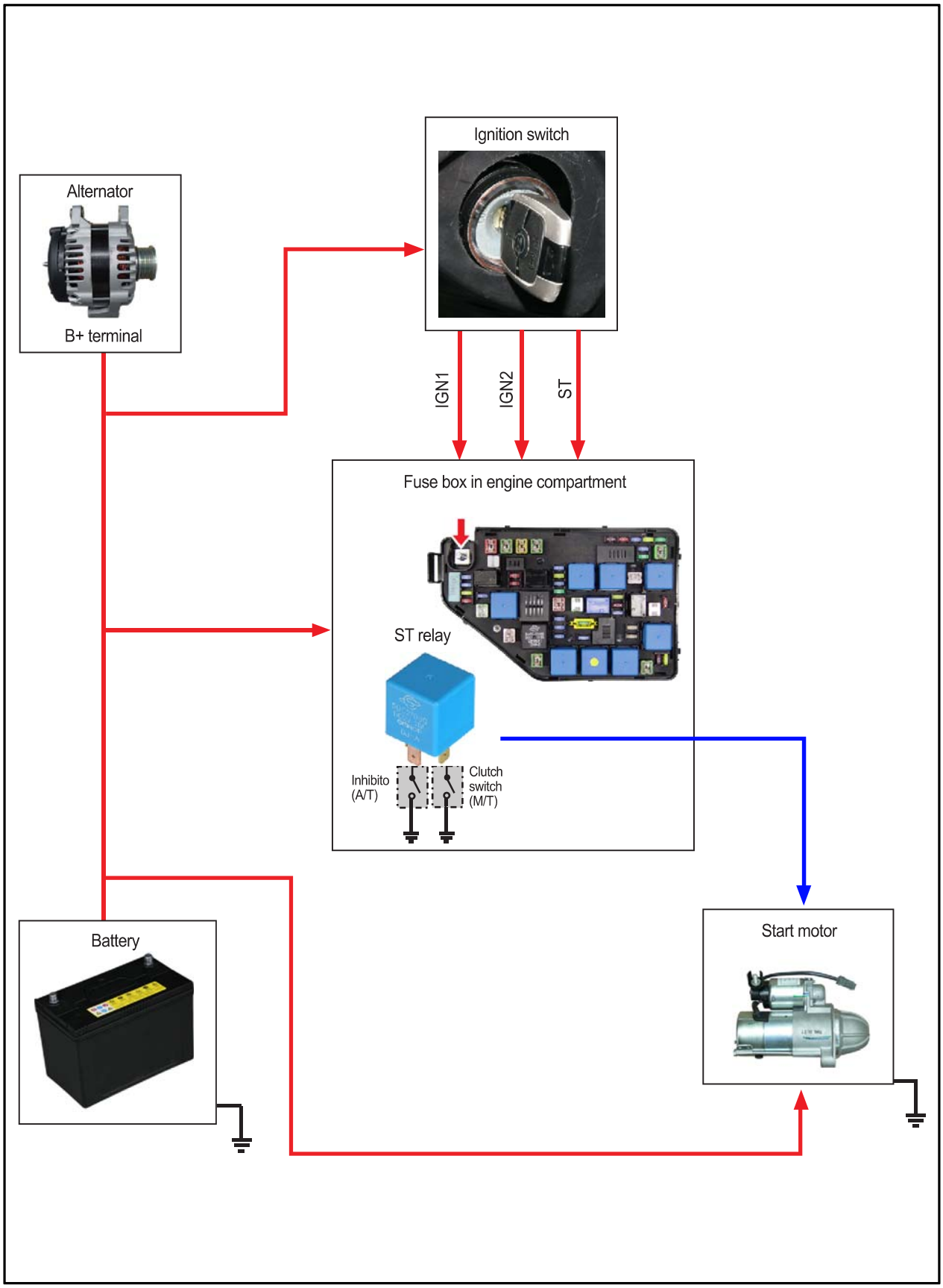
   - In vehicle equipped with A/T, when pressing the Engine Start/Stop button for more than 10 seconds with ACC ON, the engine start is requested regardless of brake signal if the gear shift lever is in "P" or 'N" position in IGN ON.

Modification basis	
Application basis	
Affected VIN	

(2) With SMART key system



(3) Without SMART key system

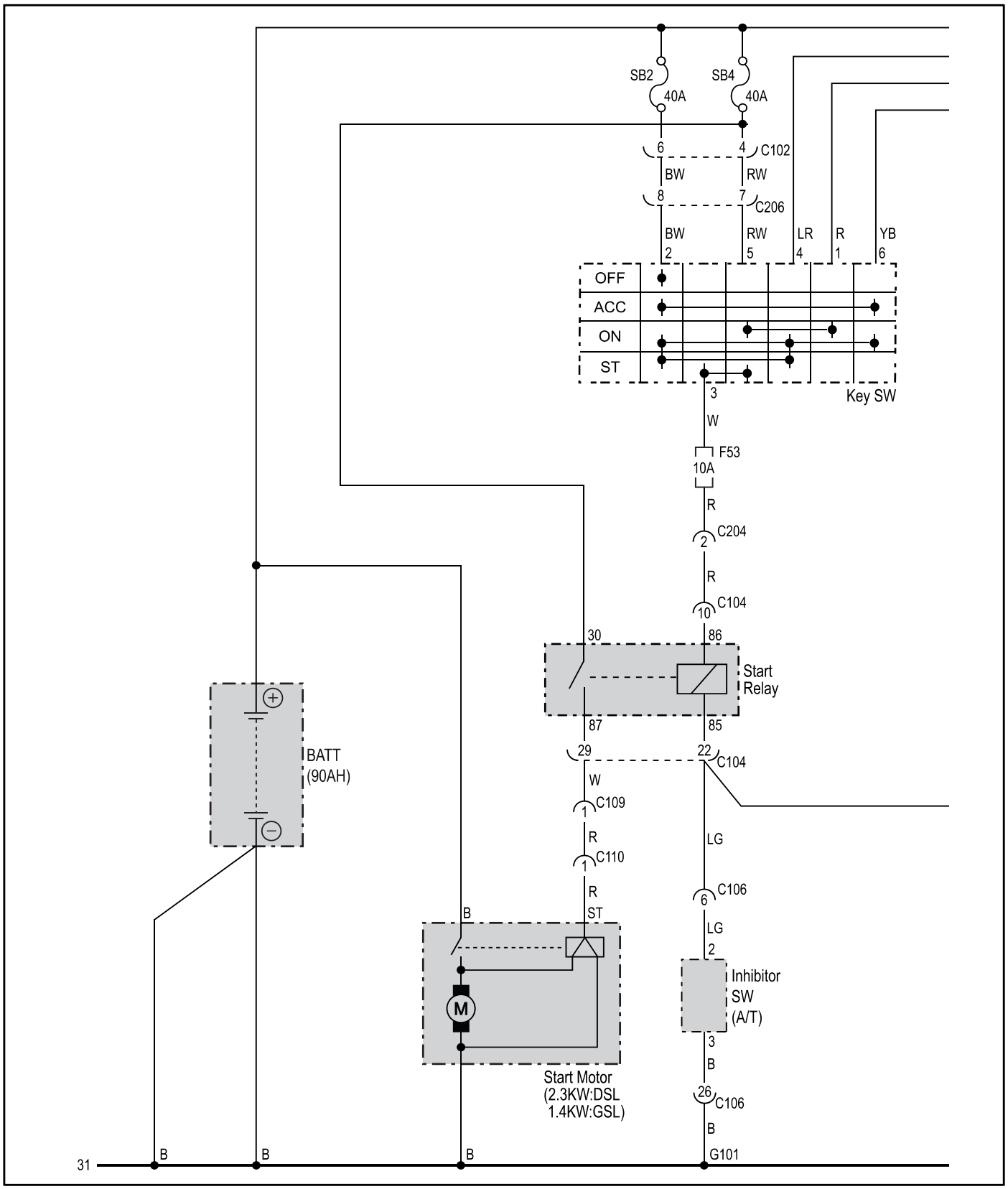


Modification basis	
Application basis	
Affected VIN	

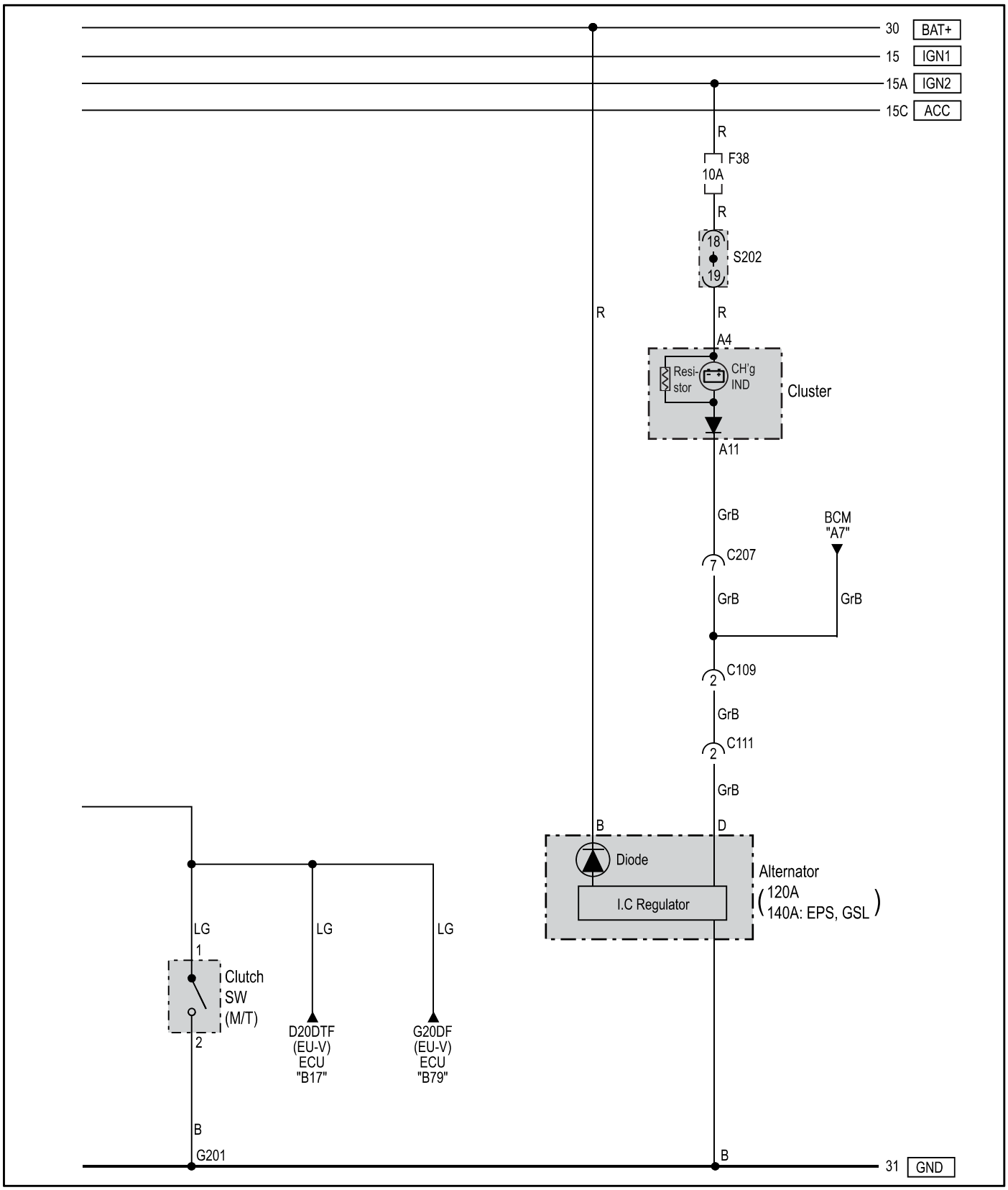
Memo

2) Circuit Diagram

(1) With SMART key system

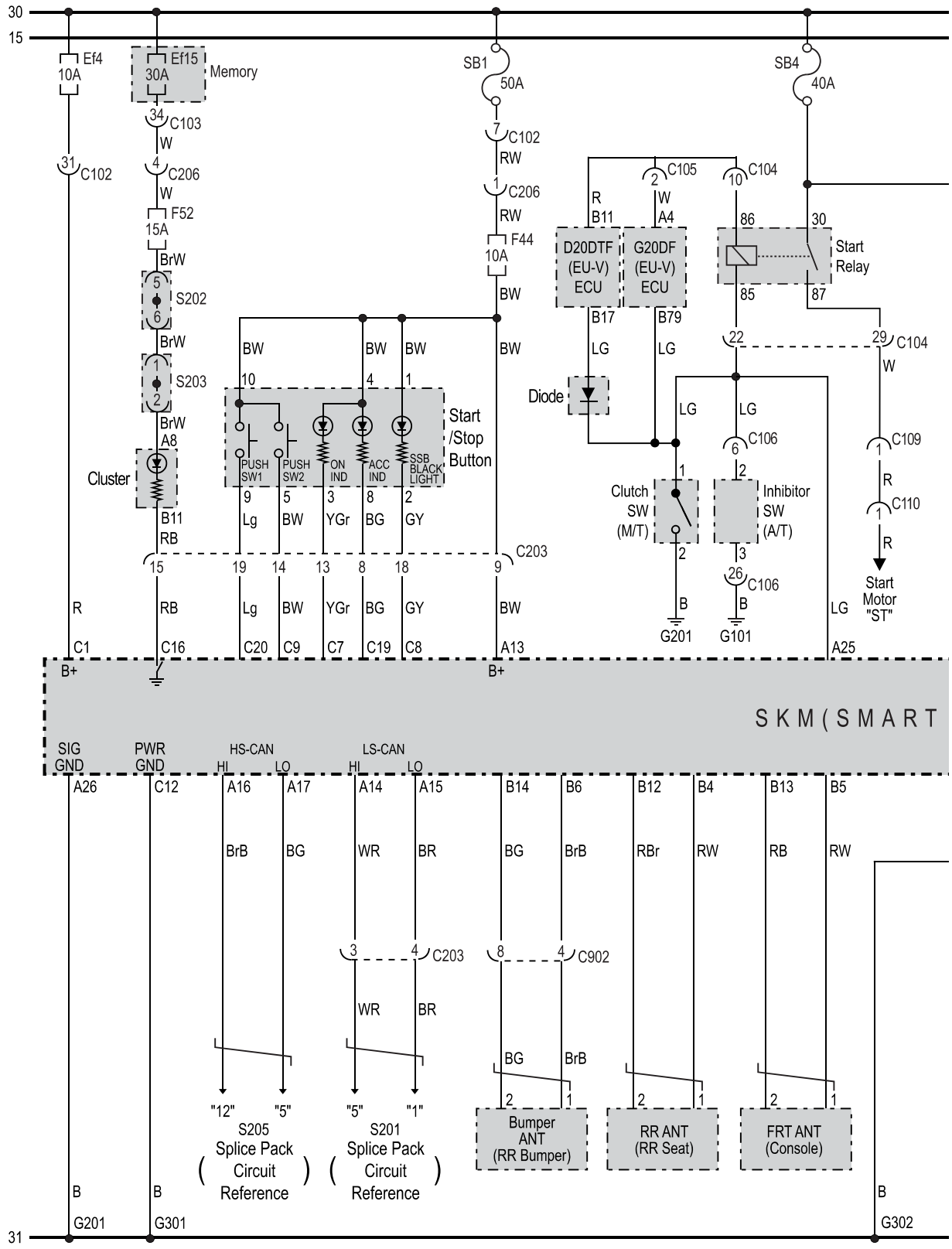


Modification basis	
Application basis	
Affected VIN	

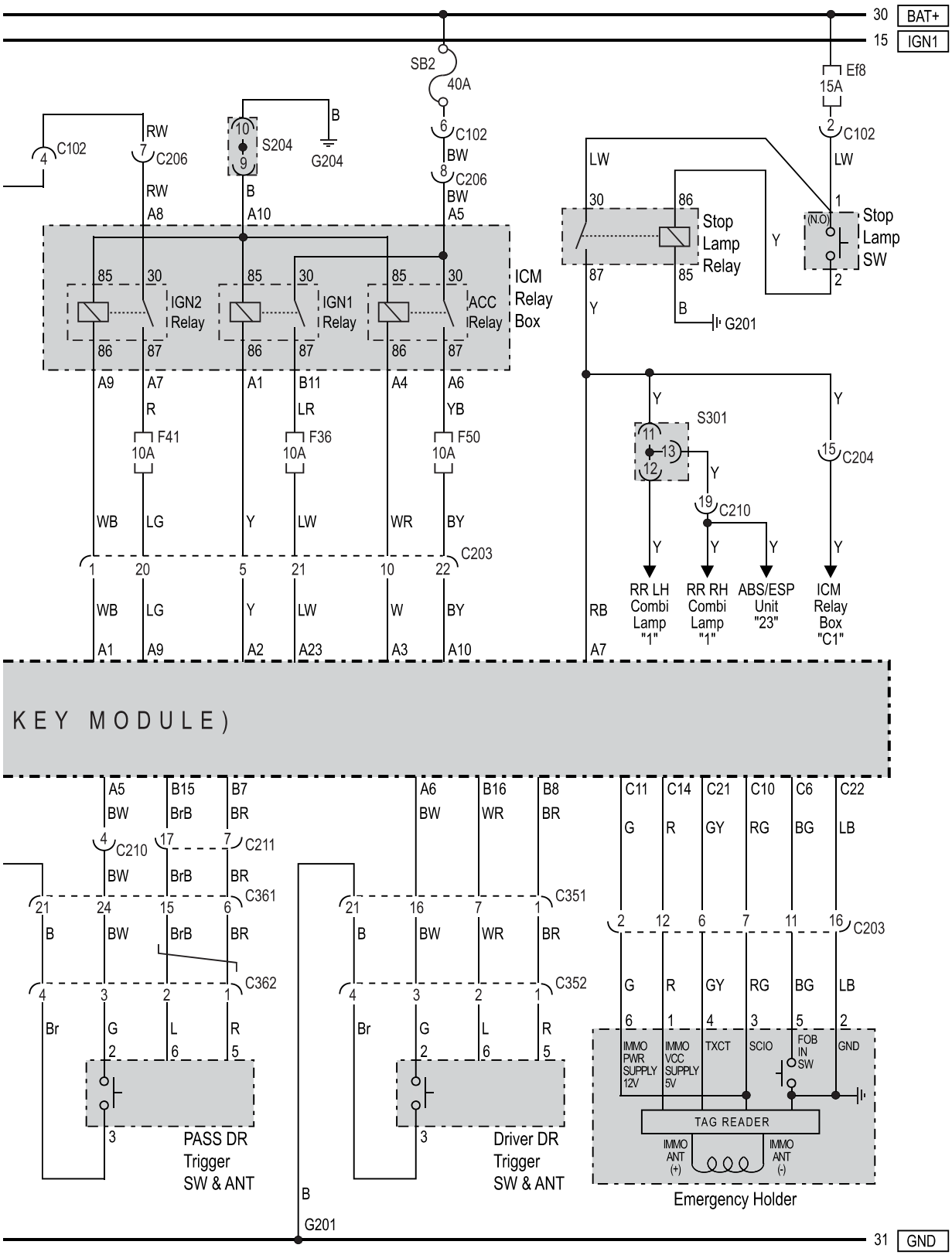


Modification basis	
Application basis	
Affected VIN	

(2) Without SMART key system



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL

0000-00

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

1) System Description



The cruise control is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal.
The vehicle speed must be greater than 38 km/h to engage the cruise control. This feature is especially useful for motorway driving.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

2) Traffic Conditions for Using Cruise Control

Use the cruise control system only when the traffic is not jammed, driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

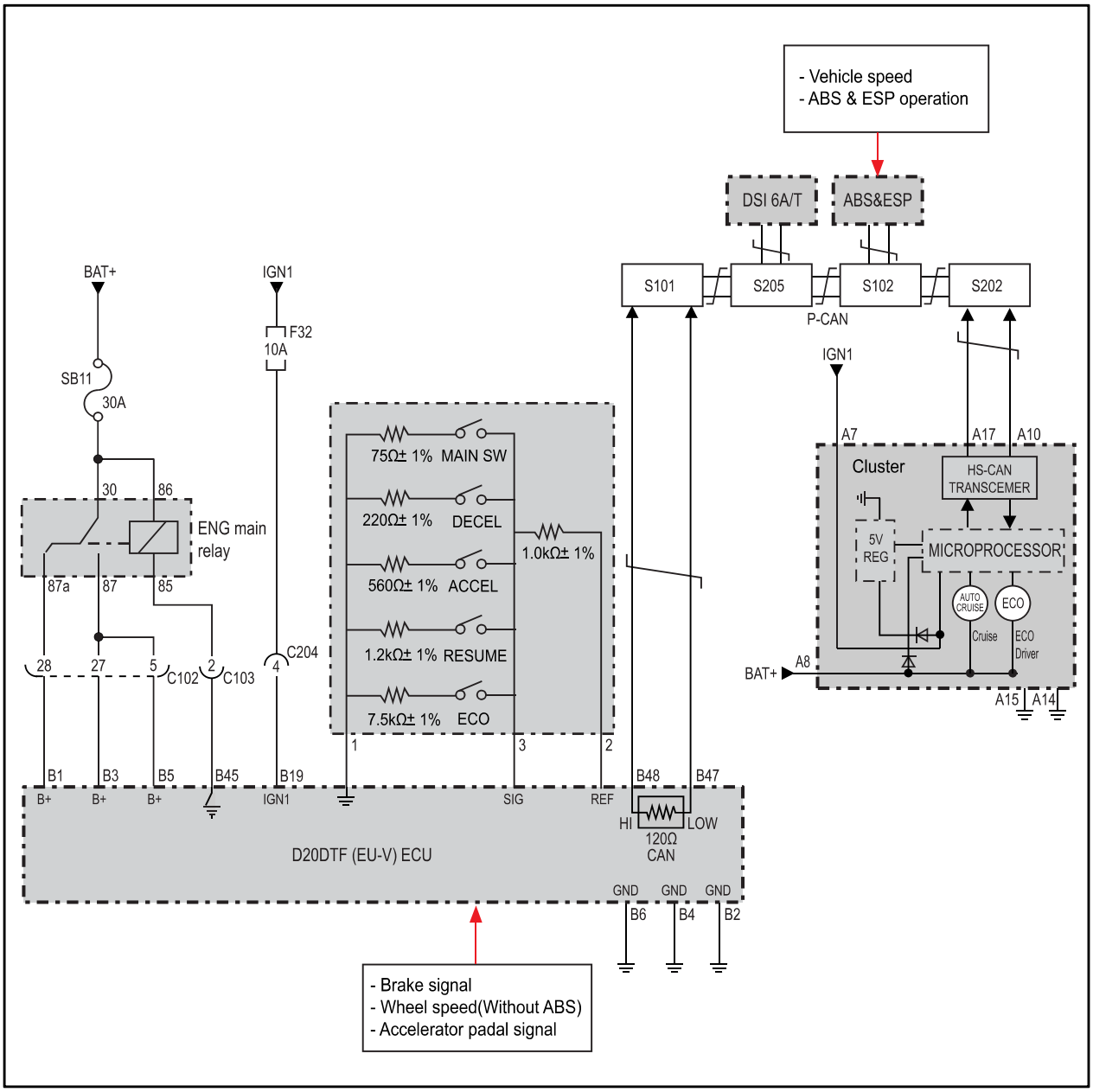
Improper use of the cruise control could be dangerous.

- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.
  This could result in a loss of control, collision, and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

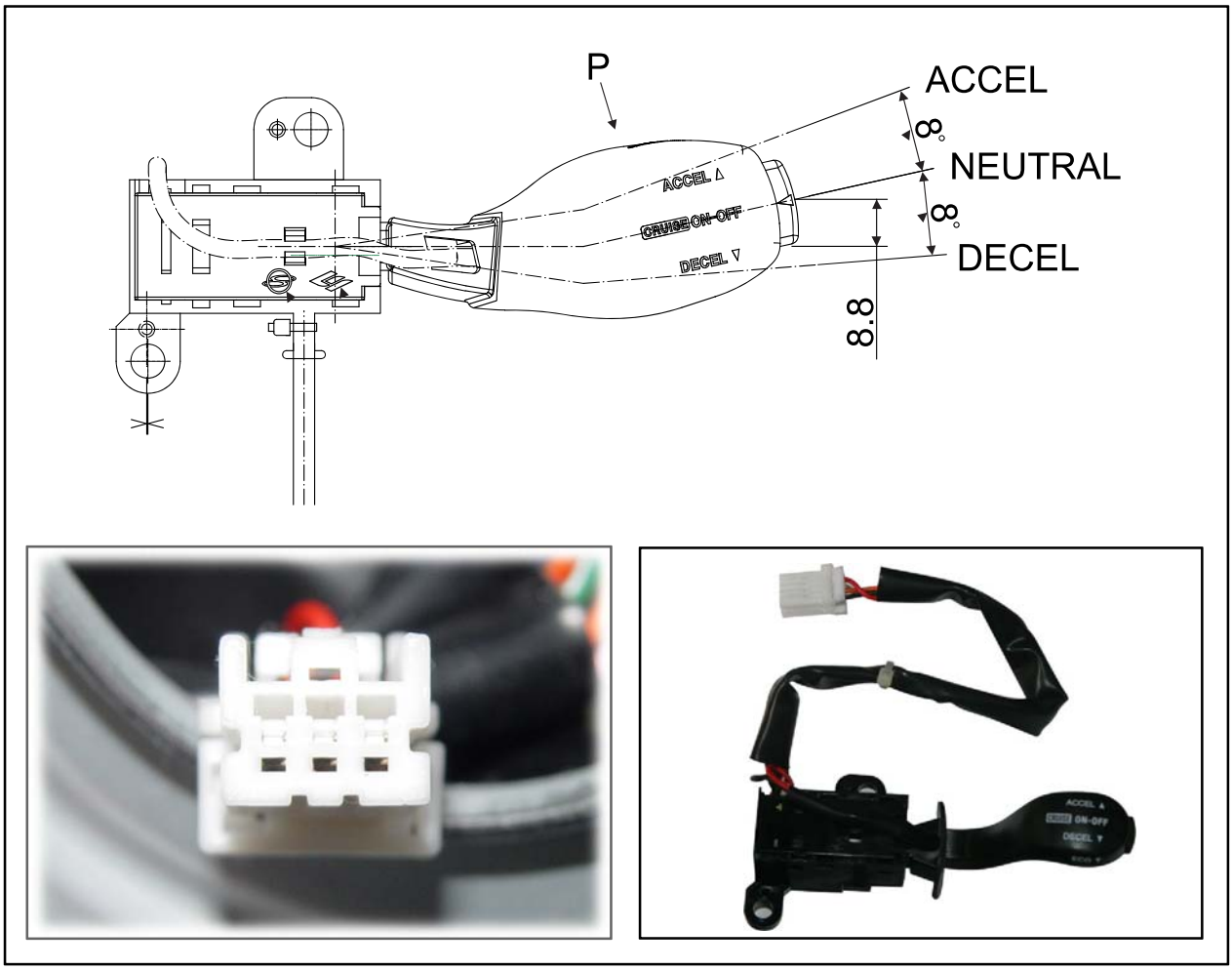
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Components



Test voltage(VCC 5V)

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-
ECO	4.22 ~ 4.82V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate the vehicle speed to the operating range.
   * Operating range: - 38 km/h ~150 km/h
   - higher than 3rd gear (M/T)
2. To set the desired speed, push up ACCEL switch or push down DECEL switch of the cruise control lever when the vehicle speed is in the operating range,.
3. Now, the vehicle is cruised by this system with the set speed. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

2) Accelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push up the ACCEL switch of the cruise control lever and hold it until the desired speed is reached without an accelerator pedal intervention.
2. When the desired speed is reached, release the lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate using the accelerator pedal over 38 km/h.
2. Push up the ACCEL switch of the cruise control lever and hold it. And then release the accelerator pedal slowly.
3. When the desired speed is reached, release the lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the ACCEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-up switching. When you operate a tap-up switching, the vehicle is accelerated for 1 km/h over the previous set speed.
   If you want to accelerate for 10 km/h, operate the tap-up switching ten times without accelerating with
2. the cruise control system.

Modification basis	
Application basis	
Affected VIN	

3) Decelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push down the DECEL switch of the cruise control lever and hold it until the desired speed is reached without a brake pedal intervention. But the cruise control system cannot maintain the cruise function at less than 38 km/h.
2. When the desired speed is reached, release the lever.

(2) When the cruise control system is not running

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 40 km/h.
2. And then release the accelerator pedal slowly.
3. When the desired speed is reached, release the lever. But the cruise control system cannot maintain the cruise function at less than 38 km/h.

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push down the DECEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-down switching. When you operate a tap-down switching, the vehicle is decelerated for 1 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the brake
2. pedal intervention.

4) Recovery of Set Speed (RESUME)



Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pulling up the cruise control lever when the current vehicle speed is over 38 km/h without an acceleration intervention. But if you turn off the ignition switch, the memorized set speed is cleared and you cannot recover the previous set speed.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

Modification basis	
Application basis	
Affected VIN	

5) ECO Cruise Control



The ECO cruise control system has nearly same functions with the auto cruise control system. It is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal.

ECO cruise driving mode

- The engine ECU controls the sharp acceleration and deceleration to improve the fuel economy.
- The ECO cruise system is ready when pushing down the cruise control lever. At this moment, the ECO indicator on the instrument cluster comes on.
- The ECO cruise system operates when pulling up the cruise control lever.
- To cancel the ECO cruise driving, push doen the cruise control lever. At this moment, the ECO indicator on the instrument cluster goes off and the auto cruise starts to operate.

Control lever	ECO indicator	
	ON	Blinking
Push down the lever	O	
Push down it again		O

6) Normal Cancellation of the Cruise Control



The cruise control system will be canceled when one or more items of the following conditions are applied;

1. When the brake pedal is depressed.
2. When the cruising speed is downed less than 38 km/h.
3. When pushing the ON-OFF switch of the cruise control lever.
4. When ESP is activated.
5. When applying the parking brake when driving.
   When using the clutch in order to shift (M/T only).
   And the cruise control system can be operated again in driving state.

CAUTION

Keep the main cruise control switch in the neutral position when not using the cruise control.

Modification basis	
Application basis	
Affected VIN	

(1) Abnormal Cancellation of the Cruise Control

1. Sharp acceleration or deceleration
   - 50 km/h faster than set speed
   - 25 km/h faster than set speed for one minute
   - 70 km/h slower than set speed
   - 65 km/h slower than set speed for 3 minutes
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

E-EGR SYSTEM

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GENERAL INFORMATION

1. SPECIFICATION

Item			
E-EGR valve	Motor	EGR response time	50 mS
		Driven by	DC motor
	Valve	EGR gas flow rate	120 Kg/h
	Position sensor	Sensing type	Hall sensor
		Supply voltage	5V ± 10%
		Signal range	5% ~ 95%
		Max. current consumption	< 15mA
E-EGR cooler		Cooling capacity	8.3 kW or more
		Coolin fin type	Wavy fin
		Coller type	U-shaped
E-EGR bypass valve	Solenoid valve	Drivien by	Vacuum (Solenoid valve)

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

The EGR (Electric-Exhaust Gas Recirculation) valve reduces the NOx emission level by recirculating some of the exhaust gas to the intake system.
To meet Euro-V regulation, the capacity and response rate of E-EGR valve in D20DTF engine have been greatly improved. The EGR cooler with high capacity reduces the Nox, and the bypass valve reduces the CO and HC due to EGR gas before warming up.
Also, the engine ECU adjusts the E-EGR opening by using the air mass signal through HFM sensor. If the exhaust gas gets into the intake manifold when the EGR valve is open, the amount of fresh air through HFM sensor should be decreased.

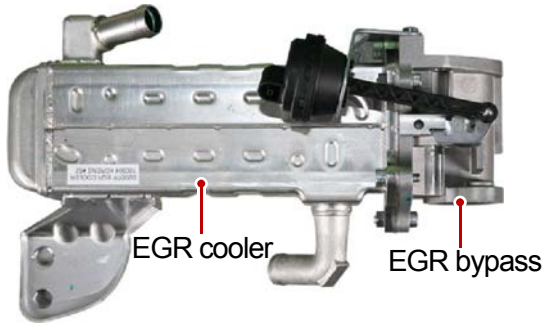
▶ **Benefits of E-EGR valve**

- Improved accuracy and response through electric control
- Feedback function (Potentiometer)
- Preventing chattering of EGR valve and improved durability
- Self-cleaning function

Modification basis	
Application basis	
Affected VIN	

2) Location and Components

E-EGR cooler and bypass valve

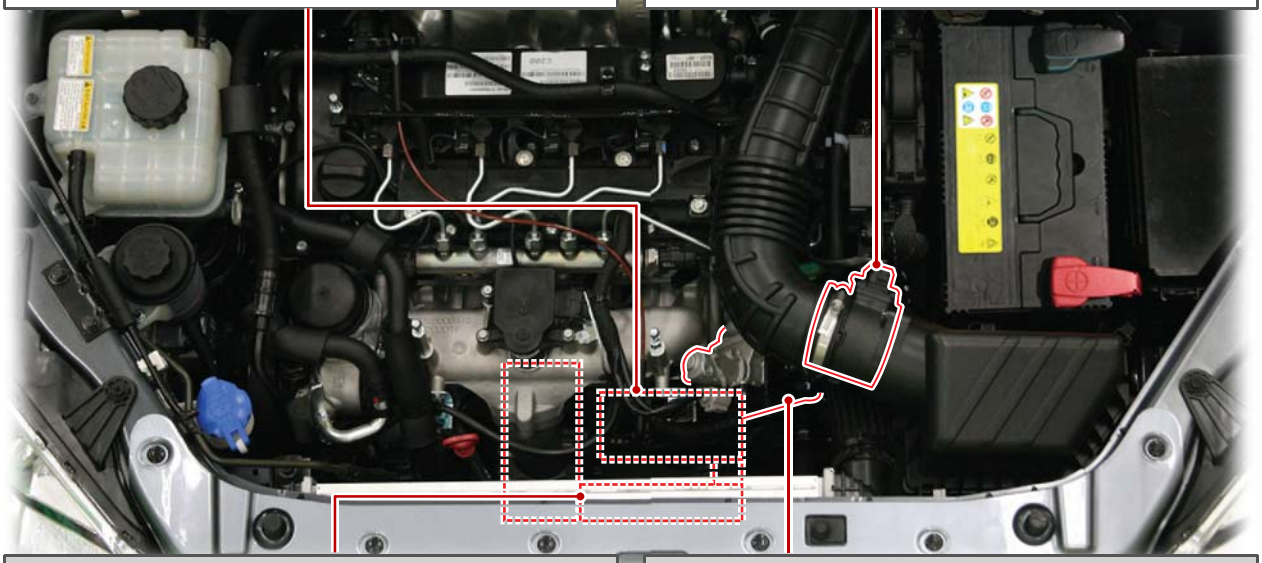


The cooler lowers the high temperature of the exhaust gas and the bypass valve directly supplies the exhaust gas to the intake duct without passing through the EGR cooler to reduce the emission of exhaust gas before warming up the engine.

HFM sensor



Used as a main map value to control the EGR. The coolant temperature, engine rpm, engine load, intake air temperature (HFM: decreased at 60°C or more), atmospheric pressure (atmospheric pressure sensor: altitude compensation) are used as auxiliary map values.



EGR pipe



Transports the exhaust gas from the EGR cooler and EGR bypass valve to the intake duct.

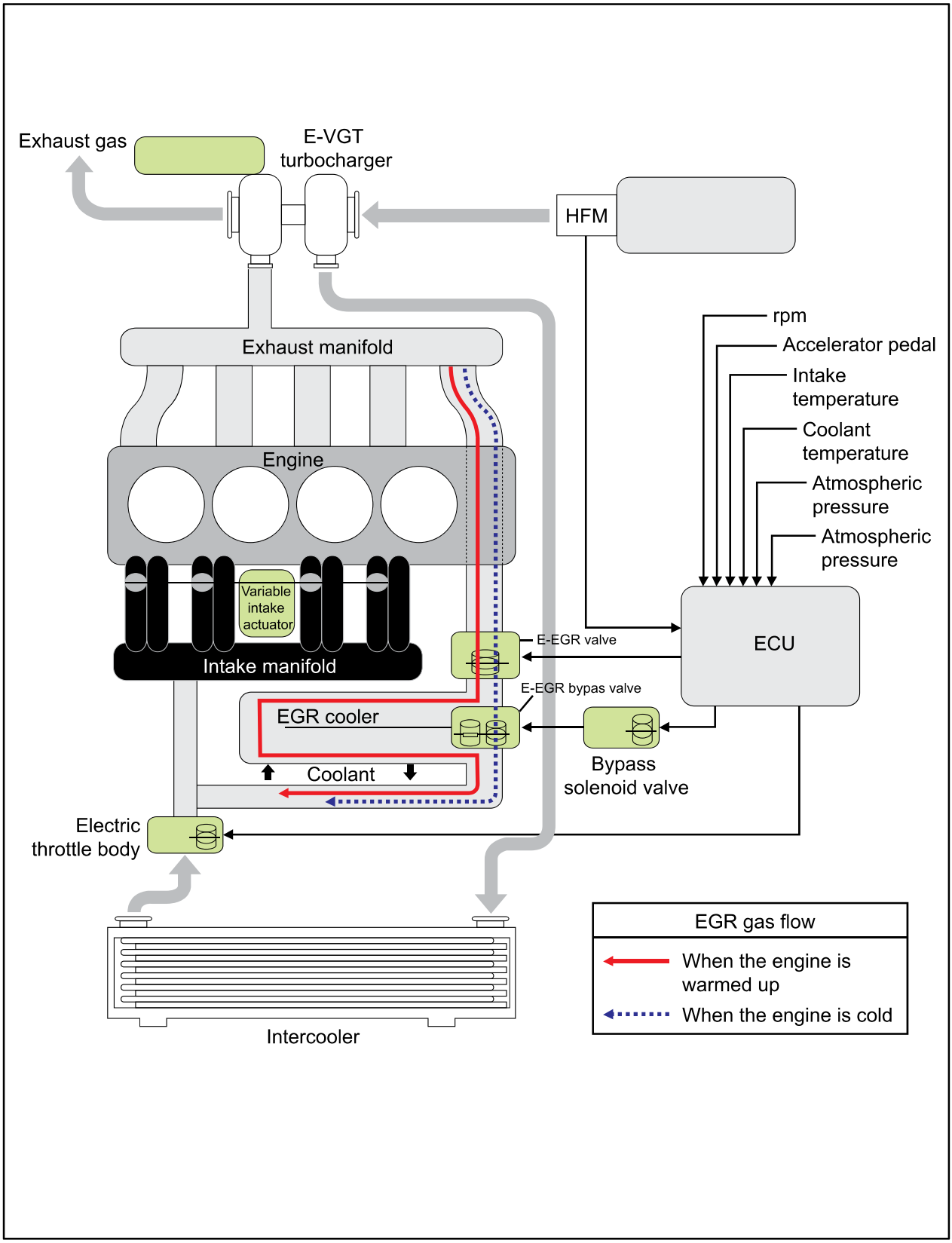
E-EGR valve



Receives the electric signal from the ECU to control the valve.

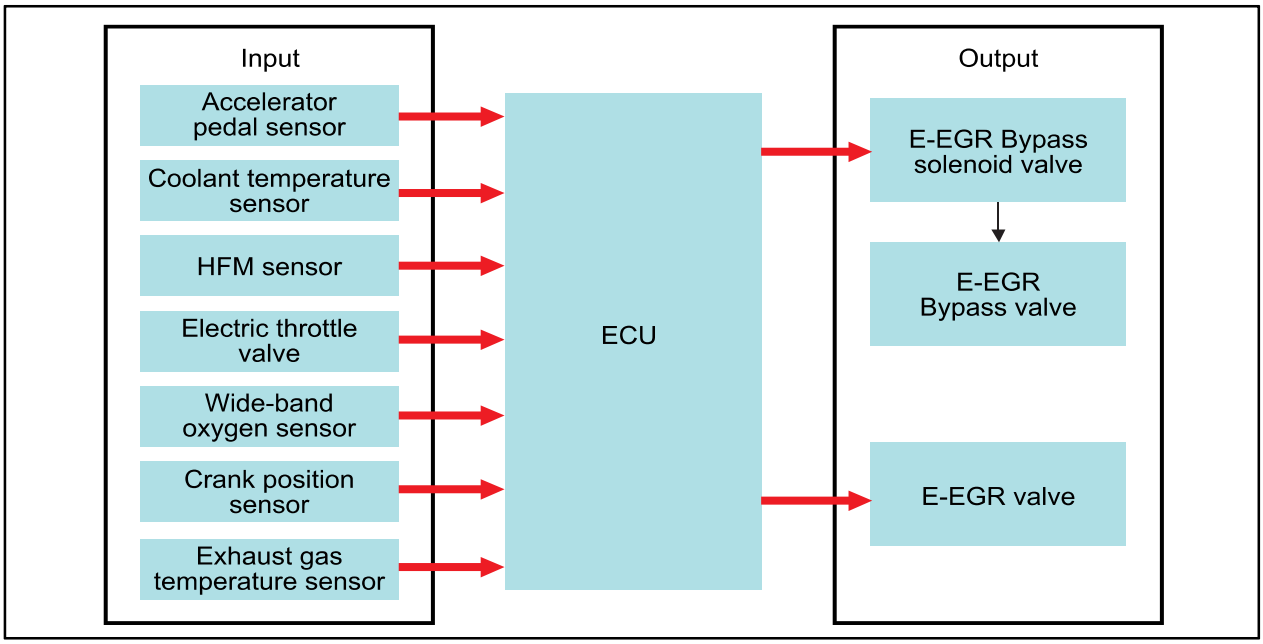
2. OPERATING PROCESS

1) Schematic Diagram



Modification basis	
Application basis	
Affected VIN	

2) Input/Output Devices



3) Control Logic

The EGR system controls the EGR amount based on the map values shown below:

※ Main map value: Intake air volume

※ Auxiliary map value:

- Compensation by the coolant temperature
- Compensation by the atmospheric pressure: Altitude compensation
- Compensation by the boost pressure deviation (the difference between the requested value and the measured value of boost pressure)
- Compensation by the engine load: During sudden acceleration
- Compensation by the intake air temperature

The engine ECU calculates the EGR amount by adding main map value (intake air volume) and auxiliary map value and directly drives the solenoid valve in the E-EGR to regulate the opening extent of the EGR valve and sends the feedback to the potentiometer.

(1) Operating conditions

- Intake air temperature: between −10 and 50℃
- Atmospheric pressure: 0.92 bar or more
- Engine coolant temperature: between 0 and 100°C
- When there is no fault code related to EGR

(2) Shut off conditions

- Abrupt acceleration: with engine speed of 2600 rpm or more
- When the engine is idling for more than 1 minute
- Vehicle speed: 100 km/h or more
- Engine torque: 380 Nm or more

CDPF SYSTEM

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GENERAL INFORMATION

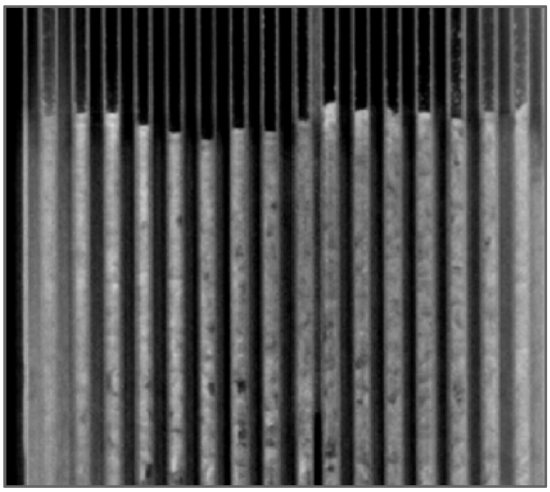
1. SPECIFICATION

Emission Regulation		Euro-V
Front Area		182.41cm
Size	DOC	124 X 158 X 78L
	DPF	124 X 158 X 194L
CDPF Canister	Shell	SUS430J1L X 1.5t
	End Cone	SUS430J1L X 2.0t (Single)
CDPF	Catalyst Capacity	4.2L
	Material of Filter	AT (Aluminum-Titanium Alloy)

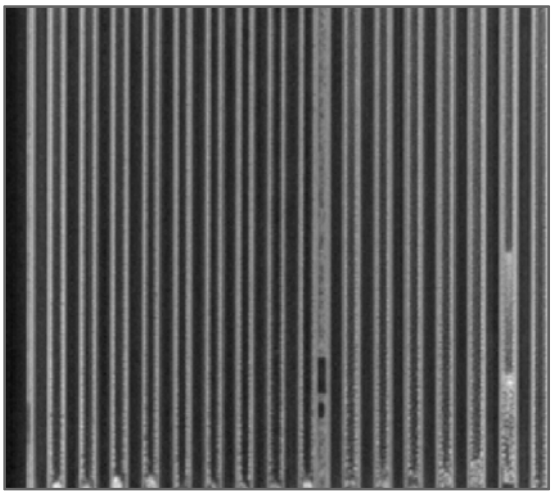
2. CAUTIONS

▶ **Standard pattern of soot accumulation**

(1) Abnormal Soot Accumulation



(2) Normal Soot Combustion



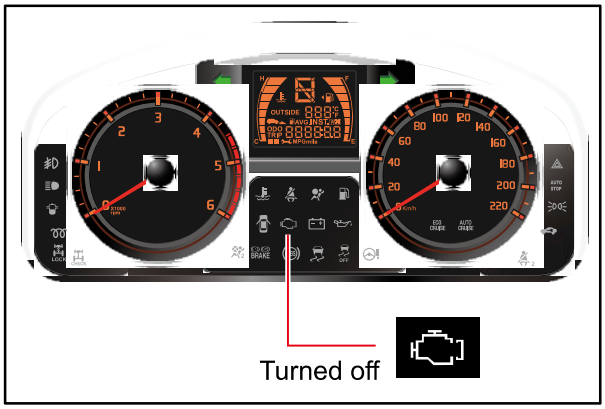
▶ **Cautions to protect the catalyst filter**

- Use the designated fuel only.
- Observe the recommended service intervals of engine oil.
- Check the engine oil level frequently and add if necessary.
- Do not idle the vehicle unnecessarily.
- Do not turn off the engine while the vehicle is running.
- Do not shift the gear selector lever to neutral when going downhill.
- Do not use improper engine oil or fuel additives.
- Do not drive for a long time when the warning lamp is illuminated.
- Make sure no flammable material, such as dry grass or tissue paper, contacts with the catalyst filter while the vehicle is parked.
- For the vehicles used in urban traffic, driving on the expressways for more than 1 hour at least once per week is needed so that the PM inside CDPF isn't collected to one side only.

Modification basis	
Application basis	
Affected VIN	

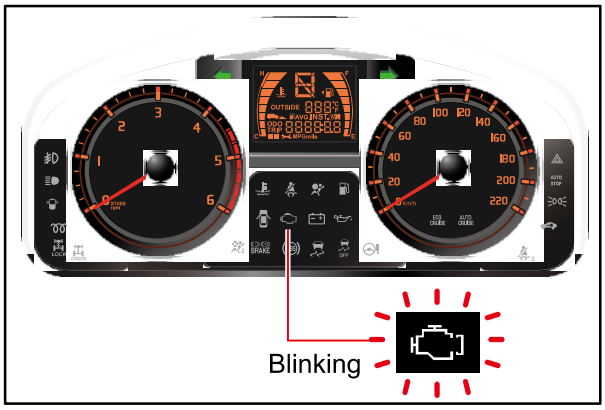
(3) Warning Lamp Related to CDPF

▶ CDPF regeneration process (warning lamp NOT illuminated)



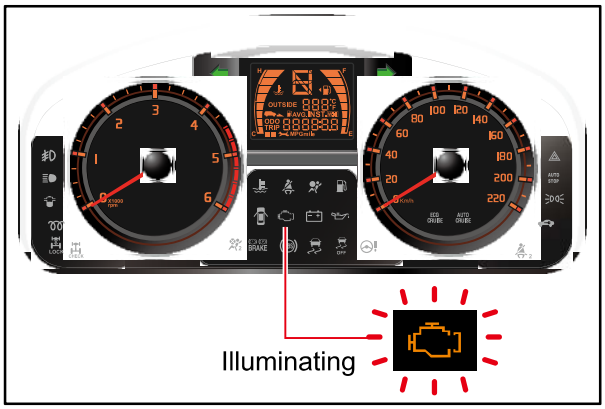
The CDPF system enters the regeneration mode when the driving distance becomes approx. 600 to 1,200 km (may differ by the driving condition and driving style). Then, the engine ECU performs the CDPF regeneration operation. However, the driver is not informed with this operation by any engine warning lamp or vehicle signal, so he/she may not detect this operation. The control logic at the post-injection dur-ing the regeneration process is to increase the fuel injection volume and control the intake air volume (by the throttle body) in order to increase the temperature of the exhaust gas. The driver may not feel any particular difference from the vehicle.

▶ Overload of CDPF (warning lamp blinking)



1. If the CDPF cannot reach the regeneration temperature due to low speed driving or other reason during the regeneration process, the soot is continuously accumulated in the CDPF. When this condition continues and the CDPF is overloaded with soot, the engine warning lamp blinks to inform this situation to the driver.
   In order to solve this problem, drive the
2. vehicle at a speed of approx. 80 km/h for 15 to 20 minutes to perform the CDPF regeneration process.
   If the engine warning lamp on the instrument
3. cluster blinks, the CDPF is overloaded. In this case, perform the step 2.

▶ Excessive overload of CDPF (warning lamp illuminated)



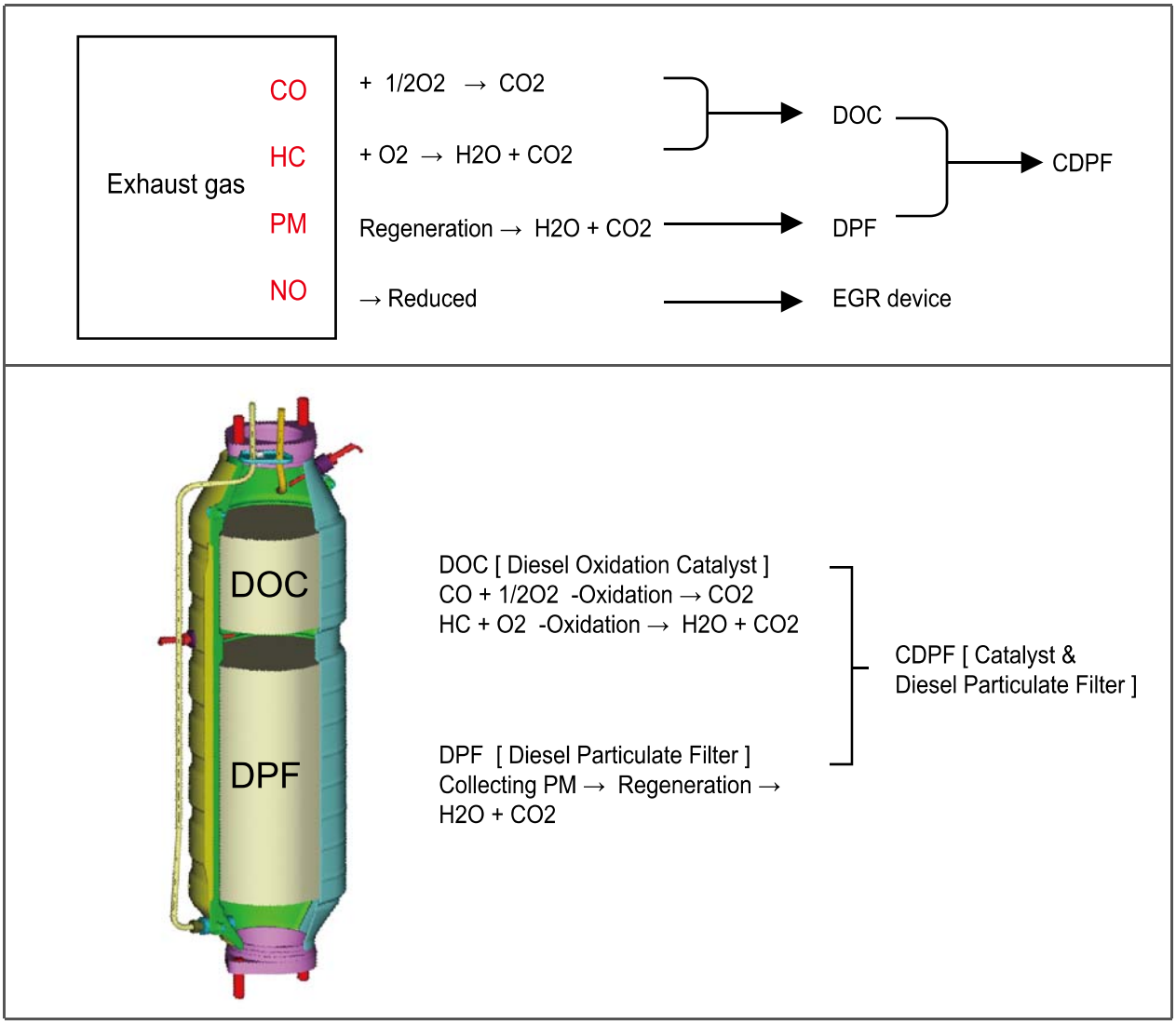
1. If the vehicle is driven at a speed of 5 to 10 km/h for an extended period of time, the soot accumulated in the CDPF cannot be burned as the CDPF cannot reach the regeneration temperature. Then, an excessive amount of soot can be accumulated in the CDPF.
2. This case is much worse than the simple overload of the CDPF. To inform this to the driver, the engine warning lamp comes on and the engine power is decreased to protect the system.
3. To solve this problem, blow soot between the engine and exhaust system several times and erase the related DTC. Then, check if the same DTC is regenerated again. If so, check the DTC related to the differential pressure sensor.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The DOC (Diesel Oxidation Catalyst) generates CO2 and H2O which are harmless through the oxidation process of CO and HC. And the DPF (Diesel Particulate Filter) collects PM (Particle Matter) and is regenerated to reduce the quantity of particulates, HC and CO. But there is a limitation in reducing the emission of exhaust gas for each system, so the CDPF which combines these two system is applied.



2. COMPONENT

Rear temperature sensor



Measures the temperature of fuel combustion.

Oxygen sensor



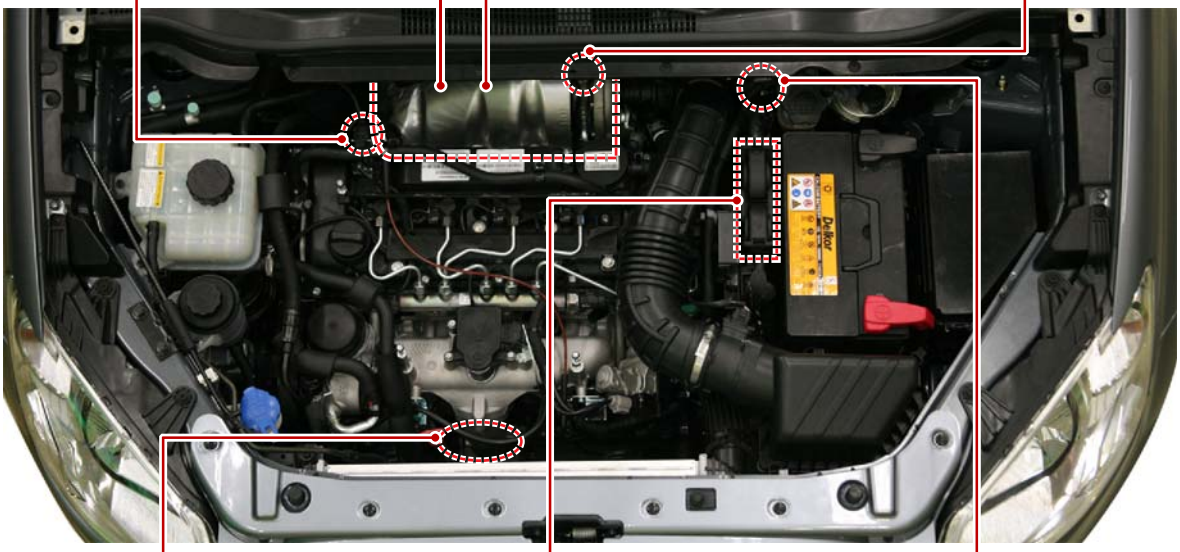
CDPF (DOC + DPF)



Front temperature sensor



Protects the turbocharger.



Electric throttle body



Regulates the rate of air intake.

Engine ECU (D20DTF)



Post-injection

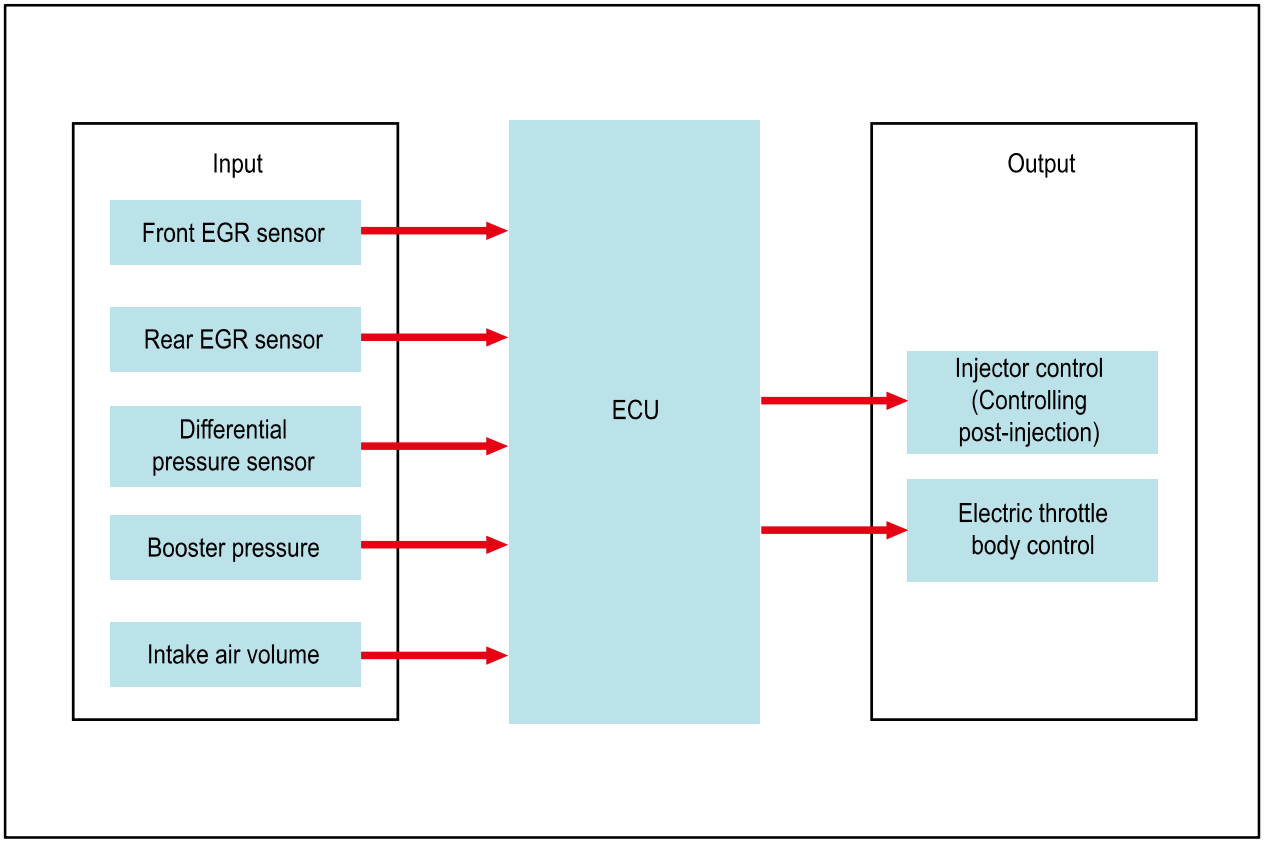
Differential pressure sensor



Calculates the amount of PM collected by reading the pressure difference between before and after the CDPF.

Modification basis	
Application basis	
Affected VIN	

3. INPUT/OUTPUT DEVICES



1. Front temperature sensor: This sensor is installed at the inlet of DOC and detects whether the DOC can burn (oxidize) the post-injected fuel or not.
2. Rear temperature sensor: This sensor is installed at the inlet of DPF and monitors that the temperature of the exhaust gas is kept at 600℃.

- If the temperature exceeds 600℃, the life of CDPF can be reduced. So the amount of fuel post-injection is decreased.
- If the temperature drops under 600℃, the rate of regeneration can be decreased. So the amount of fuel post-injection is increased.

3. Differential pressure sensor: This sensor checks the amount of PM collected by calculating the pressure difference between before and after the CDPF.
4. Electric throttle valve: This valve reduces the intake air flow to raise the temperature of the exhaust gas when the CDPF is operating during idling.

4. POST-INJECTION AND AIR MASS CONTROL

A DPS (Differential Pressure Sensor) measures the pressure difference between before and after the CDPF and detects whether the soot is collected in the CDPF or not. If PM is collected in the CDPF (In this case the pressure difference between before and after the CDPF exceeds the specified value. Normally, the system sends the signal when the driving distance becomes approx. 600 to 1,200 km), the temperature of exhaust gas is increased and the post-injection is started for regeneration. The amount of fuel post-injection is controlled by the exhaust gas temperature measured by the rear temperature sensor. If the temperature is less than 600℃, the amount of post-injection is increased to increase the regeneration temperature. Otherwise, the fuel injection amount is decreased or the fuel is not injected.

When the engine is running with low load, the intake air amount is also controlled as well as fuel injection amount. This function is used to increaser the combustion temperature by increasing the amount of fuel post-injection with the lowest air amount within the specified control logic.

Modification basis	
Application basis	
Affected VIN	

Front EGT sensor



Measures the temperature of DOC.

The DOC performs the redox reaction at between 300 and 500℃ and the front EGT sensor monitors the temperature of DOC.

Differential pressure sensor



Measures the pressure values of before and after the CDPF.

The pressure difference between before and after the CDPF is measured by the differential pressure sensor (If PM is collected in the CDPF, the pressure difference between before and after the CDPF exceeds the specified value).

HFM sensor

Intake air volume

ECU (DCM 3.7)



Detecting excess of PM amount limit

Boost pressure/ temperature

T-MAP sensor

Rear EGT sensor



Measures the temperature of DPF.

The DPF burns the soot with hot exhaust gases (regeneration) at around 600℃ and the rear EGT sensor monitors the temperature of DPF.

Injector (C3I)



Controls the post-injection.

Electric throttle body

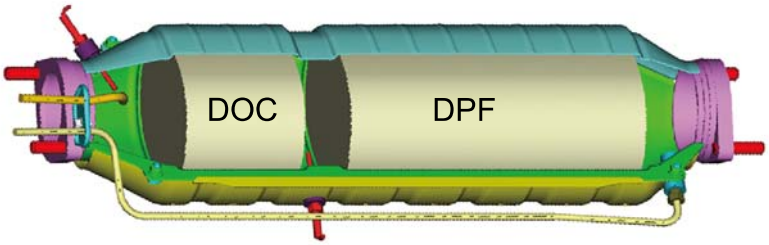


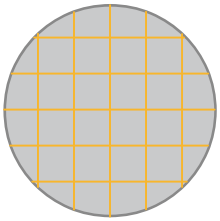
Controls the intake air volume.

Modification basis	
Application basis	
Affected VIN	

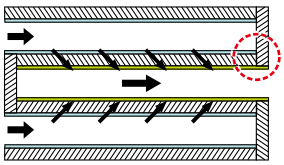
5. OPERATING PROCESS

[Configuration and principle of operation]



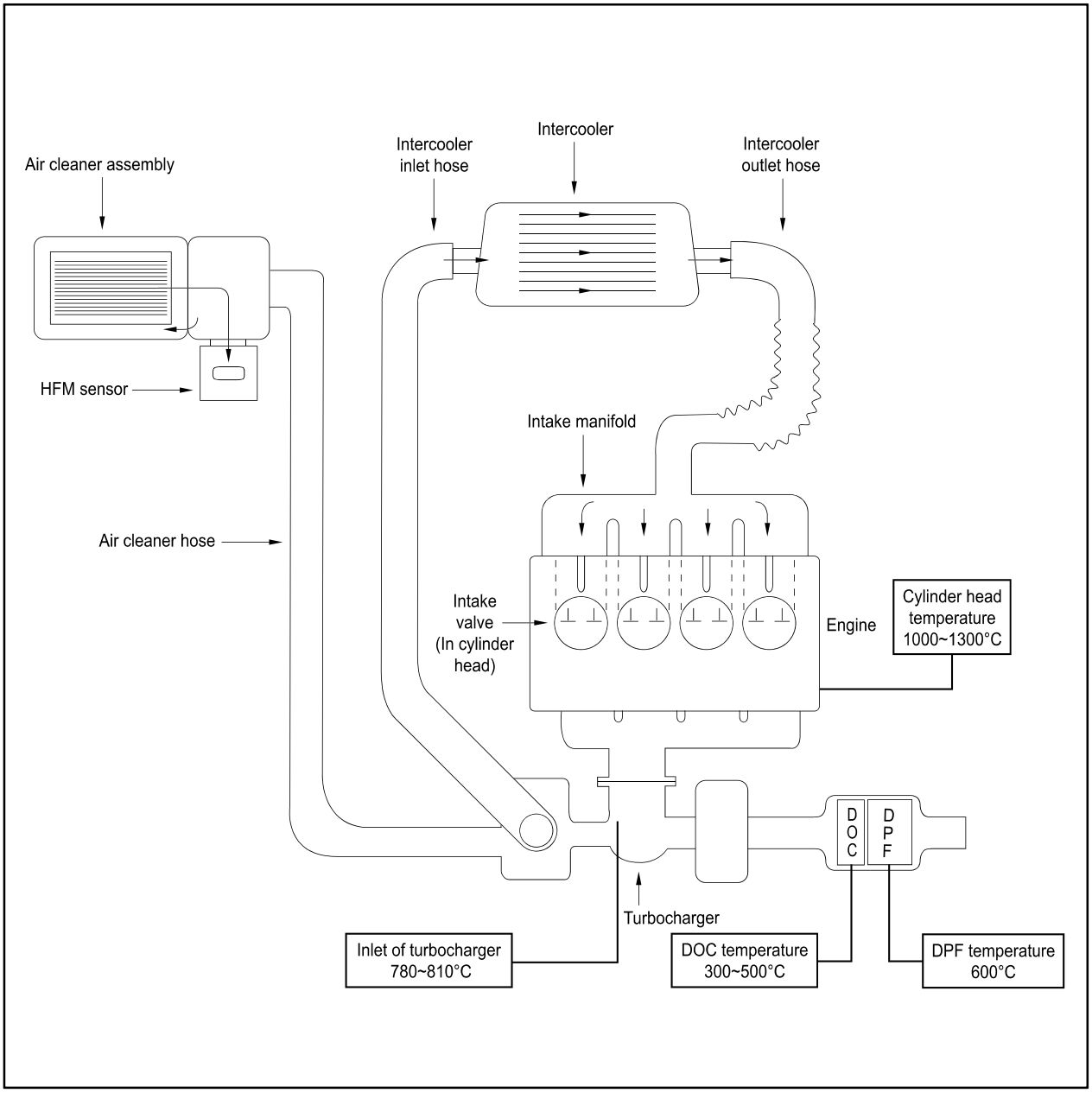


The exhaust gas passed through the exhaust manifold enters into the CDPF assembly (at approx 250℃).

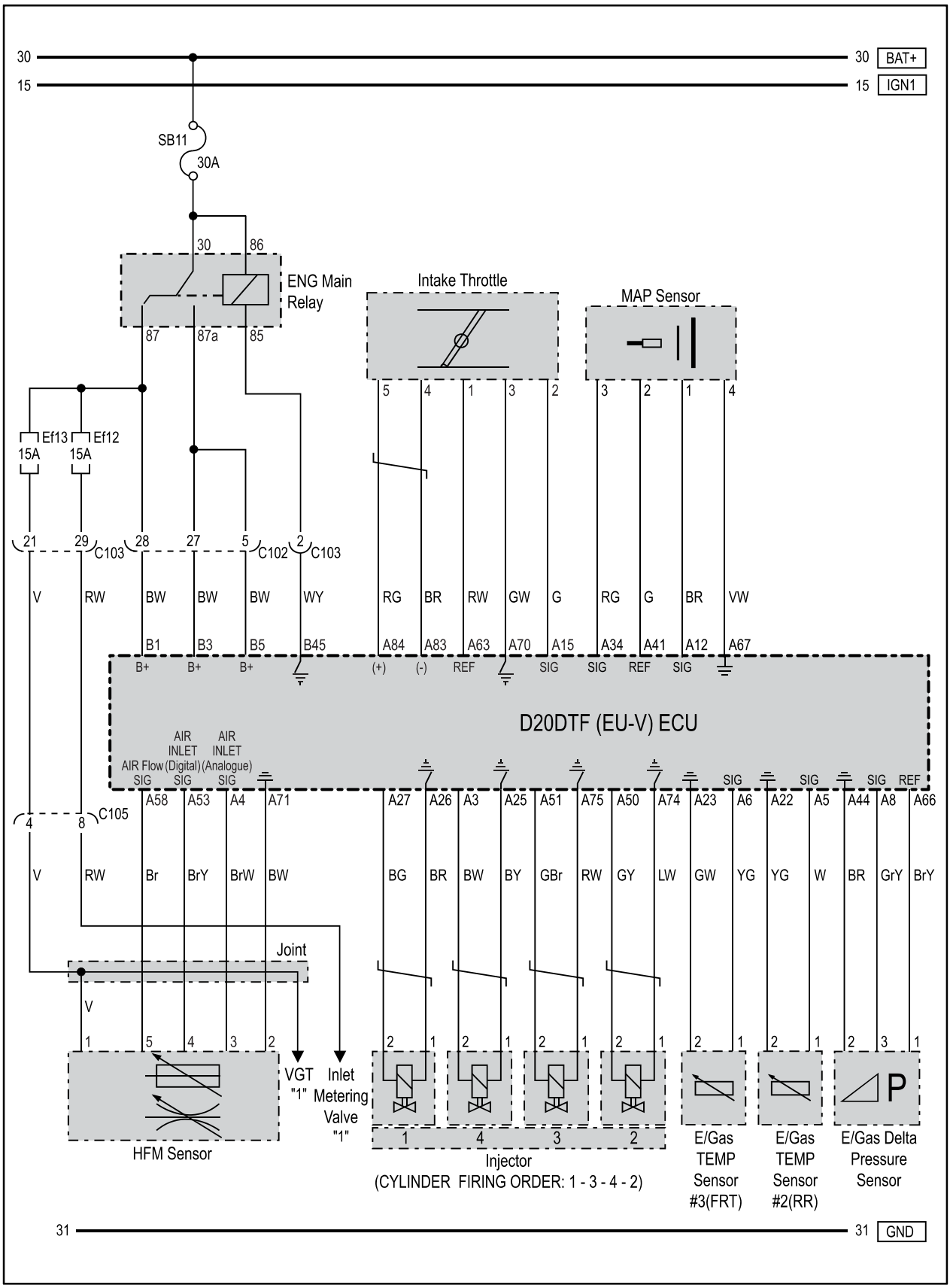
Oxidation (DOC)	Collecting PM → Regeneration
	
When the exhaust gas enters into the CDPF assembly, its CO, HC and PM are reduced by the redox reaction of the DOC. The remaining PM is filtered and collected in CDPF, and the temperature of the exhaust gas is increased to between 450 and 500°C.	The engine ECU detects the amount of PM collected by the information from the temperature sensors and differential pressure sensor. When the soot is accumulated, the engine ECU performs post-injection to increase the exhaust gas temperature and burns the collected PM at approx. 600°C.

Modification basis	
Application basis	
Affected VIN	

6. OPERATING TEMPERATURE



7. ELECTRIC CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

8. CAUTIONS

1) Designated Engine Oil for CDPF (Low Ash Oil)

1. Need to use the designated engine oil for CDPF
   - The smoke from the vehicle may generate the particle material in the ambient air. CDPF is the device to reduce the smoke by collecting and recycling it. To ensure the performance of CDPF, the designated engine oil should be used.
   - The smoke including combusted sulfur in fuel cannot be recycled in CDPF. This smoke generates the ash, resulting in clogging the filter.
2. Advantages when using the designated engine oil for CDPF
   - Reduces the amount of ash
   - Improves the fuel economy and reduces the CO2
   - Increases the life span of engine oil
   - Available for all engines (diesel and gasoline)
3. Problems when using non-designated engine oil for CDPF
   - Decreases the life span of engine oil due to accumulated ash in DPF (around 30%)
   - Decreases the fuel economy due to friction resistance, exhaust gas resistance and frequent recycling process of DPF

> **CAUTION**
> The fule containing high sulfur may cause the same problems.

2) Do Not Use the Fuel Containing High Sulfur

1. Producing white smoke during recycling
   - The sulfur in exhaust gas is changed to sulfate gas during exhaust process. This sulfate gas is shown as white smoke.
2. Producing odor during recycling
   - The sulfur after oxidation may produce the odor.
3. Accumulation of ash
   - The sulfur accumulated in DPF cannot be recycled. It reduces the life span of DPF.

3) White Smoke

The white smoke can be generated when the exhaust gas is recycled in DPF. There are two reasons as below.

1. Saturated vapor
2. Sulfate

ENGINE CONTROL

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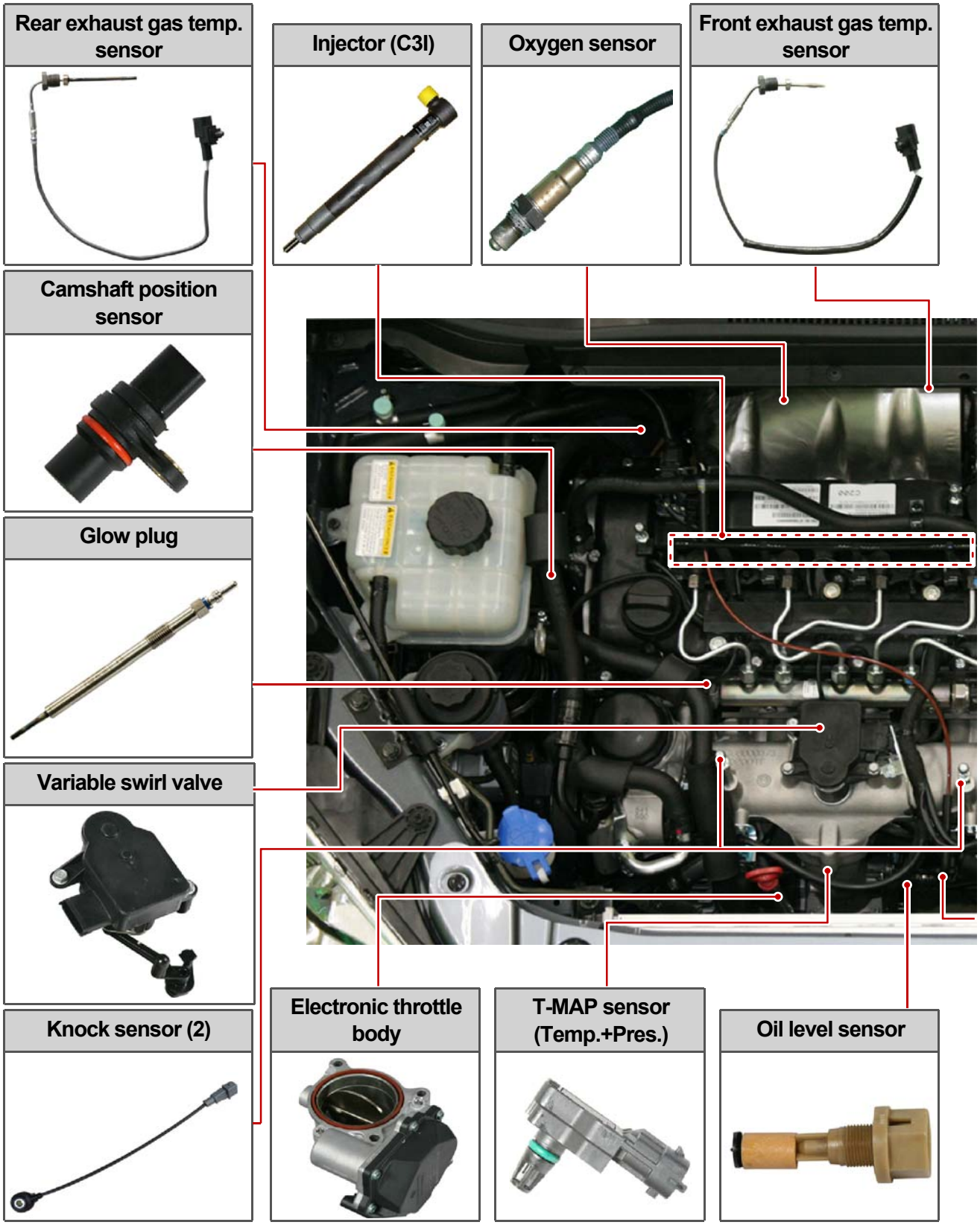
GENERAL INFORMATION

1. ENGINE DATA LIST

Data	Unit		Value
Coolant temperature	℃		0.436 V (130℃) to 4.896 V (−40℃)
Intake air temperature	℃		−40 to 130℃ (varies by ambient air temperature or engine mode)
Idle speed	rpm	A/T	780 ± 20
		M/T	750 ± 20
Engine load	%		18~25%
Mass air flow	kg/h		16 to 25 kg/h
Throttle position angle	°TA		0° (Full Open) to 78° (Close)
Engine torque	Nm		varies by engine conditions
Injection time	ms		3 to 5ms
Battery voltage	V		13.5 V to 14.1 V
Accelerator pedal position 1	V		04. to 4.8V
Accelerator pedal position 2	V		0.2 to 2.4 V
Throttle position 1	V		0.3 to 4.6 V
Throttle position 2	V		0.3 to 4.6 V
Oxygen sensor	mV		0 to 5 V
A/C compressor switch	1=ON / 0=OFF		-
Full load	1=ON / 0=OFF		-
Gear selection (A/T)	1=ON / 0=OFF		-
Knocking control	1=ON / 0=OFF		-
Brake switch	1=ON / 0=OFF		-
Cruise control	1=ON / 0=OFF		-

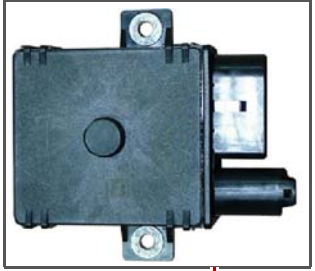
OVERVIEW AND OPERATING PROCESS

1. MAJOR COMPONENT



Modification basis	
Application basis	
Affected VIN	

GCU (Glow plug control unit)



Differential pres. sensor

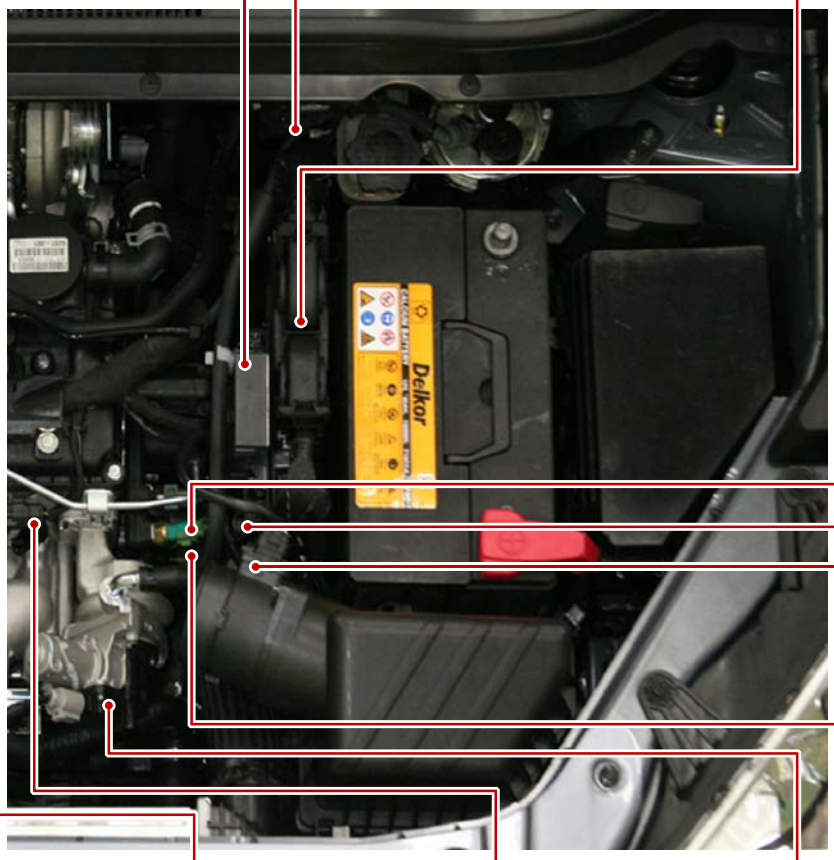


D20DTF ECU



Fuel temp. sensor





Coolant temp. sensor



HFM (air mass/temperature)



IMV



E-EGR bypass valve



Fuel rail pres. sensor



E-EGR valve

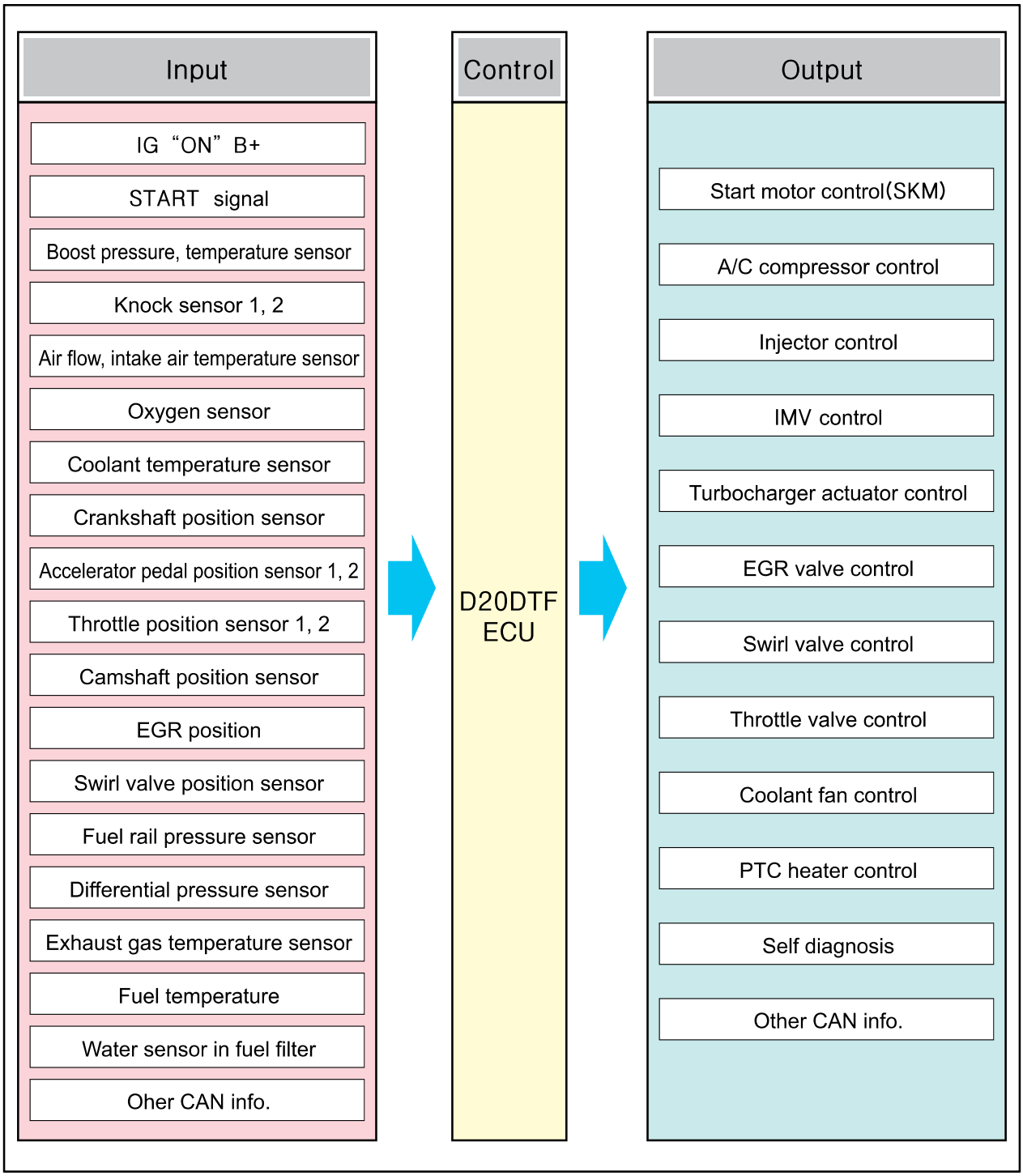


Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

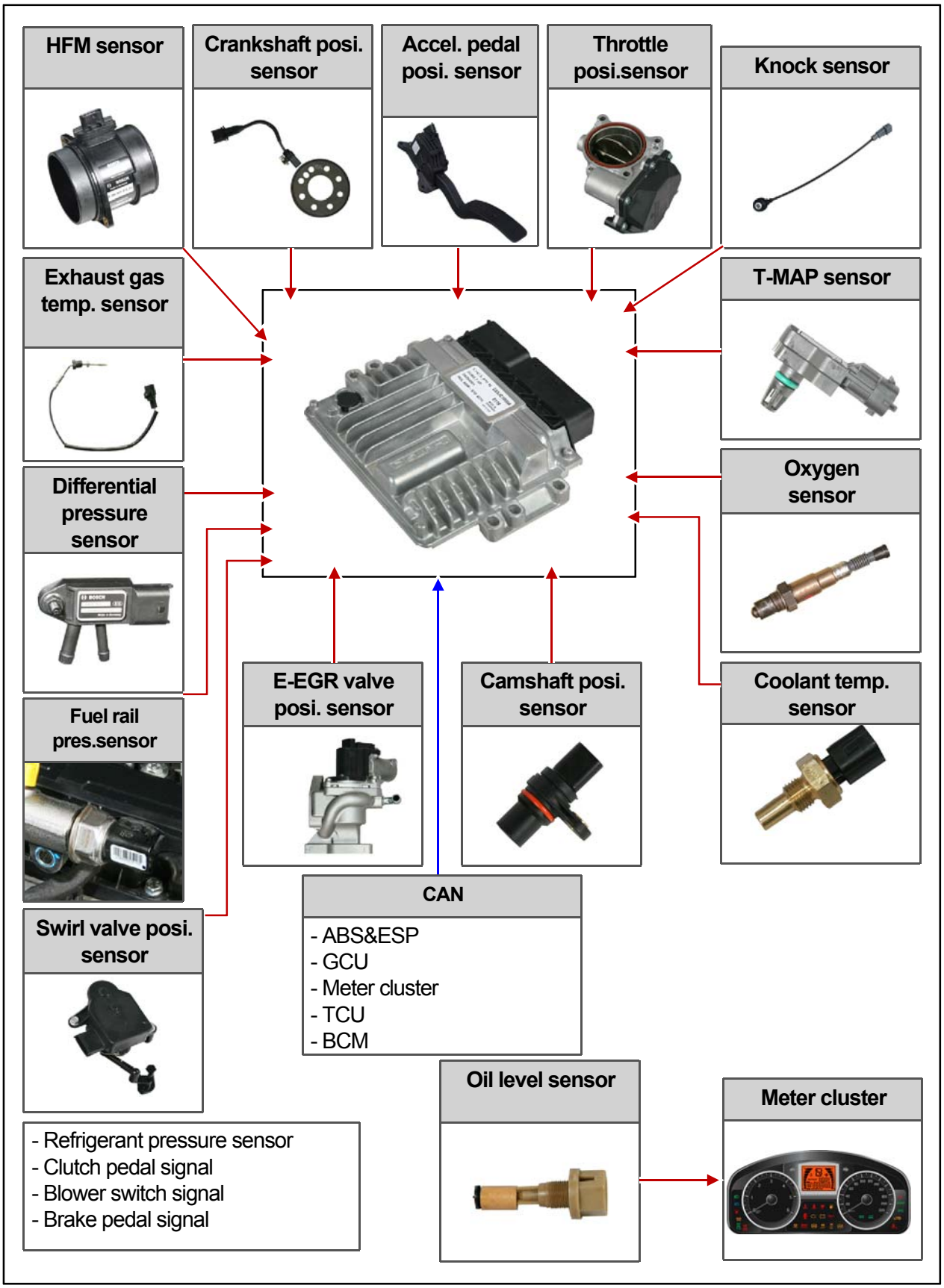
1) Input/Output of ECU

(1) ECU Block diagram

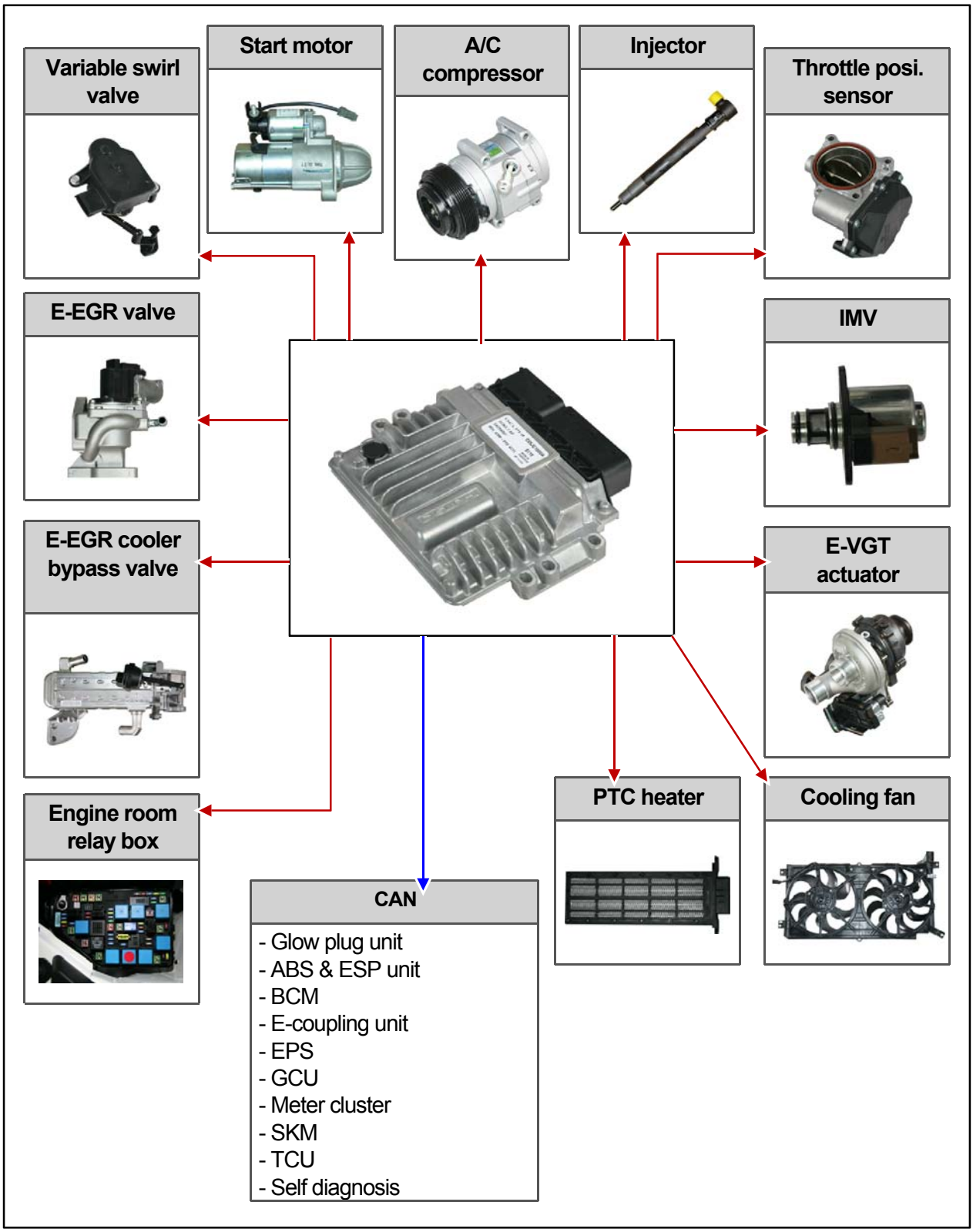


Modification basis	
Application basis	
Affected VIN	

(2) Components for ECU Input



(3) Components for ECU Input



Modification basis	
Application basis	
Affected VIN	

2) ECU Control

(1) Function

a. ECU Function

ECU receives and analyzes signals from various sensors and then modifies those signals into permissible voltage levels and analyzes to control respective actuators.
ECU microprocessor calculates injection period and injection timing proper for engine piston speed and crankshaft angle based on input data and stored specific map to control the engine power and emission gas.
Output signal of the ECU microprocessor drives pressure control valve to control the rail pressure and activates injector solenoid valve to control the fuel injection period and injection timing; so controls various actuators in response to engine changes. Auxiliary function of ECU has adopted to reduce emission gas, improve fuel economy and enhance safety, comforts and conveniences. For example, there are EGR, booster pressure control, autocruise (export only) and immobilizer and adopted CAN communication to exchange data among electrical systems (automatic T/M and brake system) in the vehicle fluently. And Scanner can be used to diagnose vehicle status and defectives.
Operating temperature range of ECU is normally −40 to +85°C and protected from factors like oil, water and electromagnetism and there should be no mechanical shocks.
To control the fuel volume precisely under repeated injections, high current should be applied instantly so there is injector drive circuit in the ECU to generate necessary current during injector drive stages. Current control circuit divides current applying time (injection time) into full-in-current-phase and hold-current-phase and then the injectors should work very correctly under every working condition.

b. Control Function

- Controls by operating stages
  To make optimum combustion under every operating stage, ECU should calculate proper injection volume in each stage by considering various factors.
- Starting injection volume control
  During initial starting, injecting fuel volume will be calculated by function of temperature and engine cranking speed. Starting injection continues from when the ignition switch is turned to ignition position to till the engine reaches to allowable minimum speed.
- Driving mode control
  If the vehicle runs normally, fuel injection volume will be calculated by accelerator pedal travel and engine rpm and the drive map will be used to match the drivers inputs with optimum engine power.

(2) Fuel Control

a. Fuel Pressure Control Elements

Pressure control consists of 2 principles.

- Determines rail pressure according to engine operating conditions.
- Controls IMV to make the rail pressure to reach to the required value.

Pressure in the fuel rail is determined according to engine speed and load on the engine.

- When engine speed and load are high
  The degree of turbulence is very great and the fuel can be injected at very high pressure in order to optimize combustion.
- When engine speed and load are low
  The degree of turbulence is low. If injection pressure is too high, the nozzle's penetration will be excessive and part of the fuel will be sprayed directly onto the sides of the cylinder, causing incomplete combustion. So there occurs smoke and damages engine durability.

Fuel pressure is corrected according to air temperature, coolant temperature and atmospheric pressure and to take account of the added ignition time caused by cold running or by high altitude driving. A special pressure demand is necessary in order to obtain the additional flow required during starts. This demand is determined according to injected fuel and coolant temperature.

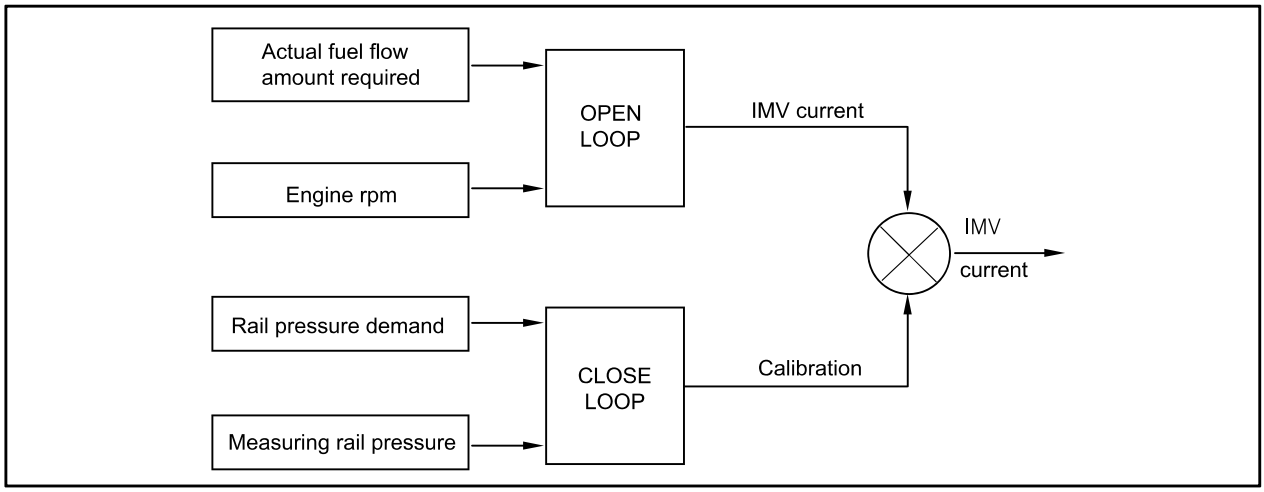
b. Fuel Pressure Control

Rail pressure is controlled by closed loop regulation of IMV.

▶ Open loop determines the current which needs to be sent to the actuator in order to obtain the flow demanded by the ECU.

▶ Closed loop will correct the current value depending on the difference between the pressure demand and the pressure measured.

- If the pressure is lower than the demand, current is reduced so that the fuel sent to the high pressure pump is increased.
- If the pressure is higher than the demand, current is increased so that the fuel sent to the high pressure pump is reduced.



Modification basis	
Application basis	
Affected VIN	

c. Fuel Injection Control

Injection control is used in order to determine the characteristics of the pulse which is sent to the injectors.
Injection control consists as below.

- Injection timing
- Injection volume
- Translating fuel injection timing and injection volume into values which can be interpreted by the injector driver.

▶ Main injection timing control

The pulse necessary for the main injection is determined as a function of the engine speed and of the injected flow.
The elements are:

- A first correction is made according to the air and coolant temperatures.
  This correction makes it possible to adapt the timing to the operating temperature of the engine. When the engine is warm, the timing can be retarded to reduce the combustion temperature and polluting emissions (NOx). When the engine is cold, the timing advance must be sufficient to allow the combustion to begin correctly.
- A second correction is made according to the atmospheric pressure.
  This correction is used to adapt the timing advance as a function of the atmospheric pressure and therefore the altitude.
- A third correction is made according to the coolant temperature and the time which has passed since starting.
  This correction allows the injection timing advance to be increased while the engine is warming up (initial 30 seconds). The purpose of this correction is to reduce the misfiring and instabilities which are liable to occur after a cold start.
- A fourth correction is made according to the pressure error.
  This correction is used to reduce the injection timing advance when the pressure in the rail is higher than the pressure demand.
- A fifth correction is made according to the rate of EGR.
  This correction is used to correct the injection timing advance as a function of the rate of exhaust gas recirculation.
  When the EGR rate increases, the injection timing advance must in fact be increased in order to compensate for the fall in termperature in the cylinder.

During starting, the injection timing must be retarded in order to position the start of combustion close to the TDC. To do this, special mapping is used to determine the injection timing advance as a function of the engine speed and of the water temperature.

▶ **Pilot injection timing control**

The pilot injection timing is determined as a function of the engine speed and of the total flow.
The elements are:

- A first correction is made according to the air and coolant temperatures. This correction allows the pilot injection timing to be adapted to the operating temperature of the engine.
- A second correction is made according to the atmospheric pressure. This correction is used to adapt the pilot injection timing as a function of the atmospheric pressure and therefore the altitude.

d. Fuel Control

1. Main Flow Control

The main flow represents the amount of fuel injected into the cylinder during the main injection. The pilot flow represents the amount of fuel injected during the pilot injection.

The total fuel injected during 1 cycle (main flow + pilot flow) is determined in the following manner.

▶ When the driver depress the pedal, it is his demand which is taken into account by the system in order
▶ to determine the fuel injected.
When the driver release the pedal, the idle speed controller takes over to determine the minimum fuel which must be injected into the cylinder to prevent the enigne from stalling.

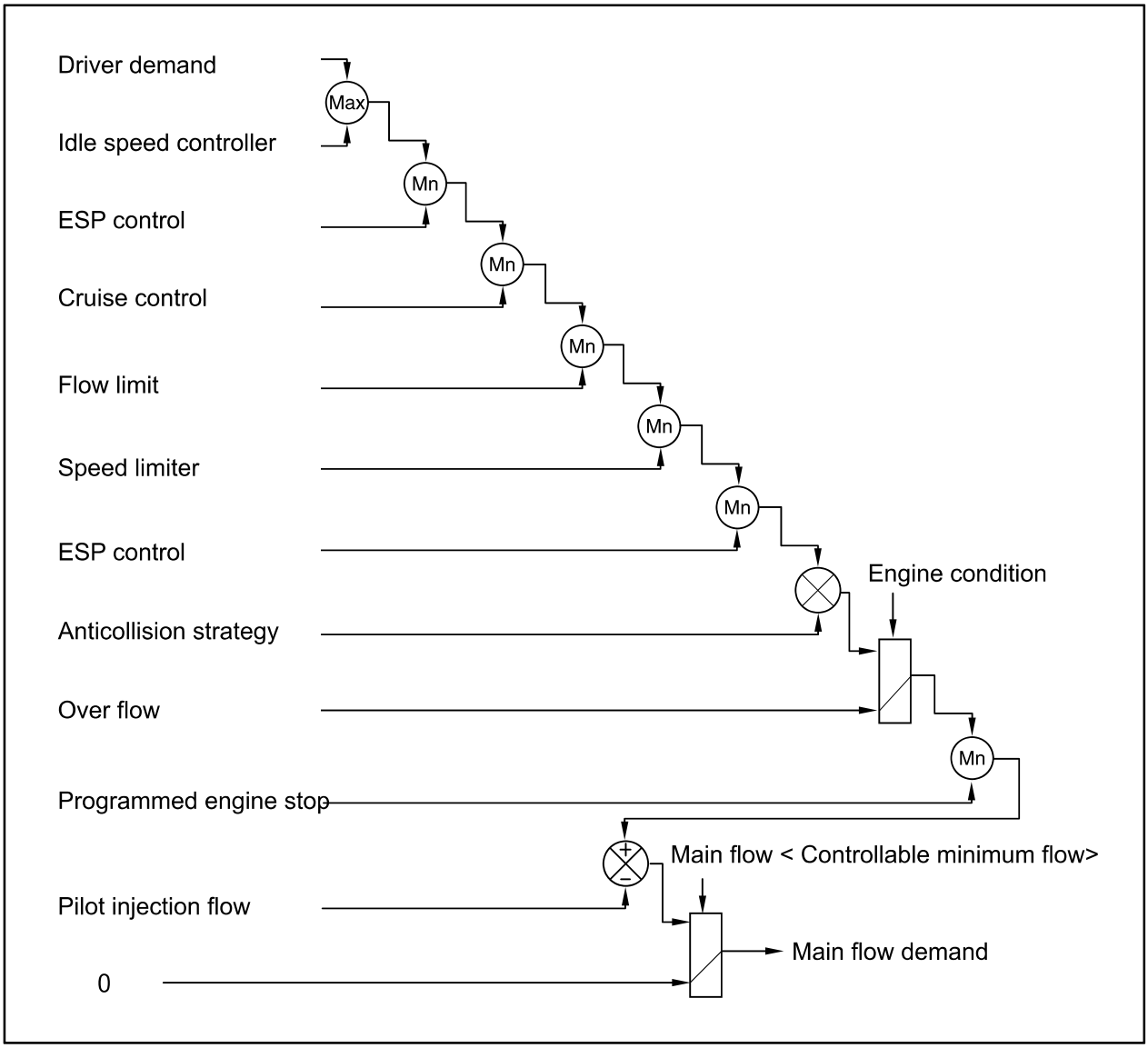
It is therefore the greater of these 2 values which is retained by the system. This value is then compared with the lower flow limit determined by the ESP system.
As soon as the injected fuel becomes lower than the flow limit determined by the ESP system, the antagonistic torque (engine brake) transmitted to the drive wheels exceeds the adherence capacity of the vehicle and there is therefore a risk of the drive wheels locking.
The system thus chooses the greater of these 2 values (main flow & pilot flow) in order to prevent any loss of control of the vehicle during a sharp deceleration.
As soon as the injected fuel becomes higher than the fuel limit determined by the ASR trajectory control system, the engine torque transmitted to the wheels exceeds the adhesion capacity of the vehicle and there is a risk of the drive wheels skidding. The system therefore chooses the smaller of the two values in order to avoid any loss of control of the vehicle during accelerations.
The anti-oscillation strategy makes it possible to compensate for fluctuations in engine speed during transient conditions. This strategy leads to a fuel correction which is added to the total fuel of each cylinder.

A switch makes it possible to change over from the supercharge fuel to the total fuel according to the state of the engine.

- Until the stating phase has finished, the system uses the supercharged fuel.
- Once the engine changes to normal operation, the system uses the total fuel.

The main fuel is obtained by subtracting the pilot injection fuel from the total fuel.
A mapping determines the minimum fuel which can control an injector as a function of the rail pressure.
As soon as the main fuel falls below this value, the fuel demand changes to 0 because in any case the injector is not capable of injecting the quantity demand.

Modification basis	
Application basis	
Affected VIN	



2. Driver Demand

The driver demand is the translation of the pedal position into the fuel demand. It is calculated as a function of the pedal position and of the engine speed. The driver demand is filtered in order to limit the hesitations caused by rapid changes of the pedal position. A mapping determines the maximum fuel which can be injected as a function of the driver demand and the rail pressure. Since the flow is proportional to the injection time and to the square root of the injection pressure, it is necessary to limit the flow according to the pressure in order to avoid extending the injection for too long into the engine cycle. The system compares the driver demand with this limit and chooses the smaller of the 2 values. The driver demand is then corrected according to the coolant temperature. This correction is added to the driver demand.

3. Idle Speed Controller

The idle speed controller consists of 2 principal modules:

- The first module determines the required idle speed according to:
  * The operating conditions of the engine (coolant temperature, gear engaged)
  * Any activation of the electrical consumers (power steering, air conditioning, others)
  * The battery voltage
  * The presence of any faults liable to interface with the rail pressure control or the injection control. In this case, increase the idle speed to prevent the engine from stalling.
- The second module is responsible for providing closed loop control of the engine's idle speed by adapting the minimum fuel according to the difference between the required idle speed and the engine speed.

4. Flow Limitation

The flow limitation strategy is based on the following strategies:

- The flow limitation depending on the filling of the engine with air is determined according to the engine speed and the air flow. This limitation allows smoke emissions to be reduced during stabilized running.
- The flow limitation depending on the atmospheric pressure is determined according to the engine speed and the atmospheric pressure. It allows smoke emissions to be reduced when driving at altitude.
- The full load flow curve is determined according to the gear engaged and the engine speed. It allows the maximum torque delivered by the engine to be limited.
- A performance limitation is introduced if faults liable to upset the rail pressure control or the injection control are detected by the system. In this case, and depending on the gravity of the fault, the system activates:

Reduced fuel logic 1: Guarantees 75 % of the performance without limiting the engine speed.
Reduced fuel logic 2: Guarantees 50 % of the performance with the engine speed limited to 3,000 rpm.
Reduce fuel logic 3: Limits the engine speed to 2,000 rpm.

The system chooses the lowest of all values.
A correction depending on the coolant temperature is added to the flow limitation. This correction makes it possible to reduce the mechanical stresses while the engine is warming up. The correction is determined according to the coolant temperature, the engine speed and the time which has passed since starting.

Superchager Flow Demand

The supercharge flow is calculated according to the engine speed and the coolant temperature. A correction depending on the air temperature and the atmospheric pressure is made in order to increase the supercharge flow during cold starts. It is possible to alter the supercharge flow value by adding a flow offset with the aid of the diagnostic tool.

Modification basis	
Application basis	
Affected VIN	

5. Pilot Flow Control

The pilot flow represents the amount of fuel injected into the cylinder during the pilot injection. This amount is determined according to the engine speed and the total flow.

- A first correction is made according to the air and water temperature.
  This correction allows the pilot flow to be adapted to the operating temperature of the engine. When the engine is warm, the ignition time decreases because the end-of-compression temperature is higher. The pilot flow can therefore be reduced because there is obviously less combustion noise when the engine is warm.
- A second correction is made according to the atmospheric pressure.

During starting, the pilot flow is determined on the basis of the engine speed and the coolant temperature.

6. Cylinder Balancing Strategy

▶ **Balancing of the point to point flows**

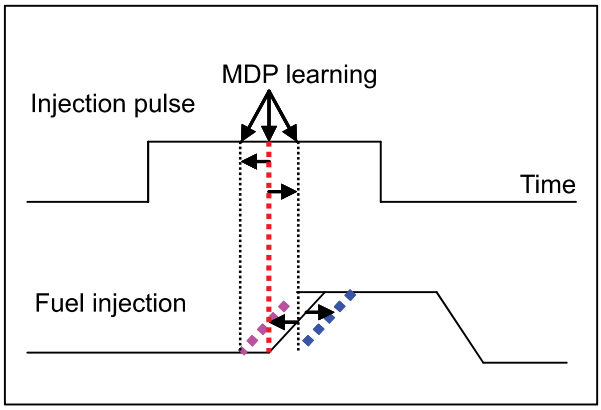
The pulse of each injector is corrected according to the difference in instantaneous speed measured between 2 successive injectors.

The instantaneous speeds on two successive injections are first calculated.
The difference between these two instantaneous speeds is then calculated.
Finally, the time to be added to the main injection pulse for the different injectors is determined. For each injector, this time is calculated according to the initial offset of the injector and the instantaneous speed difference.

▶ **Detection of an injector which has stuck closed**

The cylinder balancing strategy also allows the detection of an injector which has stuck closed. The difference in instantaneous speed between 2 successive injections then exceeds a predefined threshold. In this case, a fault is signaled by the system.

e. MDP Learning Control



MDP (Minimum Drive Pulse) refers to the minimum power supply pulse for injection which the injector can perform. It is possible to control the fuel volume for each injector accurately through correct learning for the MDP value. The basic process of MDP learning is that the pulse slightly higher than MDP is supplied and then (b) the vibration generated from the cylinder is detected. The knock sensor detects the vibration from the engine after a small volume of fuel is injected. And the time interval between the points of injection and vibration is measured so that MDP can be learned. MDP learning is helpful to prevent engine vibration, high emission and power reduction through performing calibration for the old injectors. During MDP learning, a little vibration and noise can be occur for a while. This is because the fuel pressure is increased instantaneously and the exact injection value is not input, so that the exact engine vibration timing can be detected.

Modification basis	
Application basis	
Affected VIN	

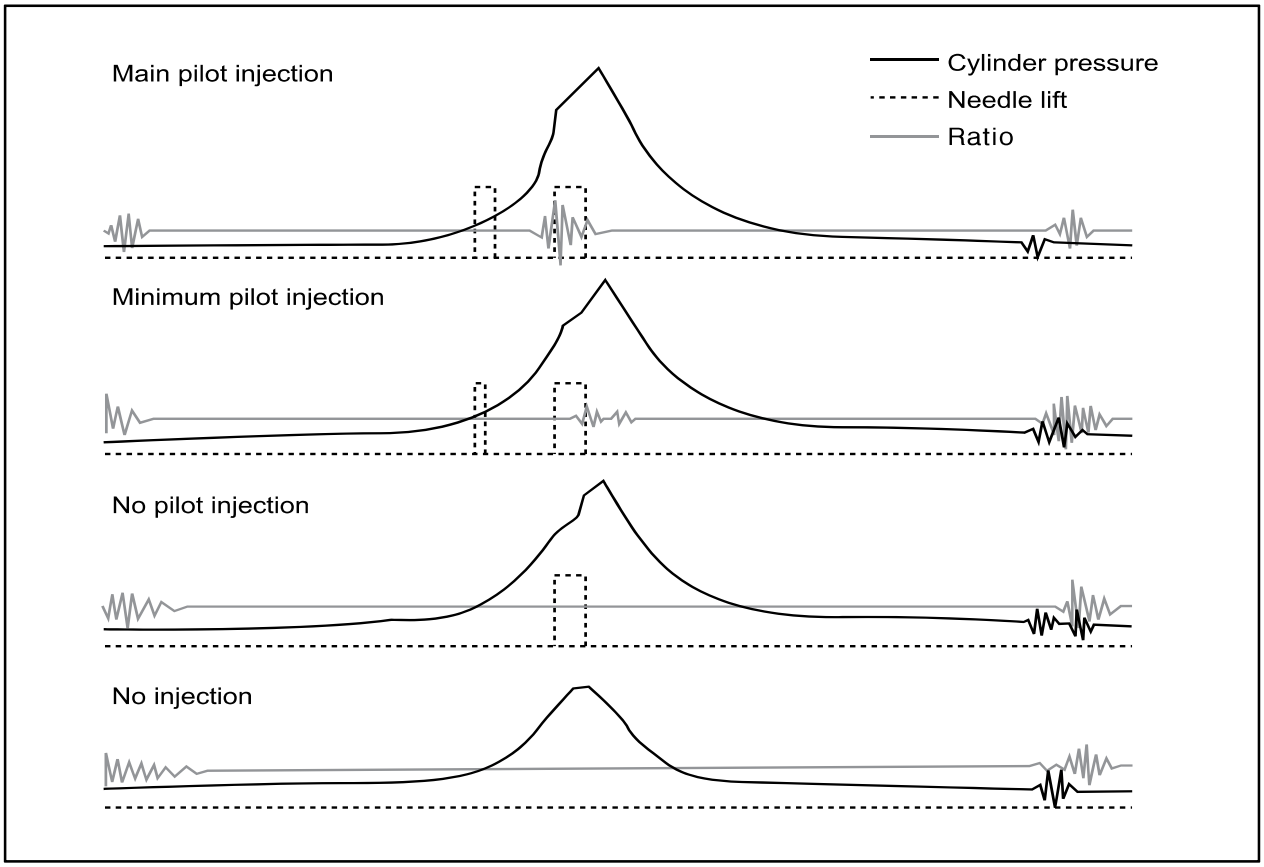
(3) Accelerometer Control

a. Resetting the pilot injection

The accelerometer is used to reset the pilot injection flow in closed loop for each injector. This method allows the correction of any injector deviations over a period of time. The principle of use of the accelerometer is based on the detection of the combustion noises.
The sensor is positioned in such a way as to receive the maximum signal for all the cylinders. The raw signals from the accelerometer are processed to obtain a variable which quantifies the intensity of the combustion. This variable, known as the ratio, consists of the ratio between the intensity of the background noise and the combustion noise.

1. A first window is used to establish the background noise level of the accelerometer signal for each cylinder. This window must therefore be positioned at a moment when there cannot be any combustion.
2. The second window is used to measure the intensity of the pilot combustion. Its position is such that only the combustion noises produced by the pilot injection are measured . It is therefore placed just before the main injection.

The accelerometer does not allow any evaluation of the quantity injected. However, the pulse value will be measured when the injector starts injection and this pulse value is called the MDP (Minimum Drive Pulse). On the basis of this information, it is possible to efficiently correct the pilot flows. The pilot injection resetting principle therefore consists of determining the MDP, in other words the pulse corresponding to the start of the increase in value of the ratio (increase of vibration due to fuel combustion).



This is done periodically under certain operating conditions. When the resetting is finished, the new minimum pulse value replaces the value obtained during the previous resetting. The first MDP value is provided by the C3I. Each resetting then allows the closed loop of the MDP to be updated according to the deviation of the injector.

b. Detection of leaks in the cylinders

The accelerometer is also used to detect any injector which may have stuck open. The detection principle is based on monitoring the ratio. If there is a leak in the cylinder, the accumulated fuel self-ignites as soon as the temperature and pressure conditions are favorable (high engine speed, high load and small leak).
This combustion is set off at about 20 degrees before TDC and before main injection.
The ratio therefore increases considerably in the detection window. It is this increase which allows the leaks to be detected. The threshold beyond which a fault is signaled is a percentage of the maximum possible value of the ratio.
Because of the severity of the recovery process (engine shut-down), the etection must be extremely robust.
An increase in the ratio can be the consequence of various causes:

- Pilot injection too much
- Main combustion offset
- Fuel leak in the cylinder

If the ratio becomes too high, the strategy initially restricts the pilot injection flow and retards the main injection. If the ratio remains high despite these interventions, this shows that a real leak is present, a fault is signaled and the engine is shut down.

c. Detection of an accelerometer fault

This strategy permits the detection of a fault in the sensor or in the wiring loom connecting the sensor to the ECU.
It is based on detection of the combustion. When the engine is idling, the detection window is set too low for the combustion caused by the main injection. If the ratio increases, this shows that the accelerometer is working properly, but otherwise a fault is signaled to indicate a sensor failure. The recovery modes associated with this fault consist of inhibition of the pilot injection and discharge through the injectors.

Modification basis	
Application basis	
Affected VIN	

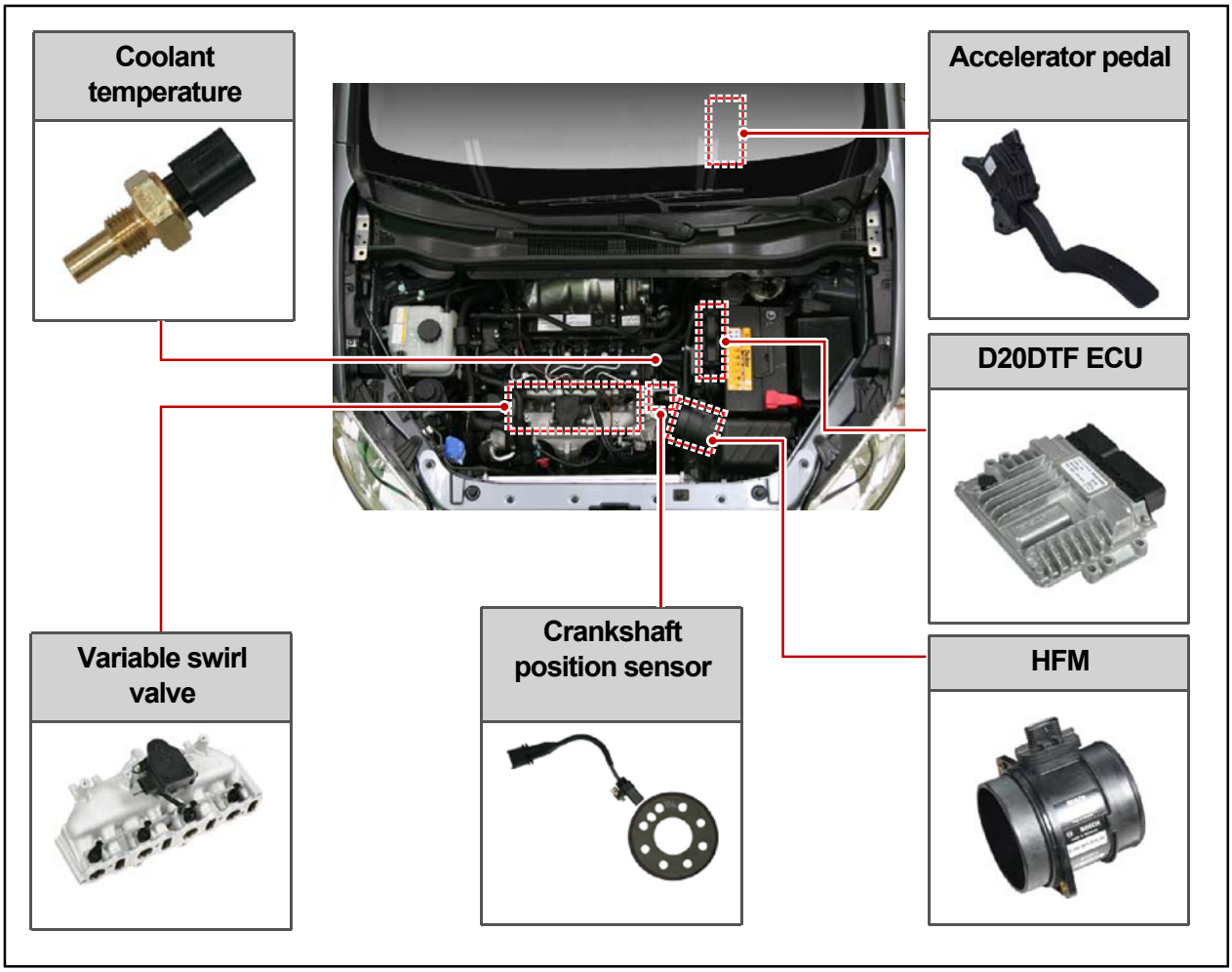
(4) Swirl control

a. Overview

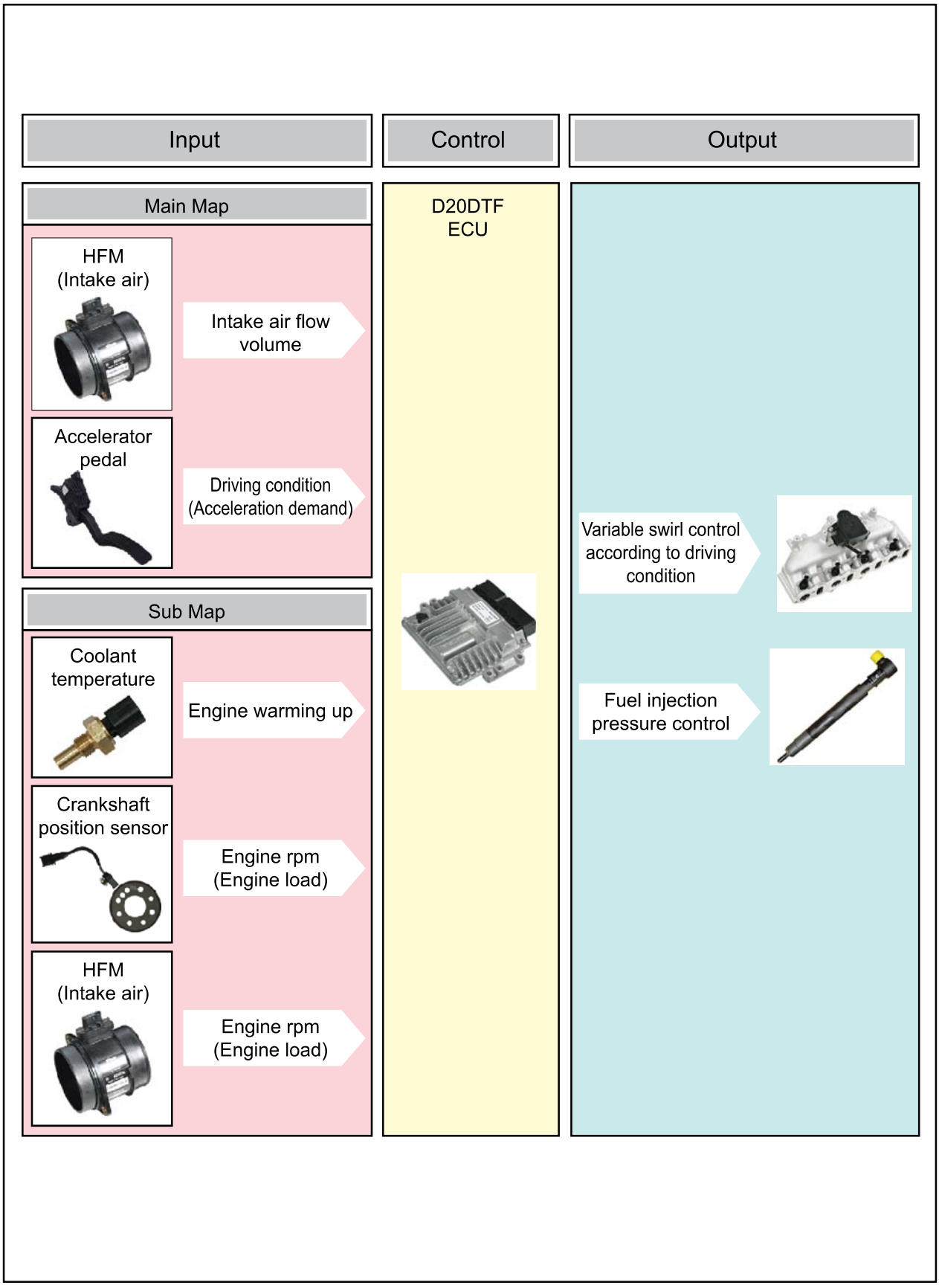
- Variable swirl valve

The strong swirl caused by intake air is important element for anti-locking function in diesel engine. The swirl control valve partially closes the intake port to generate the swirl according to the engine conditions. When the engine load is in low or medium range, the swirl could not be generated because the air flow is slow. To generate strong swirl, there are two passages in intake manifold, and one of them has the valve to open and close the passage. When the valve closes the passage, the air flow through the another passage will be faster, and the strong swirl will be generated by the internal structure of the passage. This swirl makes the better mixture of air and fuel, eventually the combustion efficiency in combustion chamber could be improved. This provides the enhanced fuel consumption, power and EGR ratio.

- Components

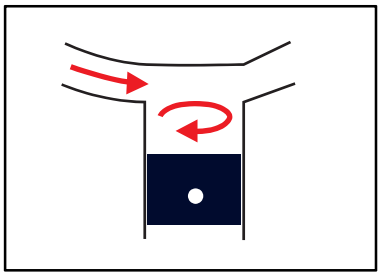


b. Input/Output for variable swirl valve

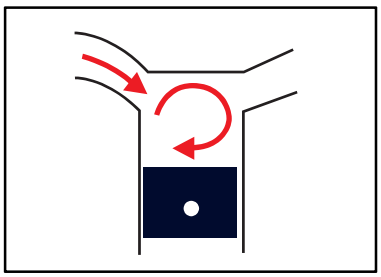


Modification basis	
Application basis	
Affected VIN	

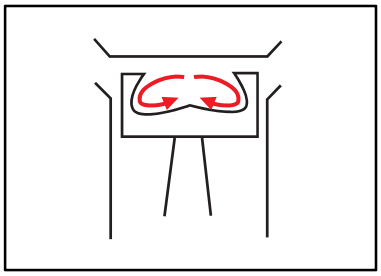
c. Types of swirl



Swirl: One cylinder has two intake air ports, one is set horizontally and the other one is set vertically. Swirl is the horizontal air flows in cylinder due to the horizontal intake air ports.



Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port

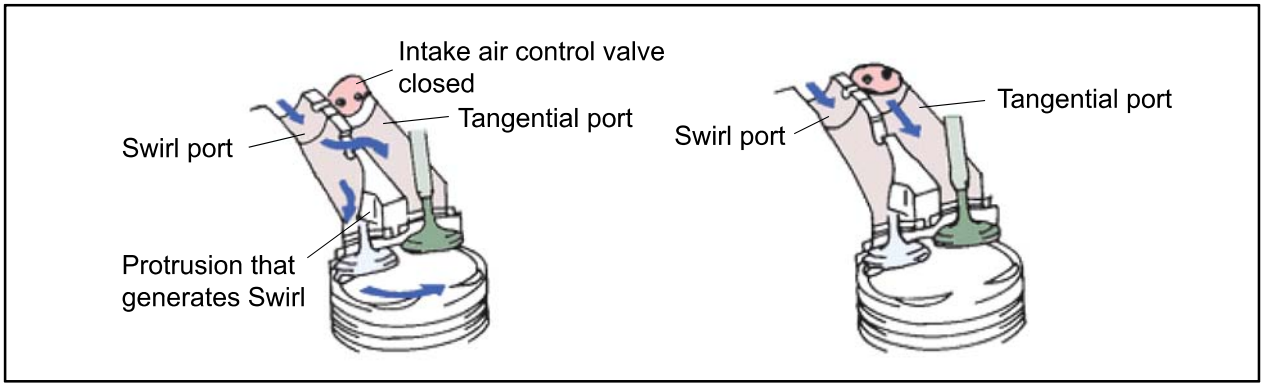


Squish: Squish is the air flows due to the piston head. Normally, this is appears at the final process of compression. In CRDi engine, the piston head creates the bowl type squish.

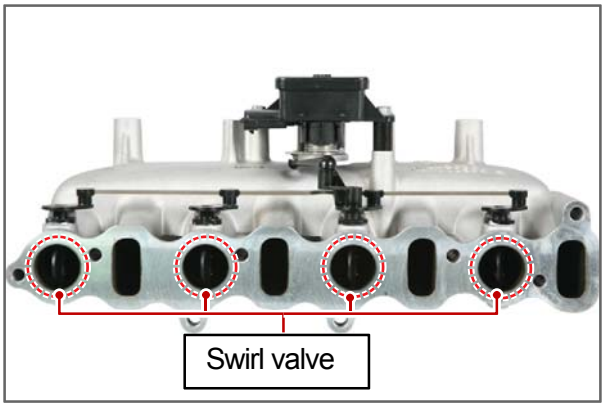
d. Swirl control

In DI type diesel engine, the liquefied fuel is injected into the cylinder directly. If the fuel is evenly distributed in short period, the combustion efficiency could be improved. To get this, there should be good air flow in cylinder. In general, there are two intake ports, swirl port and tangential port, in each cylinder. The swirl port generates the horizontal flow and the tangential port generates the longitudinal flow.

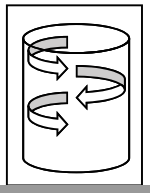
In low/mid load range, the tabgential port is closed to increase the horizontal flow. Fast flow decreases the PM during combustion and increases the EGR ratio by better combustion efficiency.



Load	Engine speed	Swirl valve	Amount of swirl	Remarks
Low speed, Low load	below 3,000 rpm	Closed	Heavy	Increased EGR ratio, better air-fuel mixture (reduce exhaust gas)
High speed, High load	over 3,000 rpm	Open	Light	Increase charge efficiency, higher engine power



The variable swirl valve actuator operates when turning the ignition switch ON/OFF position to open/close the swirl valve. In this period, the soot will be removed and the learning for swirl valve position is performed.



NOTE

Swirl: This is the twisted (radial) air flow along the cylinder wall during the intake stroke. This stabilizes the combustion even in lean air-fuel mixture condition.

e. Features

- Swirl and air intake efficiency
  To generate the swirl, the intake port should be serpentine design. This makes the resistance in air flow. The resistance in air flow in engine high speed decreases the intake efficiency. Eventually, the engine power is also decreased, Thus, the swirl operation is deactivated in high speed range to increase the intake efficiency.
- Relationship between swirl and fuel injection pressure
  The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the injection angles might be overlapped. Therefore, the system may decreases the fuel injection pressure when the swirl is too strong.

Modification basis	
Application basis	
Affected VIN	

f. Relationship between swirl and fuel injection pressure

- The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the injection angles might be overlapped. Therefore, the system may decreases the fuel injection pressure when the swirl is too strong.

NOTE

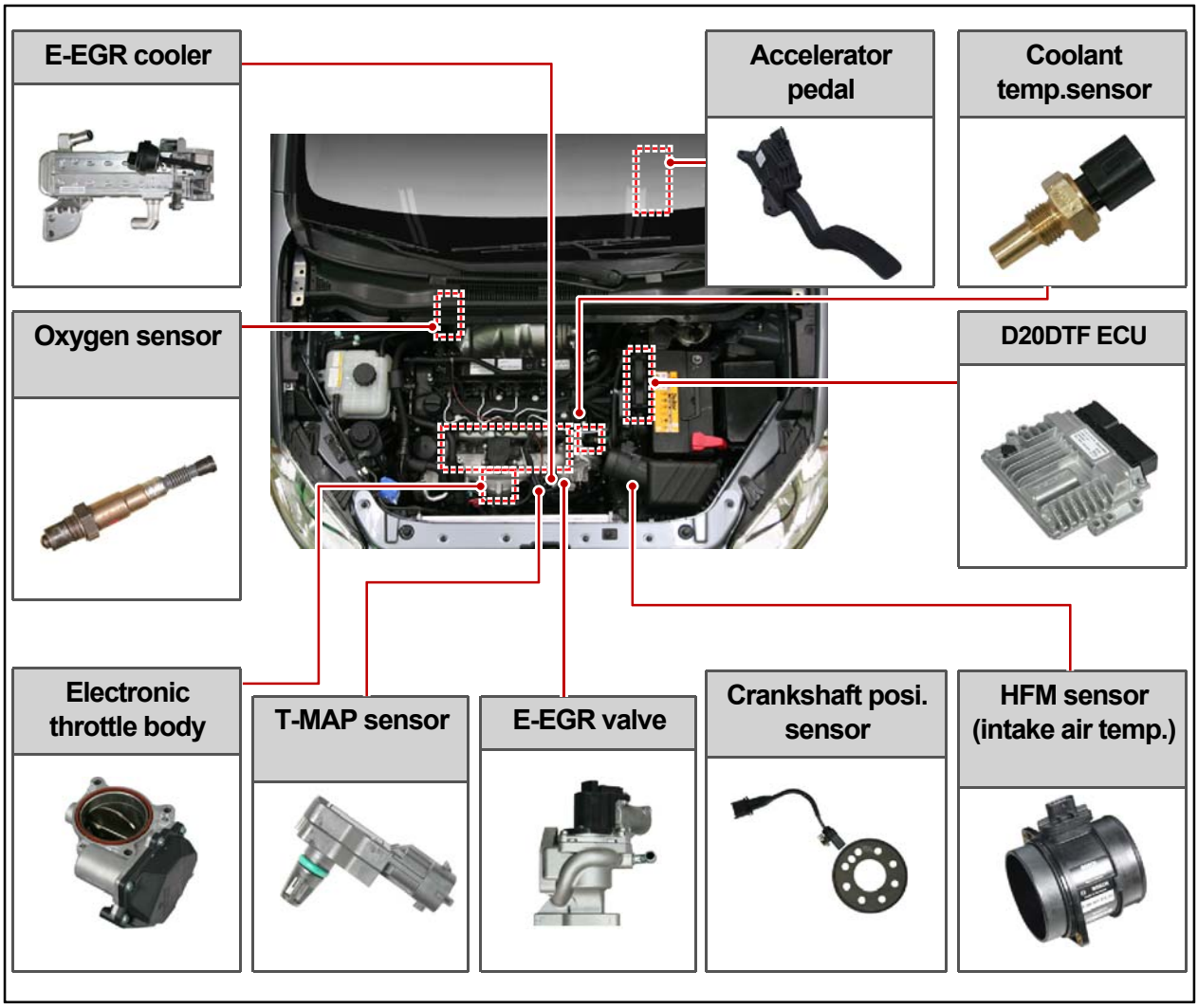
* Anti-knock methods:
- Shorten the ignition timing by pilot injection, lessen the fuel injection volume during ignition delay period.
- Increase engine speed.
- Maintain intake sir temperature with intercooler or glow plug device.
- Increase intake air pressure with turbocharger.
- Warm up engine to keep the normal operating temperature.
- Increase compression ratio.
- Use the fuel with high cetane.

(5) EGR control

a. Overview

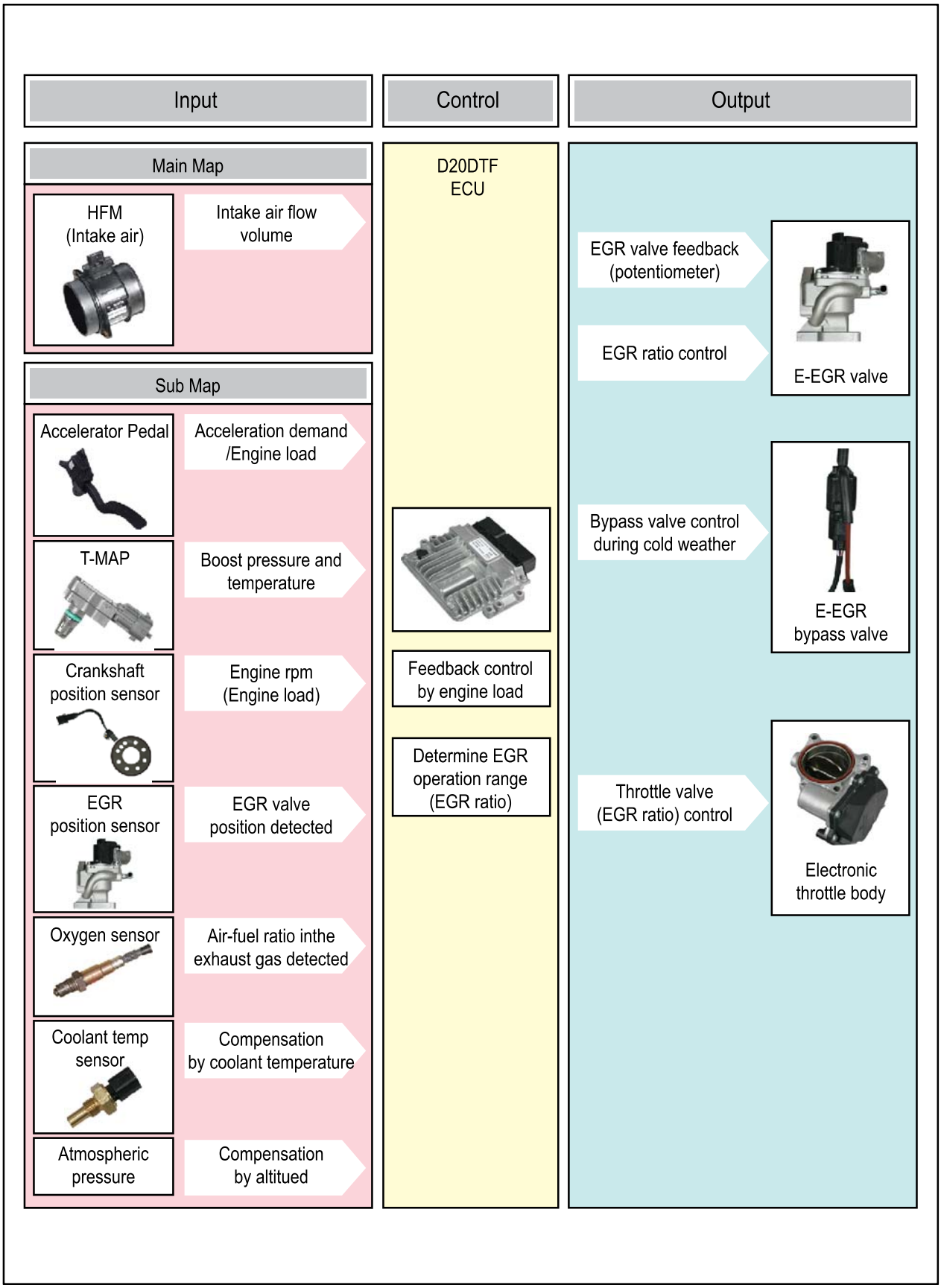
The EGR (Electric-Exhaust Gas Recirculation) valve reduces the NOx emission level by recirculating some of the exhaust gas to the intake system.
The major difference with the previous EURO 4 type, is that the DC motor with improved response rate according to the EURO 5 regulation. The solenoid type actuator is used in the conventional model, but in this new model, the DC motor type actuator with improved response rate is adopted. Also the hall sensor which provides a more stabilized signal than the potentiometer, and the EGR bypass flap which improves engine warming up efficiency are also used. The HFM sensor and the position sensor are used to feedback the amount of EGR for both EURO 4 and EURO 5.

b. Components



Modification basis	
Application basis	
Affected VIN	

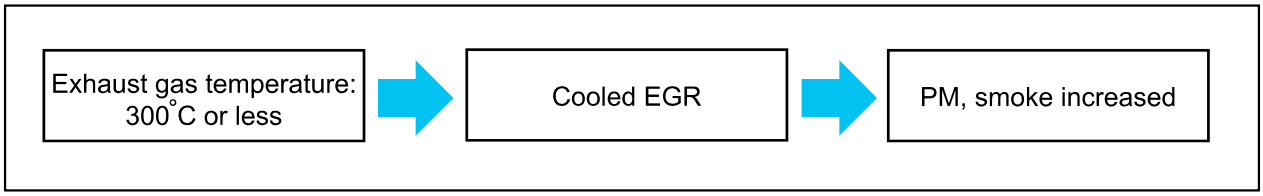
c. Input/Output of E-EGR system



d. Bypass control for EGR cooler

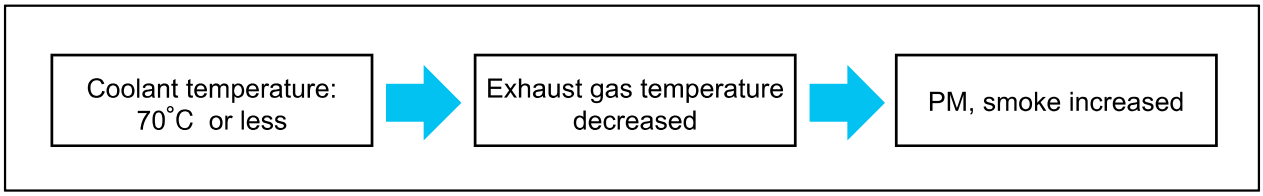
1. Cooler temperature

When the coolant temperature is below 70℃, the exhaust gas is bypassed the EGR cooler.



2. Exhaust gas temperature

When the exhaust gas temperature is below 300℃, the exhaust gas is bypassed the EGR cooler. Otherwise, PM could be increased due to too low exhaust gas temperature.

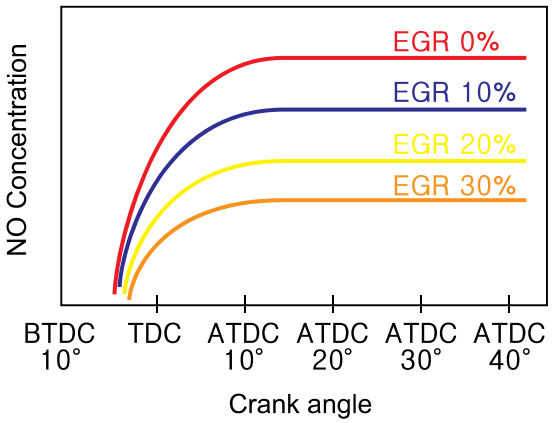


e. Control elements for EGR system

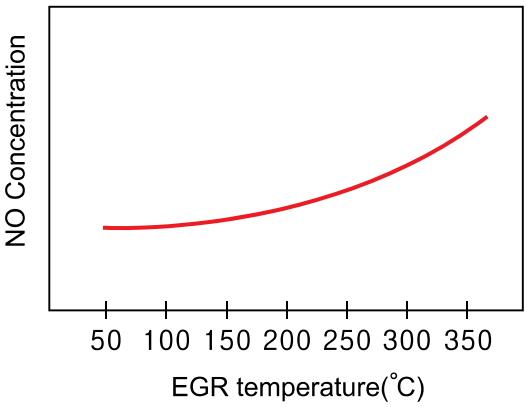
- Accelerator pedal (engine load) - Indicates the driver's intention and engine load. If the load goes up, the EGR ratio is decreased.
- T-MAP (boost pressure map stored in ECU) - Compensates the difference in boost pressure by adjusting EGR ratio.
- Engine rpm - Used as the signal for determining EGR operating range.
- Coolant temperature - When the coolant temperature is low, NOx is decreased but PM could be increased. So, to reduce PM, decrease EGR ratio when the coolant temperature is low.
- Intake air mass and temperature - HFM sensor measures the intake air mass to calculate the actual EGR volume. If the air mass is larger than programmed value in map, EGR ratio will be higher.
- EGR position sensor - Detects the actual opening angle of EGR valve and performs feedback function according to PWM control by ECU.
- Wide band oxygen sensor - Detects the oxygen volume in exhaust gas to check if the EGR ratio is proper.
- Electronic throttle body - Keeps EGR ratio to optimized level by controlling the throttle body in EGR operating range (decreasing pressure in intake manifold).

Modification basis	
Application basis	
Affected VIN	

f. Features



As EGR ratio goes up, smoke volume will be higher. But, this lowers the combustion chamber temperature and accordingly the concentration of NOx is decreased. The point with highest NOx is immediately after TDC.



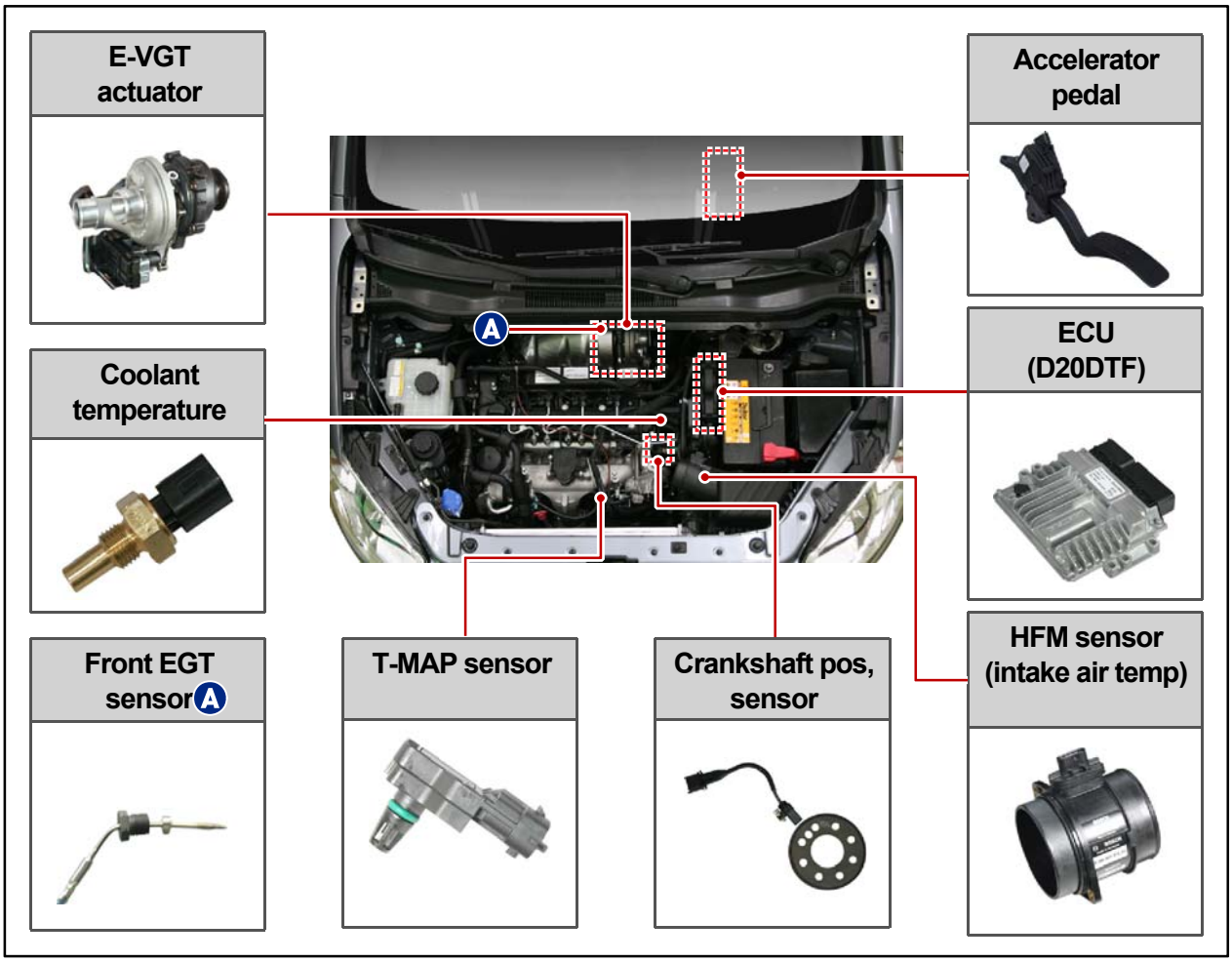
As EGR temperature goes up, the concentration of NOx will be higher. Thus, it is necessary to cool down the exhaust gas. However, during engine cooled, it may cause large amount of PM. To prevent this, the exhaust gas is bypassed the EGR cooler.

(6) E-VGT control

a. Overview

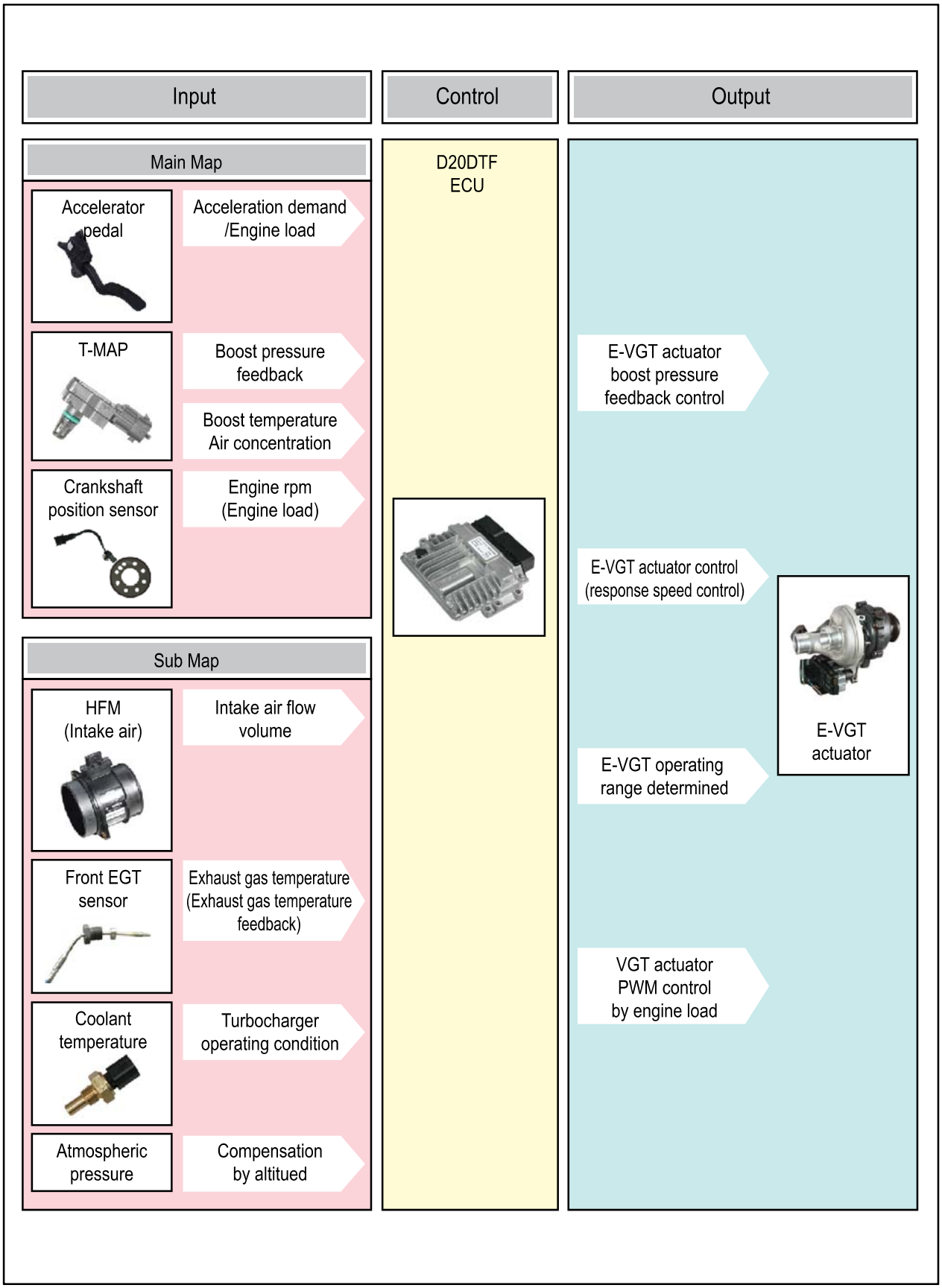
E-VGT (Electric-Variable Geometry Turbine) turbocharger system in D20DTF engine uses the venturi effect that controls the flow rate of exhaust gas by adjusting the passage in turbine housing. The newly adopted DC motor actuator (E-actuator) controls the E-VGT system more precisely and faster. To get the high operating power from turbine, the ECU reduces the exhaust gas passage In low speed range and increases it in high speed range.

b. Components



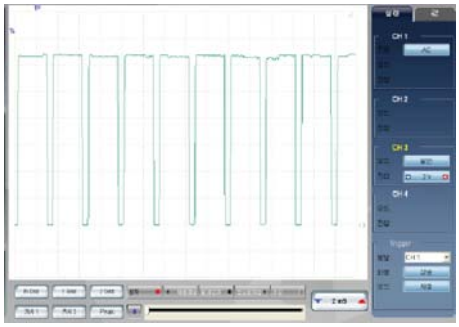
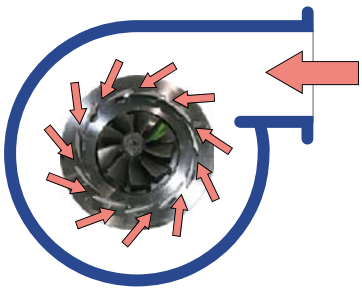
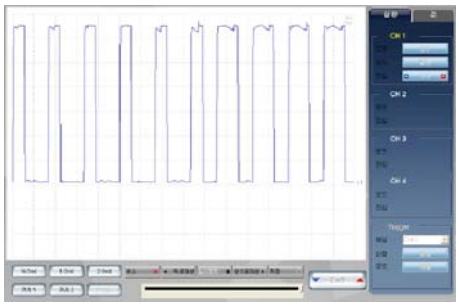
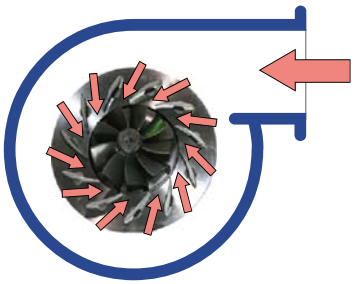
Modification basis	
Application basis	
Affected VIN	

c. Input/Output for E-VGT system



d. E-VGT system control

Turbocharger system operates the E-VGT actuator according to the signals for engine epm, accelerator pedal position, atmospheric pressure, T-MAP, coolant temperature and intake air temperature.
Turbocharger actuator is performed PWM control by ECU.
In general, the boost pressure feedbacks the turbocharger operation and the boost temperature is used for calculating the precise density.
E-VGT provides higher engine power with faster reaction speed compared to conventional VGT.

	Operating wave	Vane	Control
Low speed range			In low speed range: retract the vane to increase boost pressure. The vane has low (-) duty, and the unison ring moves to retract the vane in weak PWM signal.
High speed range			The unison ring moves to extend the vane in strong PWM signal. Maximum pressure is 3 bar and the system controls it according to the input signals.

Modification basis	
Application basis	
Affected VIN	

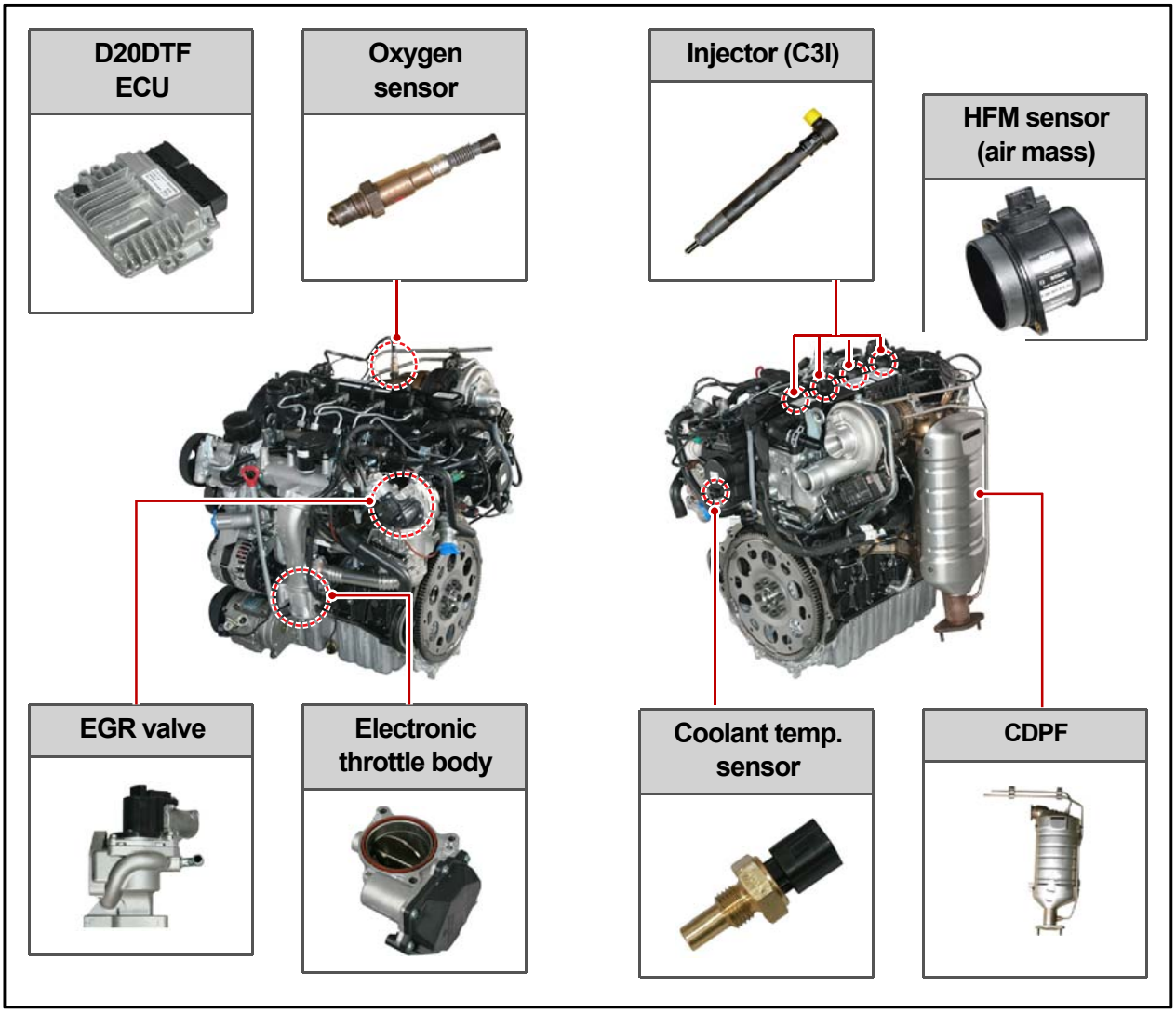
(7) Wide band oxygen sensor

a. Overview

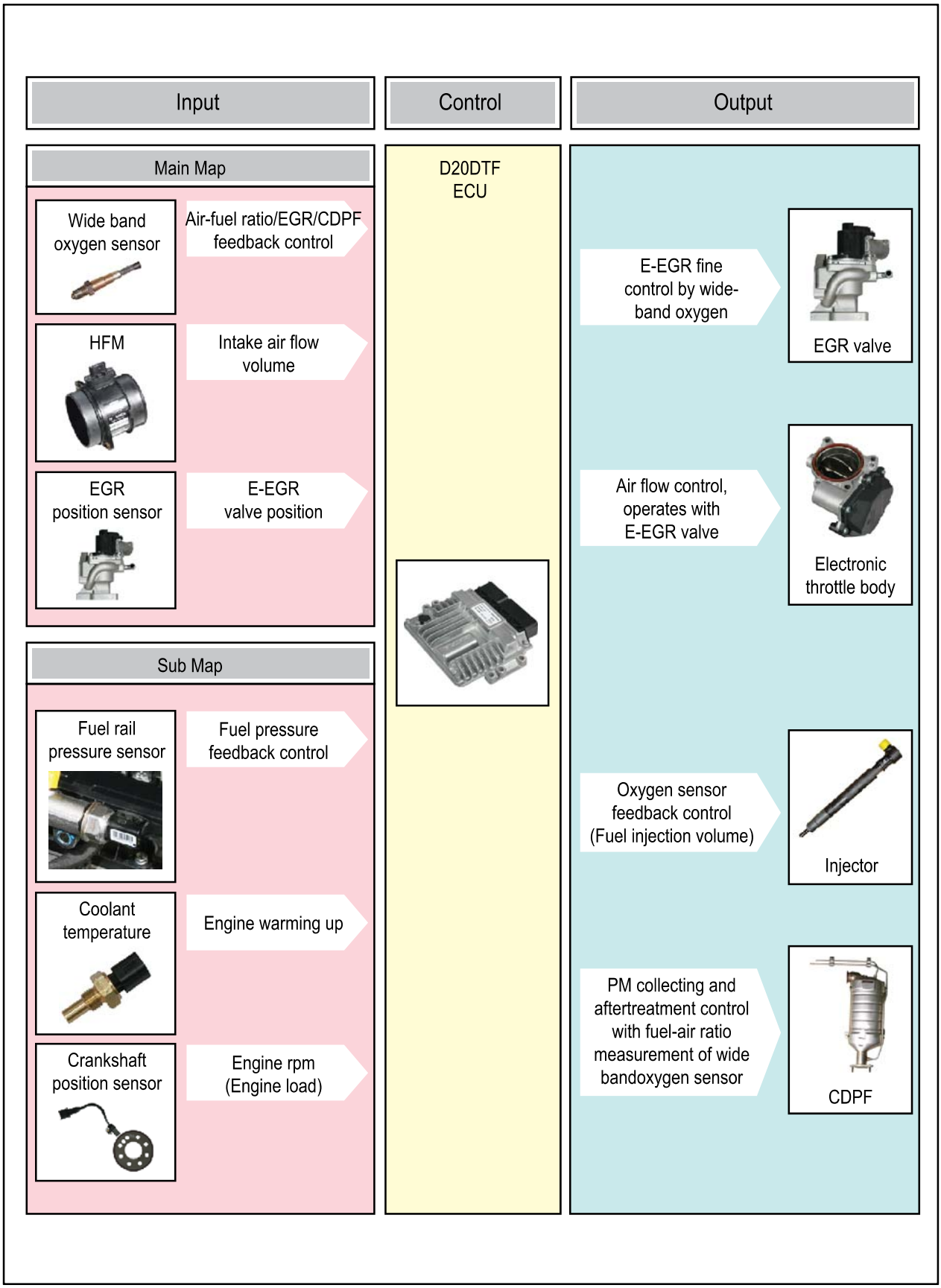
For diesel engine, combustion is not performed at the optimum (theoretically correct) air-fuel ratio and the oxygen concentration is thin in most cases. So the wide-band oxygen sensor is used for this kind of engine, and this sensor is a little different from the one that used for gasoline engine. The combustion in diesel engine is controlled by fuel injection volume. Therefore, the wide band oxygen sensor should be used in diesel engine. This sensor measures the air-fuel ratio in very wide range, and is also called full range oxygen sensor.

- The wide band oxygen sensor measures the oxygen density in exhaust gas and sends it to ECU to control the EGR more precisely.

b. Components



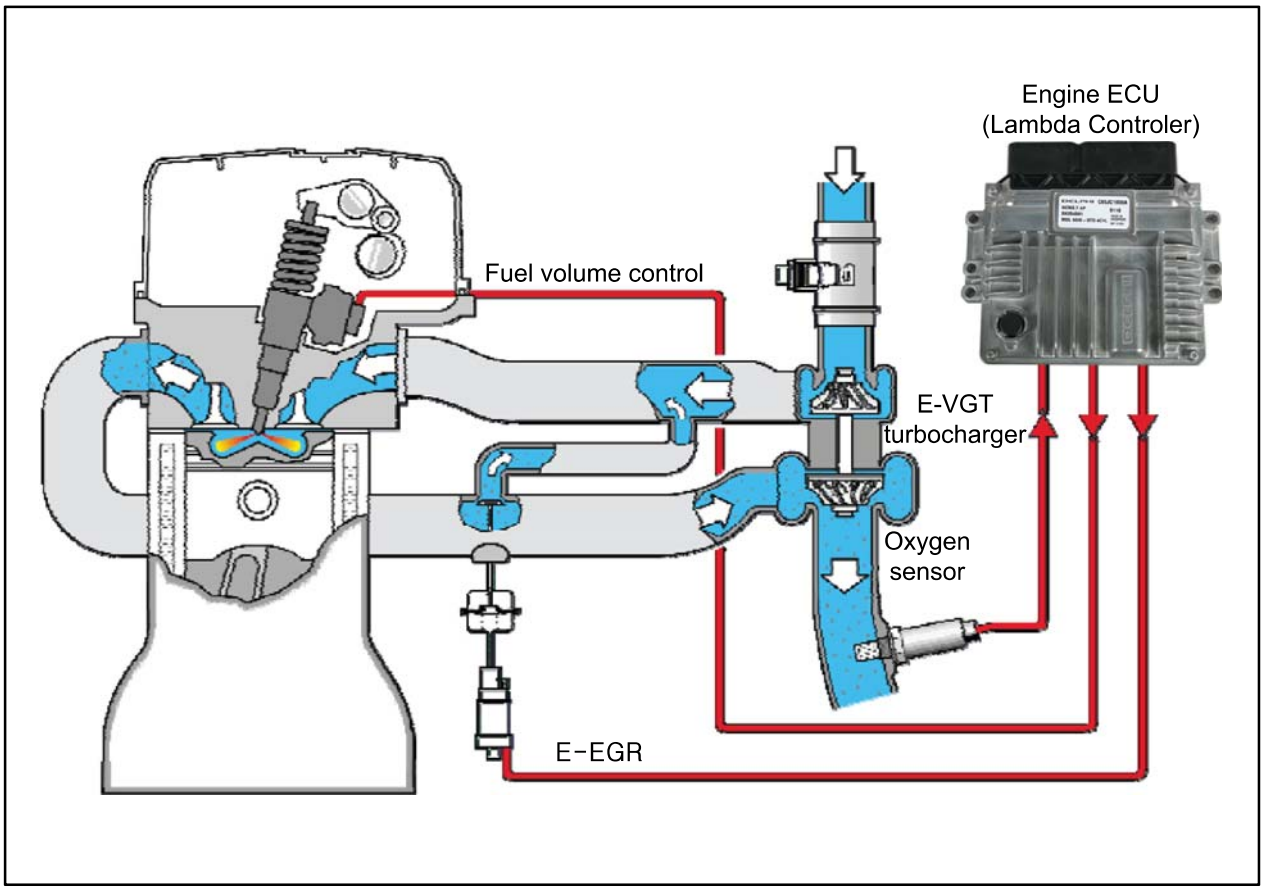
c. Input/Output for oxygen sensor



Modification basis	
Application basis	
Affected VIN	

d. Oxygen sensor control

The wide band oxygen sensor uses ZnO2. It produces the voltage by movement of oxygen ions when there is oxygen concentration difference between exhaust gas and atmosphere.
If a certain voltage is applied to the sensor, the movement of oxygen ions occurs regardless of the oxygen density. The current generated through this flow of ions, is called pumping current (IP), and the oxygen sensor measures this value.



(8) Cooling fan control

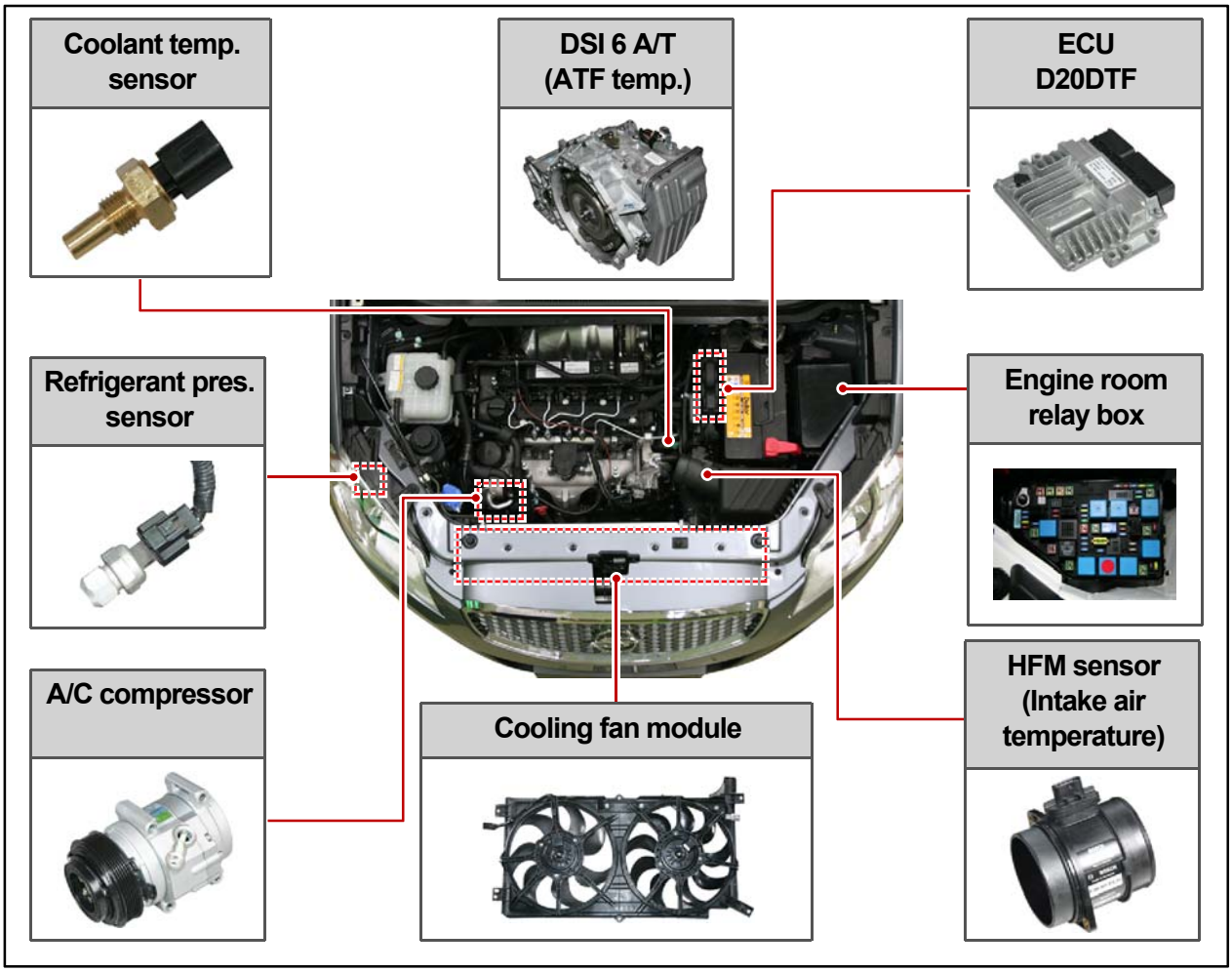
a. Overview of cooling fan and A/C compressor

The cooling system maintains the engine temperature at an efficient level during all engine operating conditions. The water pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools. The heat from automatic transaxle is also cooled down through the radiator by circulating the oil through the oil pump.
There are two cooling fans (200W+150W) in D20DTF engine. ECU controls the electric cooling fans with three cooling fan relays to improve the engine torque and air conditioning performance.

NOTE

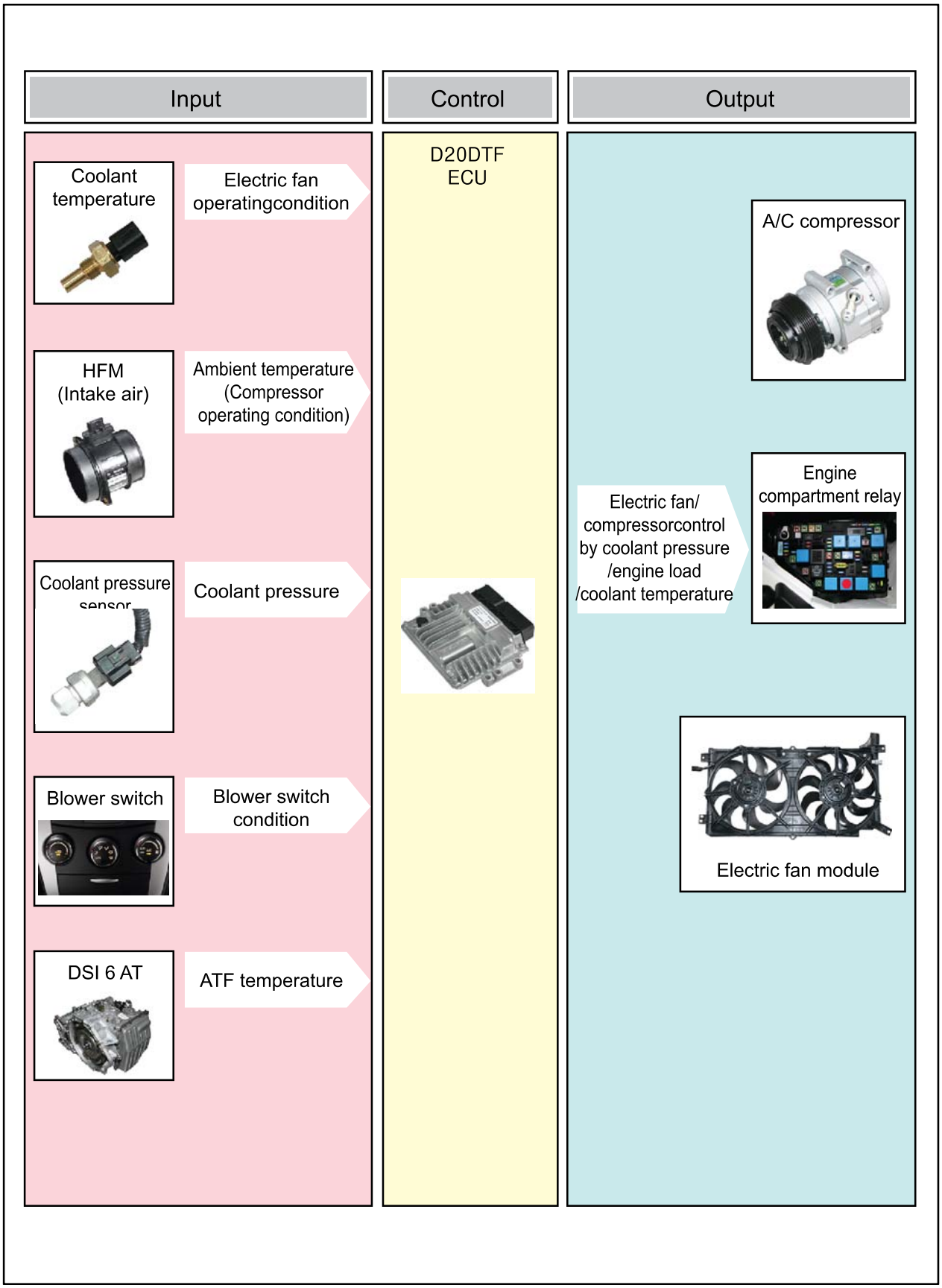
For details about A/C compressor and refrigerant pressure sensor, refer to Chapter "Air Conditioning System" in "Body" section.

b. Components



Modification basis	
Application basis	
Affected VIN	

c. Input/Output for cooling fan and A/C compressor



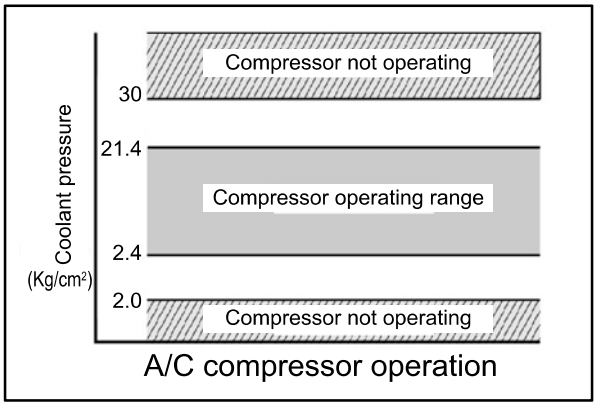
d. Cooling fan and A/C compressor control

▶ Conditions for cooling fan

The cooling fan module controls the cooling fan relay, high speed relay and low speed relay. The cooling fan is controlled by the series and parallel circuits.

A/C switch	Cooling fan	Coolant temperature	Refrigerant pressure	A/C compressor
OFF	OFF	Coolant temp. < 90℃	-	
	LO	90℃ ≤ Coolant temp. < 105℃	-	
	HI	105℃ ≤ Coolant temp	-	
ON	LO	Coolant temp. < 105℃	Refrigerant pressure < 18 bar	ON
	HI		18 bar ≤ Refrigerant pressure	
	HI	105℃ ≤ Coolant temp. < 115℃	-	
	HI	115℃ ≤ Coolant temp.	-	OFF (cut)

▶ A/C compressor OFF conditions



A/C compressor operation

- Coolant temperature: below −20℃ or over 115℃
- Approx. 4 seconds after starting the engine
- Engine rpm: below 650 rpm or over 4500 rpm
- When abrupt acceleration
- Refrigerant pressure:
  * OFF below 2.0 kg/㎠, then ON over 2.4 kg/㎠
  * OFF over 30 kg/㎠, then ON below 21.4 kg/㎠

▶ Output voltage according to refrigerant pressure

The output voltage from refrigerant pressure sensor is 1.7 V to 3.5 V when the refrigerant pressure is 10 to 24 kgf/㎠ with A/C "ON".

▶ Cooling fan control according to ATF temperature

ATF temperature	Cooling fan	Remark
Over 100˚C	High speed	-

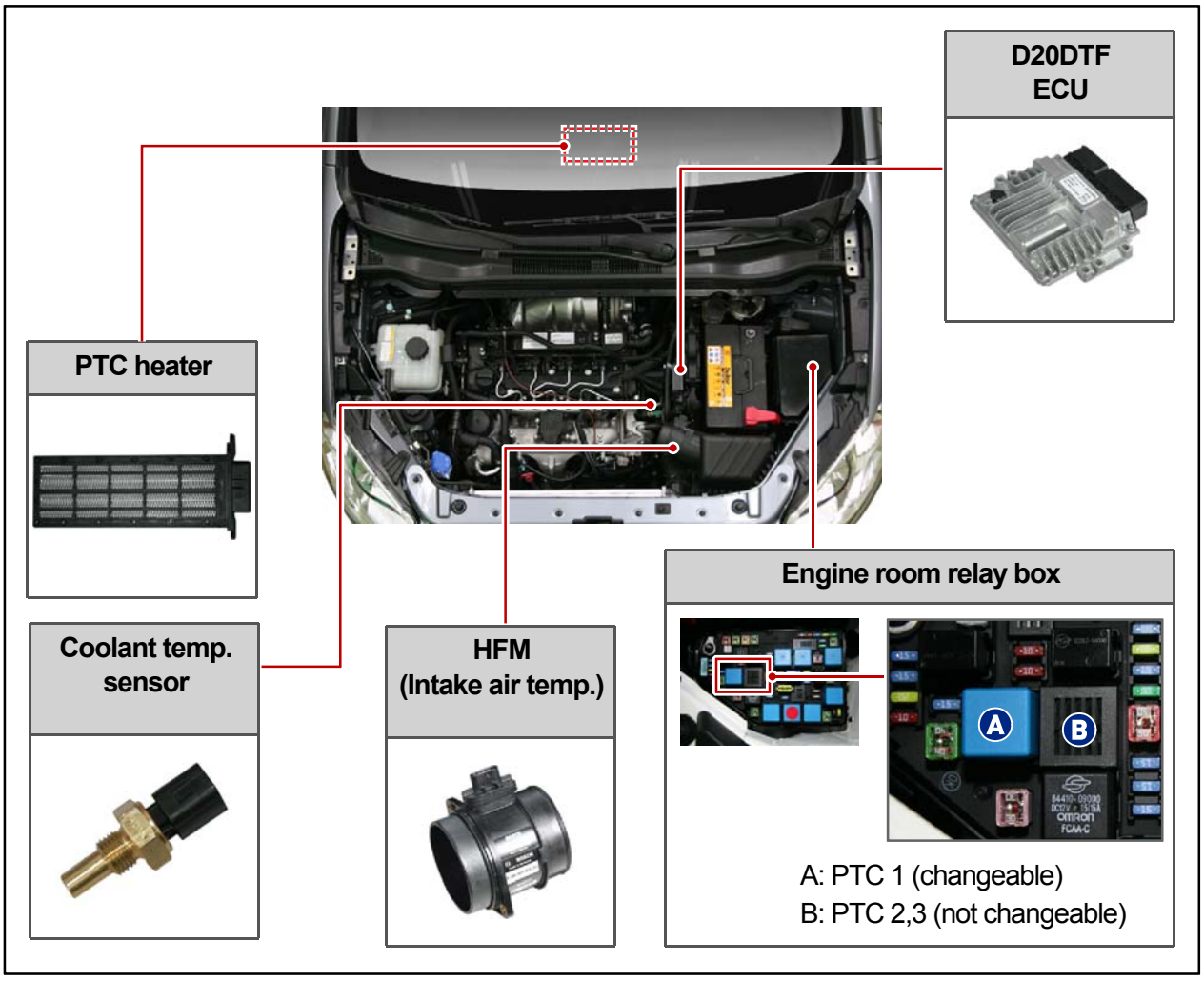
Modification basis	
Application basis	
Affected VIN	

(9) PTC heater control

a. Overview

The supplementary electrical heater is installed in DI engine equipped vehicle as a basic equipment. The PTC system is operated according to two temperature values measured at the coolant temperature sensor and HFM sensor. This device is mounted in the heater air outlet and increase the temperature of air to the passenger compartment. Because PTC system is heated by electrical power, high capacity alternator is required. PTC does not operate during engine cranking, while the battery voltage is lower than 11 V or during preheating process of glow plugs.

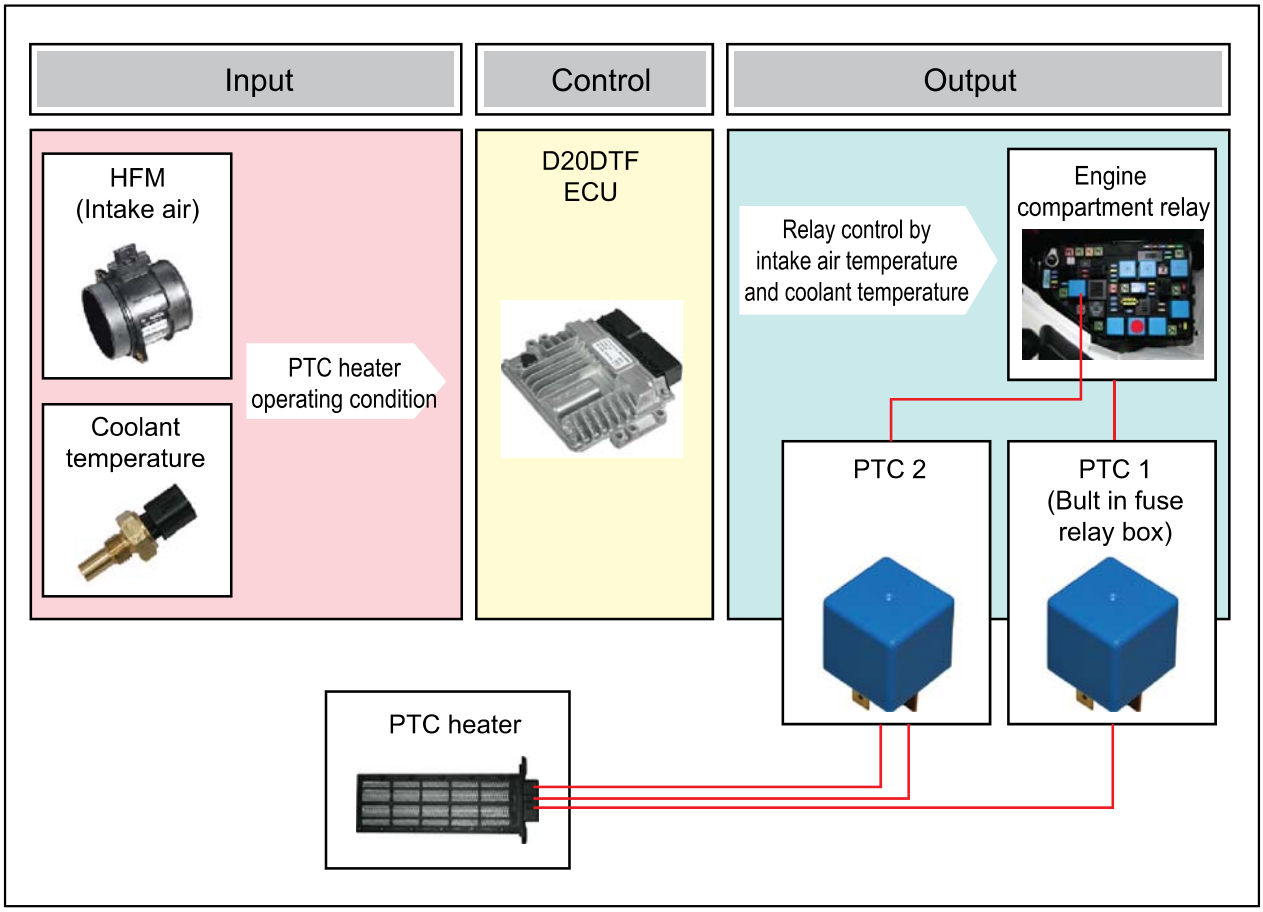
b. Components



c. Operation process

The ceramic PTC has a feature that the resistance goes up very high at a certain temperature. There are three circuits in PTC heater. Only one circuit is connected when PTC1 relay is ON, and two circuits are connected when PTC2 relay is ON.

Operation process: reaches at a certain temperature→high resistance→low current→less heat radiation→temperature down→high resistance→high current→temperature up

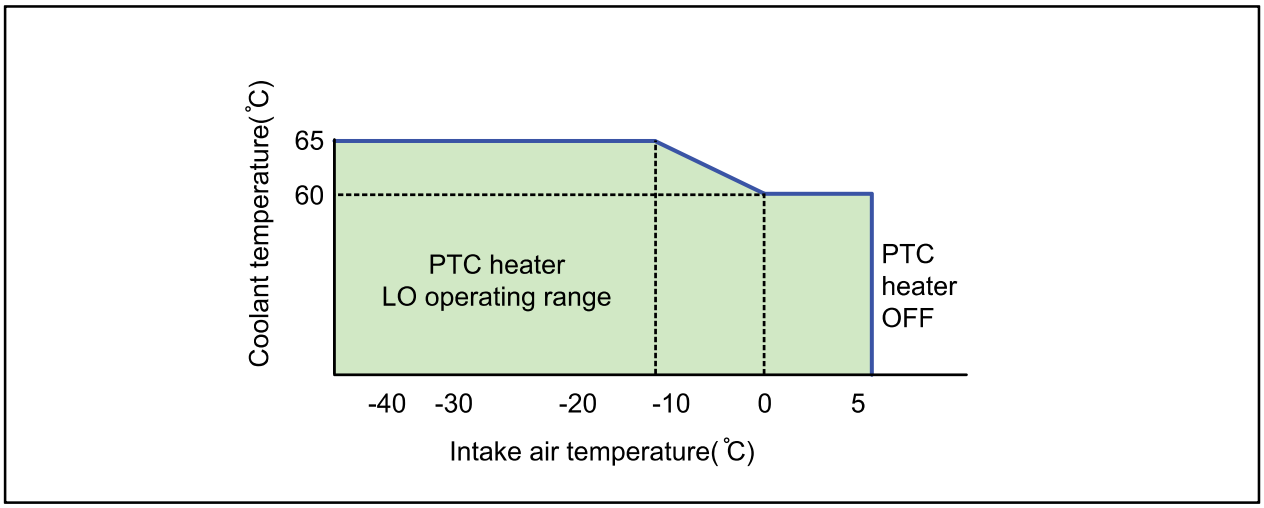


Modification basis	
Application basis	
Affected VIN	

d. Control conditions

Operation	Operating condition	PTC Heater
HI (PTC2)	- Coolant temperature < 15℃	PTC HI ON
LO (PTC1)	- Coolant temperature 15℃ ≤ 65℃, intake air temperature ≤ −10℃ - Coolant temperature 15℃ < 65 to 60℃, intake air temperature <−10℃ to 0℃ - Coolant temperature 15℃ ≤ 60℃, intake air temperature ≤ 0℃ to 5℃	PTC LO ON
Stop	- A/C blower switch OFF - Defective ambient air temperature sensor (including open or short circuit) - Engine cranking - Low battery voltage (below 11V) - During pre-glow process (glow indicator ON)	

▶ **Operation diagram for PTC heater LO (step 2)**



(10) Immobilizer control

a. Overview

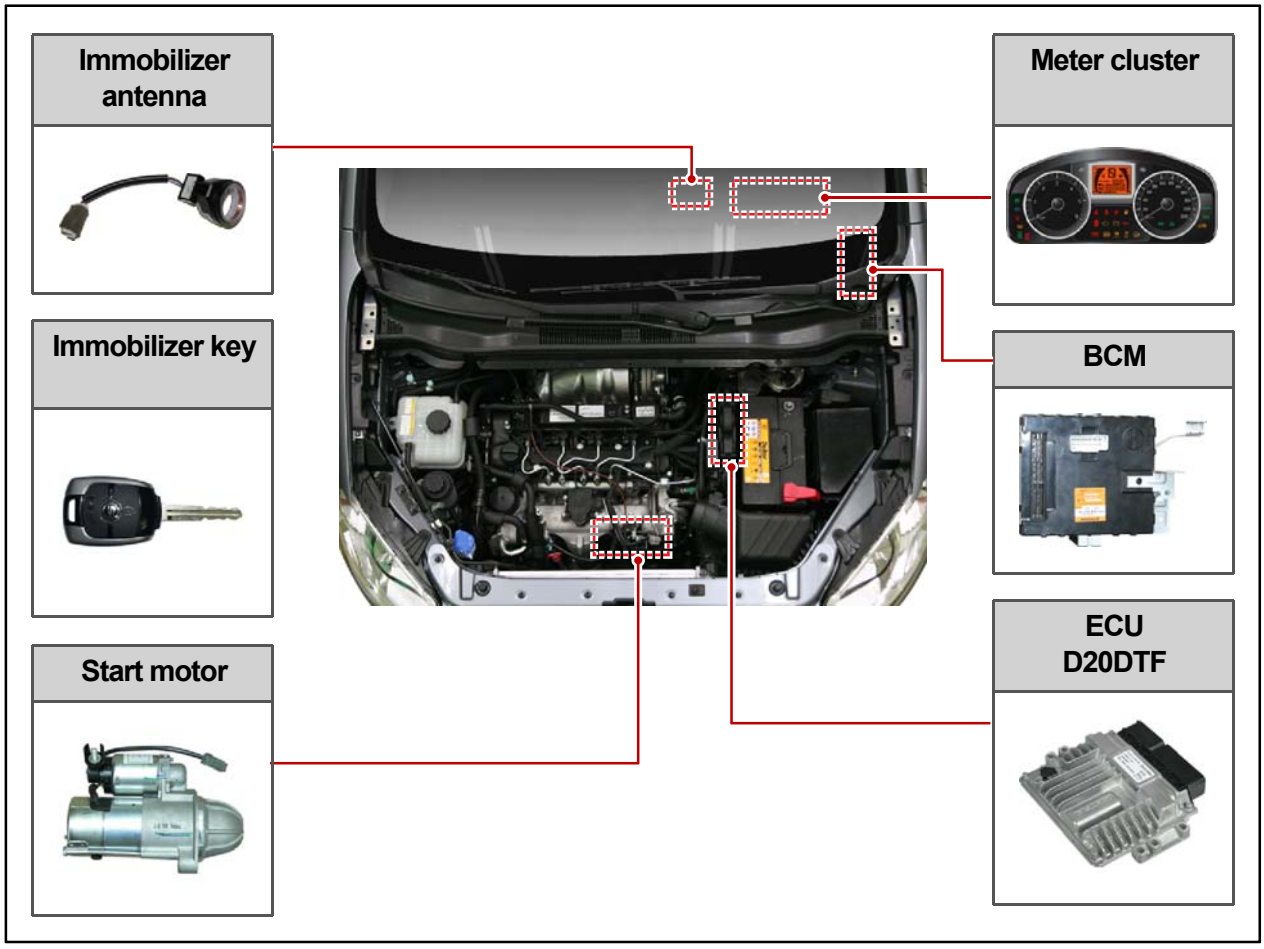
The Immobilizer System provides an additional theft deterrent to the vehicle in which it is installed and prevents it from being started by unauthorized persons. The transponder integrated in the key and the engine control unit have the same code. When the ignition key with the integrated transponder is turned to the ON position, the ECU (Engine Control Unit) checks the crypto code of the key and, if correct, allows the vehicle to start the engine.

NOTE

For details, refer to Chapter "BCM".

b. Components

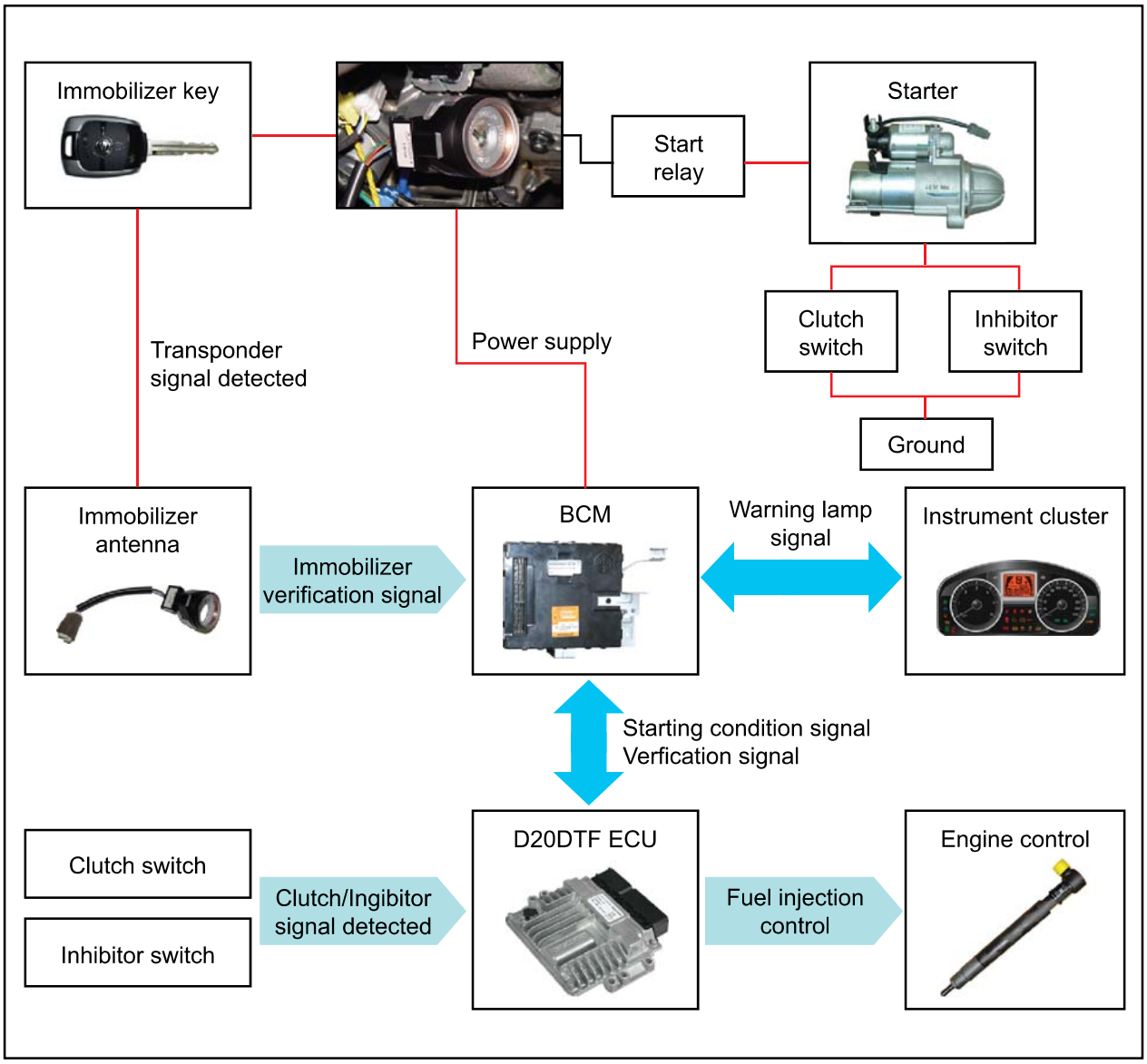
▶ **Basic components (ignition key system)**



Modification basis	
Application basis	
Affected VIN	

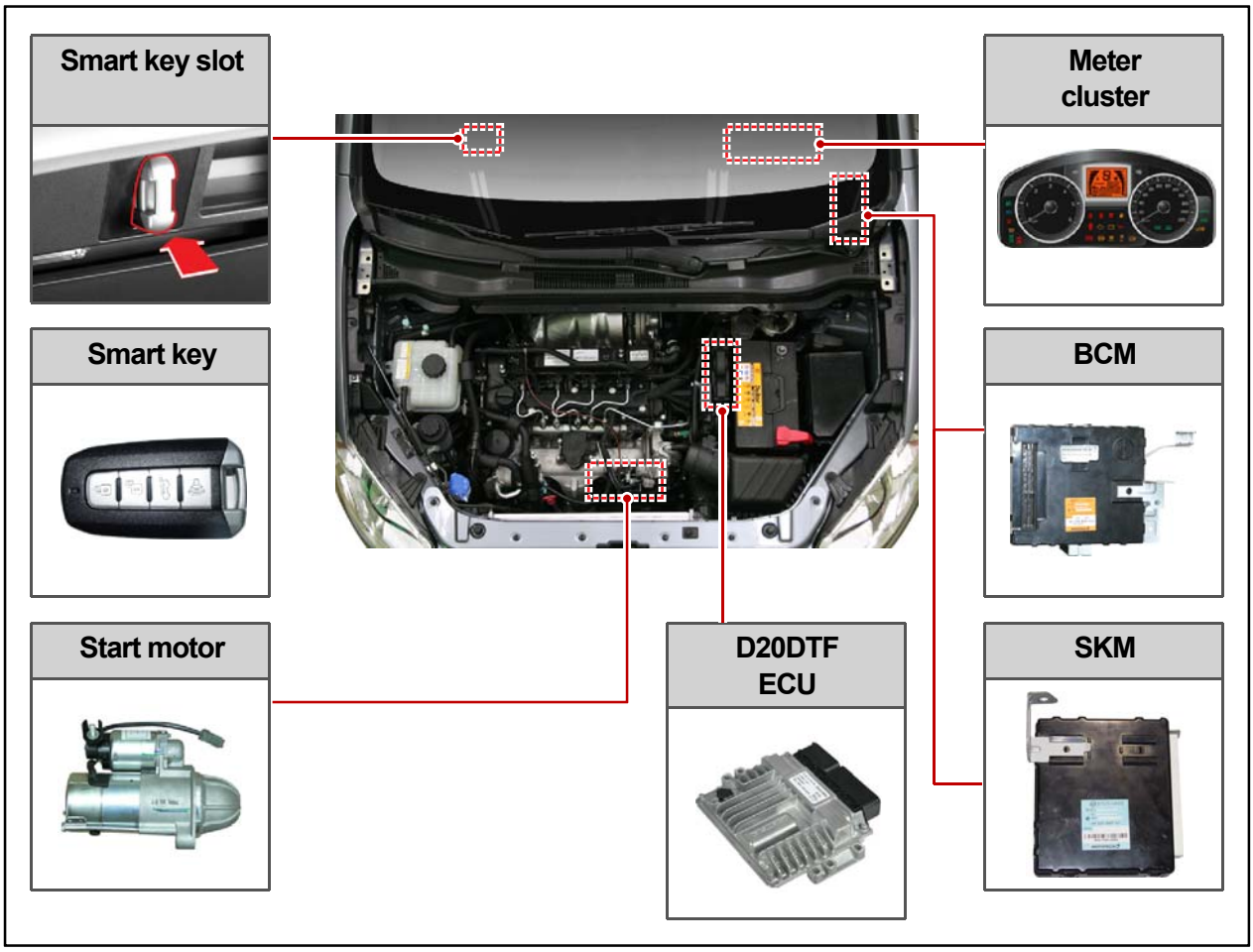
▶ Key approval process

When turning the ignition switch to ON position, the power is supplied to BCM and ECU. ECU communicate with the immobilizer key to check if it is valid crypto code. If it is valid, ECU start to control the engine when turning the ignition switch to START position.
The system has 10 seconds of valid time-out period. If the engine does not start in this period, the key approval process should be done again.



c. Components for immobilizer with Smart key system

▶ Components (For antenna, refer to Chapter "SKM")



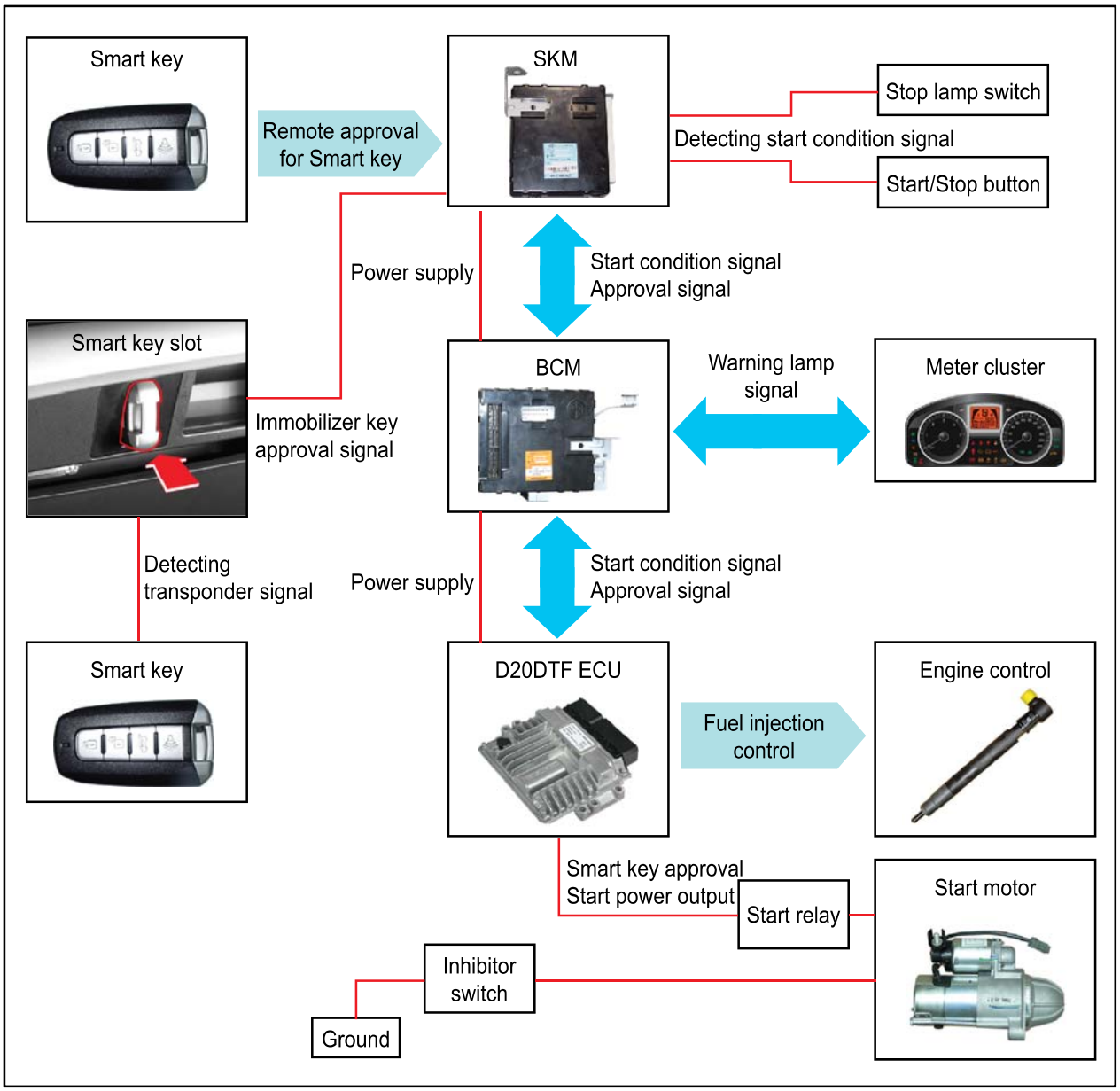
Modification basis	
Application basis	
Affected VIN	

▶ Key approval process in Smart key system equipped vehicle

The key approval consists of two processes; immobilizer key approval and Smart key approval.

Immobilizer key approval: When inserting the Smart key into Smart key slot, the power is supplied to the key slot. SKM communicate with the Smart key in key slot to check if it has valid crypto code. If it is valid, ECU start to control the engine when pressing the Engine Start/Stop button. The system has 10 seconds of valid time-out period. If the engine does not start in this period, the key approval process should be done again.

Smart key approval: When pressing the Engine Start/Stop button or depressing the brake pedal without Smart key inserted into the key slot, SKM communicate with the Smart key to check if it has valid crypto code. If it is valid, the engine can be started.



(11) CDPF control

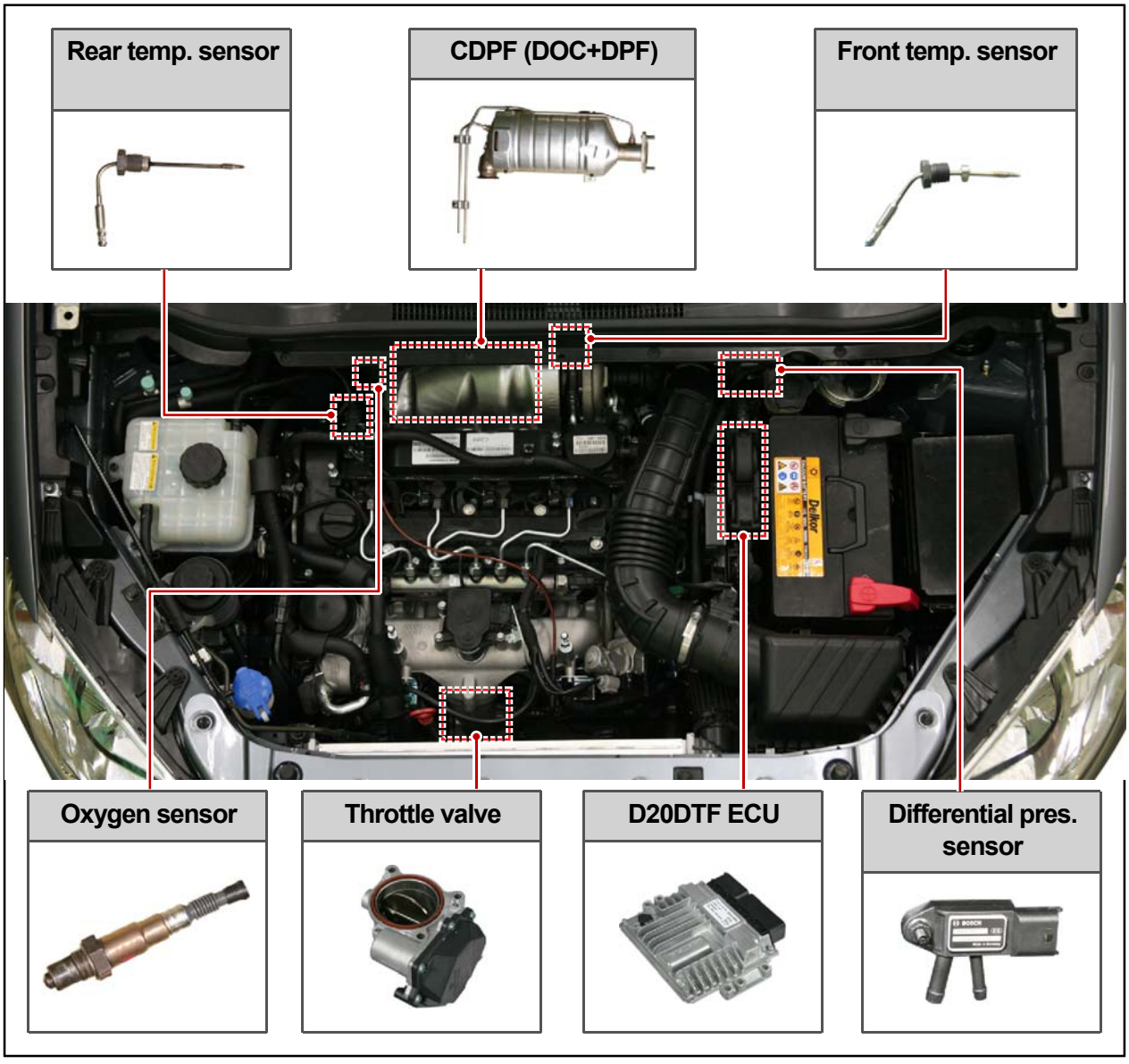
a. Overview

As the solution for environmental regulations and PM Particle Material) of diesel engine, the low emission vehicle is getting popular. This vehicle is equipped with an extra filter to collect the soot and burn it again so that the amount of PM in the exhaust gas passed through the DOC (Diesel Oxidation Catalyst) is reduced. The CDPF (Catalyst & Diesel Particulate Filter) is an integrated filter including DOC (Diesel Oxidation Catalyst) and DPF (Diesel Particulate Filter).

NOTE

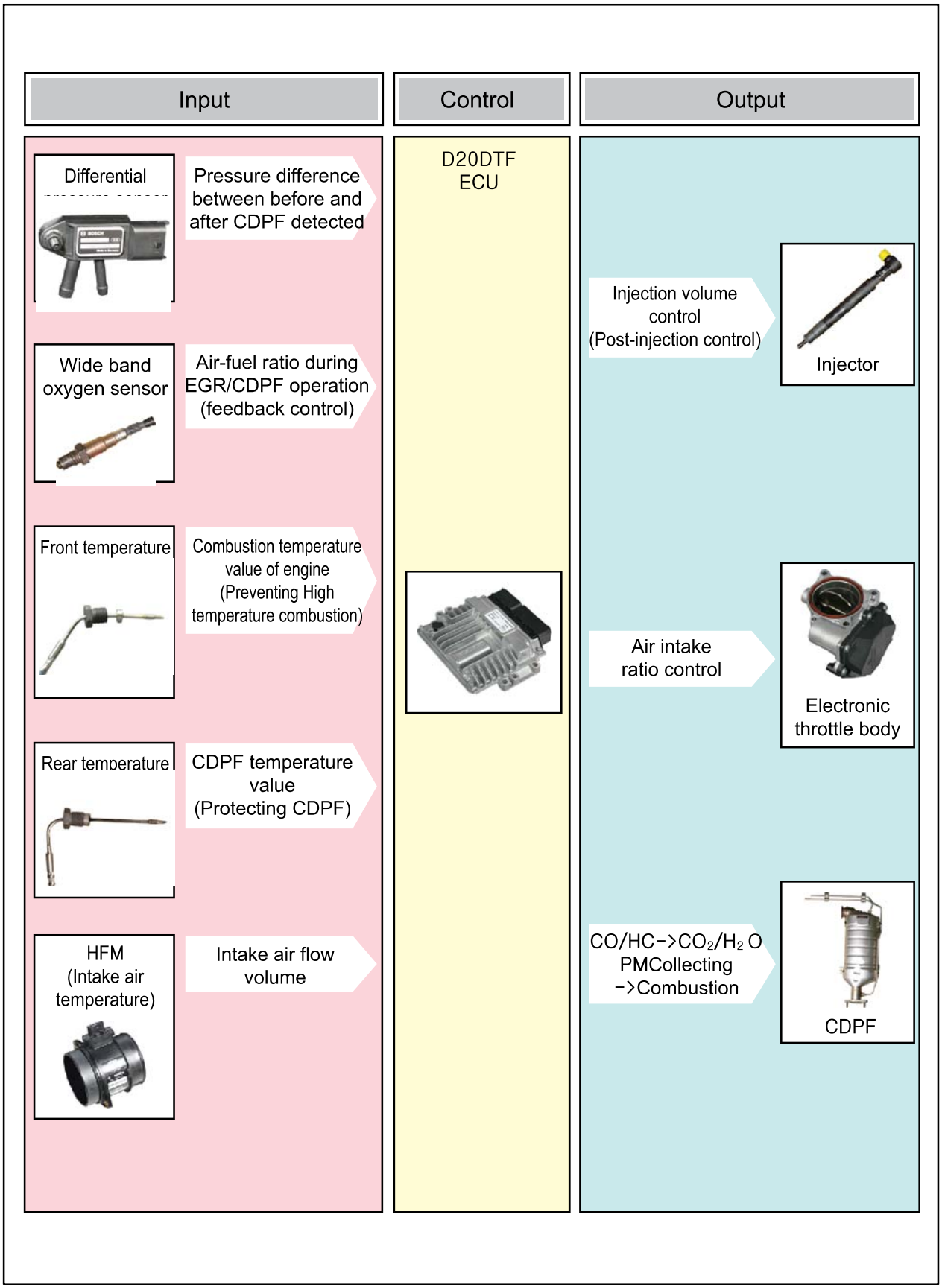
For details, refer to Chapter "CDPF".

b. Components



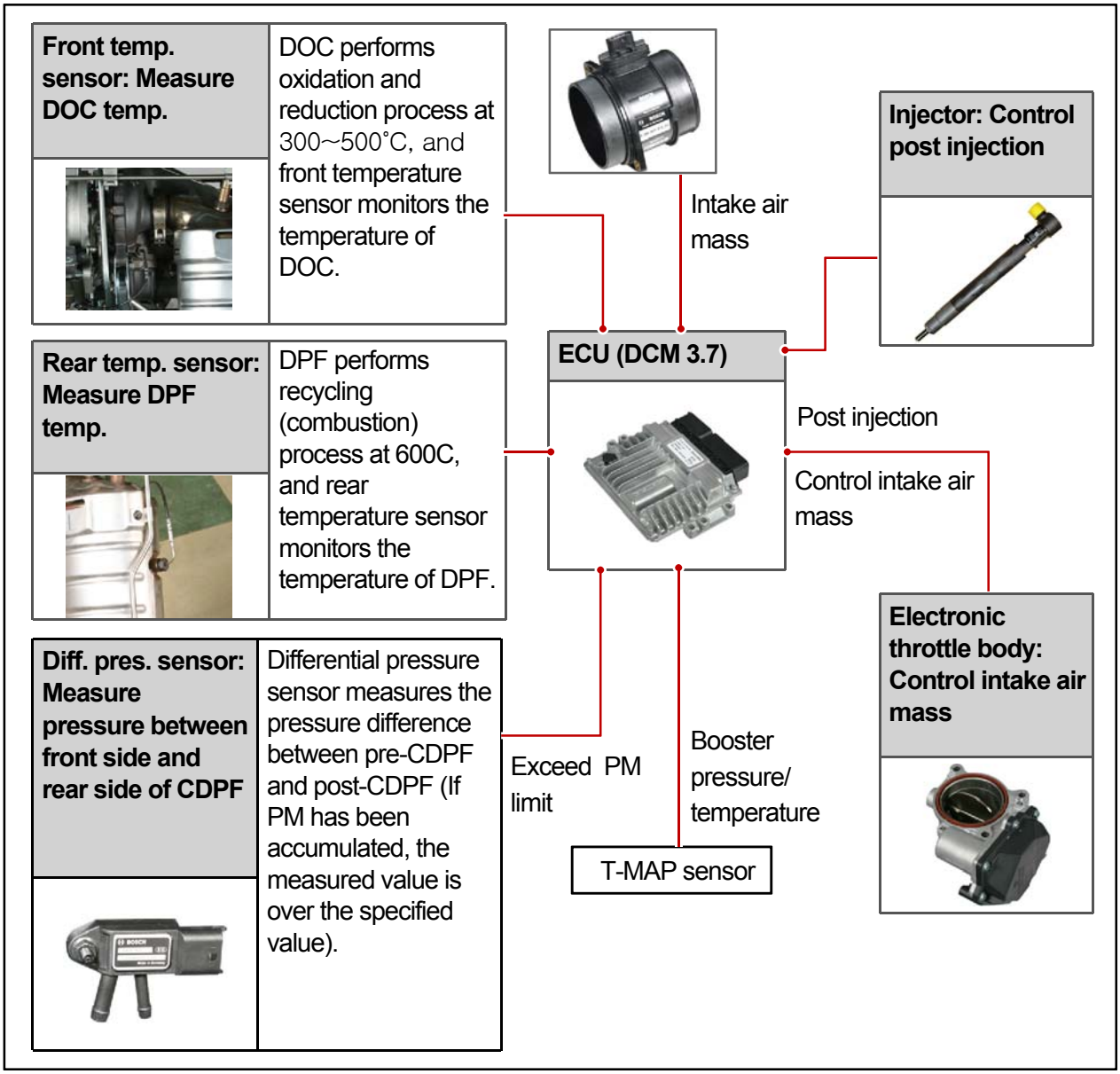
Modification basis	
Application basis	
Affected VIN	

c. Input/Output for CDPF control



d. Operation process

When the differential pressure sensor detects the pressure difference between the front and the rear side of CDPF, the sensor sends signal indicating the soot is accumulated and the post injection is performed to raise the temperature of exhaust gas. The amount of fuel injected is determined according to the temperature of exhaust gas detected by the rear temperature sensor. If the temperature is below 600°C, the amount of fuel injected is increased to raise the temperature. If the temperature is over 600°C, the amount of fuel injected is decreased or not controlled. When the engine is running in low load range, the amount of post injection and the amount of intake air are controlled. It is to raise the temperature by increasing the amount of fuel while decreasing the amount of intake air.



Modification basis	
Application basis	
Affected VIN	

e. Cautions

- Use only specified Engine Oil (approved by MB Sheet 229.51) for CDPF.

1. Use only specified engine oil (Low Ash Oil)

- The vehicle equipped with CDPF should use specific engine oil to improve the engine performance and fuel economy, and ensure the service life of CDPF.

2. Issue with normal engine oil

- Sulfur, one of the contents of engine oil is burned and generates soot that is not regenerated by the DPF. This remains on the filter as ashes and keeps accumulating. Eventually, this ashes will block the filter.

3. Benefit for specified engine oil

- Minimized the sulfur content of engine oil which reduces the service life.
- Improved fuel economy and emission level of CO2 with high performance and low viscosity.
- Increased service life of engine oil with high resistance to temperature.

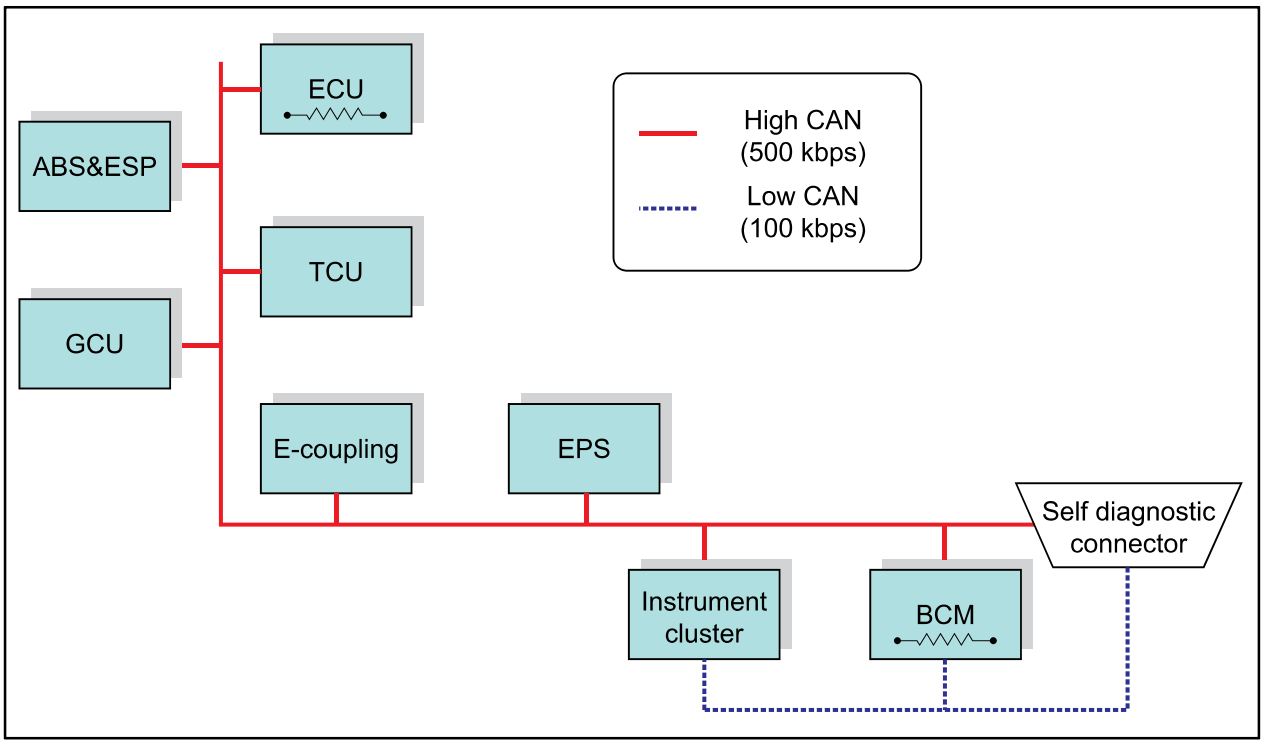
4. Problems when using unspecified engine oil

- The service life of filter may be reduced by 30% or more by the ashes accumulated on the filter.
  The fuel economy may be reduced because of engine rolling resistance, frequent regeneration of
- DPF.

* These problems are also caused by oil with high sulfur content, such as tax exemption oil and heating oil, etc.

3) Input/Output for CAN communication

(1) Configuration of CAN (P-CAN/B-CAN)

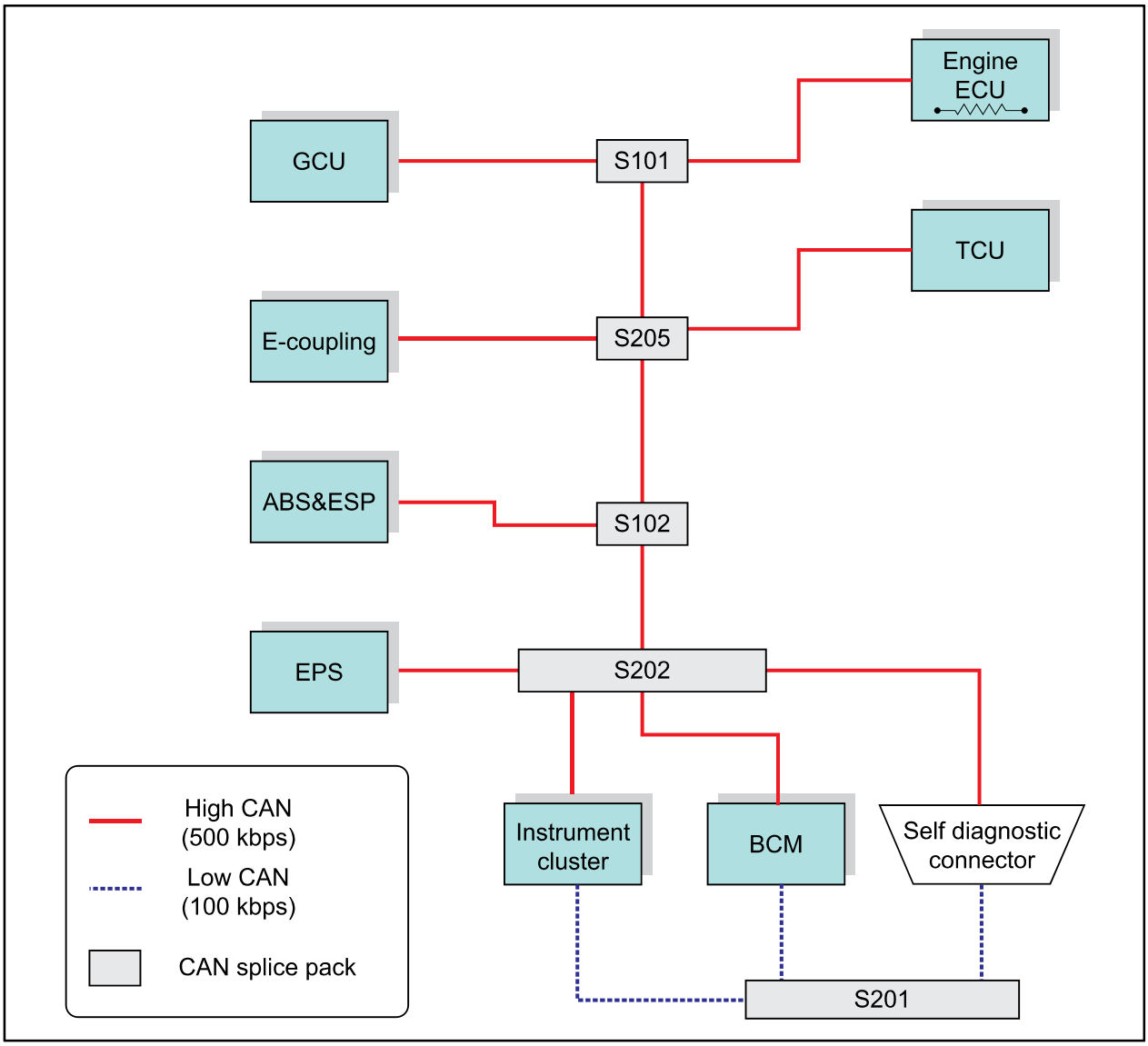


Abbreviation	Function
GCU	Glow Control Unit
EPS	Electronic Power Steering Unit
BCM	Body Control Module

CAN Topology communicate with system units. There are two types (P-CAN and B-CAN) of communication according to the communication speed. Instrument cluster, BCM and diagnostic connector use both types of communication. And, ECU, ABS & ESP, TCU, GCU, E-coupling and EPS unit use P-CAN communication because it is faster than B-CAN. The terminal resistances are installed in ECU and BCM.

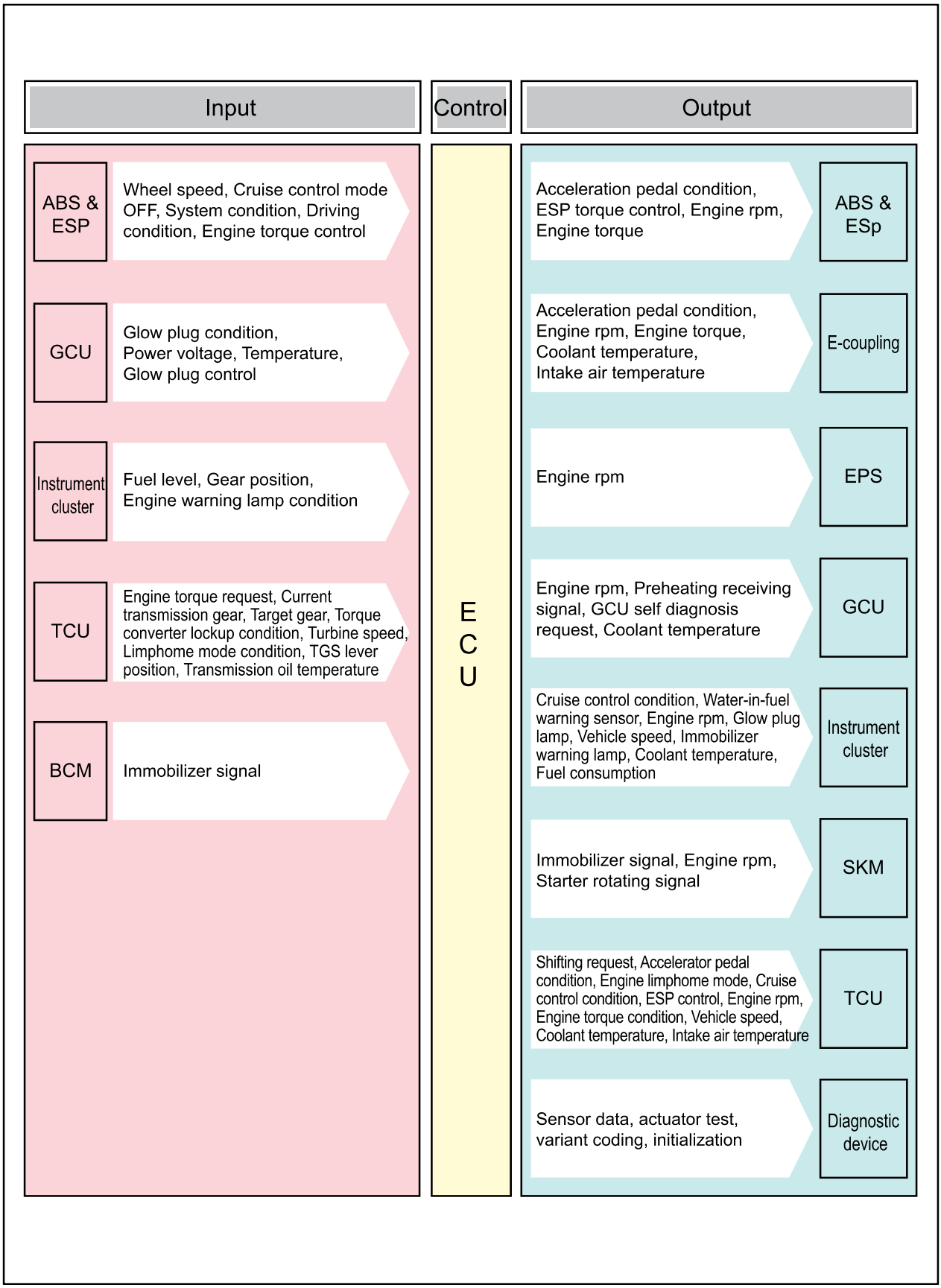
Modification basis	
Application basis	
Affected VIN	

(2) CAN communication flow chart



Splice pack	Wiring harness	Location
S101	Floor wiring (LH)	Under fuse & relay box in engine compartment
S102	Floor wiring (RH)	Inside of right fender
S201	Main wiring	Behind meter cluster (cowl cross member)
S202	Main wiring	Behind meter cluster (cowl cross member)
S205	Floor wiring (LH)	Under driver's door scarf

(3) Input/Output for CAN communication



Modification basis	
Application basis	
Affected VIN	

ENGINE GENERAL

0000-00

GENERAL INFORMATION

1. LAYOUT

Front view



Rear view



Right side view



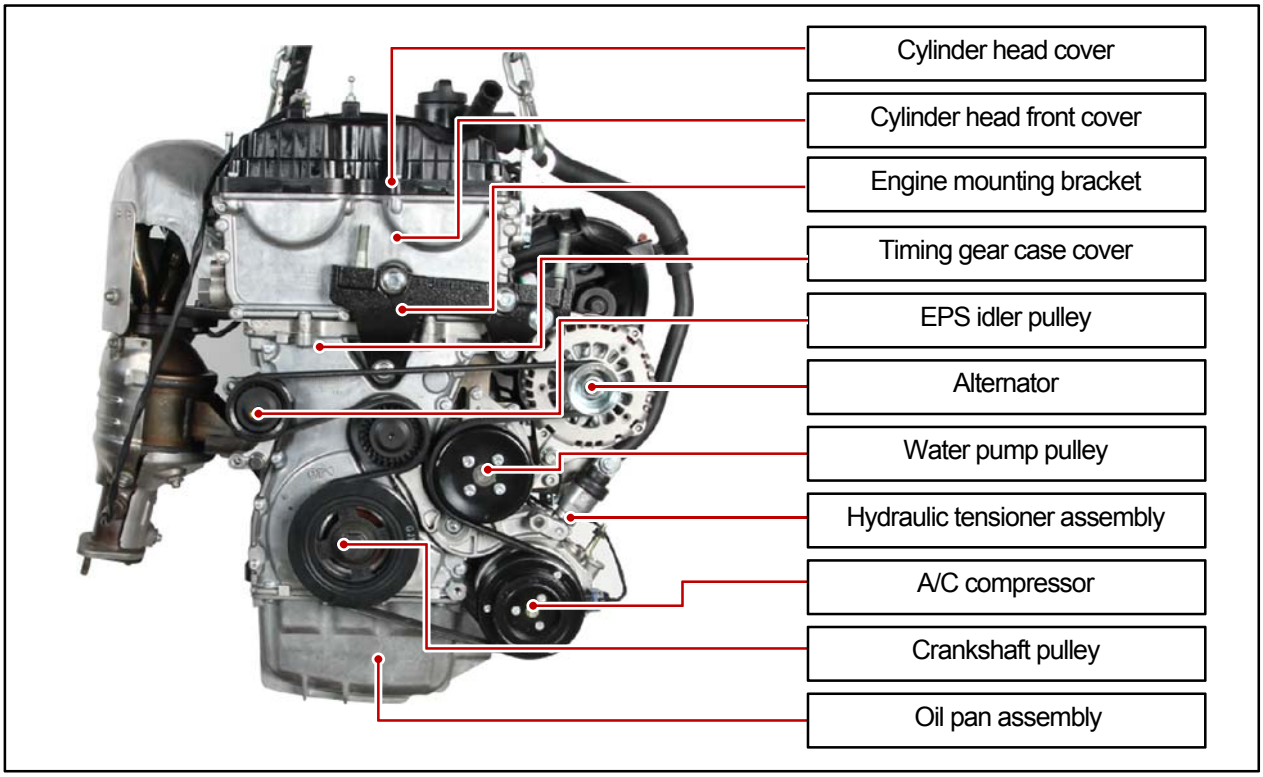
Left side view



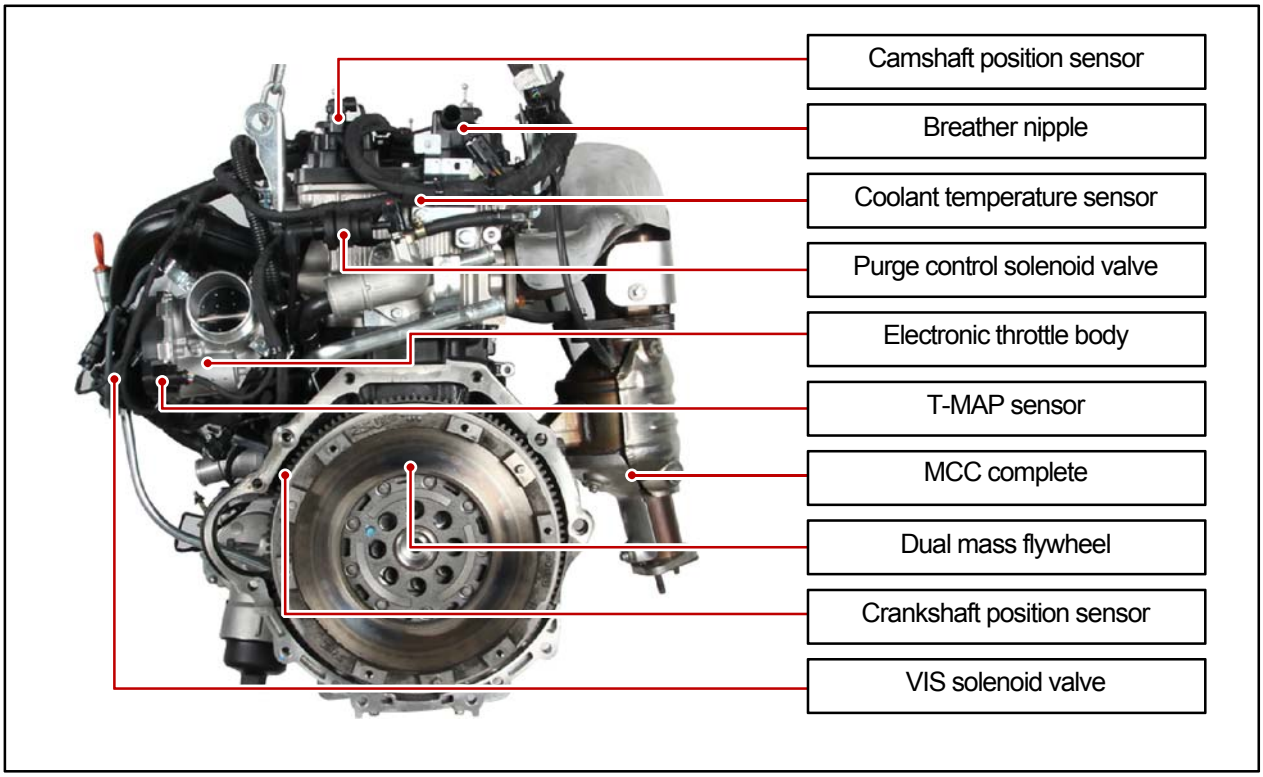
Modification basis	
Application basis	
Affected VIN	

2. MAJOR COMPONENTS

▶ **Front View**

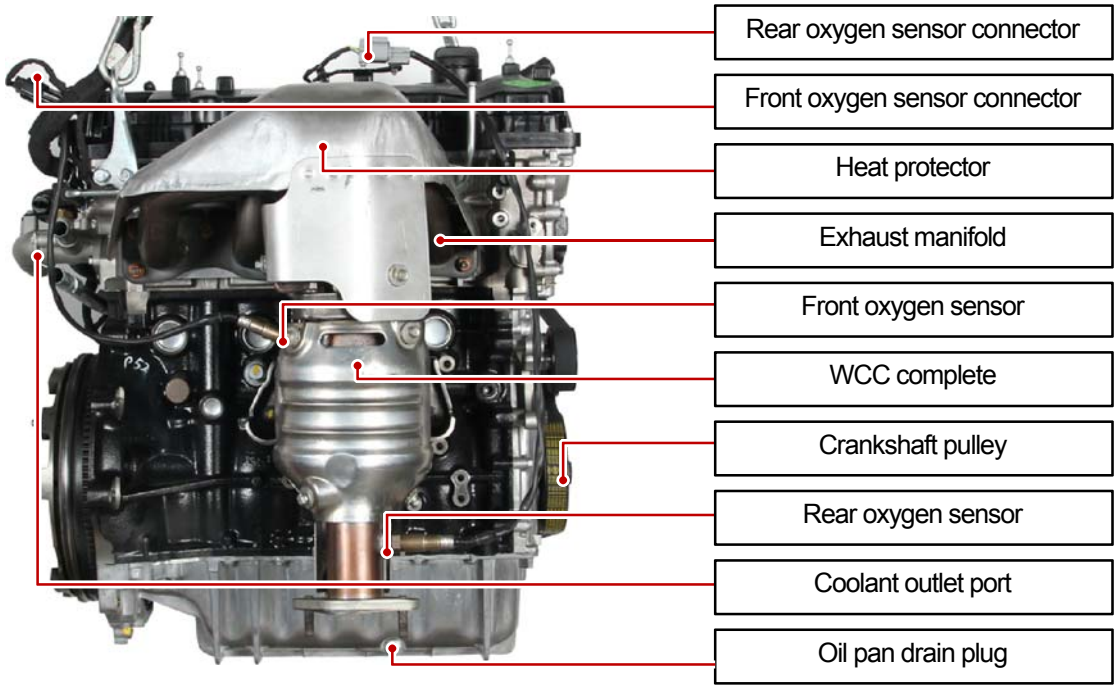


▶ **Rear View**

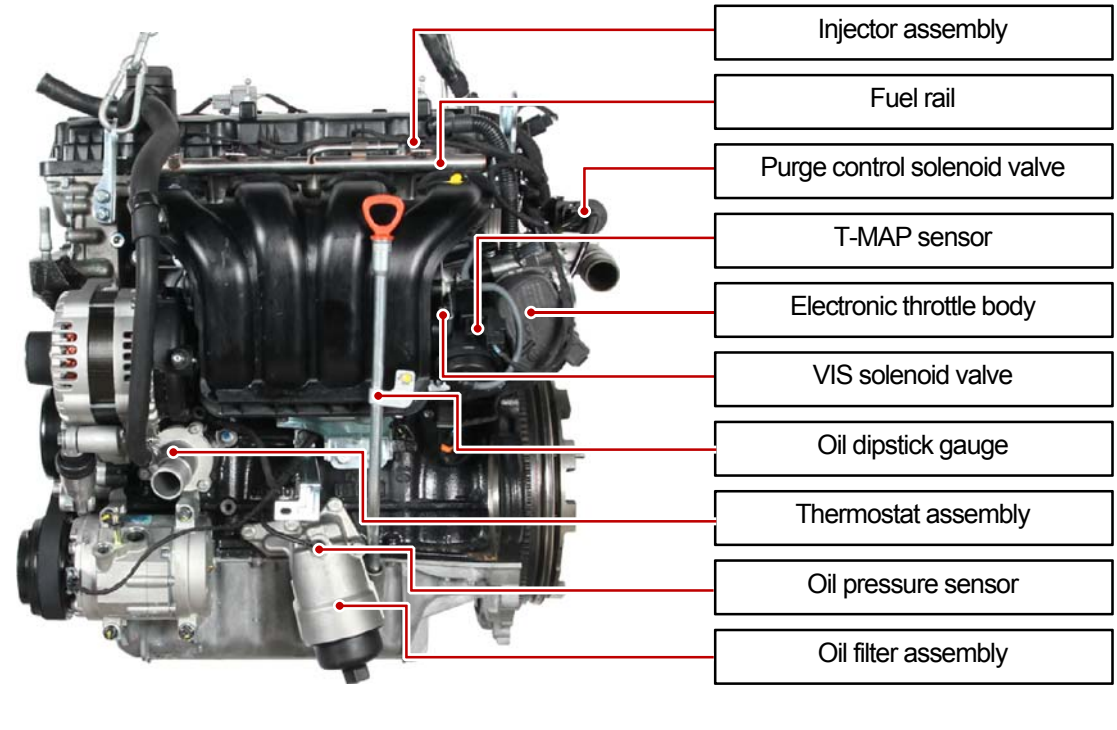


Modification basis	
Application basis	
Affected VIN	

▶ Right side view



▶ Left side view



GENERAL INSTRUCTIONS

1. GUIDELINES FOR SERVICE WORKS

1) For Safety

To perform the service works easily ans safely, the service technicians must keep the proper working procedures and rules.
This manual provides the useful instructions to the service technicians so that they can perform the servive works with standard working process, skills, tips in time.
Please read this manual and follow the instructions carefully.

Signal words such as “WARNING”, “CAUTION” and “NOTE” have special meanings.

NOTE
indicates information to assist maintenance and instructions.

CAUTION
indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

WARNING
indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

However, above references and cautions cannot be inclusive measures, so should have habits of paying attentions and cautions based on common senses.

Modification basis	
Application basis	
Affected VIN	

2) Equipment

- Korando is FF (Front Engine Front Drive) type vehicle, and engine and powertrain system are integrated into a module. Therefore, 2-post lift and general equipment are necessary when working on the engine and transmission.
- Major equipment: Engine and transmission jack, Engine stand, Engine crane, Transmission jack, Engine hanger





Remove the engine and transaxle as a set.

- Manual transaxle: Transaxle can be separated after removing the front module (sub frame, engine and transaxle).
- Automatic transaxle: Transaxle can be separated after removing the sub frame.

3) General Instructions

(1) Before lifting up the vehicle with a lift, correctly support the lifting points.
(2) When using a jack, park the vehicle on a level ground and place the wheel chocks under the tires. Position the jack under the frame and lift up the vehicle and then support with chassis stand before service work.
(3) Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
(4) If you have to work on vehicle, cover the seats and floor with protection covers to avoid any damage and contamination.
(5) Brake fluid and anti-freeze can damage the painted surface of body. So carefully handle them during service work.
(6) To improve the efficiency of service work, use only recommended and specified tools.
(7) Use only Ssangyong genuine spare parts.
(8) Never reuse the cotter pin, gasket, O-ring, oil seal, lock washer and self-locking nut. Replace them with new ones. If reused, normal functions cannot be maintained.
(9) Store the disassembled parts as a set based on disassembly order and unit.
(10) Pay particular attention not to miss or mix the fasteners.
(11) If necessary, especially for inspection, clean the removed parts completely.
(12) Apply the oil or grease on the running and sliding surfeces before installation. Use the specified sealant and gasket to prevent leakage if necessary.
(13) Tighten the fasteners to the specified tightening torque.
(14) As a final stage of service work, check if the serviced system is working properly and the problem has been eliminated clearly.

4) Basic Inspection

(1) Horn operation

- Listen for the horn sound when pressing the horn pad on the steering wheel.

(2) Brake operation

- Check if there is any abnormal noise, unusually long braking distance, or uneven braking force. If the brake warning lamp does not go out even after starting the engien or are flashing during driving, have the brake system checked immediately.
- Check the brake pipes and hoses for connection, oil leak, crack or interference after changing the position of tires. When replacing the tires, check the brake disc for surface condition and wear. Check the parking brake cable and brake operation. Shorten the checking interval if the parking
- brake is used frequently.

(3) Exhaust system

- Be aware to any changes in sound or smell from the exhaust system. These may be caused by leak or overheat. Have the exhaust system checked and repaired immediately.
- Inspect the exhaust system including catalytic converter. Inspect all the components and body frame near the exhaust system.

(4) Tires

- Unusual vibration of the steering wheel and seats or pulling to one side on the straight and level roads may indicates the uneven tire inflation pressure or poor wheel balance.

(5) Steering and suspension system

- Inspect the front and rear suspension and the steering system for damage, looseness or missing parts, signs of wear or lack of lubrication. Inspect the power steering line and the hoses for connection, leak, crack and chafing. Inspect the drive axle boot and seals for damage, tear or leak. Replace or repair the system if necessary.

(6) Engine oil

- Check the oil level when the engine is still warm and add the specified engine oil if necessary.

(7) Coolant

- Check the coolant level in the coolant reservoir, coolant conditions (contamination, foreign material), and hoses for damage and leak. Replace or add the Ssangyong genuine coolant, if needed.

(8) Engine drive belt

- Check all drive belts on the engine for wear, crack and looseness. Retighten or replace the belt, if needed.

Modification basis	
Application basis	
Affected VIN	

5) Guidelines on Engine Service

To prevent the personal injuries and vehicle damages that can be caused by mistakes during service and to provide the optimized performance and safety after service works, the service technicials must keep the basic cautions and service guidelines below. These could be easily forgotten during service works.

(1) Cautions before service works

- Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
- Make sure to clean the working area and to prepare the necessary tools before service works.
  Always place the ignition switch to OFF position if not required. Otherwise, there could be unexpected
- damage to electric devices or personal injuries due to short-circuit.
  To prevent the foreign material from entering into the fuel injection system, completely seal the inlets of
- HP pump, fuel hoses and high pressure pipes.
  To remoev the engine, use the dedicated equipments such as engine jack, transmission jack, engine
- stand and engine crane.

(2) Engine and accessories

Engine has a lot of precise components. The specified tightening torque and correct procedures should be kept during service works. And, the working area is always clean and well prepared.

- When disassembling the engine, related parts (bolts, gaskets, etc.) should be stored as a set.
- Clean the components completely with engine oil before assembling if needed.
- Fully drain the engine oil, coolant and fuel from the vehicle and seal the inlets with the plugs before removing the engine.
- All the interference should be eliminated before removing the engine.

(3) Electric devices

Extraordinary care should be taken when servicing the electric systems. Currently, the engine uses a lot of electric devices. Short circuit and poor contact may cause the low engine performance, incomplete combustion and other abnormalities.

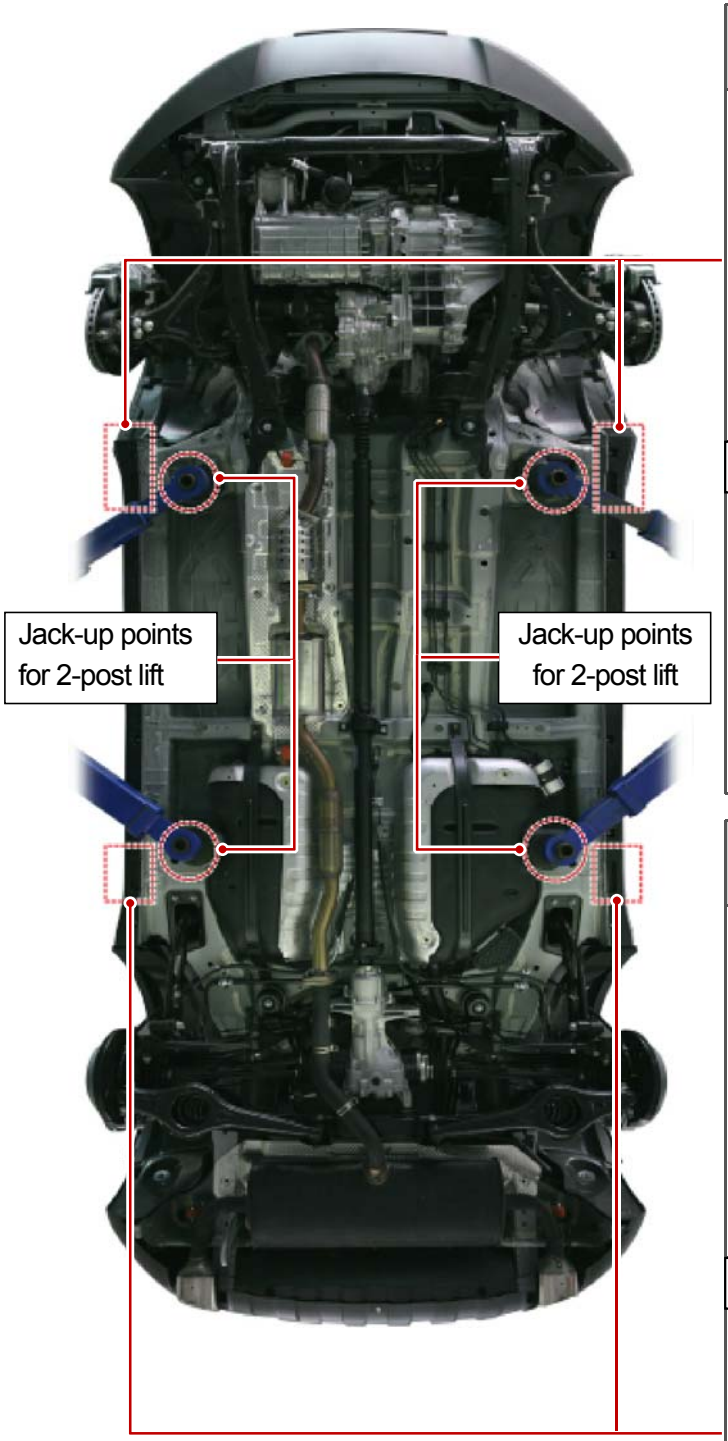
- To prevent any damage to electric systems, make sure to disconnect the negative (-) cable from the battery and place the ignition switch to OFF position before servicing.
- Use only the specified parts with same ratings when replacing the electric devices. Check the grounds and connections for looseness.

(4) Fuel and lubrication system

- When working with the fuel or oil systems in enclosed area, always keep the working area well-ventilated and never allow anybody to smoke.
- Gaskets and seals on the fuel and oil systems should be replaced with new ones. All bolts and nuts should be tightened as specified.
- Make sure to check the connections for leak after installation.

2. JACK-UP POINTS

▶ **Stand jack-up points and installation status (front side)**



Jack-up points and setup (front side)



Supporting



Jack-up points and setup (rear side)



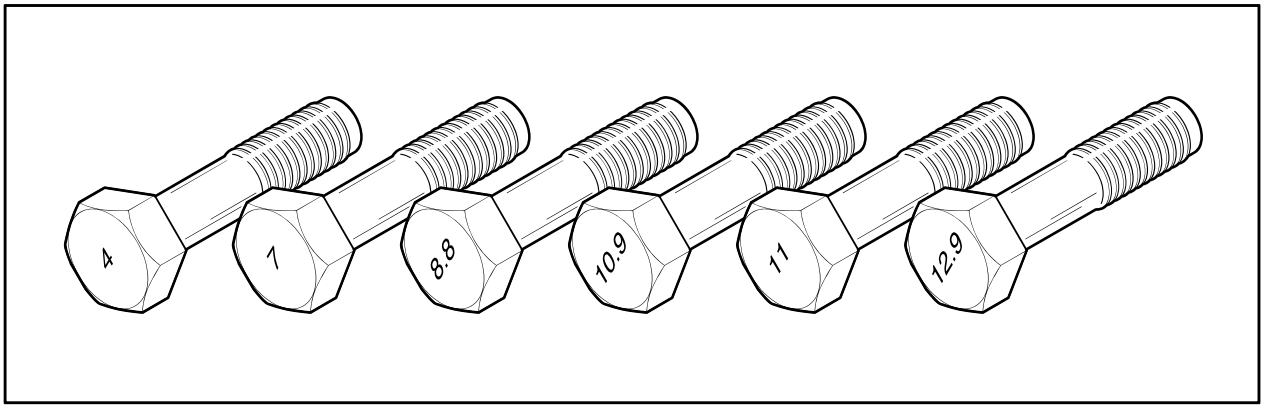
Supporting



Modification basis	
Application basis	
Affected VIN	

3. STANDARD BOLTS SPECIFICATIONS

Bolt	Pitch	Tightening torque(kgf.cm)					
		Standard			Limit		
		4T	7T	9T	4T	7T	9T
M3	0.5	5	9	13	7	12	17
M4	0.7	12	20	30	16	27	40
M5	0.8	24	40	57	32	53	77
M6	1.0	41	68	99	55	91	130
M8	1.25	88	160	230	130	210	310
M10	1.25	190	330	470	260	430	620
	1.5	190	310	450	250	420	600
M12	1.25	350	580	840	460	770	1,100
	1.75	330	550	790	440	730	1,000
M14	1.5	550	910	1,300	730	1,200	1,900
M16	1.5	830	1,100	2,000	1,100	1,900	2,700
M18	1.5	1,200	2,000	2,900	1,600	2,700	3,800
M20	1.5	1,700	2,800	4,000	2,200	3,700	5,300
M22	1.5	2,300	3,800	5,400	3,000	5,000	7,200
M24	1.5	2,900	4,900	7,000	3,900	6,500	9,400
	2.0	2,800	4,700	6,800	3,800	6,300	9,100



1) Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2) Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max. allowable tightening torque if not required to do so. Determine extra proper tightening torque if tightens with washer or packing.
3) If tightens bolts on the below materials, be sure to determine the proper torque.
4)

- Aluminum alloy: Tighten to 80 % of above torque table.
- Plastics: Tighten to 20 % of above torque table.

4. CODING AND SETUP

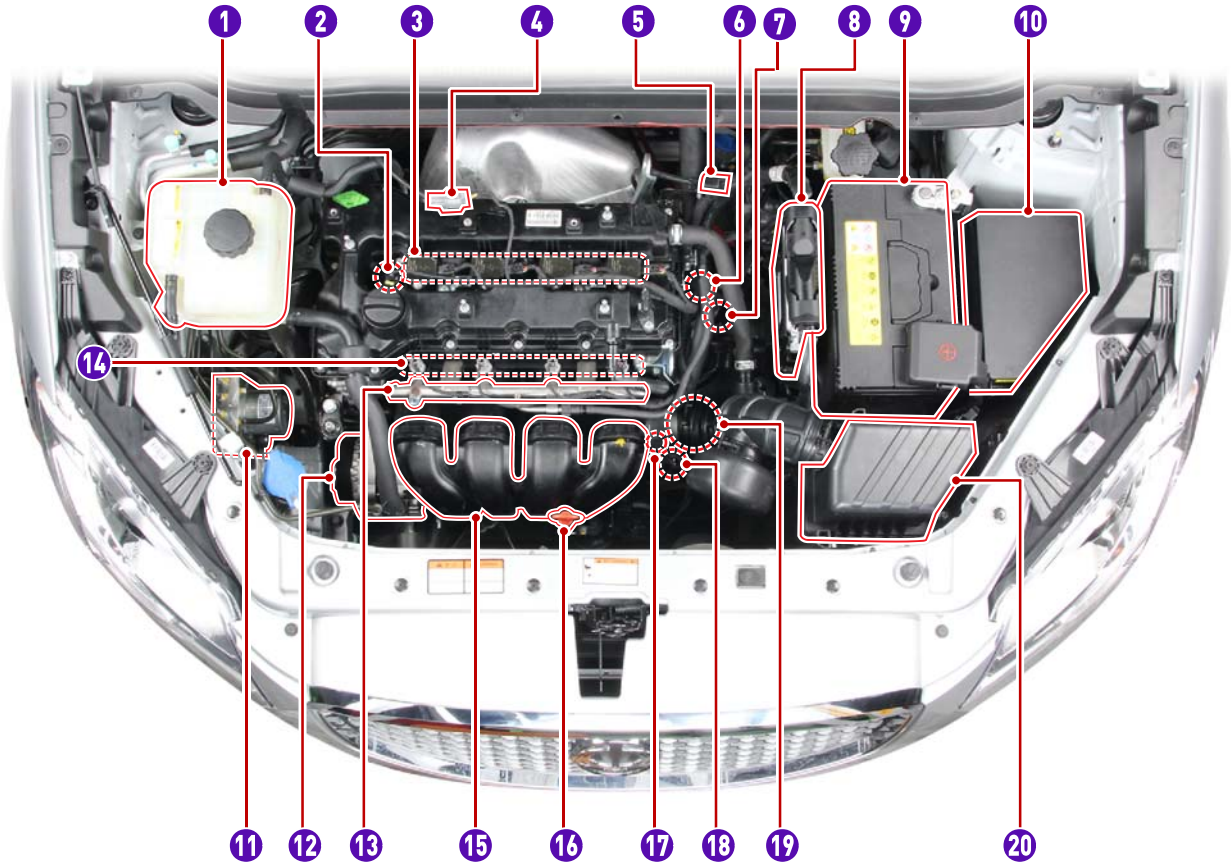
1) Engine Variant Coding

Description		Coding
Vehicle speed input to ECU	CAN	with ABS or ESP: CAN
	WIRE	
Fan	3 Relays	3 Relays
	PWM fan	
Auto cruise	NO	with Auto cruise system: YES
	YES	
Engine level control	NO	without Engine level control system: NO (Korando)
	YES	
G-sensor	NO	with 2WD ABS and non-ABS: NO with 4WD ABS and ESP: YES
	YES	
Smart key	NO	with Smart key: YES
	YES	

Modification basis	
Application basis	
Affected VIN	

OVERVIEW

1. ENGINE COMPARTMENT

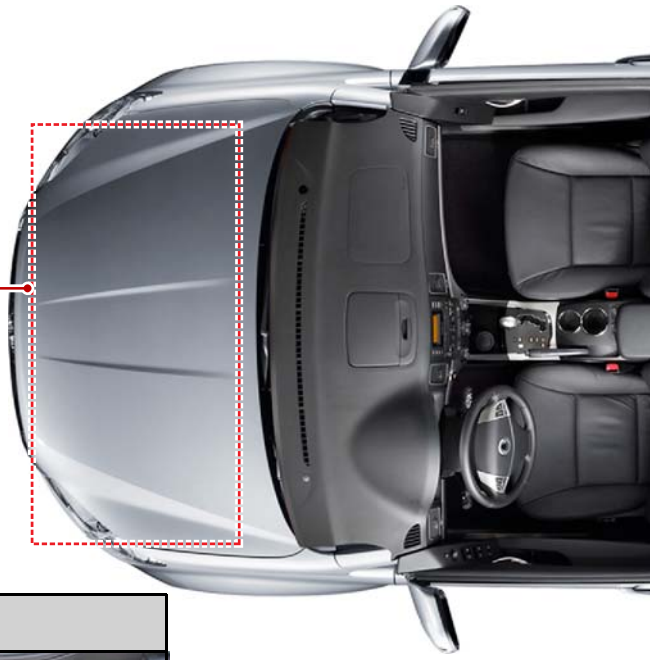


1. Coolant reservoir
2. OCV
3. Ignition coil
4. Rear oxygen sensor connector
5. Front oxygen sensor connector
6. Coolant temperature sensor
7. Purge control solenoid valve
8 Engine ECU
9. Battery
10. Fuse box
11. HECU assembly
12. Alternator
13. Fuel rail assembly
14. Injector
15. Intake manifold
16. Oil dipstick gauge
17. VIS solenoid valve
18. T-MAP sensor
19. Electronic throttle body
20. Air cleaner assembly

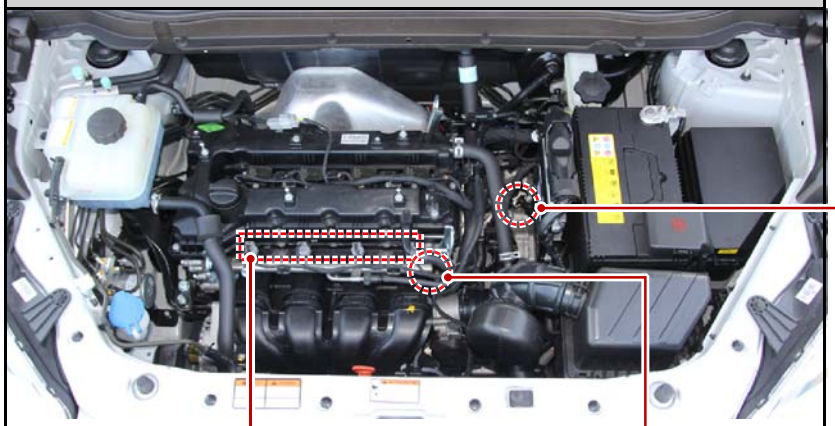
2. FUEL SYSTEM

Engine ECU





Engine compartment



Injector



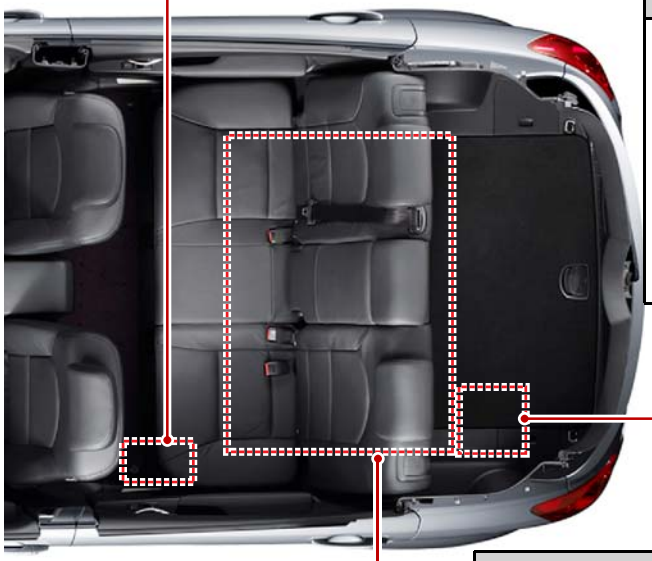
Fuel rail



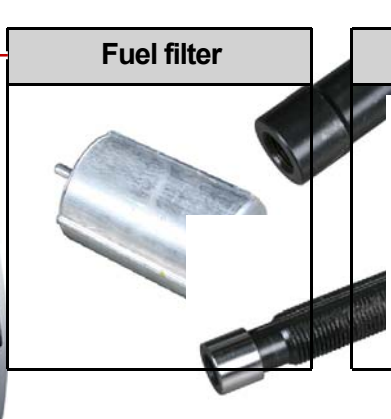
Purge control solenoid valve



Modification basis	
Application basis	
Affected VIN	



Fuel filter



Canister



Fuel pump & fuel sender assembly

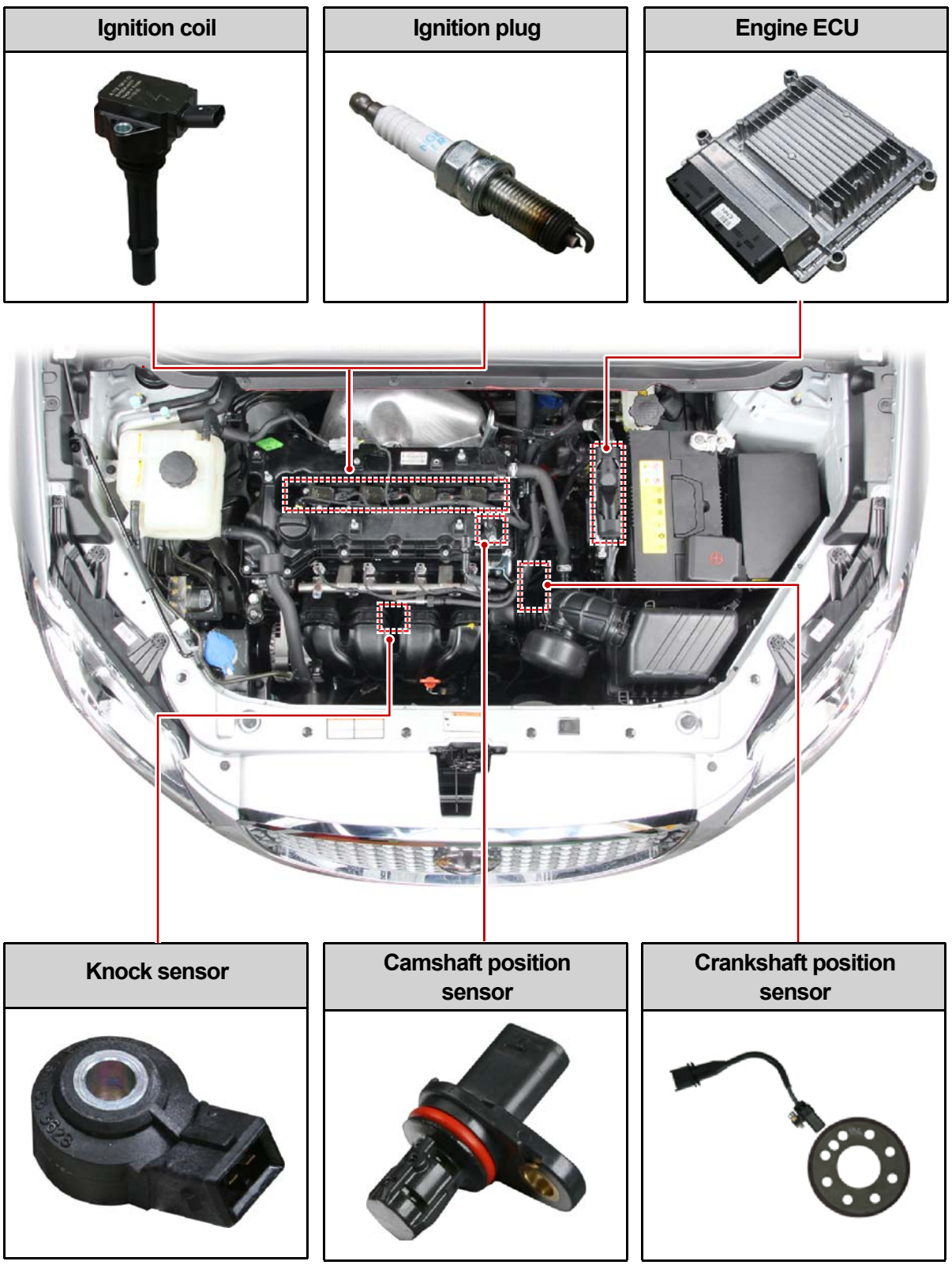


Fuel t



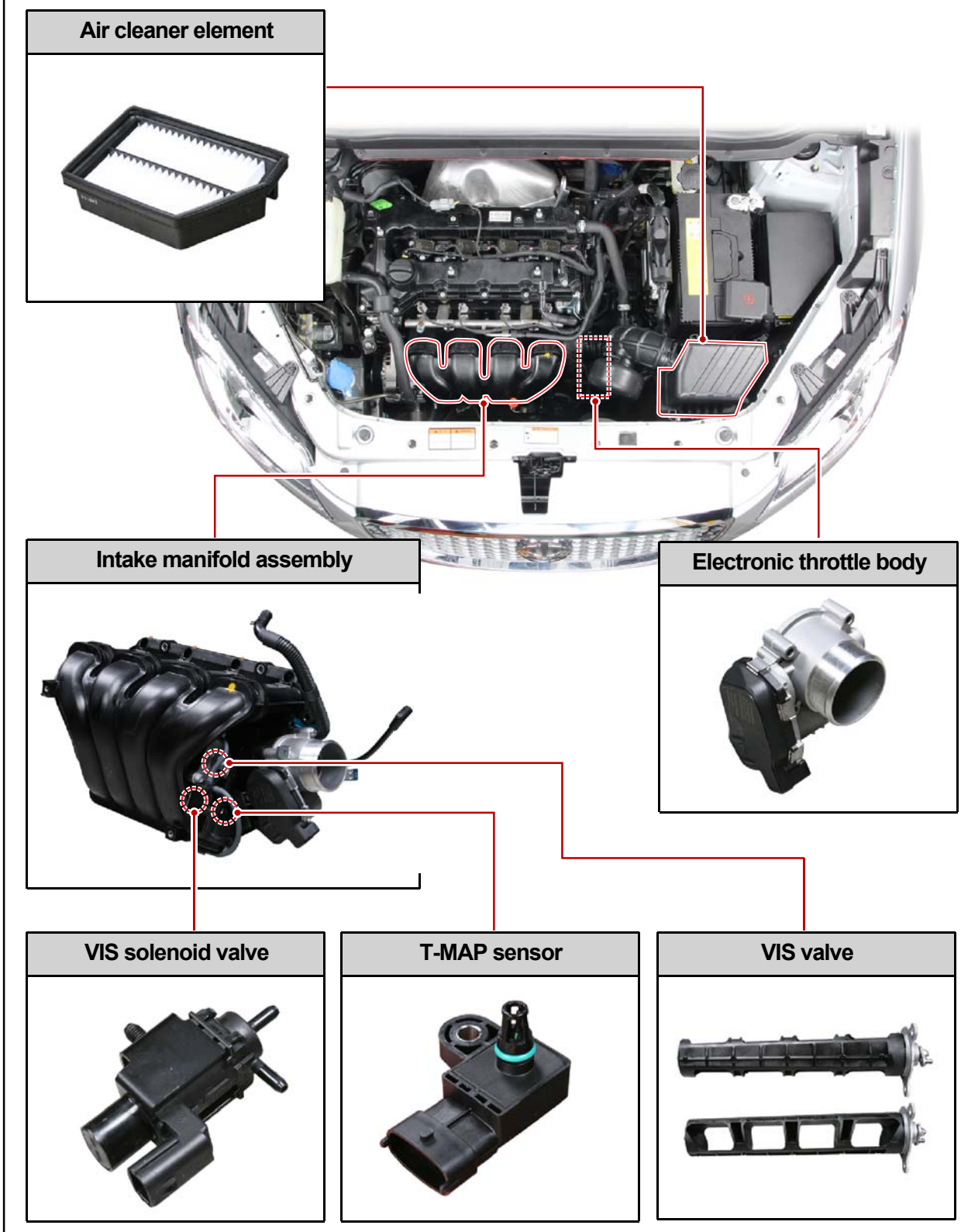
Modification basis	
Application basis	
Affected VIN	

3. IGNITION SYSTEM



Modification basis	
Application basis	
Affected VIN	

4. INTAKE SYSTEM



5. EXHAUST SYSTEM

WCC



Engine ECU

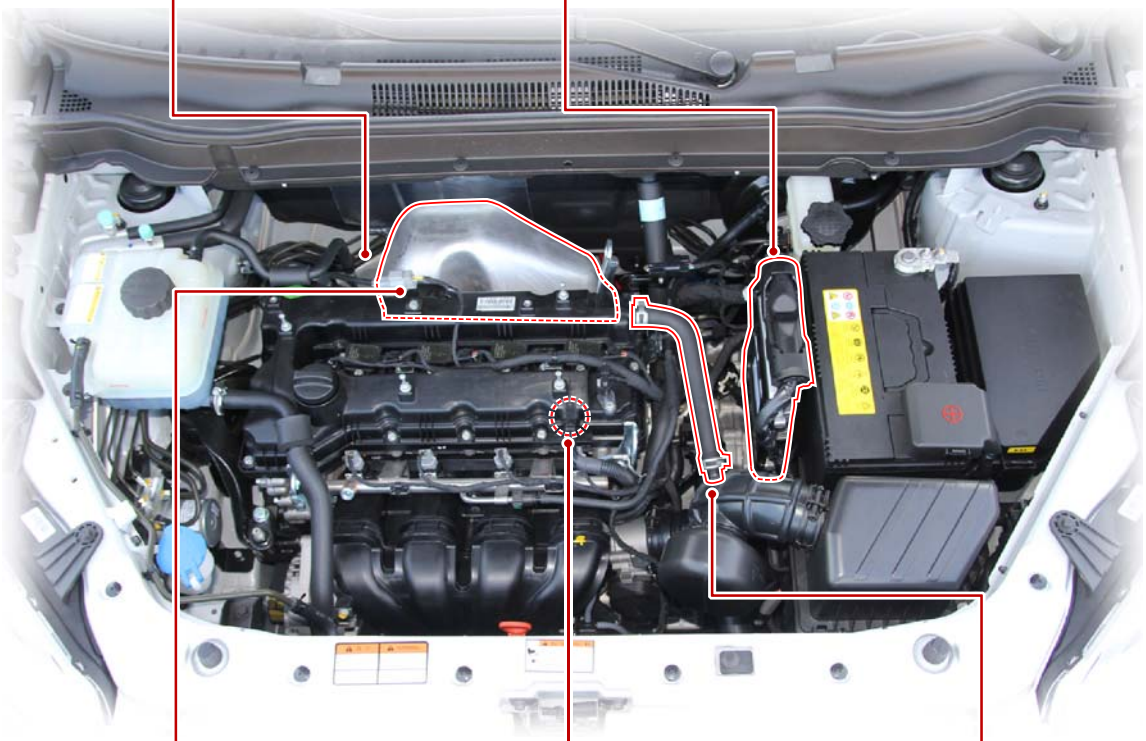


Engine CHECK warning lamp



Green





Exhaust manifold



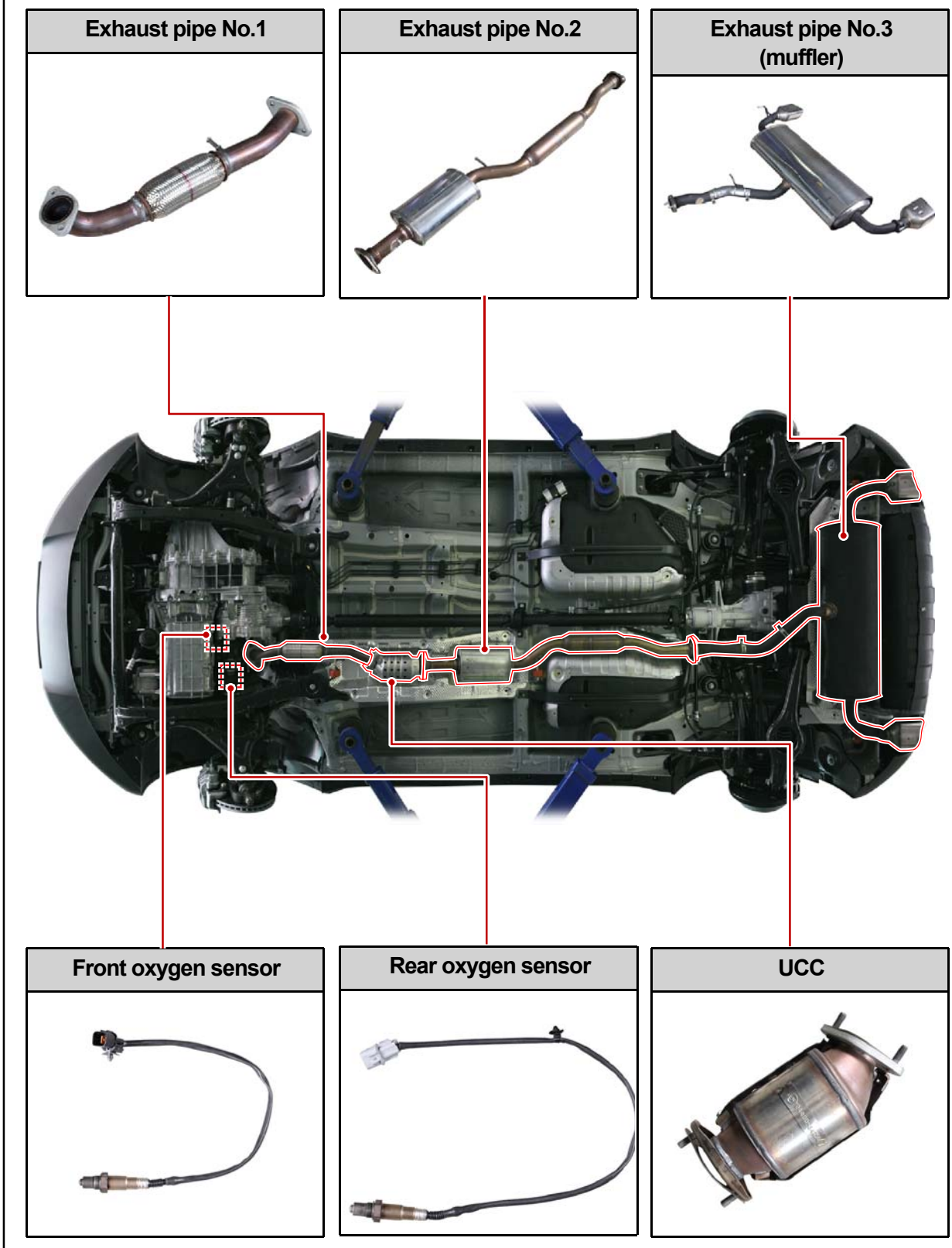
PCV valve



Blow-by hose

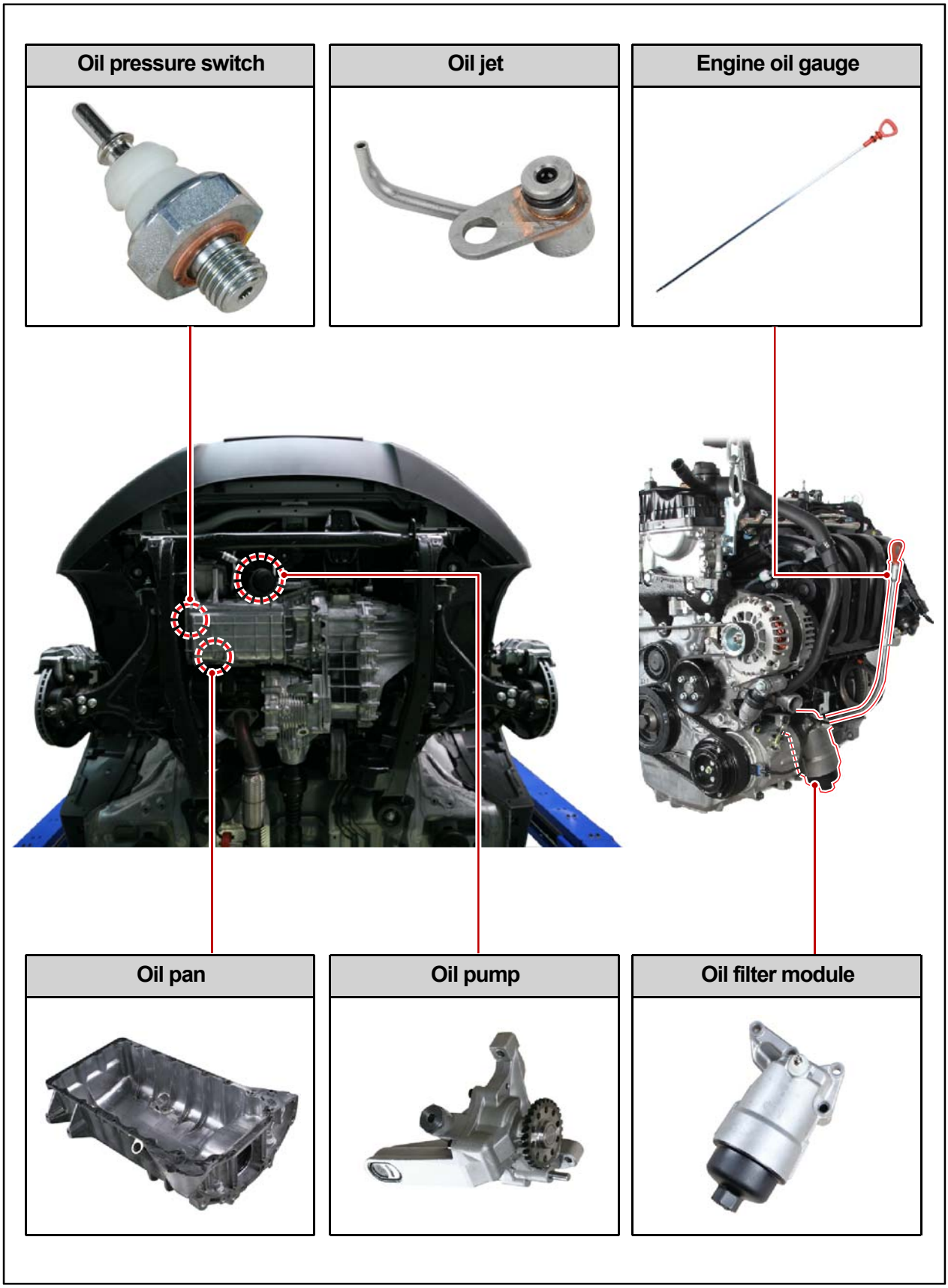


Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

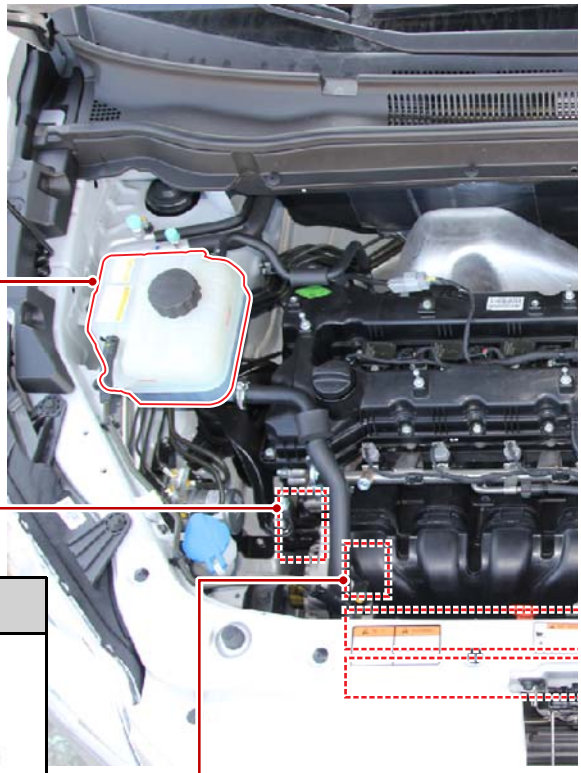
6. LUBRICATION SYSTEM



Modification basis	
Application basis	
Affected VIN	

Memo

7. COOLING SYSTEM

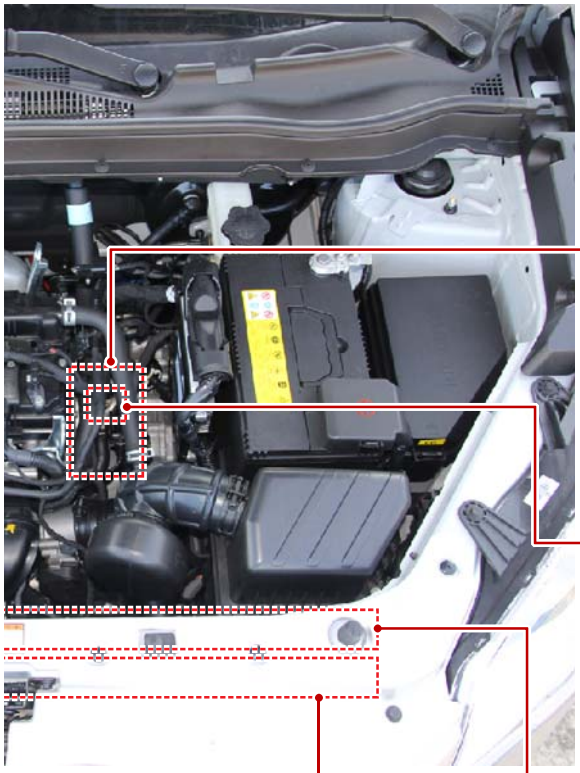


Coolant reservoir


Water pump assembly	
	
The water pump is driven by the engine drive belt and supplies the coolant to each area of the engine.	

Thermostat assembly	
	When the engine coolant reaches 90˚C, the thermostat starts to open (fully open at 100˚C) and lets the coolant flow to the radiator to maintain the engine temperature.

Modification basis	
Application basis	
Affected VIN	



Coolant outlet port



Coolant temperature sensor



Measures the coolant temperature and sends the result to the engine ECU.

Radiator assembly



Releases heat through fins and cools down the hot coolant as the coolant passes through the tube of the radiator core.

FAN



Circulates the fresh air forcibly to exchange heat with the radiator core fin.

Modification basis	
Application basis	
Affected VIN	

8. ELECTRIC SYSTEM

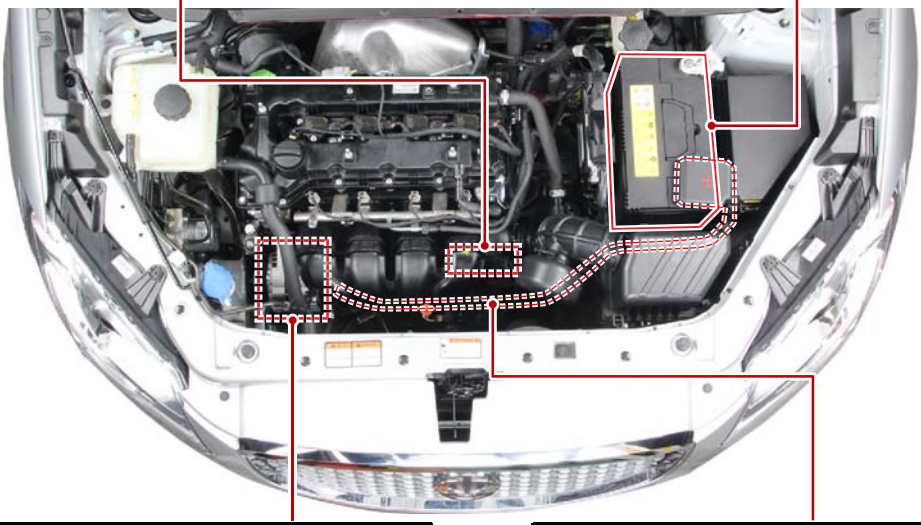
Start motor assembly



Battery



Converts the chemical energy to the electrical energy and supplies power to the corresponding electric units when starting the engine.



Alternator



Charges the battery and supplies power to each electric unit by converting the mechanical energy to the electrical energy.

B+ wiring



Modification basis	
Application basis	
Affected VIN	

ENGINE ASSEMBLY

1116-01

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification
Cylinder head	Height		142.5 mm
	Weight		15.6 kg
	Flatness		Below 0.05 mm
	Spark plug offset		2.5 mm
	Thickness of cylinder head gasket (when compressed)		0.7 mm
Camshaft	Axial end play	Intake	0.1~0.35 mm
		Exhaust	0.1~0.35mm
	Valve timing	Intake valve open	BTDC 35/-10
		Intake valve close	ABDC 14/62
		Exhaust valve open	BBDC 40/40
		Exhaust valve close	ATDC 12/12
	Journal bearing	Diameter	24mm
		Width	17 mm
		Oil clearance	0.037~0.074 mm
Intake/exhaust valve	Lift of intake valve		Max. 9.0 mm
	Lift of exhaust valve		Max. 8.0 mm
	Length of intake valve		115.0mm
	Length of exhaust valve		114.0mm
Connecting rod	End play		0.5~1.5mm

2. TIGHTENING TORQUE

Name	Size	Quantity	Tightening torque
Heater core screw bolt	-	1	70 ± 7 Nm
Ladder frame bolt	M8 X 1.25 X 20	7	25 ± 2.5 Nm
TGCC	M6 X 1.0 X 25	10	10 ± 1.0 Nm
Oil drain plug	-	1	30 ± 3.0 Nm
Oil pan bolt	M6 X 1.0 X 20	16	10 ± 1.0 Nm
Oil pan bolt	M6 X 1.0 X 35	4	10 ± 1.0 Nm
Oil pan bolt	M6 X 1.0 X 85	2	10 ± 1.0 Nm
Oil dipstick gauge bolt	M6 X 1.0 X 16	1	10 ± 1.0 Nm
Camshaft cap	M6 X 1.0 X 30	20	10 ± 1.0 Nm
Main gallery screw bolt	-	1	55 ± 5.5 Nm
Main bearing cap bolt	-	10	55 Nm + 90°
Cylinder head bolt	M12X1.75X102	10	55 Nm + 180°
Cylinder head TGCC side bolt	M8 X 1.25 X 30	4	25 ± 2.5 Nm
Cylinder head front cover bolt	M6 X 1.0 X 25	8	10 ± 1.0 Nm
Cylinder head cover bolt	M6 X 1.0 X 30	20	10 ± 1.0 Nm
Crankshaft center bolt	M18 X 1.5 X 50	1	200 ± 20 Nm
			90 ° + 10 °
Flywheel bolt	M10 X 1.0 X 22	8	45 ± 5 Nm
			90 ° + 10 °
Connecting rod bolt	M9 X 1.0 X 52	8	40 + 5 Nm
			90 ° + 10 °
Cam Cap bolt (#1)	M6 X 1.0 X 35	4	10 ± 1.0 Nm
Cam Cap bolt (#2~5)	M6 X 1.0 X 30	16	10 ± 1.0 Nm
Solenoid valve bolt	M5 X 0.8 X 22	1	8 ± 1 Nm
Intake manifold bolt	M8 X 1.25 X 32	5	25 ± 2.5 Nm

Modification basis	
Application basis	
Affected VIN	

Name	Size	Quantity	Tightening torque
Intake manifold lower bracket bolt	M8 X 1.25 X 16	4	25 ± 2.5 Nm
Exhaust manifold nut	-	7	40 ± 5 Nm
Heat protector bolt	M6 X 1.0 X 25	7	10 ± 1 Nm
Oil jet bolt	-	4	10 ± 1 Nm
Oil pump bolt	M8 X 1.25 X35	3	25 ± 2.5 Nm
Oil filter assembly assembly bolt	M8 X 1.25 X30	3	25 ± 2.5 Nm
Oil filter assembly assembly bolt	M8 X 1.25 X65	1	25 ± 2.5 Nm
Water pump bolt	M6 X 1.0 X22	1	10 ± 1 Nm
Belt tensioner upper bolt	M8 X 1.25 X30	1	25 ± 2.5 Nm
Belt tensioner lower bolt	M10 X 1.5 X55	1	82 ± 5 Nm
Water pump pulley bolt	M6 X 1.0 X12	4	10 ± 1 Nm
Thermostat bolt	M6 X 1.0 X22	3	10 ± 1 Nm
Coolant outlet port bolt	M6 X 1.0 X22	3	10 ± 1 Nm
Coolant pipe mounting bolt	M6 X 1.0 X14	3	10 ± 1 Nm
Bypass hose clamp	M24	2	3 ± 0.5 Nm
EPS idler pulley	-	1	25 ± 2.5 Nm
Engine mountinf stud bolt	-	2	50 ± 5.0 Nm
Engine front mounting bolt	M10 X 45	3	60 ± 6.0 Nm
Engine front mounting bolt	M10 X 77	1	60 ± 6.0 Nm
Engine front hanger bracket	M8 X 1.25 X 20	2	25 ± 2.5 Nm
Engine rear hanger bracket	M8 X 1.25 X 20	4	25 ± 2.5 Nm
A/C compressor bolt	-	4	25 ± 2.5 Nm
Alternator bolt	M10	4	45 ± 4.5 Nm
Start motor bolt	M10	4	Max. 48Nm

3. GUIDELINES ON ENGINE SERVICE

G20DF engine is for FF (Front Engine Front Drive) type vehicle. Therefore, there are some deferent maintenance and repair works compared to the engine for FR (Front Engine Rear Drive) type vehicle. For safe and correct works, you must observe the working procedures and instructions in this manual. And, use the designated tools as follow:
: Power train mounting stand / Engine hanger / Engine stand / Heavy duty engine jack.

▶ Cautions before service works

- G20DF engine is FF (Front Engine Front Drive) type engine, and the engine and transmission are integrated in a same module. Remember that there are many differences compared to conventional engine in FR (Front Engine Rear Drive) type SUV vehicle.
  To remove the engine, use the dedicated equipments such as engine jack, transmission jack, engine stand and engine crane (1 ton).
- To prevent the engine from abruptly starting during service in engine compartment, never allow anybody to stay in the vehicle.
- Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
- Make sure to clean the working area and to prepare the necessary tools before service works.
  Always place the ignition switch to OFF position if not required. Otherwise, there could be
- unexpected damage to electric devices or personal injuries due to short-circuit..
  To prevent the foreign material from entering into the fuel injection system, completely seal the
- inlets of HP pump, fuel hoses and high pressure pipes.
  Do not remove the engine while supporting the oil pan with a jack.
-

▶ Lifting up the vehicle

- Before lifting up the vehicle with a lift, correctly support the lifting points.
- To prevent the vehicle from rolling down, put the chocks under the tires (when using a 4-post lift).
  Make sure to support the correct lifting points (when using a 2-post lift).
-

Modification basis	
Application basis	
Affected VIN	

▶ Engine and accessories

Engine has a lot of precise components. The specified tightening torque and correct procedures should be kept during service works. And, the working area is always clean and well prepared.
When disassembling the engine, related parts (bolts, gaskets, etc.) should be stored as a set.

- Carefully read the disassembly and reassembly procedures in this manual before starting the works.
- Clean the components completely with engine oil before assembling if needed.
- Fully drain the engine oil, coolant and fuel from the vehicle and seal the inlets with the plugs before removing the engine.
- All the interference should be eliminated before removing the engine.

▶ Exhaust system

- Wear the protective gloves before removing the exhaust pipe.
- The exhaust pipe is very hot immediately after stopping th engine. Check if the exhaust pipe is fully cooled down before servicing the exhaust system.

▶ Cooling system

- Scalding hot coolant and steam could be blown out under pressure, which could cause serious injury. Never remove the coolant reservoir cap when the engine and the radiator are hot.

▶ Tightening the fastener

When reassembling the parts to G20DF, use the angle tightening as a final step.
1. Clean the mating surfaces before tightening.
2. Place the marks with paint to tighten by angle if the angle wrench is not available.

NOTE

The position and direction of the componets is based on the rear view.
Do not tighten the fasteners with excessive force. Especially, the threads of cylinder block could be damaged.
The self screw bolt makes the thread itself when tightening it. Do not apply excessive force.
Do not reuse the bolt that has been tightened with angle tightening method.

▶ **Fuel and engine oil system**

The engine oil and fuel damages the painted surfaces and rubber material of the vehicle.

- Disconnect the negative cable from the battery before servicing the fuel system, and prepare the service plug grip.
- When working with the fuel or oil systems in enclosed area, always keep the working area well-ventilated and never allow anybody to smoke.
- Do not allow the gasoline to contact to rubber or leather parts.
- Carefully separate the pipe between high pressure fuel pump and fuel injector so that any fuel can be spilled out.
- Fully release the pressure from the fuel system before removing any parts of fuel system.
- To release the fuel pressure in high pressure line, let the engine fully cool down.
- Gaskets and seals on the fuel and oil systems should be replaced with new ones. All bolts and nuts should be tightened as specified.
- Prolonged exposure to the engine oil make cause a skin cancer or an irritation.
- Used engine cotains the hazardous material that may cause the skin cancer. Do not allow the used engine to make contact with your skin.
- Make sure to wear the protection gloves and goggle when handling the engine oil. If contact happens, rinse affected areas immediately with plenty of water. Do not wash it with gasoline or solvent. If irritation persists, consult a doctor.
- Improperly disposed engine oil can pollute the environment. Dispose the used engine oil and oil filter in accordance with local environmental regulations.
- Make sure to check the connections for leak after installation.

▶ **Electric devices**

Extraordinary care should be taken when servicing the electric systems. Currently, the engine uses a lot of electric devices. Short circuit and poor contact may cause the low engine performance, incomplete combustion and other abnormalities.

- To prevent any damage to electric systems, make sure to disconnect the negative (-) cable from the battery and place the ignition switch to OFF position before servicing.
- Use only the specified parts with same ratings when replacing the electric devices. Check the grounds and connections for looseness.

OVERVIEW AND OPERATING PROCESS

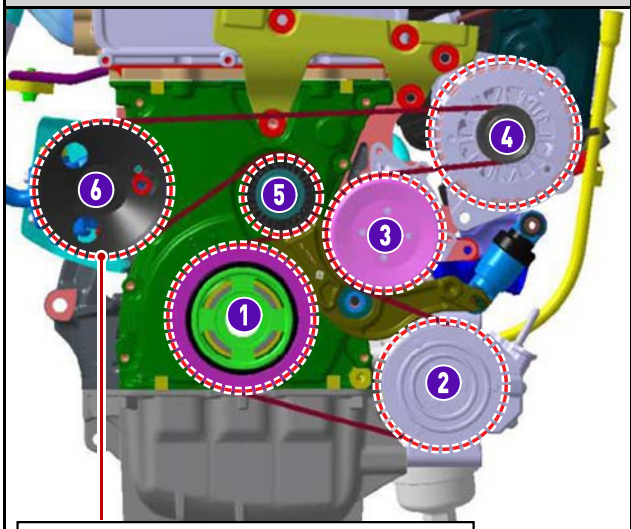
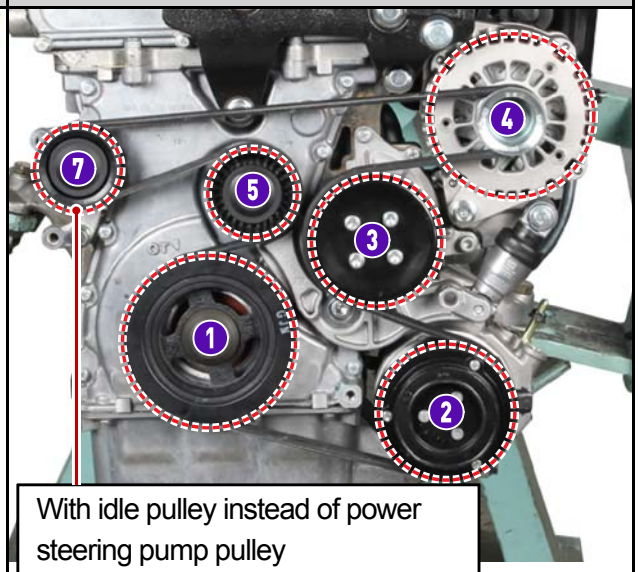
S.G.N. 1337-04 BELT SYSTEM

1) Drive Belt

▶ Overview

There are two types of belt system; EPS (Electric Power Steering) and HPS (Hydraulic Power Steering). In the vehicle with ESP, instead of power steering pulley, the idle pulley is installed on the engine. The belt system is a single belt drive system which uses single V-belt with 6 grooves. This design provides the long life span and minimizes the belt slip and noise.

▶ Components

With HPS (Hydraulic Power Steering)	With ESP (Electric Power Steering)
 With power steering pump pulley	 With idle pulley instead of power steering pump pulley
Length of belt : 1913mm	Length of belt : 1740mm

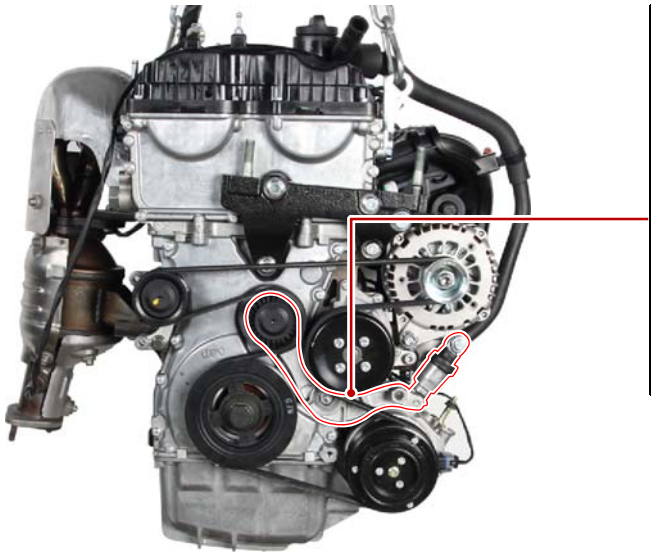
1. Crankshaft pulley
2. Air conditioner compressor
3. Water pump
4. Alternator
5. Tension pulley
6. Power steering pump pulley
7. Idler pulley

2) Hydraulic Tensioner Assembly

▶ Overview

The hydraulic tensioner maintains the belt tension to minimize the slip and vibration and provides long life span of the belt. Hydraulic tensioner consists of hydraulic tension spring, hydraulic damper, lever arm and tension pulley.
To transfer the tension to the belt from the hydraulic tensioner in small working space in G20DF engine, the belt system uses the longer lever arm.

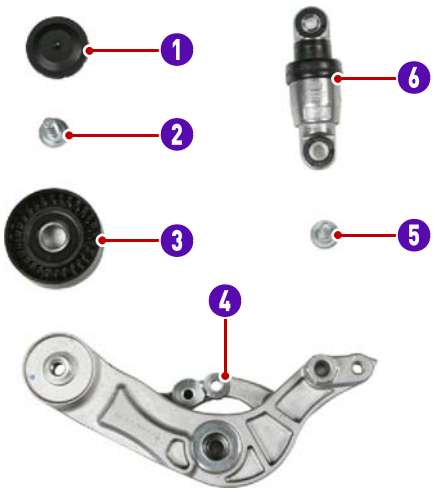
▶ Location and Components



Hydraulic tensioner assembly



Components



No	Name
1	Tensioner pulley cap
2	Tensioner pulley mounting bolt
3	Tensioner pulley
4	Lever arm
5	Hydraulic tensioner bolt
6	Hydraulic tensioner

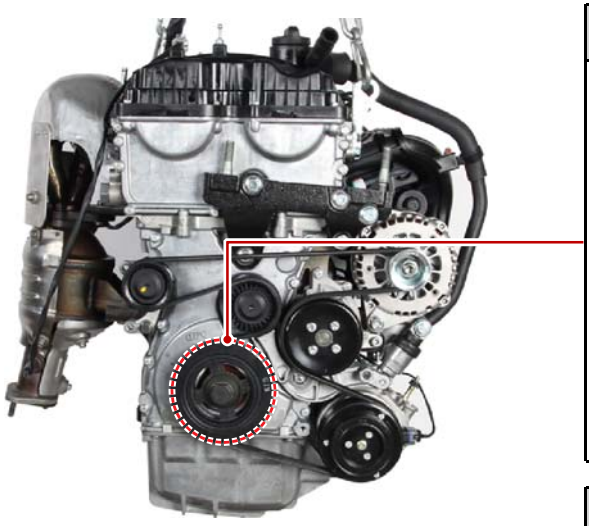
Modification basis	
Application basis	
Affected VIN	

3) Crankshaft Pulley (CRS)

▶ Overview

The strut type tensioner automatically adjusts the belt tension to provide the reliability and durability for the system. And, the belt tension is decreased to minimize the friction loss and improve the belt operating noise.

▶ Location



Crankshaft pulley (CRS)



Timing mark



S.G.N.
1990-01 ENGINE MOUNTING

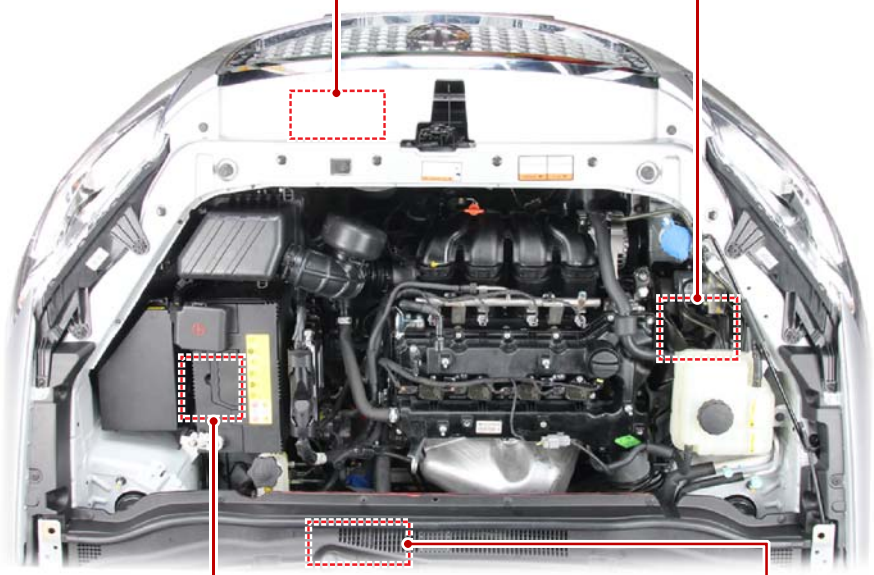
▶ **Location**

Front mounting assembly
Location: Front side of transaxle housing and front side of sub frame

Location	Front mounting
	

Right mounting assembly
Location: Engine block side and body side member

Location	Right mounting
	



Left mounting assembly
Location: Upper side of transaxle housing and body side member

Location	Left mounting
	

Rear mounting assembly
Location: Rear side of transaxle housing and front side of sub frame

Location	Rear mounting
	

Modification basis	
Application basis	
Affected VIN	

▶ Function

Appearance	Type and function
Front mounting: Bracket + Insulator 	Type: Rubber type mounting Function: support torque reaction
Rear mounting: Bracket + Insulator 	Type: Rubber type mounting Function: support torque reaction
Left mounting: Bracket + Insulator 	Type: Rubber type mounting Function: - support power train rod - support torque reaction
Rear mounting: Bracket + Insulator and D-damper 	Type: Hydraulic type mounting Function: - support power train rod - power train bounce vibration absorber - support torque reaction

S.G.N.
1211-01 CYLINDER HEAD ASSEMBLY

1) Cylinder Head

▶ Overview

The cylinder head assembly is located on the cylinder block.
This contains the combustion chamber, intake and exhaust ports, valve running housing, and oil gallery.
And, this also contains the water jacket to dissipate the heat from the combustion chamber

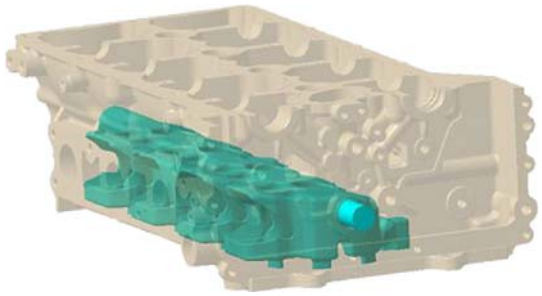
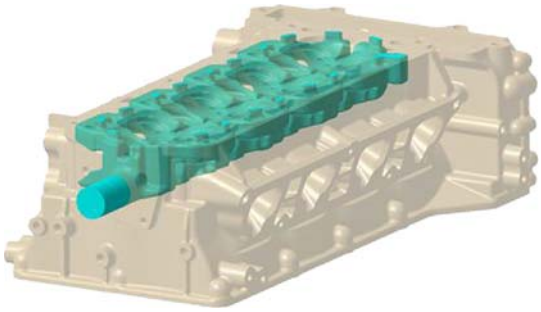
▶ Location



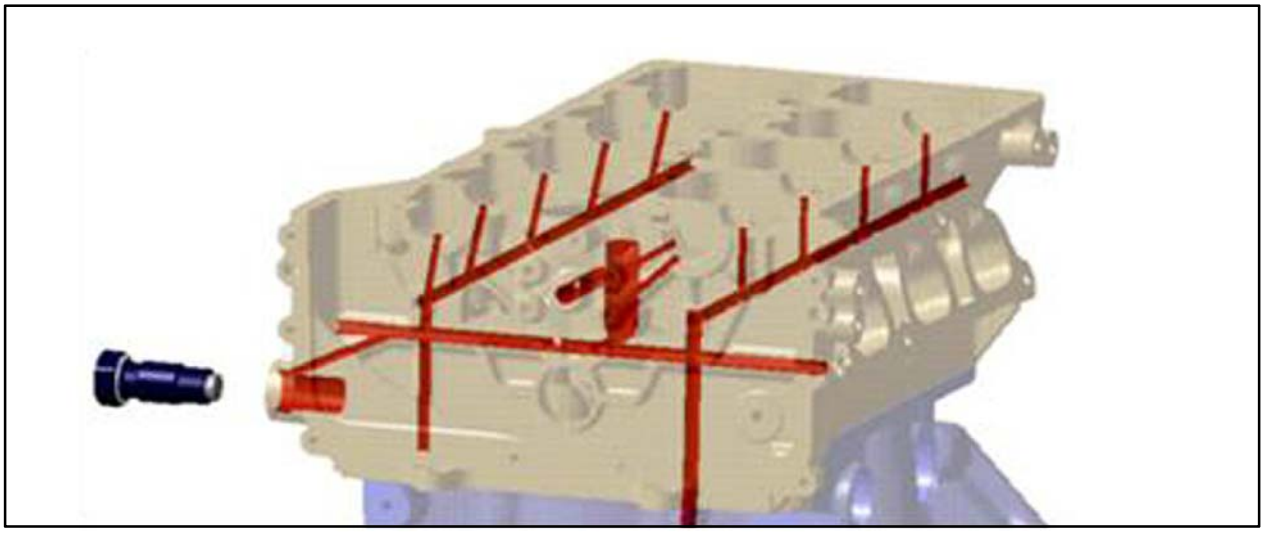
Top of cylinder head	Bottom of cylinder head
	
Intake side	**Exhaust side**
	

Modification basis	
Application basis	
Affected VIN	

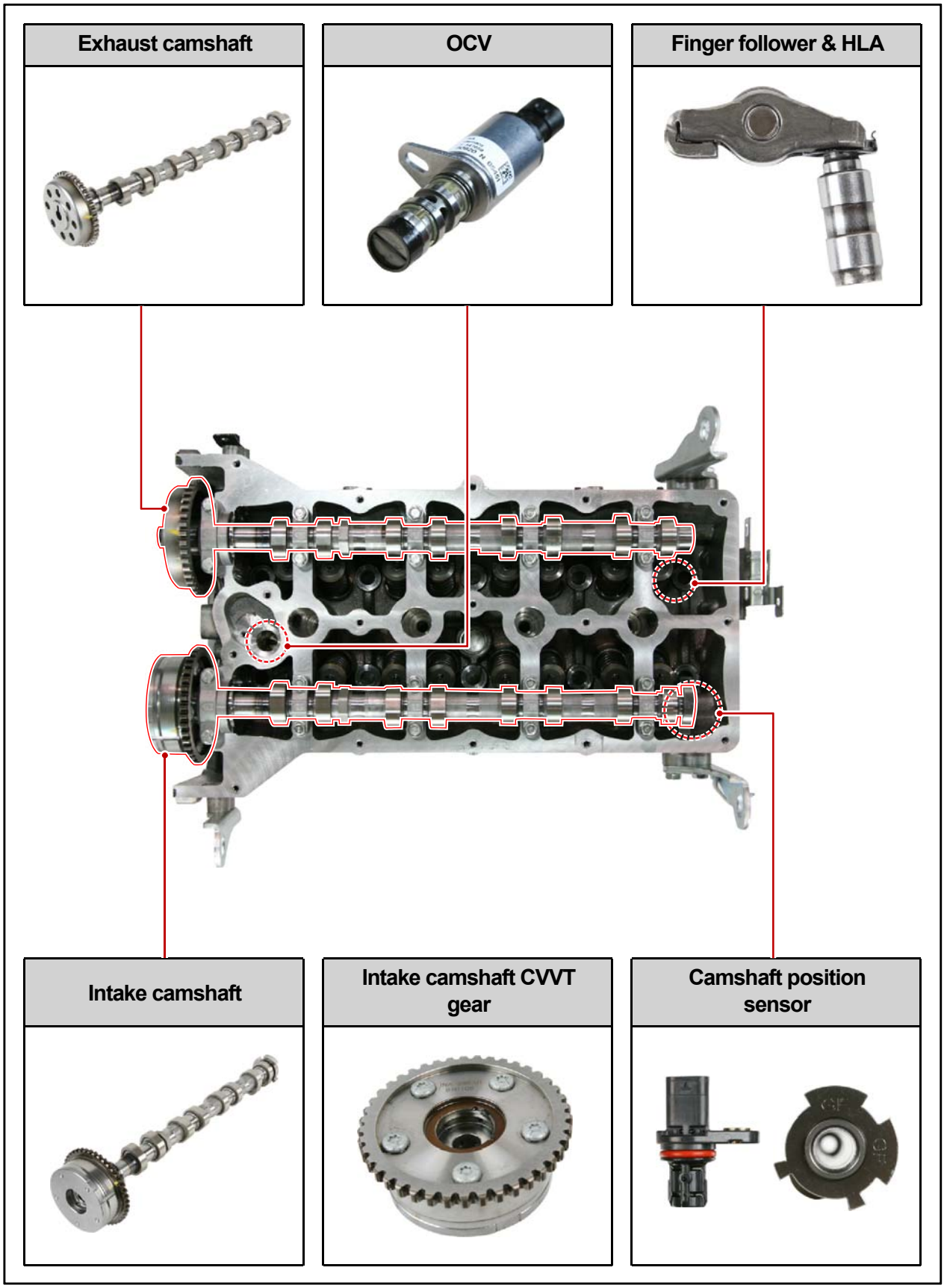
▶ Closed-roof water jacket (improving coolimg efficiency)

Intake side	Exhaust side
	

▶ Cylinder head oil gallery



▶ Components



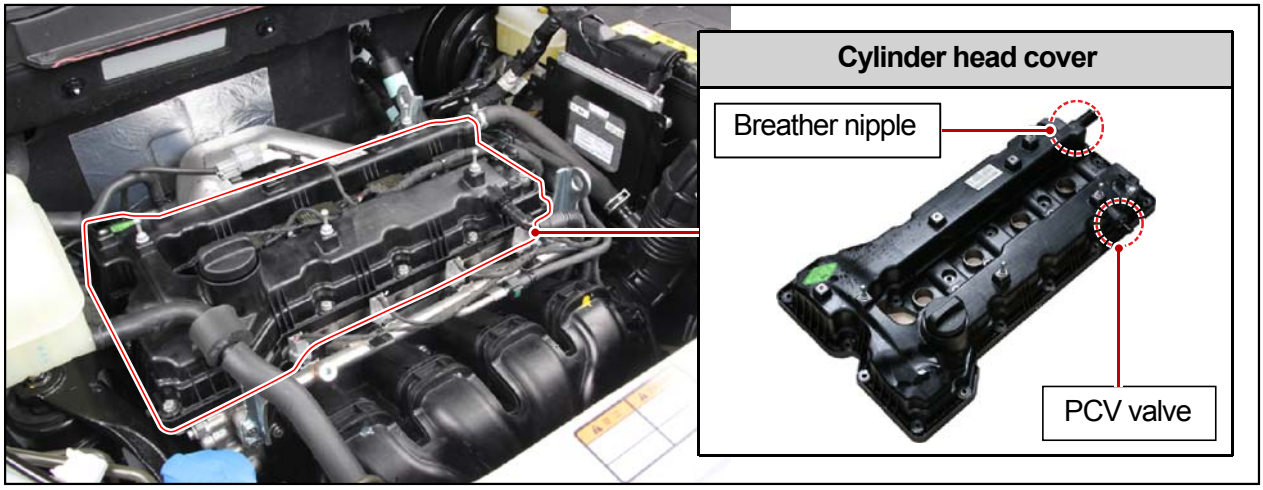
Modification basis	
Application basis	
Affected VIN	

2) Cylinder Head Cover

▶ Overview

The cylinder head cover protects the valve system. It contains the breathing system with PCV valve for recirculation of blow-by gas. The blow-by gas is induced into the intake manifold through the breather nipple and PCV Valve. To improve the sealing performance, new bolt pattern is introduced. And, to prevent the freezing, the PCV valve is tilted with 9° to the below direction.

▶ Location

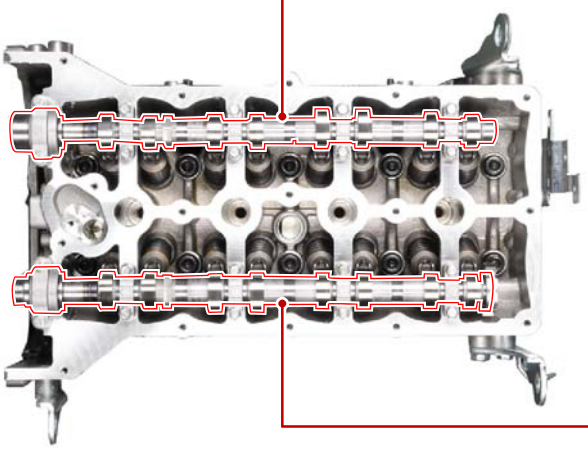


3) Camshaft Assembly

▶ Overview

The camshaft is hollow type, and contains the cam, octagon cam, OCV gallery, cam position rotor. The camshaft operates the intake and exhaust valves.

▶ Location



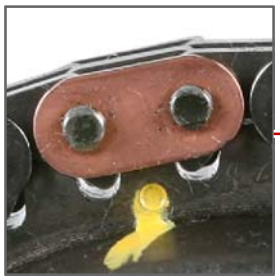
Exhaust camshaft

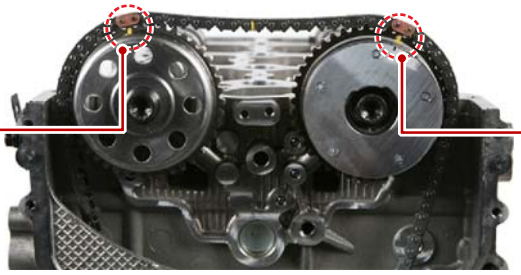


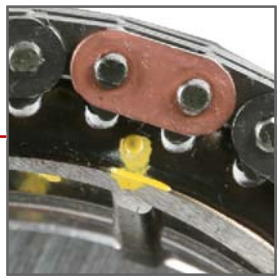
Intake camshaft

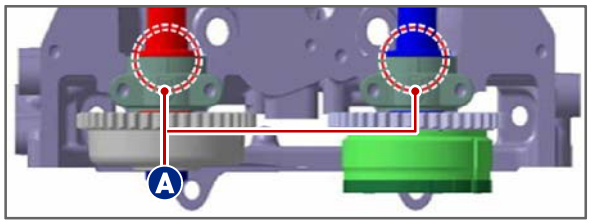


Timing marks









Align the timing marks (A) on the camshaft flange and camshaft cap when installing the intake/exhaust camshaft.

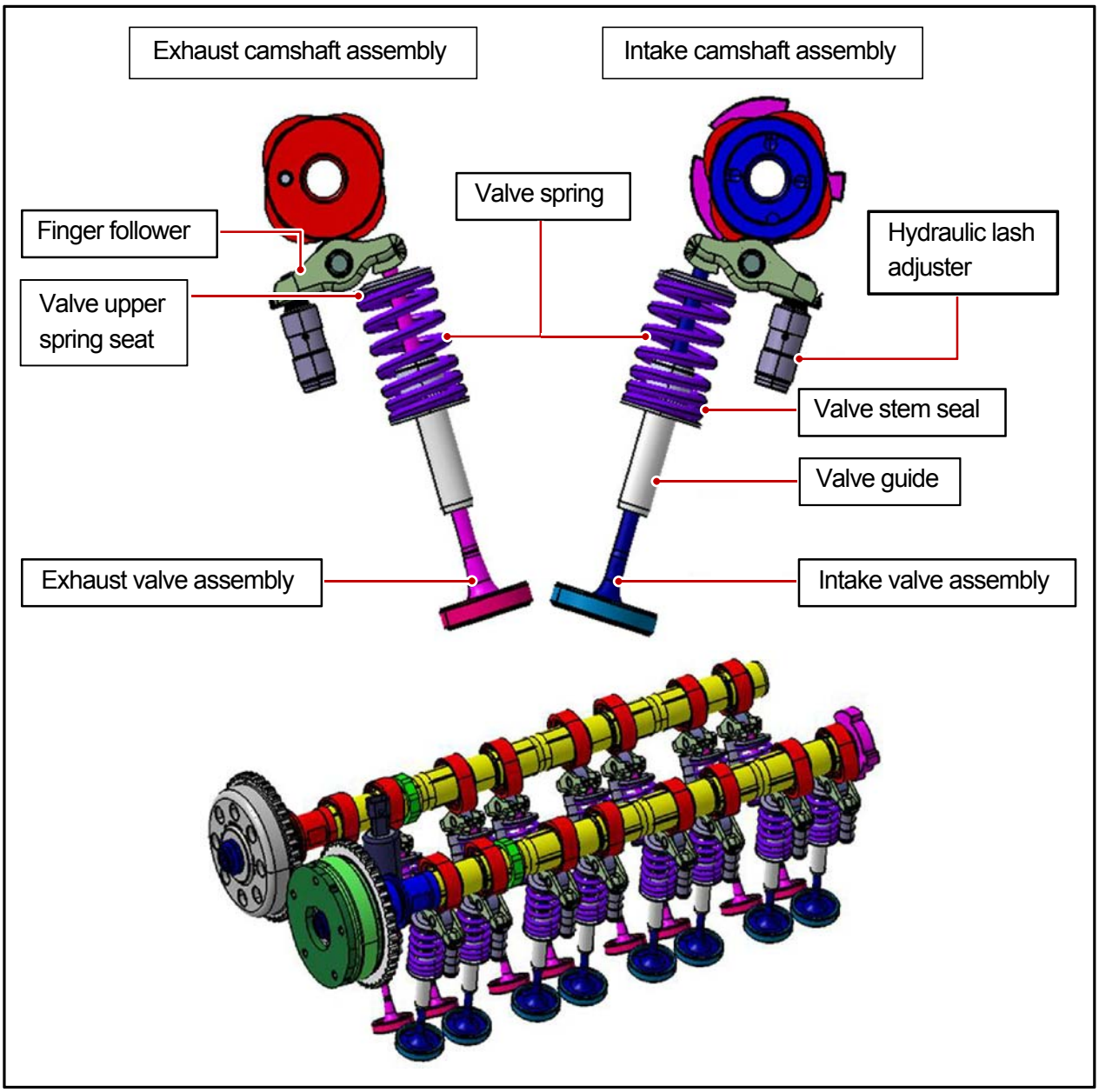
Modification basis	
Application basis	
Affected VIN	

4) Intake/Exhaust Valve Assembly (Installed on Cylinder Head)

(1) Features

- Automatic adustment of valve clearance by hydraulic pressure system (Maintenance Free)_Hydraulic lash
- Decreased valve operating noise
- Decreased friction loss by introducing the roller type finger follower
- Valave installation angle: 17°
- Decreased running amount by compact design (increased valve following movement in high speed and improved fuel economy by decreased friction loss)

(2) Layout and components

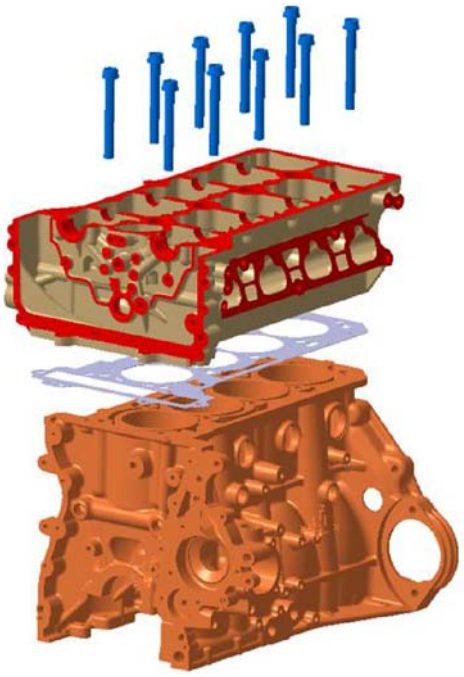


5) Cylinder Head Gasket

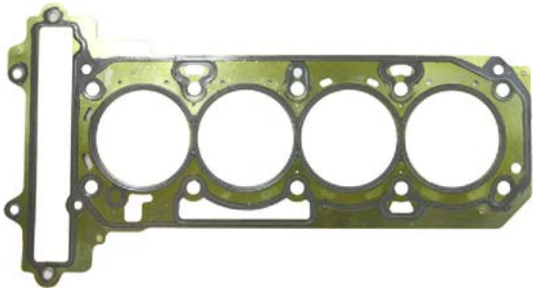
▶ **Overview**

The cylinder head gasket is installed between cylinder block and cylinder head to seal the combustion gas from the combustion chamber, engine oil and coolant.

▶ **Location**



Cylinder head gasket



- 3 Layer MLS Gasket
- Thickness : 0.7 mm (Compressed)
- PFP: Max. 85 bar

Modification basis	
Application basis	
Affected VIN	

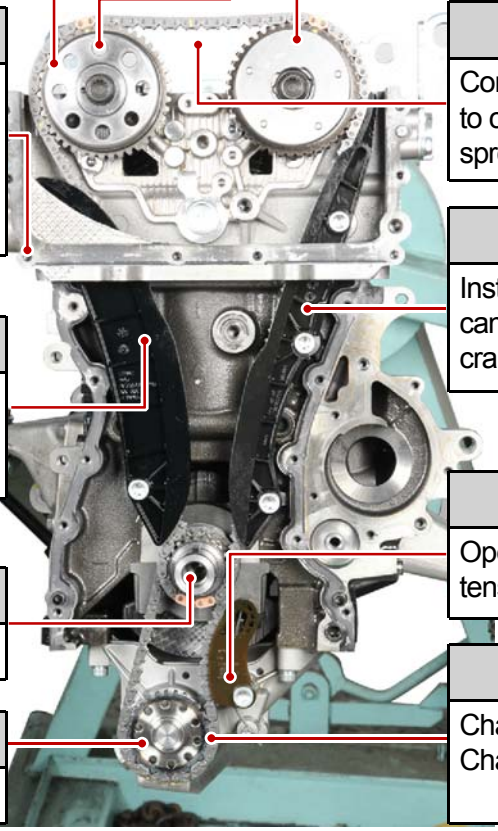
S.G.N. 1311-01

CHAIN DRIVE SYSTEM

▶ Overview

The drive chain is single chain drive system with simple design and variable performance, and it utilizes the hydraulic tensioner to reduce the wave impact generated by the chain. The silent chain provides the silence during the operation. To improve NVH, the shoulder bolt has been introduced.

▶ Layout and Components



Chain bush upper
Chain type: Single bush type
Chains: 146 ea

Exhaust camshaft sprocket
Teeth:42 ea

Intake camshaft sprocket
CVVT
Teeth: 42 ea

Hydraulic tensioner
Consists of tensioner housing plug, spring, check valve, and operated by hydraulic pressure and spring in tensioner

OCV
Controls the hydraulic circuit to control the intake cam sprocket variably

Clamping rail
Installed between intake camshaft sprocket and crankshaft sprocket

Tensioner rail
Installed between exjaust camshaft sprocket and crankshaft sprocket

Mechanical tensioner
Operated by spring in tensioner

Crankshaft sprocket
Teeth: 21 ea

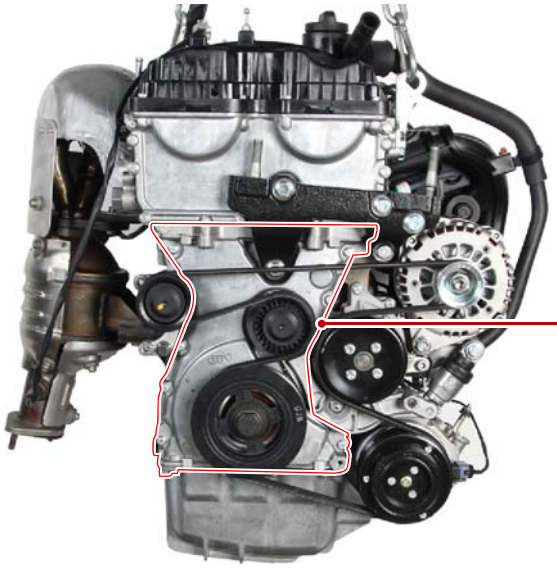
Chain lower bush
Chain type: Single bush type
Chains: 58 ea

Oil pump sprocket
Teeth: 28 ea

1) Timing Gear Case Cover

▶ **Features**

- Major function: Protecting the chain drive system, minor function: Shielding the chain noise
- Timing gear case cover prevents the oil from leaking.
- The crankshaft front seal and the engine mounting bracket are installed on the timing gear case cover.



Timing gear case cover



CAUTION

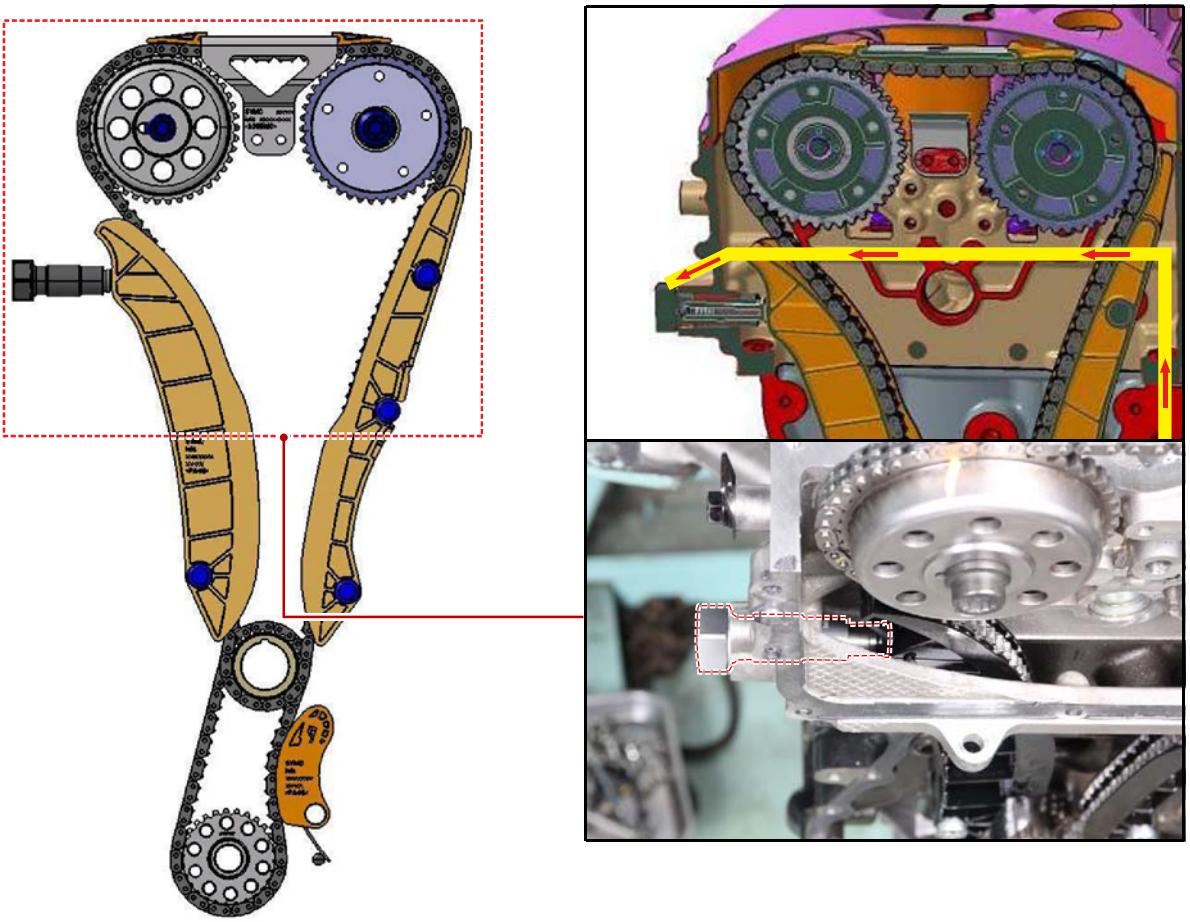
- Do not touch the inner lip of crankshaft front seal installed on the timing gear case cover.

Modification basis	
Application basis	
Affected VIN	

2) Hydraulic Auto Tensioner

In G20DF engine, the hydraulic auto tensioner is used to keep the tension for chain drive system of engine. The auto tensioner is operated by the spring in tensioner and the hydraulic pressure.

Layout and Location

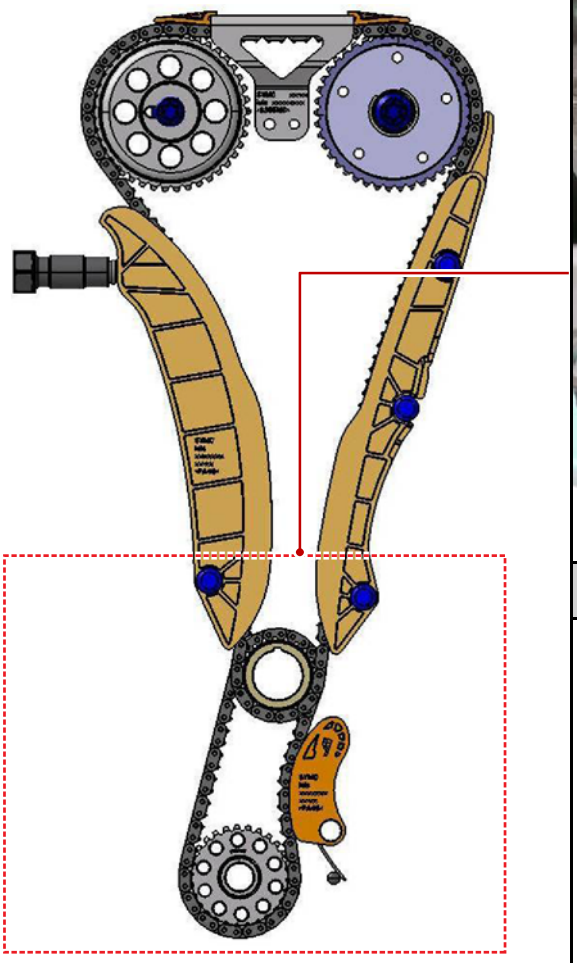


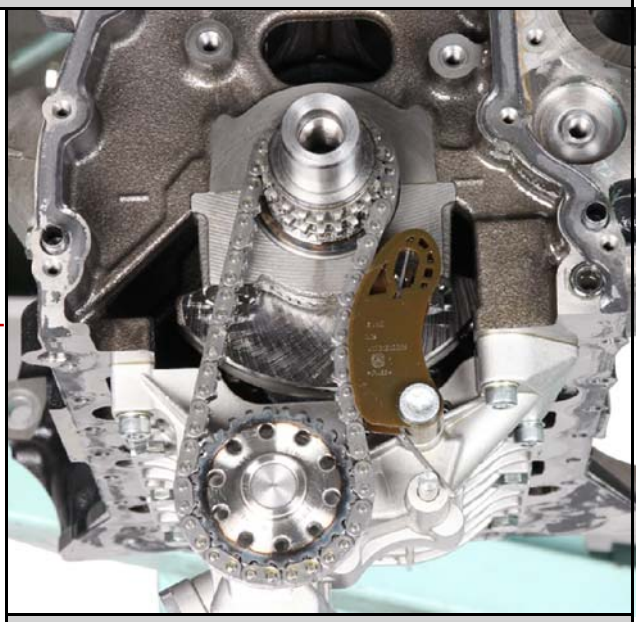
Hydraulic chain tensioner



3) Oil Pump Chain Tensioner

Layout and Location





Oil pump chain tensioner

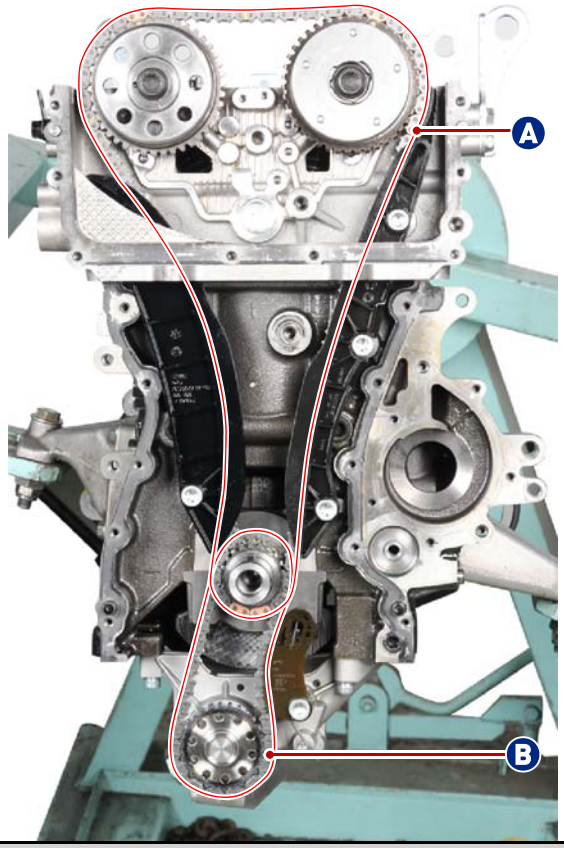


- Operated by spring in tensioner
- Tensioner type: Compensating and absorbing the impact
- Static and dynamic force: spring

Modification basis	
Application basis	
Affected VIN	

4) Timing Chain and Gear

▶ Timing chain



A. Timing chain

Teeth: 146 ea



B. Oil pump chain

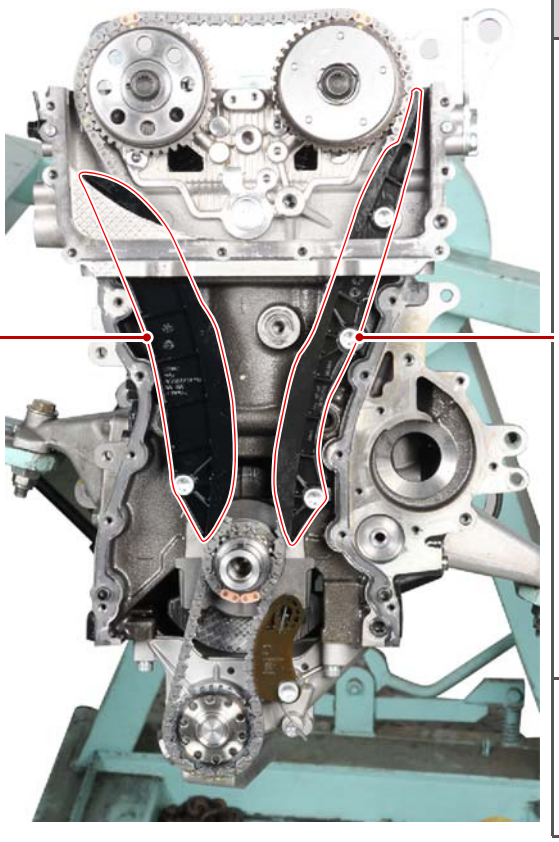
Teeth: 58 ea



- Simple layout provides the optimized timing.
- Decreased chain vibration and noise
- Single stage layout: minimized chain load

5) Chain Rails

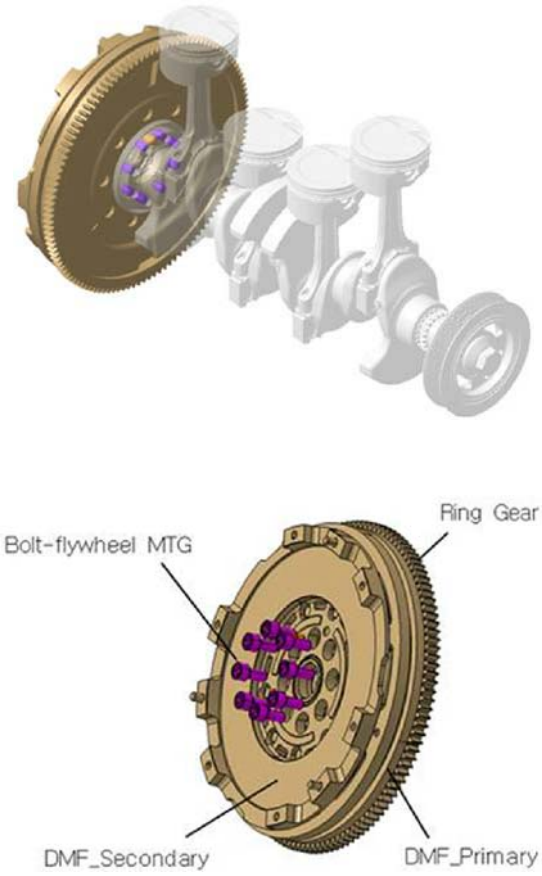
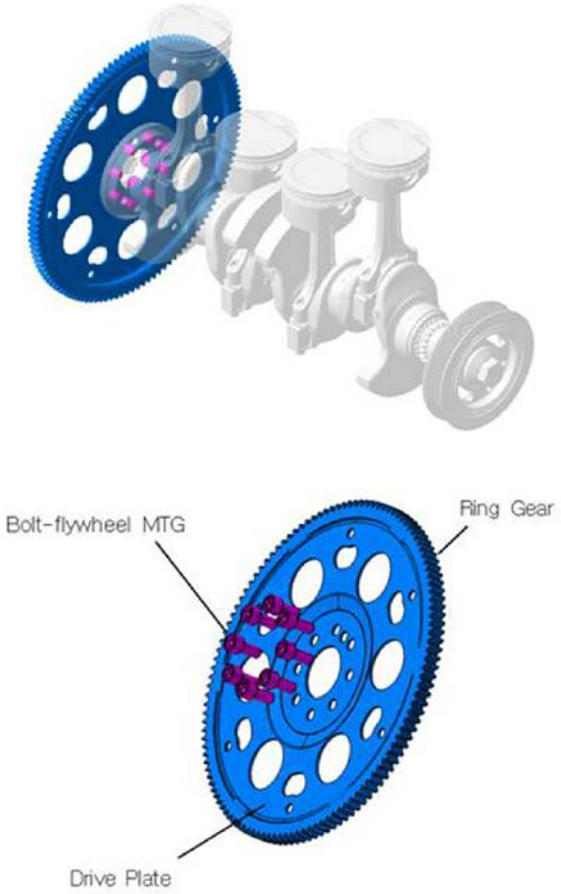
The chain rails are used for optimizing the movement of chain drive system. And they also prevent the chain from contacting each other when the chain is loose, and reduces the chain wear. The chain rail is normally made of PA (Polyamide nylon), and PA66 and PA46 are used for the chain rails in G20DF engine. For the tensioner rail, PA46 is used to provide high anti-wear function and high strength since the load to the rail is huge. Ther is an open area for shoulder bolt hole in the clamping rail. The chain rails are installed by shoulder bolts.

Tensioner rail		Clamping rail
		
Installed between exhaust camshaft sprocket and crankshaft sprocket		Installed between intake camshaft sprocket and crankshaft sprocket

Modification basis	
Application basis	
Affected VIN	

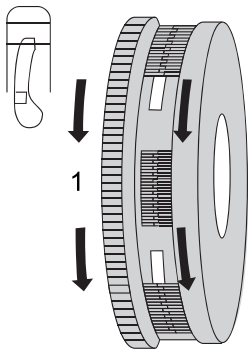
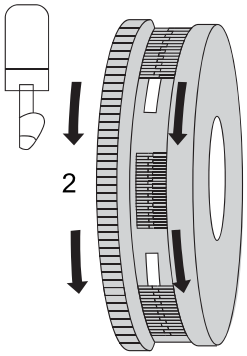
S.G.N.
1130-13 FLYWHEEL

1) Overview

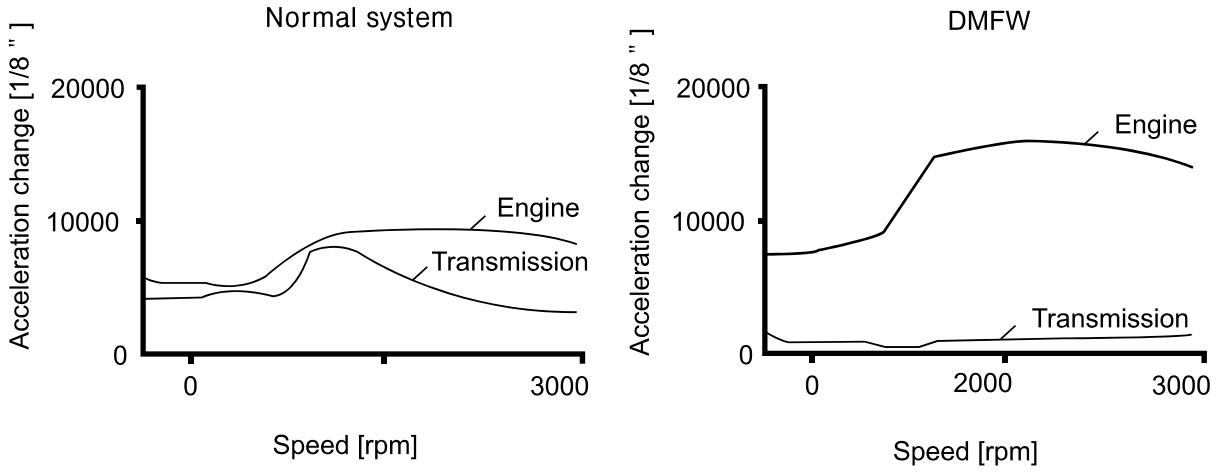
Dual mass flywheel (DMF) - Manual transaxle	Drive plate - Automatic transaxle
	
Dual mass flywheel reduces the unbalanced rotation of crankshaft in manual transaxle equipped vehicle. The flywheel is installed on the crankshaft and is engaged to the clutch disc to transfer the driving torque from the engine to the powertrain system. Additionally, DMF decreases the rattling noise in transaxle and the vehicle vibration by reducing the differences of torque and rotational speed due to the combustion in engine.	The drive plate initially drives the powertrain system by using the power from the start motor when starting the engine. The drive plate is installed on the crankshaft and is engaged to the torque converter of automatic transaxle to transfer the driving torque from the engine to the powertrain system.

2) Operation of DMF

- Compensating the irregular operation of engine: The secondary flywheel operates almost evenly so does not cause gear noises
- The mass of the primary flywheel is less than conventional flywheel so the engine irregularity increases more (less pulsation absorbing effect).
- Transaxle protection function: Reduces the torsional vibration to powertrain (transaxle) by reducing the irregularity of engine.

Compression stroke	Combustion stroke
	
Small changes from engine (k): Damper increases the torque changes to clutch	**Large changes from engine (j):** Damper decreases the torque changes to transaxle by absorbing the impact

Torque change curve of engine and drive shaft



Modification basis	
Application basis	
Affected VIN	

3) Features of DMF

- Reduced vibration noise from the powertrain by blocking the torsional vibrations
- Enhanced vehicle silence and riding comforts: reduced engine torque fluctuation
- Reduced shifting shocks
- Smooth acceleration and deceleration

4) Advantages of DMF

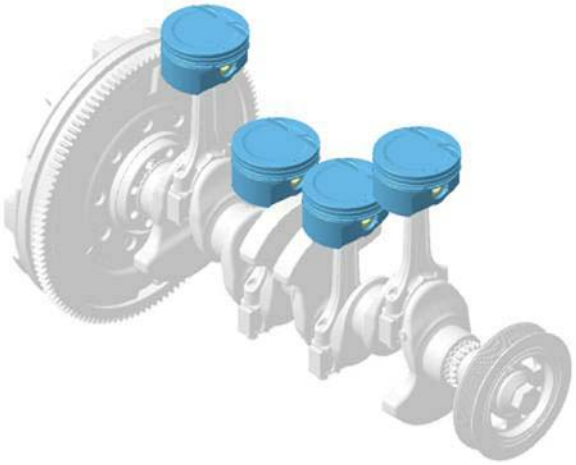
- Improved torque response by using 2-stage type spring: Strengthens the torque response in all ranges (low, medium, and high speed) by applying respective spring constant at each range.
- Stable revolution of the primary and secondary wheel by using planetary gear: Works as auxiliary damper against spring changes
- Less heat generation due to no direct friction against spring surface: Plastic material is covered on the spring outer surface
- Increased durability by using plastic bushing (extends the lifetime of grease)

S.G.N.
1130-33 PISTON ASSEMBLY

▶ Overview

Piston assembly contains piston, #1 ring, #2 ring, oil ring, piston pin and snap ring. The expansion energy from engine is transferred to the crankshaft through connecting rod to convert the linear movement to rotating energy.

▶ Layout and Components



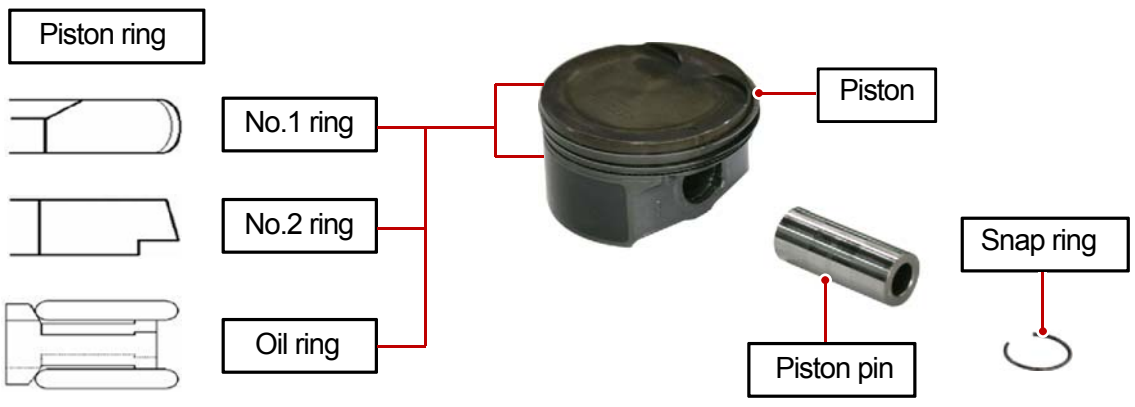
Top



Bottom



Components



Modification basis	
Application basis	
Affected VIN	

▶ Functions

Piston transfers the combustion energy from engine to connecting rod.

A. Piston ring

- #1 ring (Top ring) : Prevents the high pressurized combustion gas from leaking into crank chamber, and prevents the engine oil getting into combustion chamber.
- #2 ring: Scrapes the engine oil on the cylinder bore, and prevents the leaked combustion gas from #1 ring from leaking into the crank chamber.
- Oil ring: Scrapes the engine oil on the cylinder bore.

B. Piston pin

- Connects the piston the connecting rod, and transfers the linear movement of piston to connecting rod to convert it to rotating energy.

C. Snap ring

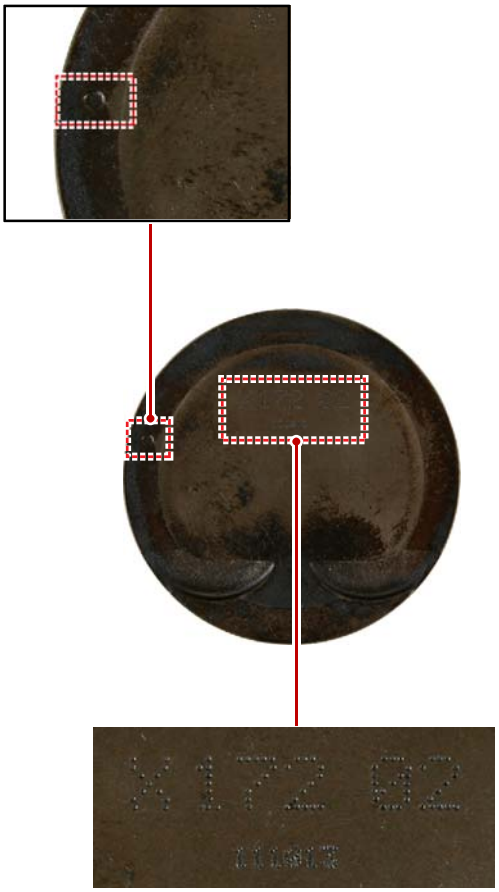
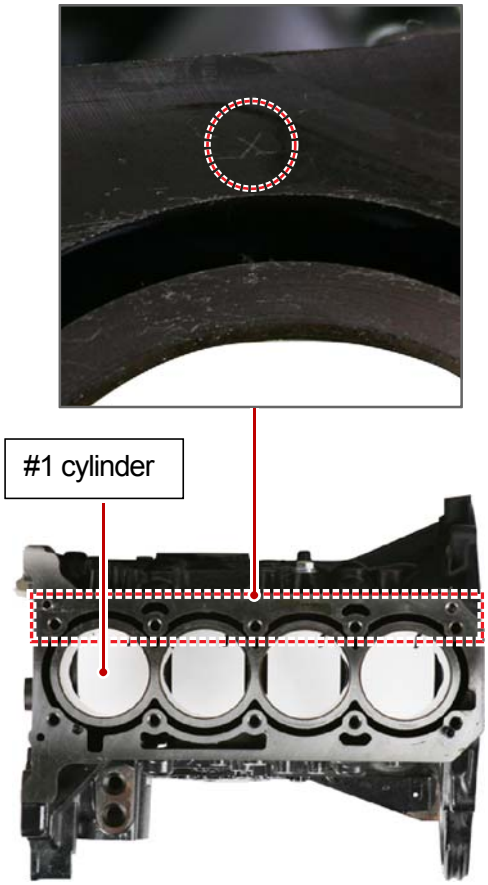
- Locks the piston pin.

▶ Piston ring

	
Piston ring end gap (mm) #1 end gap: 0.170 ~ 0.320 #2 end gap: 0.300 ~ 0.450	**Piston ring side clearance (mm)** #1 groove: 0.040 ~ 0.080 #2 groove: 0.040 ~ 0.080

▶ Assembling the piston

- Install the piston rings with the "X" mark on the ring facing upwards.
- Position the end gap of #1 ring at 180° away from the end gap of #2 ring.
- Position the end gap of oil ring at 180° away from the end gap of coil spring, and position the end gap of oil ring at 90° away from the end gap of #2 ring.

Assembly mark	
Top surface of piston	Top surface of cylinder block
	

Modification basis	
Application basis	
Affected VIN	

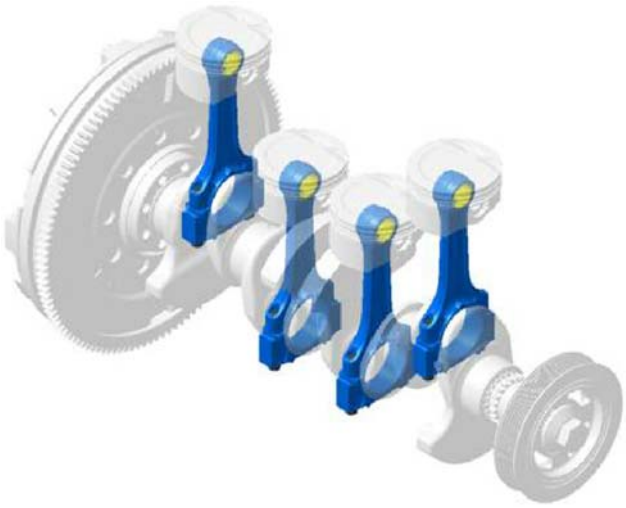
S.G.N. 1130-25

CONNECTING ROD

▶ Overview

Connecting rod converts the reciprocating movement of piston to the rotating movement of crankshaft. The big end is connected to connecting rod bearing and the crank pin journal, and the small end is connected to the piston pin.

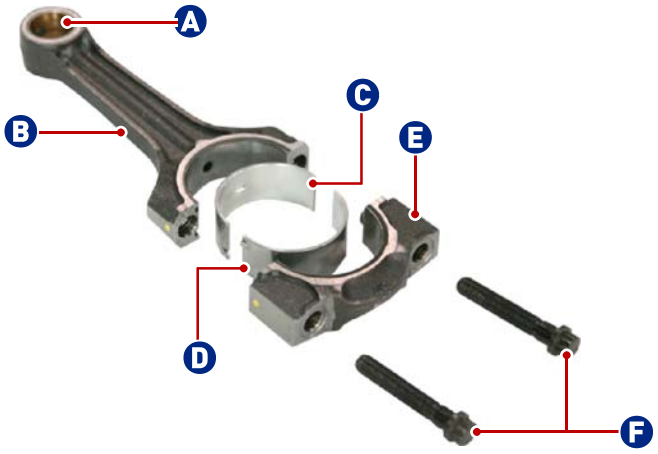
▶ Components



Connecting rod



Components



A. Piston pin bush
B. Connecting rod
C. Connecting rod upper bearing
D. Connecting rod lower bearing
E. Connecting rod cap
F. Connecting rod cap bolt

▶ **Selection of connecting rod bearing**

Select the bearing shell combination according to the table below:

Conrod_UPR Grade	Conrod_LWR Grade	Clearance
Red	Blue	0.005 ~ 0.050
Yellow	Yellow	0.005 ~ 0.050
Blue	Red	0.005 ~ 0.050

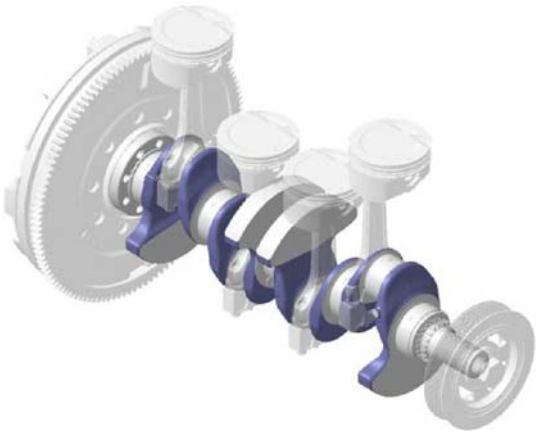
Modification basis	
Application basis	
Affected VIN	

S.G.N.
1130-01 CRANKSHAFT

▶ Overview

Crankshaft is installed on the cylinder block. The crankshaft converts the reciprocative movement of piston to the rotatinal movement.

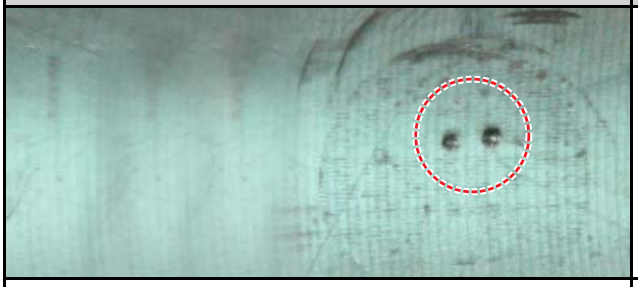
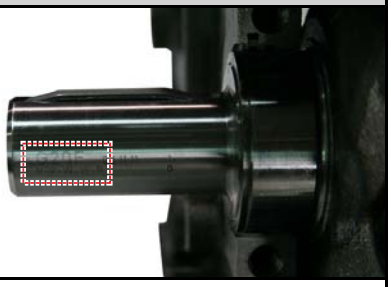
▶ Layout and Components



Crankshaft


▶ Selection of crankshaft main bearing



Bottom of cylinder block	Crankshaft sprocket installing surface
	

Engine name	G	2	0	D	F
Main journal bearing	R	R	W	W	R
	#1	#2	#3	#4	#5

Pin punch mark	Color	Diameter of crankshaft main journal in cylinder block (mm)
*	Blue	62.500 ~ 62.506
**	Yellow	62.506 ~ 62.513
***	Red	62.513 ~ 62.519

Mark	Color	Diameter of crankshaft main journal (mm)
B	Blue	57.960 ~ 57.965
Y	Yellow	57.955 ~ 57.960
R	Red	57.950 ~ 57.955
W	White	57.945 ~ 57.950
V	Violet	57.940 ~ 57.945

Crankshaft lower bearing	Crankshaft lower bearing
	

Modification basis	
Application basis	
Affected VIN	

S.G.N. 1128-01

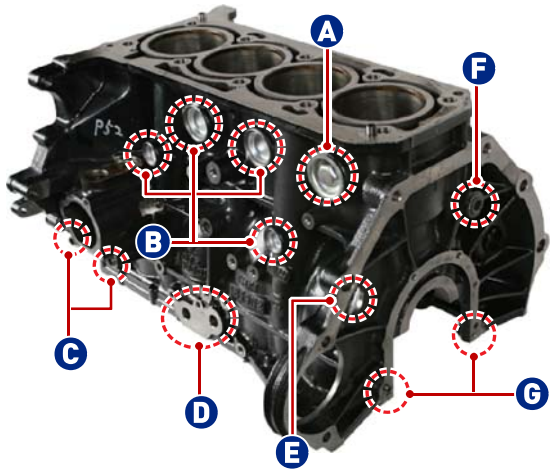
CYLINDER BLOCK

▶ Overview

The cylinder block is made of special cast iron, and contains the major components such as cylinder head, crankshaft and piston assembly. There are oil and coolant galleries to lubricate and cool the engine.

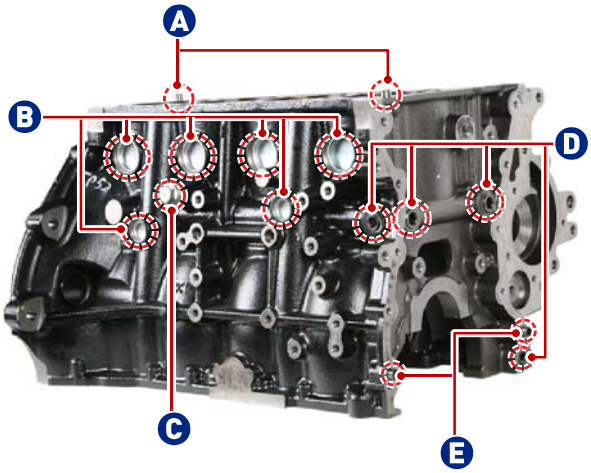
▶ Components

Front view



A. Plug screw (water jacket plug) (70Nm)
B. Expansion plug (intake: 4)
C. Spring pin (A/C mounting)
D. Oil gallery (oil filter assembly)
E. Ctankshaft position sensor mounting
F. Plug screw (oil gallery plug)
G. Spring pin (RR seal mounting)

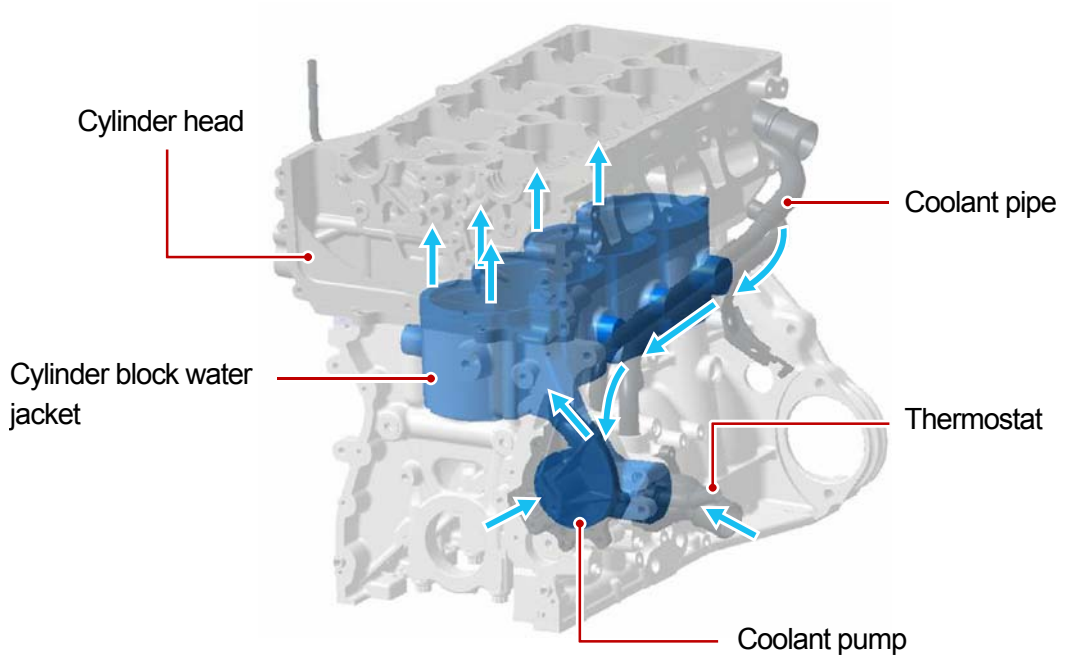
Rear view



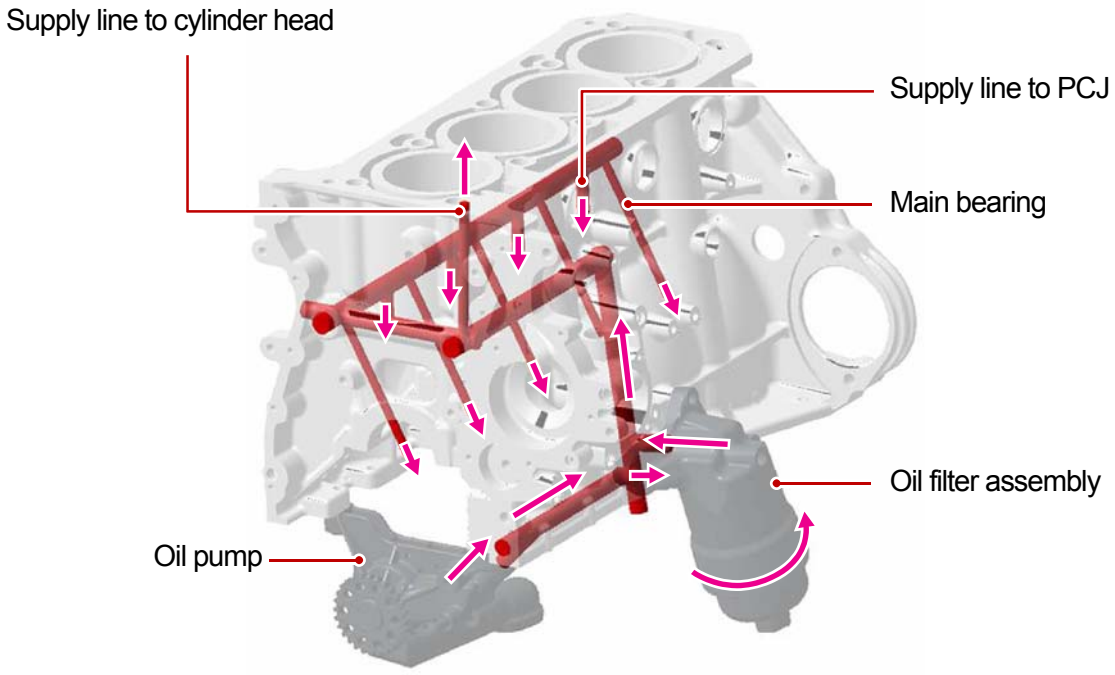
A. Spring pin (cylinder head mounting)
B. Expansion plug (exhaust: 6)
C. Screw plug (water jacket plug) (30Nm)
D. Screw plug (oil gallery plug)
E. Spring pin (T.G.C.C)

▶ Coolant and oil flows

Coolant



Engine oil



Modification basis	
Application basis	
Affected VIN	

INTAKE SYSTEM

1740-01

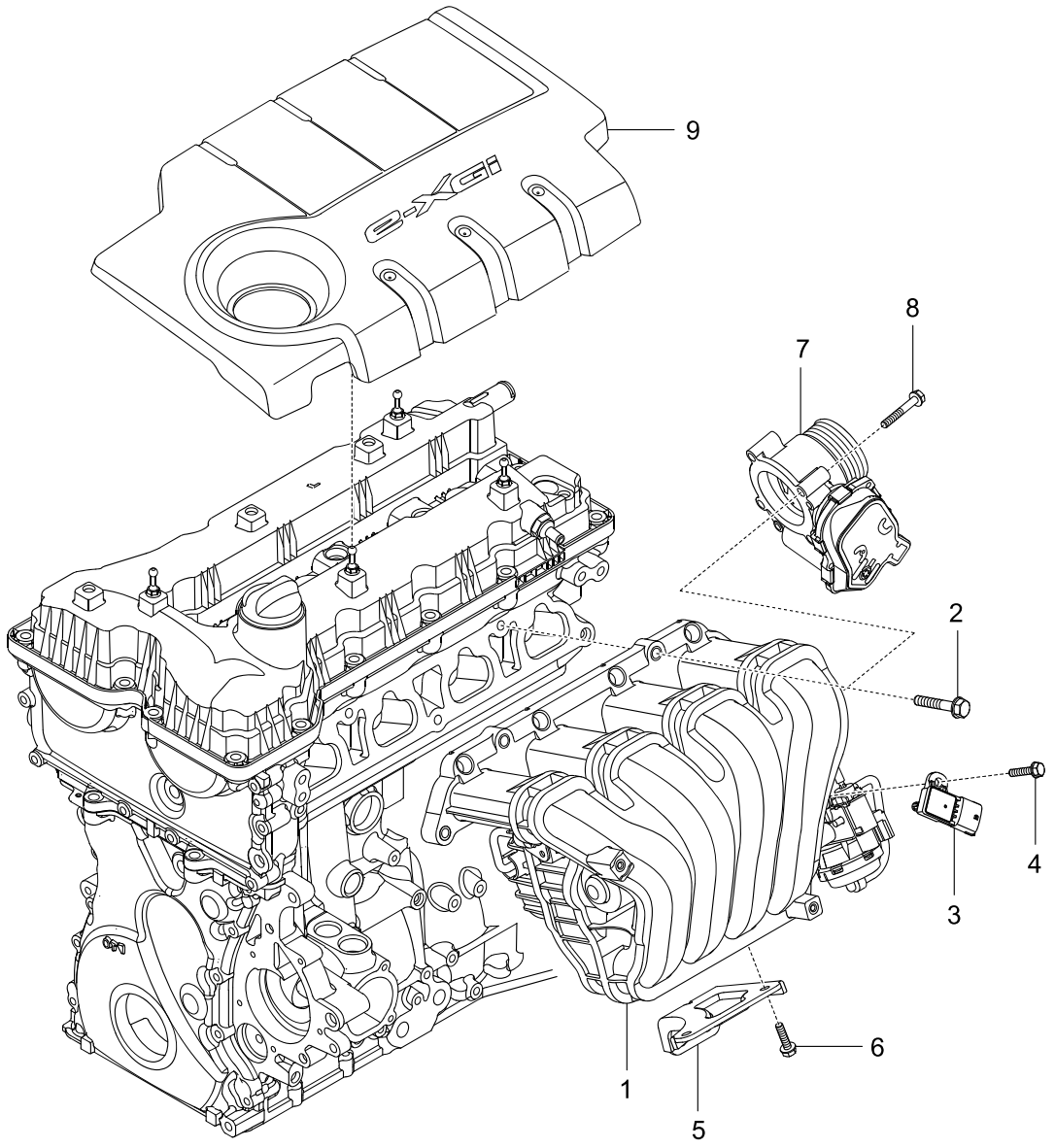
GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Air cleaner element	Filter type	Dry, filter element
	Filtering area	0.225 m²
	Service interval	Clean every 7,500 km
		Change every 15,000 km
Air cleaner assembly	Weight	1.45 kg
	Operating temperature	25℃
	Capacity	7L

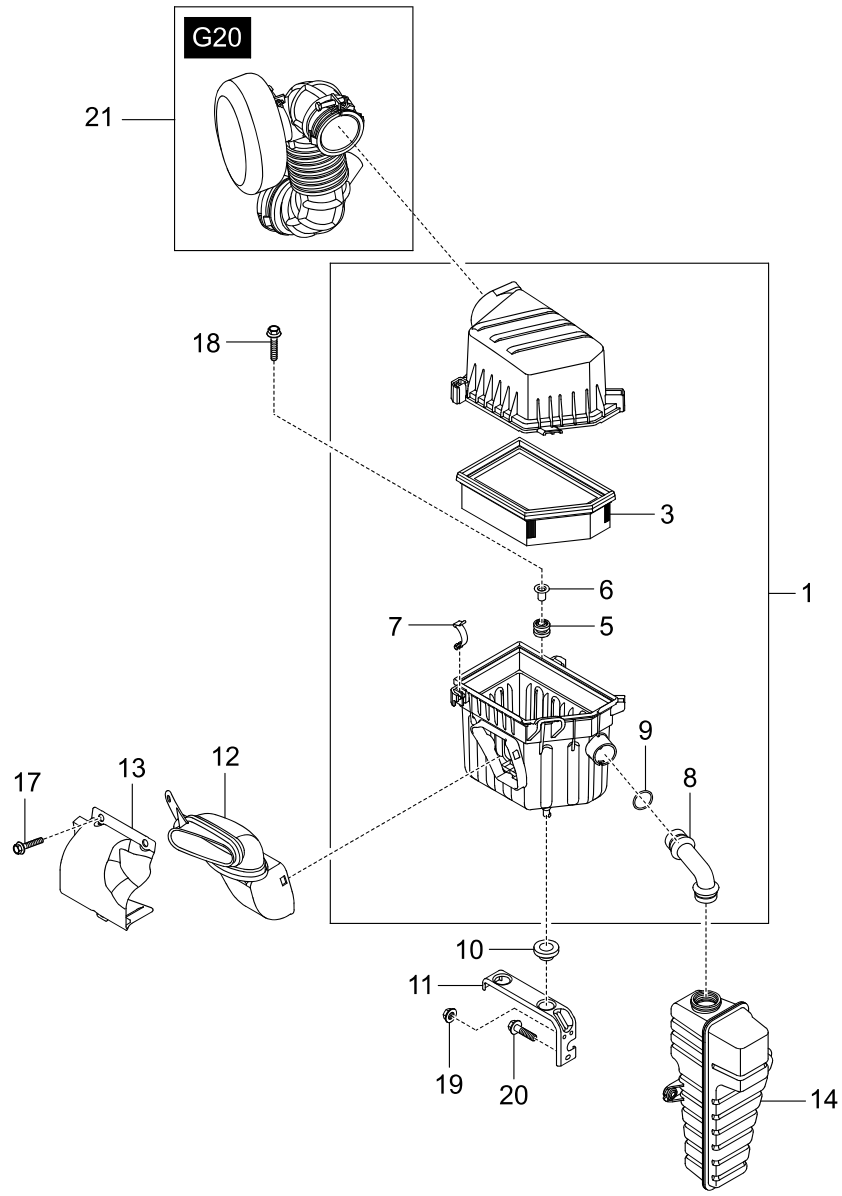
* Shorten the service interval under severe conditions such as driving on a dusty road or offroad.

2. LAYOUT



1. Intake Manifold Assy
2. Bolt
3. T-MAP sensor
4. Bolt
5. Intake Manifold Brkt
6. Bolt
7. Electric Throttle Body
8. Bolt
9. Acoustic Cover

Modification basis	
Application basis	
Affected VIN	



1. Air Cleaner Assy
3. Element Assy
5. Air Cleaner MTG NO.2
6. Insulator Collar
7. Spring Clamp
8. Resonance Duct
9. Resonance O-Ring
10. Air Cleaner MTG NO.1
11. Air Cleaner MTG Bolt
12. Snorkel Assy
13. Water Portector
14. Resonator Assy
17. RR Fascia MTG Screw Rivet
18. Bolt
19. Nut
20. Screw
21. Air Cleaner to Engine Hose Assy

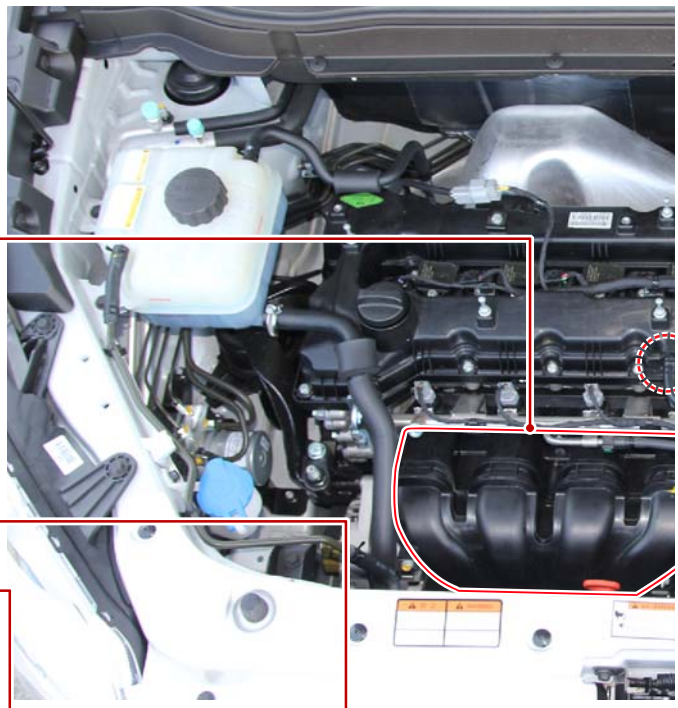
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

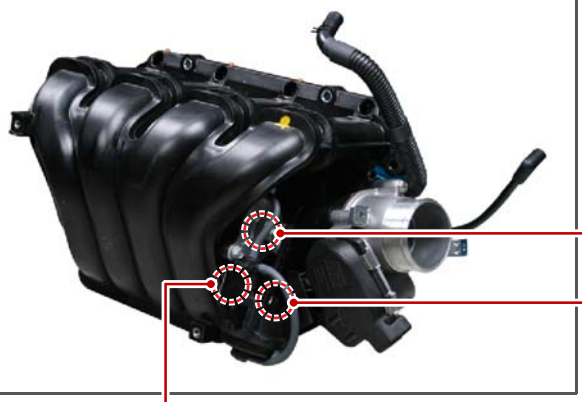
1. OVERVIEW

To improve the engine performance, the VIS system has been introduced in the intake manifold. It provides the "Long Runner" in low speed and the "Short Runner" in high speed.
And, to reduce the internal pulsation in the intake manifold, the Runner # 1 and #2 are located in symmetry position with Runner #3 and #4. To reduce the air resistance, the throttle body is tilted b

2. COMPONENTS



Intake manifold assembly



VIS solenoid valve



T-MAP sensor



VIS valve



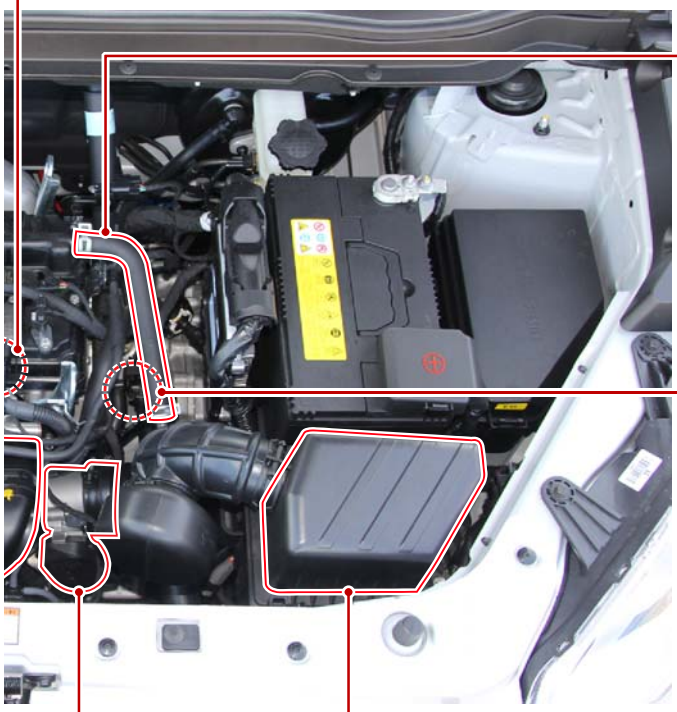
Modification basis	
Application basis	
Affected VIN	

PCV valve



Blow-by hose





Purge control solenoid valve



Electronic throttle body



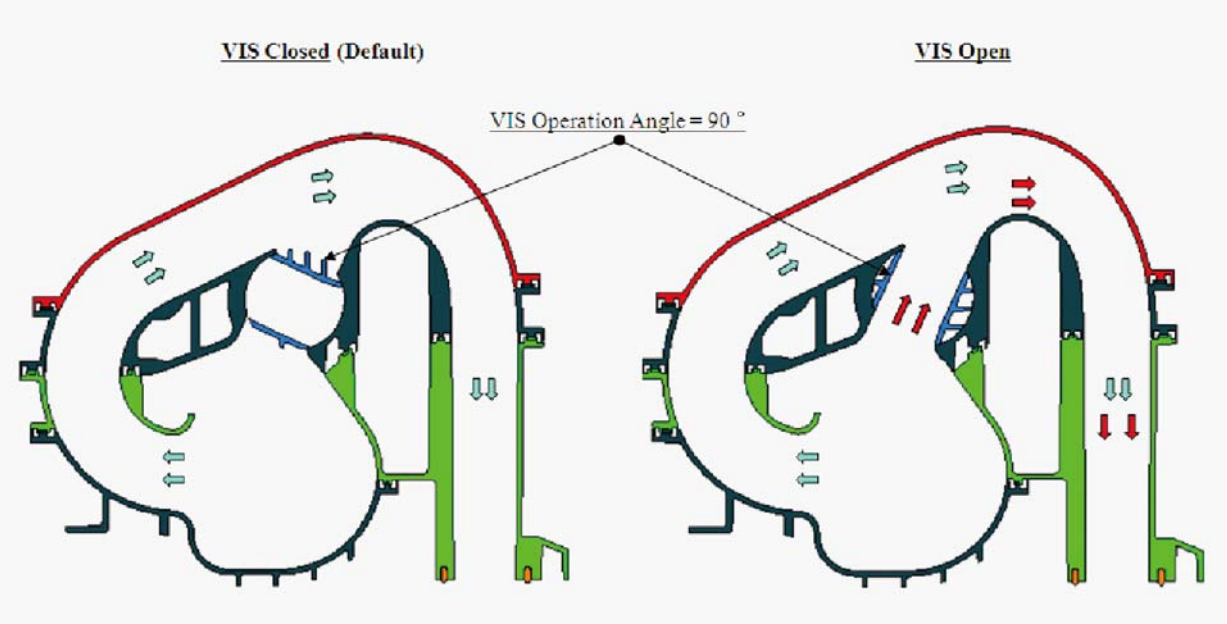
Air cleaner element



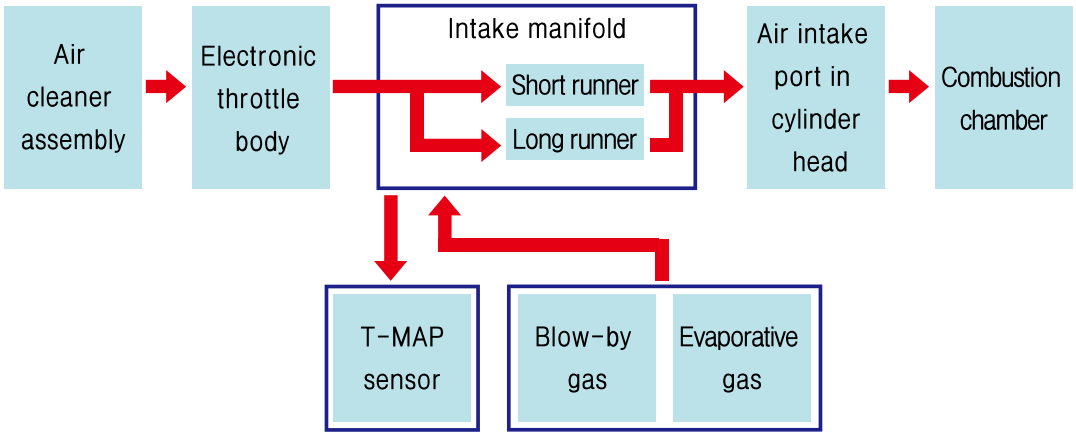
Modification basis	
Application basis	
Affected VIN	

3. OPERATING PROCESS

When Long Runner is operating	When Short Runner is operating

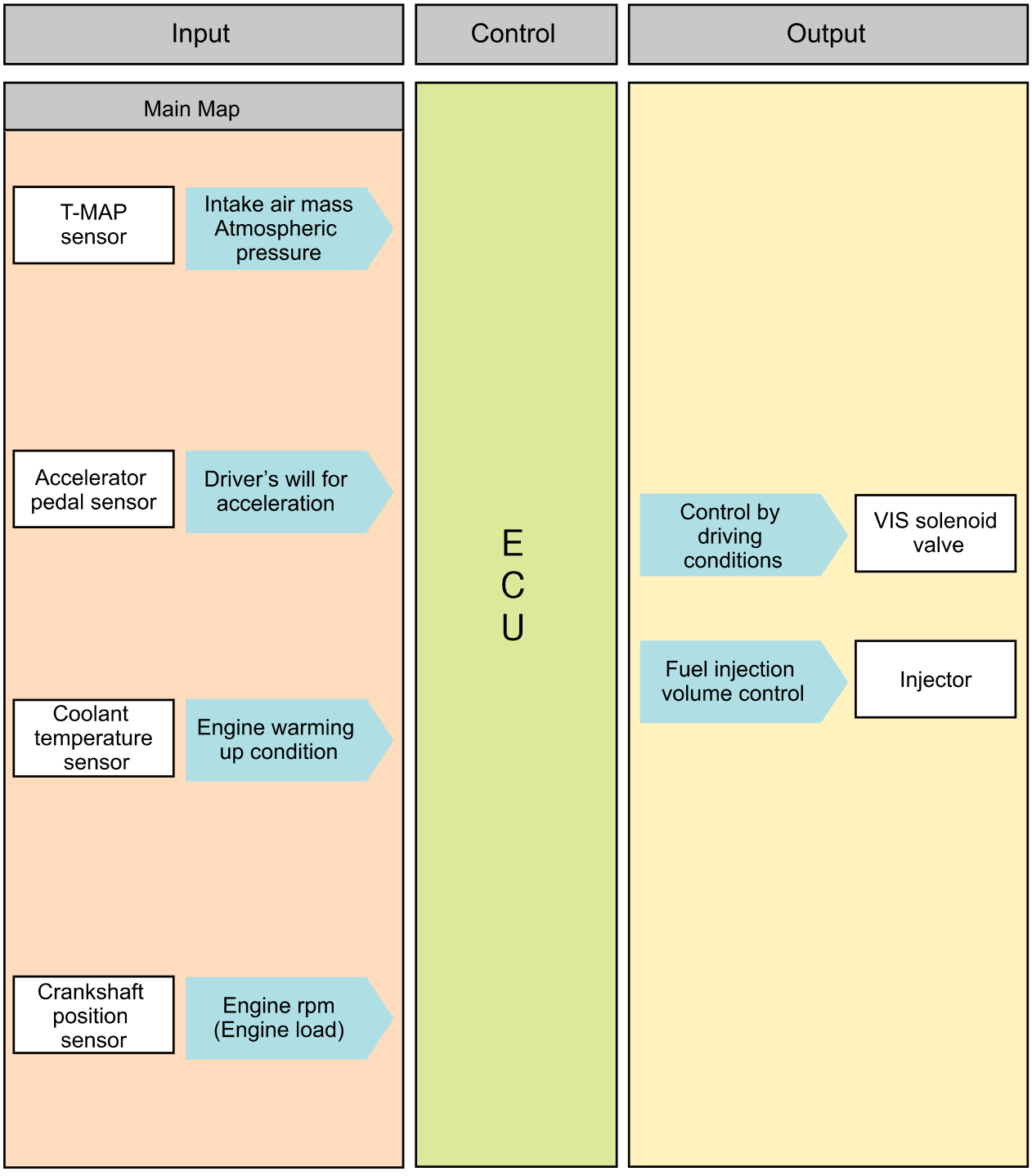


Intake air flows

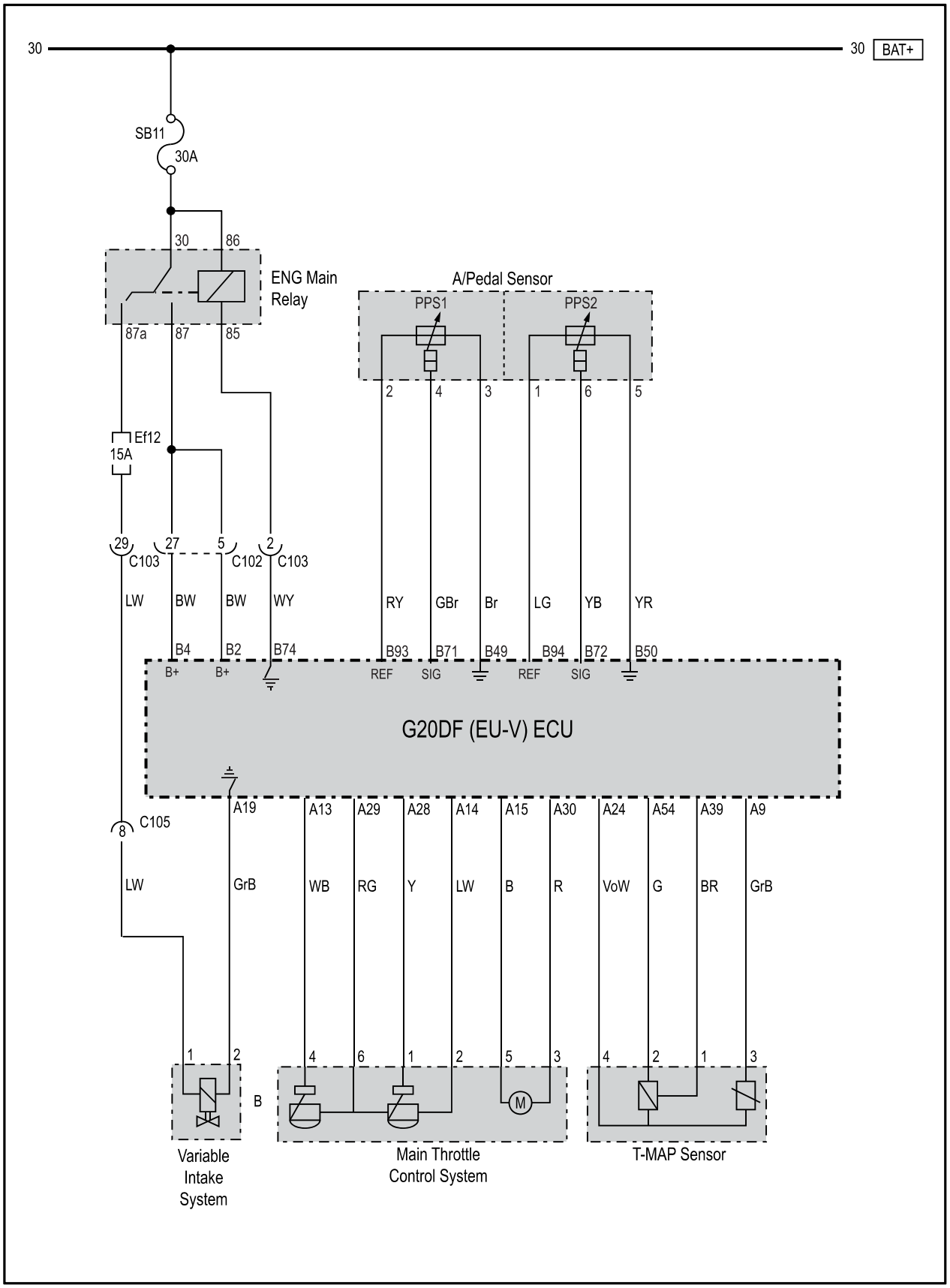


Modification basis	
Application basis	
Affected VIN	

4. INPUT/OUTPUT DEVICES



5. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

FUEL SYSTEM

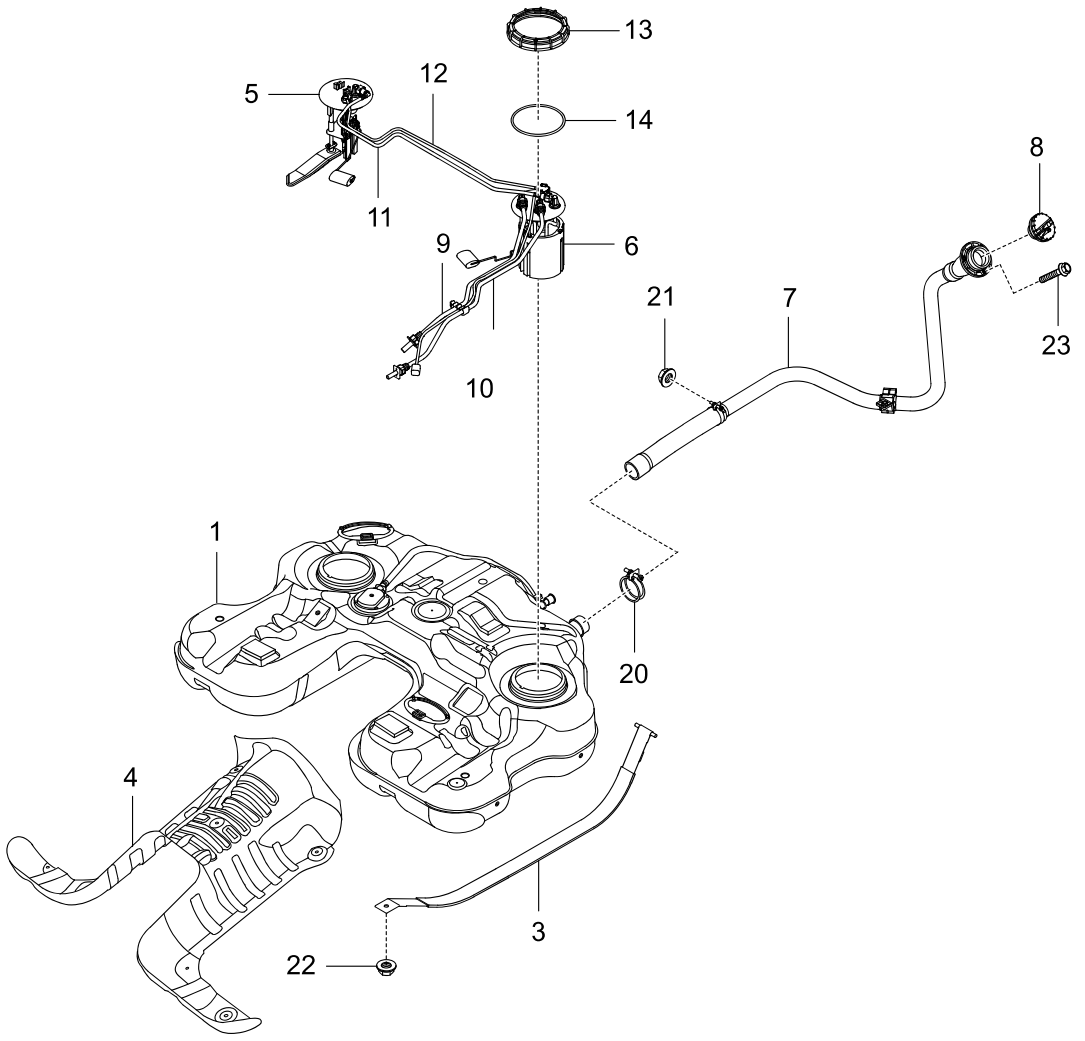
2221-01

GENERAL INFORMATION

1. SPECIFICATION

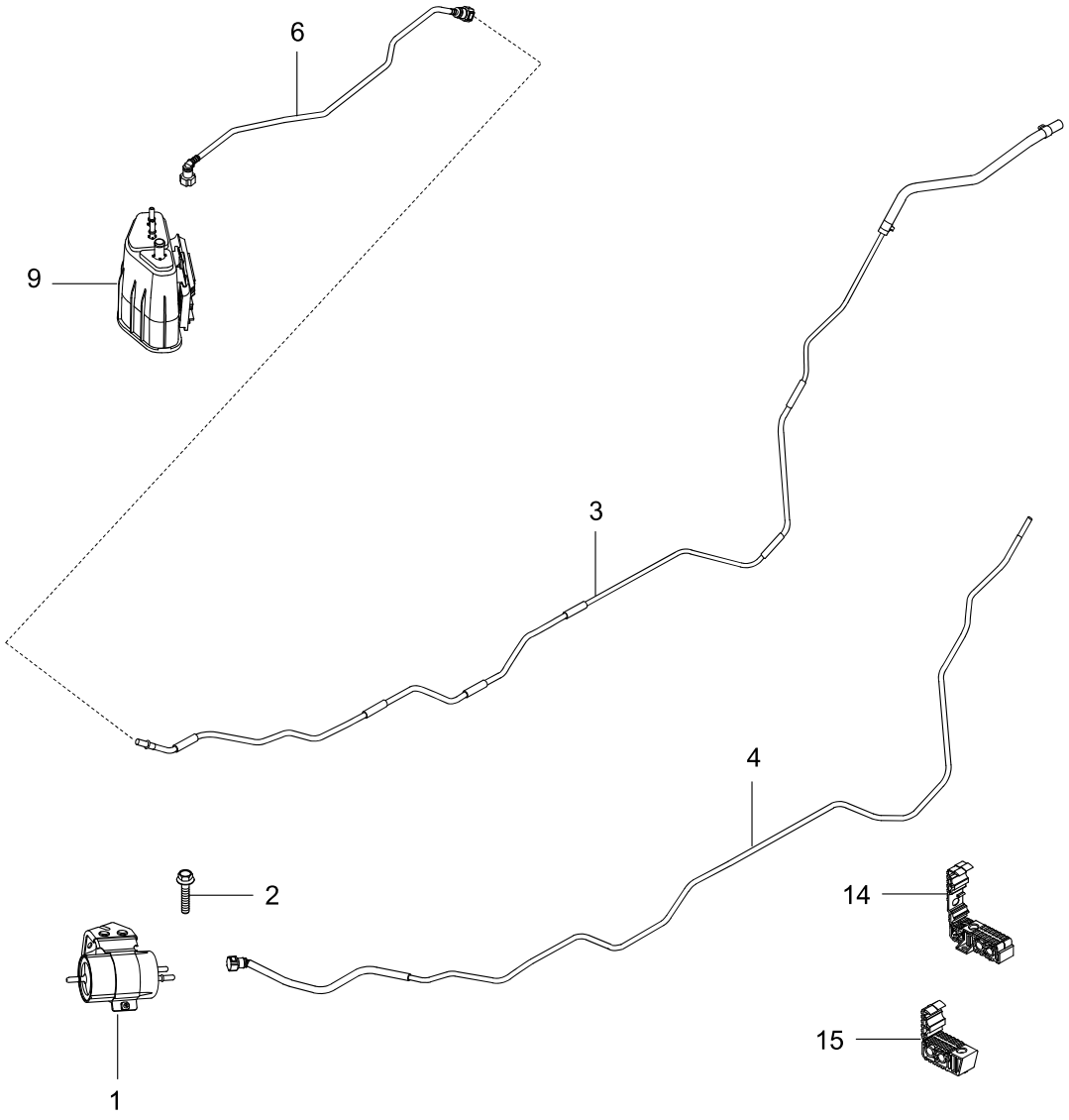
Unit		Specification
Fuel system	Fuel	Unleaded gasoline
	Fuel injection	MPI (Muilt Point Injecter) type
	Fuel supply	Returnless Fuel System
Fuel tank	Capacity	57 L
	Material	Plastic
	Fuel sender	Dual sender type
Fuel filter	Service interval	Change every 100,000 km
Fuel pump	Pressure	3.8 bar
Injector	Color	Black
	Capacity	187.2 g/min

2. SYSTEM LAYOUT



1. Fuel tank assy
3. Fuel tank strap assy
4. Heat shield assy
5. Sub sender assy
6. Main fuel pump assy
7. Fuel filler assy
8. Fuel filler cap assy
9. Feed tube assy
10. Return tube assy
11. Suction tube assy
12. Harness wiring assy
13. Fuel pump plate cover
14. O-ring
20. clamp
21. Nut
22. Nut
23. Screw

Modification basis	
Application basis	
Affected VIN	



1. Fuel Filter Assy
2. Bolt
3. Fuel Return Pipe
4. Fuel Supply pipe
6. Fuel Vapor Pipe Assy
9. Canister Compl
14. Fuel line Holder
15. Fuel line Holder

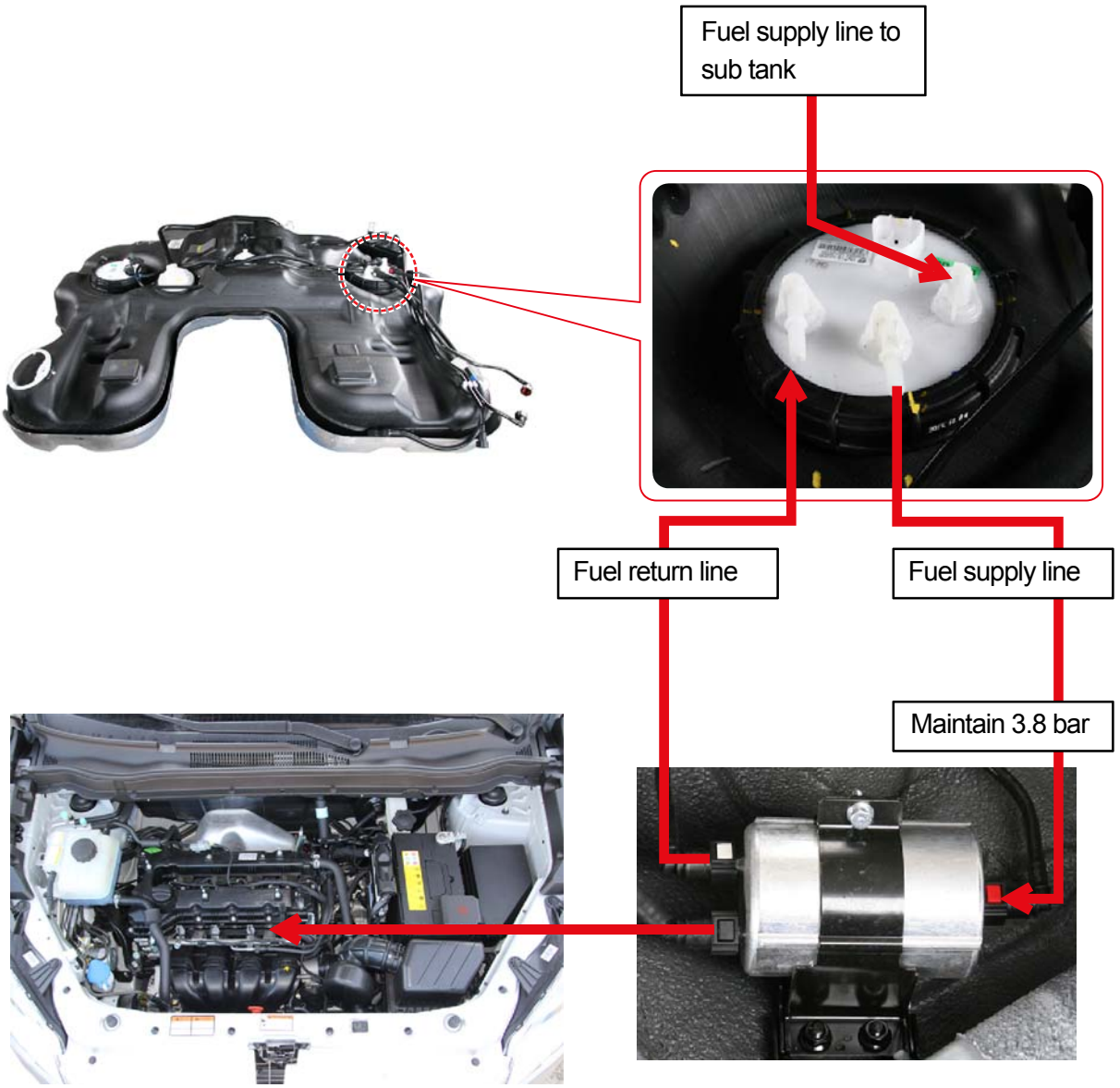
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The fuel system is a returnless type that the fuel pressure regulator is mounted inside the fuel tank.
The engine ECU controls the fuel injection in each injector electronically.
According to the engine loads, the engine ECU draws or cuts off the evaporated gas in canister into the combustion chamber. The fuel system consists of fuel tank, fuel lines, fuel pump and fuel pressure regulator.

Returnless Type



Modification basis	
Application basis	
Affected VIN	

Memo

2. COMPONENTS

Canister

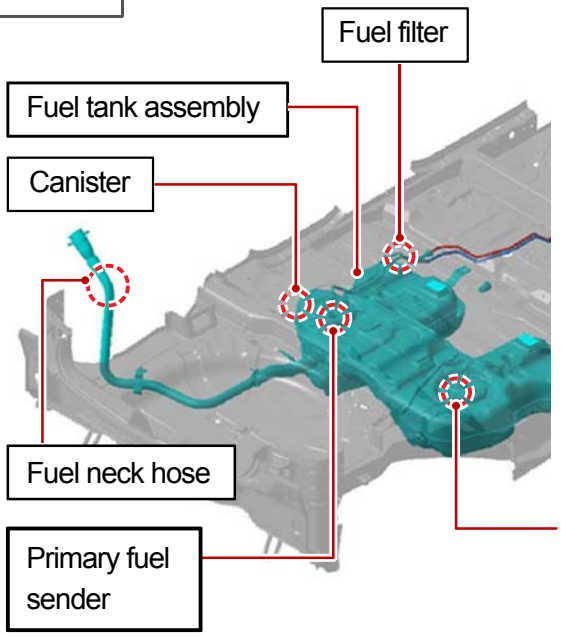


Fuel filter



Fuel pump and fuel sender assembly





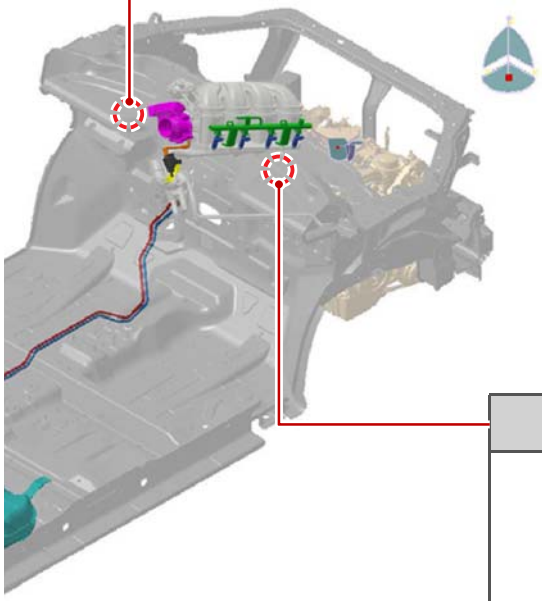
Fuel tank assembly



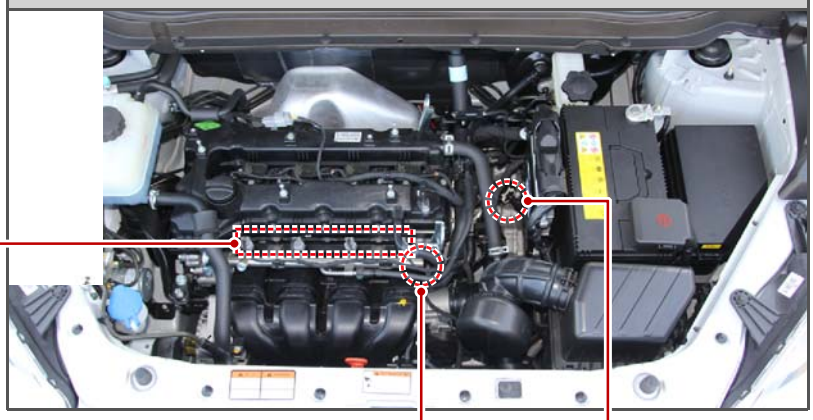
Modification basis	
Application basis	
Affected VIN	

Engine ECU





Engine compartment



Secondary fuel sender

Injector



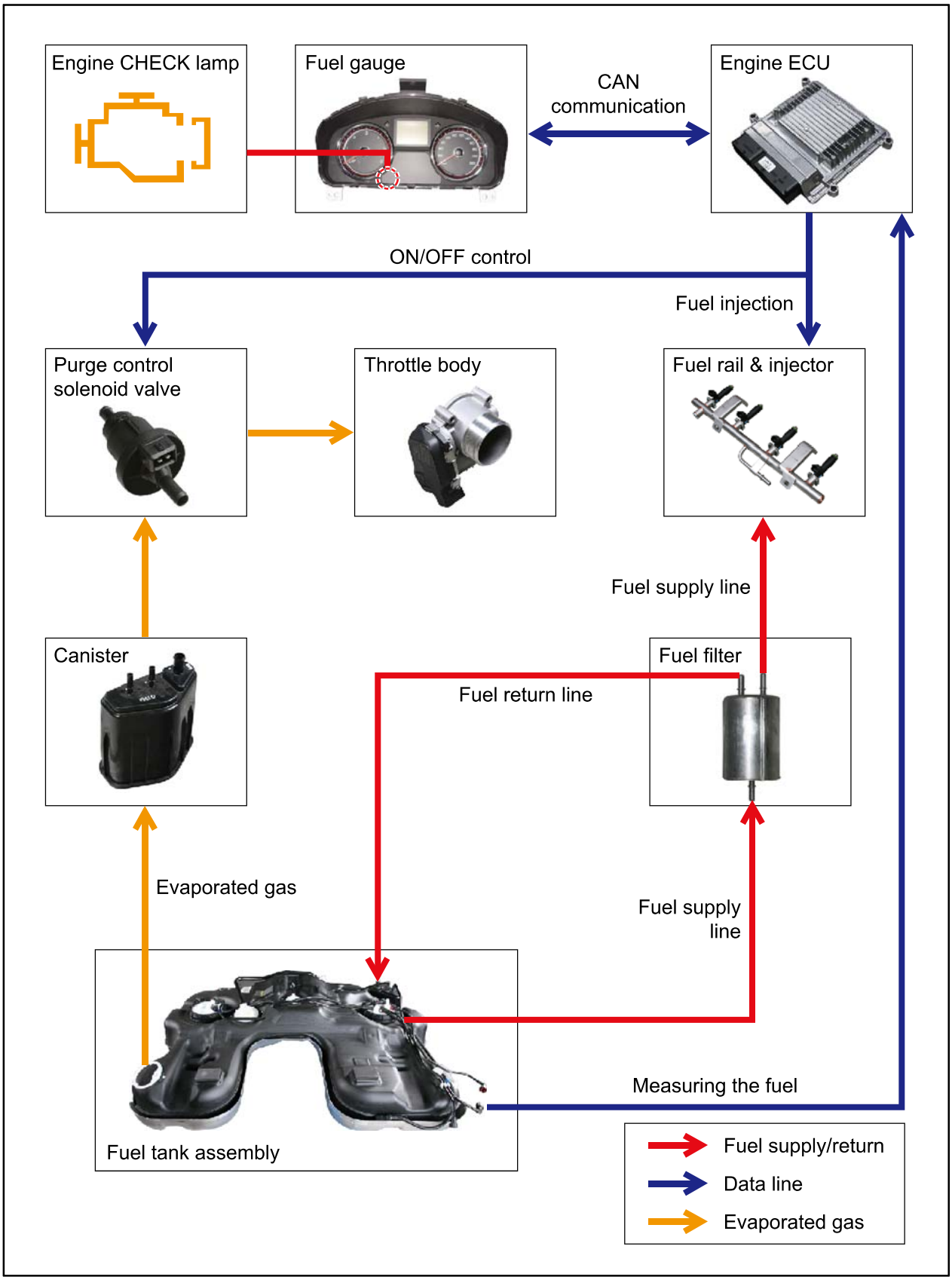
Fuel rail



Purge control solenoid valve

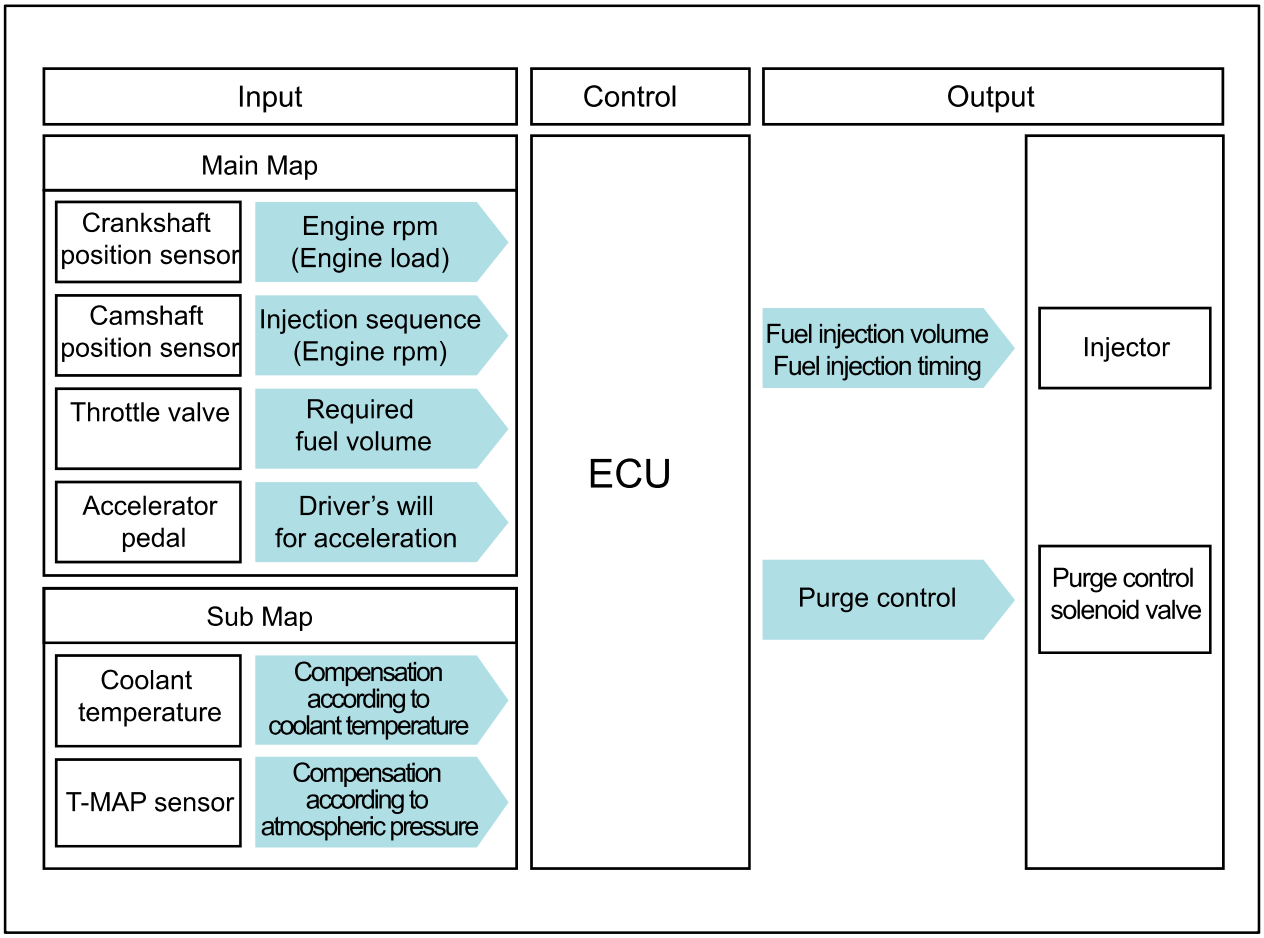


3. SCHEMATIC DIAGRAM OF FUEL FLOWS



Modification basis	
Application basis	
Affected VIN	

4. INPUT/OUTPUT DEVICES

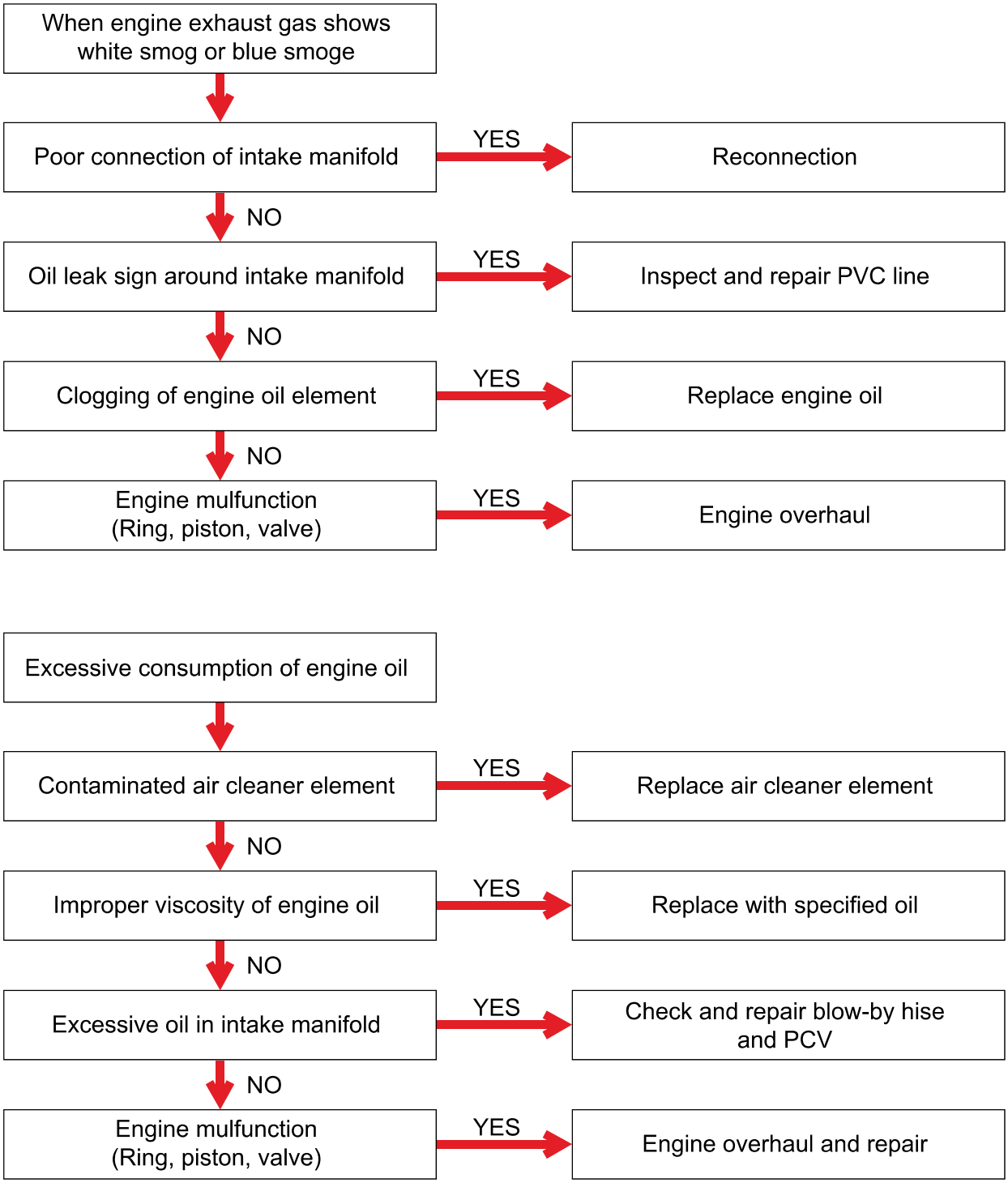


The engine ECU calculates the accelerator pedal based on the input signals from various sensors, and controls the overall operation of the vehicle.
The ECU receives the signals from various sensor through data line, and performs effective airfuel ratio control based on these signals.

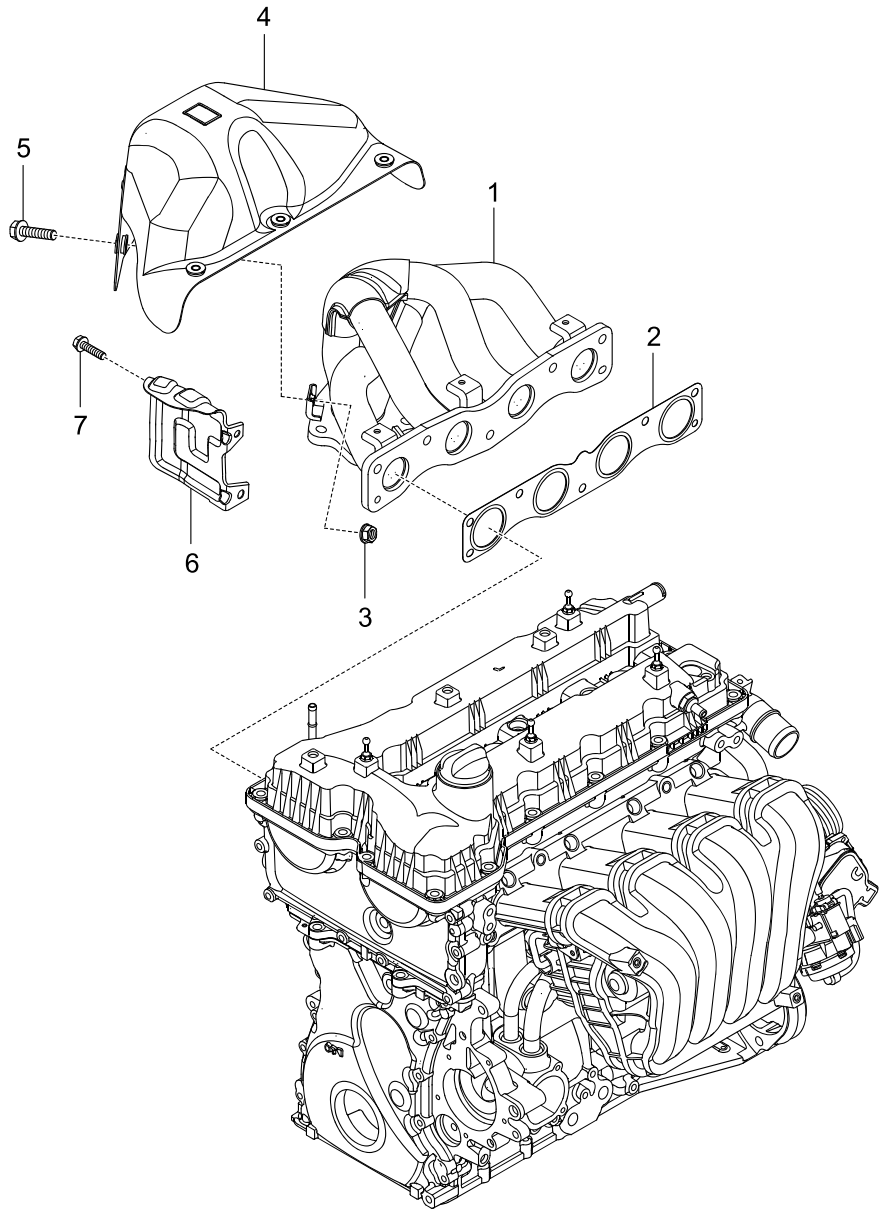
EXHAUST SYSTEM 1745-01

GENERAL INFORMATION

1. TROUBLESHOOTING

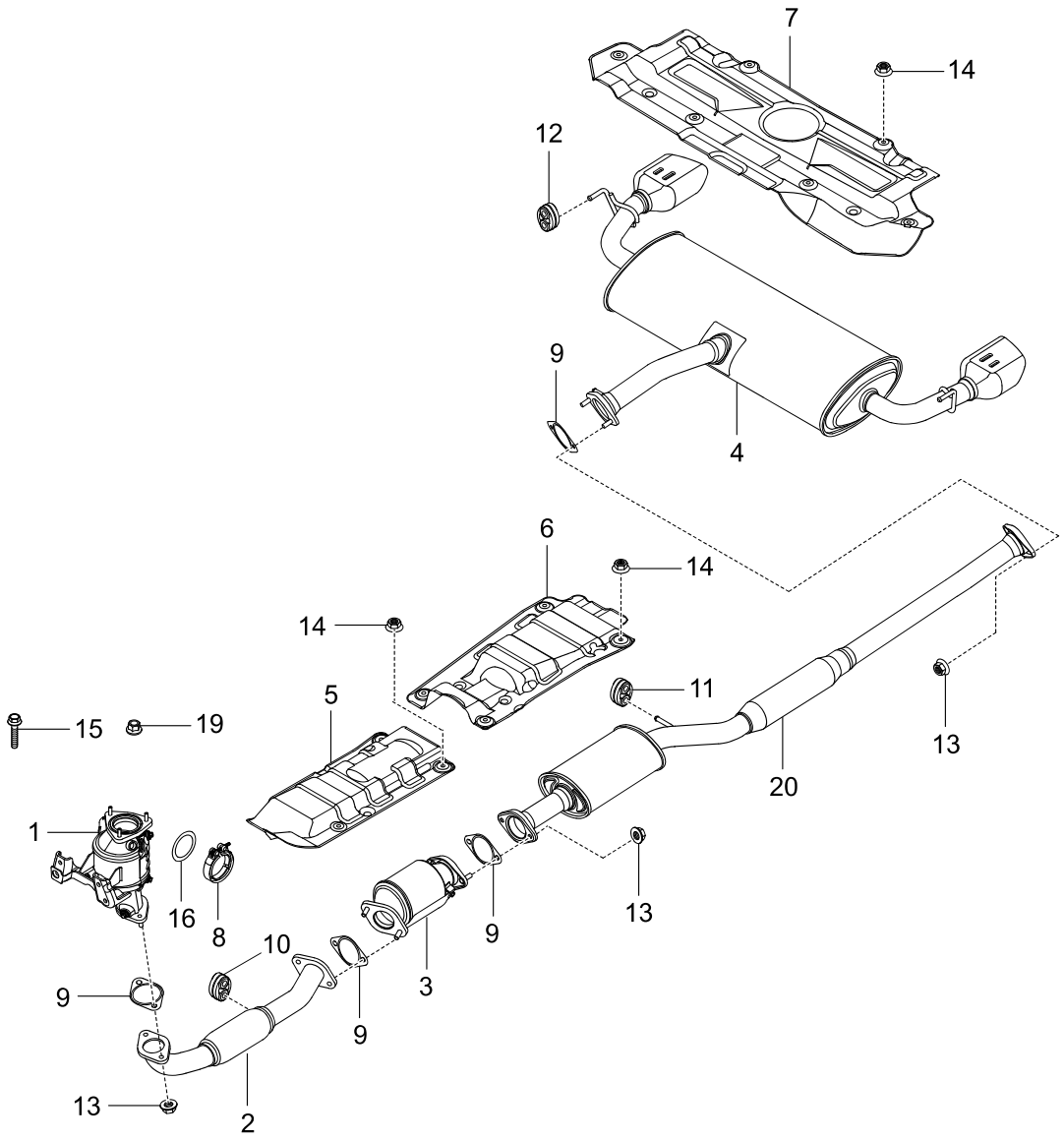


2. LAYOUT



1. Exhaust Manifold Assy
2. Exhaust Manifold Gasket
3. Hex Flange Nut
4. Heat Protector Assy
5. Hex Bolt (M6 X 1 X 25)
6. Heat Protector Assy
7. Hex Bolt (M8 X 1.25 X 16)

Modification basis	
Application basis	
Affected VIN	



1. WCC Compl
2. Exhaust FRT Pipe Assy
3. UCC Compl
4. Muffler Complete ?RR
5. Exhaust FRT Heat Protector
6. CTR Muffler Heat Protector
7. RR Muffler Heat Protector
8. Clamp
9. Gasket
10. Hanger
11. Hanger
12. Hanger
13. Nut
14. Nut
15. Bolt
16. Gasket Ring
19. Nut
20. CTR Muffler Complete

3. CAUTIONS

- Do not park the vehicle on flammable materials, such as grass, leaves and carpet.
- Do not touch the catalyst or the exhaust gas ignition system when the engine is running.
- If a misfire occurs in the combustion chamber or the emission of pollutant exceeds the specified level, the catalyst can be damaged.
- When servicing or replacing components of the exhaust system, makes sure that the components are positioned at regular intervals from all other parts of the under body.
- Be careful not to damage the exhaust system when lifting the vehicle from its side.
- All components and body parts of the engine exhaust system should be inspected for crack, damage, air hole, part loss and incorrect mounting location. Also check for any deformation which can result in exhaust gas drawn into the vehicle.
- Make sure that the exhaust pipe is cooled down sufficiently before working on it because it is still hot right after the engine is stopped.
- Wear protective gloves when removing the exhaust pipe.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

This system purifies the exhaust gas generated by the combustion in the engine to reduce the pollutants and noise during that arise during combustion.
Harmful materials produced in the combustion process is treated and reduced in the exhaust system.
Harmful materials discharged from the crankcase and fuel tank is drawn into the intake system again to reduce discharge amount of harmful materials.

▶ Emission aftertreatment system

- Catalytic Converter & O2 Sensor
  The catalytic converter is a monolith type purification system composed of cordierite which purifies exhaust gas through the small holes of active monolith catalyst from the exhaust manifold. As exhaust gas passes through the small holes in the layer in the middle, its CO and HC are reduced by oxidization reaction and its NOx is reduced by reduction reaction to Pt, Ph and Pd. The oxygen sensor sends signals for feedback and determination of catalyst condition. For detailed description, see the corresponding section.

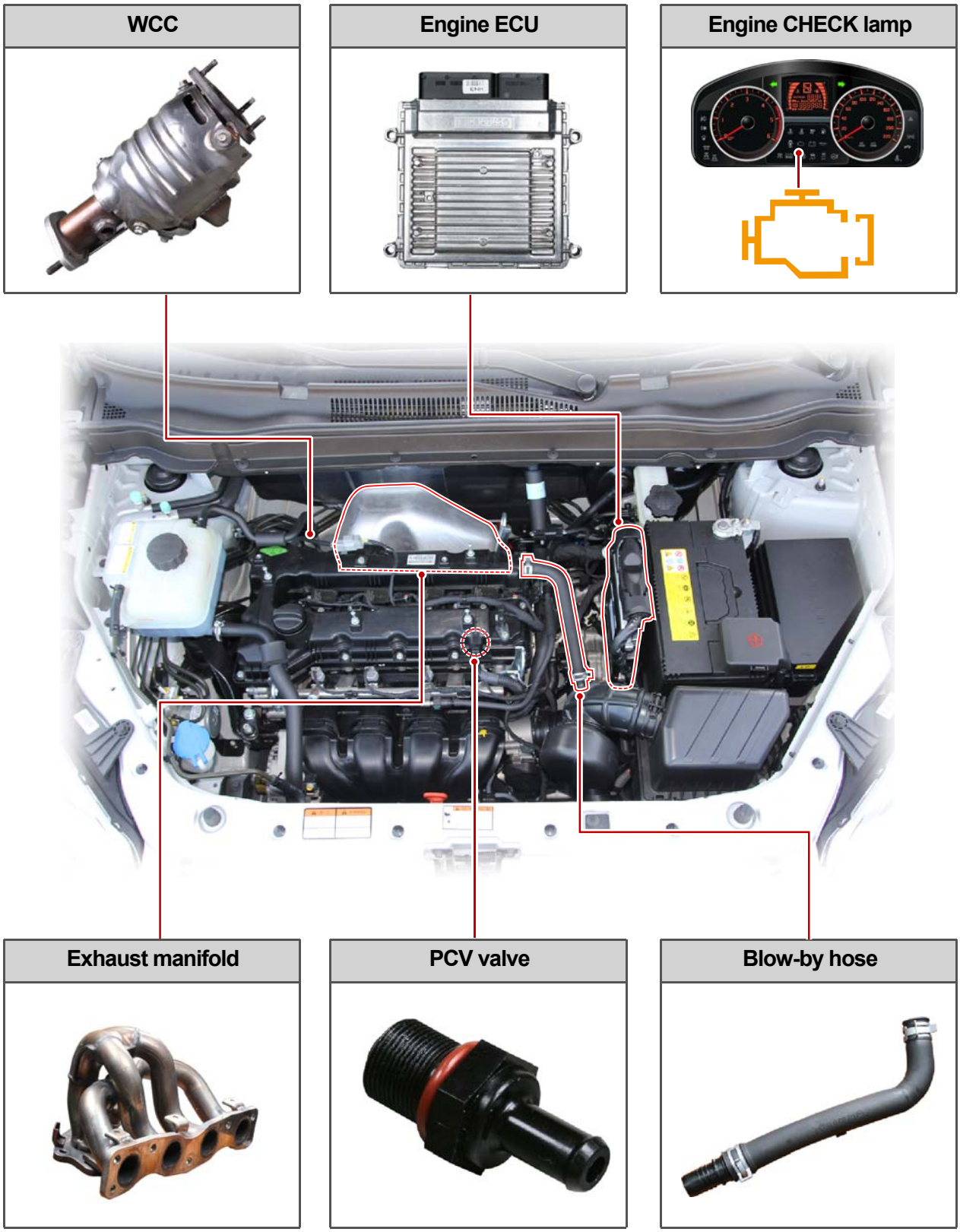
▶ Purge Canister Control

The fuel evaporative gas is a gas evaporated to the atmosphere in the section between the fuel tank and fuel line, and its main component is hydrocarbon (HC). The fuel evaporative gas is temporarily stored in the canister, and it is drawn to the engine through the throttle body when the purge control solenoid valve is open according to the engine operating condition.

▶ Blow-by gas control system (crankcase ventilation system)

Gas in the combustion chamber is sealed by the piston. However, gas is leaked through the gap between the cylinder and piston and drawn into the crankcase during the compression and explosion strokes. This gas is blow-by gas and its main components are hydrocarbon and carbon monoxide. If this gas is drawn into the crankcase, the system can be corroded and oil can be deteriorated. Also, if this gas is discharged into the air, it can pollute the environment. To prevent these, the blow-by gas reduction system (also called as crankcase ventilation system) draws the blow-by gas from the crankcase to the combustion chamber for combustion.

2. COMPONENTS



Modification basis	
Application basis	
Affected VIN	

Exhaust No.1

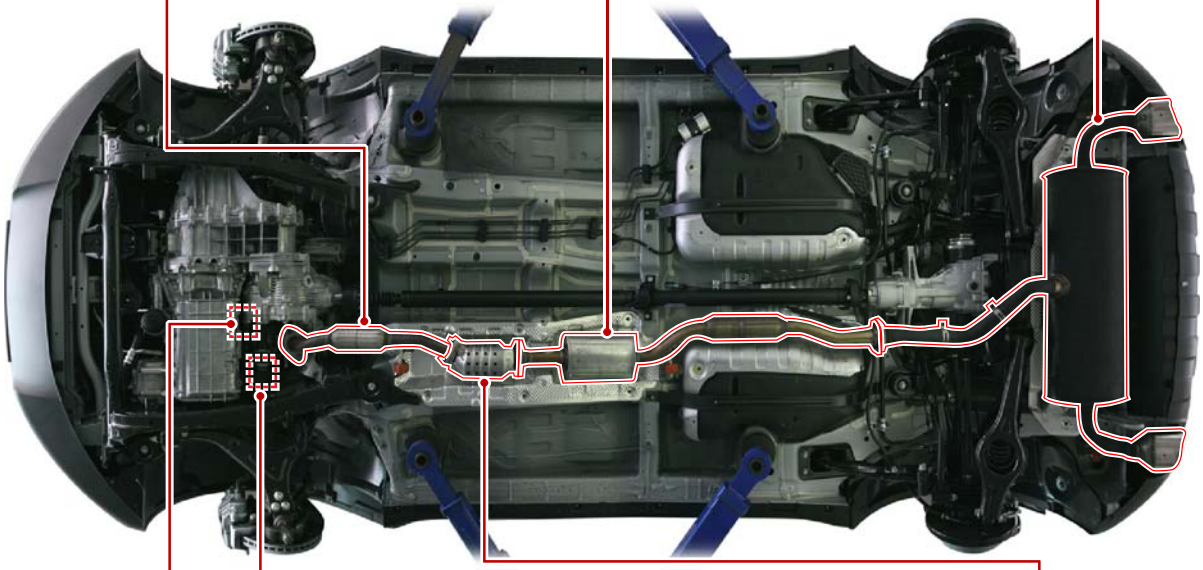


Exhaust No.2



Exhaust No.3 (main muffler)





Front oxygen sensor



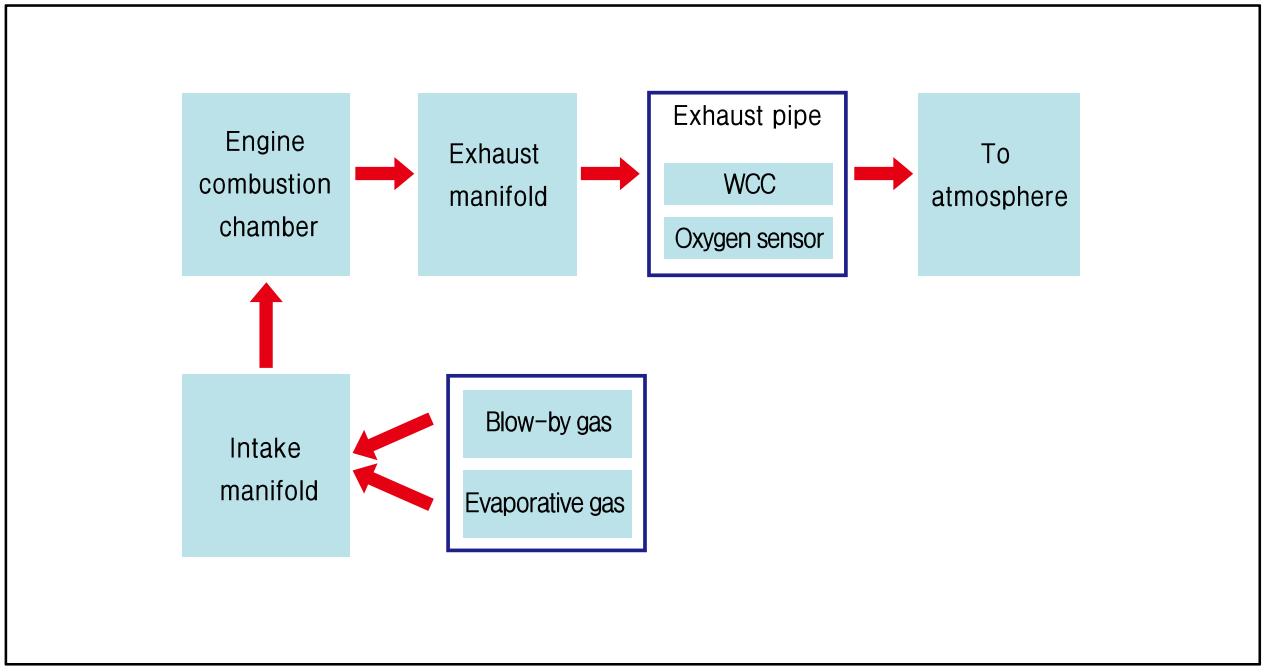
Rear oxygen sensor



UCC

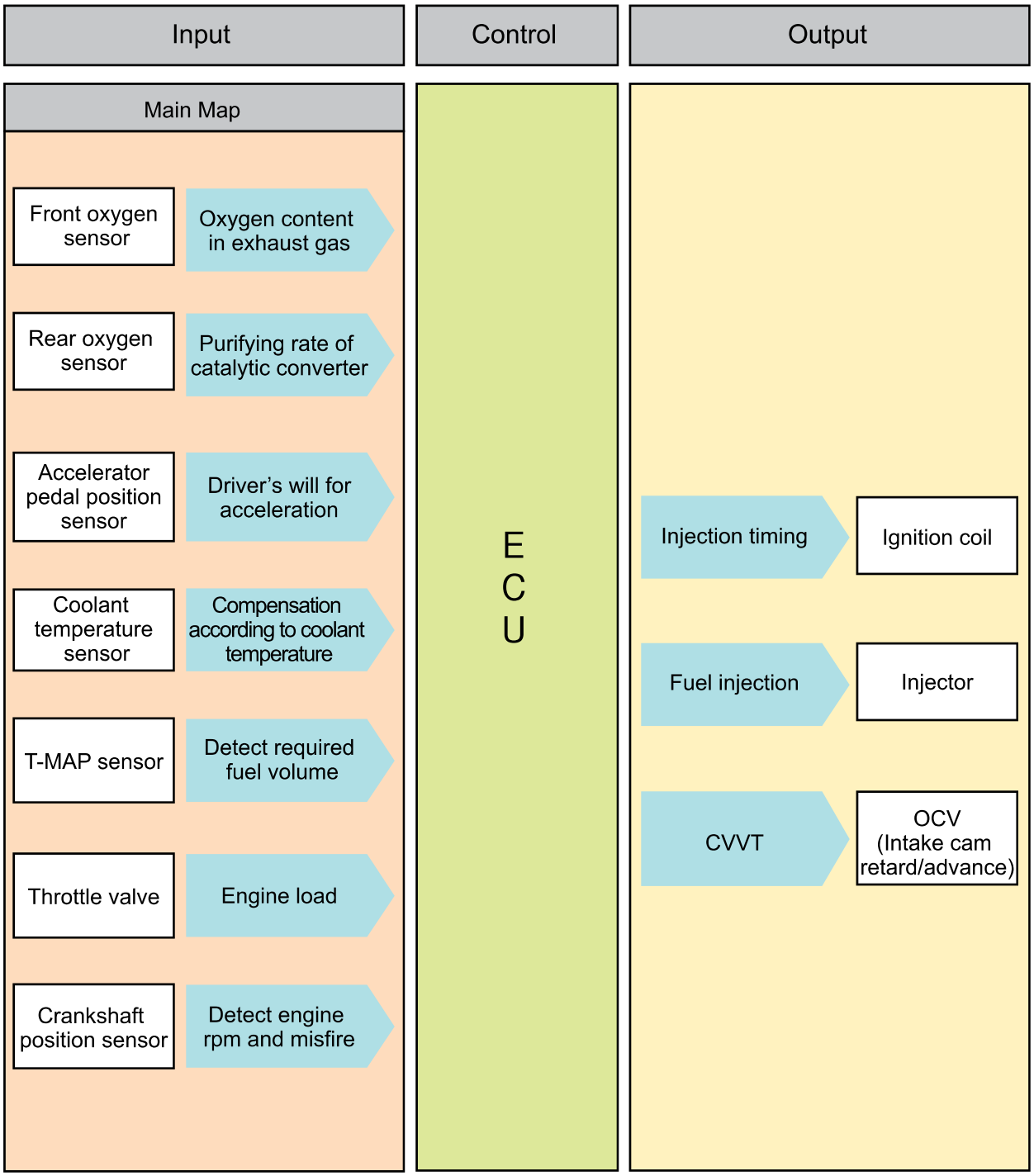


3. WORK FLOW IN EXHAUST SYSTEM



Modification basis	
Application basis	
Affected VIN	

4. INPUT/OUTPUT DEVICES



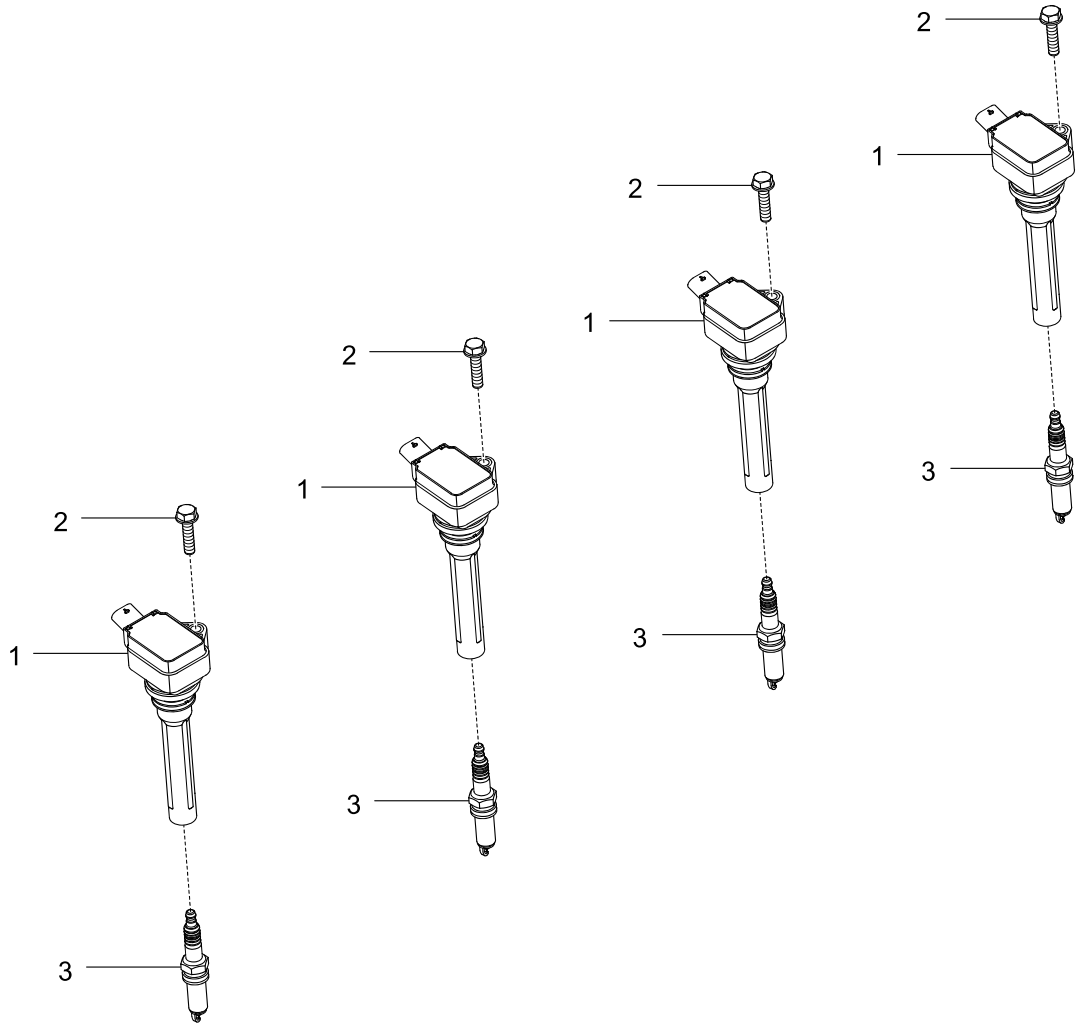
IGNITION SYSTEM 1443-01

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Spark plug	Internal resistance	3 ~ 7 kΩ
	Center electrode	Iridium alloy
	Ground electrode	Platinum alloy
	Electrode clearance	1.1 mm
	Change interval	160,000 km
Ignition coil	Primary operating current	7 ± 0.5A
	Generated voltage (primary/secondary)	Max. 400 V / 5~20 kV
	Ignition type	Independent ignition type
	Ignition sequence	1-3-4-2

2. LAYOUT



1. Ignition Coil
2. Bolt
3. Spark Plug

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The ignition system is to supply high voltage generated from the ignition coil to the spark plug. The G20DF engine is equipped with the independent type direct ignition system that the ignition coil is installed in each cylinder.
The basic ignition timing in each cylinder is determined by the signals from camshaft position sensor and crankshaft position sensor.
This ignition system controls the electronic ignition timing received from the engine ECU. To control the ignition timing precisely, the ECU use the information below:

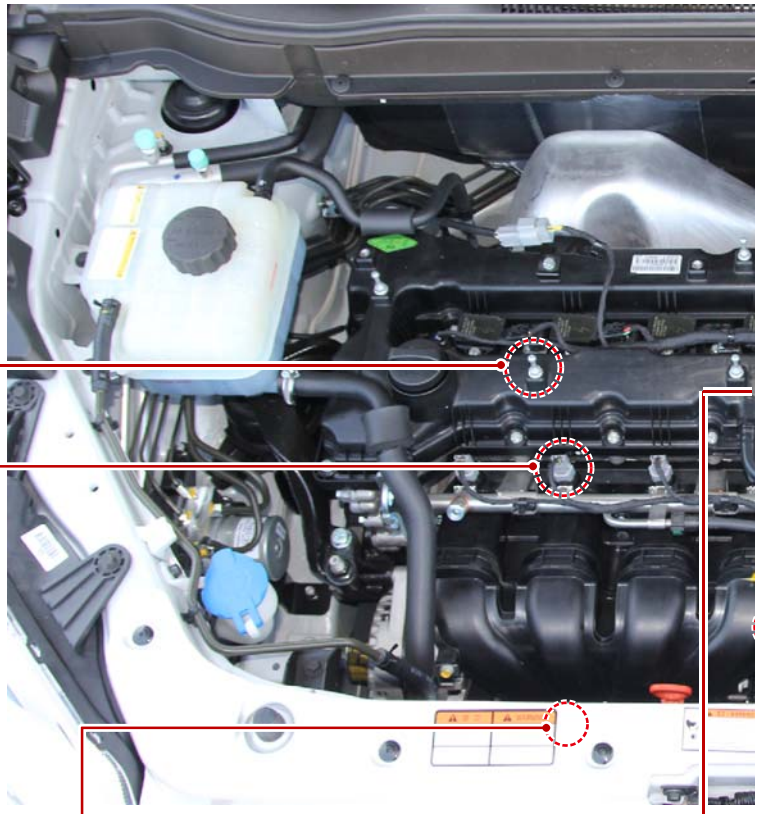
- Engine load
- Coolant temperature
- Intake air temperature
- Engine rpm
- Camshaft position sensor (CPS)
- Crankshaft position sensor (CKS)

If the signal from the camshaft position sensor is not delivered to the engine ECU, the ignition coil and fuel system cannot be operated.

2. COMPONENTS

Ignition coil





Spark plug



Injector



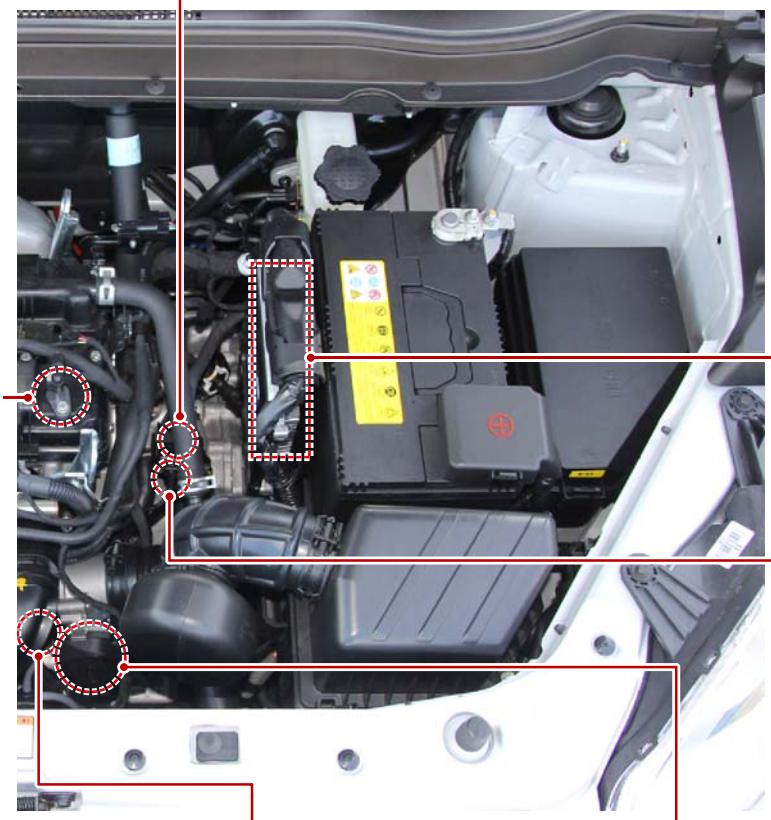
Knock sensor



Camshaft position sensor



Modification basis	
Application basis	
Affected VIN	



Crankshaft position sensor



Engine ECU



Coolant temperature sensor



T-MAP sensor



Electric throttle valve

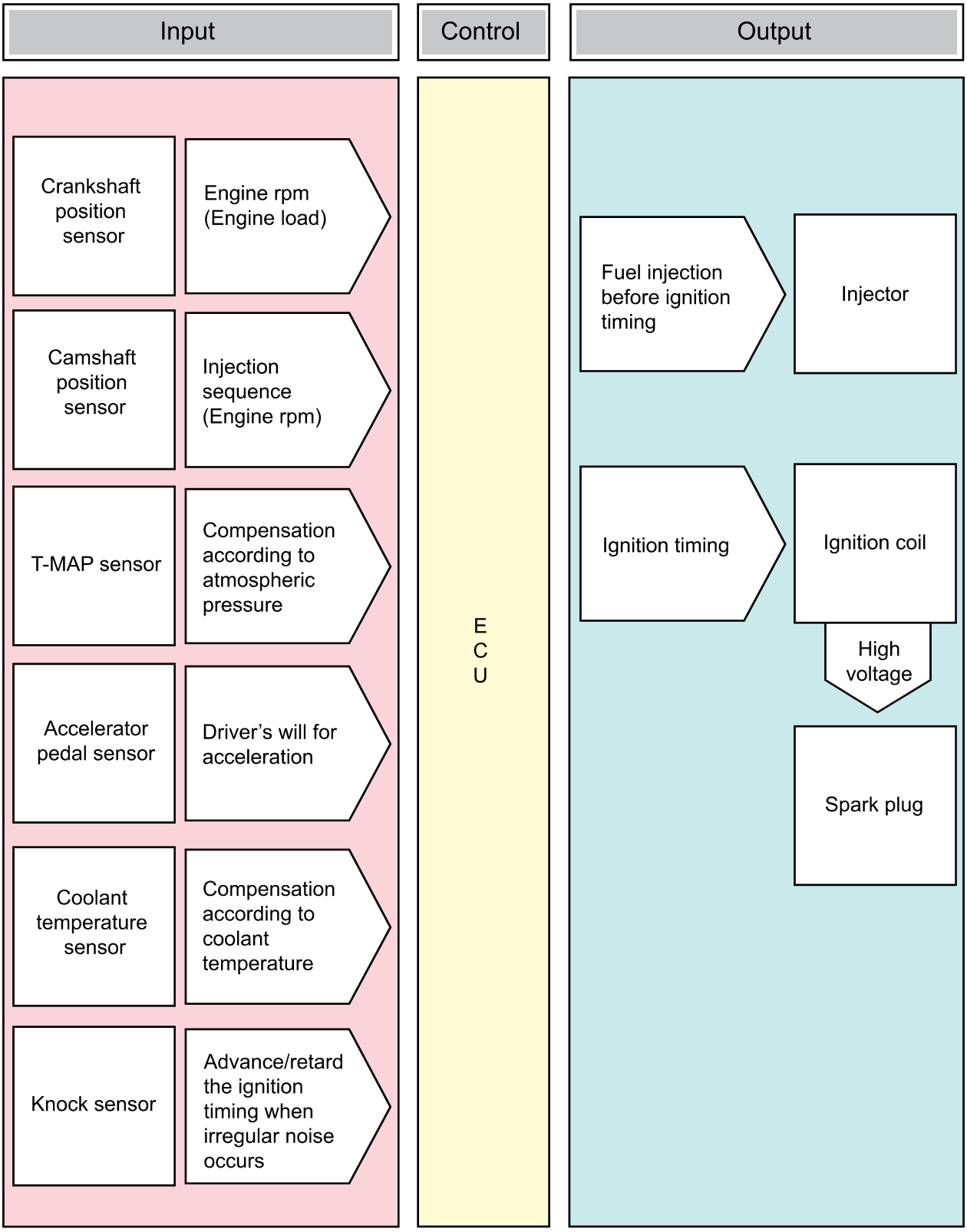


Accelerator pedal position sensor



Modification basis	
Application basis	
Affected VIN	

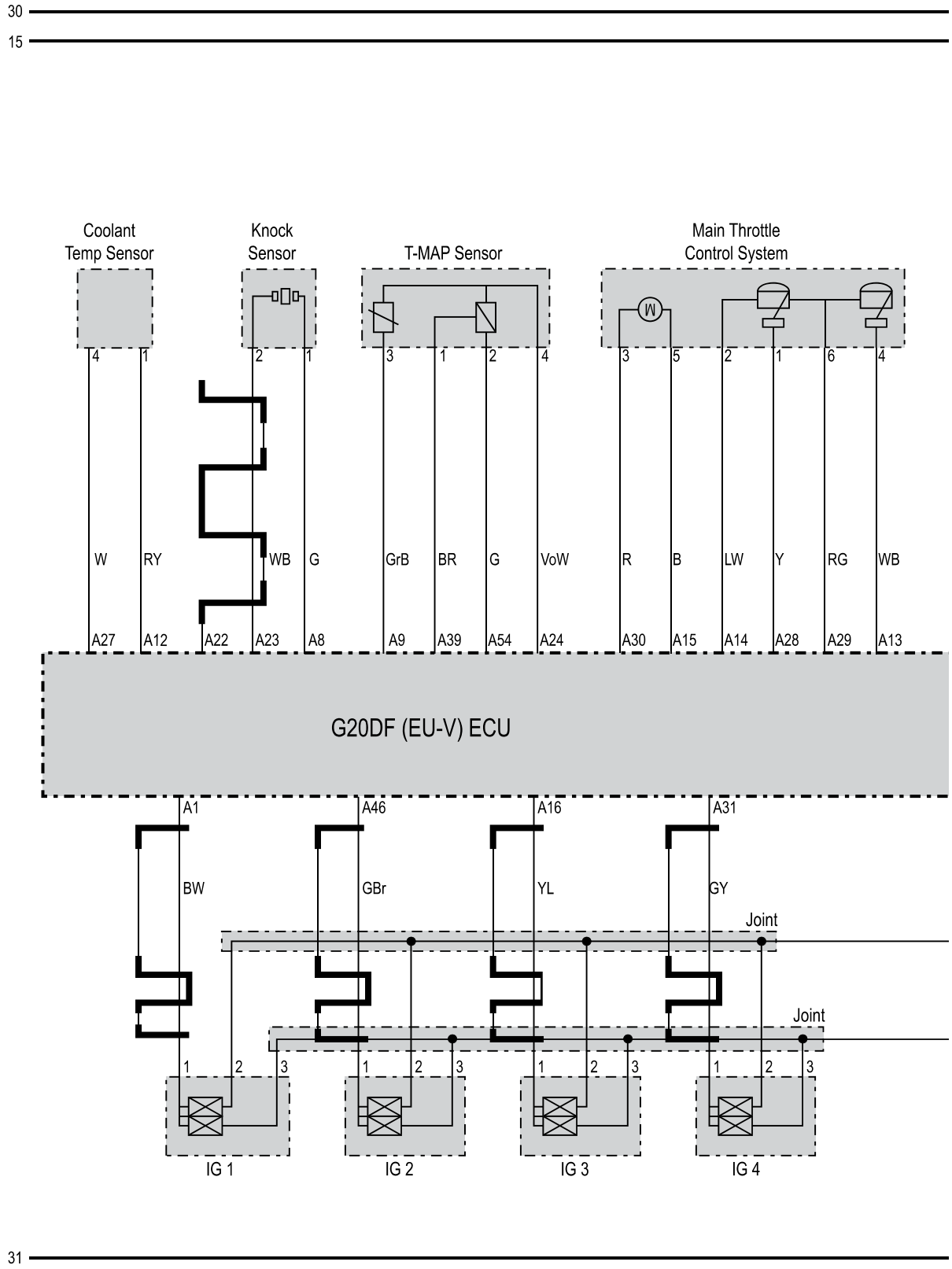
3. INPUT/OUTPUT DEVICES



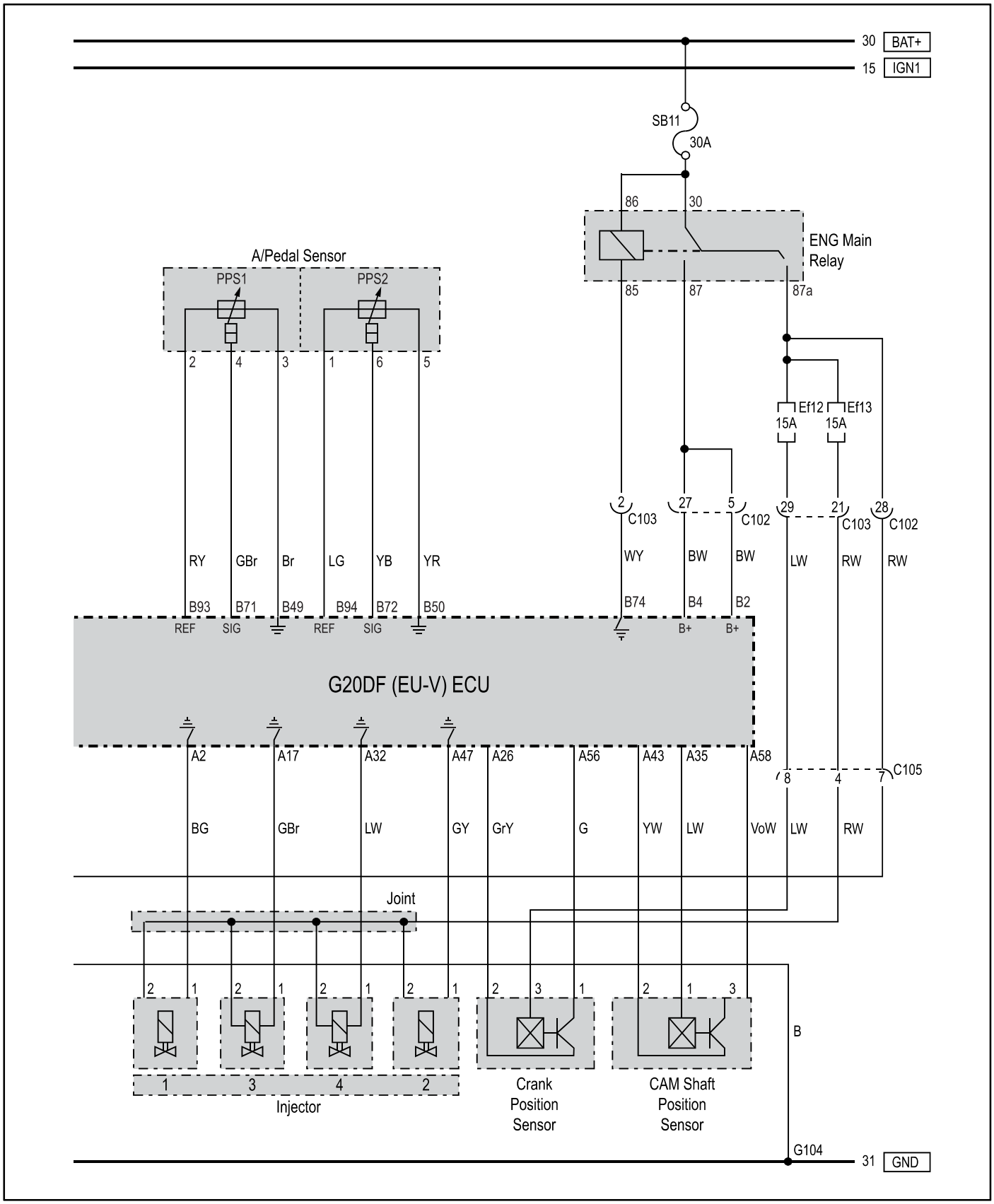
Modification basis	
Application basis	
Affected VIN	

Memo

4. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

LUBRCATION SYSTEM 1535-01

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Oil pump	Lubrication type	Gear pump, forced circulation
	Type	Internal gear
Oil filter	Type	Full flow/Paper element
Engine oil	Oil	MB 229.51 SEA 5W30 or API SN/GF-5 SAE 5W20
	Capacity	4.5 L
Oil injection nozzle	Type	Flange and bolt type

CAUTION

The engine oil filter element should be changed at the same time with the engine oil.

- Regularly check the engine oil level and add the engine oil if necessary.
- Remember to check the engine oil level and shorten the cycle to replace the engine oil under severe driving conditions.

Severe Driving Condition?

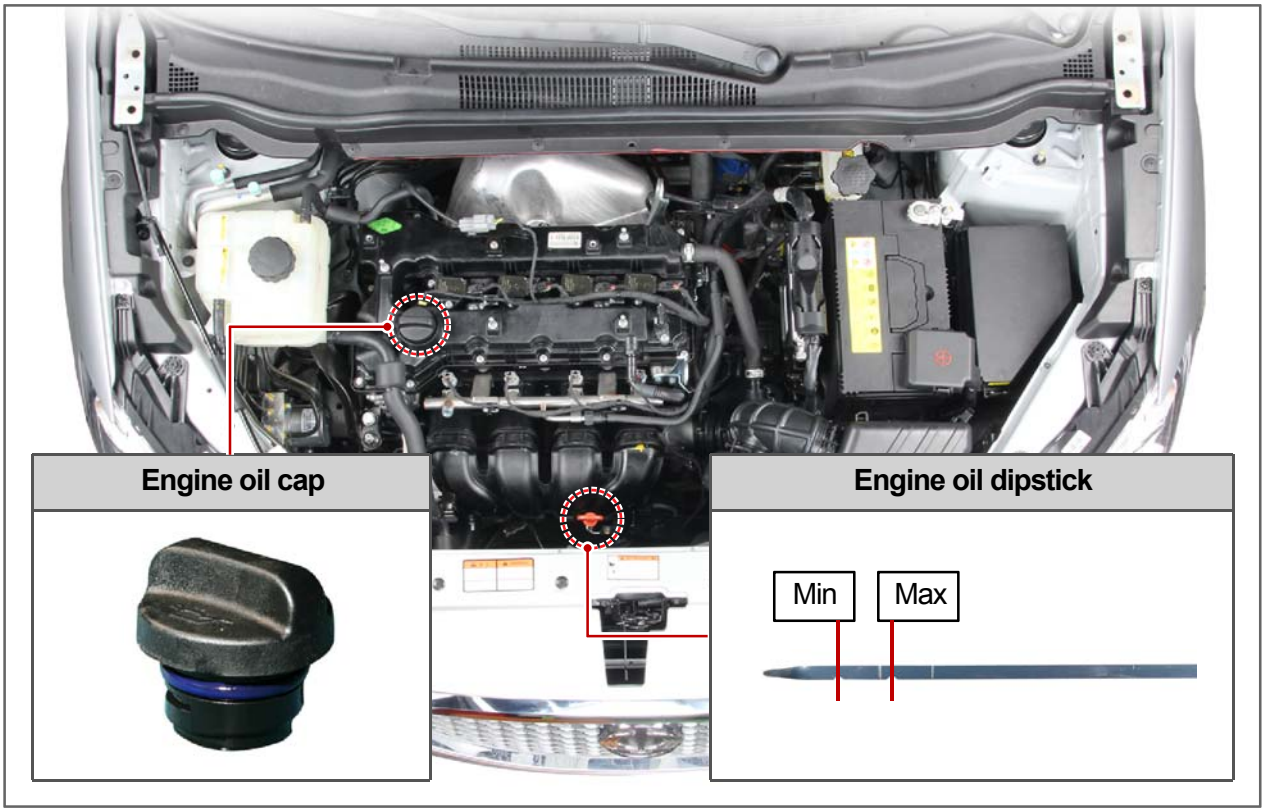
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

2. MAINTENANCE

Park the vehicle on a level ground and apply the parking brake. Stop the engine and wait more than 5 minutes.

- Pull out the dipstick and wipe it with a clean cloth. Reinsert it all the way.
- Pull out it again and check the oil level.
- The oil level should be between the maximum (Max) mark and minimum (Min) mark on the oil dipstick. Oil should be replenished before the level goes below the minimum mark.

WARNING
Operating vehicle with insufficient amount of oil can damage the engine. Make sure the engine oil level is correct and add oil if necessary.



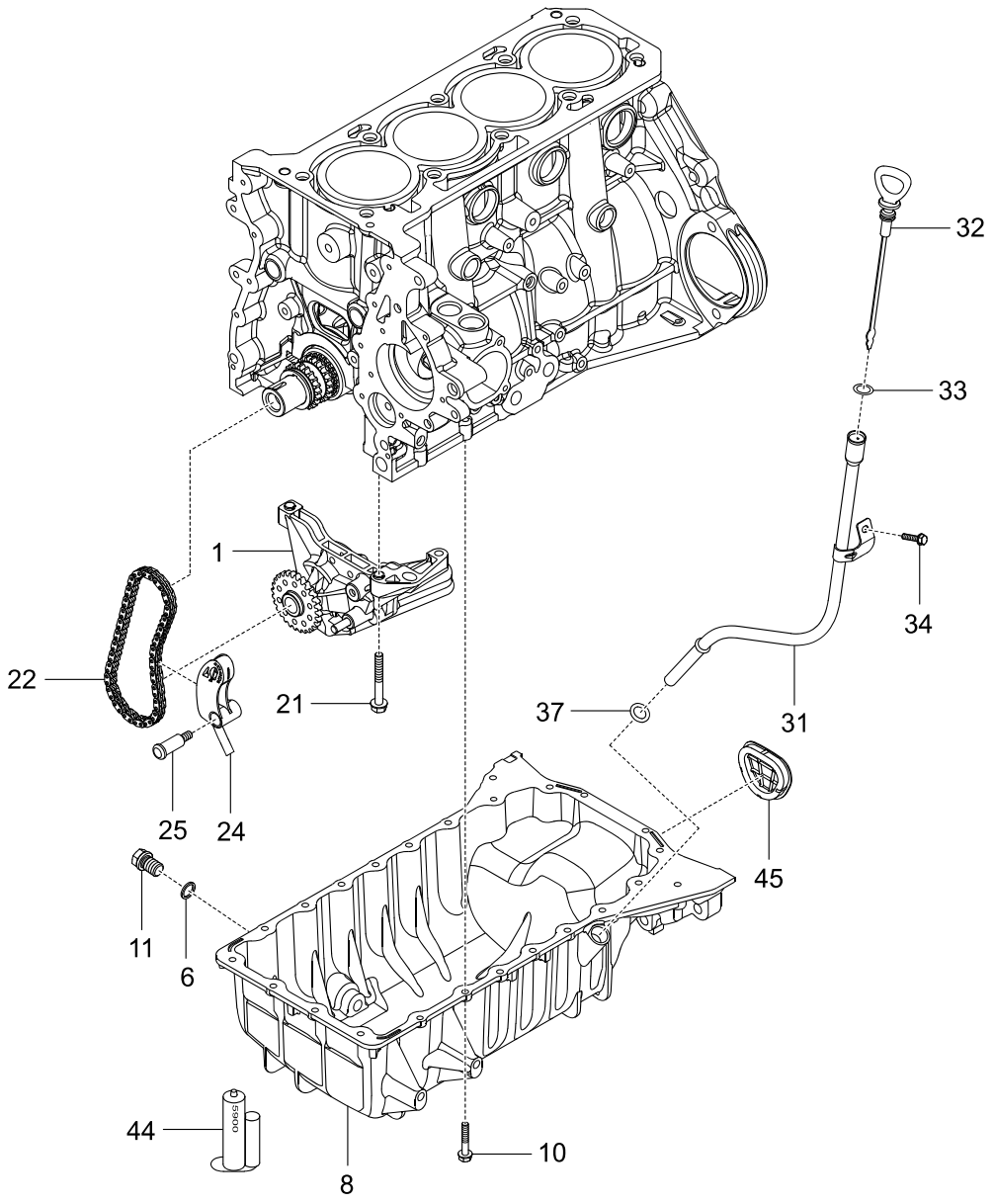
▶ **Replenishment**

If the level gets to the lower point, open the filler cap on top of the cylinder block and add the genuine oil without exceeding the level of the upper mark.
Recheck the oil level after 5 minutes.

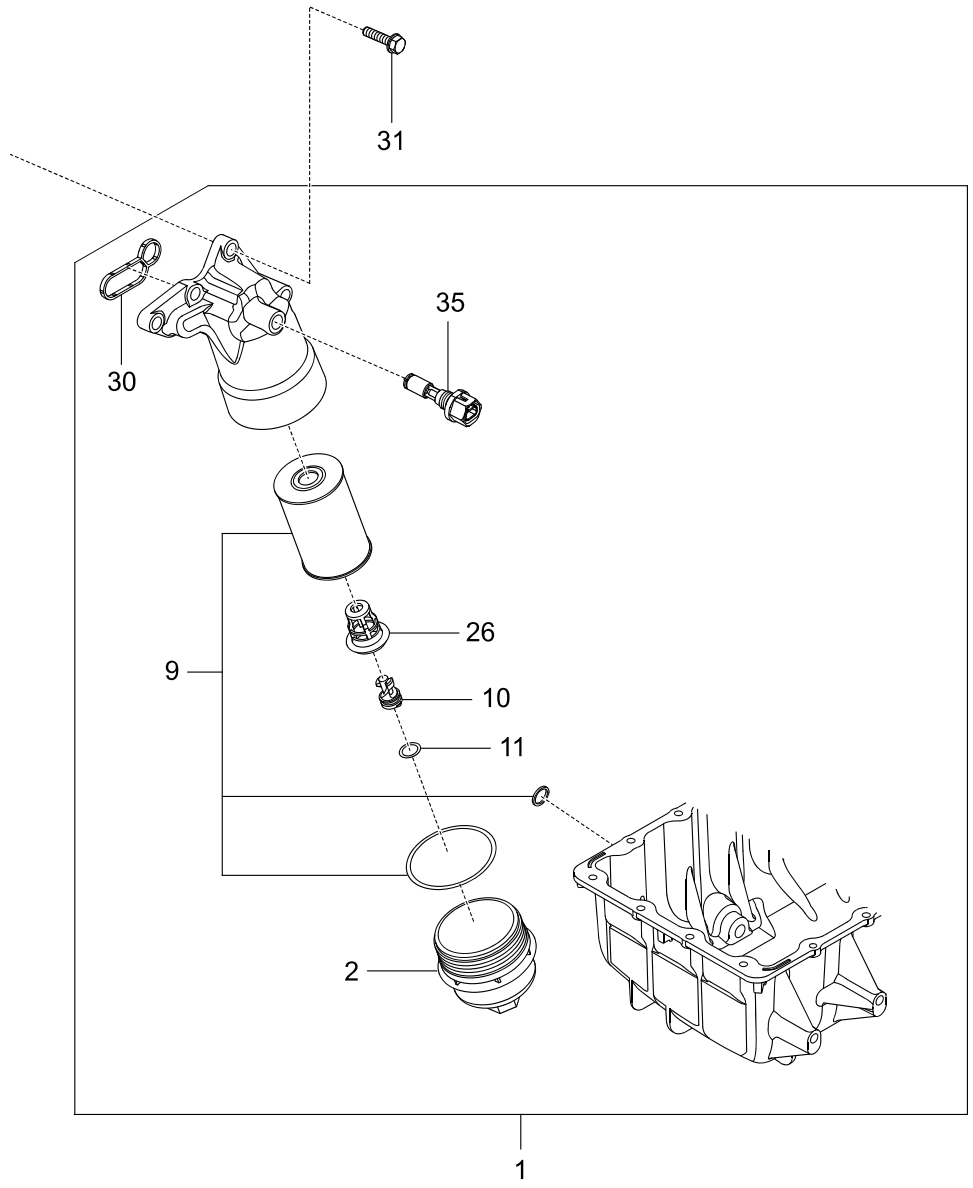
CAUTION
- Regularly check the engine oil level and add Ssangyong genuine engine oil if necessary.
- Clean the dipstick with clean cloth so that any foreign materials cannot get into the engine.
- The oil should not go above the upper mark on the dipstick.
- The engine oil may be consumed more if the engine is new.

Modification basis	
Application basis	
Affected VIN	

3. LAYOUT



1. Oil Pump Assy
6. Seal Ring
8. Oil Pan
10.Bolt
11.Drain Plug
21.Bolt
22.Oil Pump Chain
24.Oil Pump Chain Tensioner Assy
25.Bolt
31.Oil Dipstick Tube Assy
32.Oil Dipstick Gauge Assy
33.O-Ring
34.Bolt
37.O-Ring
44.Sealant
45.Dust Cover



1. Oil Filter Assy
2. Oil Filter Cover
9. Oil Filter Element Kit
10.Drain Plug
11.O-Ring
26.Oil Filter Bypass Valve Assy
30.Oil Filter Housing Gasket
31.Bolt
35.Oil pressure switch

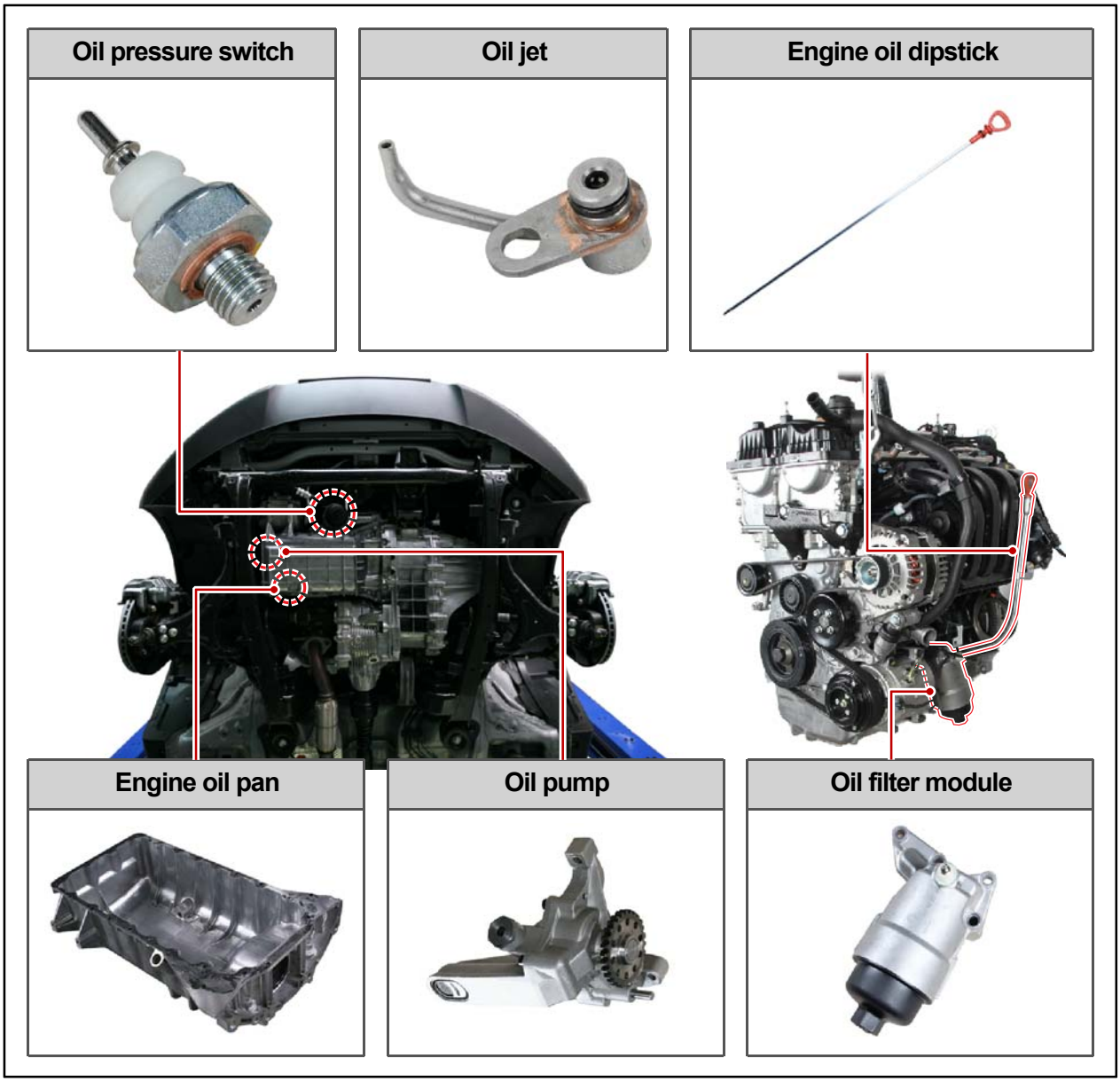
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

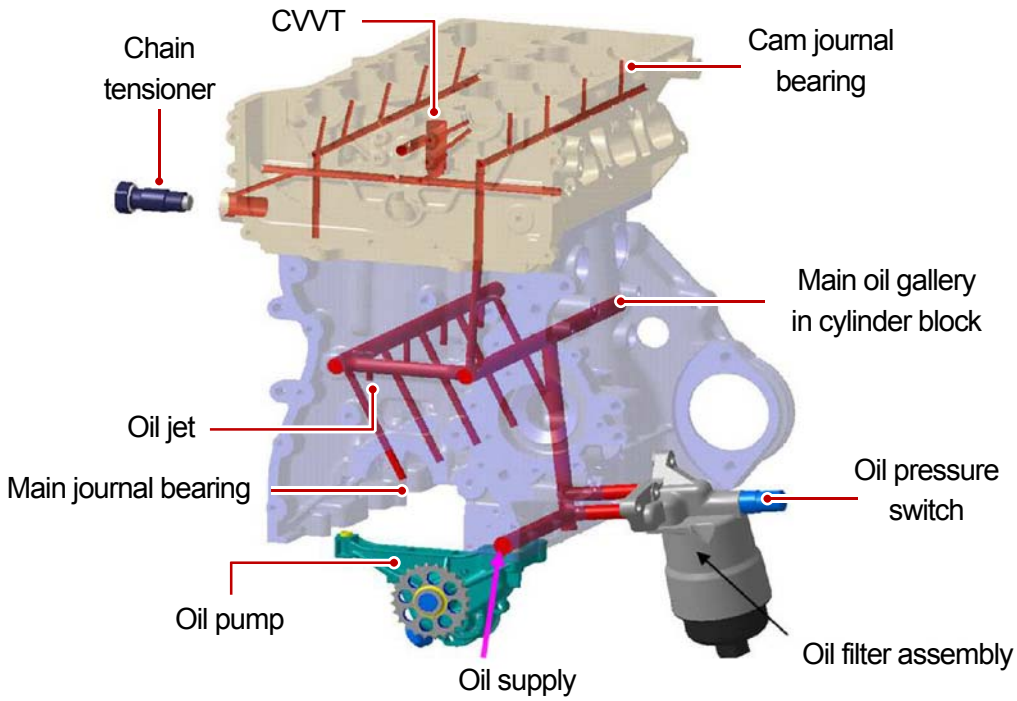
The lubrication system supplies oil to each lubrication section to prevent friction and wear and to remove heat from the friction part. As the engine runs, frictional heat is generated on each lubrication section. If this condition persists, the bearing can be burned and stuck.
In other words, it creates an oil film on each sliding surface to convert solid friction to liquid friction in order to minimize wear and prevent temperature increasing on the friction part.

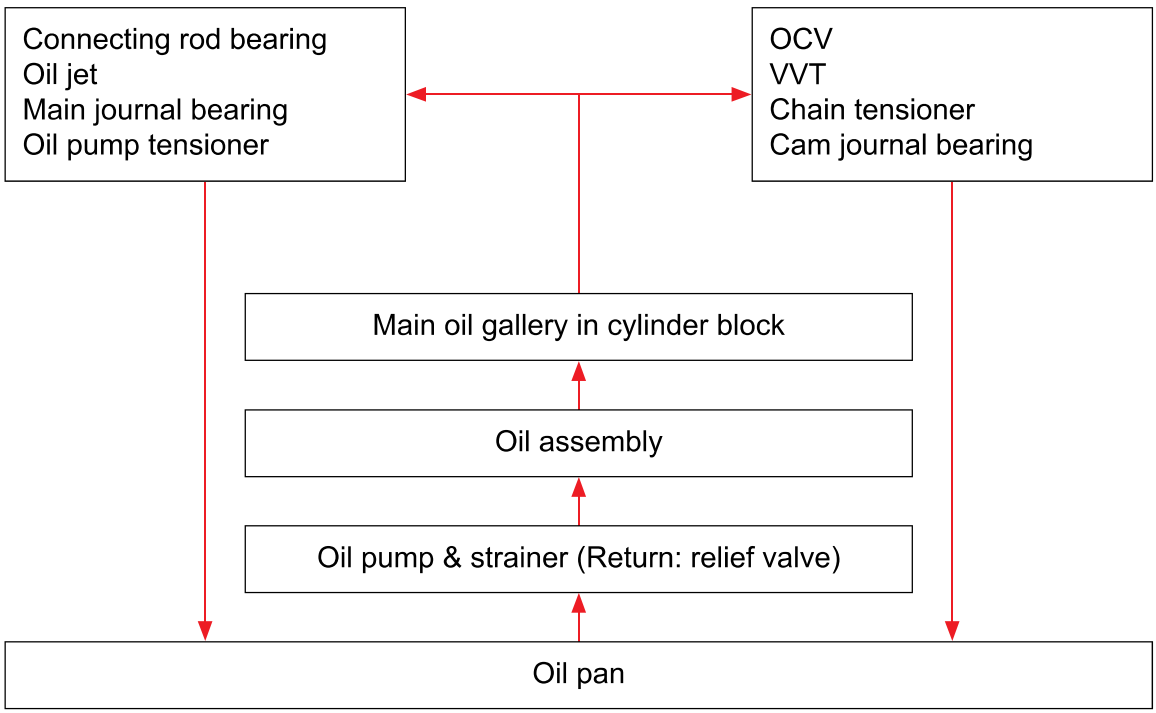
2. COMPONENTS



3. OPERATING PROCESS

1) Operation Flow





Modification basis	
Application basis	
Affected VIN	

COOLING SYSTEM 2112-01

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Cooling system	Type	Water cooling, forced circulation
Coolant	Capacity	Approx. 8.0 ~ 8.5 L
Radiator	Core size	740W X 378.9H X 27T
	Flow type	Cross flow
Antifreeze	Type	SYC 1025 (LLC)
	Mixing ratio	50:50 (water:antifreeze)
Cooling fan module	Type	Electric
	Capacity	180 W + 120 W
	Control type	Series: low speed, Parallel: high speed
Coolant reservoir	Min. capacity	1.6 L
	Circulation	Closed roof type
	Pressure cap	Screw type, 1.4 bar
Thermostat	Type	Wax pallet type
	Opening temperature	90℃
	Fully open temperature	100℃
	Valve lift	8mm

2. INSPECTION

Problem	Possible Cause	Action
Coolant level is too low	- Leak from the radiator - Leak from the coolant auxiliary tank - Leak from the heater core	- Change the radiator - Change the coolant auxiliary tank - Change the heater
	- Leak from the coolant hose connections Damaged coolant hose -	- Reconnect the hose or replace the clamp - Change the hose
	- Leak from the water pump gasket - Leak from the water pump internal seal	- Change the gasket - Change the water pump
	- Leak from the water inlet cap - Leak from the thermostat housing	- Change the water inlet cap gasket Change the thermostat sealing -
	- Incorrect tightening torque of the cylinder head bolts - Damaged cylinder head gasket	- Tighten the bolts to the specified torque - Change the cylinder head gasket
Coolant temperature is too high	- Coolant leakage (Coolant level is low) Improper coolant mixture ratio - Kinked coolant hose -	- Add coolant - Check the coolant concentration (Anti-freeze) - Repair or replace the hose
	- Defective thermostat - Defective water pump - Defective radiator - Defective coolant auxiliary tank or tank cap	- Change the thermostat - Change the water pump - Change the radiator - Change the coolant auxiliary tank or tank cap
	- Cracks on the cylinder block or cylinder head - Clogged coolant passages in the cylinder block or cylinder head	- Change cylinder block or cylinder head - Clean the coolant passage
	- Clogged radiator core	- Clean the radiator core
	- Improper operation of cooling fan	- Replace the cooling fan or repair the related circuit
	- Defective temperature sensor or faulty wiring	- Replace the sensor or repair the related wiring

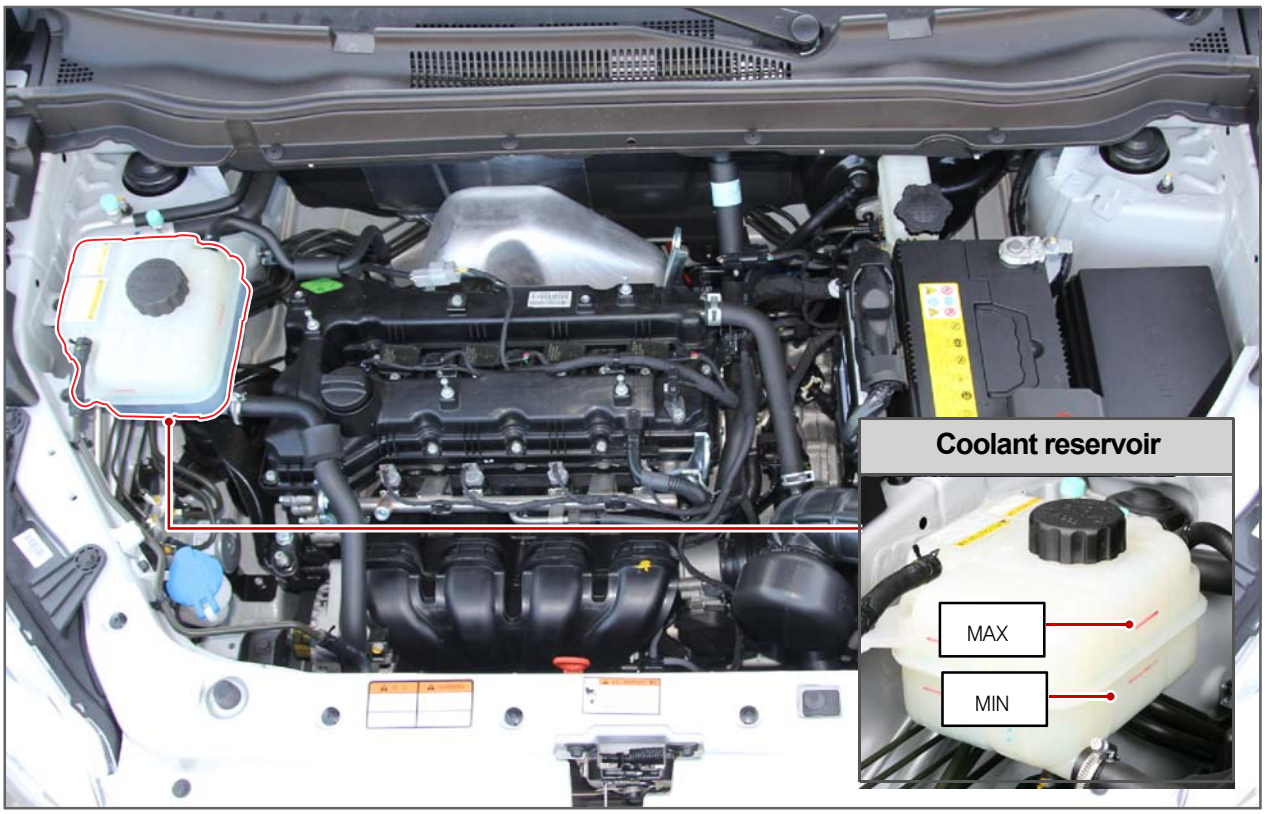
Modification basis	
Application basis	
Affected VIN	

Problem	Possible Cause	Action
Coolant temperature is too low	- Thermostat is stuck open	- Change the thermostat
	- Improper operation of cooling fan	- Replace the cooling fan or repair the related circuit
	- Defective temperature sensor or faulty wiring	- Replace the sensor or repair the related wiring

1) Coolant Level Check

A. Park the vehicle on level ground and apply the parking brake. Stop the engine and wait until it is cooled down. The coolant level should be between the MAX and MIN mark on the coolant reservoir. If the coolant level is below the "MIN" mark, immediately add coolant.

B.



CAUTION

- Scalding hot coolant and steam could be blown out under pressure, which could cause serious injury. Never remove the coolant reservoir cap when the engine and radiator are hot.
  Avoid any direct contact of the coolant to the painted body of the vehicle.
-

Modification basis	
Application basis	
Affected VIN	

2) Leak Test



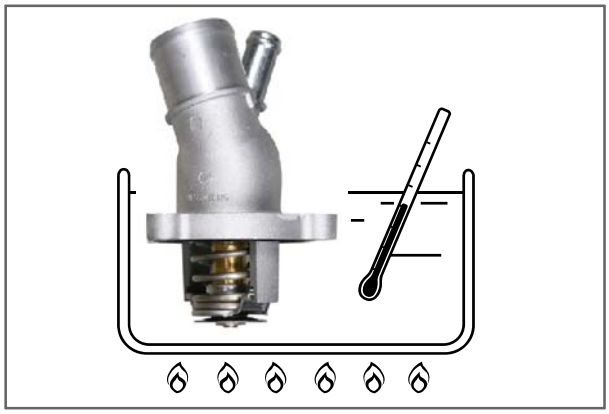
A. Release the pressure in the system by loosening the pressure cap of the coolant reservoir slightly. Then, remove the pressure cap completely.

CAUTION
Never open the cap until the coolant temperature becomes under 90℃ to prevent any burn.



B. Add the coolant so that the coolant level is between MAX and MIN mark on the coolant auxiliary tank.
C. Connect the tester to the tank filler and apply pressure (1.4 bar).
D. Check all the coolant hoses, pipes and connections for leaks when the pressure of the tester drops, and replace or tighten, if necessary.

3) Thermostat



Immerse the thermostat into the water. Heat the water and check the valve opening temperature.

Valve opening temperature	90±2℃

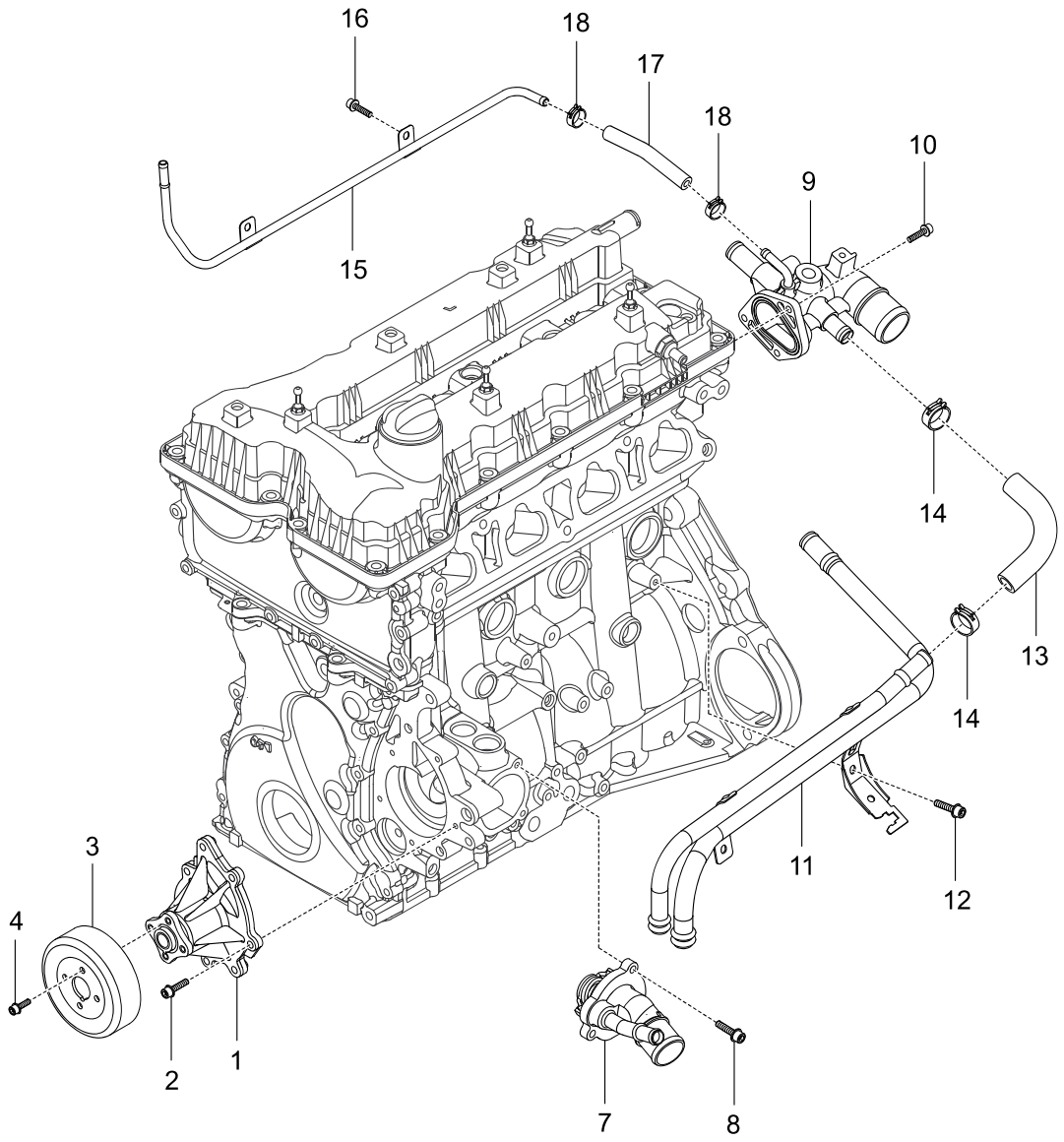
3. CAUTIONS

CAUTION

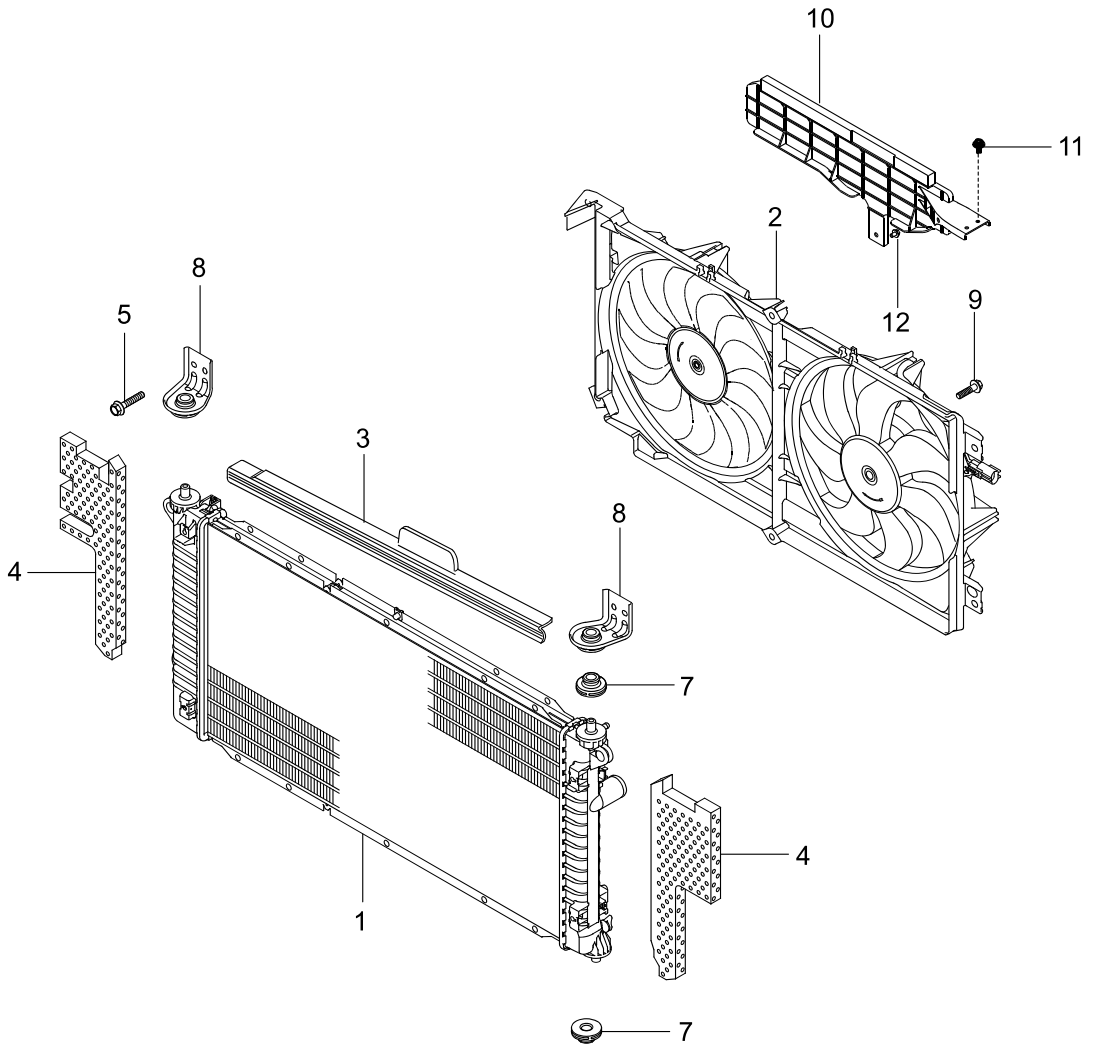
- If 100% of anti-freeze is added, the water pump vane can be damaged and thermal conductivity can be decreased resulting in poor circulation in the cooling system which leads to overheated engine.
- Use of non-recommended coolant could cause damage to the cooling system and overheating of the engine.
- Opening the coolant reservoir cap while the engine is running or hot can cause burns by hot steam or water.
- To open the coolant reservoir cap, wrap the cap with a wet towel or thick cloth after the engine is cooled down sufficiently.
- If cool water is added to the heated engine, the engine or radiator can be deformed.
- The anti-freeze in the coolant can damage the painted surface, so avoid the contact of the coolant to the painted body.
- The anti-freeze and water should be mixed in proper mixture ratio. Never add only water when adding coolant.
- If the anti-freeze content is too low, the coolant can be frozen while the engine can be overheated if anti-freeze content is too high.

Modification basis	
Application basis	
Affected VIN	

4. LAYOUT

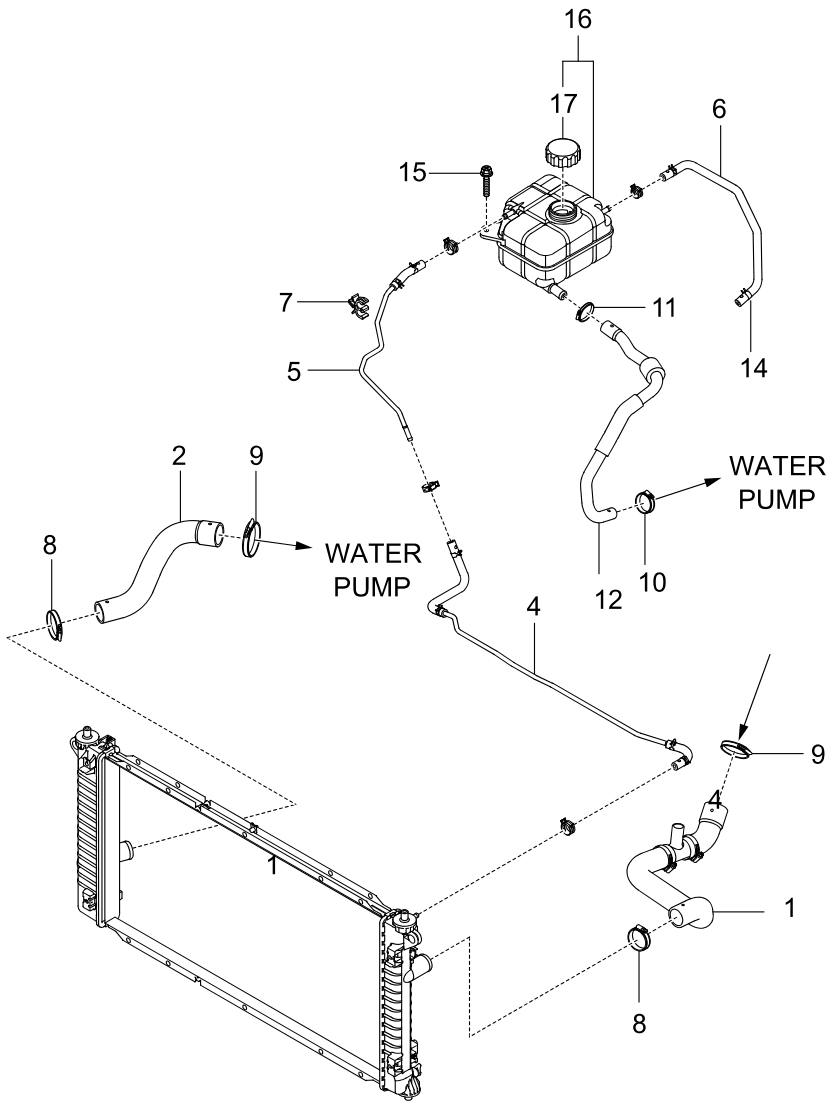


1. Water Pump Assy
2. Bolt
3. Water Pump Pulley
4. Bolt
7. Thermostat Assy
8. Bolt
9. Coolant Outlet Port Assy
10. Bolt
11. Coolant Pipe Assy
12. Bolt
13. Bypass Hose
14. Clamp
15. Deaeration Pipe Assy
16. Bolt
17. Bolt Deaeration Hose
18. Clamp



1. Cooling Radiator Assy
2. Fan & Shroud Assy
3. Cover-Radiator
4. Seal Side
5. Screw
7. Insulator Module MTG LWR
8. Module MTG UPR Brkt Assy
9. Screw
10. Protector-Eroom Hot Air
11. Screw
12. Fastener

Modification basis	
Application basis	
Affected VIN	



1. Hose-Rad Inlet
2. Hose-Rad Outlet
3. Hose-Make Up
4. Hose Assy-Deaeration Rad
5. Hose Assy-Deaeration Rsvr
6. Hose Assy-Deaeration Eng
7. Clip-Deaeration Tube mtg
8. WDT_Spring_Clamp_M45
9. WDT_Spring_Clamp_M50
10. WDT_Clamp_M24
11. WDT_Clamp_M30
12. Clip_Closed_CT_M25
13. Bolt-Tapping
14. Clamp_Spring_M14
15. Screw
16. Tank Assy-Reservoir
17. Cap-Reservoir Tank

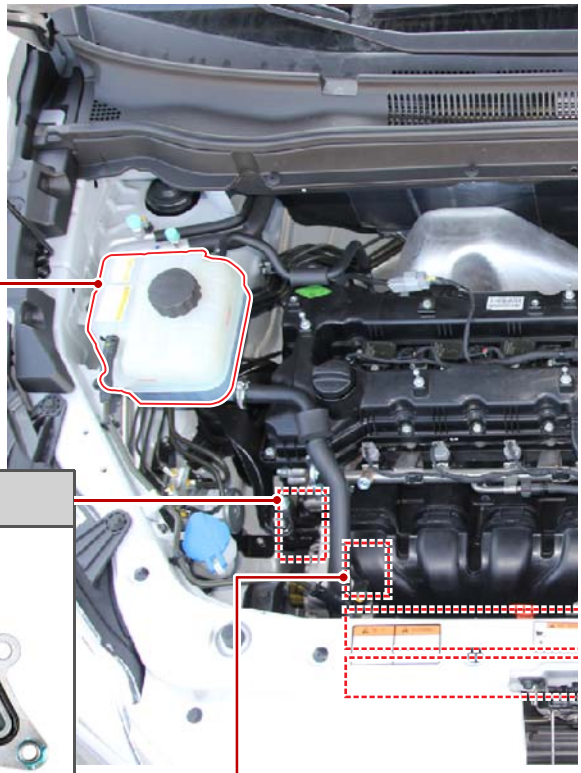
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The coolant system is to keep the engine temperature stable.

2. COMPONENTS



Coolant reservoir



Water pump





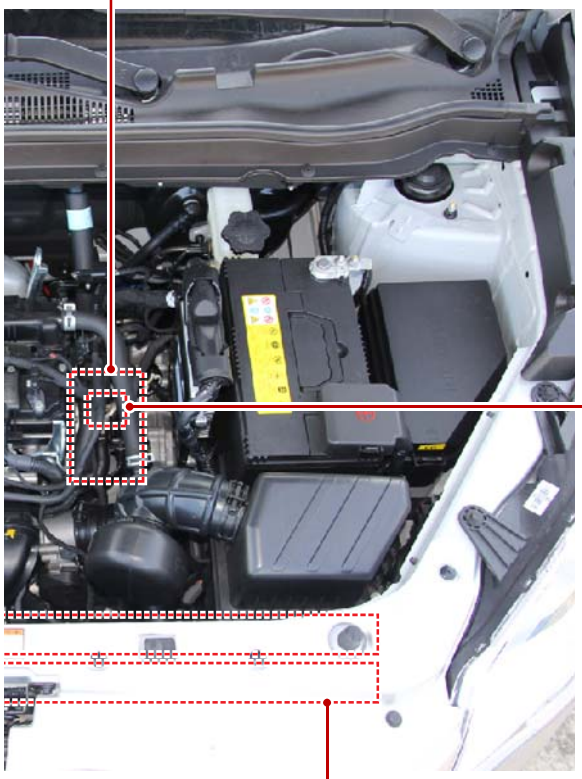
The water pump is driven by the engine drive belt and supplies the coolant to each area of the engine.

Thermostat



When the engine coolant reaches 90℃, the thermostat starts to open (fully open at 100℃) and lets the coolant flow to the radiator to maintain the engine temperature.

Modification basis	
Application basis	
Affected VIN	



Coolant outlet port



Coolant temperature sensor



Measures the coolant temperature and sends the result to the engine ECU.

Radiator



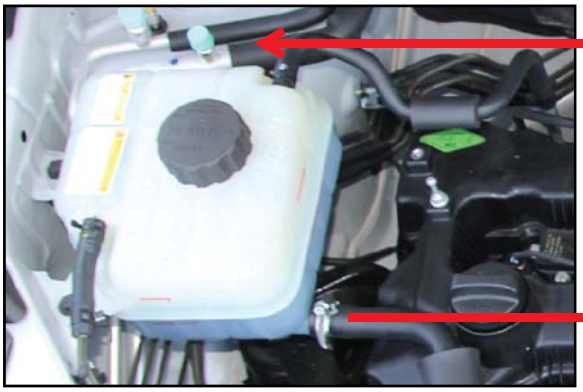
Radiates the heat through fins and cools down the hot coolant as the coolant passes through the tube of the radiator core.

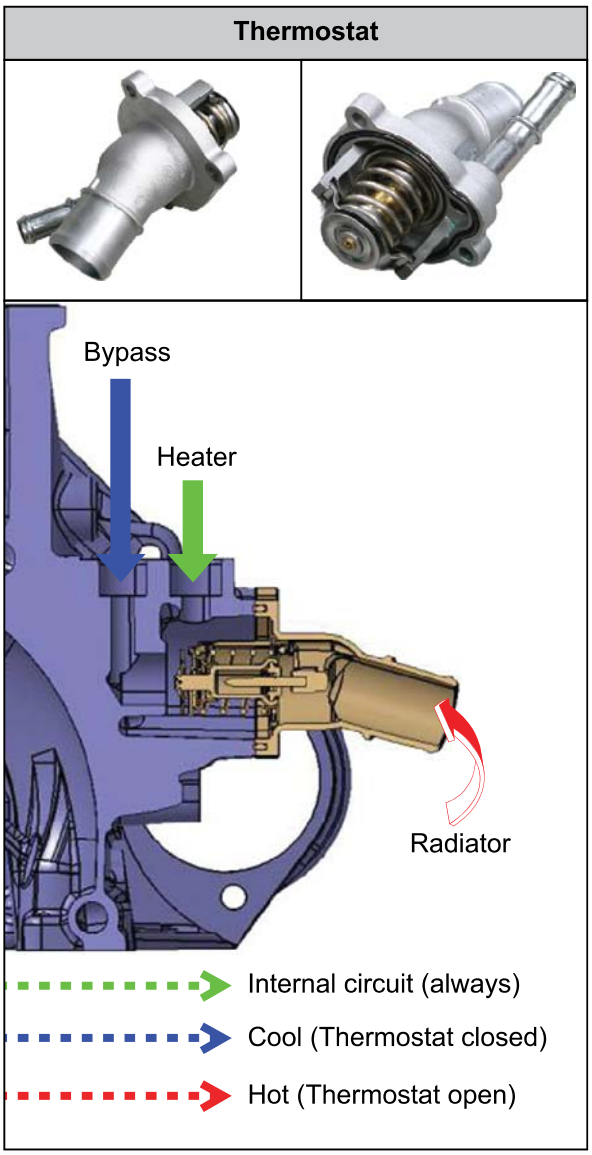
PWM fan

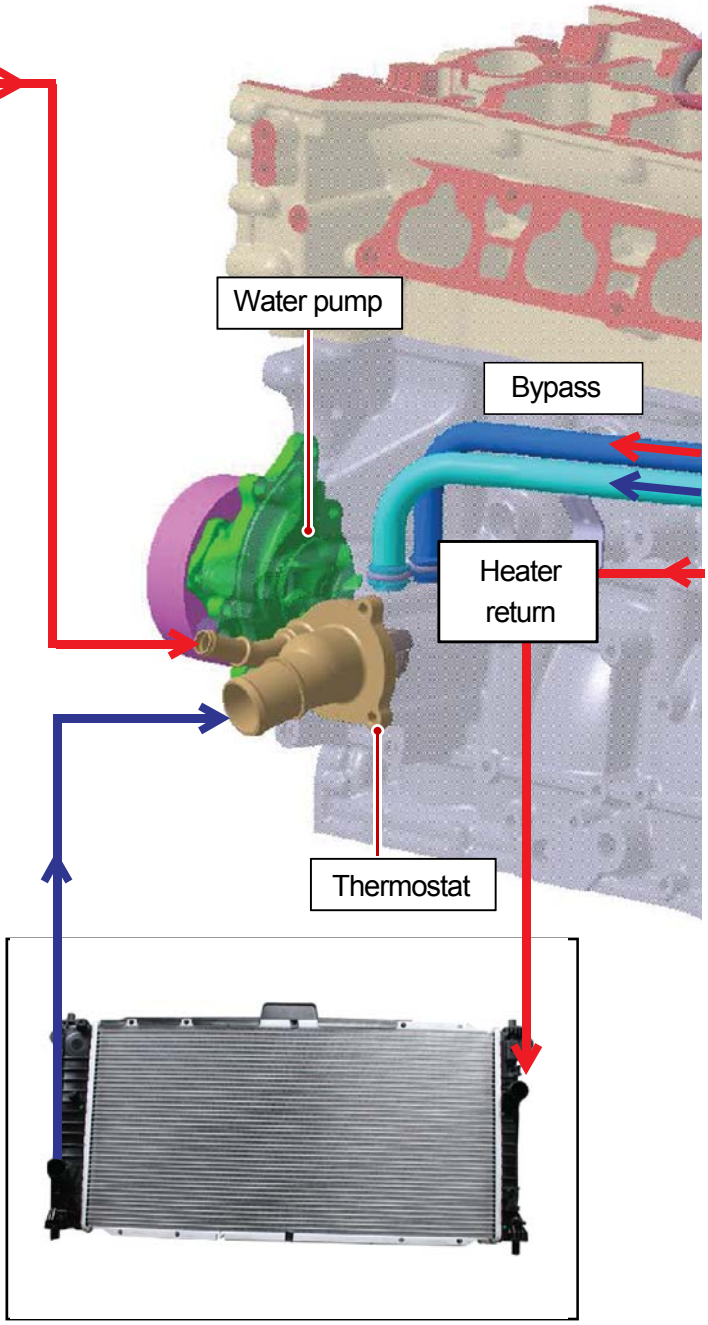


Circulates the fresh air forcibly to exchange heat with the radiator core fin.

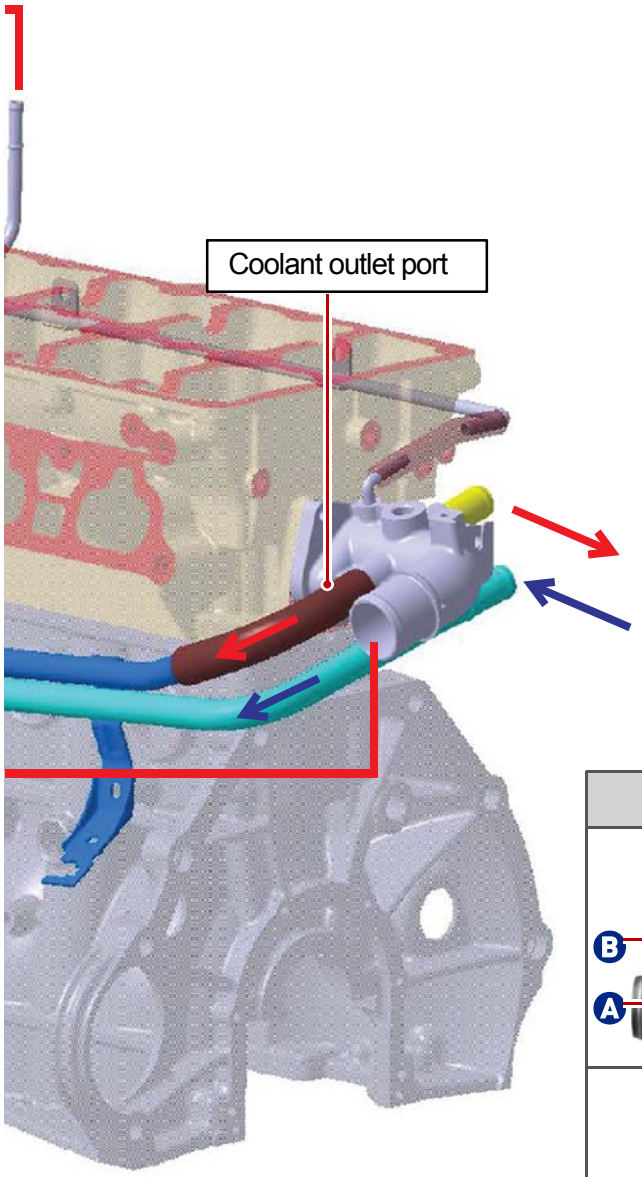
3. COOLANT FLOW DIAGRAM



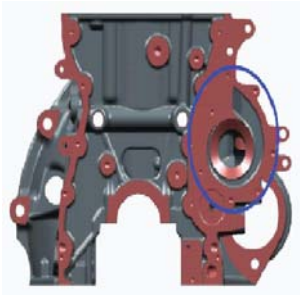




Modification basis	
Application basis	
Affected VIN	



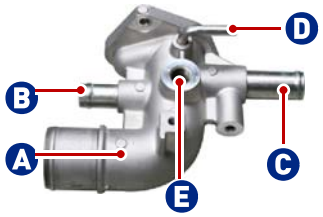
Water pump

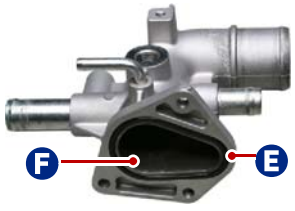






Coolant outlet port





A: to radiator
B: to water pump (bypass) to cabin heater
C: to coolant reservoir
D: Coolant temperature
E: sensor mountinh boss from cylinder head
F: Gasket
G:

CHARGE SYSTEM 1452-01

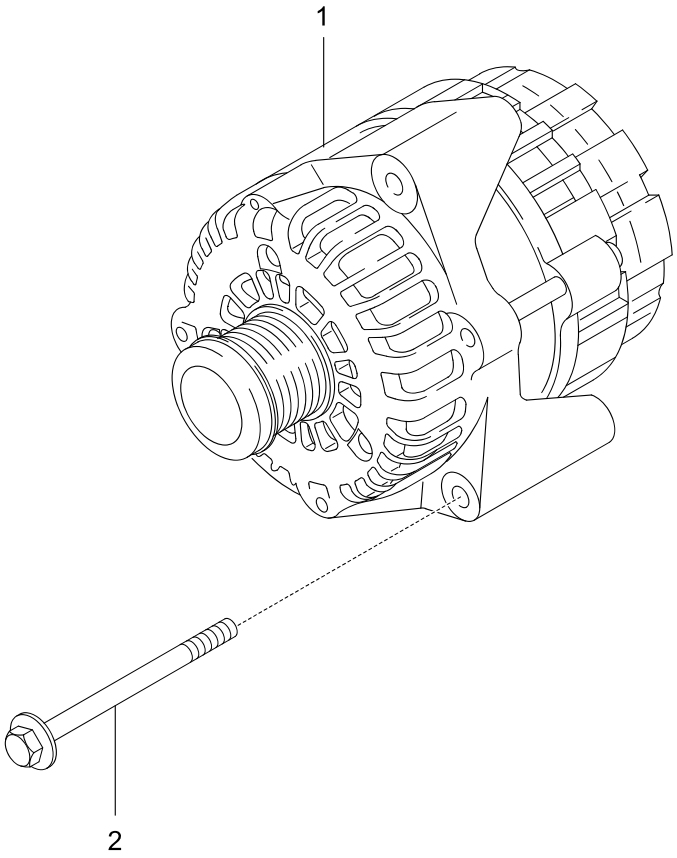
GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification	
Alternator	Type		HPS	EPS
	Crankshaft pulley : Alternator pulley		1 : 2.66	
	Normal output (idle/2200rpm)		70/140A	←
	Regulator voltage		12V	←
	Brush	Length	12.5mm	←
		Wear limit	7.0mm	←
Battery	Type		MF	←
	Capacity		90AH	←

2. LAYOUT

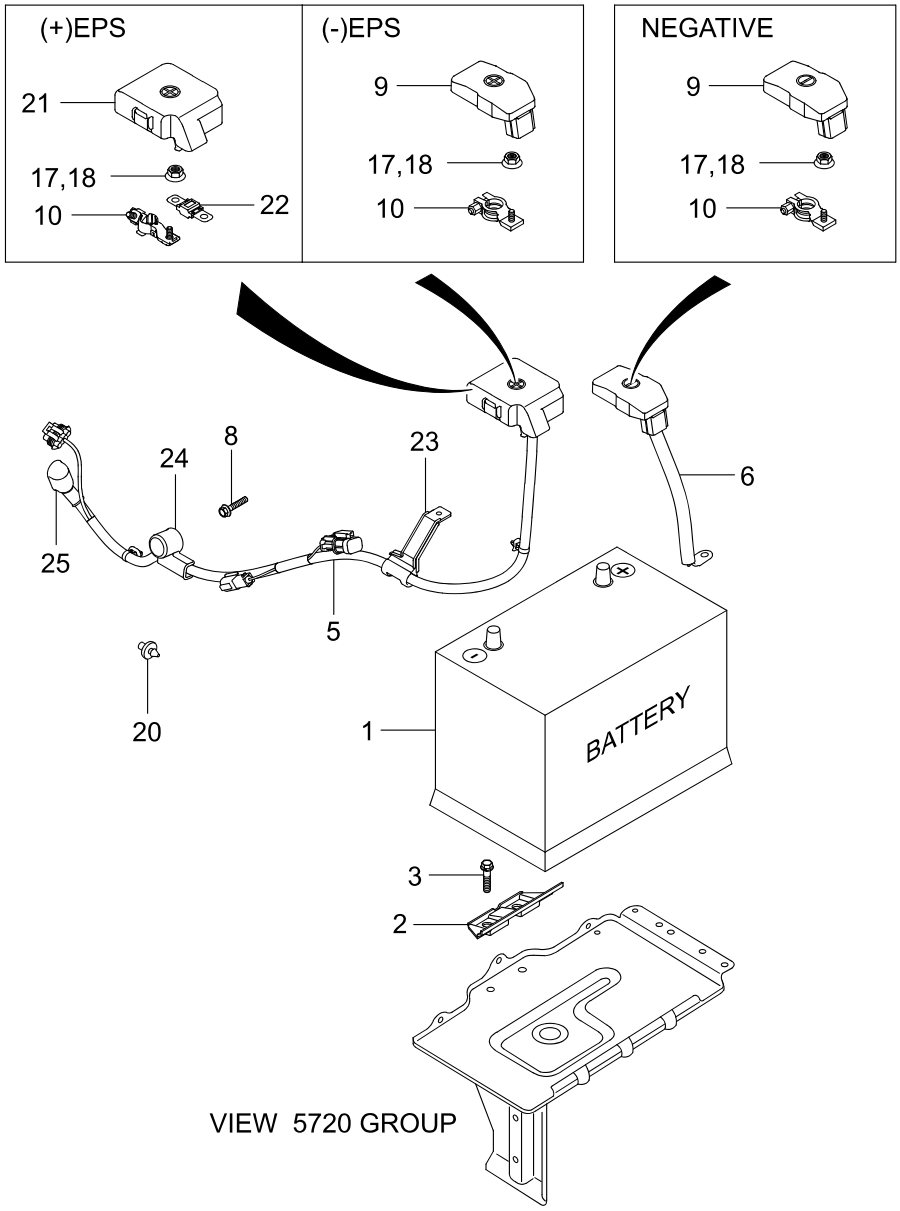
1) Alternator



1. Alternator assembly
2. Bolt

Modification basis	
Application basis	
Affected VIN	

2) Battery



1. Battery assembly
2. Clamp - Battery
3. Bolt
5. Cable assembly - Cable positive
6. Cable assembly - Battery ground
8. Bolt - Earth
9. Cap - Terminal
10. Connector - Battery
17. Nut
18. Nut
20. Cab - Earth
21. Box assembly - Battery sub
22. Fuse - MID 80A
23. Clamp - Battery cable
24. Grommet - Ring terminal
25. Grommet - Ring terminal

3. INSPECTION

1) Alternator

▶ **Output Test**

Item	How to check	DTC set value / Action
Output current	1. Disconnect the cable connected to the B terminal on the alternator. Connect one end of the ammeter to the B terminal and the other end to the cable connected to the B terminal. 2. Measure the maximum output value. (Maintain the engine speed between 2,500 and 3,000 rpm.) (Turn the headlamp and all the electrical switches on.)	- Pass: If the measured current is 45 A or higher. - Fail: If the measured current is less than 45 A. - Check the current of the B terminal.
B terminal current	1. Move the gear selector lever to the neutral position. 2. Maintain the engine speed at 2,500 rpm with the vehicle unloaded. (Turn all the electrical switches off.)	- Open circuit: If the measured current is 5 A or higher.
Rotor coil resistance	1. Disconnect the negative cable from the battery. 2. Remove the B terminal and turn off the ignition switch. 3. Measure the resistance between the L and F terminals with an ohmmeter.	- Pass: If the measured resistance is between 3 and 6Ω. - Faulty rotor coil or slip ring: If the measured resistance is less than 3Ω or greater than 6Ω.
L terminal voltage	1. Connect the B terminal wiring. 2. Measure the voltage with the engine running.	- Specification: 12.5V to 14.5V Faulty IC regulator or field - coil: If the measured voltage is 14.5V or higher.

CAUTION
- Disconnect the negative cable from the battery.
- Connect the negative cable again after connecting the ammeter.

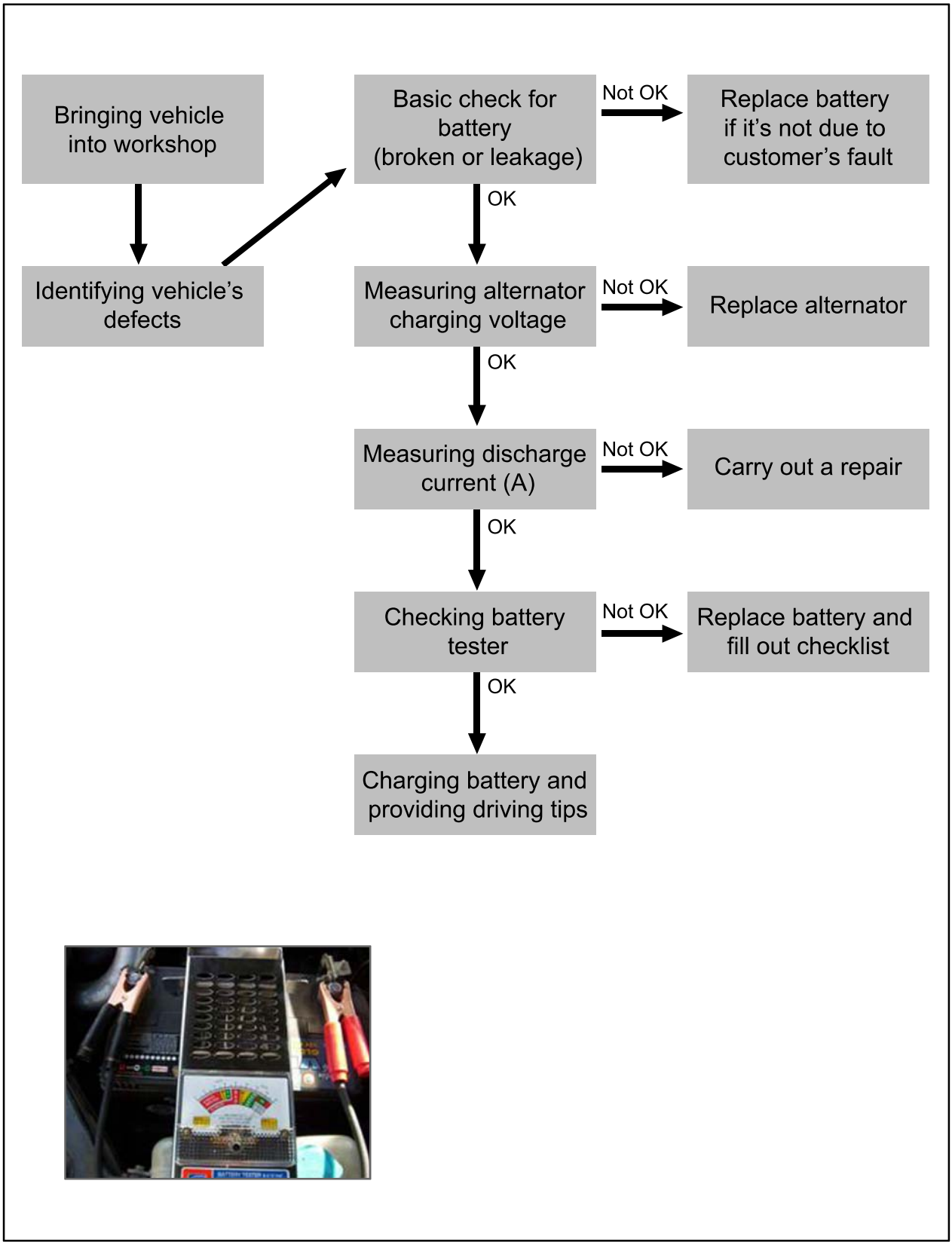
Modification basis	
Application basis	
Affected VIN	

▶ **Troubleshooting**

Item	Cause	Action
Overcharged battery	Defective alternator voltage regulator	Replace
	Defective voltage detection wiring	Repair or replace
Discharged battery	Loose alternator drive belt	just the belt tension or replace
	Poor connection of related circuit or open circuit	Retighten the loose connection or repair open circuit
	Defective alternator voltage regulator	Replace
	Terminated battery	Replace
	Defective ground	Repair
Charge warning lamp does not come on when turning on ignition switch with engine stopped	Defective alternator voltage regulator	Replace
	Open circuit in charge warning lamp, fuse or wiring	Replace or repair the charge warning lamp or fuse
	Defective ignition switch	Replace
	Defective ground of alternator circuit	Repair
Charge warning lamp does not go off after starting engine	Defective alternator voltage regulator	Replace
	Corroded or worn battery cable	Repair or replace
	Loose alternator drive belt	Adjust the belt tension or replace the belt
	Defective wiring harness	Repair or replace

2) Battery

▶ **Inspection**



Modification basis	
Application basis	
Affected VIN	

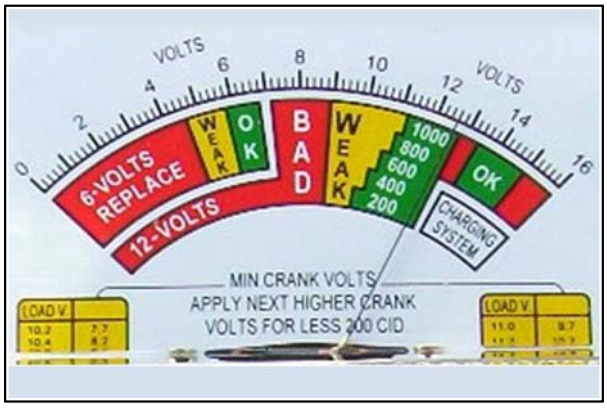
▶ Using battery tester

- PASS (11.0 V or more): Explain to the customer that the battery is reusable.
- Need to be charged (9.0 to 11.0 V): Charge the battery with a charger and reinstall it. Explain it to the customer.
- Need to be replaced (9.0 V or more): The battery should be replaced due to overdischarging.

▶ How to use battery tester



- Determine battery capacity by fixing current (load capacity) and time and varying voltage. Determine battery capacity based on the
- amount of voltage drop when discharging a fixed load capacity (120 A) for 5 seconds. Connect the tester to the battery and read the display while applying a load for 5 seconds.
-



- Red area (①): overdischarge or faulty battery
- Yellow area (②): Need to be charged (using a vehicle alternator and a battery charger)
- Green area (③): Normal
- Red area on the left-hand side of OK (④):
- Impossible to charge with an alternator
- Green area with OK (⑤): Normally charged Red area on the right-hand side of OK
- (⑥): Overcharged by an alternator

▶ Jump start

If the battery is weak or terminated, the battery from another vehicle can be used with jumper cables to start the engine.

▶ Connecting order

1. The positive (+) terminal of the discharged battery
2. The positive (+) terminal of the booster battery
3. The negative (-) terminal of the booster battery
4. Connect one end of the other jumper cable to the body of the discharged vehicle, such as the engine block or a front towing hook.

▶ Starting

1. Prepare a set of jumper cables.
2. Place another vehicle that has the same 12 V of power near to the discharged vehicle.
3. Switch off all electrical accessories for the discharged vehicle.
4. Apply the parking brake and shift the transaxle to the P position (automatic transaxle) or neutral (N) position (manual transaxle).
5. Connect the jumper cables.
6. Try to start the discharged vehicle while accelerating the engine rpm in the booster vehicle.
7. Attempt to start the engine with the discharged battery.
8. After starting the engine, carefully disconnect the jumper cables in the reverse sequence of connection.

Modification basis	
Application basis	
Affected VIN	

▶ Maintenance

If the charge warning lamp ( ) on the instrument cluster comes on while driving, there is a malfunction in the charge system including the battery. Therefore, carrying out the system check is needed.



- Make sure that the battery cables are firmly connected.
- If the terminals are corroded, clean them with a wire brush or sandpapers.
- Always disconnect the battery cables with the ignition key removed. When disconnecting the battery cables with the ignition key turned to ON or ACC position, several electric units can be damaged due to sudden voltage change.
- Check the battery for crack, damage or fluid leaks. Replace it if necessary.
- Wipe out the battery fluid on the battery surface using a rubber glove and a clean cloth wetted with soapy water.

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The charge system is designed to supply electrical energy to the vehicle while driving, and supplies a constant direct current voltage by converting mechanical rotational movement to electrical energy. The voltage regulator on the back of the alternator controls the generated voltage in all rotating ranges and adjusts the system voltage according to the electric load and ambient temperature change.

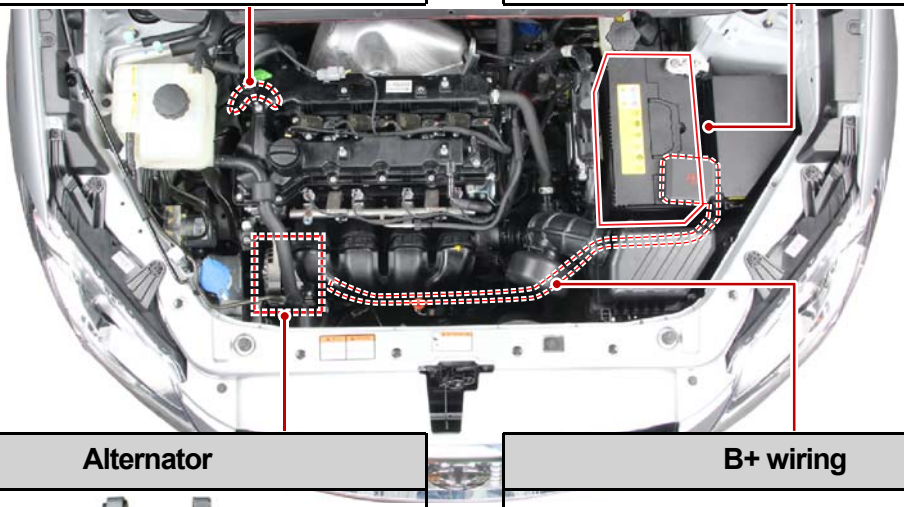
Body ground



Battery



It converts the chemical energy to the electrical energy and supplies power to the corresponding electric units when starting the engine.



Alternator



The alternator charges the battery and supplies power to each electric unit by converting the mechanical energy to the electrical energy.

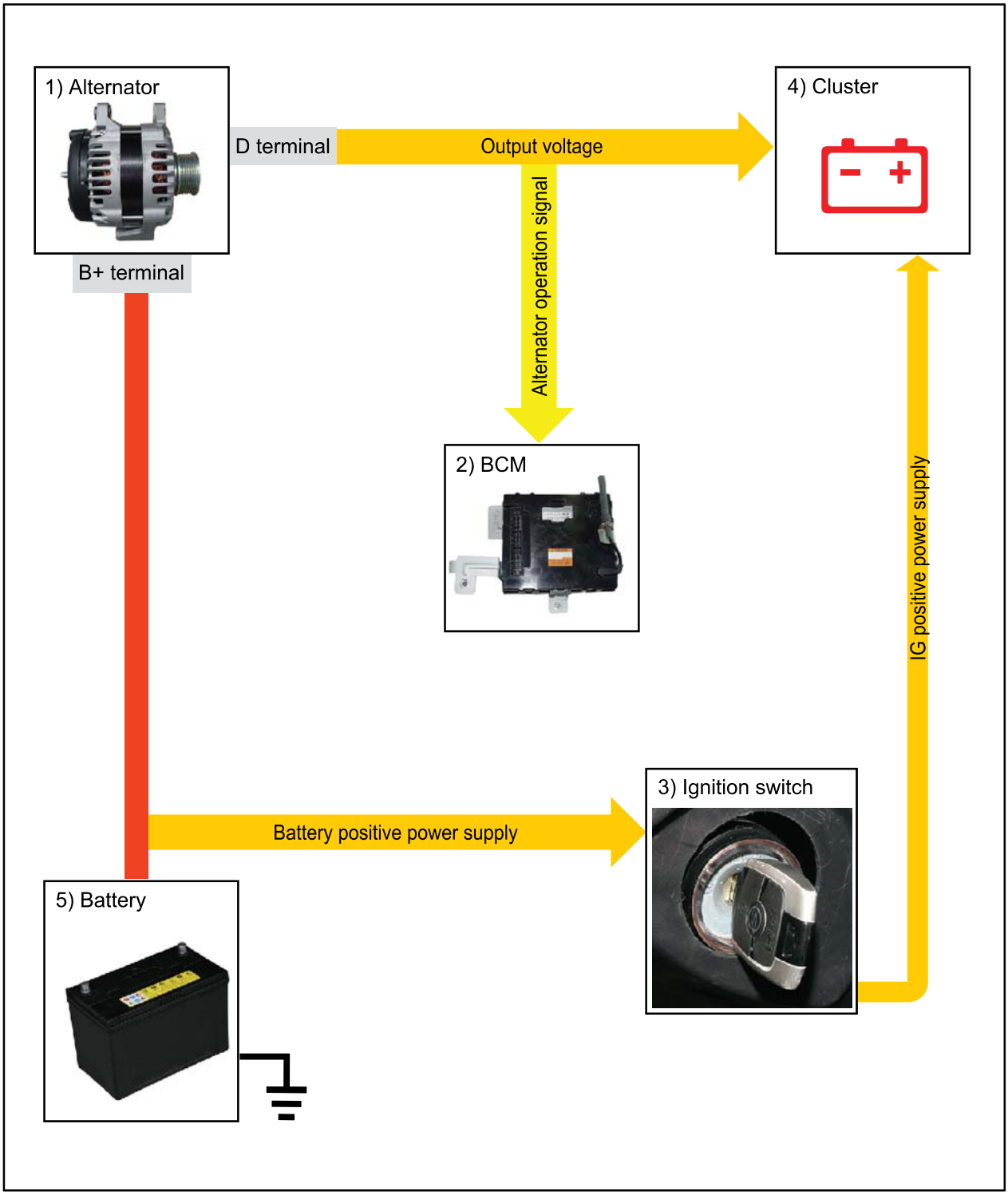
B+ wiring



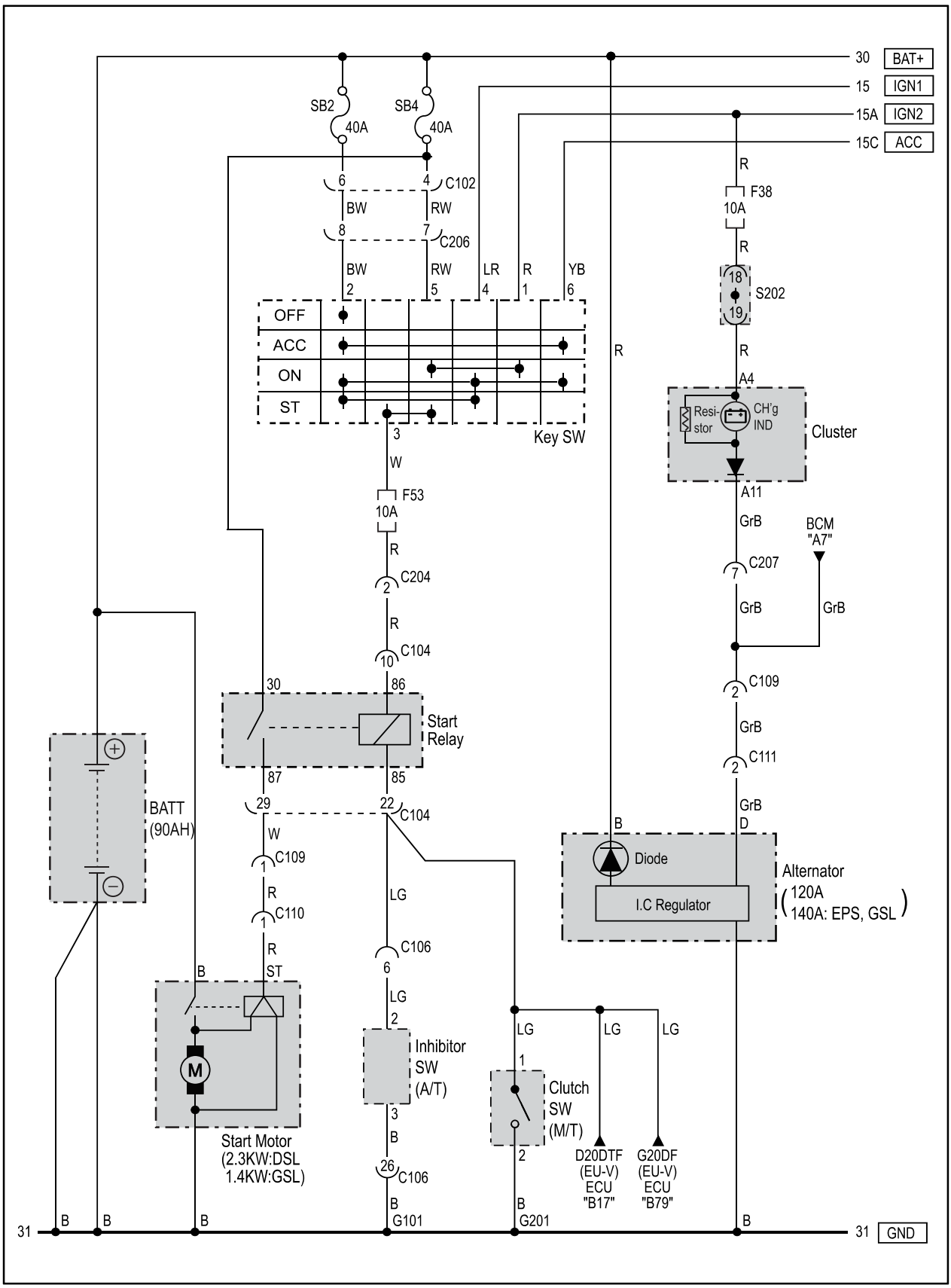
Modification basis	
Application basis	
Affected VIN	

2. CHARGING OPERATION

1) Vehicle without Smart key system



2) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

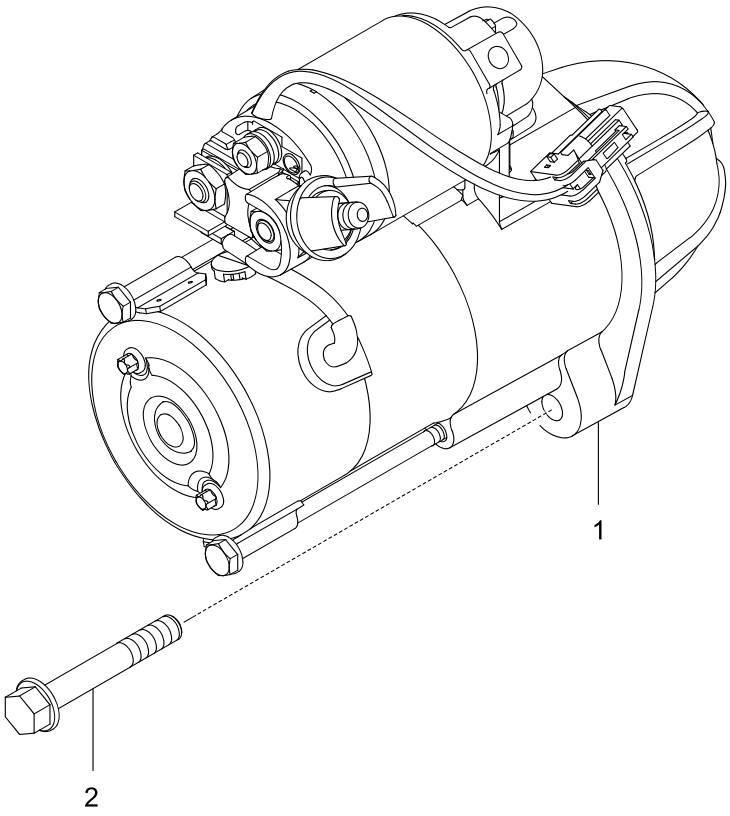
STARTING SYSTEM 1462-01

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Start motor	Capacity	12V 1.4kw
	Engagement	Meshed type
	Rotating direction	Clockwise
	Solenoid operating voltage	Max. 8V
	Weight	2.5kg

2. LAYOUT



1. Starter
2. Bolt

Modification basis	
Application basis	
Affected VIN	

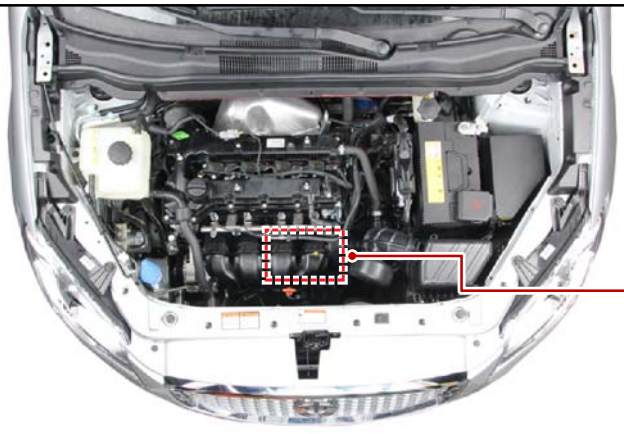
3. TROUBLESHOOTING

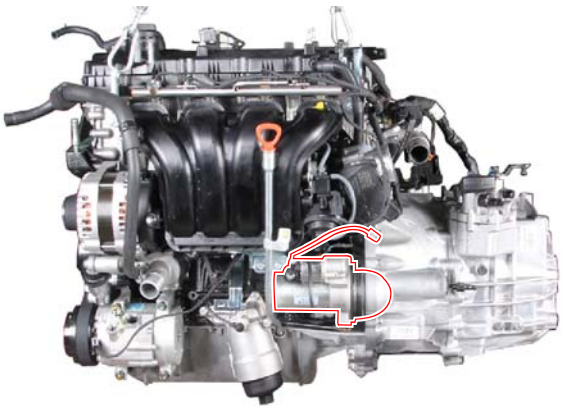
Problem	Possible Cause	Action
Engine will not crank	Low battery voltage	Charge or replace
	Loose, corroded or damaged battery cable	Repair or replace
	Faulty starter or open circuit	
	Faulty ignition switch or blown fuse	Repair or replace
	Poor engine ground	Repair
Engine cranks too slow	Low battery voltage	Charge or replace
	Loose, corroded or damaged battery cable	Repair or replace
	Faulty starter	
Starter does not stop	Faulty starter	Repair or replace
	Faulty ignition switch	Replace
Engine cranks normally, but does not start	Broken pinion gear or faulty starter	Replace the starter
	Broken flywheel ring gear	Replace
	Open circuit	Repair

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

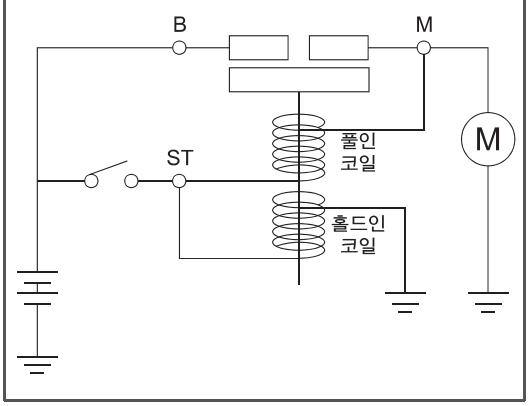
The starter (start motor) starts the engine with rotational power by converting the electric energy to the mechanical energy.
When the engine is cranking, the pinion gear meshes with the ring gear. If the ring gear overruns, the pinion gear clutch overruns to protect the pinion gear.





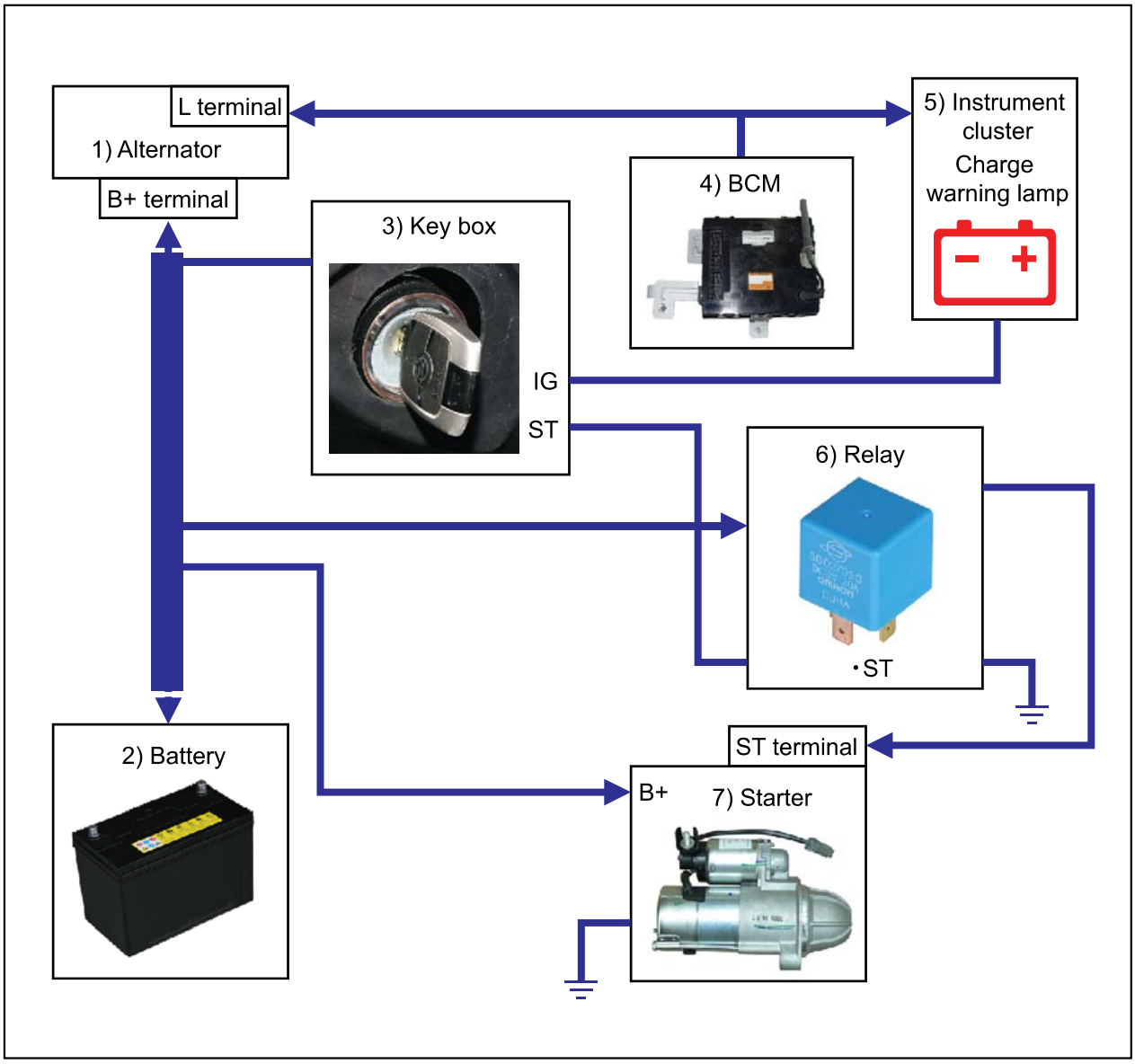
Start motor assembly



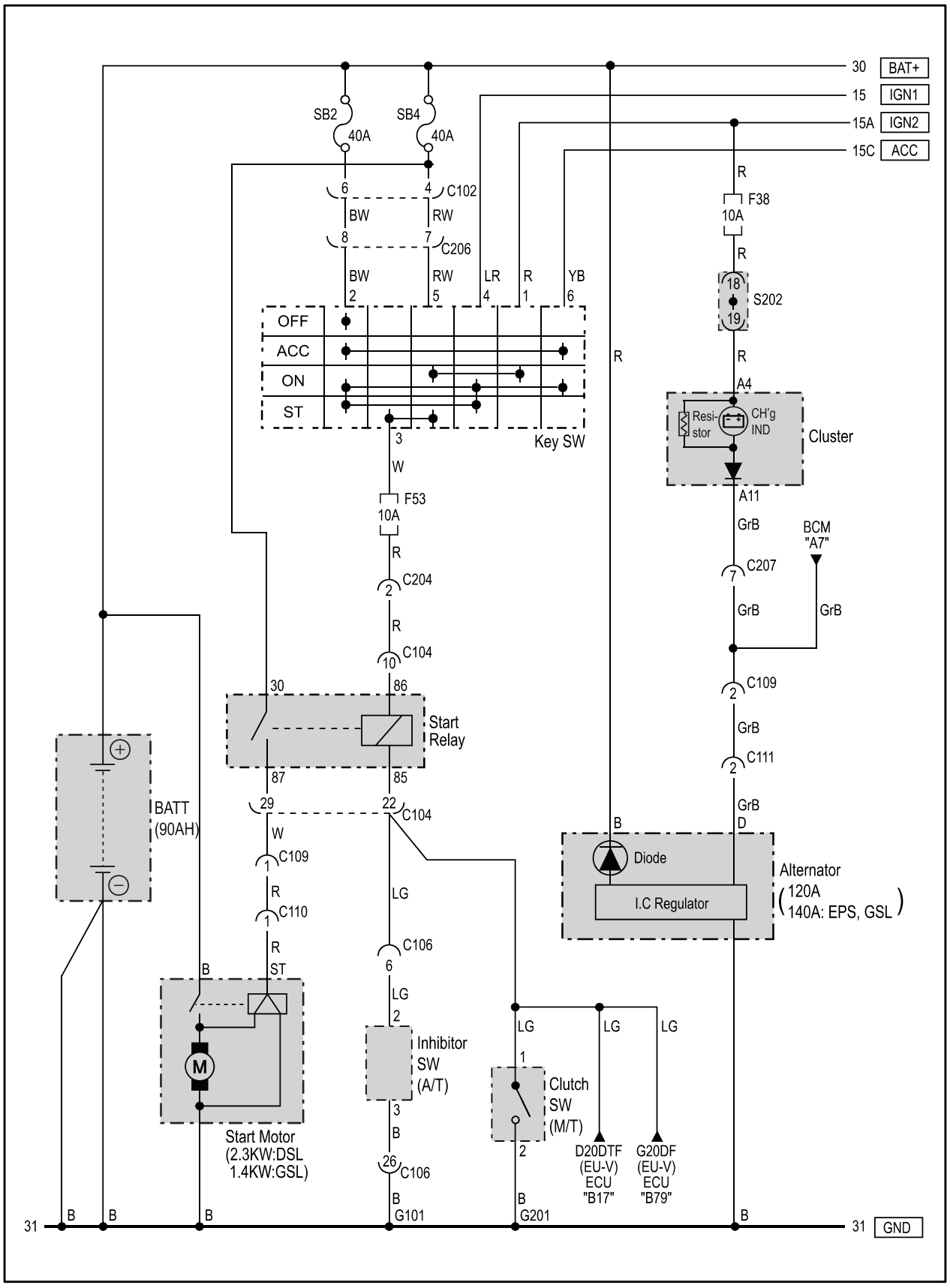


Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS



3. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL

0000-00

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

1) System Description



The cruise control is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal.
The vehicle speed must be greater than 38 km/h to engage the cruise control. This feature is especially useful for motorway driving.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

2) Traffic Conditions for Using Cruise Control

Use the cruise control system only when the traffic is not jammed, driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

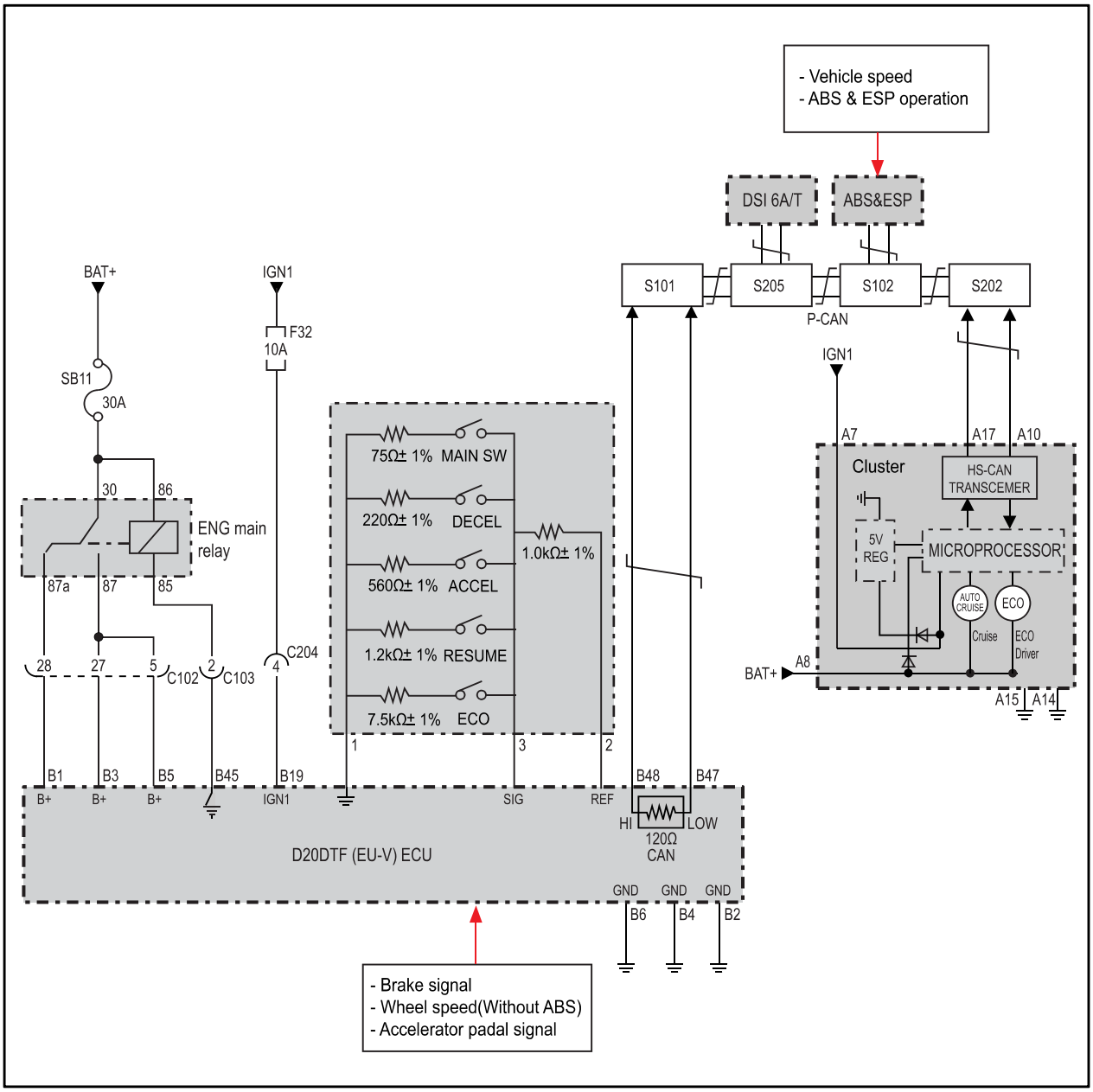
Improper use of the cruise control could be dangerous.

- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.
  This could result in a loss of control, collision, and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

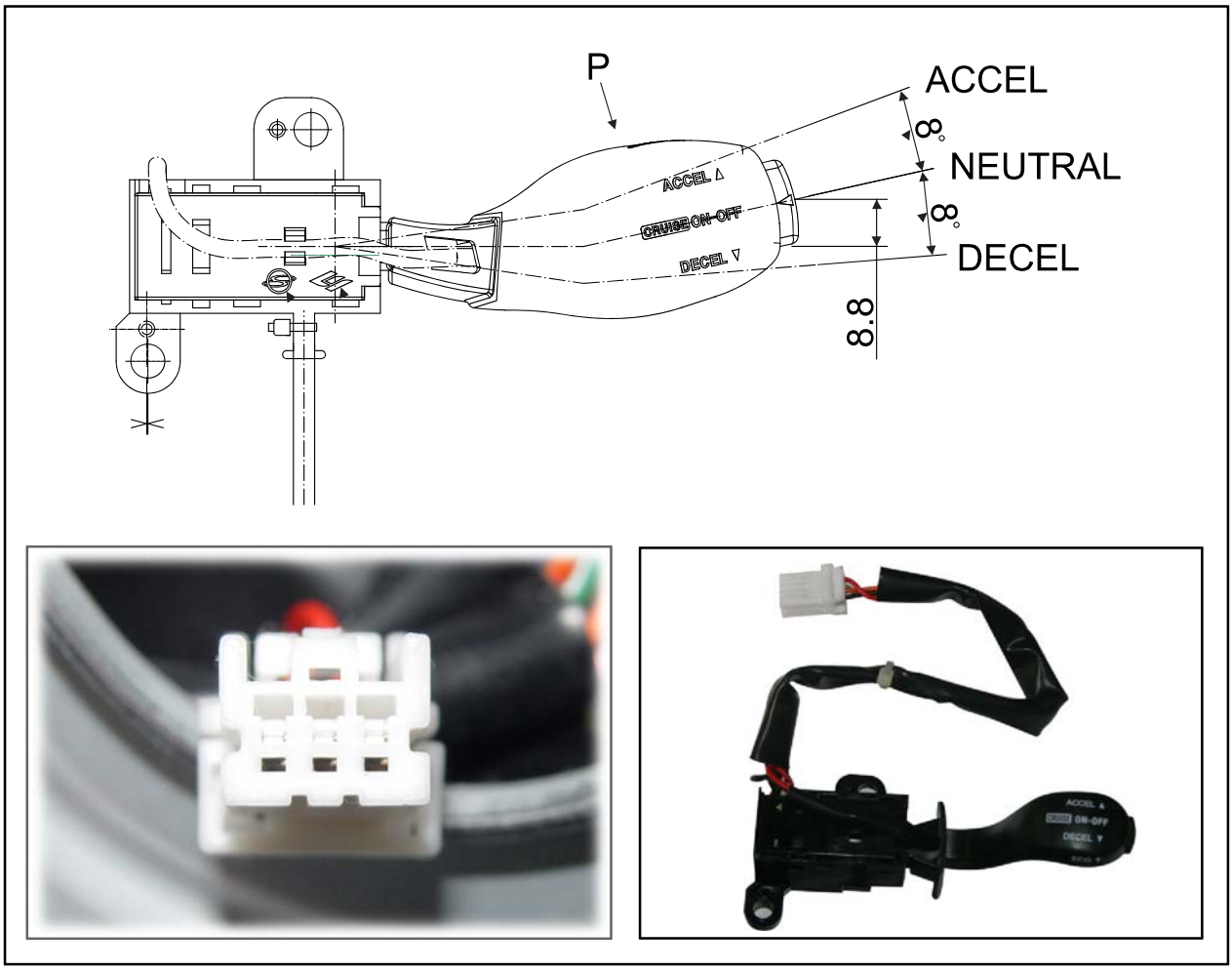
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Components



Test voltage(VCC 5V)

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-
ECO	4.22 ~ 4.82V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 38 km/h (24 MPH) and less than 150 km/h (90 MPH). In the vehicle equipped with manual transaxle, the gear shift lever should be in 3rd or higher gear position.
2. Diesel engine equipped vehicle: When the desired speed is reached, press CRUISE ON (3) switch of cruise control lever.
   Gasoline engine equipped vehicle: When the desired speed is reached, press CRUISE ON (3) switch of cruise control lever. The system is ready to activate the cruise control function. To activate the cruise control function, push up (1) the ACCEL switch of the cruise control lever or push down (2) the DECEL switch.
3. Now, the vehicle is cruised by this system with the set speed.
4. And you can set to other vehicle speeds again with above steps after an accelerator pedal intervention during the cruise control running.

CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

2) Accelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push up the ACCEL switch of the cruise control lever and hold it until the desired speed is reached without an accelerator pedal intervention.
2. When the desired speed is reached, release the lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate using the accelerator pedal over 38 km/h.
2. Push up the ACCEL switch of the cruise control lever and hold it. And then release the accelerator pedal slowly.
3. When the desired speed is reached, release the lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the ACCEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-up switching. When you operate a tap-up switching, the vehicle is accelerated for 1 km/h over the previous set speed.
   If you want to accelerate for 10 km/h, operate the tap-up switching ten times without accelerating with
2. the cruise control system.

Modification basis	
Application basis	
Affected VIN	

3) Decelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push down the DECEL switch of the cruise control lever and hold it until the desired speed is reached without a brake pedal intervention. But the cruise control system cannot maintain the cruise function at less than 38 km/h.
2. When the desired speed is reached, release the lever.

(2) When the cruise control system is not running

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 40 km/h.
2. And then release the accelerator pedal slowly.
3. When the desired speed is reached, release the lever. But the cruise control system cannot maintain the cruise function at less than 38 km/h.

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push down the DECEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-down switching. When you operate a tap-down switching, the vehicle is decelerated for 1 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the brake
2. pedal intervention.

4) Recovery of Set Speed (RESUME)



Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pulling up the cruise control lever when the current vehicle speed is over 38 km/h without an acceleration intervention. But if you turn off the ignition switch, the memorized set speed is cleared and you cannot recover the previous set speed.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

Modification basis	
Application basis	
Affected VIN	

5) ECO Cruise Control



The ECO cruise control system has nearly same functions with the auto cruise control system. It is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal.

ECO cruise driving mode

- The engine ECU controls the sharp acceleration and deceleration to improve the fuel economy.
- The ECO cruise system is ready when pushing down the cruise control lever. At this moment, the ECO indicator on the instrument cluster comes on.
- The ECO cruise system operates when pulling up the cruise control lever.
- To cancel the ECO cruise driving, push doen the cruise control lever. At this moment, the ECO indicator on the instrument cluster goes off and the auto cruise starts to operate.

Control lever	ECO indicator	
	ON	Blinking
Push down the lever	O	
Push down it again		O

6) Normal Cancellation of the Cruise Control



The cruise control system will be canceled when one or more items of the following conditions are applied;

1. When the brake pedal is depressed.
2. When the cruising speed is downed less than 38 km/h.
3. When pushing the ON-OFF switch of the cruise control lever.
4. When ESP is activated.
5. When applying the parking brake when driving.
   When using the clutch in order to shift (M/T only).
   And the cruise control system can be operated again in driving state.

CAUTION

Keep the main cruise control switch in the neutral position when not using the cruise control.

Modification basis	
Application basis	
Affected VIN	

(1) Abnormal Cancellation of the Cruise Control

1. Sharp acceleration or deceleration
   - 50 km/h faster than set speed
   - 25 km/h faster than set speed for one minute
   - 70 km/h slower than set speed
   - 65 km/h slower than set speed for 3 minutes
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

ENGINE CONTROL

1490-00

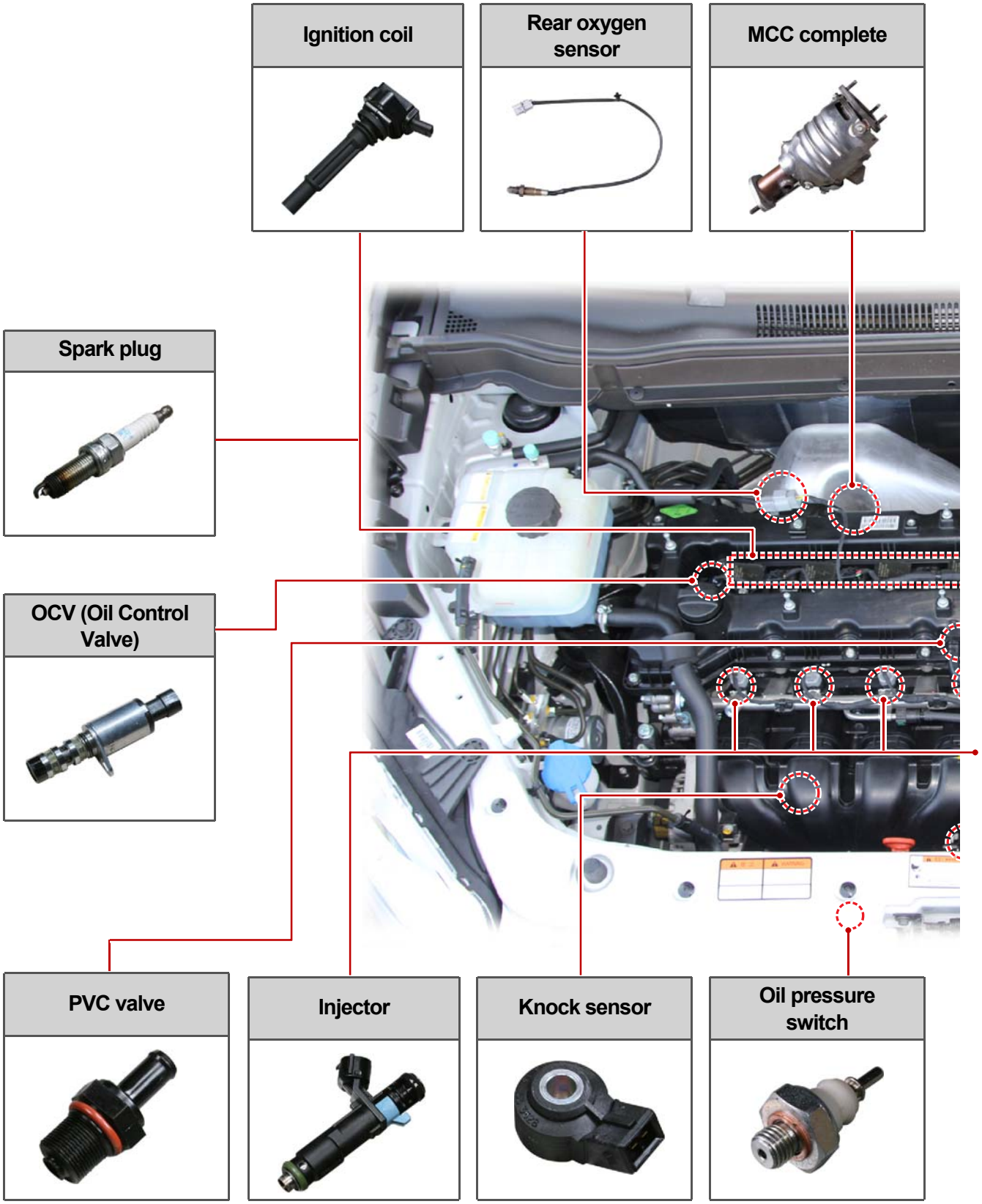
GENERAL INFORMATION

1. ENGINE DATA LIST

Data	Unit	Value
Coolant temperature	℃	0.436V (130℃) ~4.896V (-40℃)
Intake air temperature	℃	-40~130℃ (varies according to ambient air temperature or engine mode)
Idle speed	rpm	700±50(P/N), 600±(D)
Engine load	%	18~25%
Mass air flow	kg/h	16~25kg/h
Throttle position angle	°TA	0° (Full Open) ~ 78° (Close)
Engine torque	Nm	varies according to engine conditions
Injection time	Ms	-
Battery voltage	V	13.5V~14.1V
Accelerator pedal position 1	V	0.3~4.8 V
Accelerator pedal position 2	V	0.3~2.4 V
Oxygen sensor	mV	0~5 V
OCV (Oil Control Valve)	%	0~100%
VIS solenoid valve	1=ON / 0=OFF	-
A/C compressor switch	1=ON / 0=OFF	-
Full load	1=ON / 0=OFF	-
Knocking control	1=ON / 0=OFF	-
Brake switch	1=ON / 0=OFF	-
Cruise control	1=ON / 0=OFF	-

OVERVIEW AND OPERATING PTOCESS

1. MAJOR COMPONENTS



Modification basis	
Application basis	
Affected VIN	

Camshaft position sensor



Coolant Temp sensor

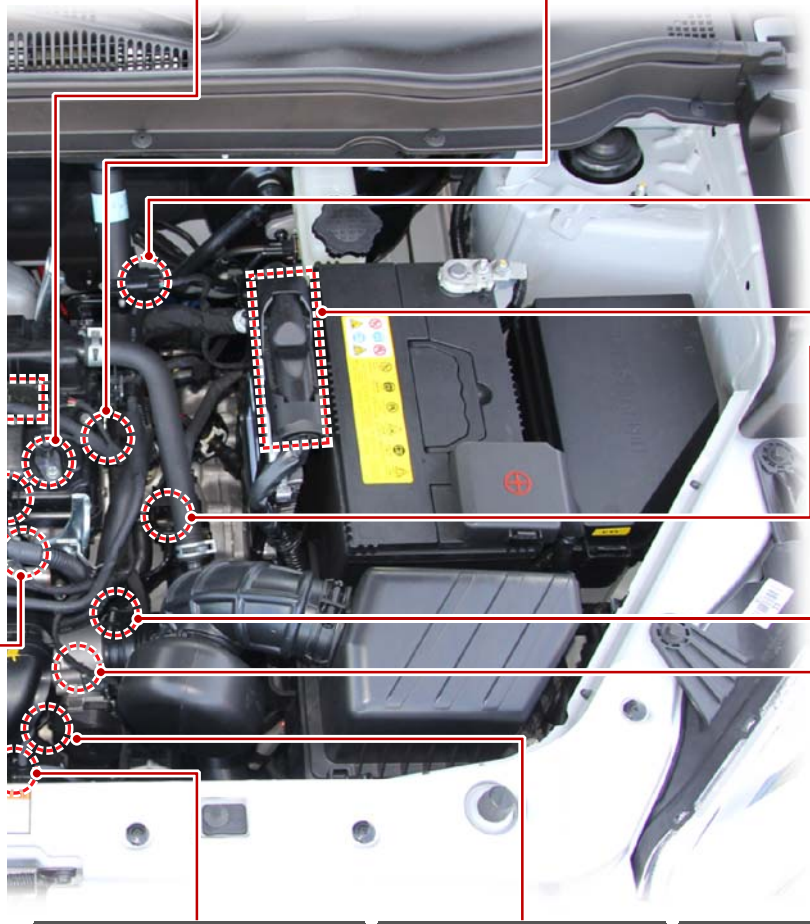


Front oxygen sensor



G20DF engine ECU





Purge control solenoid valve



Crankshaft position sensor



VIS solenoid valve



T-MAP sensor



Electronic throttle body



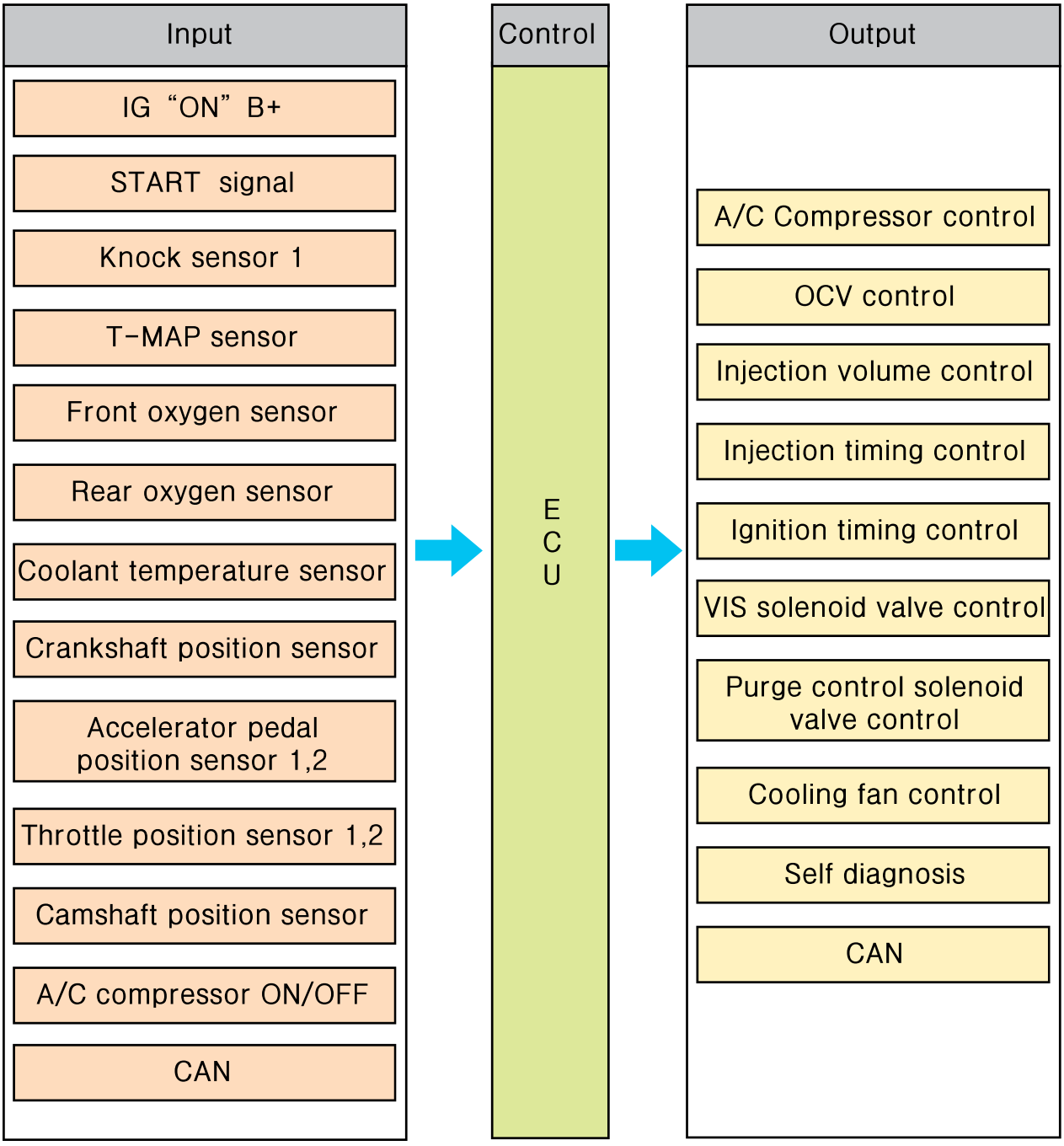
Magnetic trigger ring



Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

1) Input/Output of ECU



Modification basis	
Application basis	
Affected VIN	

2) Components for ECU Input

Rear oxygen sensor



Coolant temperature sensor



Camshaft position sensor



Crankshaft position sensor



Front oxygen sensor



G20DF Engine ECU



Electronic throttle body



Knock sensor



T-MAP sensor



Refrigerant pressure sensor
Clutch pedal signal
Blower switch signal
Brake pedal signal

CAN

- ABS & ESP
- Instrument cluster
- TCU

Oil pressure switch

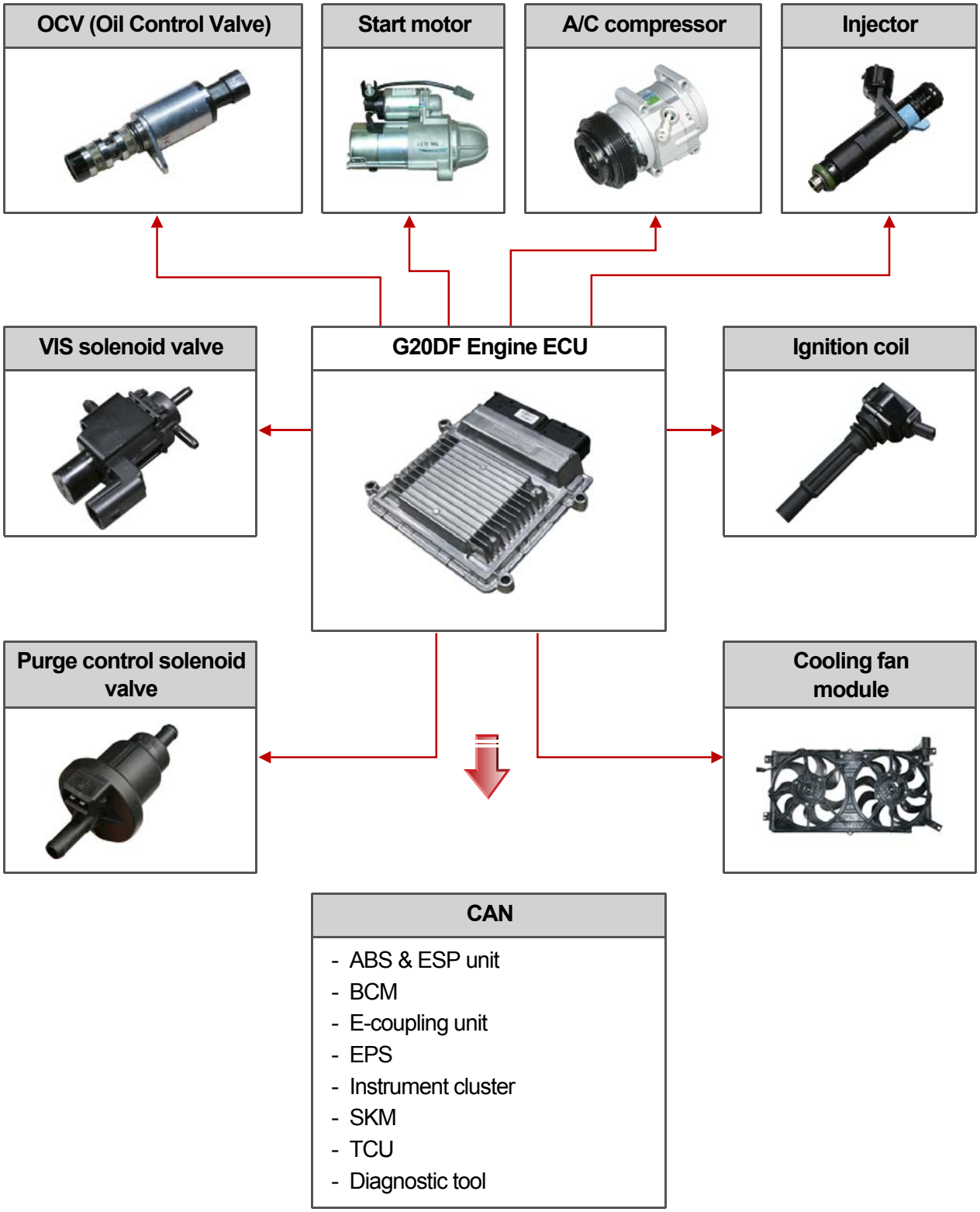


Oil pressure warning lamp



Modification basis	
Application basis	
Affected VIN	

3) Components for ECU Output



Modification basis	
Application basis	
Affected VIN	

3. ECU CONTROL

1) Functions

ECU receives and analyzes signals from various sensors and then modifies those signals into permissible voltage levels and analyzes to control respective actuators.
ECU microprocessor calculates injection period and injection timing proper for engine piston speed and crankshaft angle based on input data and stored specific map to control the engine power and emission gas.
Output signal of the ECU microprocessor activates the injector solenoid valve to control the fuel injection period and injection timing; so controls various actuators in response to engine changes.
Auxiliary function of ECU has adopted to reduce emission gas, improve fuel economy and enhance safety, comforts and conveniences. For example, there are autocruise and immobilizer and adopted CAN communication to exchange data among electrical systems (automatic T/M and brake system) in the vehicle fluently. And the diagnostic tool can be used to diagnose vehicle status and defectives.
Operating temperature range of ECU is normally −40 to +85°C and protected from factors like oil, water and electromagnetism and there should be no mechanical shocks.

2) Control Functions

- Controls by operating stages:
  To make optimum combustion under every operating stage, ECU should calculate proper injection volume in each stage by considering various factors.

- Starting injection volume control:
  During initial starting, injecting fuel volume will be calculated by function of temperature and engine cranking speed. Starting injection continues from when the ignition switch is turned to ignition position to till the engine reaches to allowable minimum speed.

- Driving mode control:
  If the vehicle runs normally, fuel injection volume will be calculated by accelerator pedal travel and engine rpm and the drive map will be used to match the drivers inputs with optimum engine power.

3) Injection Volume Control

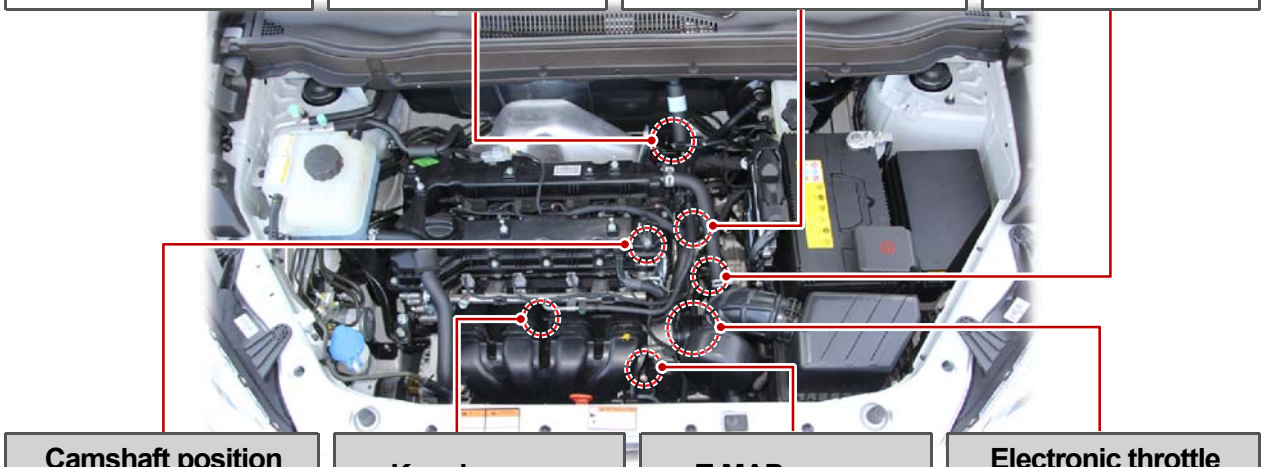
(1) Overview

To keep the best engine conditions and to reduce the emission gas, ECU determines the injection volume and timing.

(2) Components

▶ **Input Components**

Accelerator pedal position sensor	Front oxygen sensor	Coolant temperature sensor	Crankshaft position sensor
			



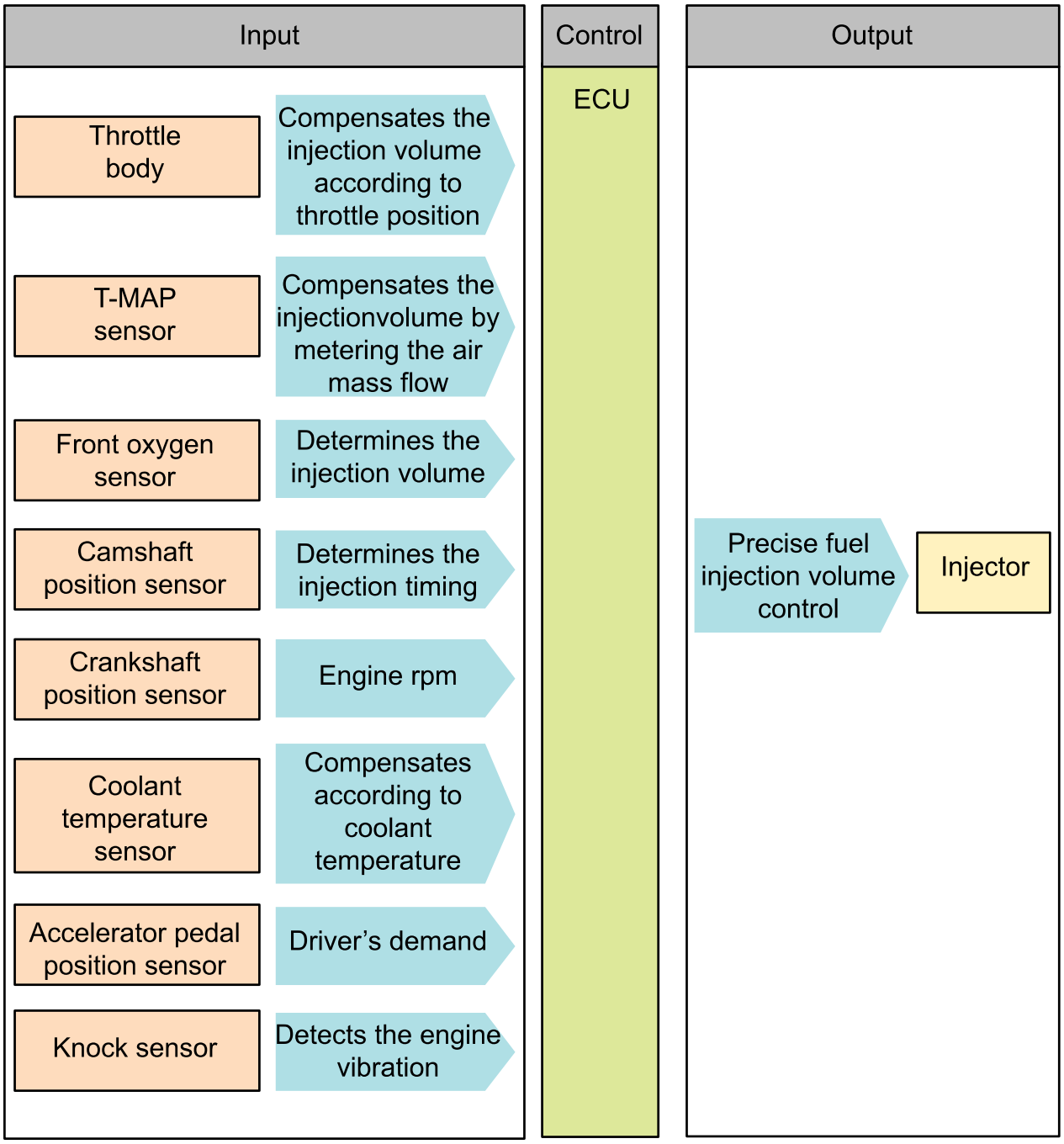
Camshaft position sensor	Knock sensor	T-MAP sensor	Electronic throttle body
			

▶ **Output Components**

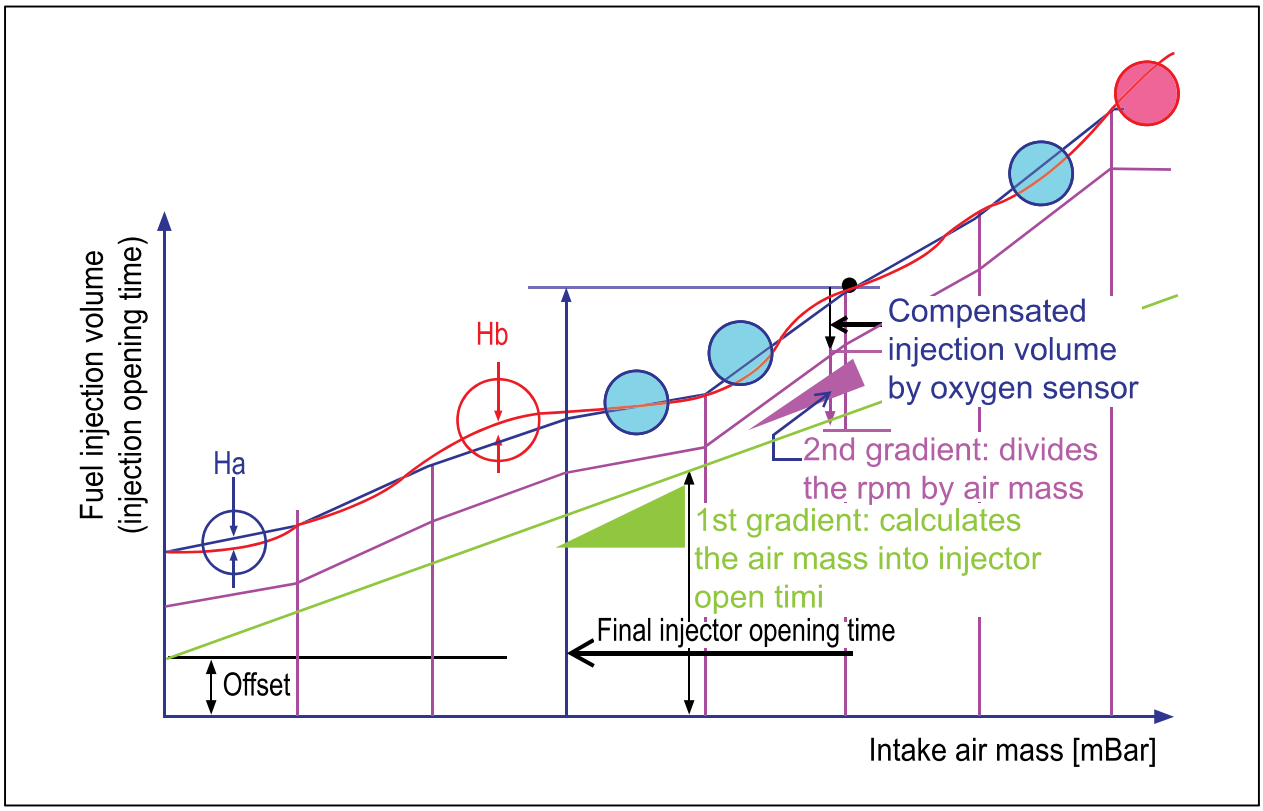
Various sensor data	→	Engine ECU	→	Injector
				
		Determines the basic injection volume.		Operates the injector by receiving the signal from ECU.

Modification basis	
Application basis	
Affected VIN	

(3) Input/Output for Injection Volume Control



(4) Basic Injection Volume Map



Modification basis	
Application basis	
Affected VIN	

4) Ignition System Control

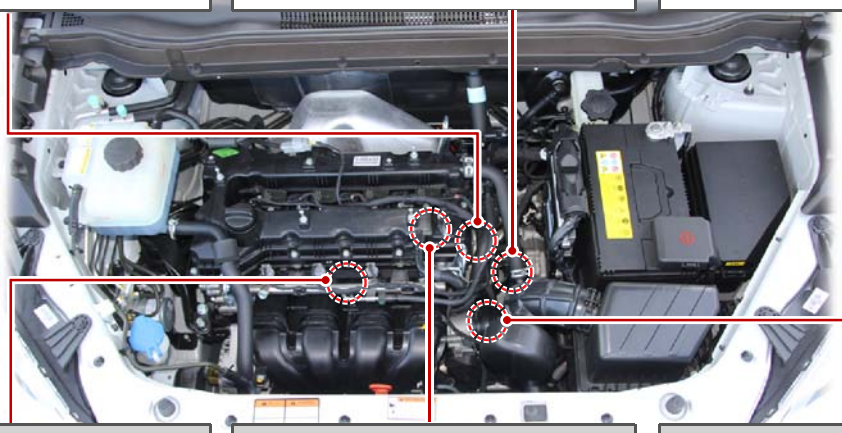
(1) Overview

G20DF engine is equipped with the single ignition system. Each spark plug is operated independently by the ECU and one ignition coil and spark plug are provided for each cylinder.

(2) Components

▶ **Input Components**

Coolant temperature sensor	Crankshaft position sensor	Accelerator pedal position sensor
		

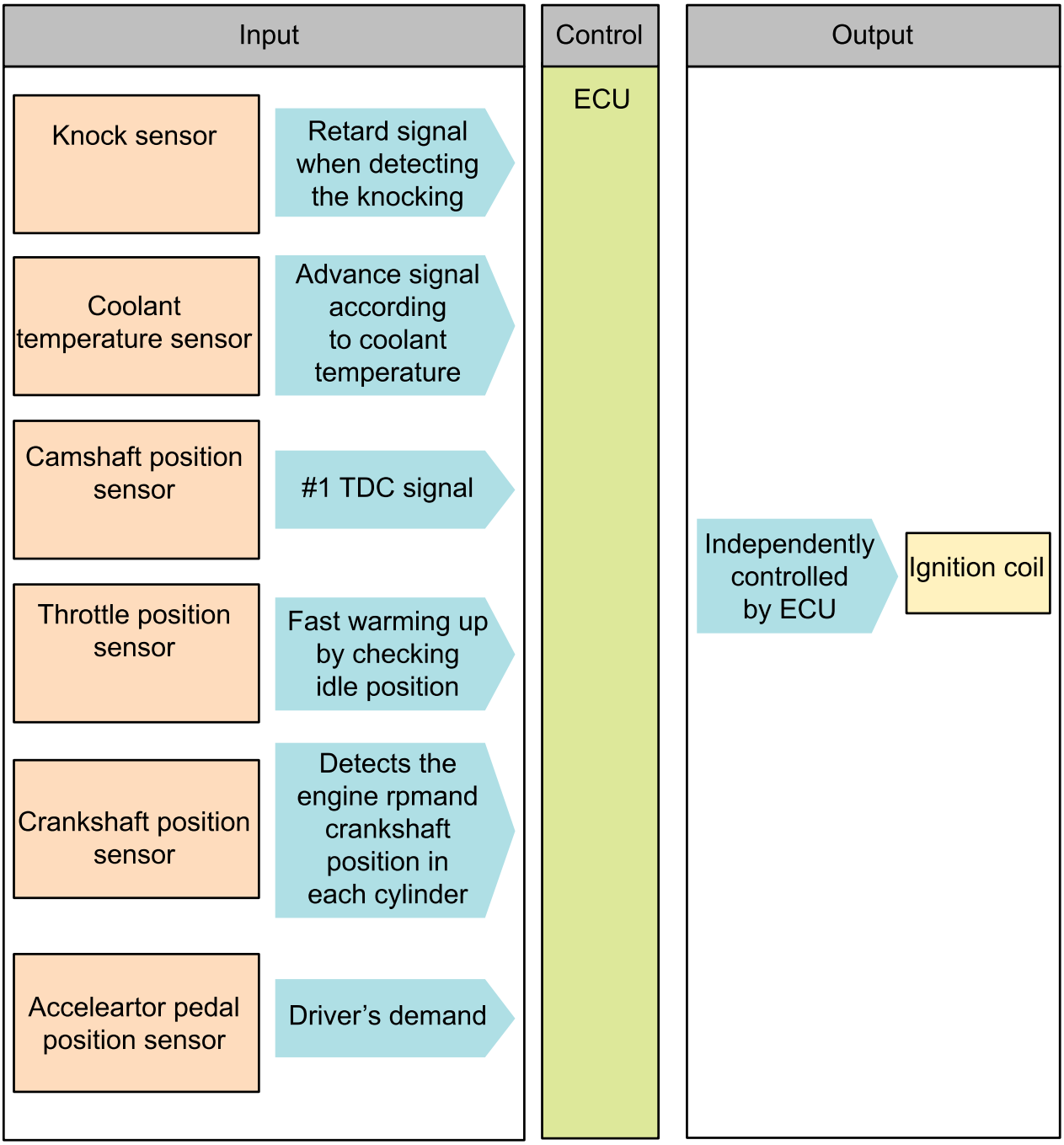


Knock sensor	Camshaft position sensor	Electronic throttle body
		

▶ **Output Components**



(3) Input/Output for Ignition System



Modification basis	
Application basis	
Affected VIN	

(4) Features

1. Determines the ignition timing according to input signal
   The ECU always analyzes the following elements when determining the ignition timing.

   - Crankshaft position sensor
   - Camshaft position sensor
   - Coolant temperature sensor
   - Intake air temperature/air mass

2. Warm-up of catalytic converter
   The ignition timing is retarded for about 20 seconds to operate the catalytic converter according to the operating temperature under the following conditions:

   - The coolant temperature is 15°C ~ 40°C at starting.
   - The idle speed is increased by the idle speed control to help warming up of the catalytic converter

3. Idle speed control
   The ignition timing can be retarded up to 36° or advanced up to 20° to help idle speed control.
   The ignition timing control can be performed faster than the control through the throttle valve.

4. Fuel cut-off in deceleration
   The ignition timing is retarded temporarily to prevent abrupt increase of the torque when the combustion is restarted.

5. Intake air temperature/coolant temperature
   The ignition timing is retarded to prevent knocking if the intake air temperature or coolant temperature is high. The ignition timing is retarded in the following cases.

   - The intake air temperature is above 30°C.
   - The coolant temperature is above 105°C.

   The ignition timing retard for intake air temperature and for coolant temperature is added up for correction.

6. ESP/ASR control mode
   The ignition timing is retarded to reduce engine torque as fast as possible under the ESP/ASR control mode.

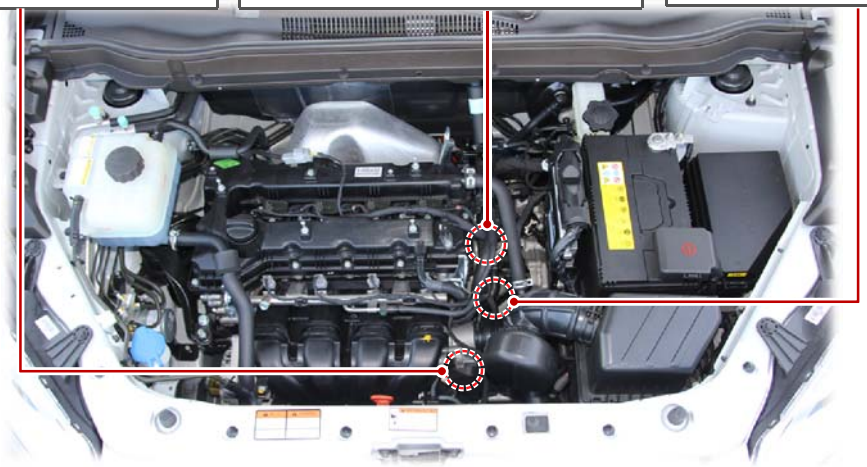
7. Knocking control
   If knocking occurs in the cylinder, the ignition angle of the corresponding cylinder is retarded. The coolant temperature is 15°C to 40°C when starting.

5) Warm-Up of Catalytic Converter

(1) Components

▶ Input Components

T-MAP sensor	Coolant temperature sensor	Crankshaft position sensor
		



▶ Output Components

Various sensor data	Engine ECU	Injector	Ignition coil
			
	- Determines the fuel injection volume - Heats the oxygen sensor	Operates the injector by receiving the signal from ECU	Retards the ignition by receiving the signal from ECU

Oxygen sensor

Heats the oxygen sensor by receiving the signal from ECU

Modification basis	
Application basis	
Affected VIN	

(2) Warm-up Control Function

▶ **Idle speed control**

The idle speed is controlled according to the fuel/air mixture when the engine load is changed, the power steering wheel is turned to its end, the selector lever is in the "D" position and the A/C compressor is in operation. It is also controlled according to the charge level during the purge control operation.

▶ **Ignition timing**

The idle speed is controlled according to the fuel/air mixture when the engine load is changed, The ignition angle can be retarded up to 36˚ or advanced up to 20˚ to help idle speed control.

▶ **Air conditioner compressor operation**

The air conditioner control unit sends the air conditioner operation signal to the ECU to increase the throttle valve opening amount in order to prevent reduction of the engine speed when the air conditioner compressor is in operation at idling.

▶ **Low voltage**

If low voltage is detected by the ECU, the idle speed increases up to 100 rpm selectively under the driving mode until the ignition switch is turned off.

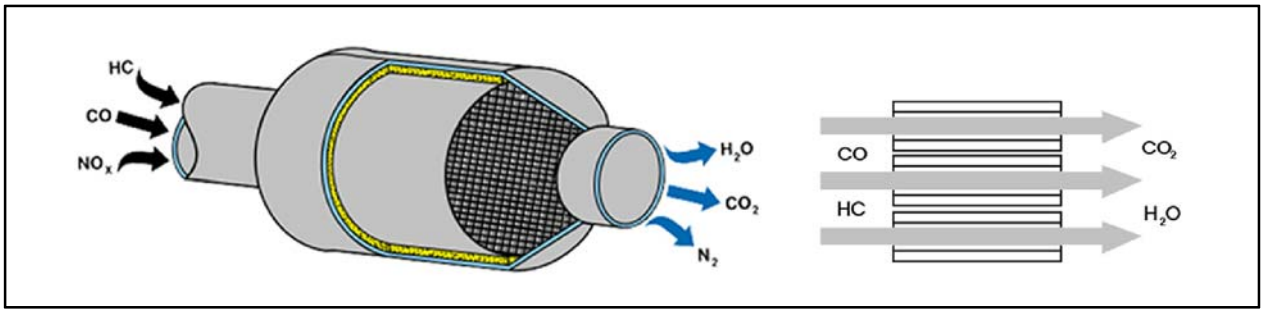
(3) Warm-up Control Operating Conditions

To make the catalytic converter reach a operating temperature, the ignition timing is retarded for about 20 seconds under the following conditions:

▶ The coolant temperature is 15°C ~ 40°C when the engine is started.
▶ **The selector lever is in the "P" or "N" position.**

Also, the idle speed increases to 1100 ~ 1500 rpm simultaneously by the idle speed control. However, as soon as the selector lever is shifted to the D position, warming up control of the catalytic converter will be inhibited. The information necessary to perform such control is as follows:

▶ **Coolant temperature**
▶ **Engine rpm**
▶ **Intake air mass**
▶ **Recognizing idling status**
▶ **Selector lever position**

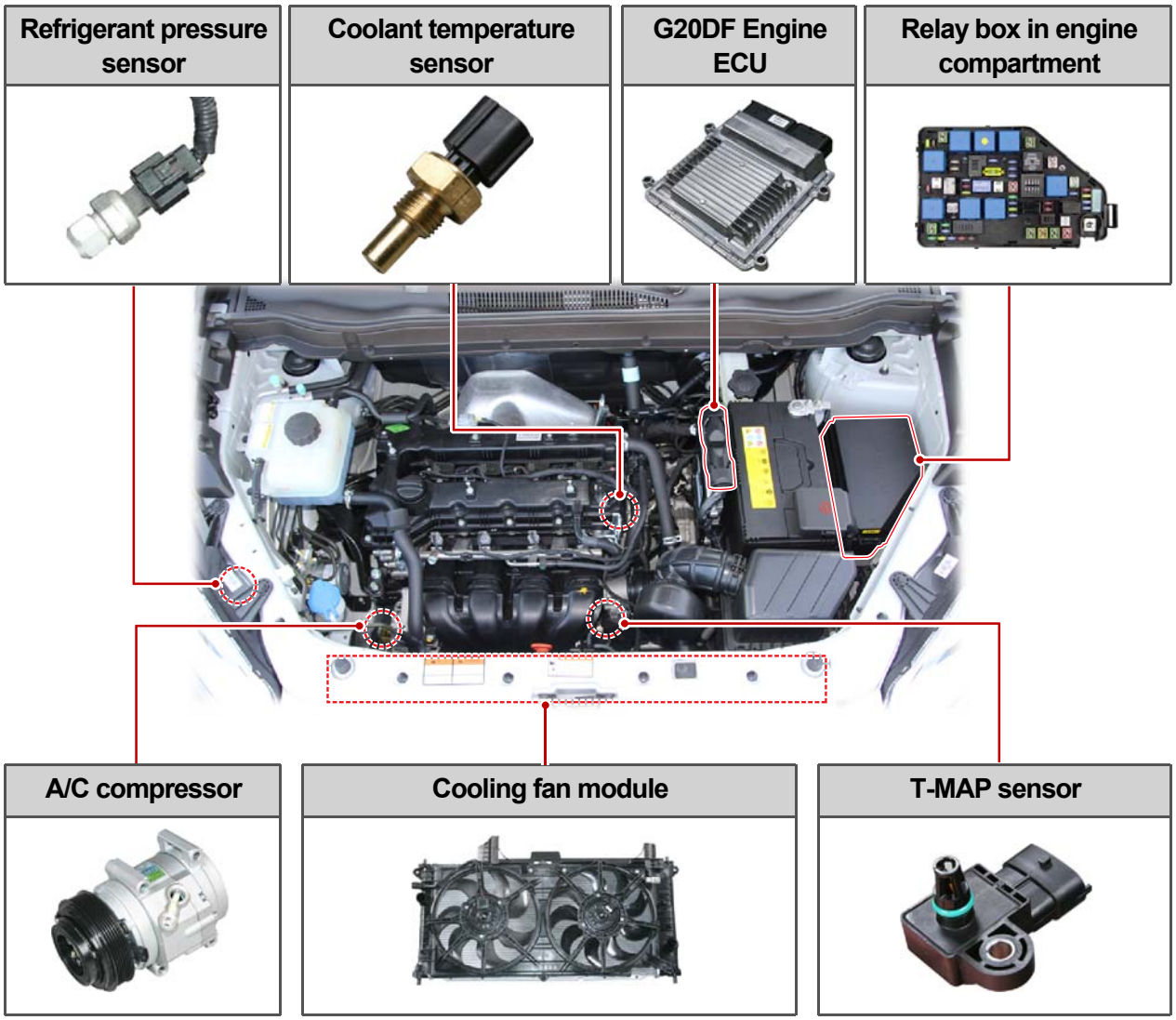


6) Cooling Fan Control

(1) Overview of Cooling Fan and A/C Compressor

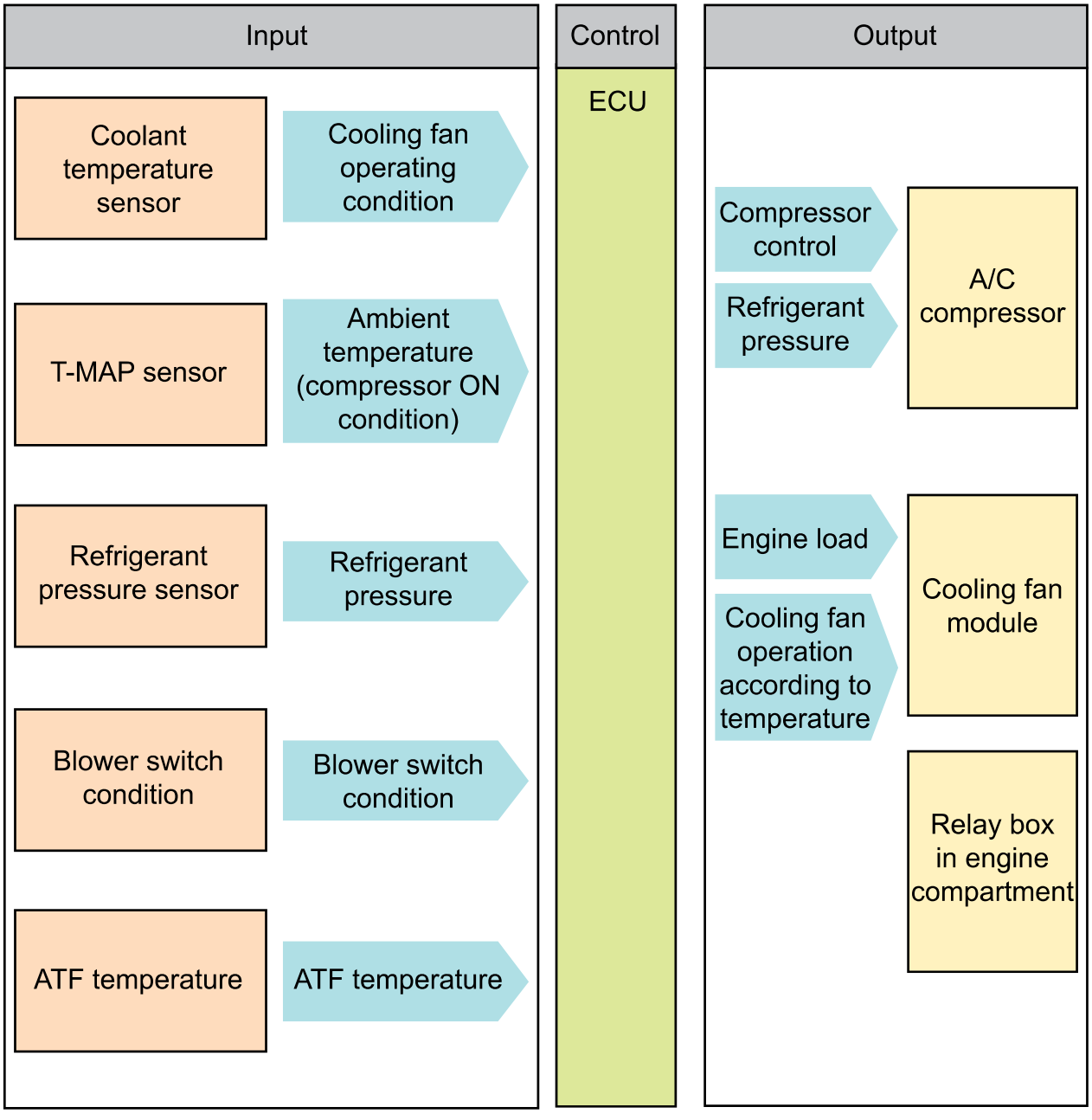
The cooling system maintains the engine temperature at an efficient level during all engine operating conditions. The water pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools. The heat from automatic transaxle is also cooled down through the radiator by circulating the oil through the oil pump. There are two cooling fans (180W+120W) in G20DF engine. ECU controls the electric cooling fans with three cooling fan relays to improve the engine torque and air conditioning performance.

(2) Components



Modification basis	
Application basis	
Affected VIN	

(3) Input/Output for Cooling Fan and A/C Compressor



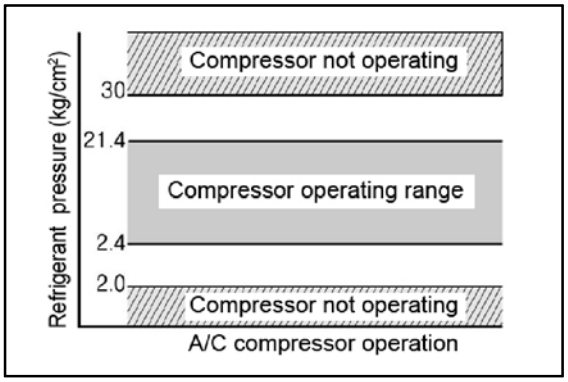
(4) Cooling Fan and A/C Compressor Control

▶ Conditions for cooling fan

The cooling fan module controls the cooling fan relay, high speed relay and low speed relay.
The cooling fan is controlled by the series and parallel circuits

A/C switch	Cooling fan	Coolant temperature	Refrigerant pressure	A/C compressor
OFF	OFF	Coolant temp.<90℃	-	
	LO	90℃≤Coolant temp.<105℃	-	
	HI	105℃≤Coolant temp.	-	
ON	LO	Coolant temp.<105℃	Refrigerant pressure<18 bar	ON
	HI		18 bar≤Refrigerant pressure	
	HI	105℃≤Coolant temp.<115℃	-	
	HI	115℃≤Coolant temp.	-	OFF (cut)

▶ A/C compressor OFF conditions



- Coolant temperature: over 118℃
- Approx. 4 seconds after starting the engine
- When abrupt acceleration
- Refrigerant pressure:
  * OFF below 2.0 kg/㎠, then ON over 2.4 kg/㎠
  * OFF over 32 kg/㎠, then ON below 26.0 kg/㎠

▶ Output voltage according to refrigerant pressure

The output voltage from refrigerant pressure sensor is 1.7 V to 3.5 V when the refrigerant pressure is 10 to 24 kgf/㎠ with A/C "ON".

▶ Cooling fan control by ATF temperature

ATF temperature	Cooling fan speed	Remark
Over 110˚C	HI	-

Modification basis	
Application basis	
Affected VIN	

7) Immobilizer Control

(1) Overview

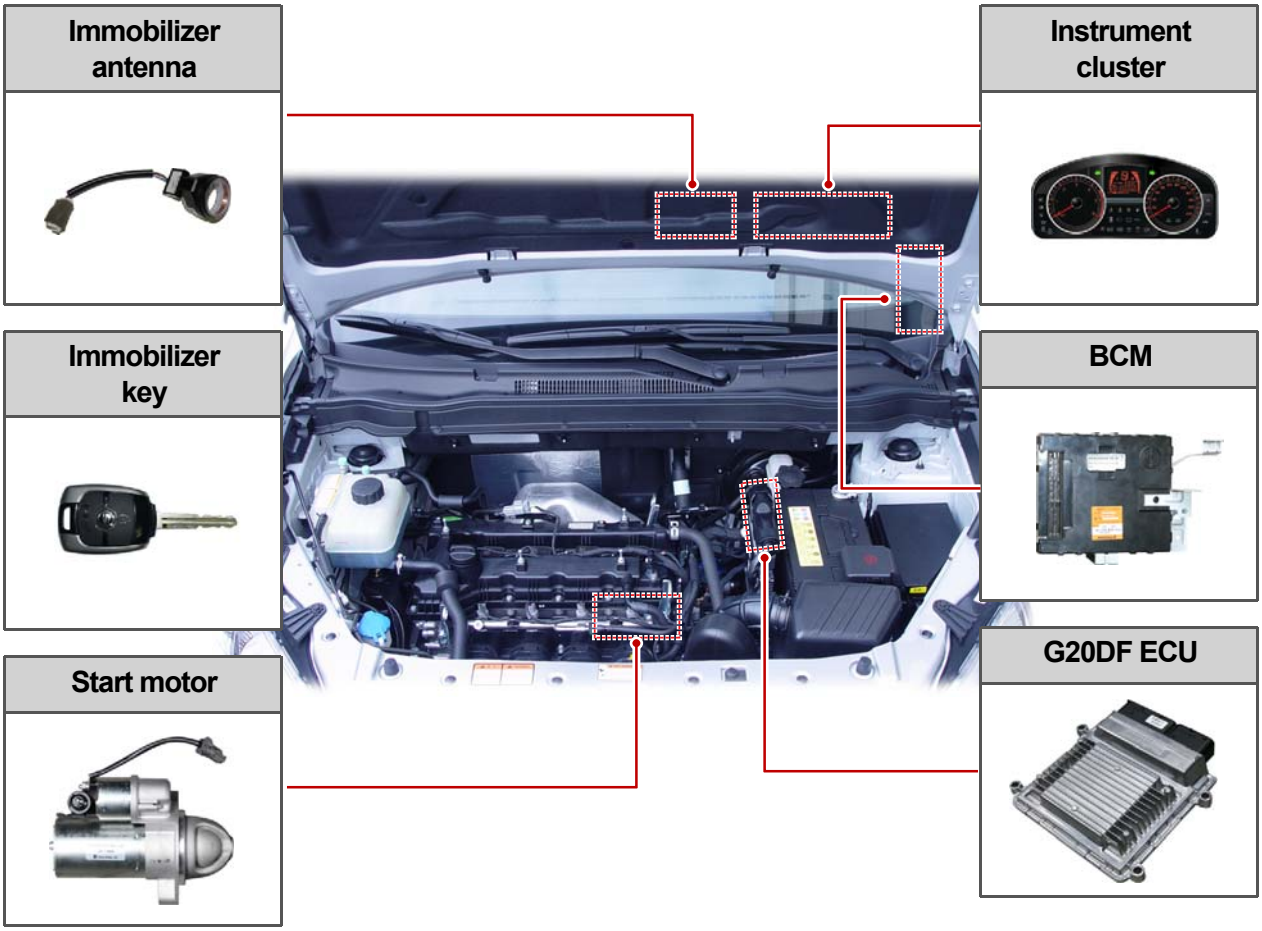
The Immobilizer System provides an additional theft deterrent to the vehicle in which it is installed and prevents it from being started by unauthorized persons. The transponder integrated in the key and the engine control unit have the same code. When the ignition key with the integrated transponder is turned to the ON position, the ECU (Engine Control Unit) checks the crypto code of the key and, if correct, allows the vehicle to start the engine.

NOTE

For details, refer to Chapter "BCM".

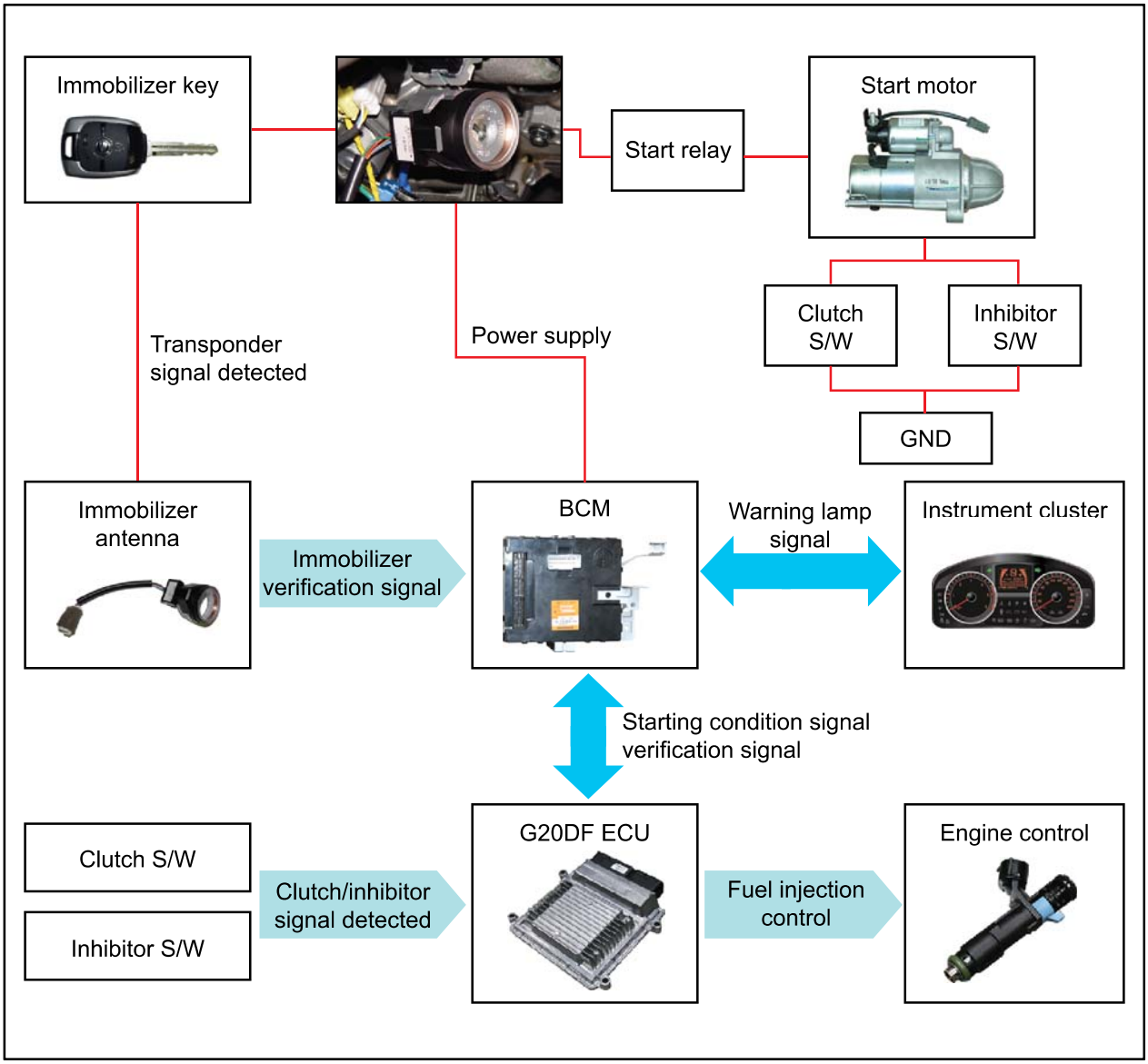
(2) Components

▶ **Conditions for cooling fan**



▶ Key approval process

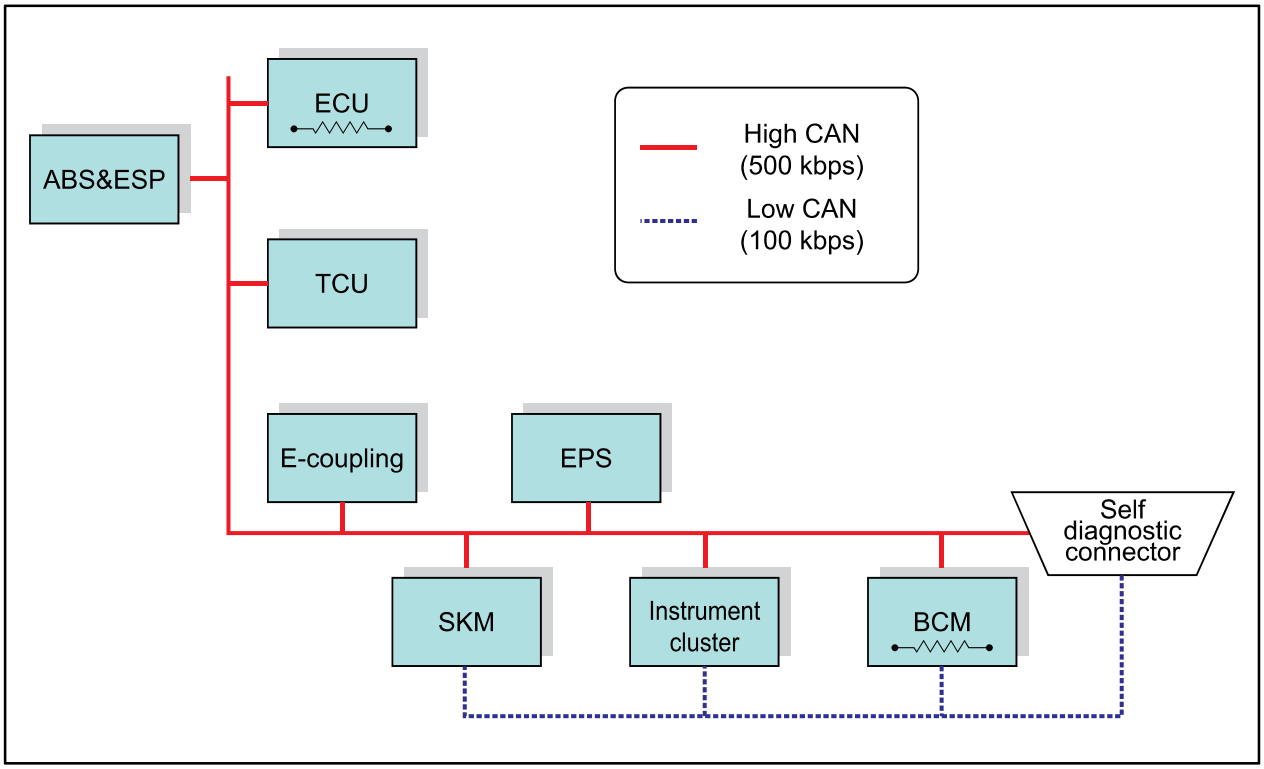
When turning the ignition switch to ON position, the power is supplied to BCM and ECU. ECU communicate with the immobilizer key to check if it is valid crypto code. If it is valid, ECU start to control the engine when turning the ignition switch to START position.
The system has 10 seconds of valid time-out period. If the engine does not start in this period, the key approval process should be done again.



Modification basis	
Application basis	
Affected VIN	

8) CAN Configuration (P-CAN/B-CAN)

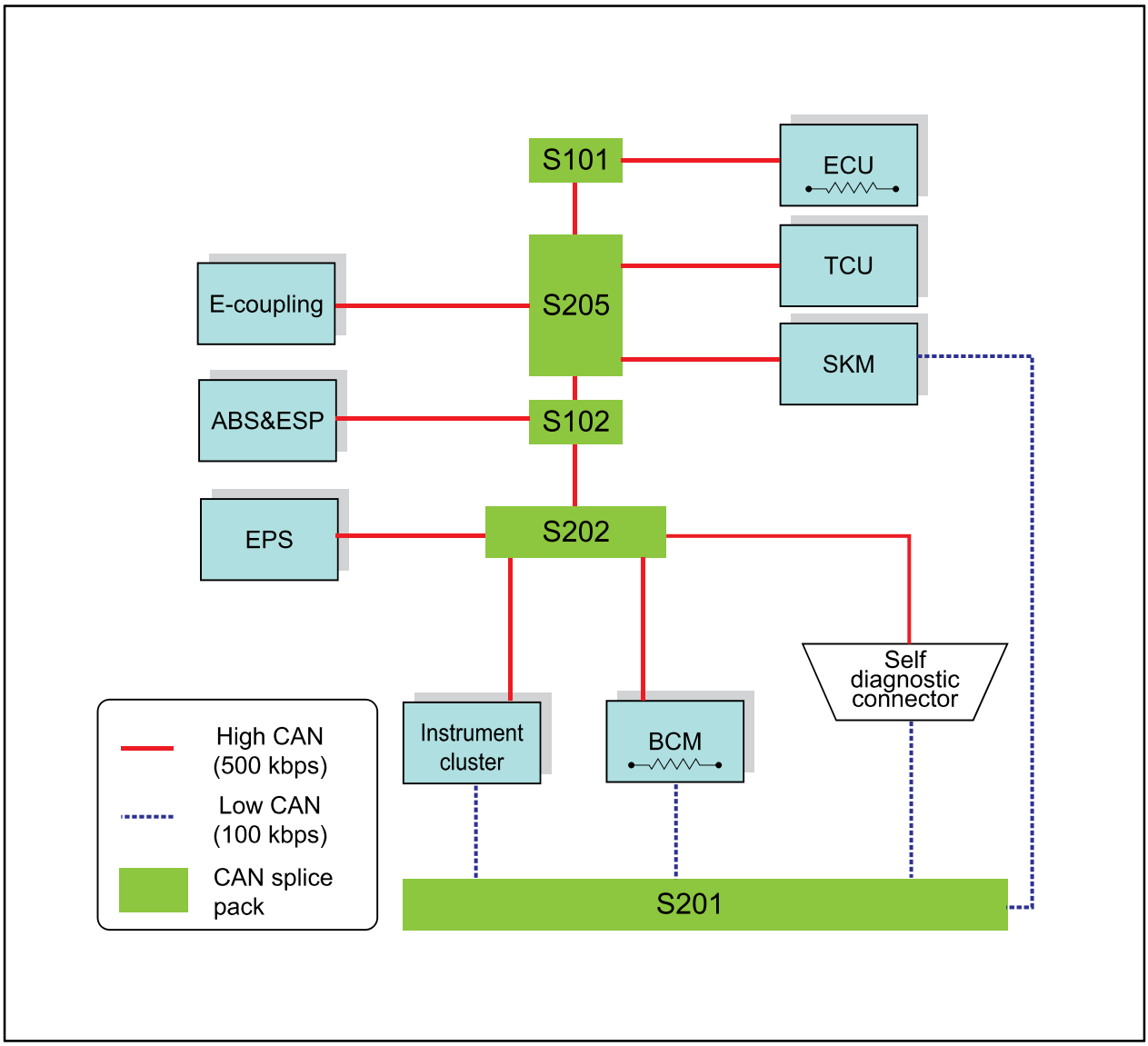
(1) CAN Configuration (P-CAN/B-CAN)



Name	Function
ECU	Electronic Control Unit
TCU	Transmission Control Unit
EPS	Electronic Power Steering Unit
BCM	Body Control Moudule
SKM	Smart Key Moudule

CAN system communicates with the system units in vehicle. It consists of P-CAN and B-CAN according to the communication speed.
P-CAN & B-CAN: SKM, Instrument cluster, BCM, Disgnostic connector
P-CAN: ECU, ABS & ESP, TCU, E-coupling, EPS unit
Terminal resistance: installed on ECU and BCM

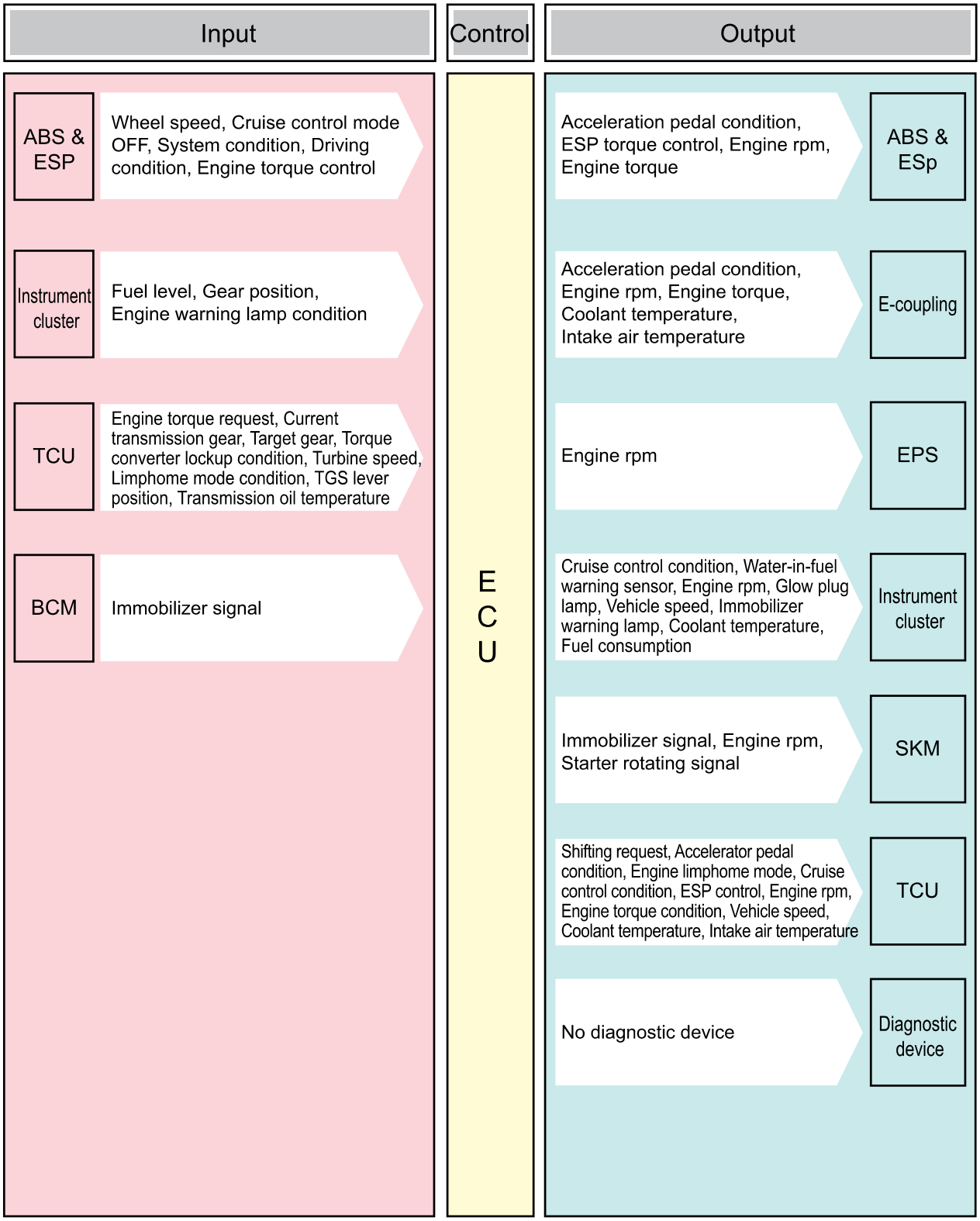
(2) Wiring Connection of CAN Communication



Splice pack	Wiring	Location
S101	Floor wiring (LH)	Under fuse & relay box in engine compartment
S102	Floor wiring (RH)	Inside of right fender
S201	Main wiring	Behind instrument cluster (cowl cross member)
S202	Main wiring	Behind instrument cluster (cowl cross member)
S205	Floor wiring (LH)	Under driver's door scuff

Modification basis	
Application basis	
Affected VIN	

(3) Input/Output for CAN communication



VEHICLE GENERAL

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GENERAL INFORMATION

1. SPECIFICATIONS

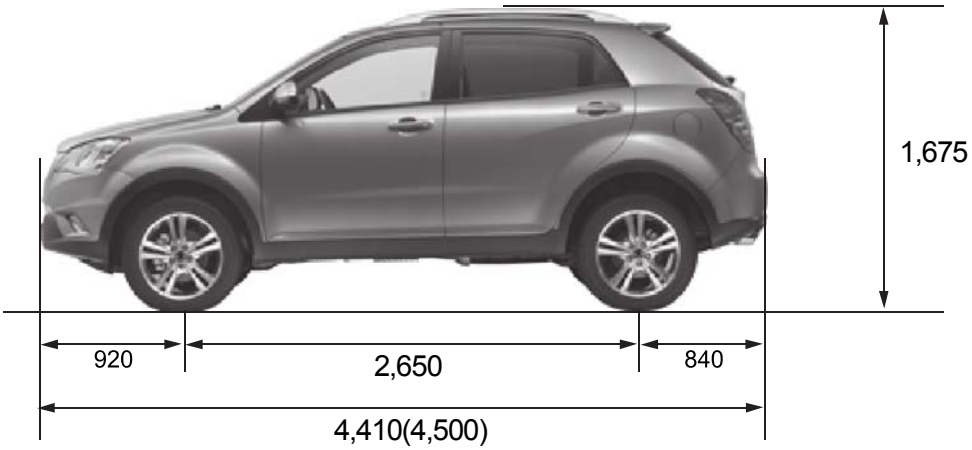
1) Dimensions

*Unit: mm, ( ): option

Top view



Side view



Front side



Rear view



Modification basis	
Application basis	
Affected VIN	

2) Identifications

1) The engine number (ex: 671 950 0 0 999999) is stamped on the lower area of cylinder block in exhaust manifold side.

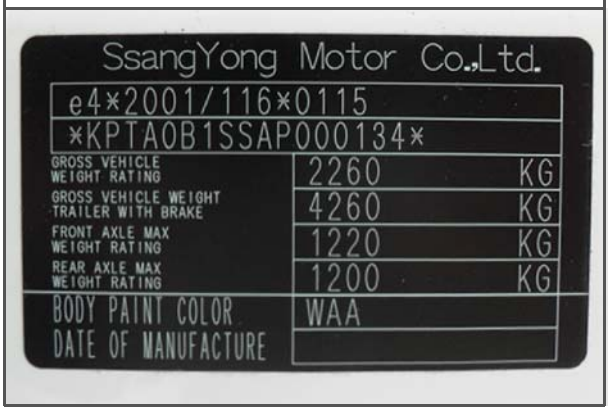


2) The chassis number (ex: KPTP0A19S10P012345) is stamped on the fire wall in engine compartment (front passenger side).





3) The certification label is affixed on the bottom of driver side B-pillar.



Modification basis	
Application basis	
Affected VIN	

▶ VIN NO.

5) VIN NO.

K P T A O B 1 S S C P XXXXXX

- Manufactured in: K (Korea)
- Manufactured by: P (Ssangyong Motor Company)
- Vehicle type: T (Passenger Car)
- Line model: A (Korando C LHD)
- Body type: O (5 door)
- Trim level: A: STD, B: DLX, C: SUPER DLX
- Others (Seat Belt): 1: 3 point, 2: 2 point
- Engine type (Displacement): S (1998 cc, D20DTF)
- Confirmation of identification: S (Mass production model)
- Year manufactured: C (2012)
- Manufactured at: P (Ssangyong Pyeongtaek Facility)
- Manufacture serial number: XXXXX

▶ Engine NO.

5) Engine no.

671 950 0 0 999 999

- Engine model: 1. 664 - D20DT 4-cylinder, 2. 665 - D27DT 5-cylinder, 3. 671 - D20DTF 4-cylinder, 4. 667 - D32DT 6-cylinder
- Engine version: 950 (C200)
- Steering type: 1) 0 - LHD, RHD (Common), 2) 1 - LHD, 3) 2 - RHD
- Transmission: 0 (Manual transmission), 1 (Auto transmission)
- Manufactured sequence no.: Varies according to engine model, version, steering type, transmission type.

2. SPECIFICATION

Description			Diesel 2.0 Engine (D20DTF(Low CO2))
General	Overall length (mm)		4,410 (4,500: with trailer hitch)
	Overall width (mm)		1,830
	Overall height (mm)		1,675
	Gross vehicle weight (kg)	M/T	4WD : 2,065(2,110) 2WD : 1,905(1,920)
	Curb vehicle weight (kg)	M/T	4WD : 1,740(1,785) 2WD : 1,580(1,595)
	Fuel		Diesel
	Fuel tank capacity (ℓ)		57
Engine	Engine		D20DTF
	Number of cylinders/ Compression ratio		4 / 16.5:1
	Total displacement (cc)		1,998
	Camshaft arrangement		DOHC
	Max. power	M/T	149 ps / 4,000 rpm
	Max. torque		360 Nm / 1,500~2,800 RPM
	Idle speed		750 ± 20 rpm
	Cooling system		Water-cooled / forced circulation
	Coolant capacity (ℓ)		8.5
	Lubrication type		Gear pump, forced circulation
	Max. oil capacity (ℓ)		6.0
	Turbocharger and cooling type		Turbocharger, water-cooled

Modification basis	
Application basis	
Affected VIN	

Description			Diesel 2.0 Engine (D20DTF(Low CO2))
Manual Transaxle	Operating type		Floor change type
	Gear ratio	1st	3.385
		2nd	1.708
		3rd	1.033
		4th	0.786
		5th	0.730
		6th	0.595
		Reverse	3.747
Transfer Case	Model		4WD
	Type		Electronic control type
Clutch	Operating type		Hydraulic type
	Disc type		Dry single diaphragm type
Power Steering	Type		Rack and pinion
	Steering angle	Inner	39.0°
		Outer	31.24°
Rear Axle	Drive shaft type	Independent suspension	Ball joint type (4WD)
	Axle housing type		Build-up type (4WD)
Brake	Master cylinder type		Tandem type
	Booster type		Vacuum assisted booster type
	Brake type	Front wheel	Disc
		Rear wheel	Disc
	Parking brake		Mechanical type
Suspension	Front suspension		MacPherson + Coil spring
	Rear suspension		Multi-link + Coil spring
Air Conditioner	Refrigerant (capacity)		R-134a(430 ± 30g)
Electrical	Battery type / Capacity (V-AH)		MF / 12 - 90
	Starter capacity (V-KW)		12 - 2.3
	Alternator capacity (V-A)		14V-140A (EPS), 14V-120A (NPS)

* ( ) option

3. RECOMMENDED FLUIDS AND LUBRICANTS

Descriptions		Capacity	Specifications
Engine Oil	Diesel 2.0	≒ 6.0ℓ	Quality class: Ssangyong genuine engine oil (Total Quartz INEO ECS 5W 30, SK ZIC SY 5W 30 or oil Approved by MB 229.51 SAE 5W30)
Engine Coolant	Diesel 2.0	≒ 8.5ℓ	Ssangyong genuine coolant Anti-Freeze: SYC-1025
Manual Transaxle Fluid	6-speed	≒ 1.6ℓ	Ssangyong genuine oil (HD MTF 75W/85 (SHELL) or HK MTF 75W/85(SK))
Transfer Case Fluid	4WD	≒ 0.58ℓ	Ssangyong genuine oil (IDEMITSU LW 80W/90)
Rear Axle Oil	4WD	≒ 0.7ℓ	Ssangyong genuine oil (SAE 80W/90, API GL-5)
Brake / Clutch Fluid		As required	Ssangyong genuine oil (DOT4)
Power Steering Fluid		≒ 1.0ℓ	Ssangyong genuine oil (ATF DEXRON II) * TOTAL FLUIDE DA (Extreme cold condition only)

CAUTION

- Use only Ssangyong genuine fluids. Use of non-recommended products could cause damage to the unit
- Keep the specified capacity and service interval.

Modification basis	
Application basis	
Affected VIN	

4. SCHEDULED MAINTENANCE SERVICES

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner's responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first							
x1000 km	20	40	60	80	100	120	140	160
x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
Months	12	24	36	48	60	72	84	96

ENGINE CONTROL SYSTEM

Drive belt	I	I	I	I	I	I	I	I
* Engine oil & filter *1 (1)* (3)* (4)*	R	R	R	R	R	R	R	R
	Shorten the service interval under severe conditions							
Cooling system hose & connections	I	I	I	I	I	I	I	I
Engine coolant (3)* (4)	Change every 200000 km or 5 years. And, inspect and replenish if necessary.							
Fuel filter (1)*		R		R		R		R
	Drain the water from fuel filter when the warning light comes on							
Fuel line & connections	I	I	I	I	I	I	I	I
Air cleaner (2)*	R	R	R	R	R	R	R	R
	Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

*1 Check the engine oil level and leak every 3000 km (2000 miles) or before starting a long trip.

R- Replace or change.

(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, driving in dusty condition or sandy condition, pollutant area or off-road driving, frequently inspect the air cleaner, if necessary, change the air cleaner.

(3)* More frequent maintenance is required if under dusty driving condition.

(4)* Refer to "Recommended fluids, coolant and lubricants".

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transaxle oil (5)*				I			I		
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Power transfer unit oil (6)*		I	I	I	I	I	I	I	I
		Severe driving condition: Change every 60000 km							
Rear axle oil		Inspect every 20000 km, change every 100000 km (Frequnt check of oil leak)							
Automatic transaxle fluid (6)*		I	I	I	I	I	I	I	I
		Change every 60000 km under severe condition							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R - Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 3 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)

(6)* If vehicle is operated under severe condition: Shorten the service interval.
- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

Modification basis	
Application basis	
Affected VIN	

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first							
x1000 km	20	40	60	80	100	120	140	160
x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
Months	12	24	36	48	60	72	84	96

CHASSIS AND BODY

Power steering fluid & lines (3)*	I	I	I	I	I	I	I	I
Drive shaft boots (8)*	I	I	I	I	I	I	I	I
Seat belts, buckles & anchors	I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch	Check frequently and adjust or replace if necessary							
Wheel bearing grease	I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*	I	I	I	I	I	I	I	I
Air conditioner filter (10)*	R	R	R	R	R	R	R	R
	Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(8)* After completion of off-road operation, the drive shaft boots should be inspected.

(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.

- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)*Severe Conditions in Air Conditioner Filter

- Pollutant area or off-road driving, extended air conditioner or heater operation

Memo

NO DATA

ENGINE

0000-00

GENERAL INFORMATION

1. SPECIFICATIONS

System	Unit	Description	Specification
Intake system	Air cleaner element	Filtering type	Dry, filter element
		Filtering area	0.208m²
		Service interval	EU: Change every 20,000 km (But, shorten the service interval under severe conditions) GEN: Clean every 7,500 km, change every 15,000 km (But, shorten the service interval under severe conditions)
	Air cleaner assembly	Weight	1.5kg
		Operating temperature	−30 ~ 100℃
		Capacity	8L
	Intercooler	Core material	Aluminum
		Size	510X122X67(WxHxT)
		Tank material	Plastic (Molding)
		Efficiency	80%
Exhaust system	Turbocharger assembly	Max. temperature of turbine housing	780 ℃
		Diameter of turbine housing	ø40.0
		Diameter of compressor housing	ø46.8
		Cooling type	Air cooled type

Memo

OVERVIEW AND OPERATING PROCESS

1. MAJOR COMPONENTS (D20DTF(Low CO2))

CDPF

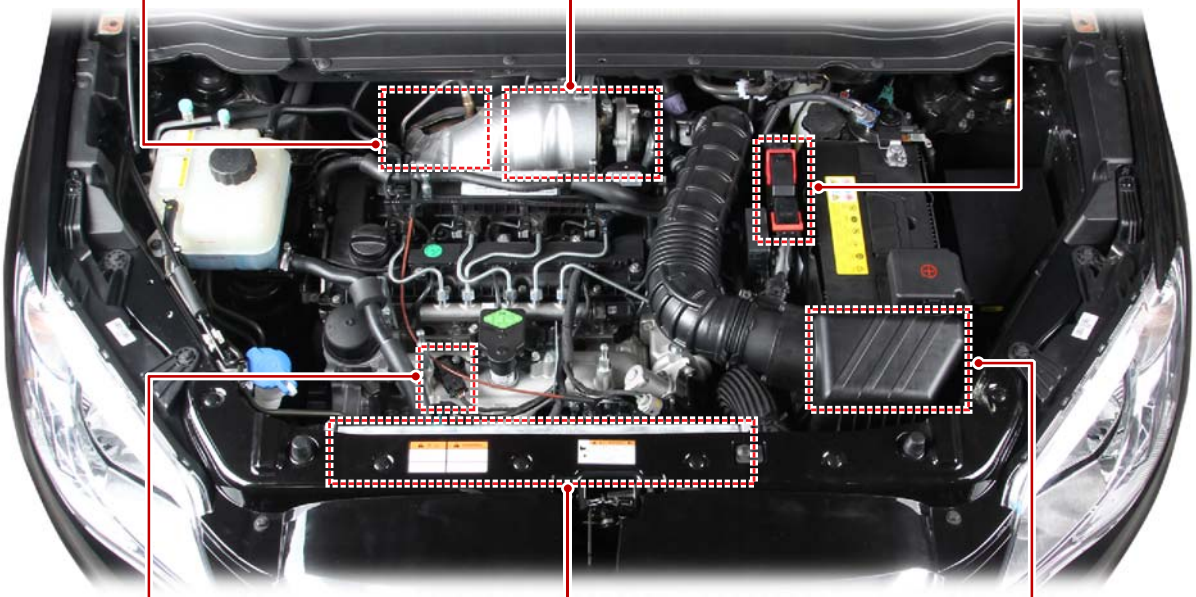


Turbocharger



ECU





T-MAP sensor



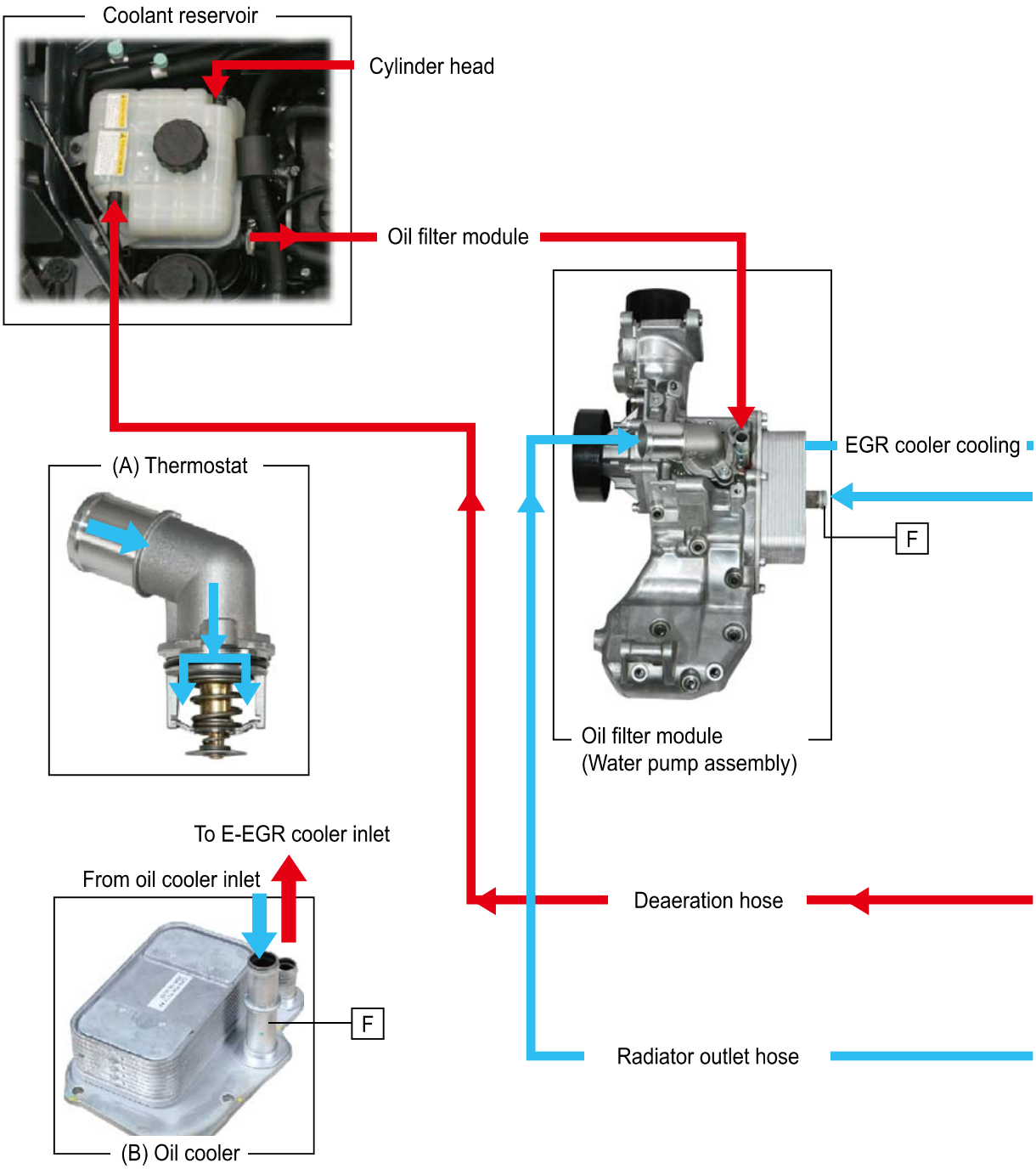
Intercooler assembly



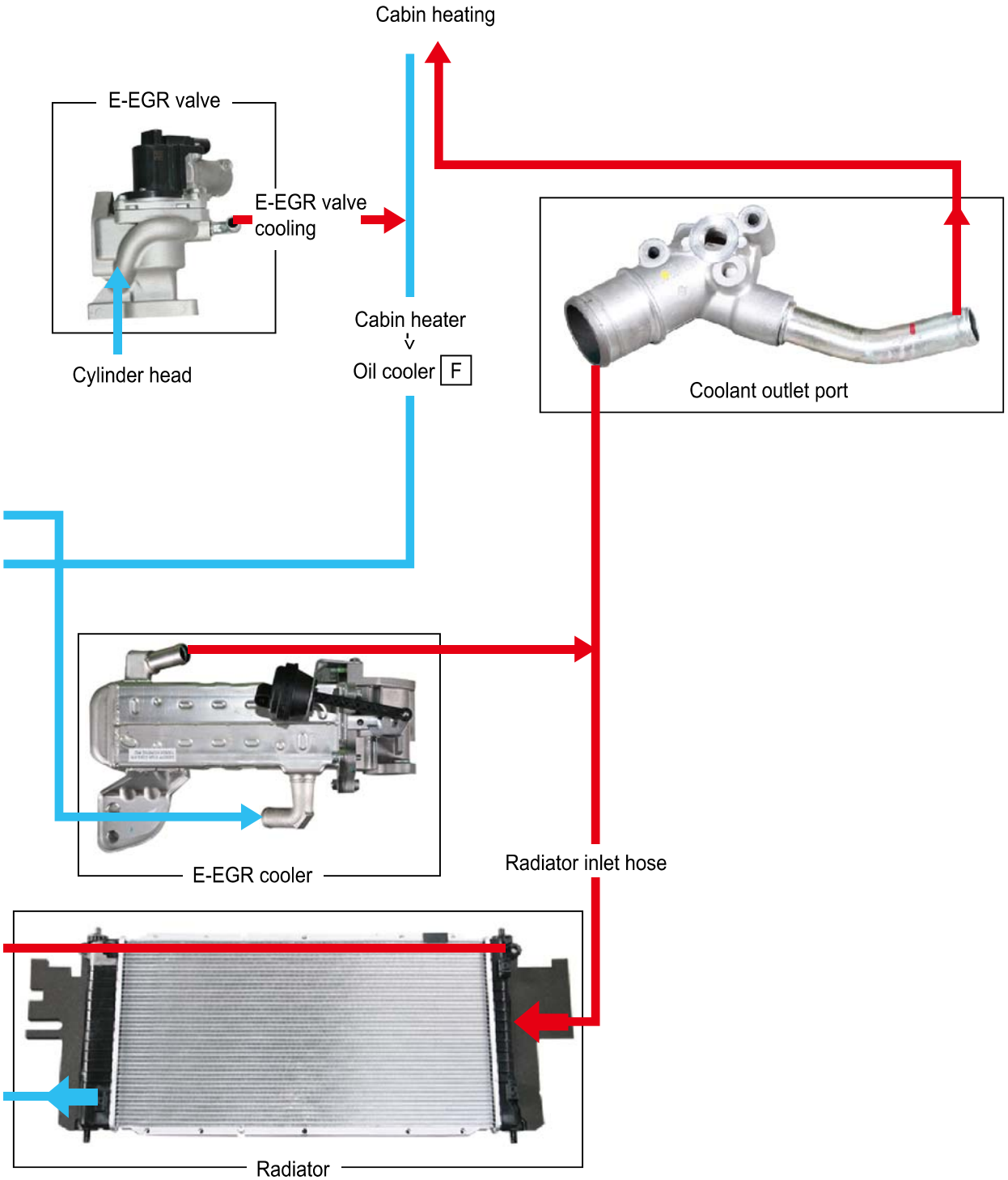
Air cleaner assembly



2. COOLANT FLOWS IN COOLING SYSTEM



Modification basis	
Application basis	
Affected VIN	


Cabin heating
E-EGR valve
E-EGR valve cooling
Cylinder head
Cabin heater
Oil cooler F
Coolant outlet port
E-EGR cooler
Radiator inlet hose
Radiator

3. LAYOUT OF INTAKE SYSTEM

1) Overview

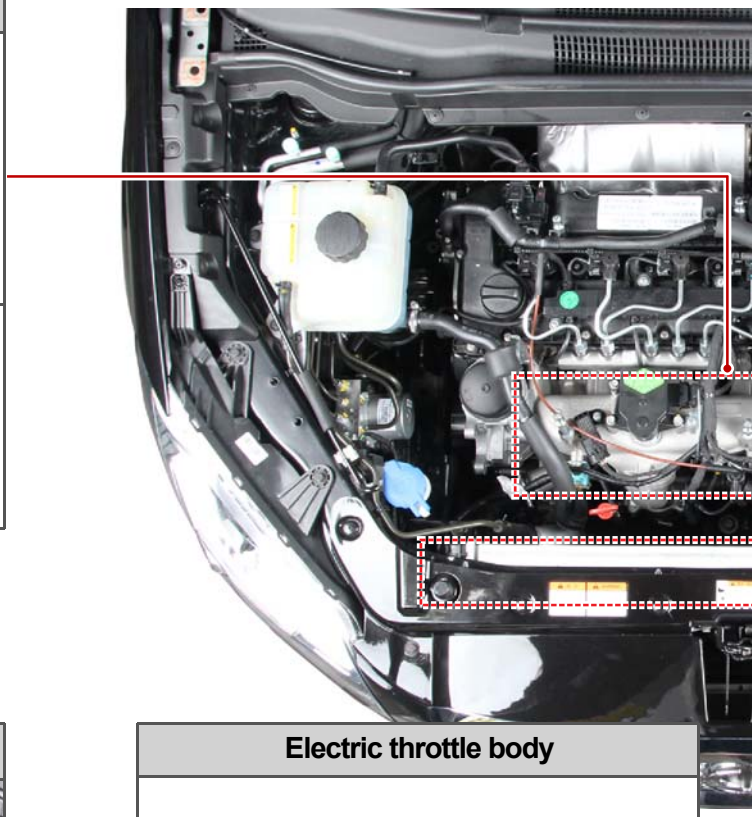
The intake system for D20DTF(Low CO2) engine is equipped with a throttle body which includes a flap. This flap is controlled by an electrical signal to cut off the intake air entering to the engine when the ignition switch is turned off. The intake manifold contains the swirl control valve and dual port system to make the optimum turbulence. The T-MAP sensor is located on the left top of the intake manifold and the HFM sensor for precise control is located at the rear side of air cleaner. To reduce the intake noise and to improve the intake efficiency, the volume of air cleaner has been increased.

2) Components

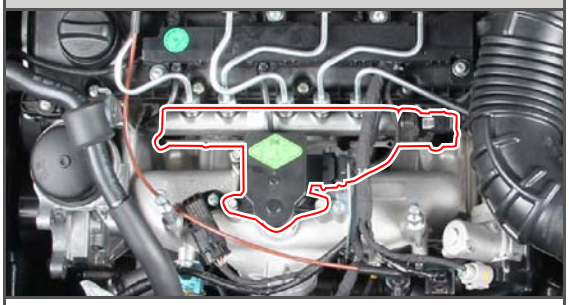
Intake manifold



It is the passage for intake air when the swirl vale is operating. The T-MAP sensor for measuring the pressure and temperature of pressurized air in turbocharger is installed on the left top of intake manifold.



Swirl control valve



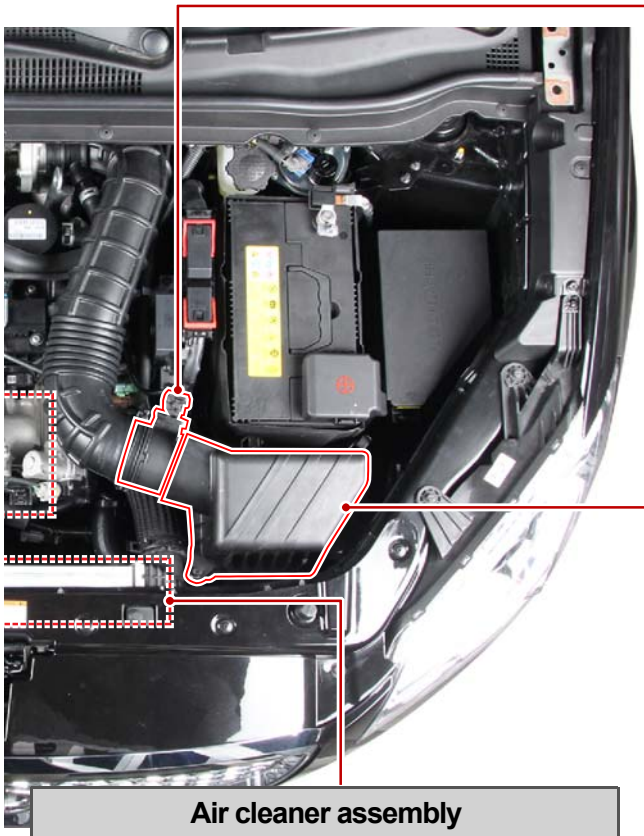
It operates variably in accordance with the engine load and rpm.
Refer to Chapter “Engine Control”.

Electric throttle body



Refer to Chapter “Engine Control”.

Modification basis	
Application basis	
Affected VIN	



HFM (Hot Film Air-Mass Sensor)



HFM sensor, version 6
Refer to Chapter "Engine Control".

Air cleaner assembly



Its volume is increased and air flowing efficiency is improved.

Intercooler assembly



Its volume is increased and cooling efficiency is improved.

EEM (Energy Efficiency Management) 0000-00

GENERAL INFORMATION

1. SPECIFICATIONS

Unit	Description	Specification
Alternator	Rated output	140A (25℃, 6500rpm) 76A/1800rpm, 140A/6500rpm, 25℃, 13.5V
Battery	Capacity	90Ah(20hr)
	Reserve capacity	180 minutes
	Starting current (when engine cooed)	710A
	Weight	23kg
EBS (Electronic Battery Sensor)	Resolving power	1mA
	Operating voltage	7~18V
	Operating temperature	−40~105℃
	Communication	LIN 2.0

2. COMPARISON

Item	Description	
	D20DTF	D20DTF (Low CO2)
Effective date	From March, 2012	
Applied engine	D20DTF	
Battery capacity	12V 90Ah	
Alternator capacity	Delphi 120A	Delphi 140A
Alternator	Changed the diameter of belt pulley (Front view)	
		
	Changed the regulator and control logic (Rear view)	
		
ECU	Without EEM logic	With EEM logic
EBS	None	Monitoring the battery conditions (voltage, current, temperature and SOC)

Modification basis	
Application basis	
Affected VIN	

3. BASIC INSPECTION

1) Battery Terminal



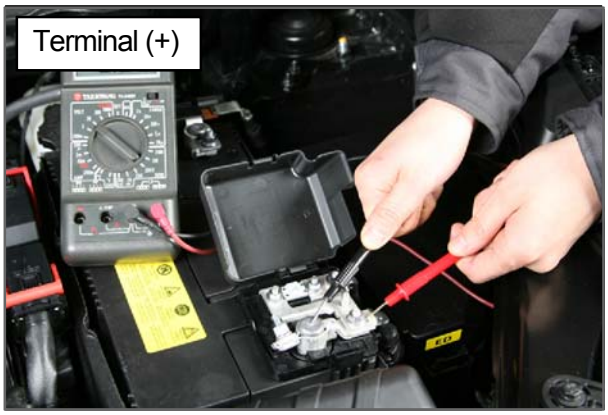
- Make sure the terminal connections are securely tightened. If the terminals are corroded, clean them or replace the battery.

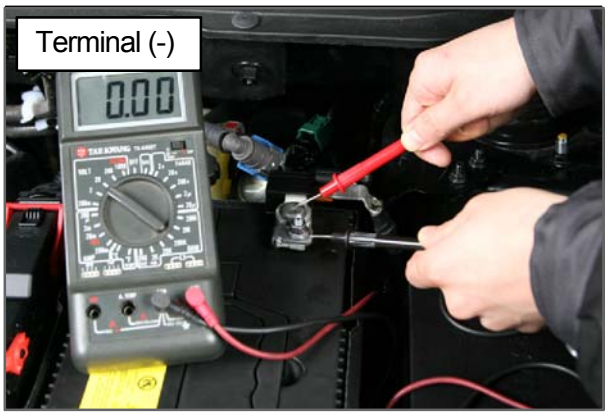
NOTE

* Cleaning
Remove the corrosion or dirt with a wire brush or sand paper, and then wash out with lukewarm soapy water.

2) Measuring the Voltage Drop

▶ **Measuring at battery terminal**





- Measure the voltage between battery terminal (+. -) and wiring clamp.

Specified value	below 0.3V

NOTE

If the terminals are corroded, clean and retightening them. If the specified tightening torque cannot be kept, replace the clamp.

Tightening torque **Terminal (+): 4 ~ 5 Nm**
Terminal (−): 6 ± 1Nm

▶ Measuring at (-) wiring



- Measure the voltage between battery wiring and body ground.

Specified value	below 0.3V

NOTE

If the voltage is out of the specified value, check the wiring mounting bolt for corrosion and looseness. If there is a poor contact due to corrosion or paint, wipe out the contact area and retighten it.

Tightening torque **Wiring mounting bolt to body ground (-): 17 Nm**

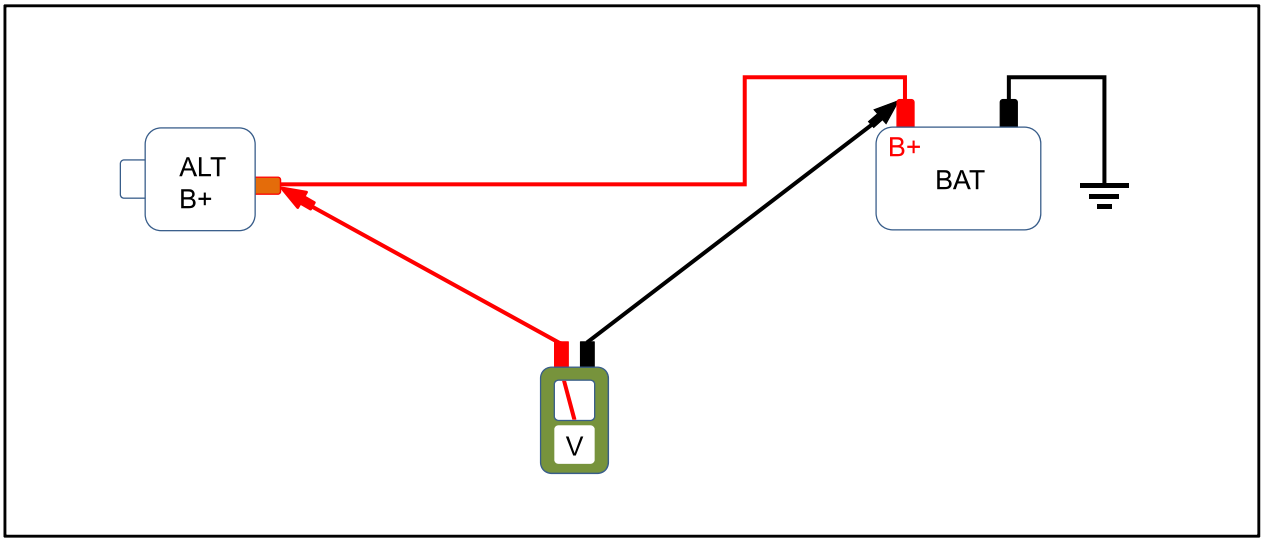
▶ Measuring the battery voltage



- Stop the engine and wait for 20 minutes. Measure the voltage between terminal (+) and terminal (-) with the ignition switch OFF and all electric devices OFF.

Specified value	over 12V

▶ Measuring the voltage drop between lines



- Measure the voltage drop between alternator B+ and battery B+.

Specified value	below 0.3V

NOTE

If the value is out of the specified value, check the terminal and clamp for looseness.

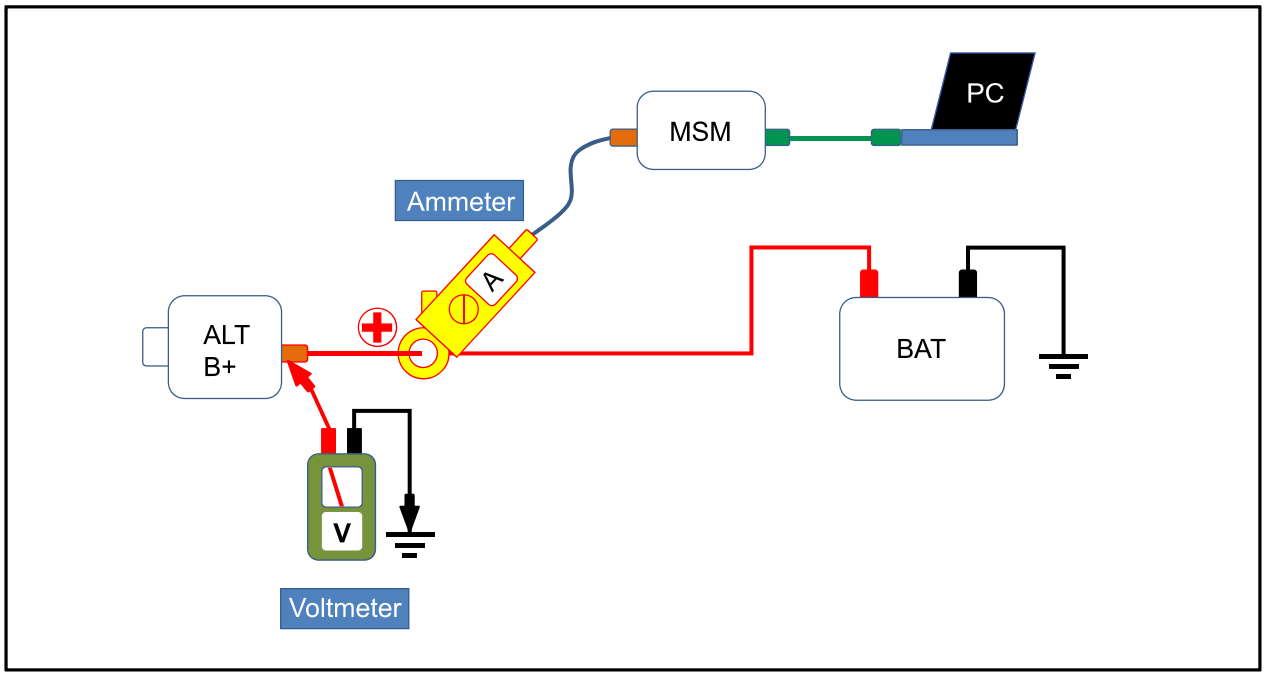
▶ Checking the charge warning lamp

1. Turn off all electric devices and put the ignition switch “ON” (Pre-warning).
2. Check if the charge warning lamp goes out.
   - If the charge warning lamp does not go off, inspect the electric circuit.
3. Start the engine and check if the charge warning lamp keeps off.

4. INSPECTION - CHARGING CURRENT

Preceding work - Perform the basic inspection.

▶ **Setting up the testers**



▶ **Preparation**



1. Set up the ammeter and voltmeter as shown in the figure.

CAUTION

Make sure to set up the tester while keeping its polarity.

Modification basis	
Application basis	
Affected VIN	

▶ Inspection

1. Start the engine and turns on the headlamp, blower and heated wire at their full load. Then, measure the maximum output current (MSM measurement value) when racing the engine to 2,700 rpm.

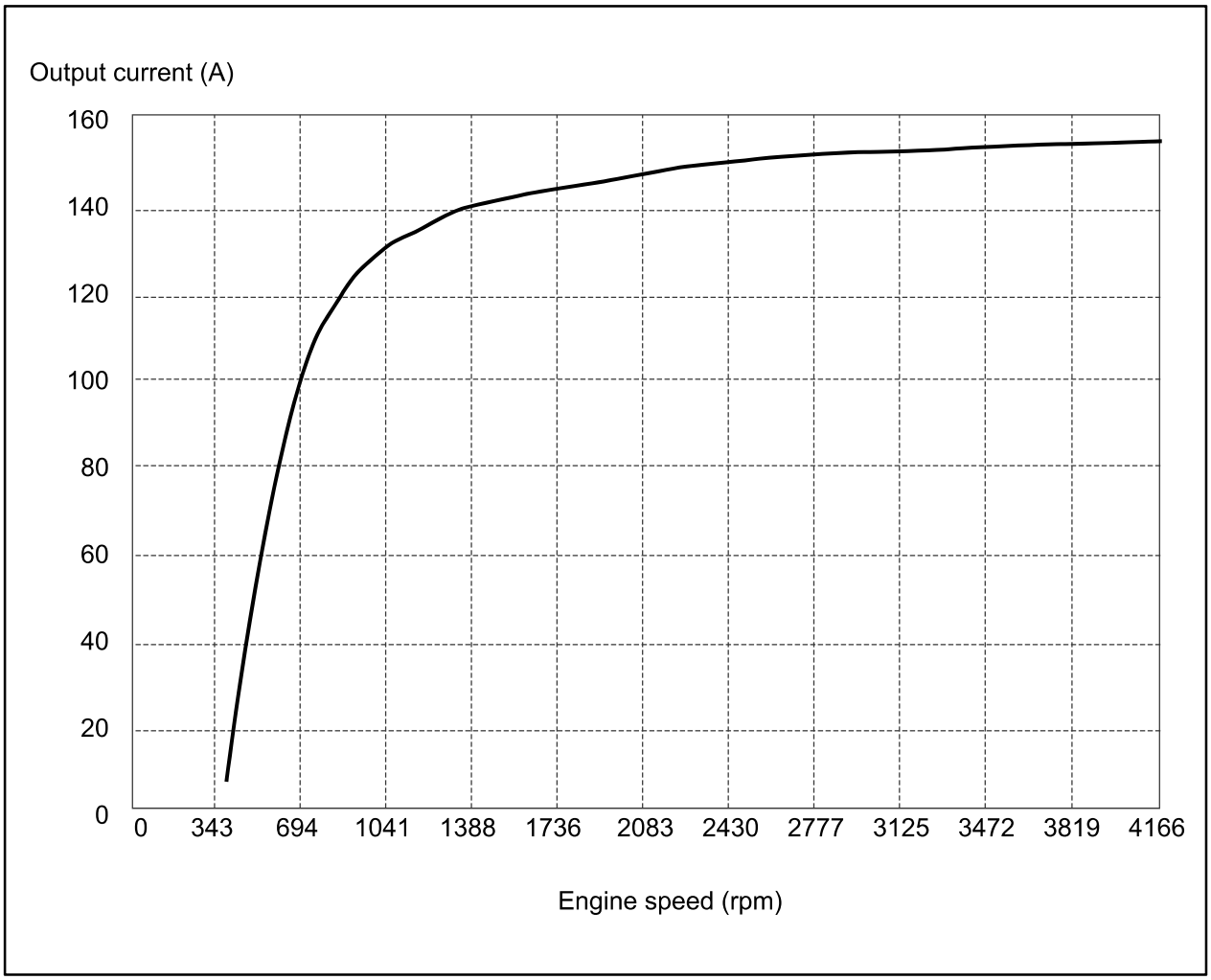
Specified value	60% of rated current (limit)

NOTE

The output current may not reach the limit value due to various parameters (high temperature or electric load etc.). Thus, do not perform the inspection with fully charged battery.

2. Turn the ignition OFF after inspection.
3. Disconnect the negative cable from the battery and remove the testers (ammeter and voltmeter).

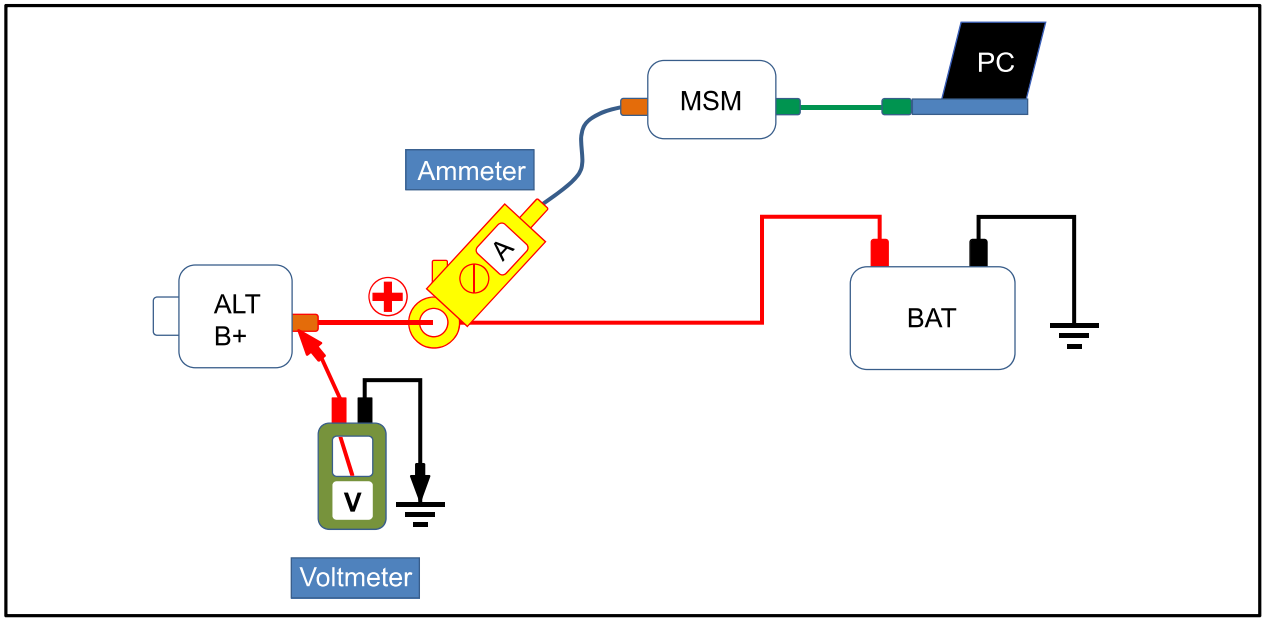
▶ Characteristic curve (output from alternator)



5. INSPECTION - REGULATING VOLTAGE

Preceding work - Perform the basic inspection.

▶ **Setting up the testers**



▶ **Preparation**



1. Set up the ammeter and voltmeter as shown in the figure.

CAUTION

Make sure to set up the tester while keeping its polarity.

▶ **Inspection**

1. Turn the ignition ON and measure the voltage on the voltmeter.

Specified value	over 12V

2. Start the engine and turn all electric devices OFF.
3. Increase the engine speed to 2,700 rpm and maintain the speed. Measure the voltage when the output current from alternator decrease below 30A.

Specified value	11.5 ~ 15.5V

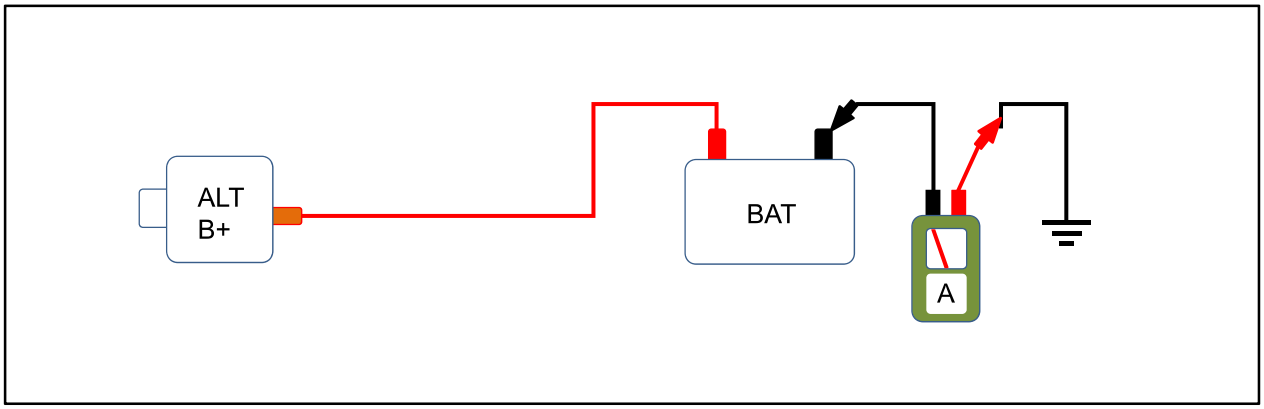
Modification basis	
Application basis	
Affected VIN	

6. INSPECTION - DARK CURRENT

Preceding work - Perform the basic inspection.

1) When Using Multi-tester

▶ Setting up the tester



▶ Preparation

1. Disconnect the negative cable from the battery.
2. Set up the ammeter as shown in the figure above.

CAUTION

Connect the "+" probe to ground wiring and "−"probe to "−"terminal of battery.

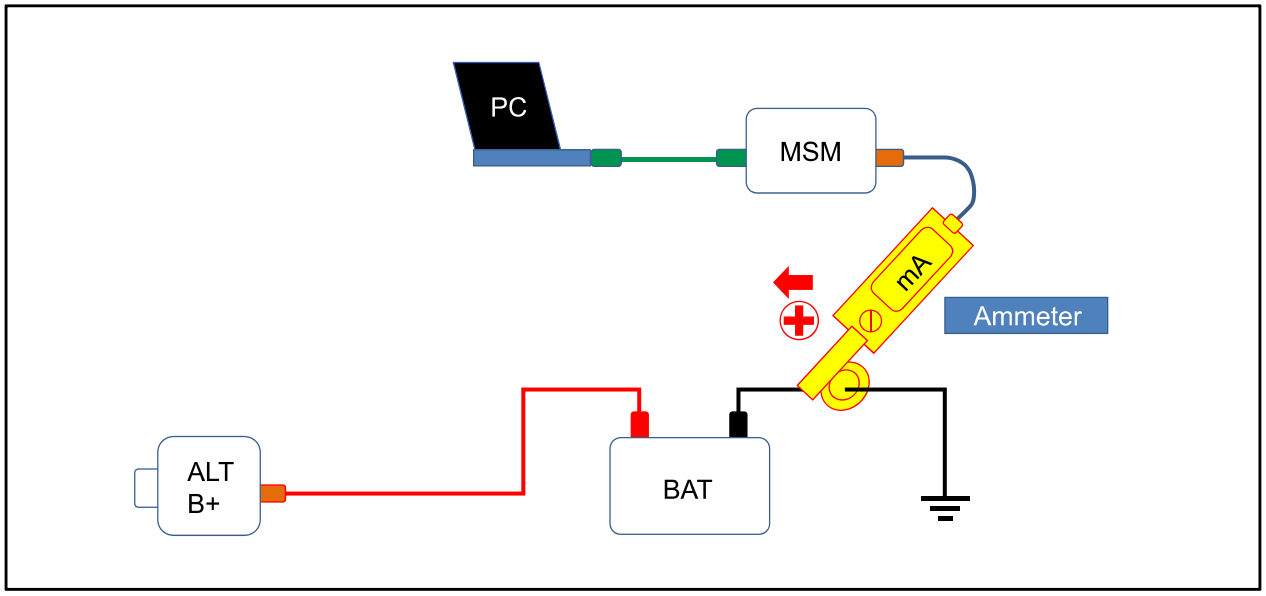
▶ Inspection

1. Measure the current while removing the fuses one by one. If the current drops sharply when a certain fuse is removed, inspect the affected circuit.

Specified value	below 0.05A

2) When Using MSM

▶ Setting up the tester



▶ Preparation



1. Disconnect the negative cable from the battery.
2. Set up the ammeter and MSM as shown in the figure above.

CAUTION

Make sure to set up the tester while keeping its polarity.

3. Connect the negative cable to the battery.

Specified value	below 0.05A

NOTE

Measure the current while removing the fuses one by one. If the current drops sharply when a certain fuse is removed, inspect the affected circuit.

Modification basis	
Application basis	
Affected VIN	

7. INSPECTION - BATTERY

Preceding work - Perform the basic inspection (all electric devices OFF).



Battery tester



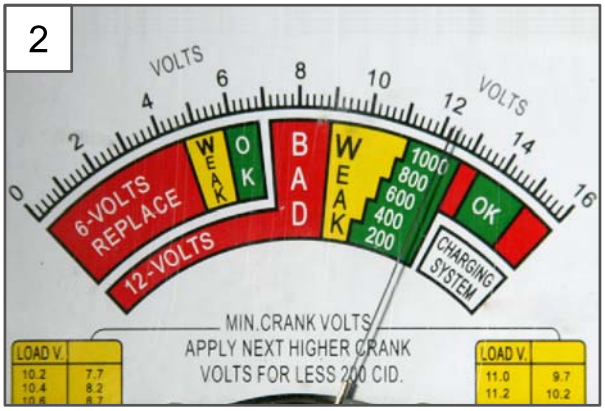
1) Voltage Check (without load)

1



1. Connect one measuring clamp to "+" terminal of battery first, then connect the other one to "−"terminal. (Disconnect the clamps in the reverse order).

2

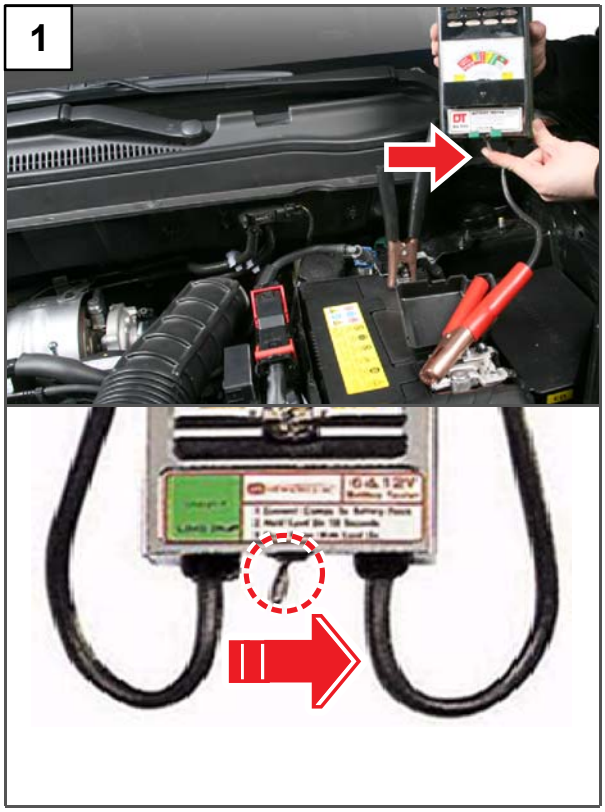


2. Read the measurement.

Specified value	over 11V: Normal 9 ~ 11V: Charging required below: 9V: Over discharged, battery replacement required

2) Voltage Check (with load)

1

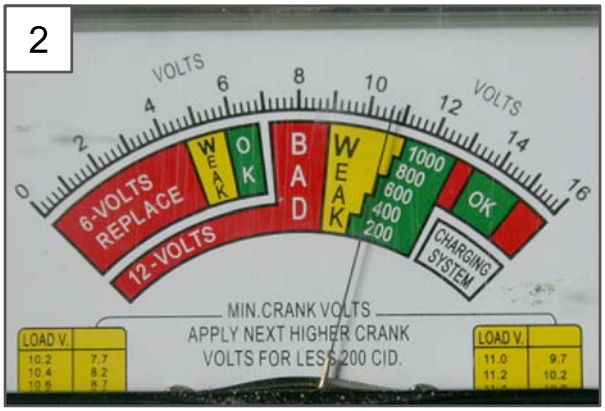


1. Push the load switch to ON (to arrow direction) direction for less than 5 seconds.

NOTE

To identify the battery capacity with the voltage drop (V) value, discharge the fixed load capacity (120A) for a certain period (5 seconds).

2



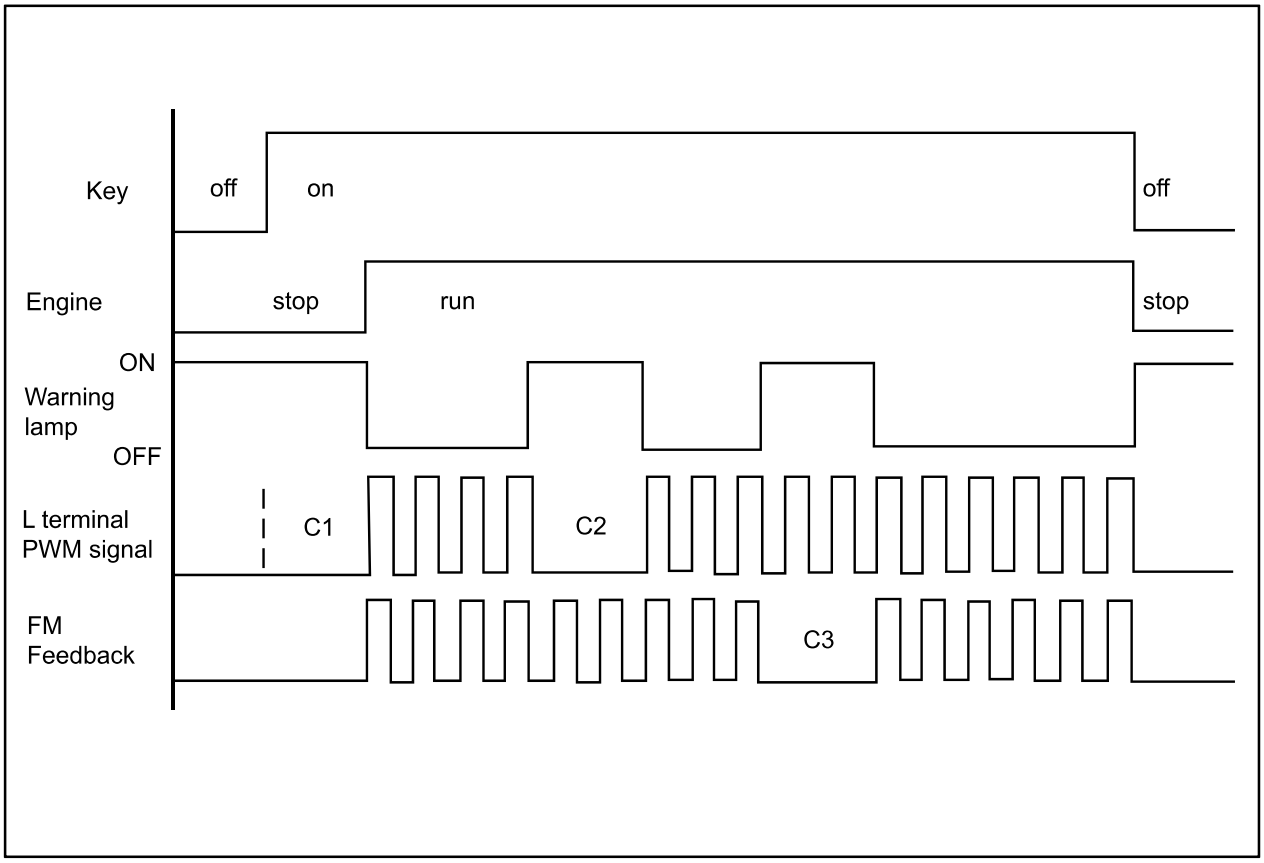
2. Read the measurement.

Specified value	7 ~ 9V (Red): Over discharged or faulty 9 ~ 11V (Yellow): Charging required 11 ~ 13V: Normal

Modification basis	
Application basis	
Affected VIN	

8. DTC SETTING CONDITIONS

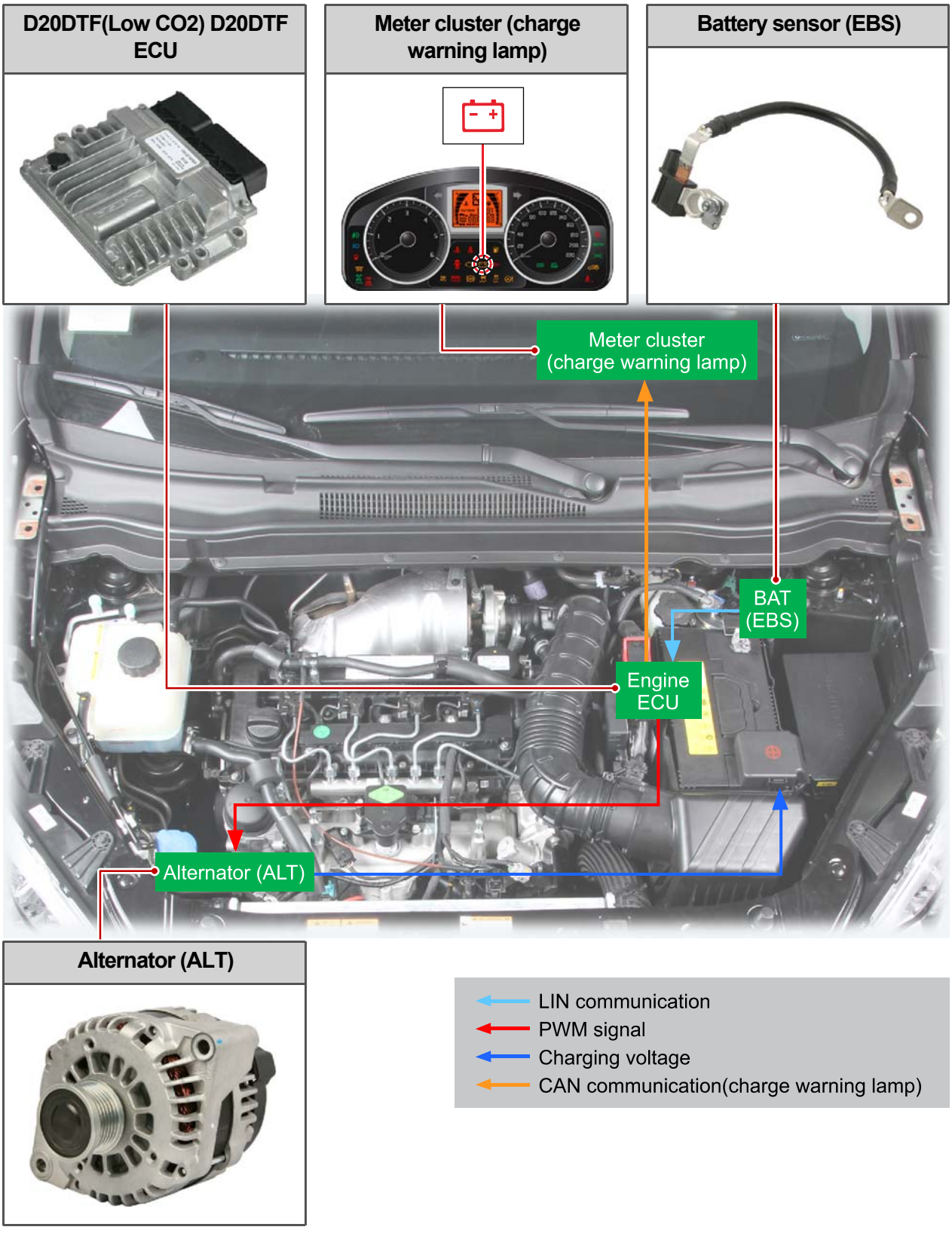
▶ **Charge warning lamp ON condition**



1. Turn the ignition ON (Engine stopped)
2. Open or short circuit of L terminal wiring, open or short internal circuit of alternator (fixed control of 13.8V)
3. Open or short circuit of F terminal wiring, no feedback output signal

OVERVIEW AND OPERATING PROCESS

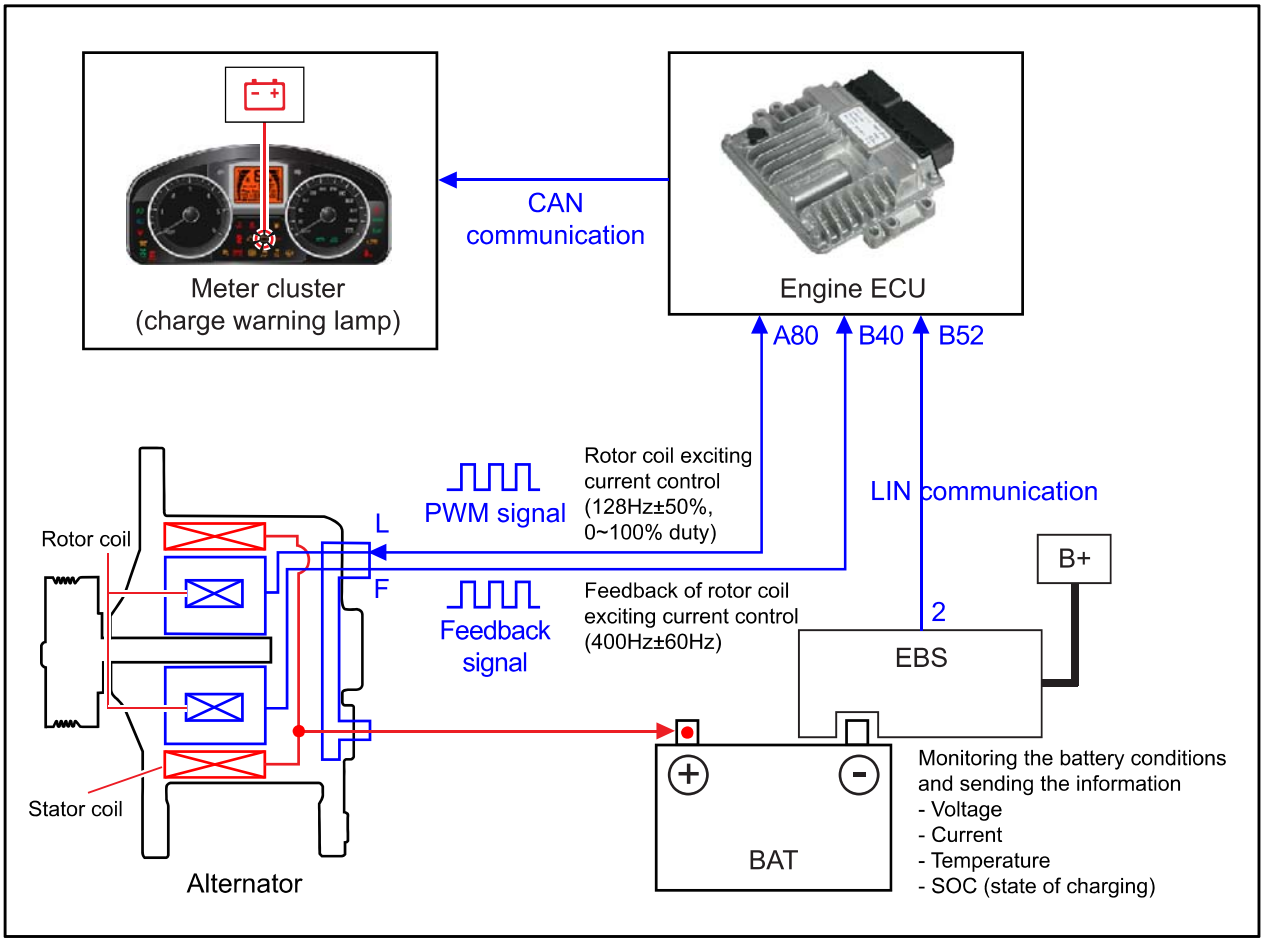
1. LAYOUT



Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

▶ System diagram



▶ Operation

- EEM monitors the electric loads and battery conditions and controls the voltage to improve the fuel economy and battery charging efficiency.
- EBS on "−" terminal of battery sends the battery information (voltage, current, temperature and SOC) to engine ECU with LIN communication.
- Engine ECU outputs the information from EBS and regulating control signal (PWM) according to the engine load conditions to "L" terminal on alternator.
- Engine ECU controls the magnetic resistance between stator coil and rotor coil by controlling the current in rotor coil according to PWM duty value.
- The alternating voltage induced to stator coil is converted to direct voltage by rectifier. And, EBS outputs the charging voltage to "B" terminal on alternator.

▶ Basic control logic according to the driving conditions

Engine ECU determines the engine loads according to the fuel injection volume and engine speed. It charges the battery by increasing the generating voltage during deceleration. To improve the fuel economy by reducing the alternator load during acceleration, engine ECU decreases the generating voltage and consumes the battery voltage.

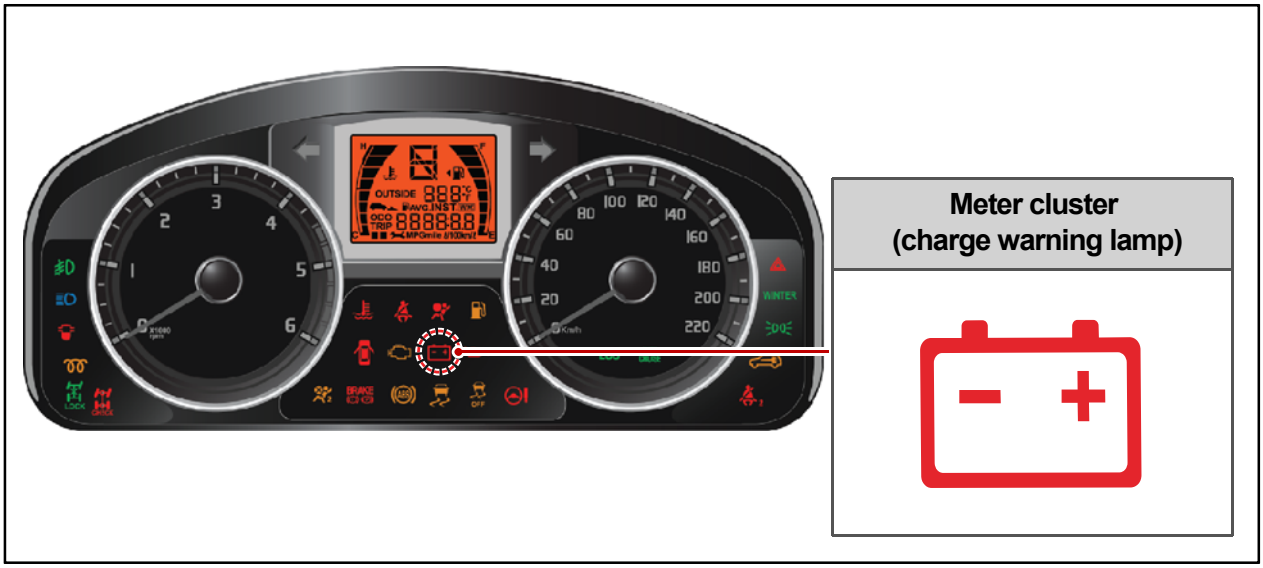
▶ Operation of charge warning lamp

ECU checks the generating voltage from alternator and circuit conditions and sends the warning lamp ON signal to meter cluster through CAN line.

Modification basis	
Application basis	
Affected VIN	

3. CAN COMMUNICATION (Charge Warning Lamp)

▶ Overview

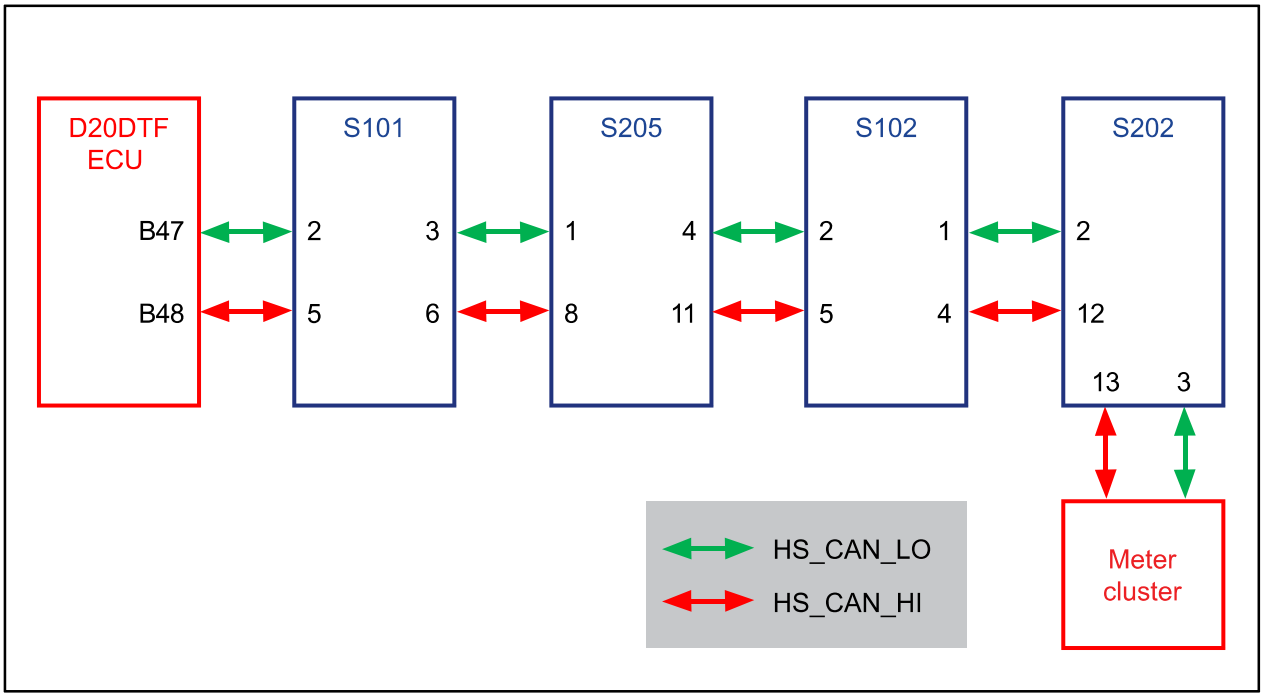


The meter cluster receives the charge warning lamp ON signal from ECU through CAN line.

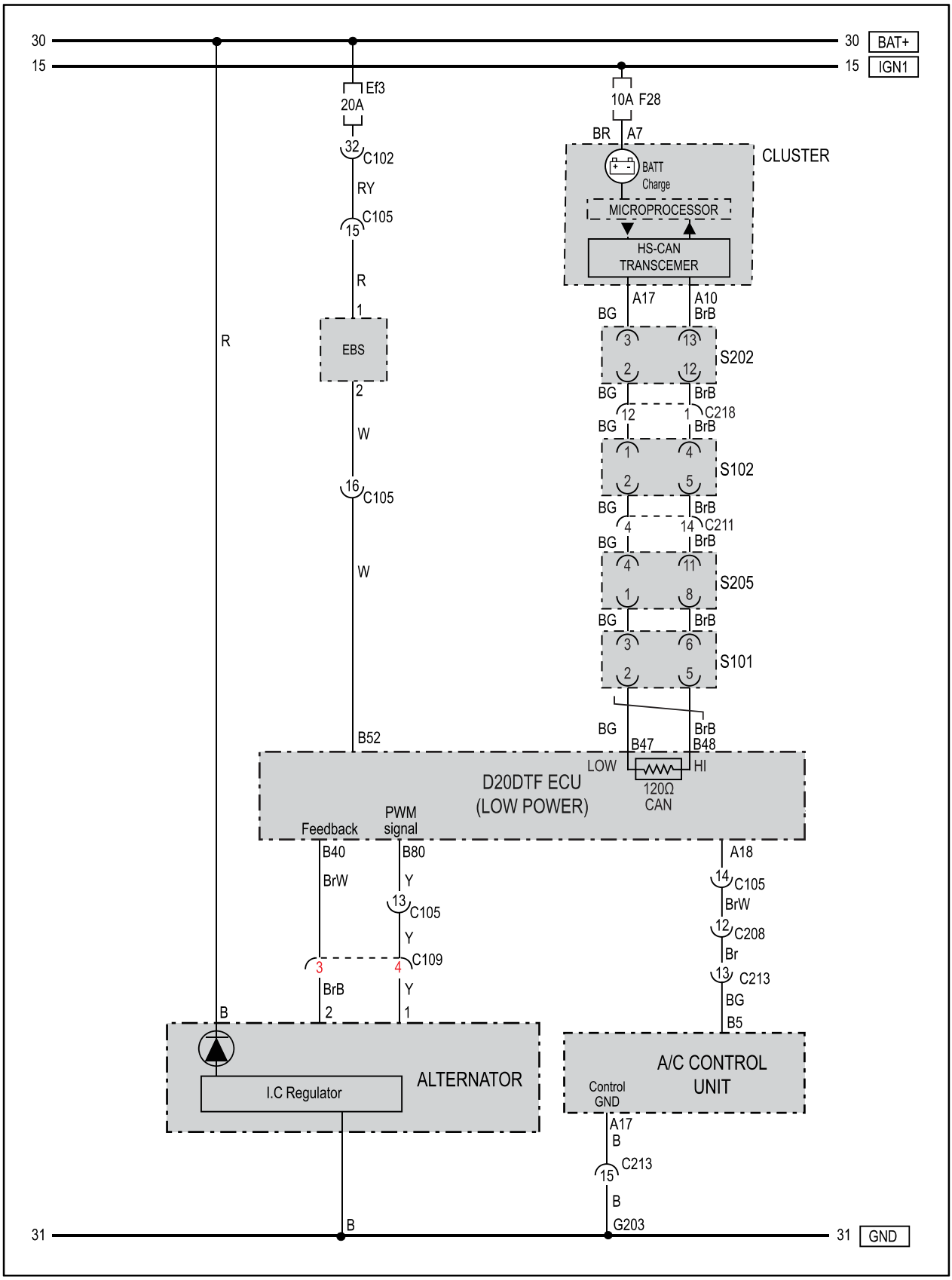
Charge warning lamp ON conditions

- Pre-warning
- When DTC related EEM set
- Open or short circuit in alternator

▶ Circuit diagram



4. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

0000-00

GENERAL INFORMATION

1. EXTERIOR LAMP SYSTEM LAYOUT

Front view



- Side repeater lamp
- Puddle lamp
- Front turn signal lamp
- Position lamp
- Headlamp assembly
- Front fog lamp

Rear view



- High-mounted stop lamp
- Tail/stop lamp
- Rear turn signal lamp
- Backup lamp
- Rear fog light
- Reflector
- License plate lamp

Modification basis	
Application basis	
Affected VIN	

1 Headlamp





2 Front fog lamp



3 Puddle (approach) lamp

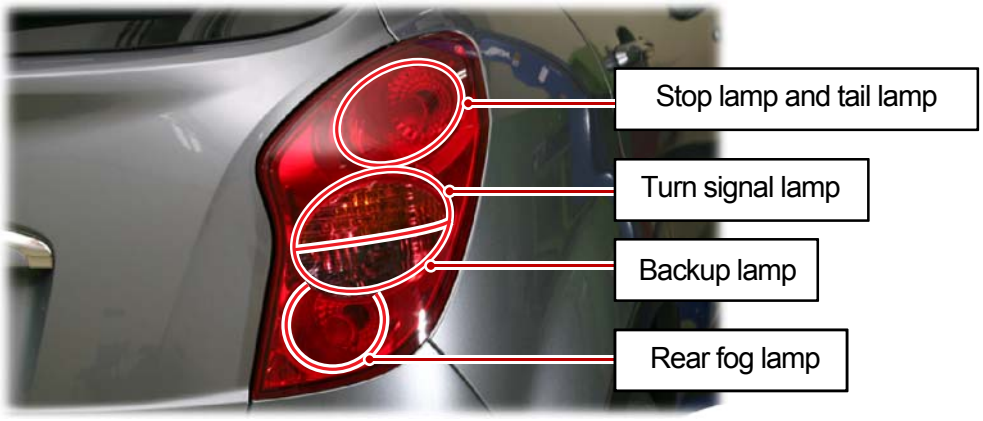


4 Side repeater lamp



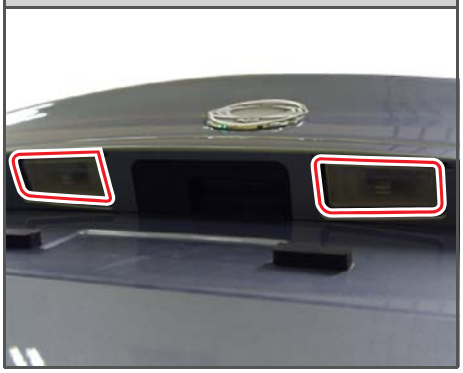
Modification basis	
Application basis	
Affected VIN	

5 Rear combination lamp





6 License plate lamp

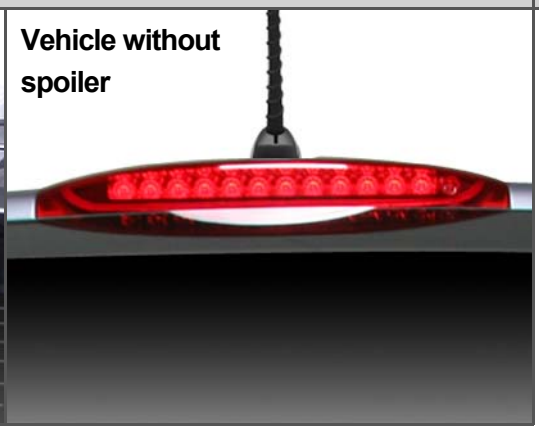


7 High mounted stop lamp

Vehicle with spoiler



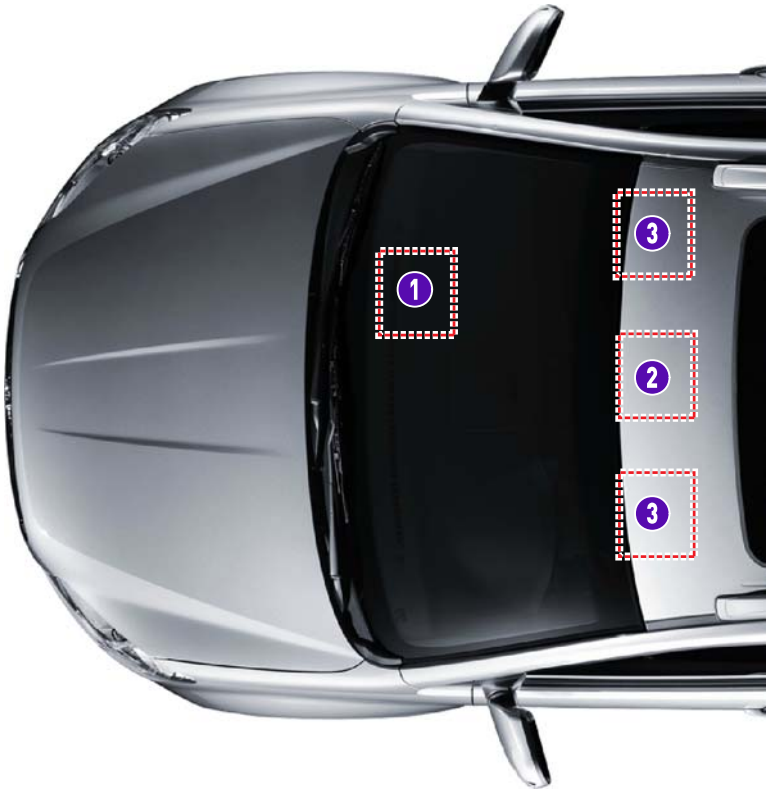
Vehicle without spoiler



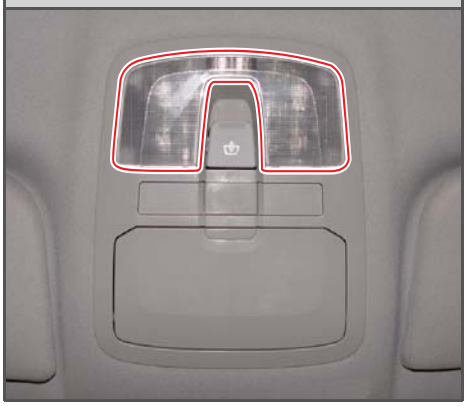
2. INTERIOR LAMP SYSTEM LAYOUT

1 Glove box lamp





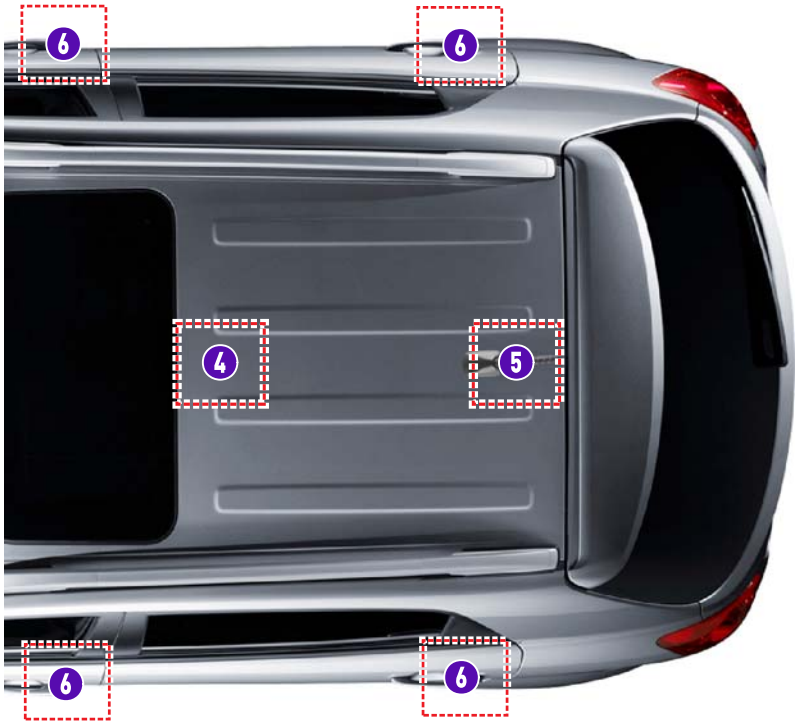
2 Front room lamp



3 Sun visor lamp



Modification basis	
Application basis	
Affected VIN	



4 Center room lamp



5 Luggage lamp



6 Door courtesy lamp



3. SWITCH SYSTEM LAYOUT

Steering wheel remote control switch

1



Start/stop switch

2



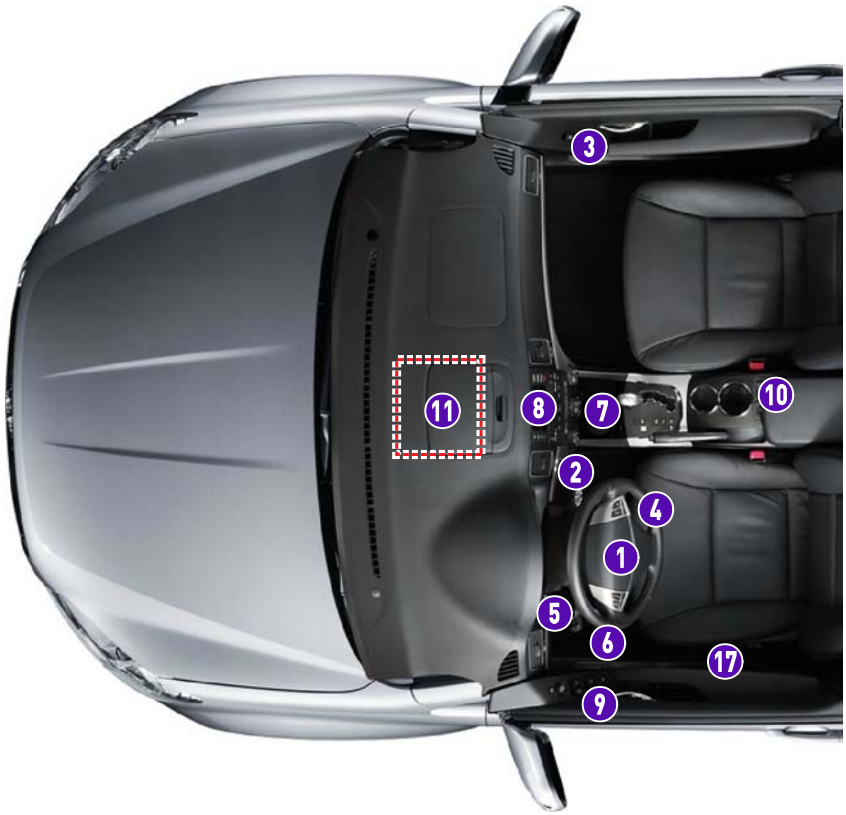
Passenger door switch



Cruise control switch

4





Multifunction switch

5



Lower main panel switch

6



FATC switch

7



Hazard warning switch bezel assembly

8



Drive door main switch & Outside rearview mirror switch

9



Modification basis	
Application basis	
Affected VIN	

Front seat heated wire switch (DLX)



Front seat heated wire switch (STD)



Overhead console switch





Center room lamp switch



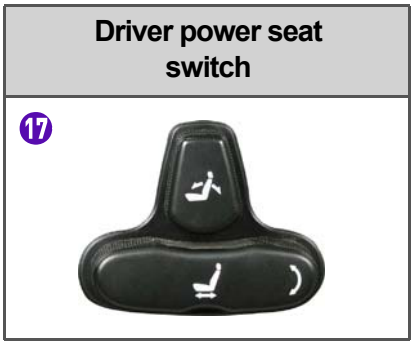
Luggage lamp switch



Tailgate switch



Driver power seat switch



Rear door switch (RH)



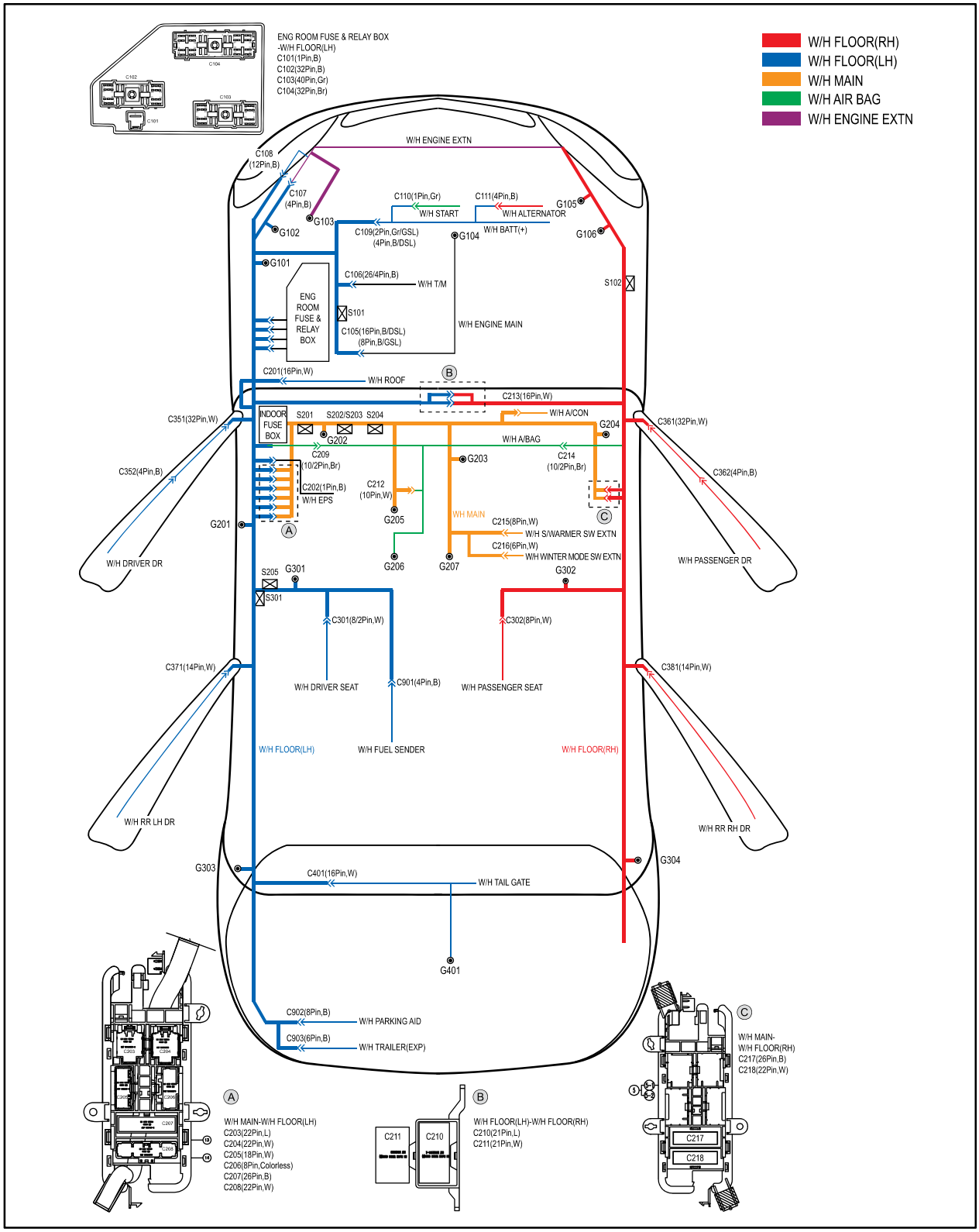
Rear door switch (LH)



Modification basis	
Application basis	
Affected VIN	

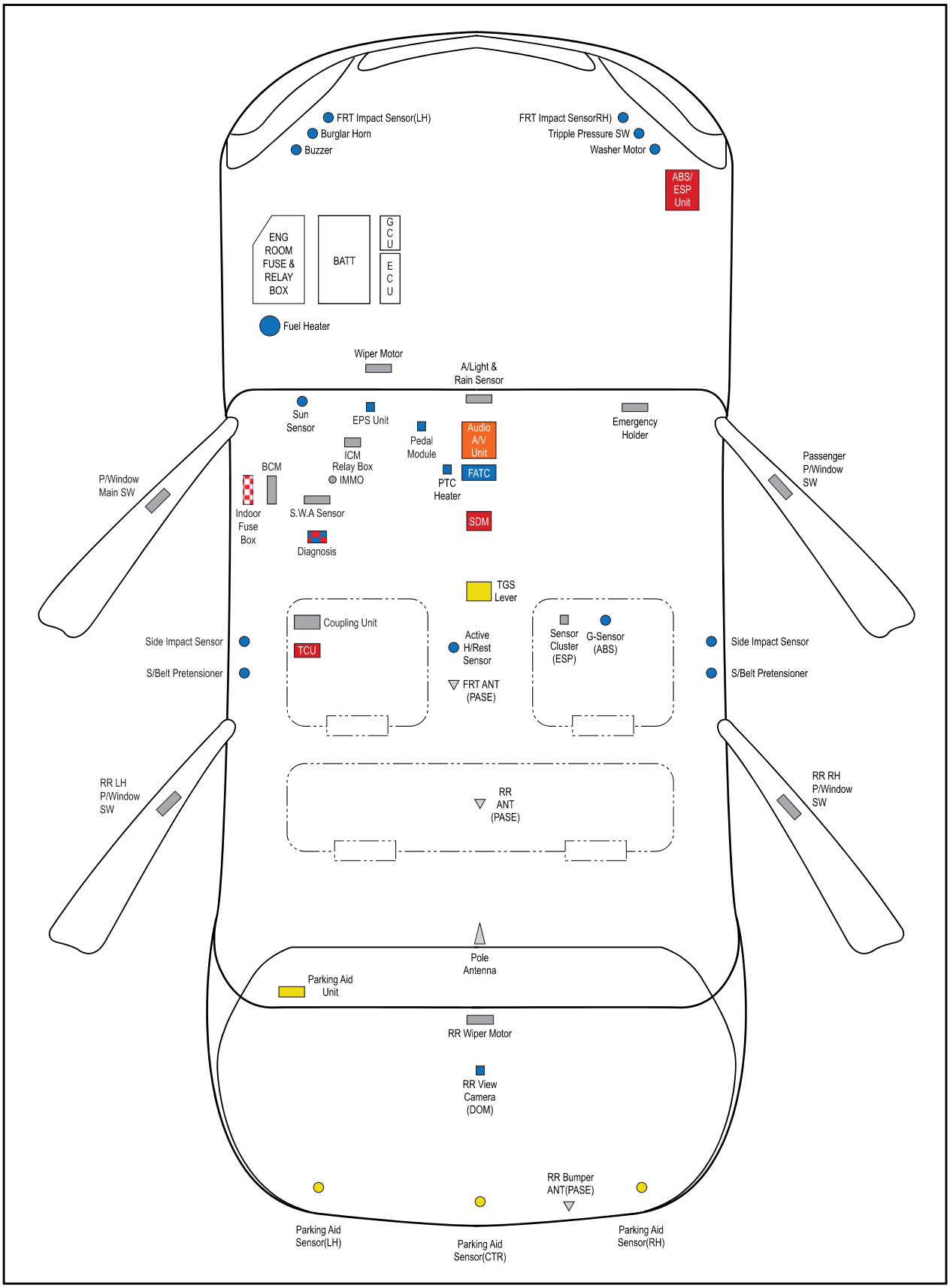
4. SCHEMATIC DIAGRAM FOR WIRING AND ELECTRICAL DEVICES

1) Wiring Harness Arrangement



Modification basis	
Application basis	
Affected VIN	

2) Electrical Devices Mounting Locations



Modification basis	
Application basis	
Affected VIN	

3) Connector, Ground And Splice Pack

▶ Connector

Connector Number (Pin Number/Color)			Connecting Wiring Harness	Connector Position	Remark
C101	1	Black	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C102	32	Black	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C103	40	Gray	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C104	32	Brown	W/H Floor(LH) - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C105	8	Black	W/H Floor(LH) - W/H Eng	Upper BATT Tray(Beside Fuel Heater)	GSL
	16	Black	W/H Floor(LH) - W/H Eng	Upper BATT Tray(Beside Fuel Heater)	DSL
C106	26	Black	W/H Floor(LH) - W/H T/M	Upper T/M(Under BATT Tray)	A/T
	4	Black	W/H Floor(LH) - W/H T/M	Upper T/M(Under BATT Tray)	M/T
C107	4	Black	W/H Floor(LH) - W/H Eng EXTN	Inside FRT Bumper(Behind LH Fog Lamp)	
C108	12	Black	W/H Floor(LH) - W/H Eng EXTN	Inside FRT Bumper(Behind LH Fog Lamp)	
C109	2	Gray	W/H Floor(LH) - W/H BATT(+)	Lower Air Cleaner Duct	GSL
	4	Black	W/H Floor(LH) - W/H BATT(+)	Lower Air Cleaner Duct	DSL
C110	1	Gray	W/H BATT(+) - Start Solenoid	Beside Starter Motor	
C111	4	Black	W/H BATT(+) - Alternator	Beside Alternator	
	2	Black	W/H BATT(+) - Alternator	Beside Alternator	LOW CO_2
C201	16	White	W/H Floor(LH) - W/H Roof	Upper Driver Cowl Side Connector Holder	
C202	1	Black	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	EPS
C203	22	Blue	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C204	22	White	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C205	18	White	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C206	8	Colorless	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C207	26	Black	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C208	22	White	W/H Main - W/H Floor(LH)	Driver Cowl Side Connector Holder	
C209	10	Brown	W/H Air Bag - W/H Air Bag EXTN	Driver Cowl Side Connector Holder	Curtain/Side A/Bag
	2	Brown	W/H Air Bag - W/H Air Bag EXTN	Driver Cowl Side Connector Holder	
C210	21	Blue	W/H Floor(LH) - W/H Floor(RH)	Upper CTR Dash PNL	
C211	21	White	W/H Floor(LH) - W/H Floor(RH)	Upper CTR Dash PNL	
C212	10	White	W/H Main - W/H Air Bag	Inside I.P (Upper Driver LegRoom)	
C213	16	White	W/H Main - W/H Air Con	Inside I.P (Upper CTR Cowl Cross Member)	
C214	10	Brown	W/H Air Bag - W/H Air Bag EXTN	Passenger Cowl Side Connector Holder	Curtain/Side A/Bag
	2	Brown	W/H Air Bag - W/H Air Bag EXTN	Passenger Cowl Side Connector Holder	
C215	8	White	W/H Main - W/H Seat Warmer switch EXTN	Inside Console	A/T, M/T DLX
C216	6	White	W/H Main - W/H Winter Mode switch EXTN	Inside Console	A/T, DSL
C217	26	Black	W/H Main - W/H Floor(RH)	Passenger Cowl Side Connector Holder	
C218	22	White	W/H Main - W/H Floor(RH)	Passenger Cowl Side Connector Holder	
C301	8	White	W/H Floor(LH) - W/H Driver Seat	Under Driver Seat	S/Warmer, Active
	2	White	W/H Floor(LH) - W/H Driver Seat	Under Driver Seat	
C302	8	White	W/H Floor(RH) - W/H Passenger Seat	Under Passenger Seat	
C351	32	White	W/H Floor(LH) - W/H Driver DR	Under LH A Pillar	
C352	4	Black	W/H Driver DR - W/H Smart Key	Inside Driver DR	Smart Key
C361	32	White	W/H Floor(RH) - W/H Passenger DR	Under RH A Pillar	
C362	4	Black	W/H Passenger DR - W/H Smart Key	Inside Passenger DR	Smart Key
C371	14	White	W/H Floor(LH) - W/H RR LH DR	Under LH B Pillar	
C381	14	White	W/H Floor(RH) - W/H RR RH DR	Under RH B Pillar	

Modification basis	
Application basis	
Affected VIN	

Connector Number (Pin Number/Color)			Connecting Wiring Harness	Connector Position	Remark
C401	**16**	White	W/H Floor(LH) - W/H Tail Gate	Upper Tail Gate LH	
C901	**4**	Black	W/H Floor(LH) - W/H Fuel Sender	FRT Fuel Tank	
C902	**8**	Black	W/H Floor(LH) - W/H RR Bumper	Under RR LH Bumper	PAS
C903	**6**	Black	W/H Floor(LH) - W/H Trailer	Under RR LH Bumper	

▶ Ground

Connector Number	Connecting Wiring Harness	Connector Position	Remark
G101	W/H Floor(LH)	Behind LH Head Lamp	
G102	W/H Floor(LH)	Under BATT Tray	ECU
G103	W/H Eng EXTN	Under BATT Tray	
G104	W/H Eng Main	FRT Intake Valve	
G105	W/H Floor(RH)	Behind RH Head Lamp	
G106	W/H Floor(RH)	Beside ABS/ESP Unit	ABS/ESP
G201	W/H Floor(LH)	Under Driver Cowl Side Connector Holder	
G202	W/H Main	Backside Cluster(LH Cowl Cross Member)	AUDIO
G203	W/H Main	Backside Audio(CTR Cowl Cross Member)	
G204	W/H Main	Inside I.P(RH Glove Box)	
G205	W/H Main	Left Side I.P(Beside CTR Support BRKT)	PTC
G206	W/H Main	Left Under TGS Lever	AIR BAG
G207	W/H Main	Right Under TGS Lever	EPS
G301	W/H Floor(LH)	Under Driver Seat	
G302	W/H Floor(RH)	Under Passenger Seat	
G303	W/H Floor(LH)	Driver QTR PNL	
G304	W/H Floor(RH)	Passenger QTR PNL	
G401	W/H Tail Gate	CTR Under Tail Gate	

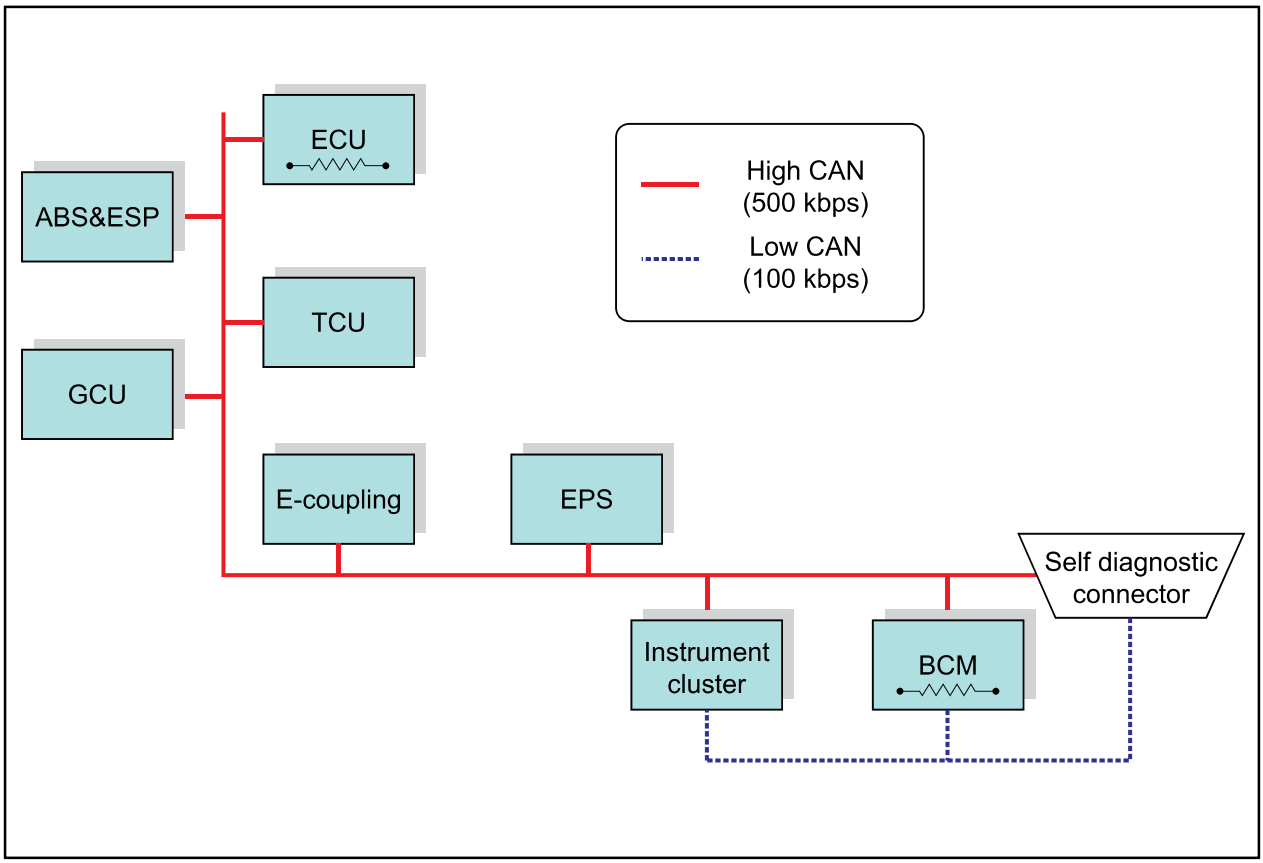
▶ Splice pack

Connector Number (Pin Number/Color)		Connecting Wiring Harness	Connector Position	Remark
S101	**6**	W/H Floor(LH)	Under Eng Room Fuse & Relay Box	HS-CAN
S102	**6**	W/H Floor(RH)	Inside RH Fender	HS-CAN
S201	**8**	W/H Main	Backside Cluster(LH Cowl Cross Member)	LS-CAN
S202	**20**	W/H Main	Backside Cluster(LH Cowl Cross Member)	HS-CAN
S203	**20**	W/H Main	Backside Cluster(LH Cowl Cross Member)	ILL +
S204	**20**	W/H Main	Backside Cluster(Upper ICM Relay Box)	GND
S205	**14**	W/H Floor(LH)	Under Driver Seat	HS-CAN
S301	**14**	W/H Floor(LH)	Under Driver Seat	

5. CAN COMMUNICATION CONFIGURATION

The CAN topology is linked with CAN communication system, which consists of P-CAN and B-CAN. The instrument cluster and BCM (Body Control Module) communicate through both P-CAN and B-CAN at the same time, and the SKM (SMART Key Module) communicates with the instrument cluster and BCM through B-CAN.

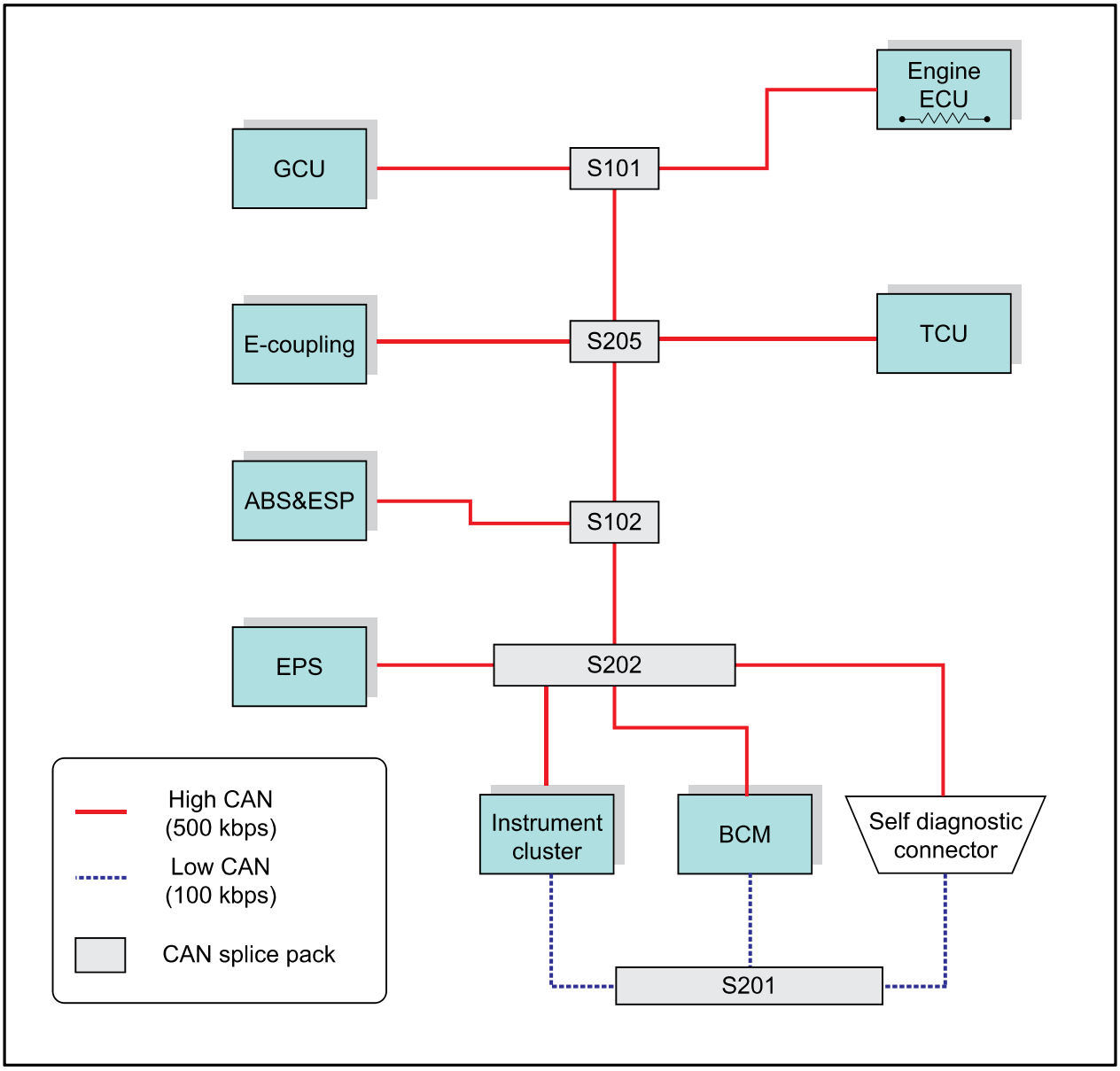
1) CAN Configurations (P-CAN/B-CAN)



Abbreviations	Meaning	Function
GCU	Glow Control Unit	Glow control unit
EPS	Electronic Power Steering Unit	Electrically driven power steering unit
BCM	Body Control Module	Body control module
SKM	Smart Key Module	Smart key module

Modification basis	
Application basis	
Affected VIN	

2) CAN Communication Wiring Diagram



Splice pack	Wiring	Location
S101	Floor wiring (LH)	Under fuse and relay box in engine compartment
S102	Floor wiring (RH)	Inside of right fender
S201	Main wiring	Behind the instrument cluster (cowl cross member)
S202	Main wiring	Behind the instrument cluster (cowl cross member)
S205	Floor wiring (LH)	Bottom of driver seat (front right)

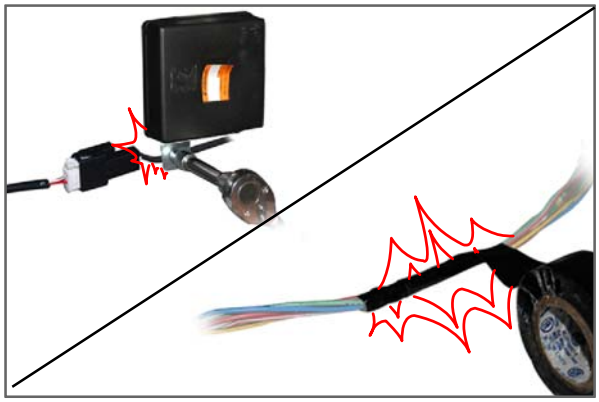
Memo

Fuse and relay

8410-00

GENERAL INFORMATION

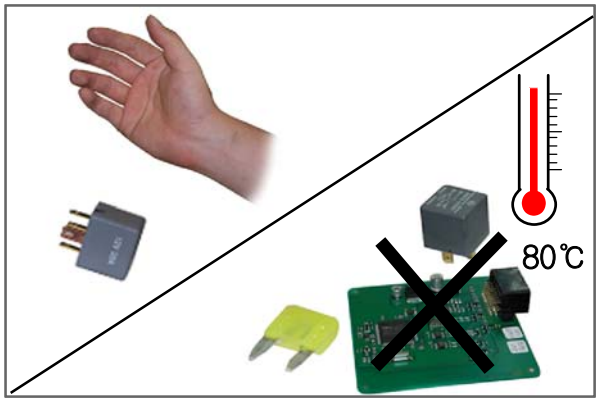
1. CAUTIONS WHEN WORKING ON ELECTRICAL UNITS



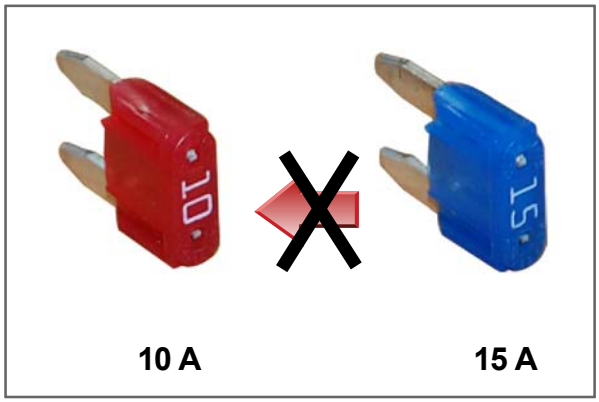
- Disconnect the negative cable from the battery in advance when working on electrical units.

CAUTION

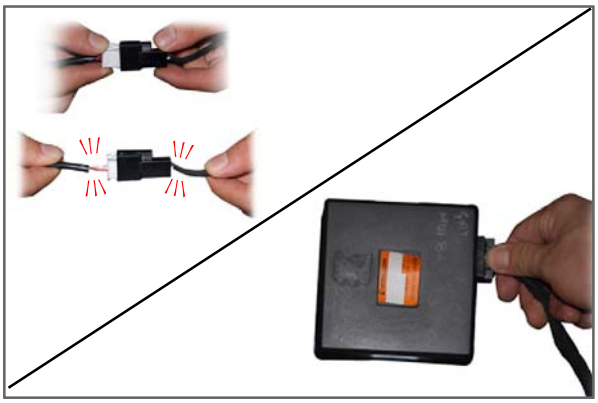
Make sure to turn "OFF" the ignition switch and other lamp switches before disconnecting or connecting the negative battery cable. (Otherwise, semiconductor parts can be damaged.)



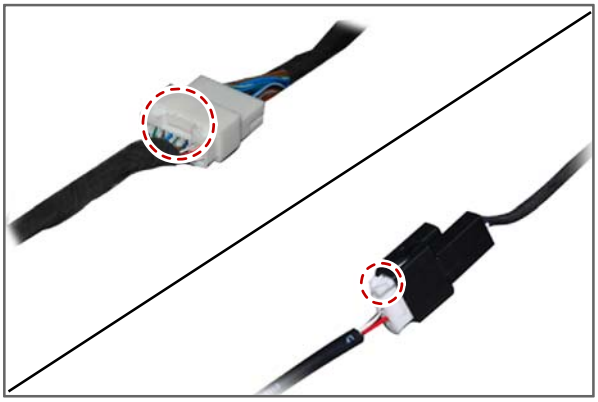
- Do not drop or appy excessive impact to sensors and relays.



- If a fuse is blown, replace it with a fuse which has the correct amperage rating. If you use a fuse with higher capacity than the specification, the component can be damaged or catch fire.



- Make sure a connector is connected securely. Loose connection results in malfunction.



- When disconnecting a connector equipped with a lock, press it down to the direction in the below figure.



- When checking voltage or continuity of the connector terminal with a circuit tester, connect the tester probe to the terminal at the harness side. For a sealed type connector, connect the probe to the terminal through the hole in the rubber cap of the wiring. Take care not to damage the insulation of the wires. Insert the probe until it contacts the terminal completely.

CAUTION

When inspecting the airbag system, make sure to use a diagnostic device, not a circuit tester.

Modification basis	
Application basis	
Affected VIN	

2. CHECKING CABLES AND WIRES

- Check for loose connection or rust.
- Check terminals and wires for corrosion due to electrolyte leakage.
- Check terminals and wires for open circuit.
- Check the wire insulation and coat for damage, cracks or deterioration.
- Check if the conductive parts of the terminals do not contact with vehicle body or other metal parts. Check that the grounding part has continuity with mounting bolts and vehicle body.
- Check that wires are properly routed.
- Make sure that wires are securely fixed to avoid contact with sharp body parts and high-temperature
- parts, such as the exhaust manifold and exhaust pipes.
  The rotating parts, such as fan pulley and fan belt, perturbative parts and wiring should be secured
- tightly at regular intervals.
  Secure the wiring between the fixed parts, such as the vehicle body, and vibrating parts, such as the
- engine, after slackening it slightly to prevent it from being damaged.

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The fuse and relay boxes consist of three boxes: Integrated Control Module (ICM) box in which the relays of rear wiper, rear fog lamp, mirror folding, ACC, IGN1 & 2, horn, tailgate, power outlet, shift lock (A/T) are integrated, relay & fuse box in engine compartment and interior fuse box.

2. SYSTEM LAYOUT

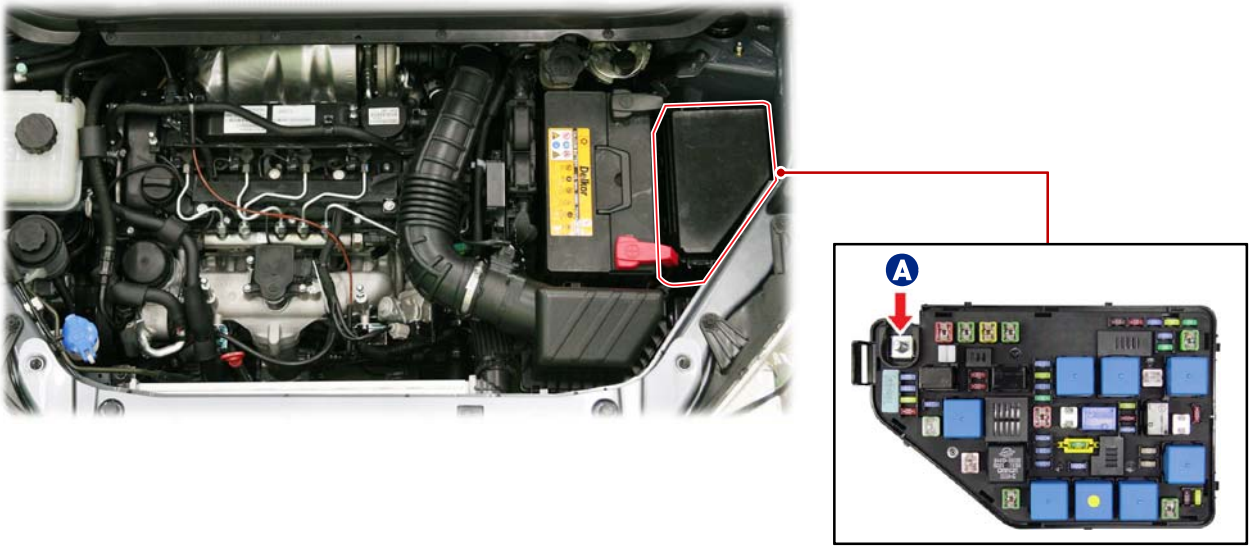


Modification basis	
Application basis	
Affected VIN	

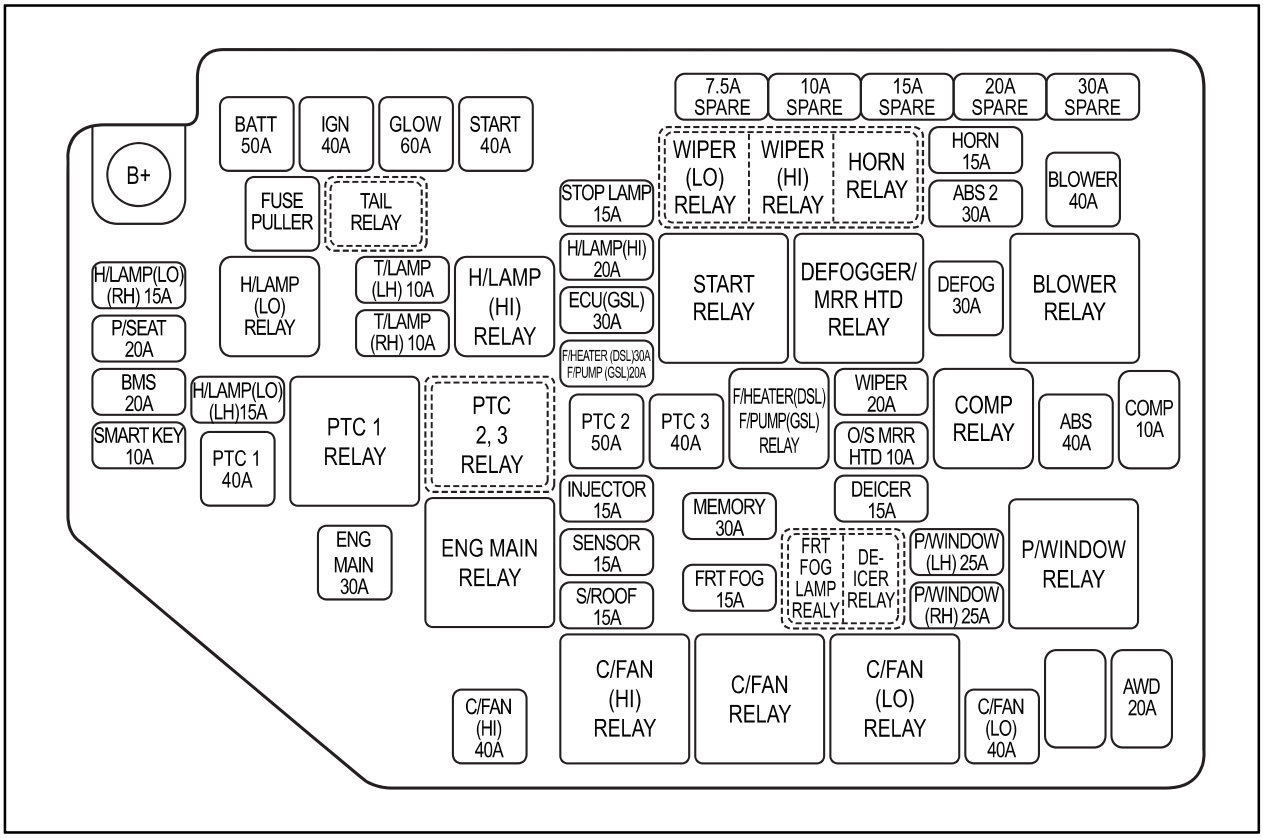
3. OPERATING PROCESS

1) Fuse Box In Engine Compartment

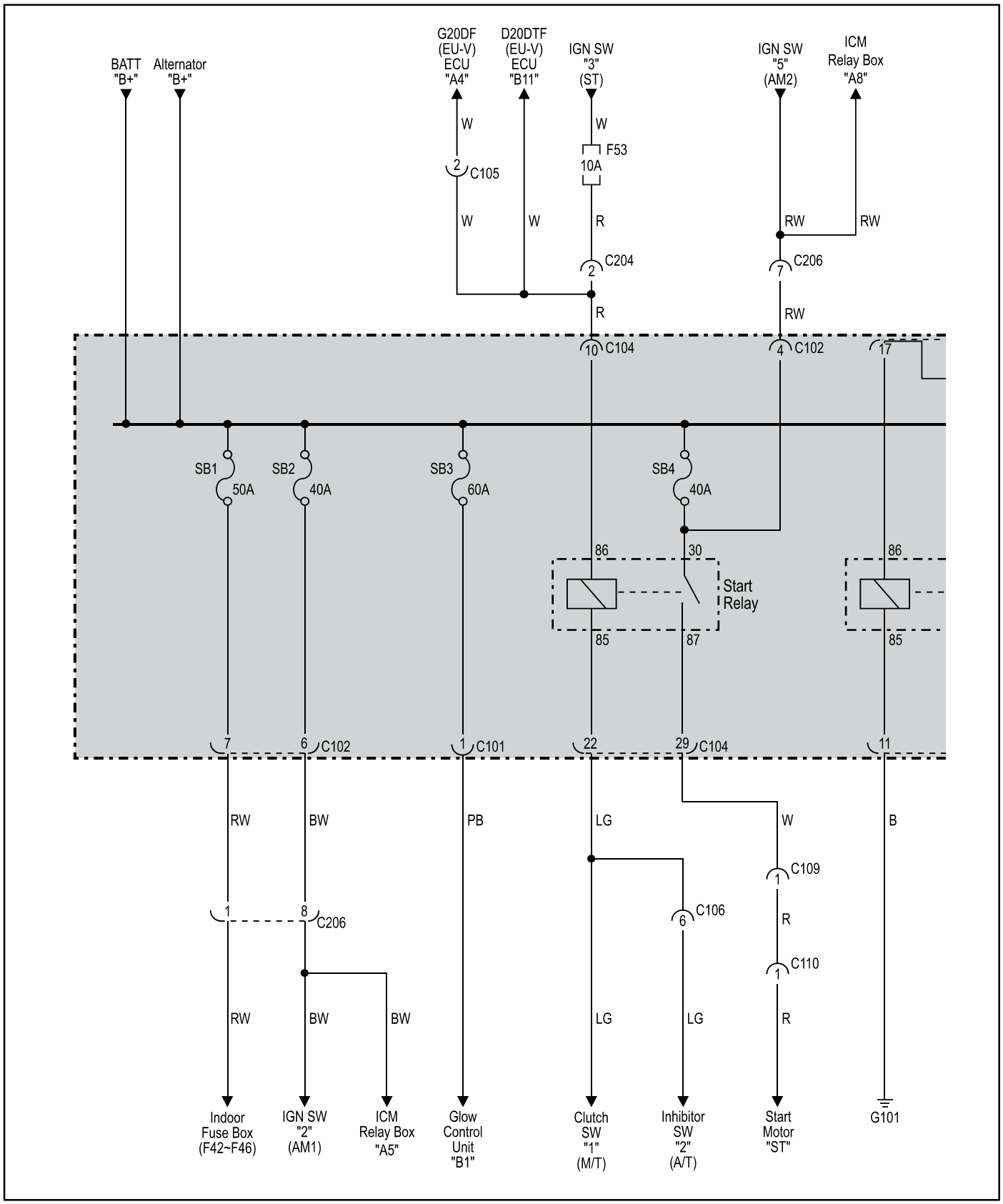
The relay & fuse box in engine compartment is located in the left side of the engine compartment. The wiper relay, horn relay, fog lamp relay, tail lamp relay and PTC relay are included in the PCB. The B+ supply is provided through the ALT+ (A) line, not by an extra fuse.



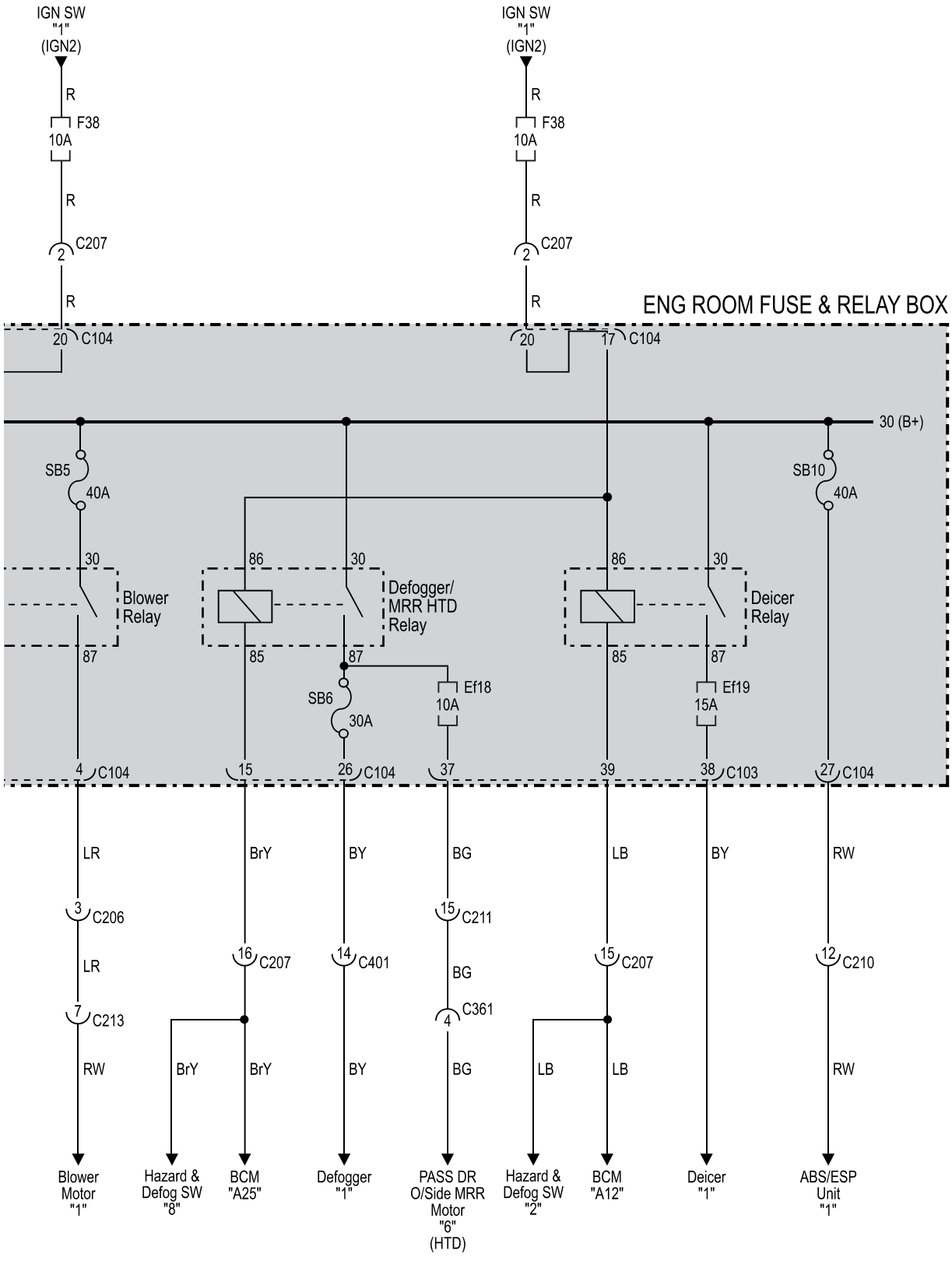
▶ **Capacity and name of engine compartment fuse and relay**



▶ Engine compartment fuse and relay box I (SB1~SB6, SB10, Ef18~Ef19, START RELAY, BLOWER RELAY, DEFOGGER RELAY, DEICER RELAY)

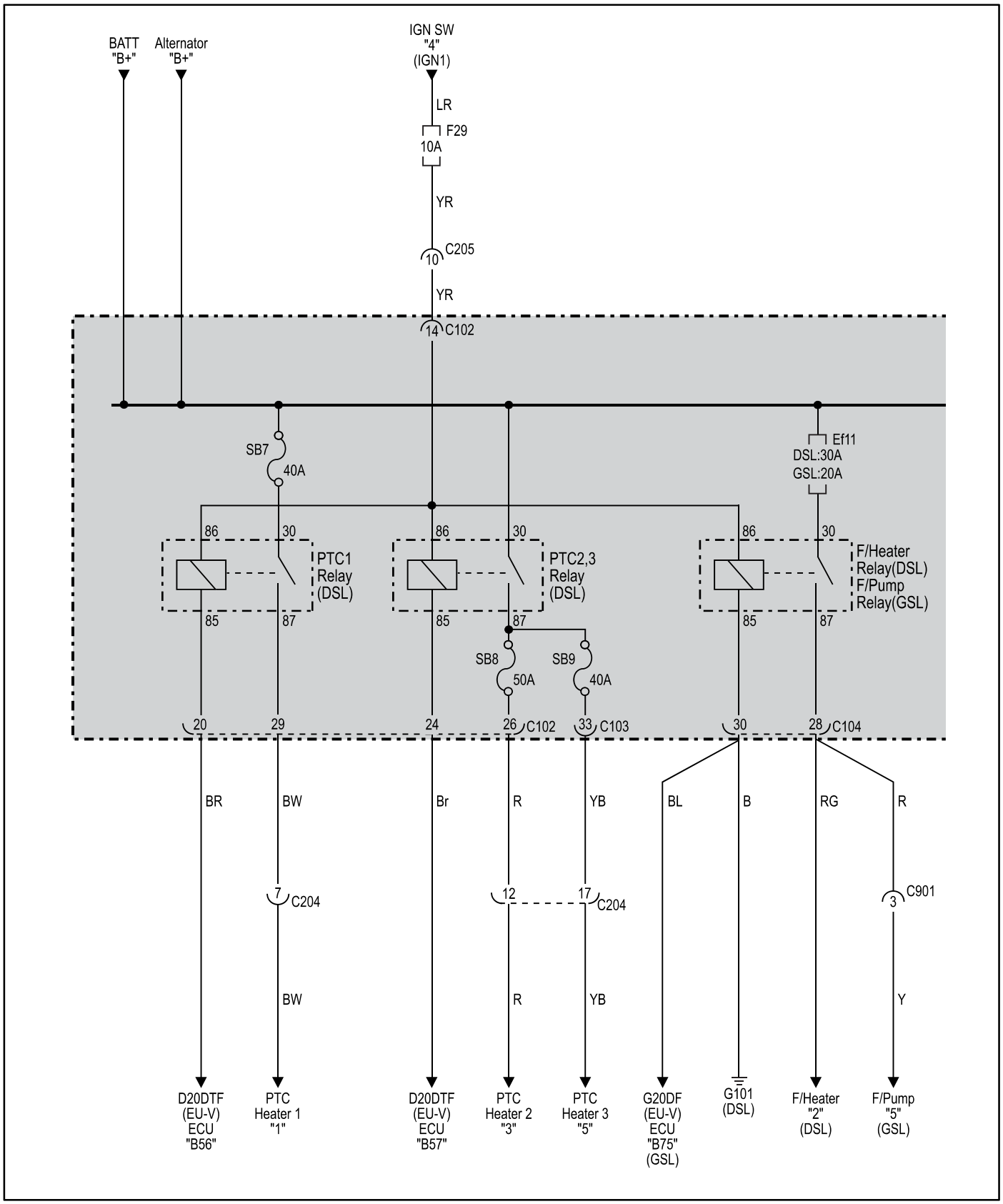


Modification basis	
Application basis	
Affected VIN	

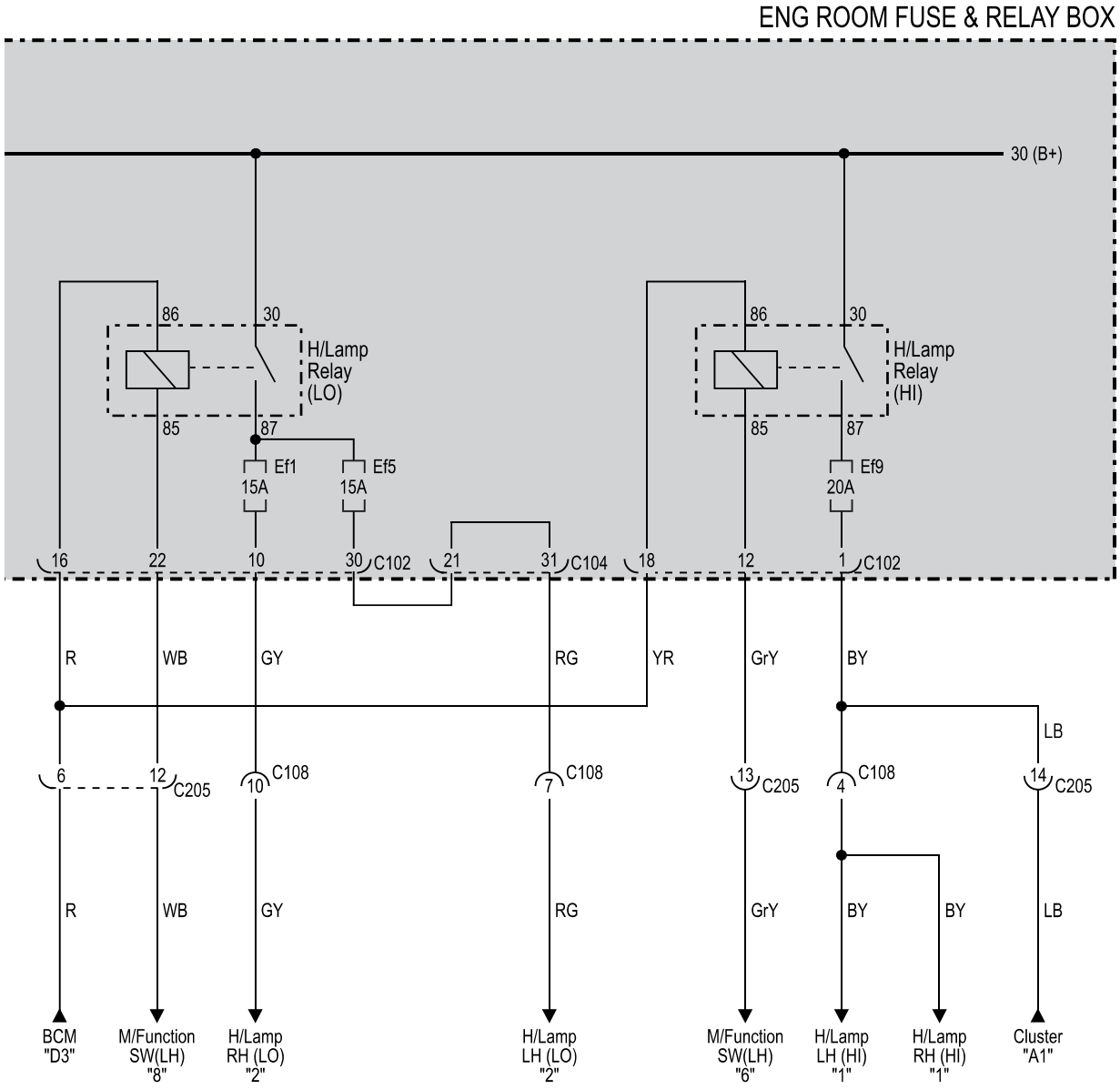


Modification basis	
Application basis	
Affected VIN	

▶ Engine compartment fuse and relay box II (SB7~SB9, Ef1, Ef5, Ef9, Ef11, PTC RELAY, FUEL HEATER RELAY, HEAD LAMP RELAY(HI, LO))

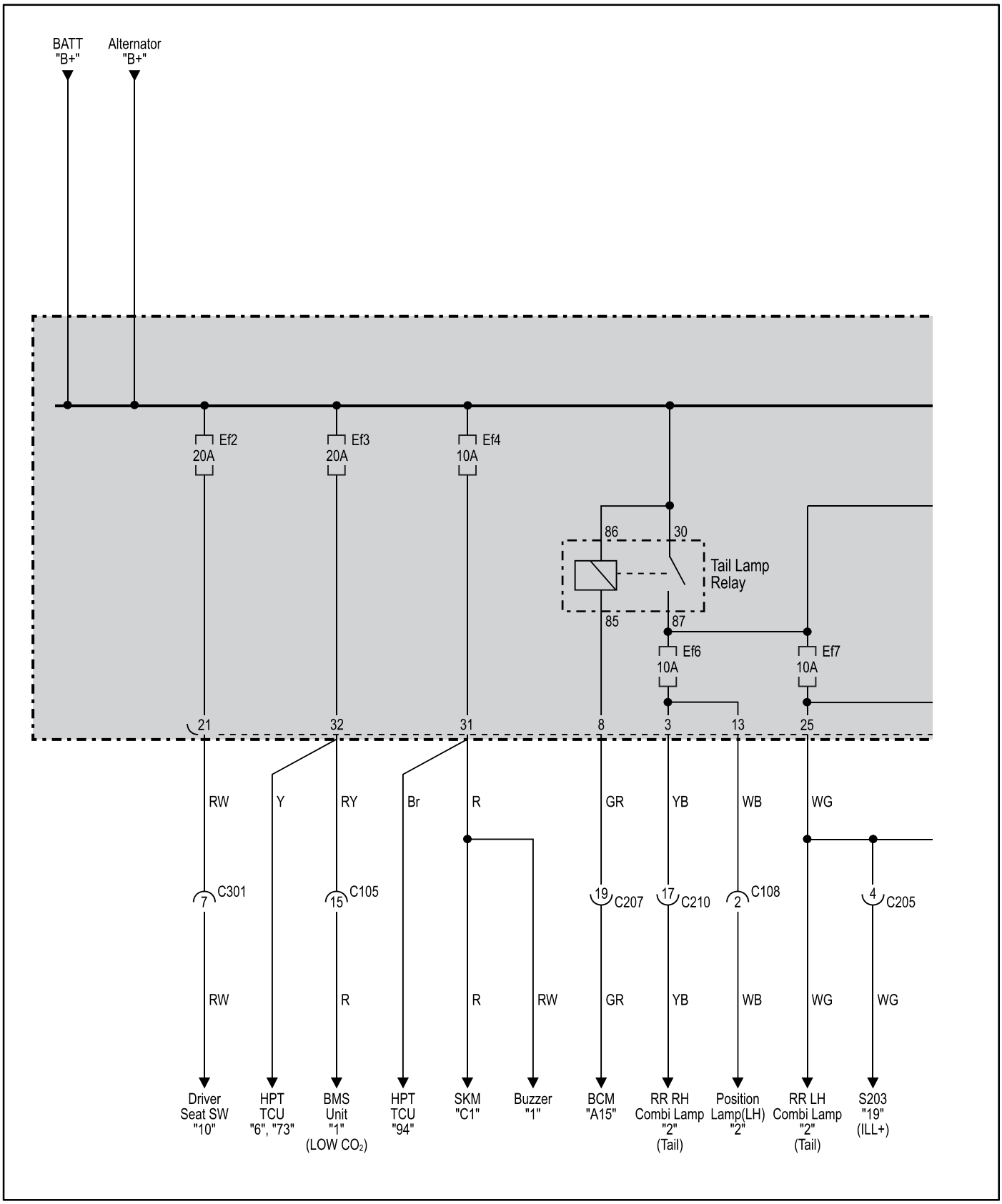


Modification basis	
Application basis	
Affected VIN	

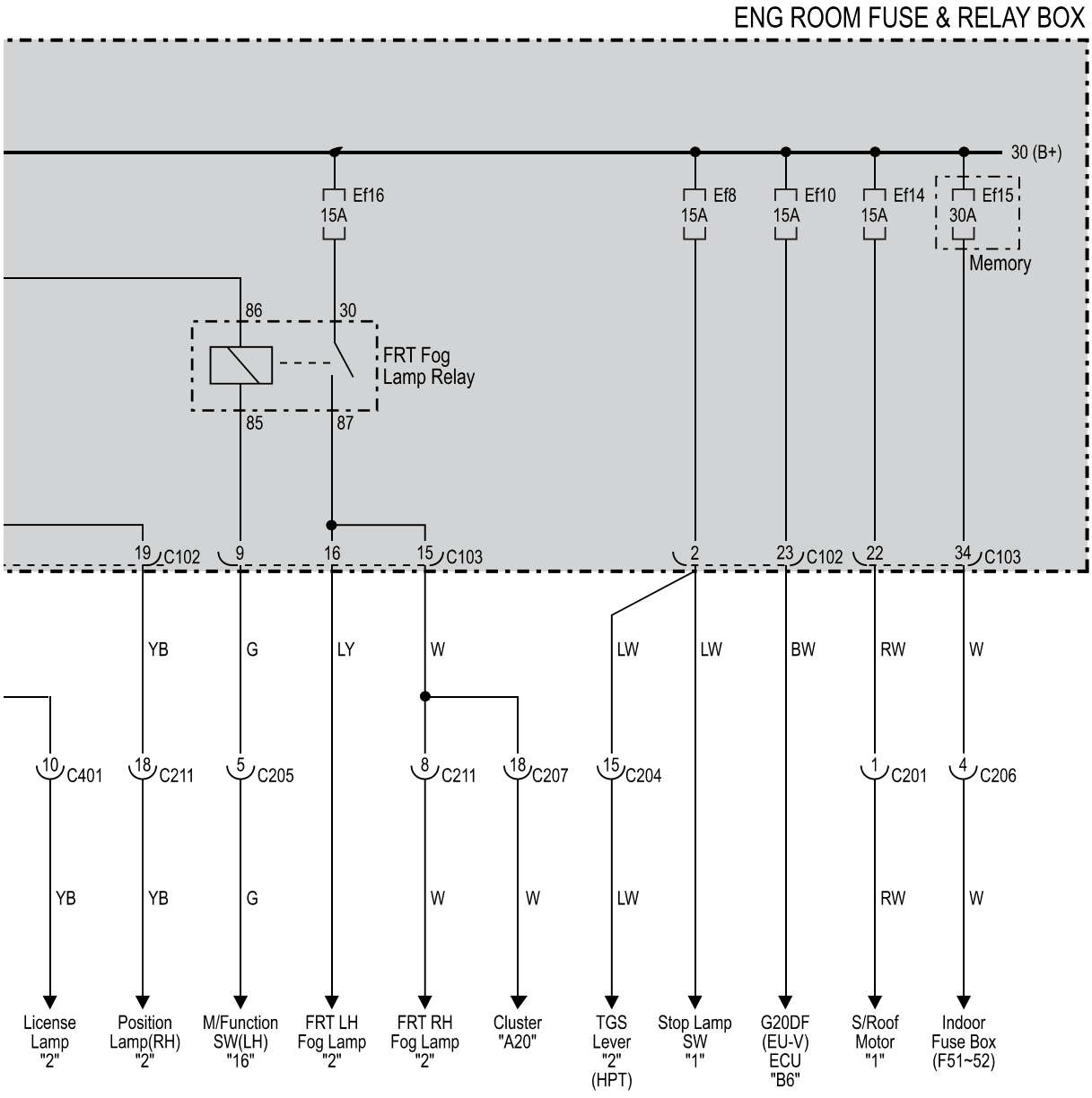


Modification basis	
Application basis	
Affected VIN	

▶ Engine compartment fuse and relay box IV (SB11~SB14, Ef12~Ef13, Ef24, ENG MAIN RELAY, C/FAN RELAY, C/FAN RELAY(HI, LO), COMP RELAY)

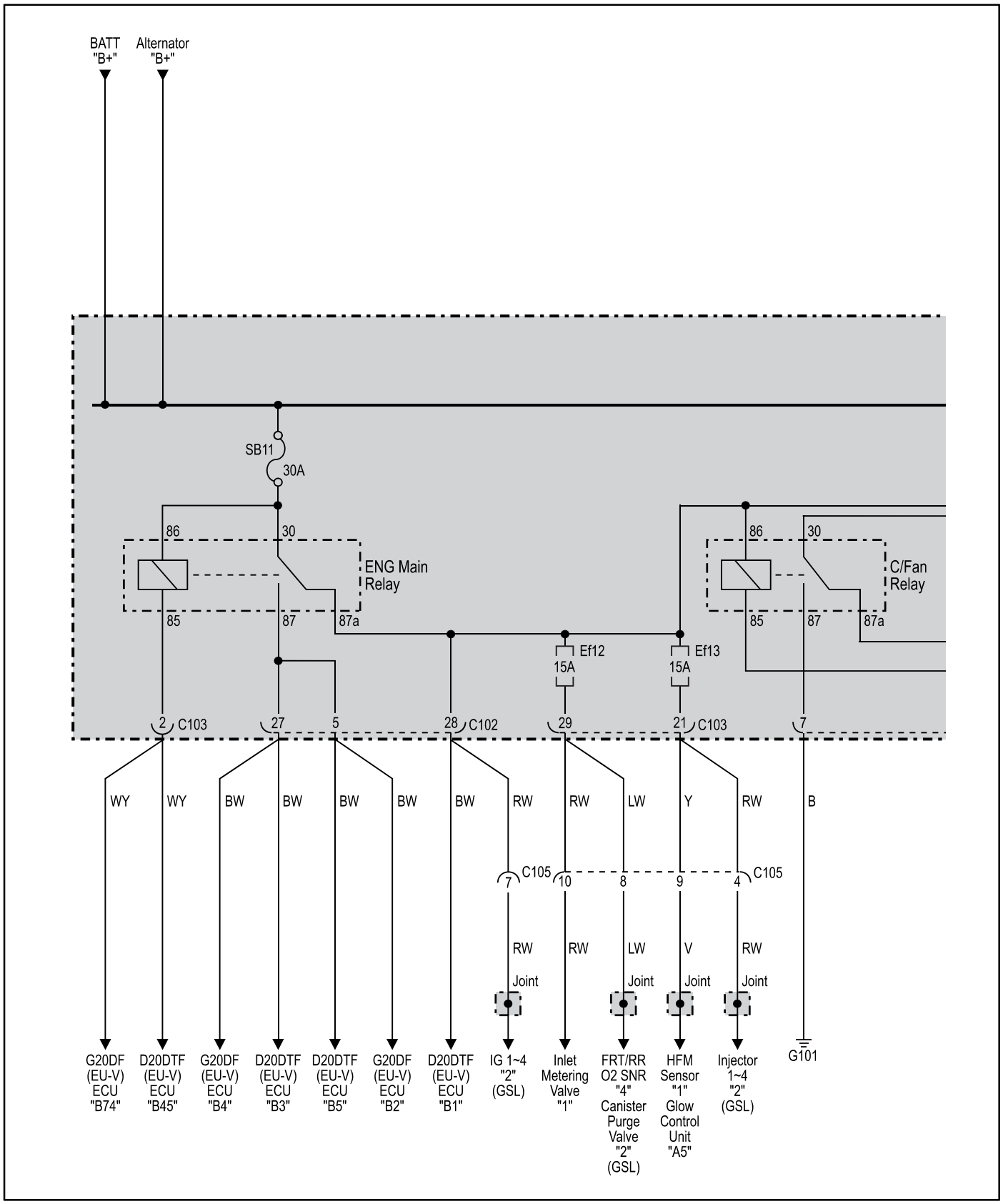


Modification basis	
Application basis	
Affected VIN	

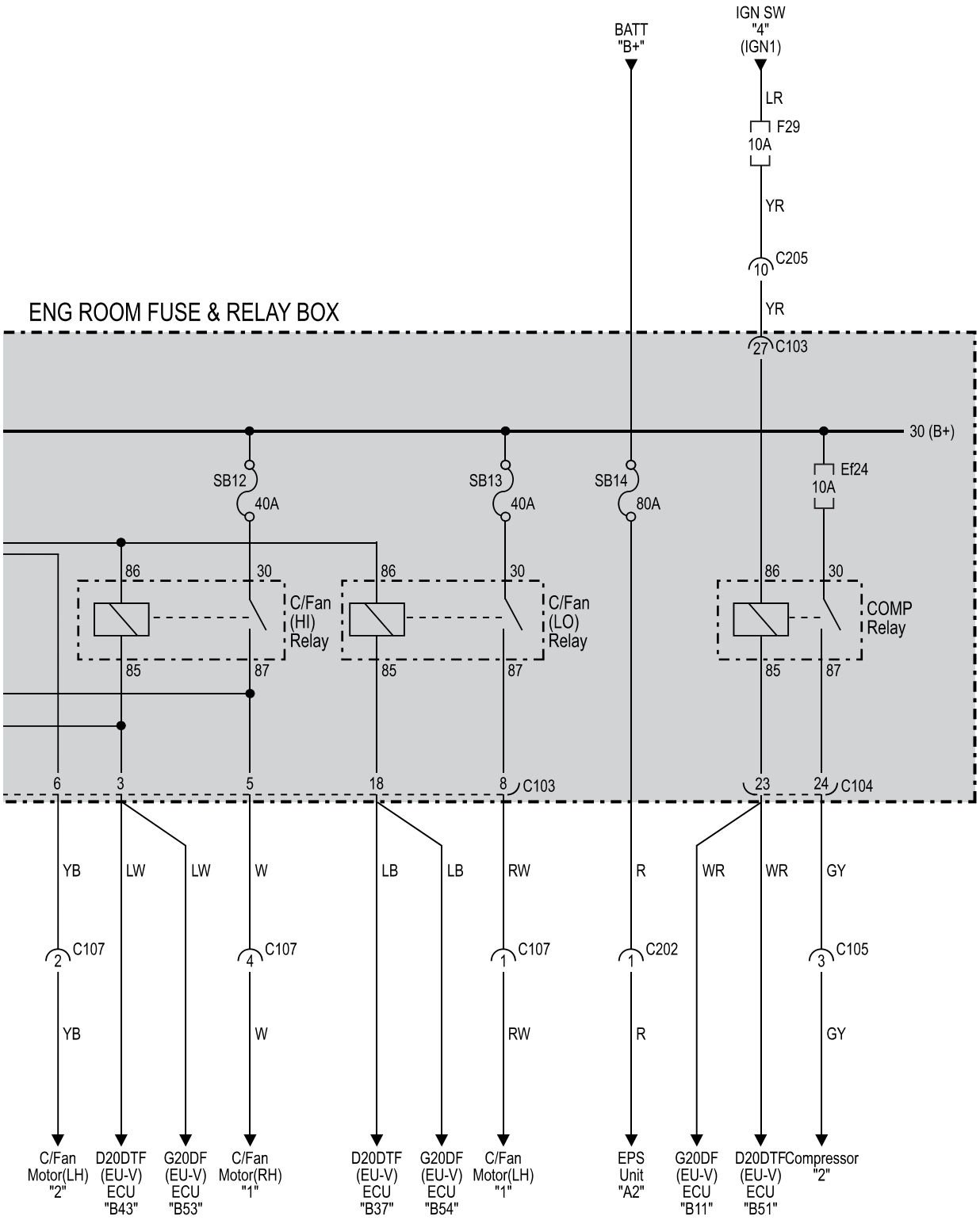


Modification basis	
Application basis	
Affected VIN	

▶ Engine compartment fuse and relay box V (Ef17, Ef20~Ef23, Ef25~Ef26, WIPER MOTOR RELAY(HI, LO), HORN RELAY, POWER WINDOW RELAY)



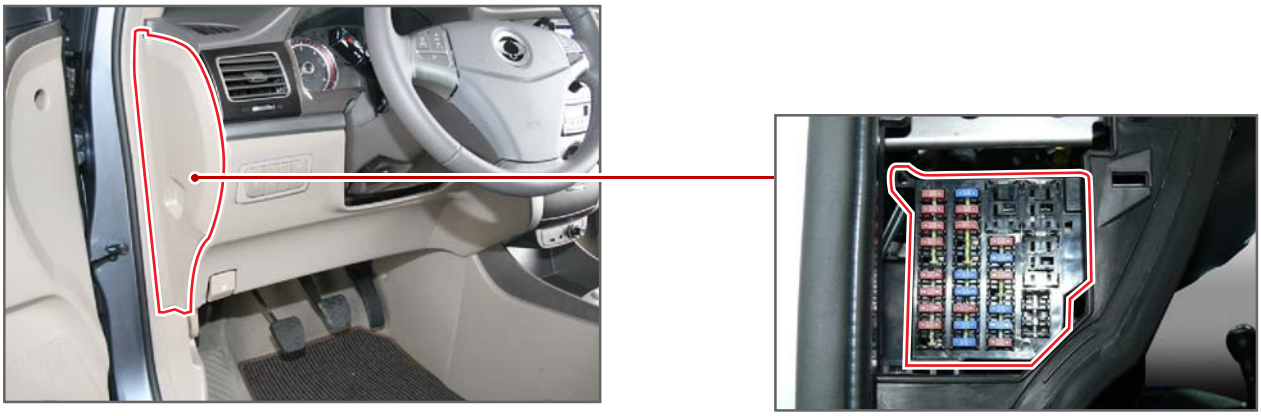
Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

2) Interior Fuse Box

The interior fuse box is located in the left side of the instrument panel. To remove this fuse box, disconnect the main wiring first.



▶ **Capacity and name of interior fuse and relay**

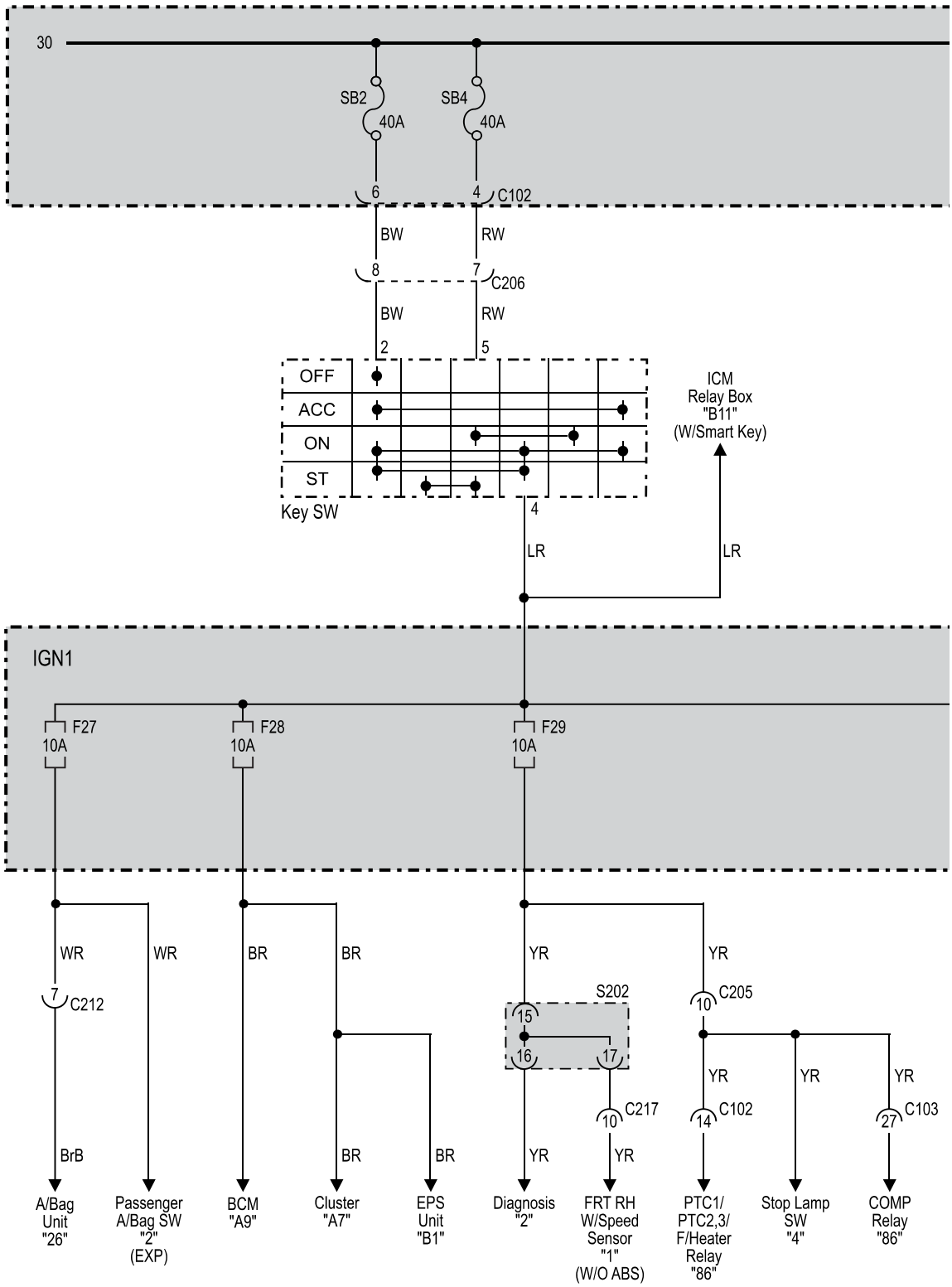
NO.27 10A	AIR BAG	NO.37 15A	FRT SEAT WARMER	SAPRE		SAPRE	
NO.28 10A	CLUSTER BCM EPS	NO.38 10A	AIR CON FRT/RR DEFOGGER ALTERNATOR				
NO.29 10A	*FUEL HTR DIAGNOSIS *PTC	NO.39 10A	REAR WIPER				
NO.30 10A	BACK UP LAMP BACK SONAR	NO.40 15A	RR SEAT WARMER	NO.47 10A	DIGITAL CLOCK O/SIDE MRR SUN ROOF HEAD REST	SAPRE	
NO.31 10A	TCU AWD	NO.41 15A	STEERING WHEEL HEATED	NO.48 15A	CIGAR LIGHT		
NO.32 10A	* ENG ECU	NO.42 15A	BCM (DOOR LOCK)	NO.49 10A	AUDIO		
NO.33	SPARE	NO.43 15A	BCM (HAZARD)	NO.50 10A	SMART KEY	NO.54	SAPRE
NO.34 10A	ABS/ESP	NO.44 10A	DIAGNOSIS SMART KEY	NO.51 15A	AUDIO	NO.55	SAPRE
NO.35 10A	HLLD ECM MRR	NO.45 15A	B/HORN MRR FOLD	NO.52 15A	INTERIOR LAMP BCM CLUSTER	NO.56	SAPRE
NO.36 10A	SMART KEY	NO.46 20A	POWER OUTLET	NO.53 10A	START		

- PLEASE USE THE DESIGNATED FUSE AND RELAY.
- CONSULT OWNER'S MANUAL FOR FUSE & RELAY SERVISE.
- " * "DSL, " ** " GSL

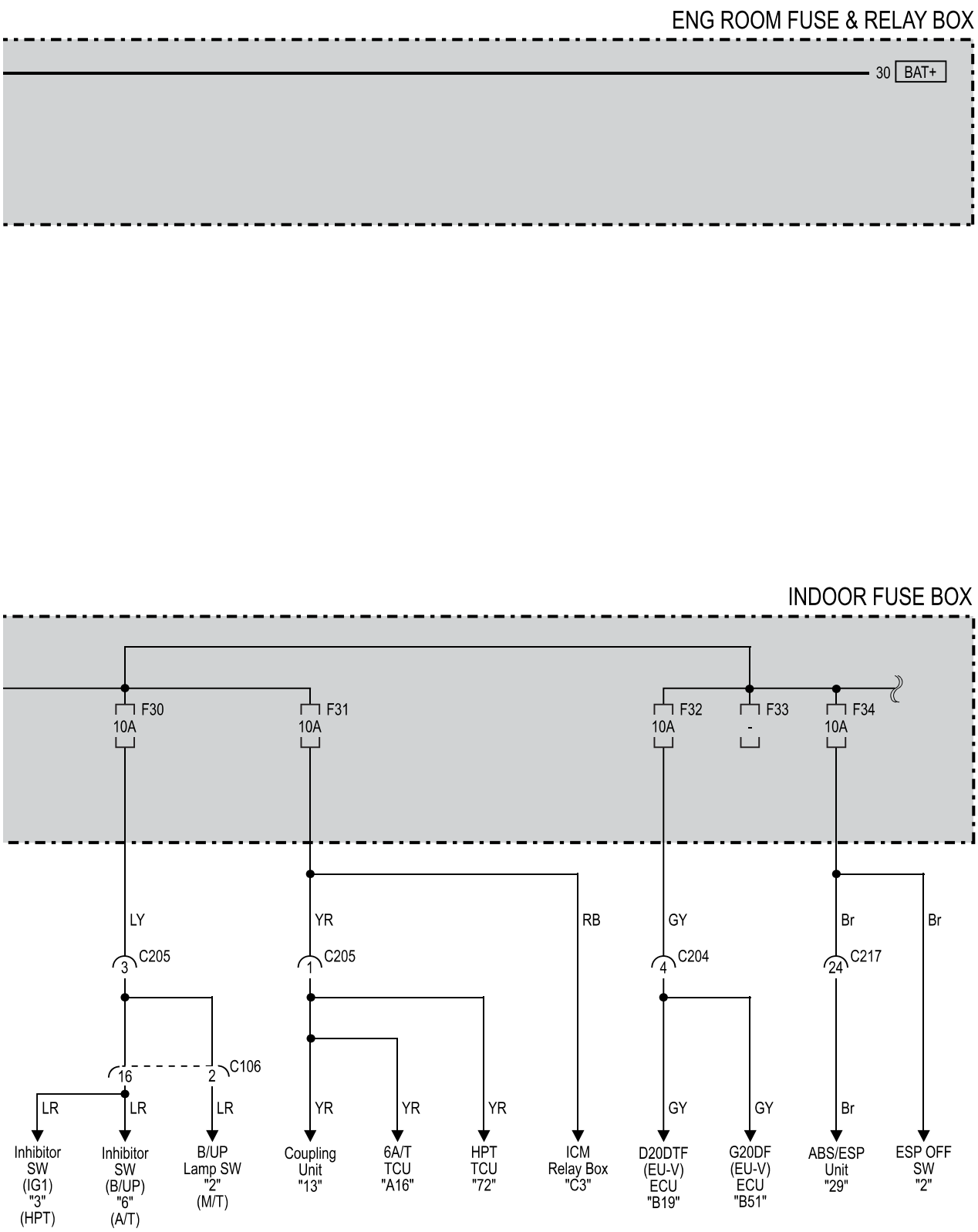
Modification basis	
Application basis	
Affected VIN	

Memo

▶ Interior fuse and relay box I (F27~F34)

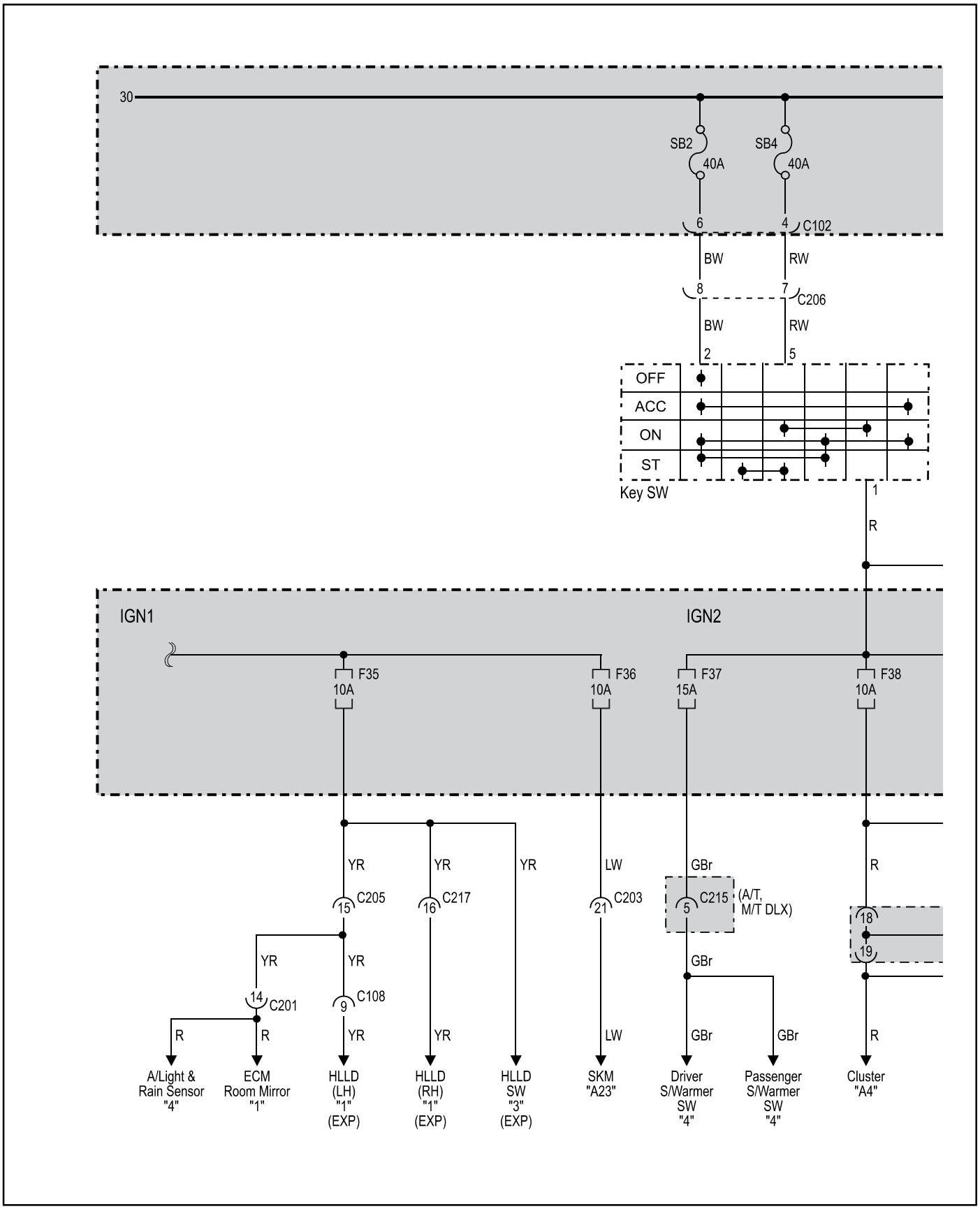


Modification basis	
Application basis	
Affected VIN	

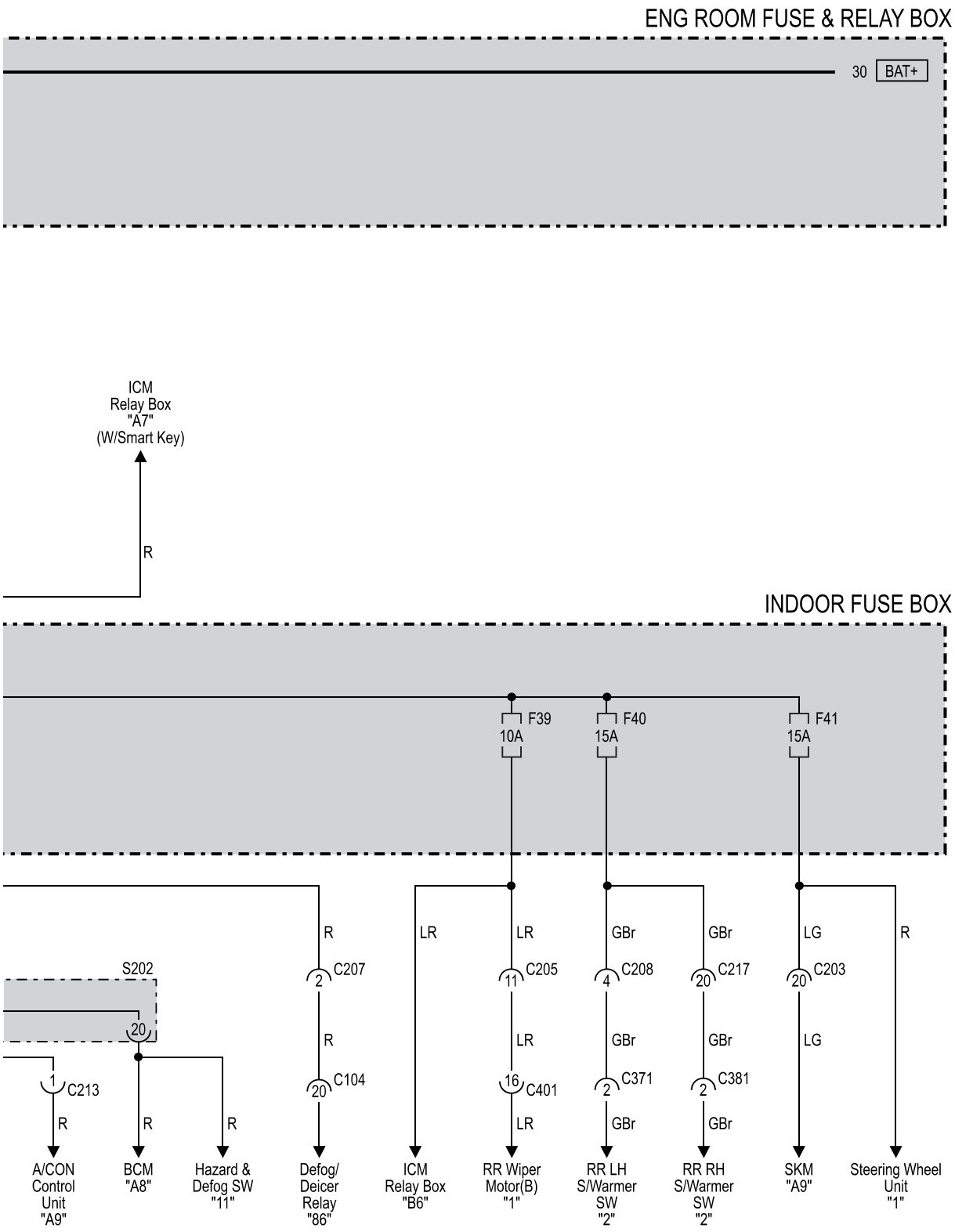


Modification basis	
Application basis	
Affected VIN	

▶ Interior fuse and relay box II (F35~F41)

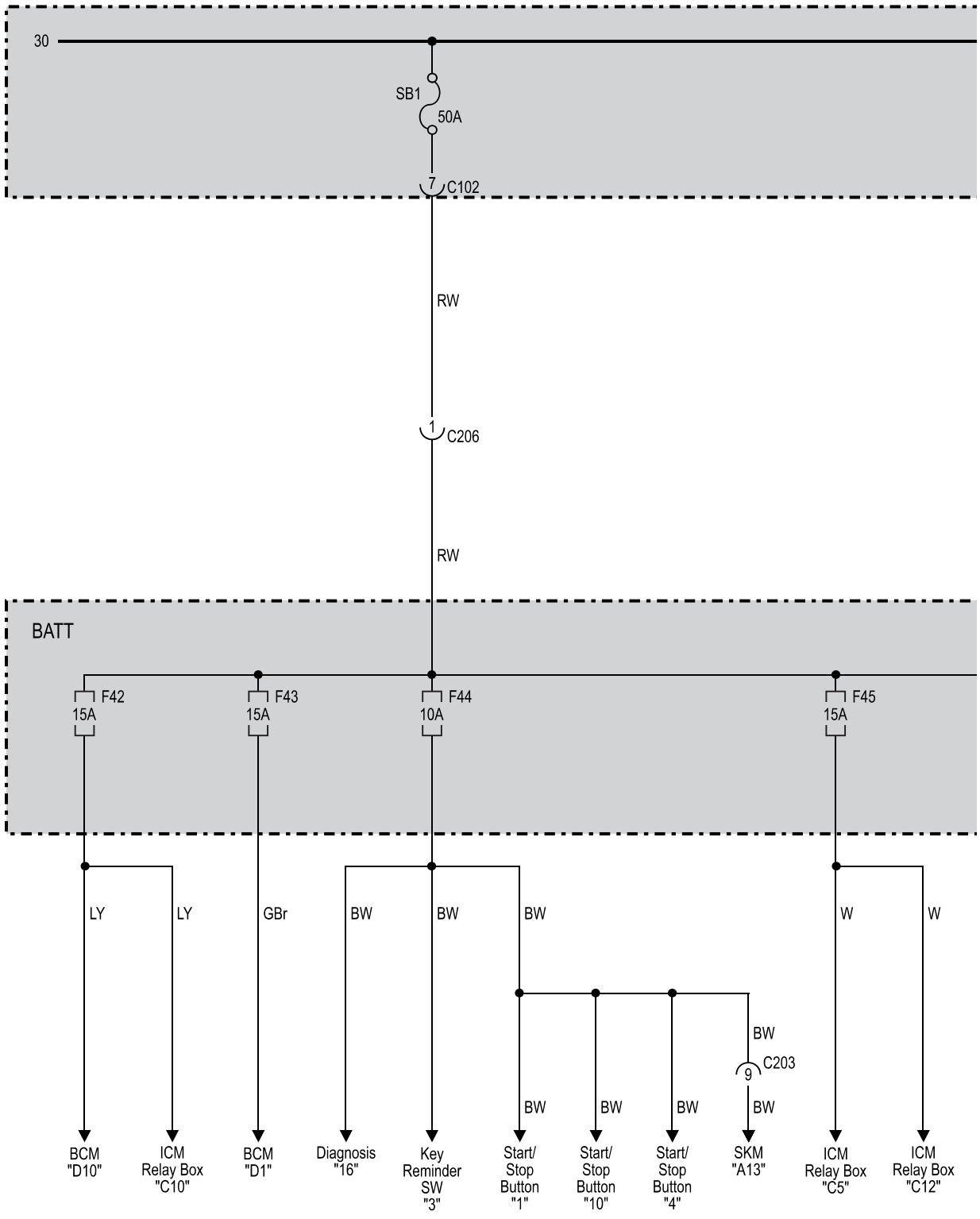


Modification basis	
Application basis	
Affected VIN	

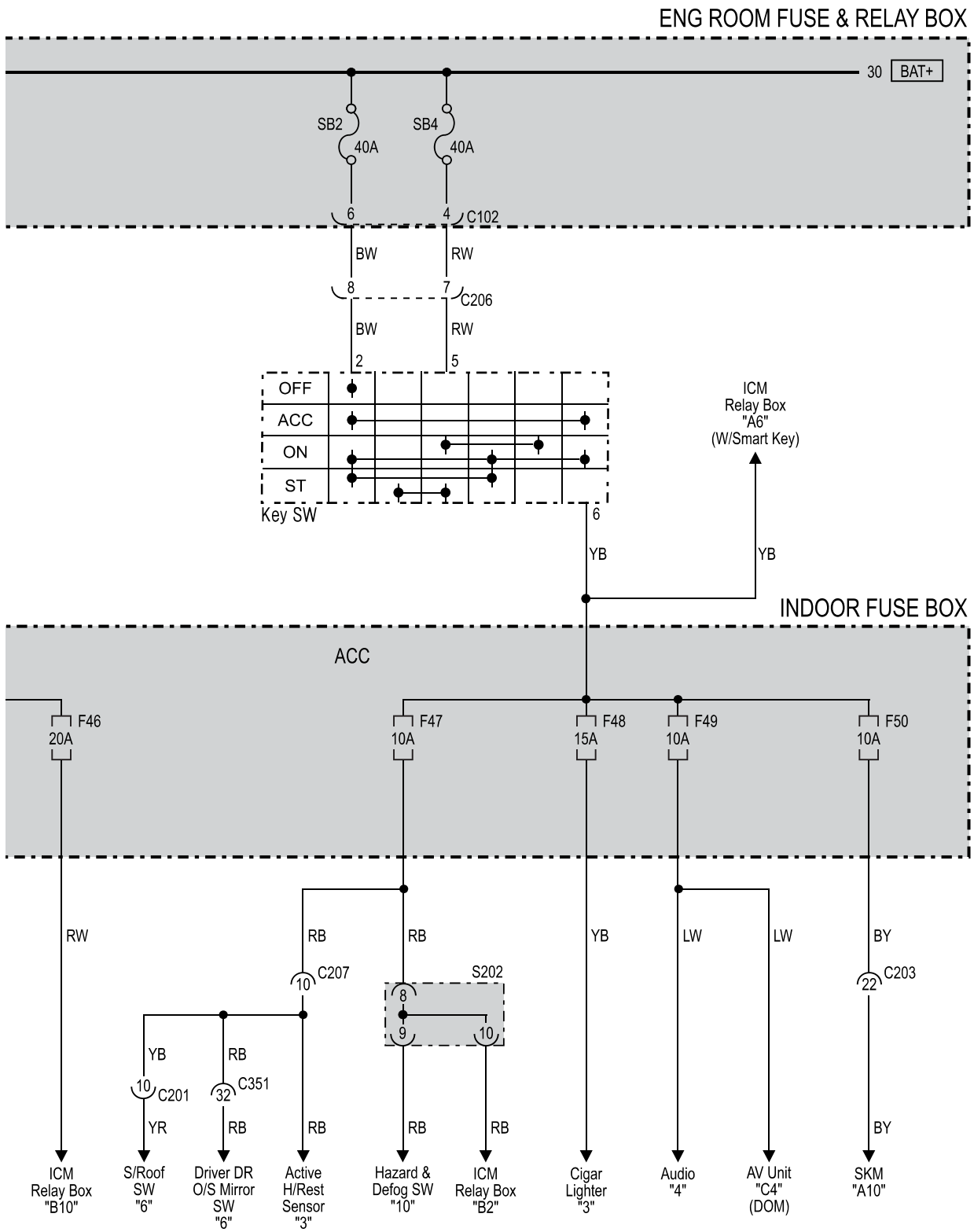


Modification basis	
Application basis	
Affected VIN	

▶ Interior fuse and relay box III (F42~F50)

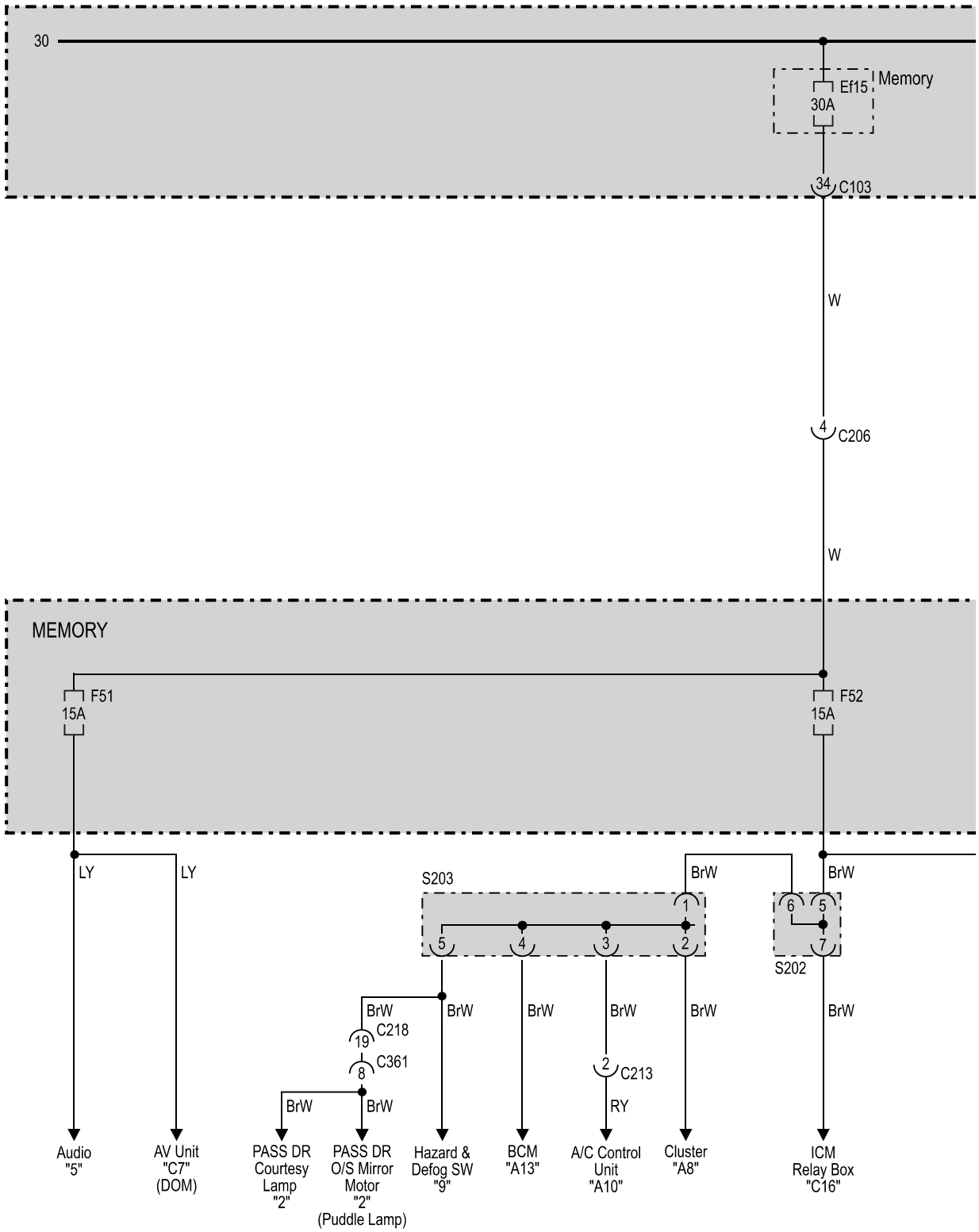


Modification basis	
Application basis	
Affected VIN	

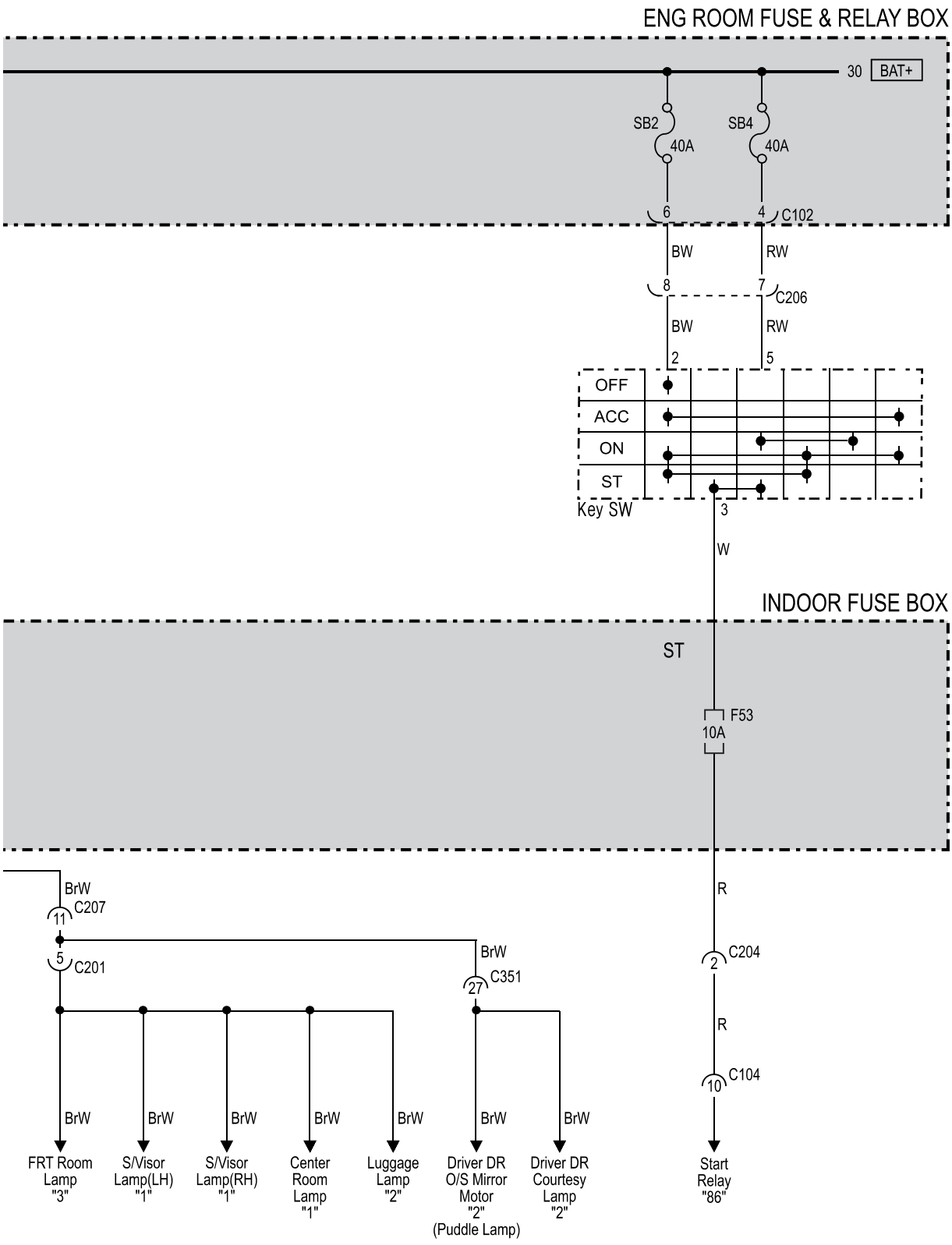


Modification basis	
Application basis	
Affected VIN	

▶ Interior fuse and relay box IV (F51~F53)

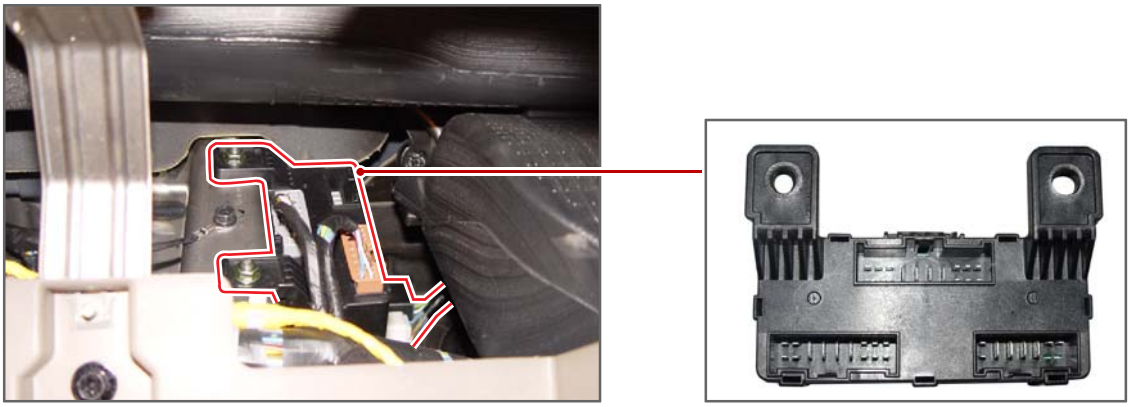


Modification basis	
Application basis	
Affected VIN	

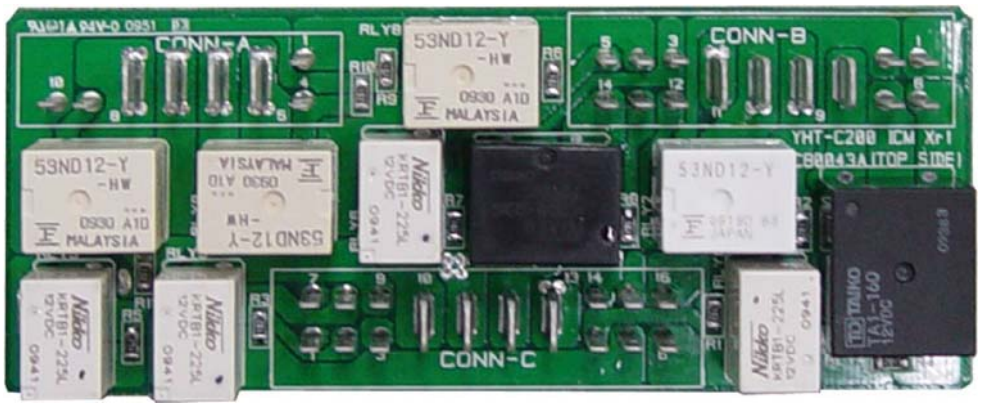

ENG ROOM FUSE & RELAY BOX
30
BAT+
SB2
40A
SB4
40A
6
4
C102
BW
RW
8
7
C206
BW
RW
2
5
OFF
ACC
ON
ST
Key SW
3
W
INDOOR FUSE BOX
ST
F53
10A
BrW
C207
11
5
C201
BrW
C351
27
R
C204
2
R
C104
10
BrW
BrW
BrW
BrW
BrW
BrW
BrW
FRT Room Lamp "3"
S/Visor Lamp(LH) "1"
S/Visor Lamp(RH) "1"
Center Room Lamp "1"
Luggage Lamp "2"
Driver DR O/S Mirror Motor "2" (Puddle Lamp)
Driver DR Courtesy Lamp "2"
Start Relay "86"

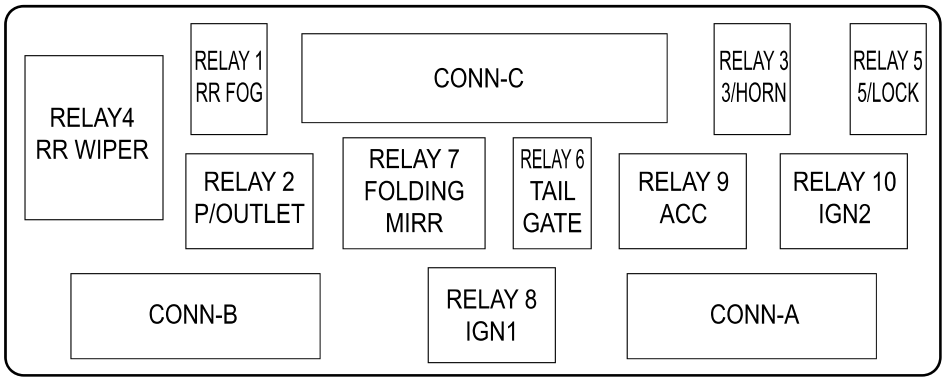
3) ICM Box

The ICM box is installed on the back side of the instrument panel.



▶ **Arrangement of connectors and relays**

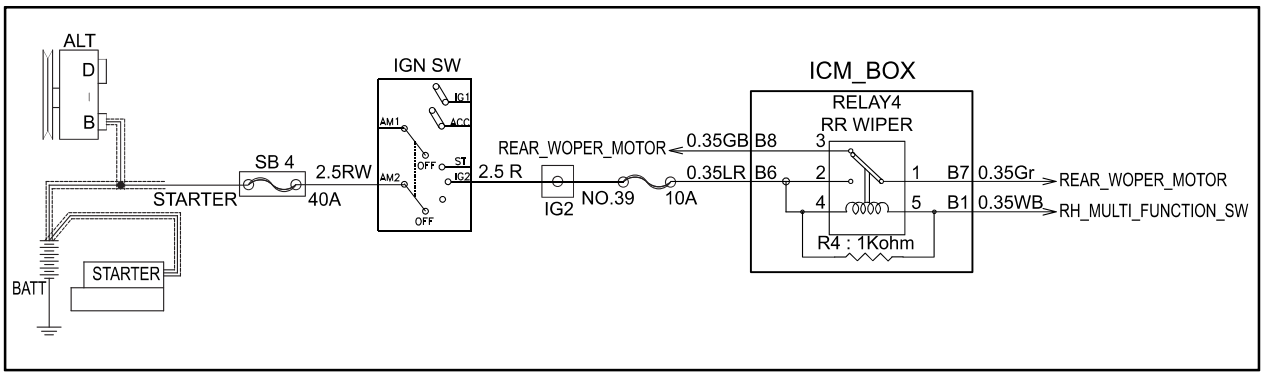




Modification basis	
Application basis	
Affected VIN	

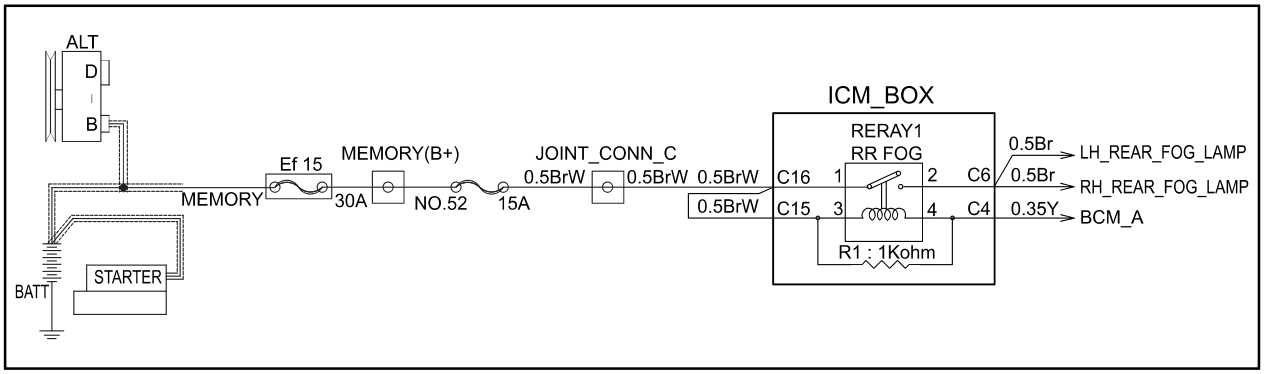
4) Operating Process By Power Supply

(1) Rear wiper relay



The rear wiper motor relay is turned on when the rear wiper switch is turned on with the ignition key ON. This relay is turned off when the rear wiper switch is turned off.
The power is supplied to the ICM no. B6 connector through the SB4 and no. 39.

(2) Rear fog lamp relay

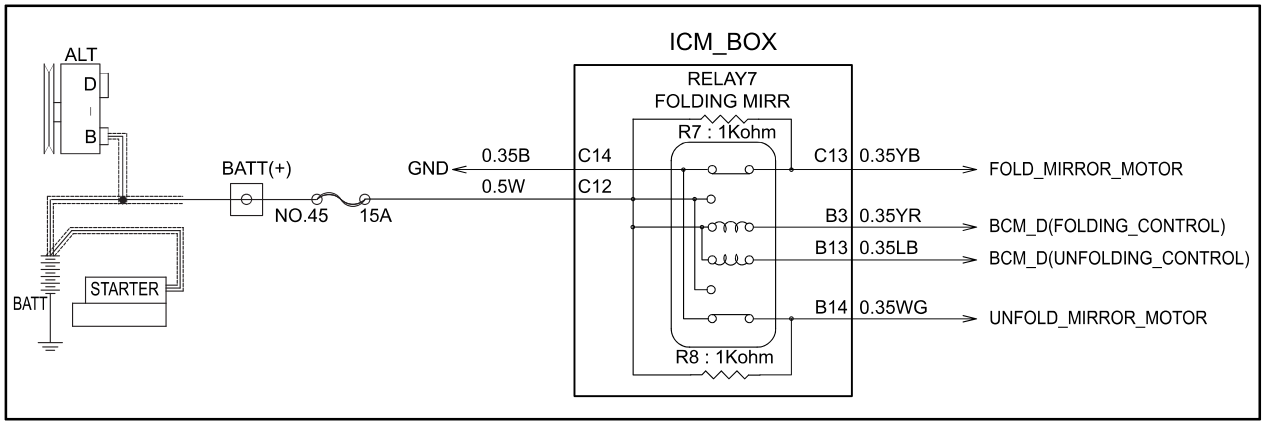


The power for the rear fog lamp relay is supplied through the memory fuse in the engine compartment CE box and fuse no. 52 in the interior IP box. This relay is controlled (ON/OFF) by the relay operation signal which is connected to the no. A11 of the BCM.

▶ **Operating conditions**

1. The rear fog lamp is turned on when the rear fog lamp switch is turned on with the headlamp turned on (i.e. IGN2 switch ON).
2. Turning on the rear fog lamp switch again when the relay is activated turns off the fog lamp.
3. The rear fog lamps do not come ON when the IGN2 switch is turned to OFF position or the light switch is OFF.
4. The rear fog lamp should not automatically come on again if it has been turned off by any methods other than the rear fog lamp switch.

(3) Outside mirror folding relay

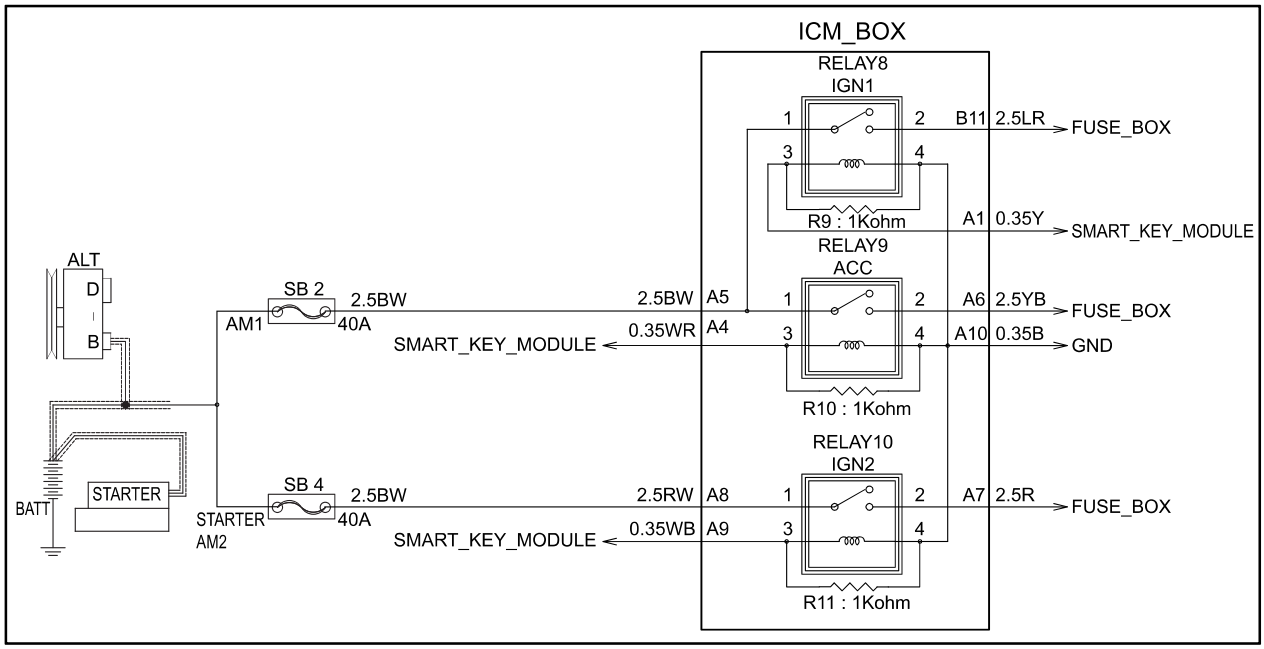


The power for the outside mirror folding relay is supplied through the fuse no. 45 in the engine compartment CE box and the relay is operated by the operation signals from the no. D16 and no. D17 of the BCM.

▶ **Manual operation of BCM**

When pressing the outside mirror folding/unfolding switch with IGN ON, the mirrors are folded or unfolded according to the previous mirror position. If the mirror is already folded, then the mirror will be unfolded and vise versa. This operation will be performed for T1.

(4) IGN1, IGN2, ACC relays

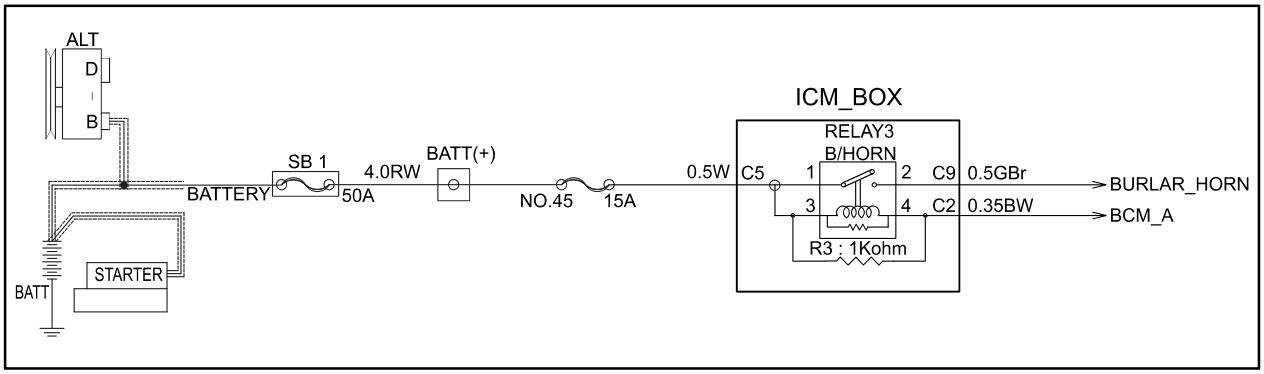


▶ **For models with SKM**

The power supplied through the AM1 fuse goes to the ACC relay no.1 and IGN1 relay no. 1. The power supplied through the starter motor AM2 goes to the IGN2 relay no. 1. The IGN1 and IGN2 relays are operated by the signals from the no. A1 and no. A2 of the SKM. Refer to SKM description for operating conditions.

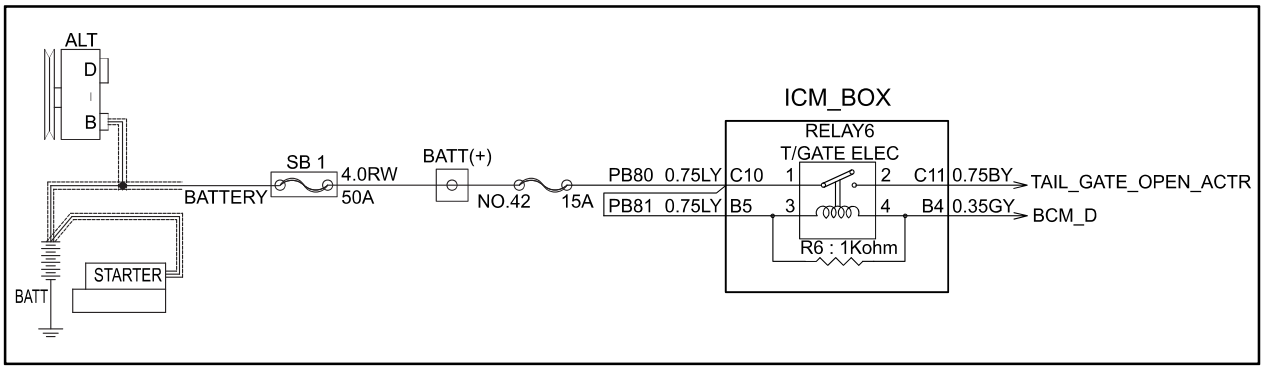
Modification basis	
Application basis	
Affected VIN	

(5) Horn relay



The power for the theft deterrent horn relay is supplied to the ICM terminal no. C5 through the battery SB1 and fuse no. 45 in the interior fuse box.
The relay is operated by the signals from the BCM terminal no. A24. Refer to Conditions For Theft Deterrent for operating conditions.

(6) Tailgate relay

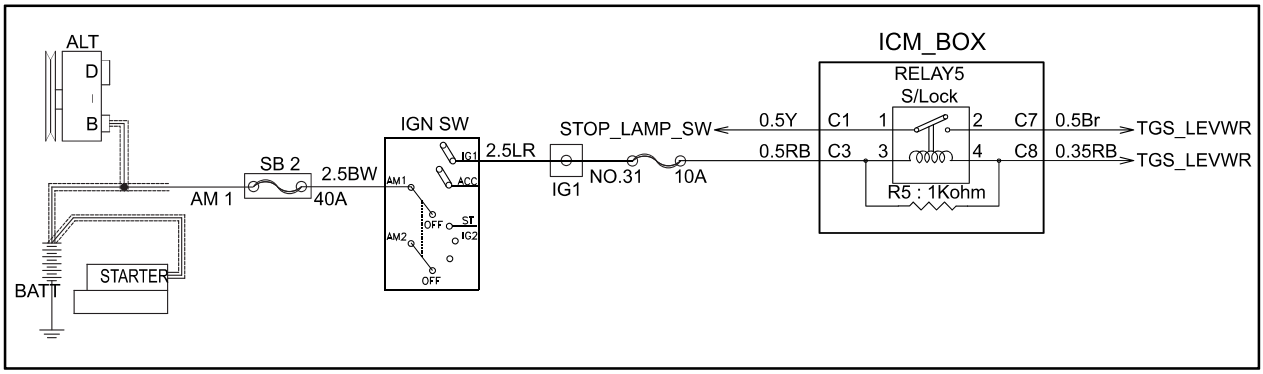


The power for the tailgate relay is supplied to the ICM terminals no. C10 and no. B5 through the battery SB1 and fuse no. 42 in the interior fuse box. The relay is operated (i.e. ON/OFF) by the operation signal from the BCM terminal no. D6.

▶ Deactivation condition

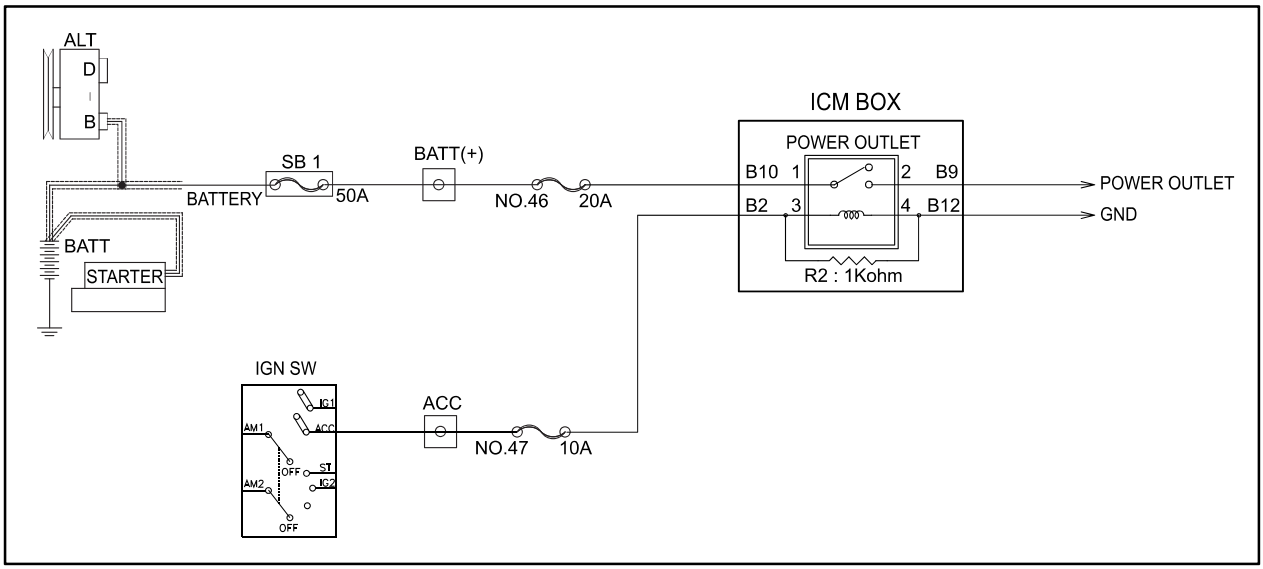
- Without SKM
  The tailgate open relay is turned OFF immediately after the driver's door is locked or the vehicle speed becomes 3 km/h or more during its activation.
- With SKM
  Refer to the section Tailgate of BCM for the operating conditions.

(7) Shift lock relay



The shift lock relay is used in the models with A/T and receives power through the SB2 and fuse no. 31 in the interior fuse box with the IGN1 turned ON. If the operating conditions are met (stop lamp switch ON), the battery power is supplied to the ICM terminal no. C1. If the gear mode conditions are met, the relay is operated by the signals from the terminal no. 10 of the gear selector lever.

(8) Power outlet relay



The power for the power outlet relay is supplied to the ICM terminal no. B10 through the battery SB1 and fuse no. 46 in the interior fuse box. The relay is earthed through the fuse no. 47 in the interior fuse box and then ICM terminals no. B2 and no. B12 when the ignition key is turned to ACC.

Modification basis	
Application basis	
Affected VIN	

BCM (BODY CONTROL MODULE) 8710-01

GENERAL INFORMATION

1. SPECIFICATION

Pin No.		Specification	Remark
Rated voltage		DC 13.5 V	-
Operating voltage		DC 9.0 to 16.0 V DC 7.0 to 18.0 V (CAN)	-
Operating temperature		−30 to +80°C	-
Storage temperature		−40 to +85°C	-
Transponder	Frequency	134.2 KHz ± 4 KHz	-
	Operating temperature	−40 to +85°C	-
Max. humidity		95%	-
High resistant voltage		24 V	-
Dark current		BCM without SKM: 7.0 mA or less BCM with SKM: 4.0 mA or less	All switches OFF, key removed, all doors LOCK and in sleep mode
Voltage drop		1.0 V or less	at pin B6 and all pins for IN/OUT

▶ **Frequency characteristics**

Pin No.	Specification	Remark
Receive frequency	433.920±0.015 MHz	-
Bandwidth	15KHz ± 2KHz or less	-
Modulation method	FSK	-
Range	10M or longer (open)	-

2. FUNCTIONS

1) Functional List

Function			SKM without BCM	SKM with BCM
1	Wiper control	Wiper mist & washer coupled wiper	O	O
		Auto washer coupled wiper	O	O
		Auto light-rain sensor coupled wiper (LIN)	O	O
		Speed sensitive intermittent wiper	O	O
		Wiper low/high control	O	O
2	Key reminder warning	Key reminder warning	O	X
		Ignition key reminder	O	X
		External buzzer control	X	O
		Anti-lock function when opening door	O	O
3	Tail lamp control	Tail lamp ON warning	O	O
		External lamp warning display	X	O
		Tail lamp auto OFF	O	O
4	Door ajar warning	Door status management	X	O
		Door ajar warning	O	O
5	Seat belt control	Seat belt warning	O	O
		Seat belt reminder	O	O
6	Sunroof warning	Sunroof warning control	O	O
		Sunroof warning display	X	O
7	Room lamp control	Door coupled room lamp and dimming control	O	O
		Room lamp OFF control	O	O
		Room lamp control display	X	O
8	Key hole illumination control	Key hole illumination	O	X
9	Defogger (heated wire) control	Front defogger timer	O	O
		Rear defogger timer	O	O

Modification basis	
Application basis	
Affected VIN	

Function			SKM without BCM	SKM with BCM
10	Keyless entry control	Transmitter	O	X
		Receiver	O	X
		Remote door lock	O	X
		Remote door unlock	O	X
		Remote panic	O	X
		After 30 seconds delay auto door lock	O	X
11	Door lock/unlock control	Lock/unlock control by door lock control	O	O
		Lock/unlock control by central door lock switch	O	O
		Lock/unlock control by REKES signal	O	X
		Lock/unlock control by SKM REKES control	X	O
		Lock/unlock control by SKM passive entry	X	O
		Auto door lock control	O	O
		Auto door unlock (crash signal) control	O	O
12	Panic alarm	Panic alarm control by REKES signal	O	X
		Panic alarm control by SKM REKES FOB	X	O
13	Headlamp control (escort)	Coming-home-light control	O	O
14	Tailgate open control	Tailgate open control in BCM without SKM	O	X
		Tailgate open control in BCM with SKM	X	O

Function			SKM without BCM	SKM with BCM
15	Theft deterrent control	Theft deterrent mode control in control	O	X
		Theft deterrent mode control in smart BCM	X	O
16	Time lag power window control	Time lag power window control	O	O
17	System power sleep mode	System power sleep mode control	O	O
18	Flasher (blinking) function	LH turn signal control	O	O
		RH turn signal control	O	O
		Hazard warning flasher switch control	O	O
		Hazard warning flasher indicator control	X	X
		Auto hazard warning flasher control	O	O
		Emergency hazard warning flasher control (coupled with ABS)	O	O
19	DRL (Daytime Running Light) control	DRL (Daytime Running Light) control	X	X
20	Fog lamp control	Fog lamp control	O	O
21	Auto light control (LIN)	Auto light control	O	O
22	Immobilizer function	Key coding and synchronization	O	X
		Challenge	O	X
		CAN information	O	X
23	Mirror folding/unfolding control	Folding/unfolding control	O	O
		Auto folding/unfolding control	O	O
24	Approach (puddle) lamp control	Approach (puddle) lamp control in BCM without SKM	O	X
		Approach (puddle) lamp control in BCM with SKM	X	O
25	SKM warning buzzer control	SKM warning buzzer control	X	O
26	Diagnosis function		O	O

3. MAJOR CHANGES



Emergency hazard warning flasher control	
Previous	**Current**
Operating condition If the emergency braking signal is received, the hazard warning flasher blinks 4 times/second for 10 seconds. **Deactivation conditions:** 1. Returns to normal operation after blinking 4 times/second 2. Deactivated when hazard warning flasher switch is pressed once during operation by emergency braking signal	**Operating condition** If the emergency braking signal is received, the hazard warning flasher blinks 4 times/second for 10 seconds. **Operation priority** Hazard warning flasher switch → Emergency braking signal → Emergency hazard warning flasher → Multi-function automatic hazard warning flasher **Deactivation conditions:** 1. Vehicle speed exceeds 50 km/h when emergency braking signal is received 2. (activated at speed of 50km/h or less) Vehicle speed increases more than 10 km/h above the speed when the signal is received during operation by emergency braking signal Turn emergency hazard warning flasher switch OFF during operation by emergency braking signal Deactivated automatically 10 seconds after if items 2) and 3) above are not met during operation by emergency braking signal If multi-function automatic hazard warning flasher signal is received during operation by emergency braking signal, it will be overridden.



Seat belt reminder (SBR)	
Previous	**Current**
If the driver seat belt is not fastened with the ignition switch ON, engine running and vehicle speed above 10 km/h, the seat belt reminder is activated. In addition, even though the vehicle speed reduces to below 10 km/h after the reminder is activated at speed of 10 km/h or higher, it will remain activated.	If the driver seat belt is not fastened with the ignition switch ON, engine running and vehicle speed above 25 km/h, the seat belt reminder is activated. In addition, if the seat belt reminder is activated at the speed of 25 km/h or higher and the speed reduces to below 25 km/h within 5 minutes, the interior buzzer sound stops. The buzzer sounds for 5 minutes again when the speed is 25 km/h or higher.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW & FUNCTIONS

BCM (Body Control Module) controls the electric equipment on car body and outputs the control and warning signals as below.

<Table 1>

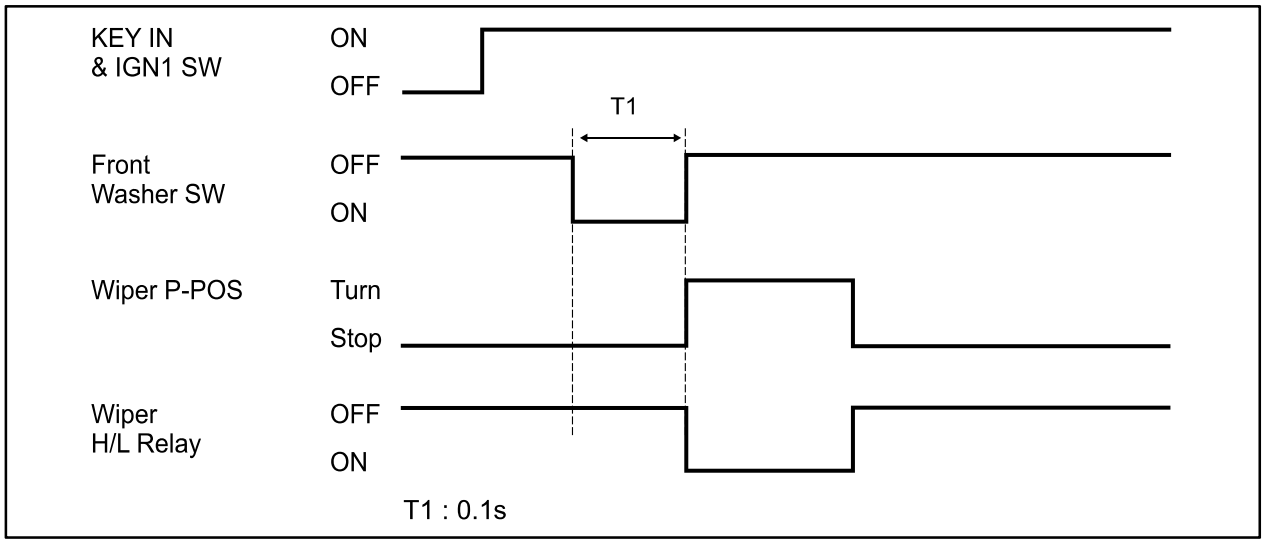
List	Function	List	Function
1	Wiper control	14	Tailgate open control
2	Ignition key reminder warning	15	Theft deterrent
3	Tail lamp control	16	Time lag power window control
4	Door ajar warning	17	System power sleep mode
5	Seat belt control	18	Flasher function
6	Sunroof warning	19	DRL (daytime running lamp) control
7	Room lamp control	20	Fog lamp control
8	Key hole illumination control	21	Auto light control (LIN)
9	Defogger control	22	Immobilizer function
10	Keyless entry function	23	Folding/unfolding function
11	Door lock/unlock control	24	Approach (puddle) lamp control
12	Panic alarm	25	SKM warning buzzer control
13	Headlamp control (escort)	26	Diagnosis function

1) Wiper Control

(1) Wiper mist & front washer coupled wiper

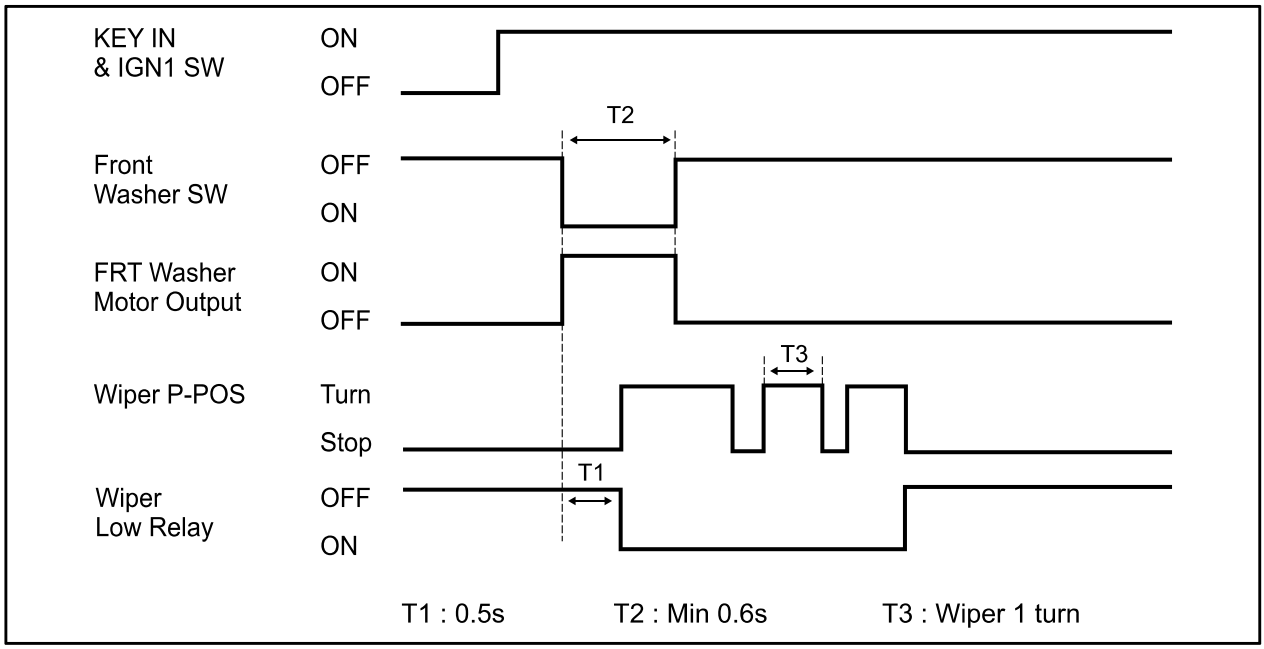
▶ Wiper mist

1. When the multi-function switch is rotated for more than 0.1 second to activate the mist mode with IGN1 ON, the wiper relay is activated after 0.1 second. It will be deactivated when the wiper motor is in the parking position.
2. While the wiper operates at high speed when the mist switch signal is received, it operates at low speed if the switch is returned to its starting position.



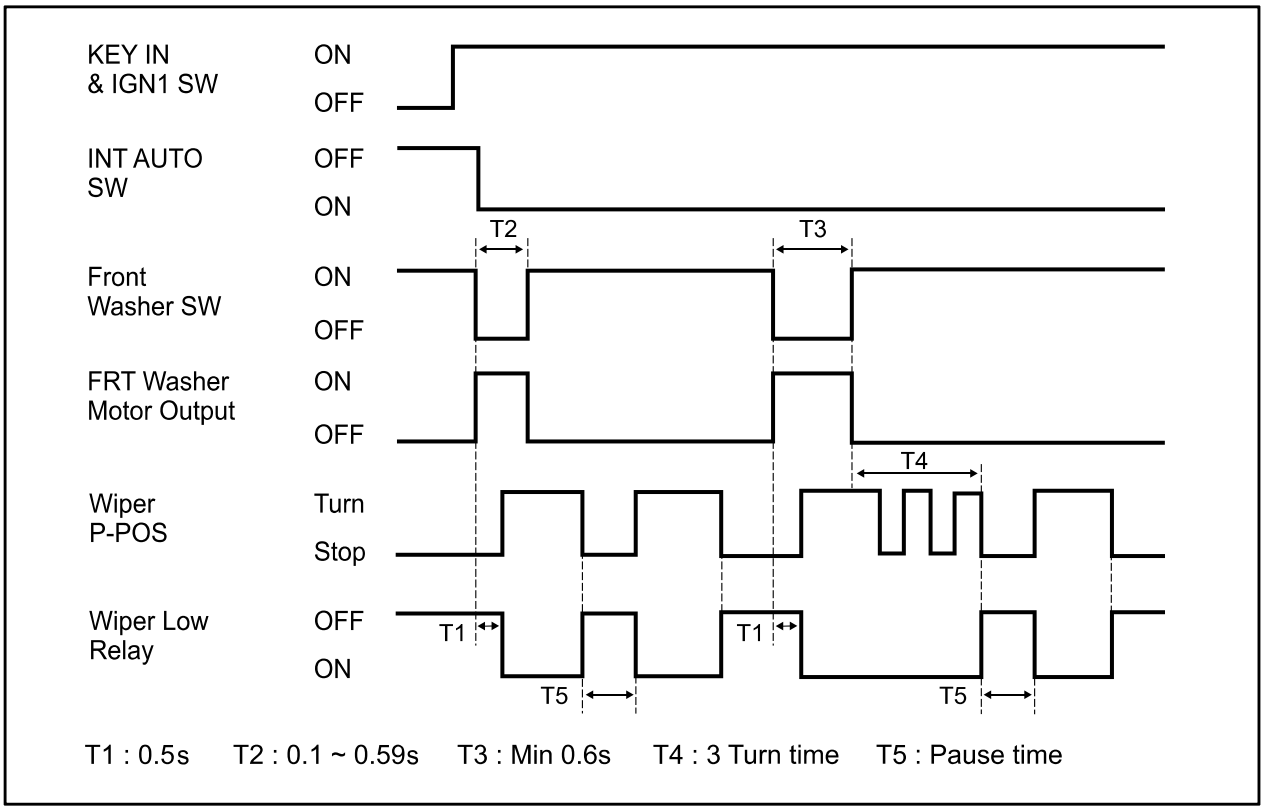
▶ Front washer coupled wiper

1. When holding the front washer switch at ON position for more than 0.6 seconds with IGN ON, the wiper relay is activated 0.5 seconds after. The wiper stops after three more wipes since that the washer switch is turned to "OFF" position.



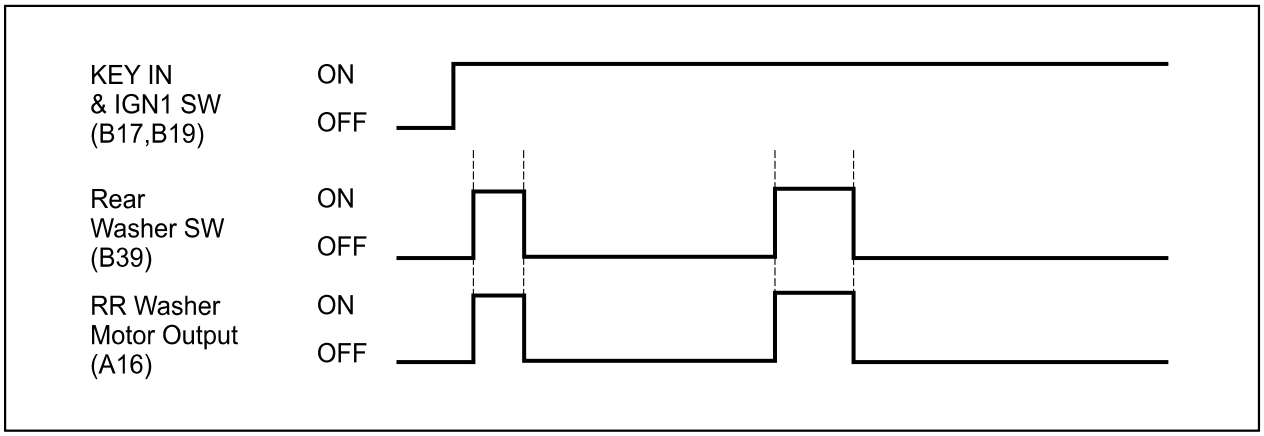
Modification basis	
Application basis	
Affected VIN	

3. When holding the front washer switch at ON position for 0.1 to 0.59 seconds during the wiper operation by the intermittent/automatic wiper switch, the wiper will operate only once. When holding the washer switch for more than 0.6 seconds, the wiper relay is activated 0.5 seconds after. The wiper stops after three more wipes since that the washer switch is turned to "OFF" position.



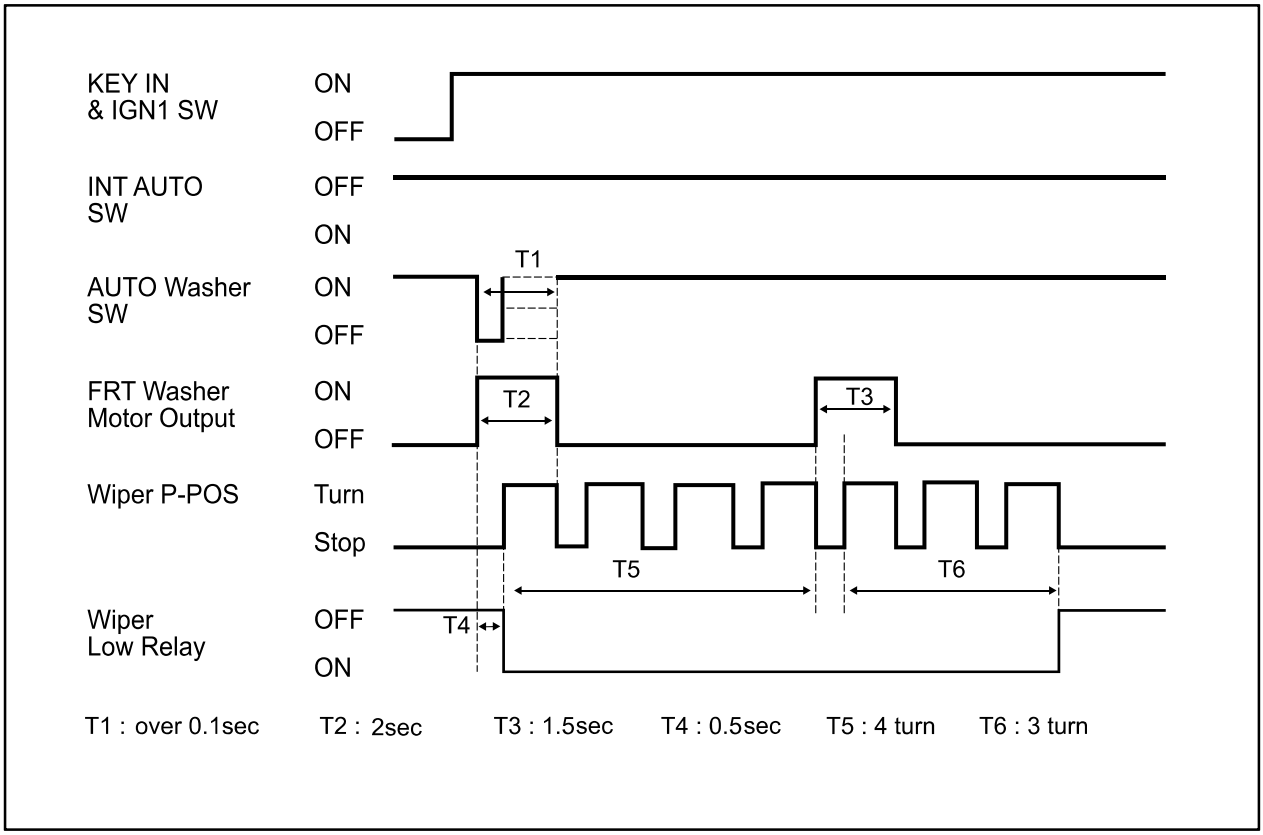
▶ Rear washer motor control

1. When turning ON the rear washer switch with the key inserted and IGN ON, the washer fluid is sprayed the side fascia panel.
2. If the front washer or automatic washer switch signal is received during the rear washer switch operation, the washer motor stops and the front washer or automatic washer motor begins to operate.

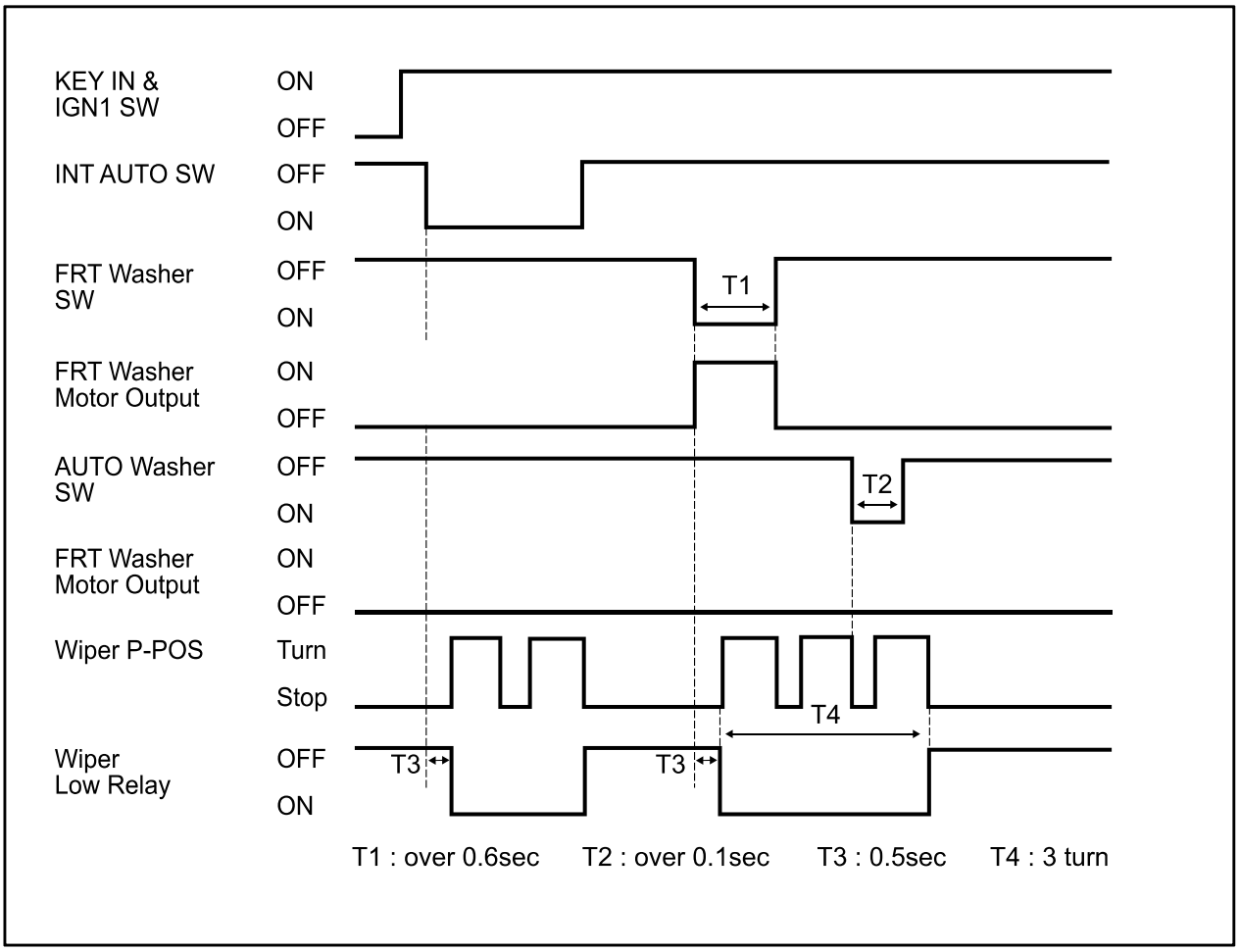


▶ Auto washer coupled wiper

1. When turning ON the auto washer switch with IGN ON and intermittent/automatic wiper switch OFF, the washer fluid is sprayed onto the windshield glass for 2 seconds and the wipers operate 4 times. After then, additionally, the washer fluid is sprayed for 1.5 seconds and the wipers operate 3 times again.
2. The auto washer switch signal is overridden during speed sensitive intermittent wiper, washer coupled wiper or auto washer coupled wiper operation.
3. When turning the wiper switch to AUTO position during the operation of auto washer, the auto washer stops its operation and the intermittent/automatic wiping mode will be started.
4. The front and rear washer switch signal are overridden during the operation of auto washer.

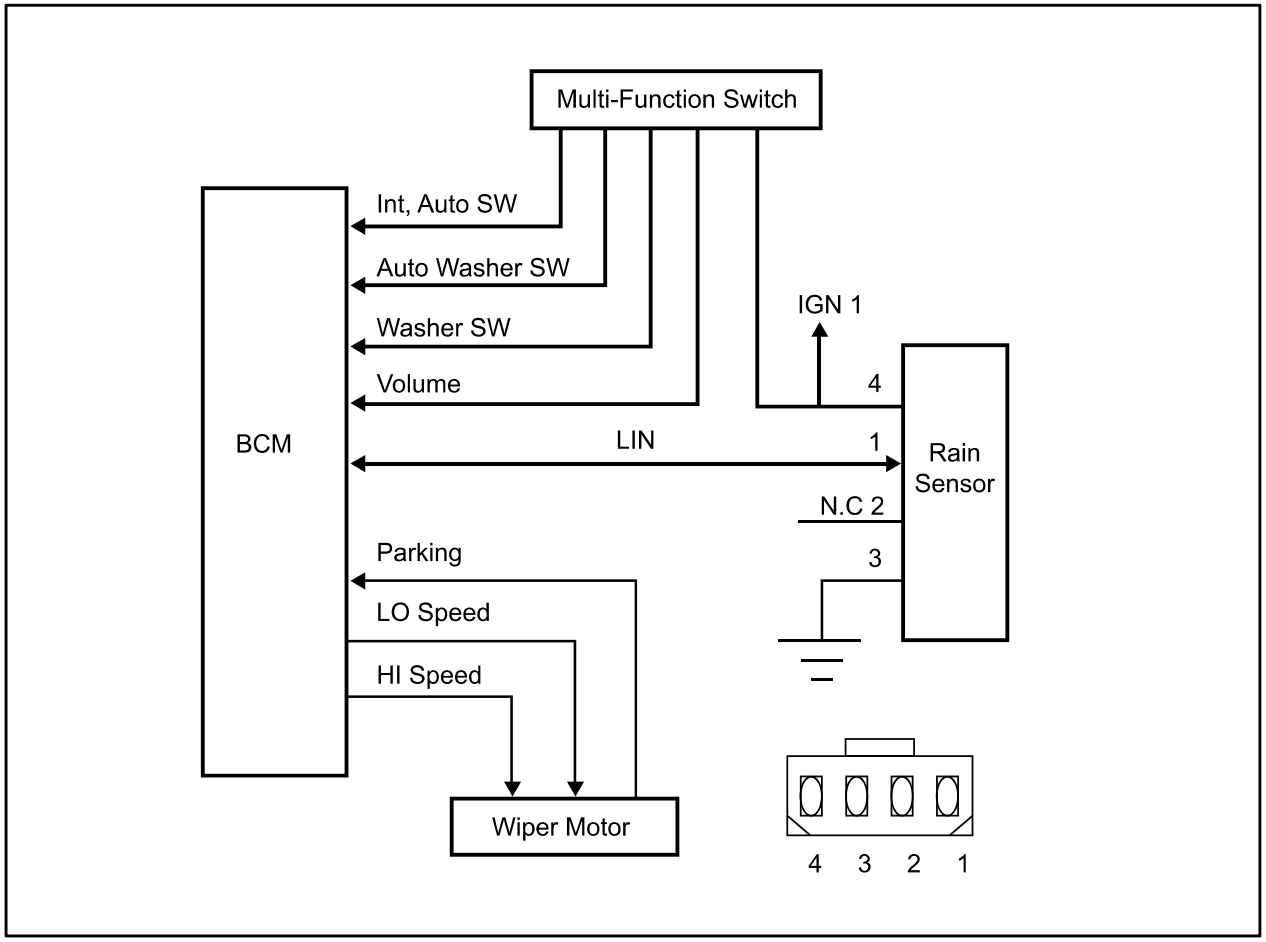


Modification basis	
Application basis	
Affected VIN	


KEY IN & IGN1 SW
ON
OFF
INT AUTO SW
OFF
ON
FRT Washer SW
OFF
ON
T1
FRT Washer Motor Output
ON
OFF
AUTO Washer SW
OFF
ON
T2
FRT Washer Motor Output
ON
OFF
Wiper P-POS
Turn
Stop
T4
Wiper Low Relay
OFF
ON
T3
T3
T1 : over 0.6sec
T2 : over 0.1sec
T3 : 0.5sec
T4 : 3 turn

▶ **Rain sensor coupled wiper (LIN)**

1. System layout



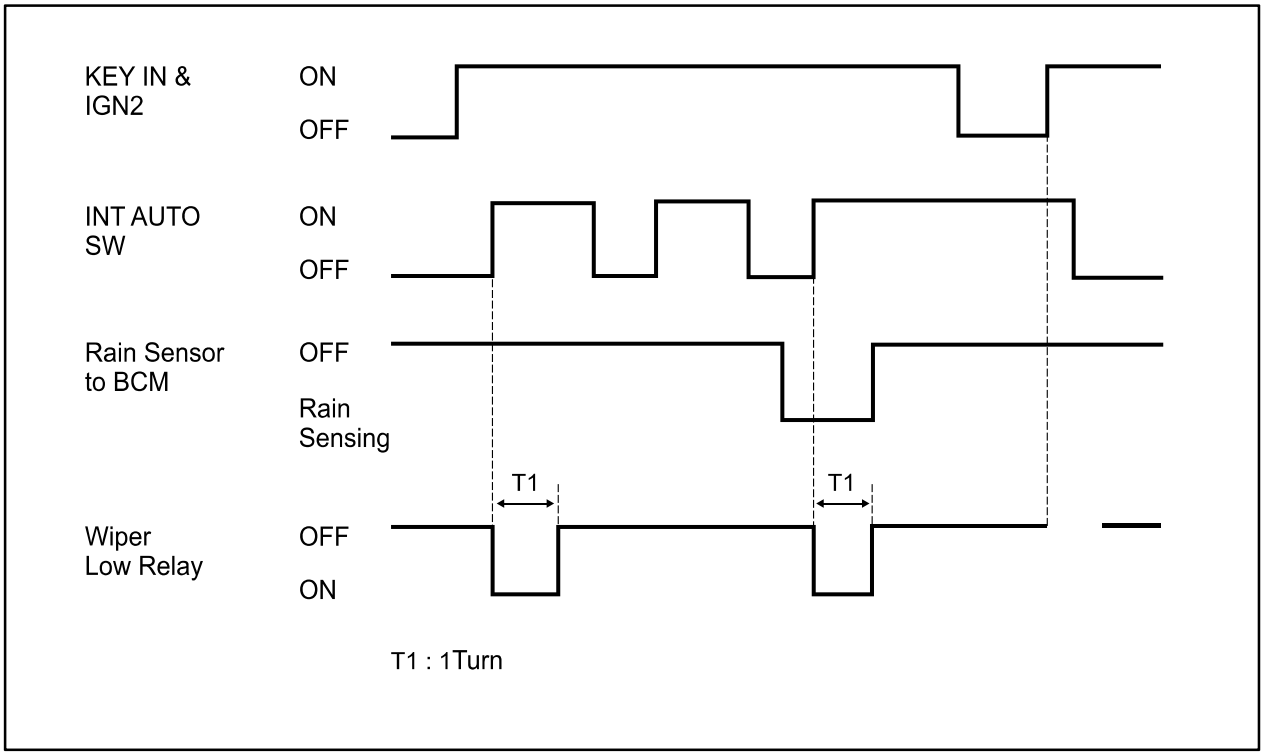
2. Data recognition & operation

- **Data recognition time**
  The system performs LIN communication regardless of the conditions of wiper and light switch when the ignition switch is in ON position. If the intermittent/automatic wiper switch is in "AUTO" and the light switch is in "AUTO" position, the wiper system operates according to the LIN data.
  The data received from the rain sensor is recognized for 2 times consecutively.
- **Operation when recognizing data**
  No data: wiper low/high relay OFF
  Low speed signal: low relay ON (ON for at least one cycle), but high relay OFF
  High speed signal: high relay ON (ON for at least one cycle), but low relay OFF
  The washer switch signal is overridden during continuous operation of the wiper.
  (Washer coupled wiper function is available only during intermittent operation)

Modification basis	
Application basis	
Affected VIN	

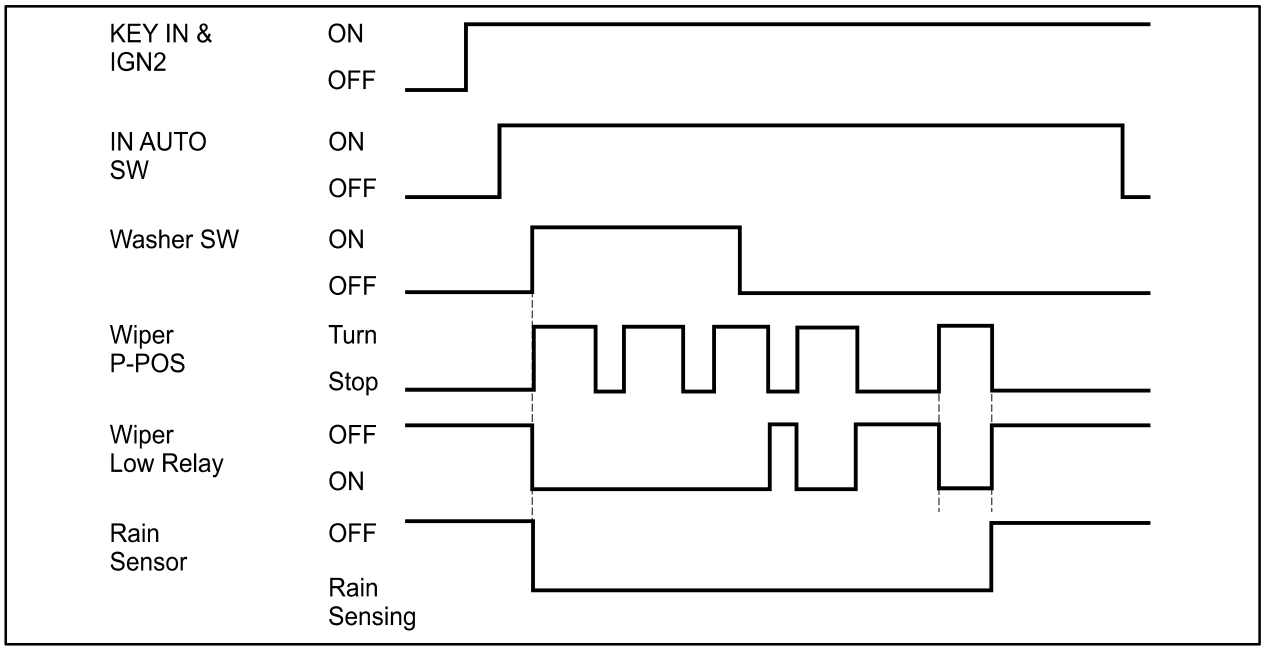
▶ Power-up reminder wiper

1. If the intermittent/automatic wiper switch is in "ON" position, the wiper motor does not operate even when turning the ignition switch to ON from OFF position.
2. When turning the intermittent/automatic wiper switch to ON from OFF position with IGN ON, the wipers operate once at low speed initially regardless of the communication with the rain sensor. After that, the wipers operate once at low speed only when the rain sensor detects the side fascia panel.



▶ **Washer coupled wiper in rain sensing mode**

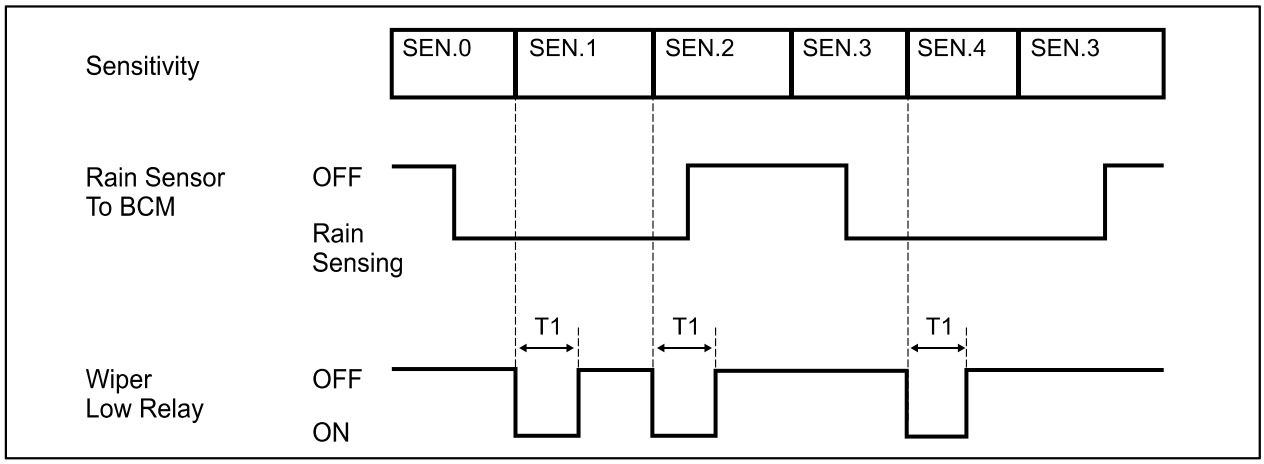
1. When the washer switch signal is received during intermittent operation coupled with rain sensor with IGN ON and intermittent/automatic washer switch operation, the wipers operate in washer coupled mode regardless of the communication with the rain sensor. However, if the washer switch signal is received the washer relay is activated and wiper relay remains activated, when the data coupled with rain sensor indicates continuous wiper operation.
2. Even though the wiping system is in washer coupled wiper mode, the operating data are sent to rain sensor.



▶ **Sensitivity adjustment (instant wiping)**

1. When the wiping speed control switch is turned to "FAST" with IGN2 ON, intermittent/automatic wiper switch in "ON" position and wiper motor stop (parking position), the wiper motor operates one cycle at low speed.
   (only when the rain sensor detects raindrops)

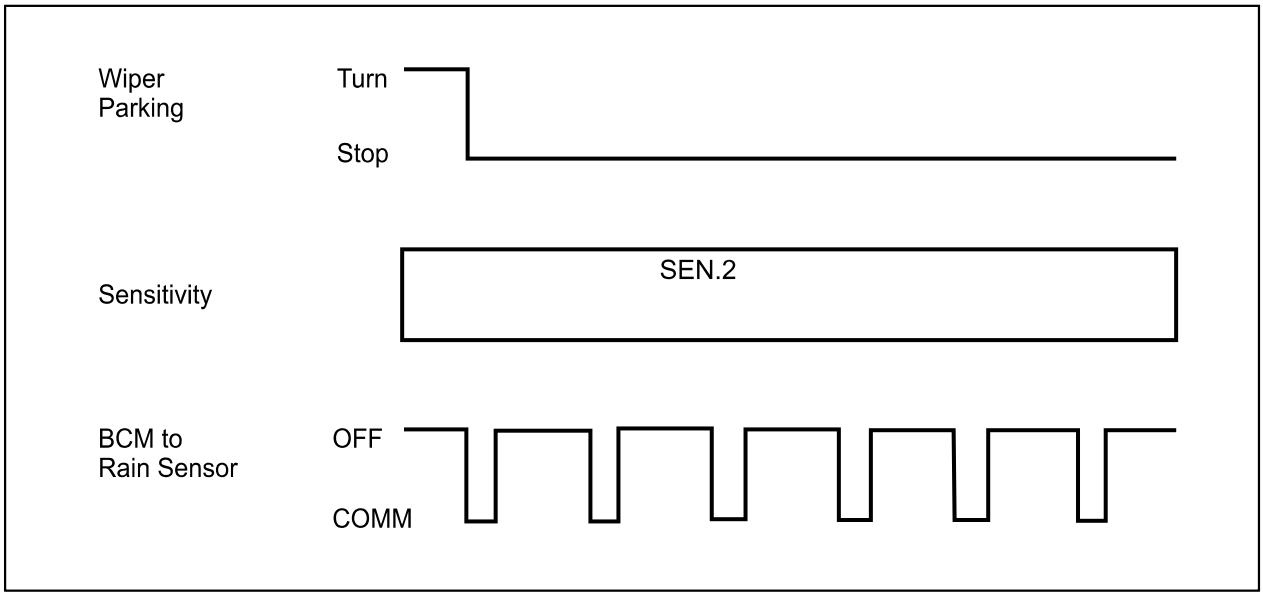
* If the wiping speed control switch is changed more than 2 stages within 2 seconds, the wiper motor operates only one cycle.



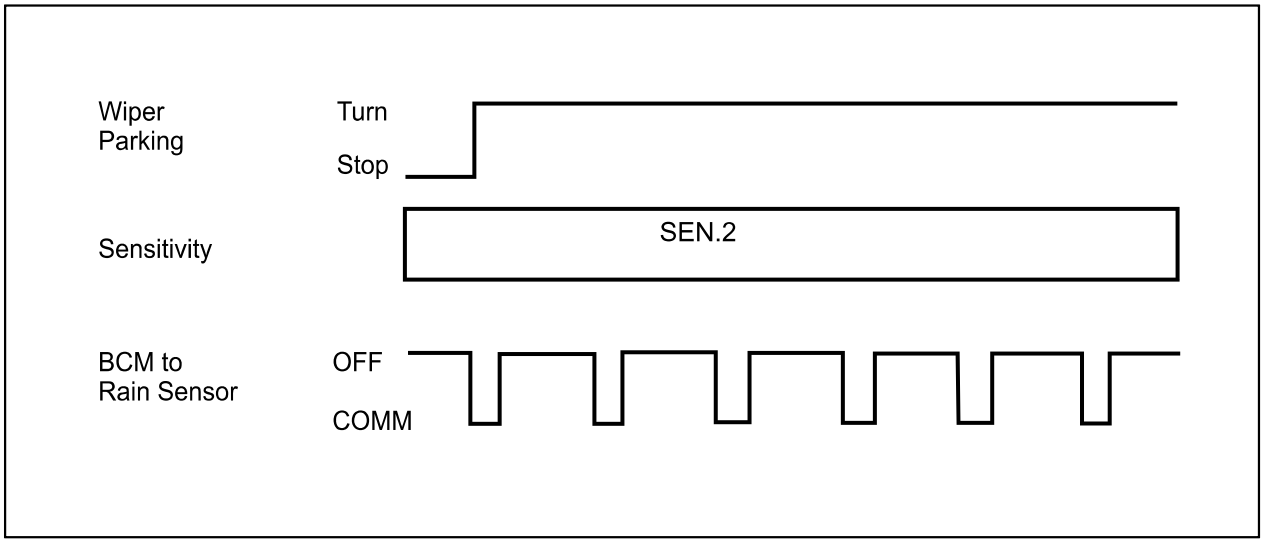
Modification basis	
Application basis	
Affected VIN	

▶ Processing method for abnormal wiper parking signal

1.* The wiper system sends continuously the signal for current status when the wiper parking terminal is shorted to ground with IGN2 ON and intermittent wiper switch in "ON" position.
The wiper motor runs only when the rain sensor requires the wiper operation.

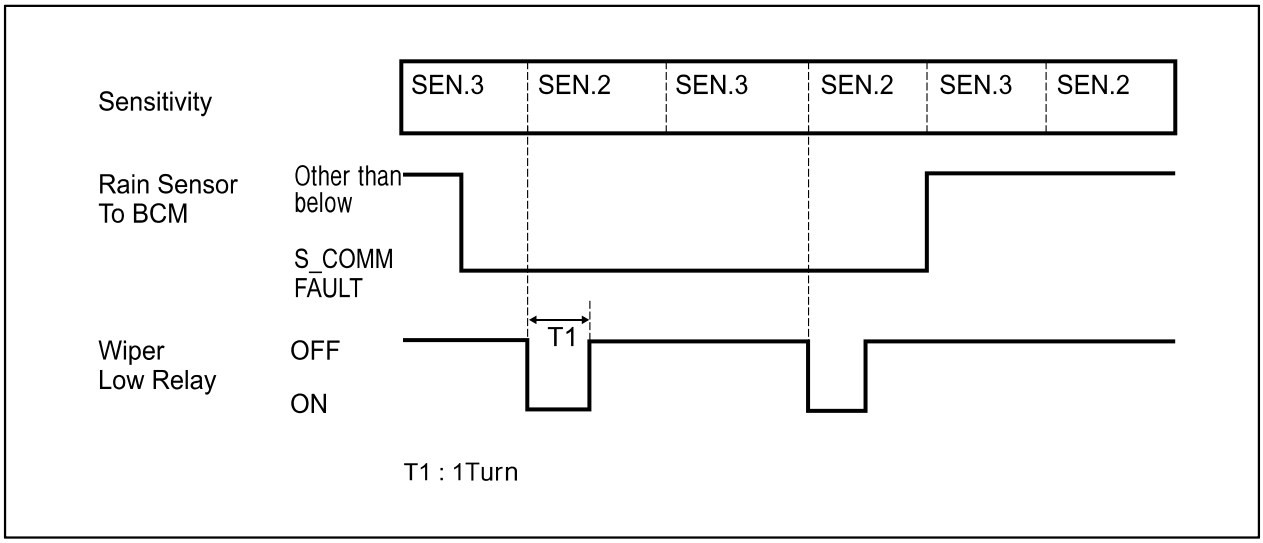


2.* When the parking terminal is shorted to power with IGN2 ON and intermittent wiper switch in "ON" position, the wiper system sends the signal for current wiping status for 2 seconds. After that, it sends the current signal for parking status continuously.
The wiper motor runs only when the rain sensor requires the wiper operation.

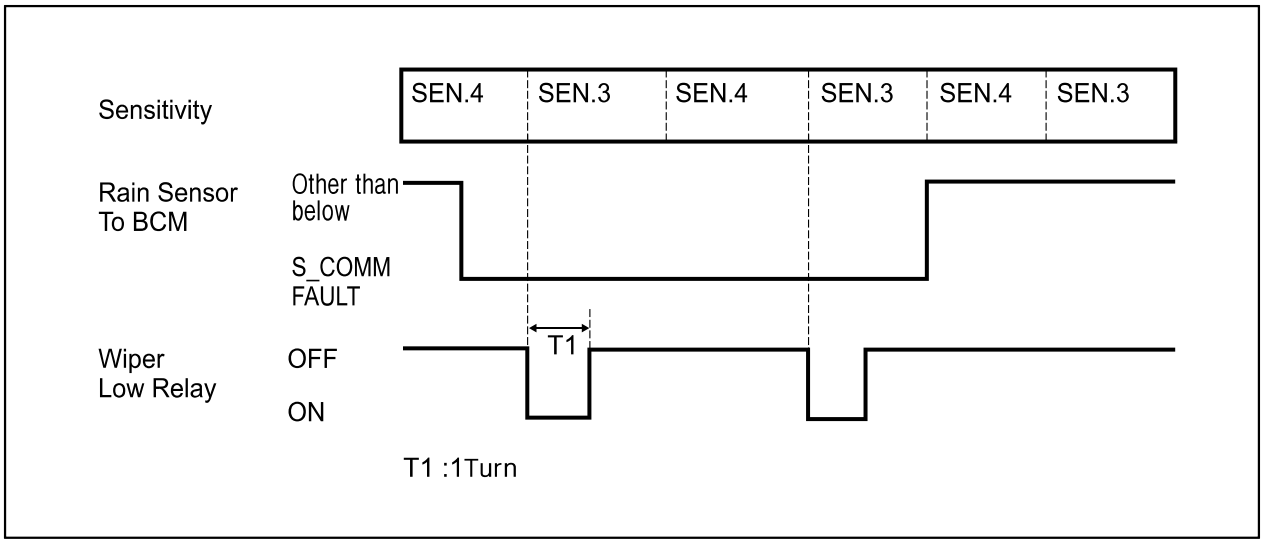


▶ **Processing method for rain sensor malfunction**

1. If the BCM is received the signal for sensor malfunction from the rain sensor unit when turning the wiping speed control switch to 2 from 3 stage with IGN ON and intermittent/automatic wiper switch in "ON" position, the wiper motor operates one cycle at low speed.



2. If the BCM is received the signal for communication error from the rain sensor unit when turning the wiping speed control switch to 3 from 4 stage with IGN ON and intermittent/automatic wiper switch in "ON" position, the wiper motor operates one cycle at low speed.

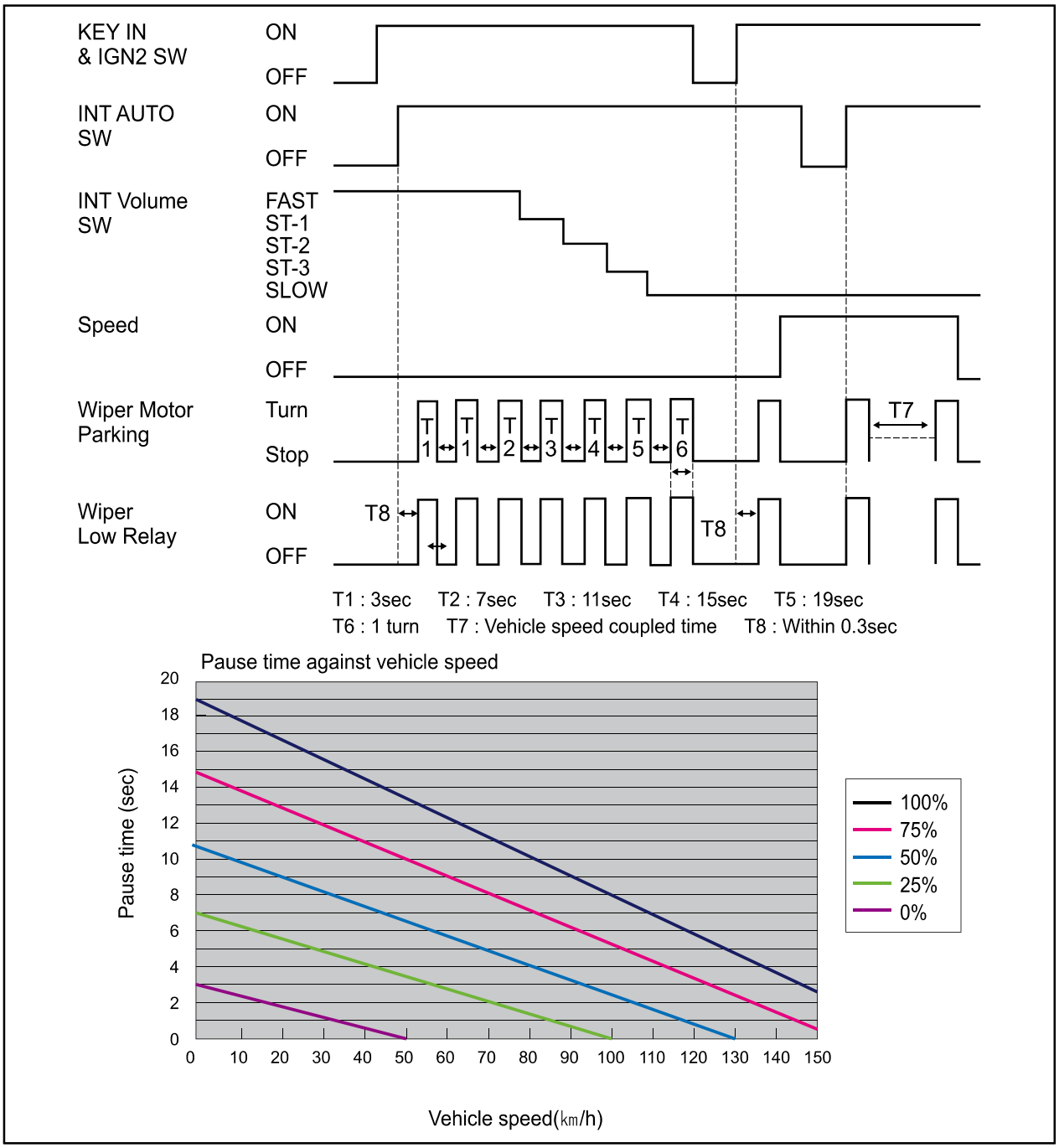


Modification basis	
Application basis	
Affected VIN	

▶ Speed sensitive intermittent wiper

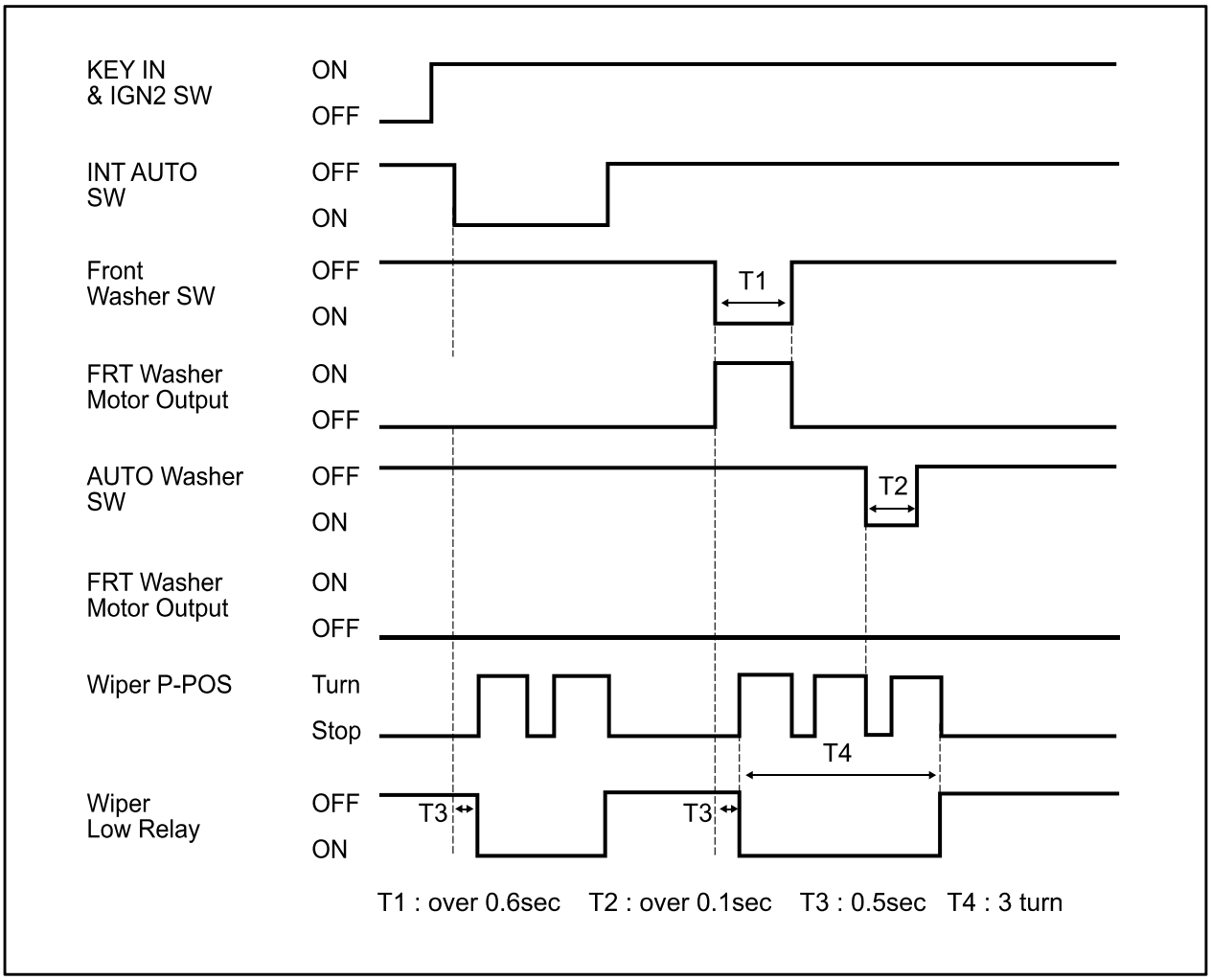
The BCM without rain sensor operates the wiper as follows:

1. When turning the ignition switch to ON from OFF position with the intermittent wiper switch in "ON" position, the wipers do not operate.
2. When turning the wiper switch to ON from OFF position after turning the ignition switch to ON position, the wipers operate one cycle.
3. The wiper's operation cycle depends on the vehicle speed (CAN communication with instrument cluster) and wiping speed the side fascia panel.
   - Operation cycle: 3±0.5 sec (FAST) to 19±2 sec (SLOW)



▶ Wiper low/high control

1. The wiper low relay is activated when the wiper low switch is operated and the wiper high relay activated when the wiper high switch is operated.
2. The wiper motor returns to parking position and stops, even when turning off the ignition switch during wiper operation.
3. The wiper relay should remain activated during wiper operation in low/high mode even though the system does not receive P-POS signal. (During intermittent/automatic wiper operation, the wiper relay should be deactivated after 5 seconds if there is no P-POS signal for 3 seconds in order to inform the driver of faulty signal)
4. While the wiper operates at low/high speed, the front/rear washer switch can be operated but the auto washer switch cannot.
5. The wiper motor returns to parking position and stops when turning off the ignition switch during wiper operation in high mode.

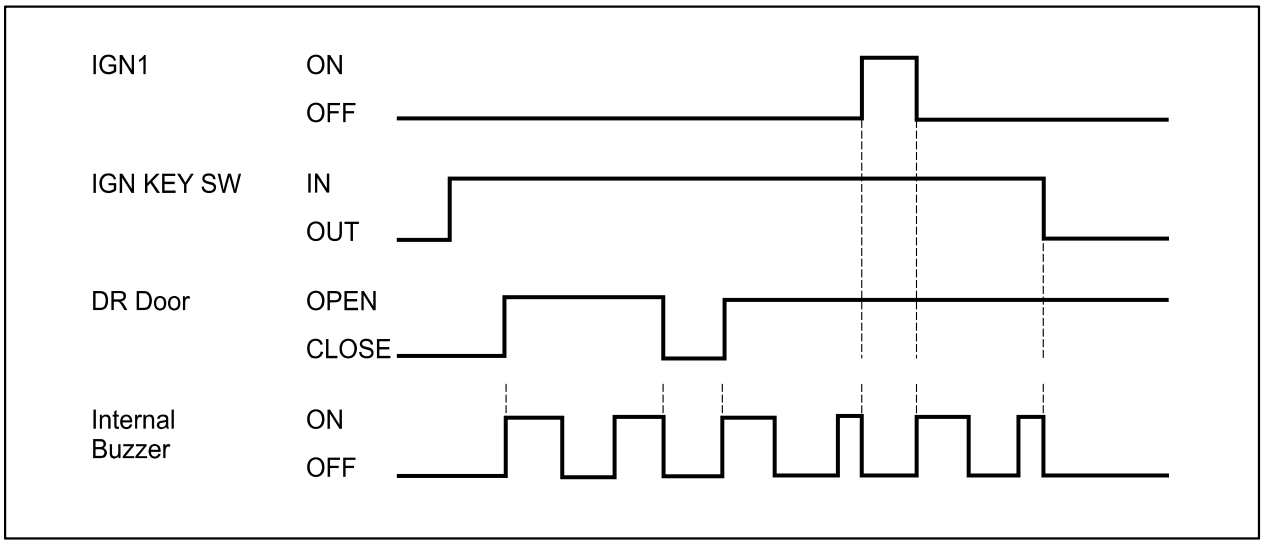


Modification basis	
Application basis	
Affected VIN	

2) Ignition Key Reminder

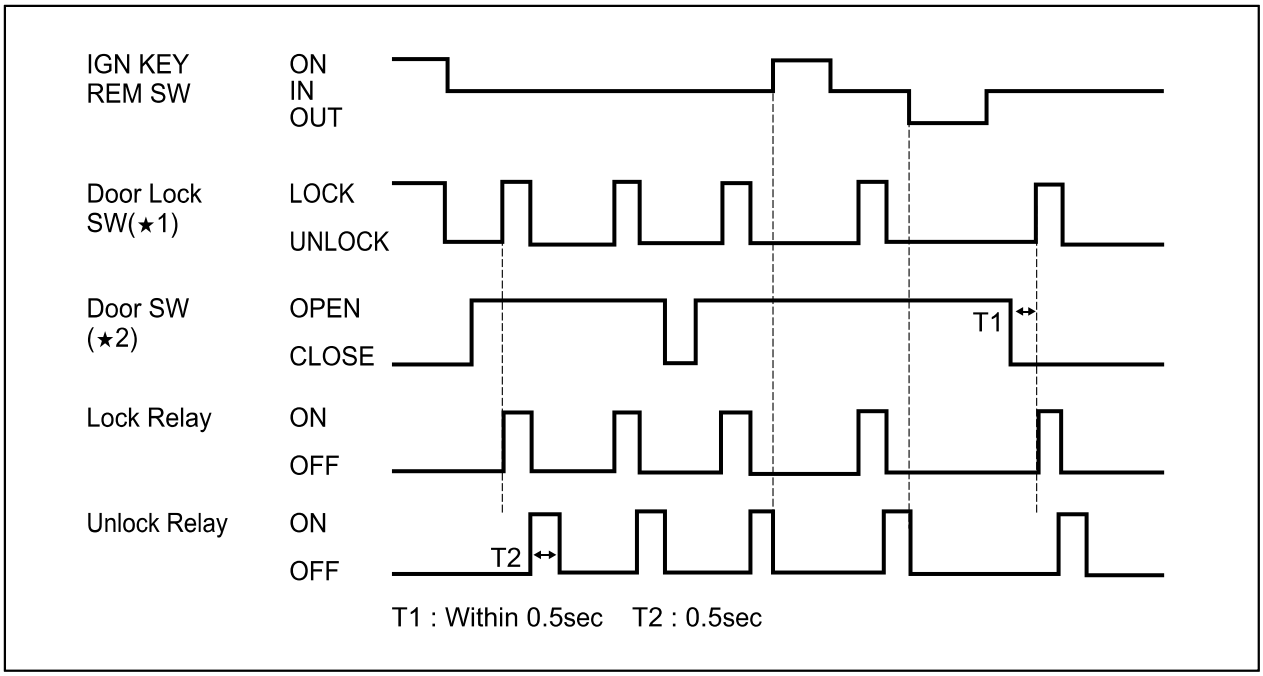
▶ **Key reminder warning**
(This function has priority over the "Tail lamp on warning".)

1. When opening the driver door while the ignition key is inserted into the key cylinder, the buzzer sound for 10 seconds with the interval of 0.02 s ON and 1.38 s OFF.
2. When removing the ignition key or closing the driver door during the buzzer output (within 10 seconds), the buzzer stops its operation.
3. This function is not available when the ignition switch (IGN1) is in "ON" position.



▶ Ignition key reminder

1. When opening a front door or turning on the door lock switch while the ignition key is inserted into the key cylinder, the doors are locked for 0.5 seconds, and unlocked.
2. The door remain unlocked even when the door lock switch is received "door lock" signal within 0.5 seconds after opening and closing the door.
3. However, the doors should not be unlocked when removing the ignition key during the locking process by door lock switch.



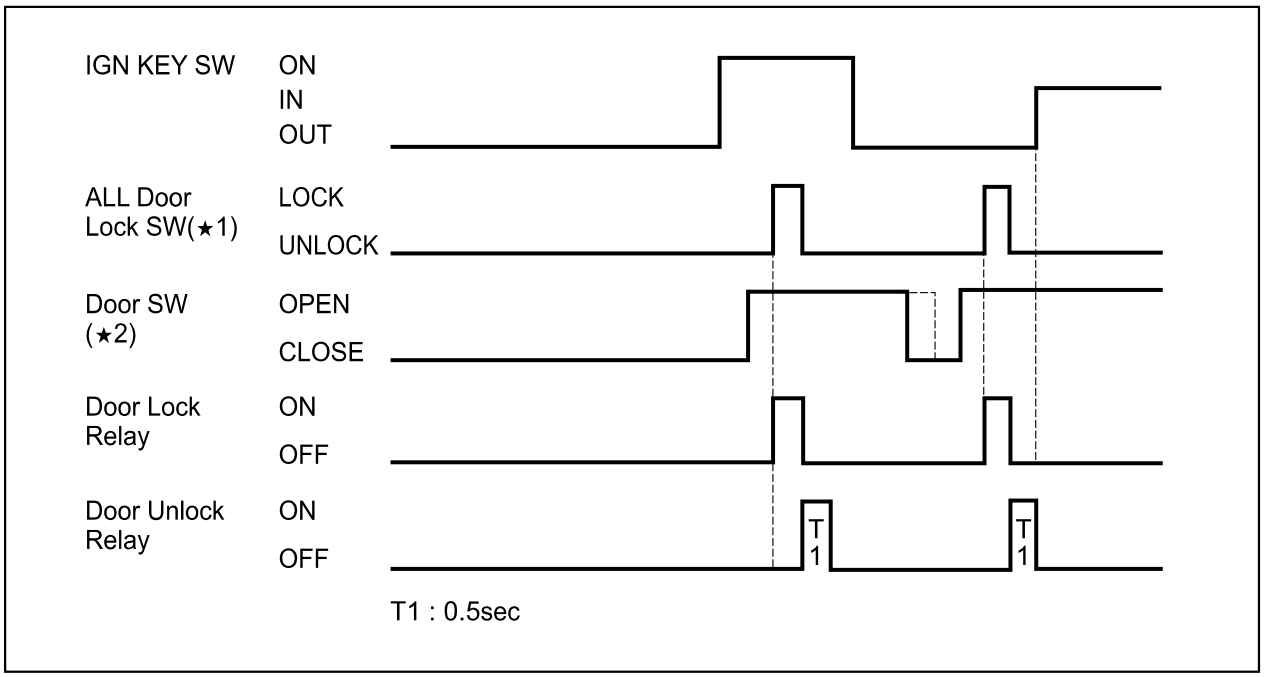
(*1) : Driver door lock switch or passenger door lock switch

(*2) : Driver door switch or passenger door switch

Modification basis	
Application basis	
Affected VIN	

▶ Anti-lock function when a door is open

1. If any of doors (except tailgate and engine hood) is open, the doors are locked once but immediately unlocked when receiving the lock signal.
2. The door remains unlocked for 0.5 seconds when closing the door during unlock.
3. The system also performs operation as above while the key is removed or the ignition switch is turned to "ON" position. The ignition key reminder function is activated while the ignition key is inserted into the key cylinder.
4. This function is not available when the vehicle speed is over 10 km/h.



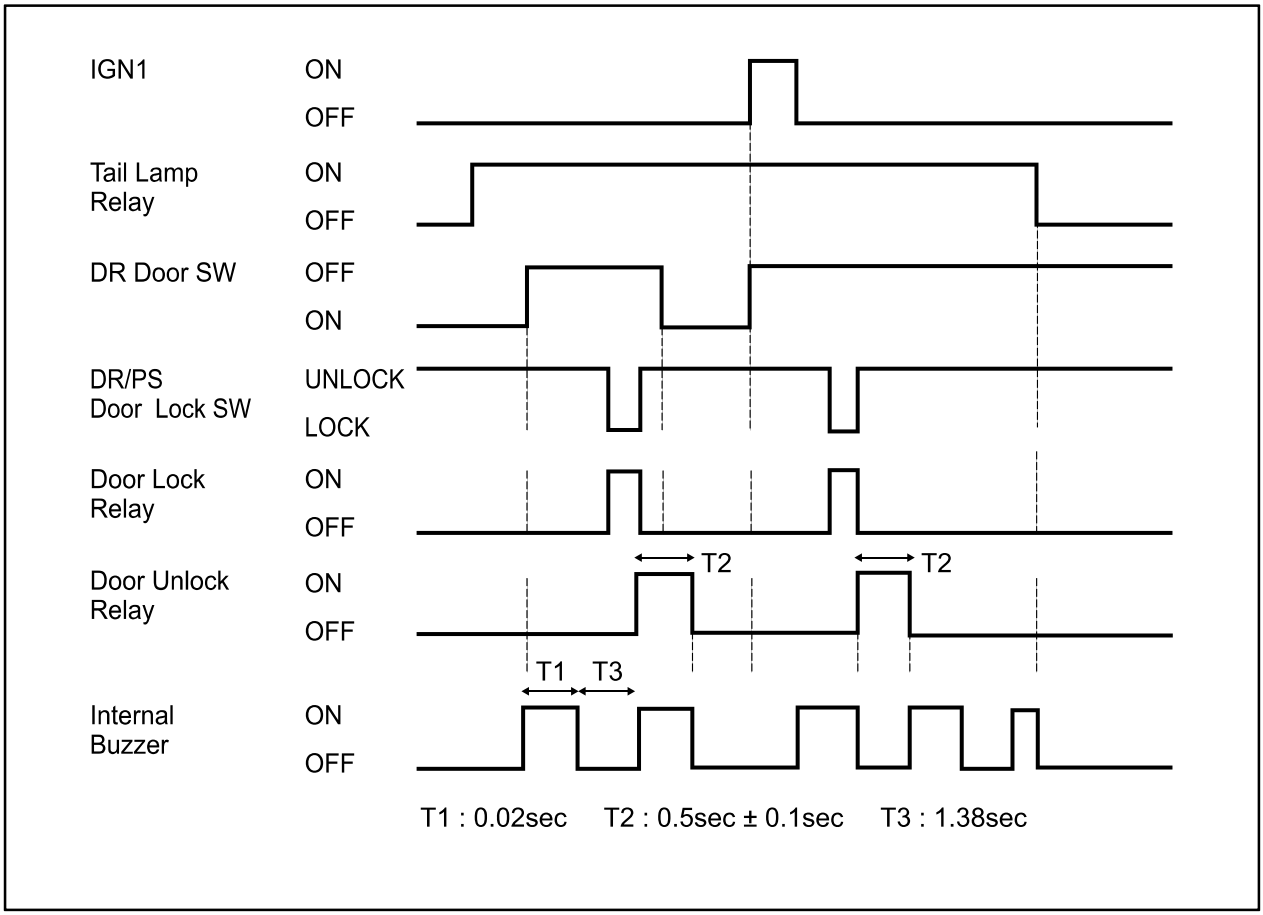
(*1) : Driver door lock switch or passenger door lock switch

(*2) : Driver door switch or passenger door switch

3) Tail Lamp

▶ **Tail lamp left ON warning (sunroof and ignition key reminder functions have priority)**

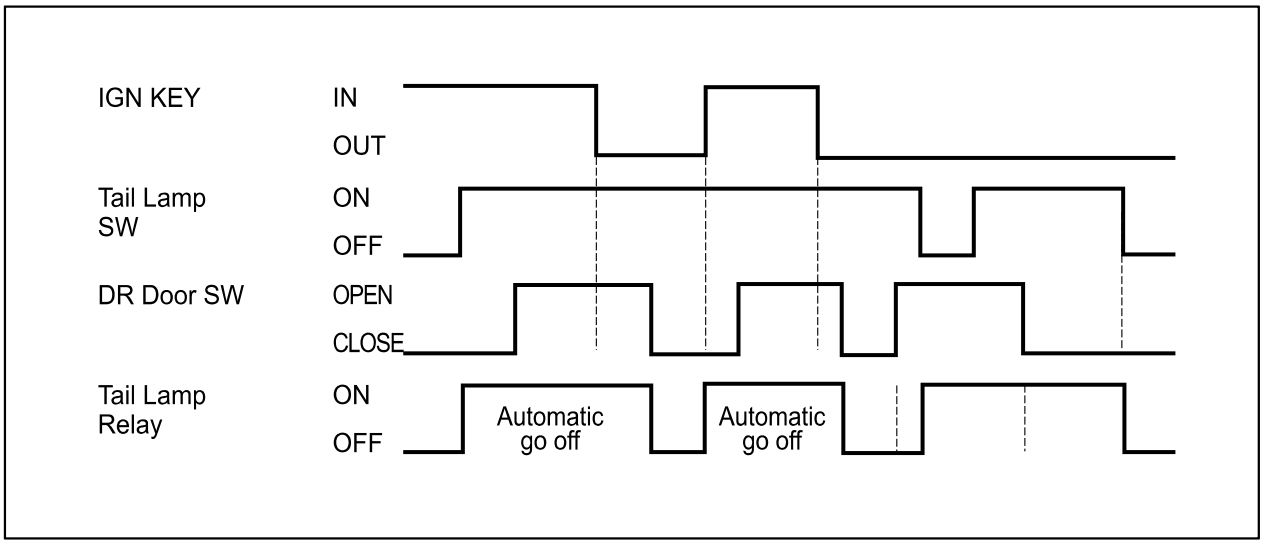
1. The buzzer sounds for 10 seconds with the interval of 0.02 s ON and 1.38 s OFF when opening the driver door with the key removed (without SKM)/with IGN OFF or ACC (with SKM) and tail lamp ON. The buzzer stops its operation when turning off the tail lamp or closing the driver door during buzzer
2. operation. The buzzer stays ON when turning the tail lamp on again after turning it off during buzzer operation.
   This function is not available when the ignition switch (IGN1) is in ON position.
3.



Modification basis	
Application basis	
Affected VIN	

▶ Tail lamp auto OFF

1. When opening and closing the driver door after turning off the ignition with the tail lamp ON, the tail lamps go off automatically.
2. The tail lamps come on again when inserting the ignition key (without SKM) and turning on the ignition (with SKM) after tail lamp auto OFF.
3. The tail lamp should not go off when turning on the tail lamp switch with the ignition key removed (without SKM) and with power off or ACC ON (with SKM).



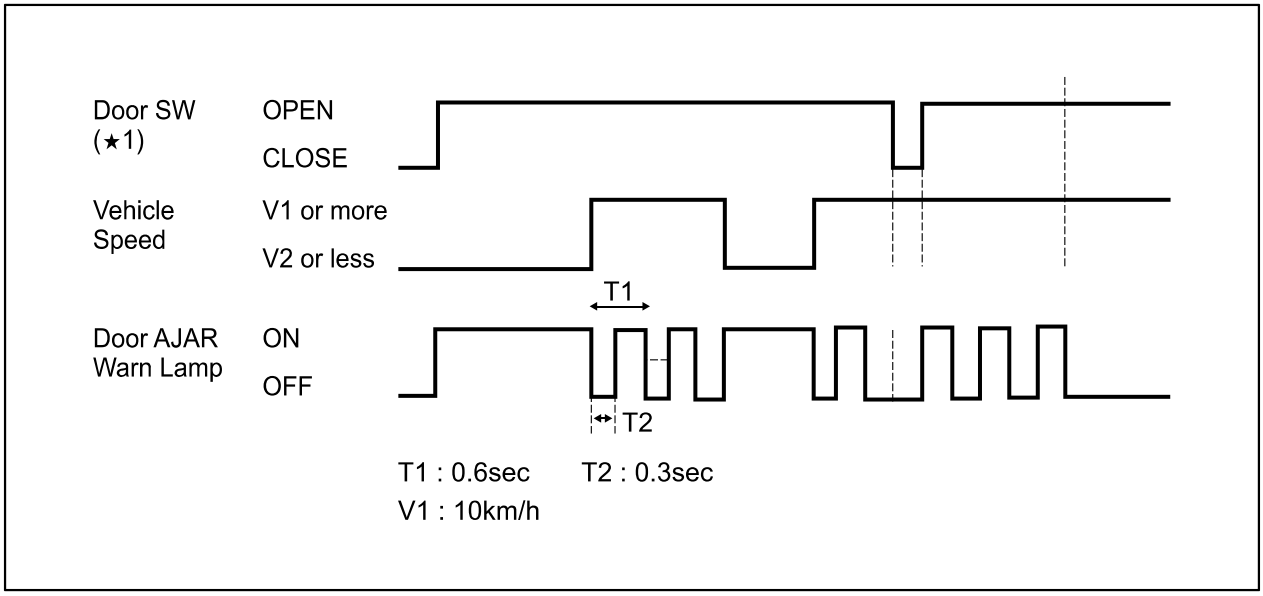
▶ Tail lamp ON warning (with SKM)

1. The tail lamp ON warning signal is sent via the BCAN communication when the tail lamp remains ON with the ignition key OFF or ACC.

4) Door Ajar Warning

While the BCM without SKM controls the warning lamp, the BCM with SKM controls the warning lamp and sends the signal via the BCAN communication. But, this control is available only when any of doors or tailgate, except engine hood, is open.

1. The instrument cluster controls the door ajar warning lamp according to the signal from the BCM. (However, the BCM controls the door ajar warning lamp with the electric wire together with the BCAN communication.)
2. Also, the instrument cluster controls the blinking function according to the vehicle speed. (However, the BCM controls the door ajar warning lamp blinking with the electric wire together with the BCAN communication.)



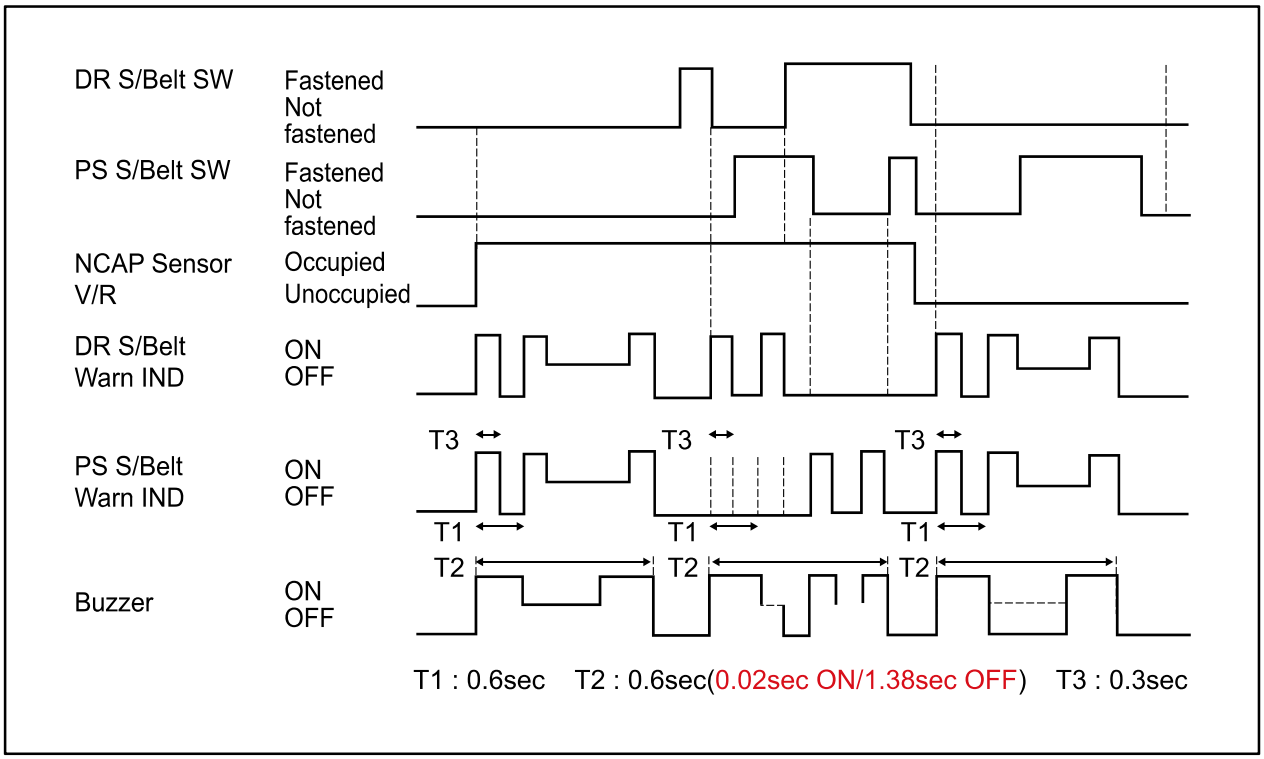
(*1) : Ajar: Driver, passenger, rear door or tailgate is open
Close: Driver, passenger, rear door and tailgate are closed

Modification basis	
Application basis	
Affected VIN	

5) Seat Belt

▶ Seat belt warning

1. When turning the ignition switch (IGN1) to ON from OFF position, the BCM sends the driver and front passenger seat belt warning signals to the instrument cluster module through the CAN communication, and the buzzer sounds for 0.6 seconds with the interval of 0.02 s ON and 1.38 s OFF. If the driver/passenger seat belts are fastened, the buzzer does not sound but the warning lamp blinks during the period. (the buzzer is controlled by BCM and the warning lamp is controlled by ICM)
   For the passenger seat, however, the system detects if the passenger seat is empty or occupied and operates the warning lamp only for the first time.
   After that, the only seat belt reminder detects if the passenger seat is occupied.
   For the driver seat, the seat belt reminder operates only when the seat belt is not fastened at the vehicle speed of 25 km/h or higher.
   The instrument cluster module controls the driver/passenger seat belt warning lamps by receiving the
2. driver/passenger seat belt warning lamp signals.
   When turning the ignition switch (IGN1) to OFF position during the warning operation, the buzzer
3. stops and the warning lamp goes off.
   If the driver/passenger seat belt is fastened during the warning operation, the buzzer stops but the
4. warning lamp blinks for the remaining time of the period.
   If the driver/passenger seat belt signal changes to "unfastened" from "fastened" with IGN1 ON, the
5. driver/passenger seat belt warning lamp comes on and the buzzer sounds again for 0.6 seconds.
   But, if the condition for seat belt reminder operation is met during the warning operation, the warning operation stops and the seat belt reminder function is activated.



▶ **Seat belt reminder**

1. Operating conditions for seat belt reminder are as follows: IGN ON, engine running (over 300 rpm), vehicle speed of 25 km/h or higher, driver seat belt unfastened, passenger seat belt unfastened and passenger seat occupied. In addition, if the seat belt reminder is activated at the speed of 25 km/h or higher and the speed reduces to below 25 km/h within 5 minutes, the interior buzzer sound stops. The buzzer sounds for 5 minutes again when the speed is 25 km/h or higher.
2. The seat belt reminder stops its operation when fastening the seat belt, but starts the operation again if unfastening the seat belt.
3. If the seat belt reminder is initially operated due to unfastened driver seat belt, the buzzer sounds with the interval of 0.02s ON/1.18s OFF, the instrument cluster sends the driver seat belt warning signal (SBR) and the seat belt warning lamp stays on.
   At this time, the buzzer sounds for 5 minutes.
4. If the seat belt reminder is operated due to unfastened passenger seat belt when the passenger seat belt reminder sensor detects that the passenger seat is occupied, the instrument cluster sends the driver seat belt warning signal and the seat belt warning lamp stays on.
   For this case, the indicator shows each status of the driver and passenger seats but the indoor buzzer is common to both seats.
   If the simultaneous operating condition for the indoor buzzer is met, the driver seat has the priority.
   If the driver seat belt is fastened, the same operation is also carried out in the passenger seat automatically.
   The buzzer and the warning lamp are operated according to the vehicle speed as below table during the seat belt reminder operation.
5.

Seat belt reminder operation

Function / Vehicle speed	Buzzer	Warning lamp
25 Km/h ~ 49 Km/h	0.02s ON / 1.18s OFF	Keep ON
50 Km/h ~ 99 Km/h	0.02s ON / 0.98s OFF	Keep ON
10 Km/h ~ 49 Km/h	0.02s ON / 0.78s OFF	Keep ON

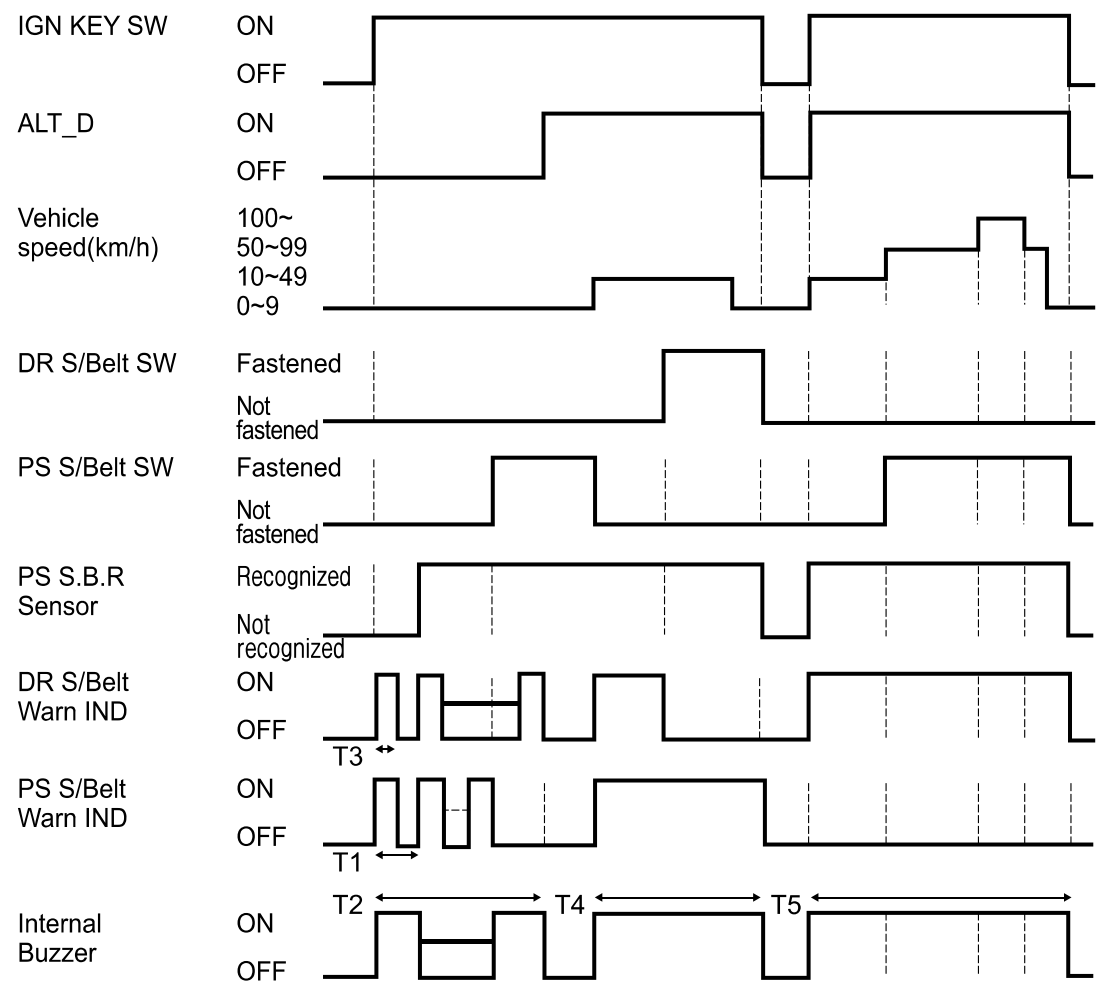
6. Priority of buzzer operation: SBR ⇒ Key reminder warning ⇒ Sunroof warning ⇒ Tail lamp ON warning ⇒ Hazard warning flasher ⇒ Turn signal lamp.

NOTE

Seat belt remind warning lamp (EU only)

- This lamp comes on for 6 seconds after turning on the ignition switch. If the vehicle speed goes over 10 km/h without fastened the seat belt, the inside buzzer sounds.

Modification basis	
Application basis	
Affected VIN	

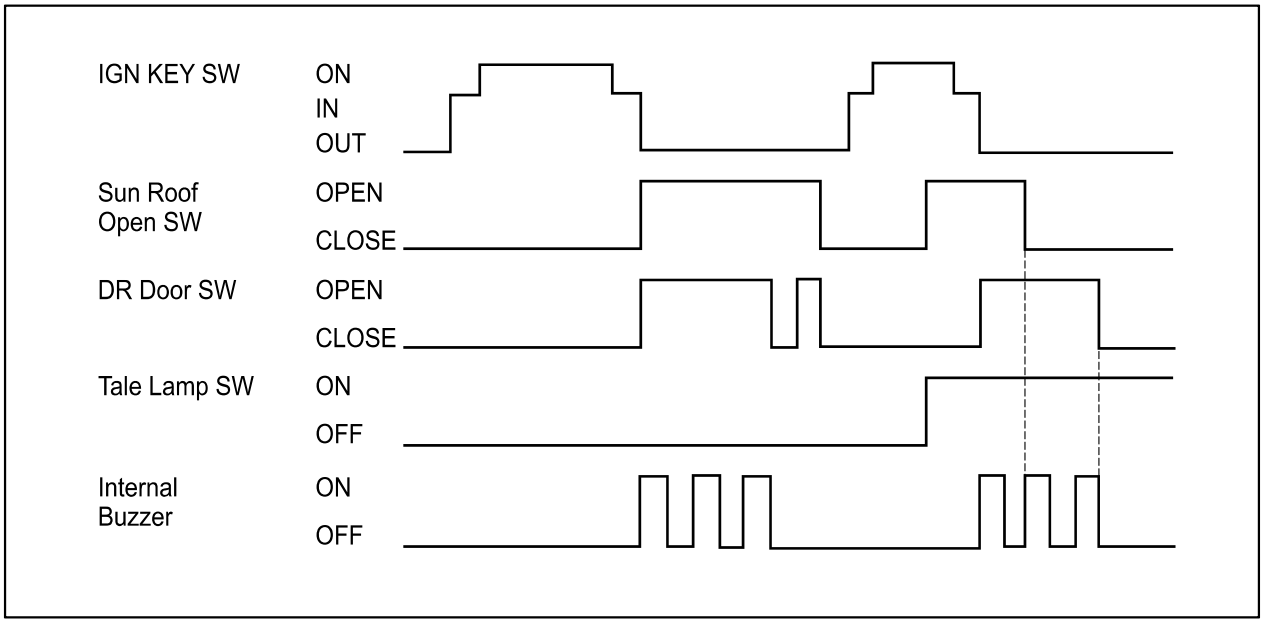


T1 : 0.6s T2 : 6.0s(0.02s ON / 1.38s OFF) T3 : 0.3s
T4.T5 : See above table “1-1"

6) Sunroof

▶ **Sunroof warning**

1. When removing the ignition key with the sunroof open (without SKM) or when opening the driver door with IGN OFF or ACC and sunroof open (with SKM), the indoor buzzer sounds for 10 seconds with the interval of 0.02s ON/1.58s OFF.
2. When opening and closing the driver door or closing the sunroof during indoor buzzer operation, the buzzer stops its operation immediately.
3. When closing the driver door or sunroof and opening again during warning operation, the sunroof warning does not work. If the condition is met after the ignition switch is turned to "ON" position again, the indoor buzzer sounds for 10 seconds with the interval of 0.02s ON/1.58s OFF.
   The sunroof warning has a priority over the tail lamp ON warning.
4.



Modification basis	
Application basis	
Affected VIN	

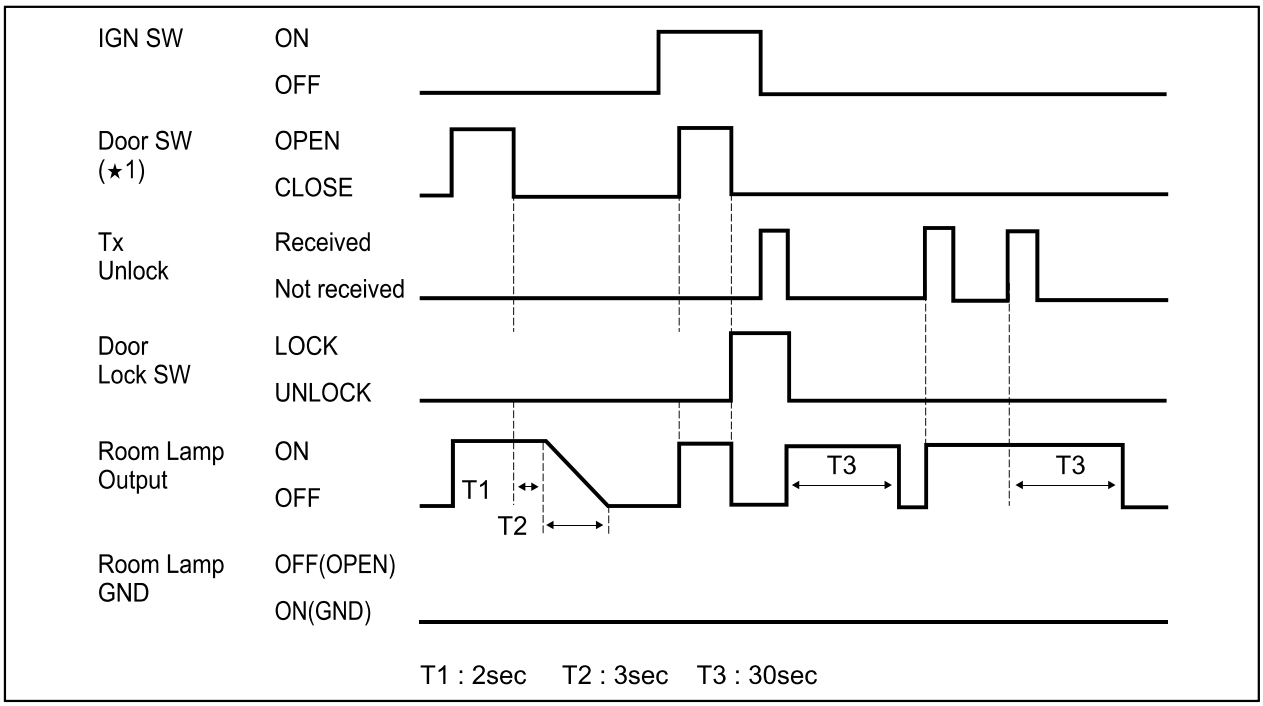
7) Room Lamp

▶ **Door coupled room lamp and dimming control**

When opening any of doors while the room lamp switch in overhead console is pressed in ("Door" coupled position), the room lamps come on. If the key is removed and door stays open, the room lamps automatically goes off after 10 minutes. The sleep mode will be deactivated when the door is locked or closed with the lamp OFF automatically.

▶ **Room lamp control by door coupled room lamp operation**

1. When closing the door with IGN ON, the room lamps go off immediately.
2. When closing the door with IGN OFF, the room lamps stays on for 2 seconds and are dimmed out for 3 seconds.
3. When turning the ignition switch to ON position during dimming out operation, the room lamps go off immediately.
4. When receiving the door unlock signal with IGN OFF, key removed and door closed, the room lamps come on for 30 seconds. (It operates depending on REKES unlock and manual unlock signals for BCM with SKM.)
5. 4. When receiving the door unlock signal again in Step (4), the overhead room lamp and center room lamp stay on for 30 seconds additionally. (For BCM with SKM, the extension depends on the REKES unlock signal.)
6. When opening a door during the linked and dimming operation, the room lamps stays ON. When closing it again, the system performs the operation in Step (1) and (2).
7. When all the door switches are changed from its closing state to its opening state, the room lamps are dimmed out. The room lamps go off immediately when entering into the theft deterrent mode. (For BCM with SKM, door lock is carried out by the REKES lock and manual lock signals.)
   The room lamps come on when the auto approach function is activated.
8.

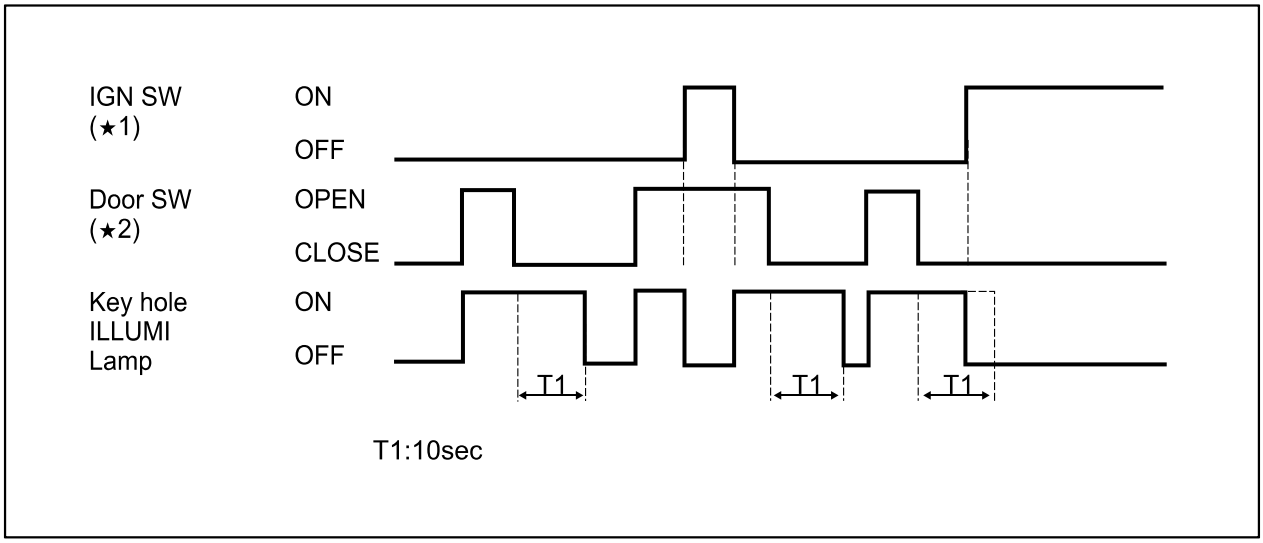


▶ **Room lamp OFF control**

1. The room lamps stop operating when the BCM enters into the theft deterrent or sleep mode. (This is to prevent battery discharge if the overhead room lamp and sensor room lamp switch is ON position.)
   The room lamps go off automatically 10 minutes after the key is removed. After that, if the door unlock
2. or all door open signal is received and the key is inserted, the sleep mode is deactivated and the room lamps operate for another 10 minutes.
   The room lamps come on when the key is inserted (BCM without SKM) or the ignition switch is turned
3. to "ACC" or "ON" position (BCM with SKM) while the room lamps are OFF.

8) Key Hole Illumination

1. When opening the door with IGN OFF, the key hole lamp comes on.
   When closing the door, the key hole lamp stays on for 10 seconds and goes off.
2. When turning the ignition switch to ON position during the operation of key hole illumination, it goes off immediately.
3. When receiving the door lock signal (entering into theft deterrent mode), the lamp goes off.
4. The key hole illumination function has a priority over the immobilizer function.
5. If the communication with the immobilizer is interrupted, the lamp comes on for 11 seconds with the interval of 0.5s ON/0.5s OFF regardless of the operating conditions of key hole lamp.
6. When turning the ignition switch to ON position in "Virgin" condition, the lamp comes on for 8 seconds with the interval of 0.5s ON/0.5s OFF.



(*1) ON: IGN ON
OFF: IGN OFF

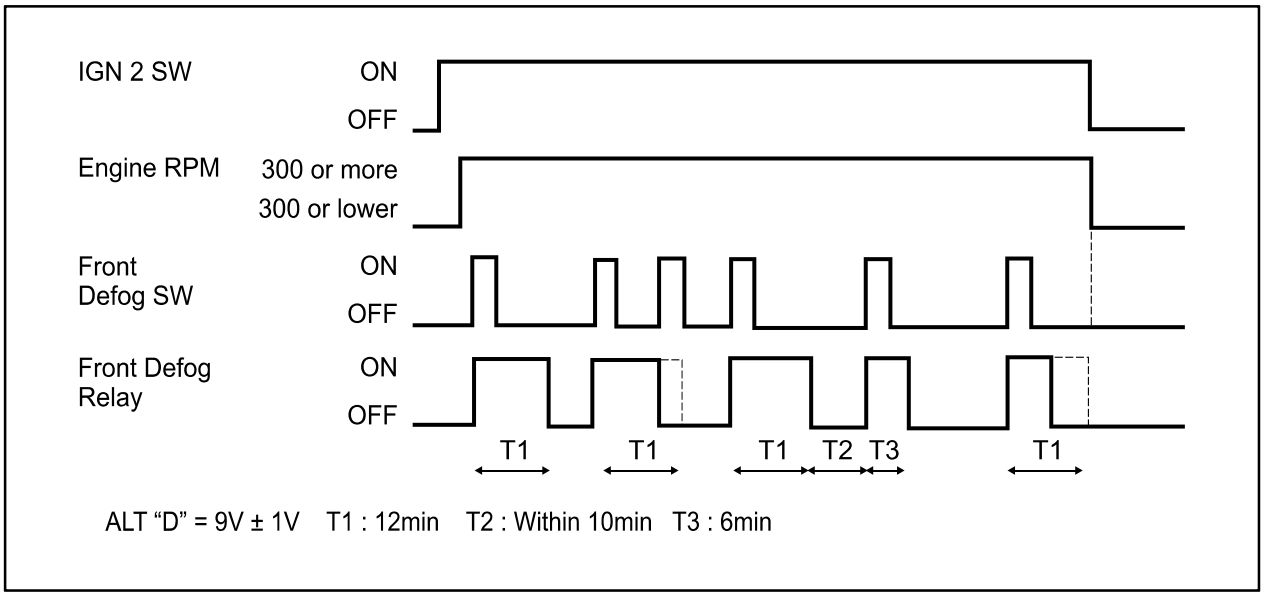
(*2) Open: driver or passenger door is open
Close: driver and passenger door are closed

Modification basis	
Application basis	
Affected VIN	

9) Defogger (Heated Wire) Timer

▶ **Front defogger timer control**

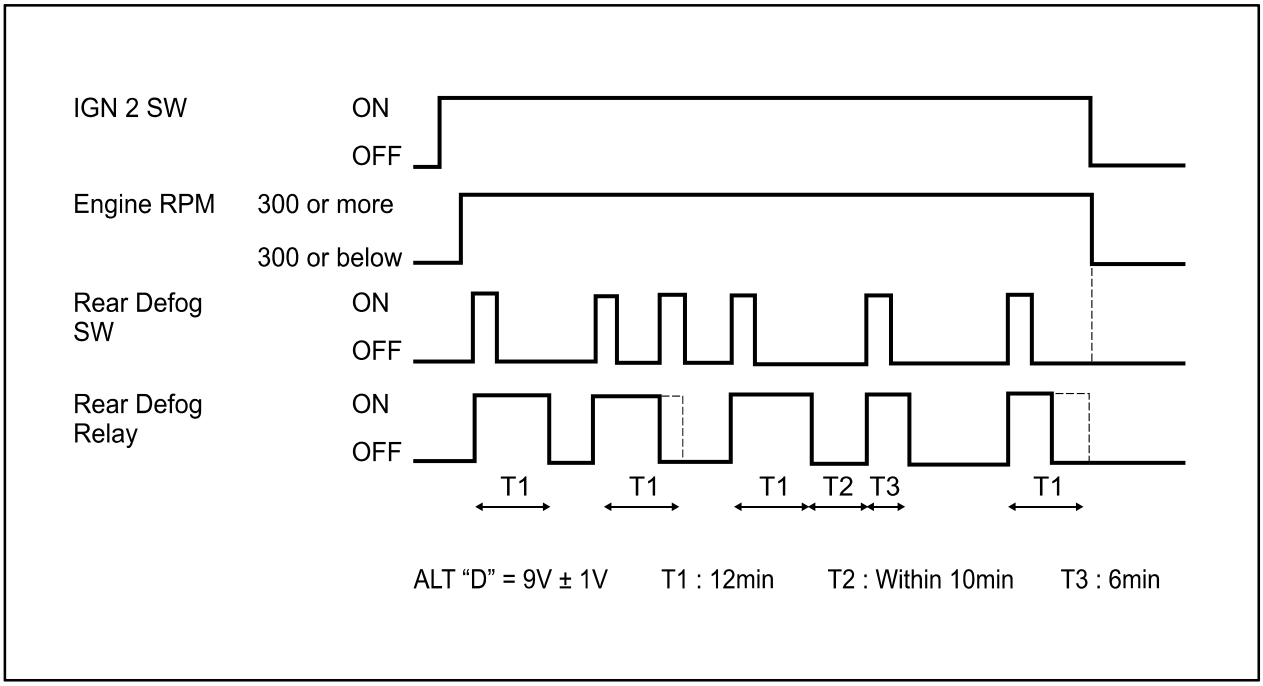
1. When turning ON the front defogger switch with IGN2 ON (engine speed over 300 rpm), the front defogger operates for 12 minutes.
2. When turning OFF the front defogger switch during the operation, the defogger stops working.
3. If turning ON the defogger again within 10 minutes after completion of the first 12 minute operation, the defogger additionally operates for 6 minutes one time only. (However, this not applied if the defogger has been turned off by engine stop or defogger switch)
4. The defogger stops working when the ignition switch is turned to OFF position or engine speed is lower than 300 rpm.



ALT "D" = 9V ± 1V T1 : 12min T2 : Within 10min T3 : 6min

▶ Rear defogger timer control

1. When turning ON the rear defogger switch with IGN2 ON (engine speed over 300 rpm), the rear defogger and outside rearview mirror defogger operate for 12 minutes.
2. When turning OFF the rear defogger switch during the operation, the defogger stops working.
3. If turning ON the defogger again within 10 minutes after completion of the first 12 minute operation, the defogger additionally operates for 6 minutes one time only. (However, this not applied if the defogger has been turned off by engine stop or defogger switch)
4. The defogger stops working when the ignition switch is turned to OFF position or engine speed is lower than 300 rpm.

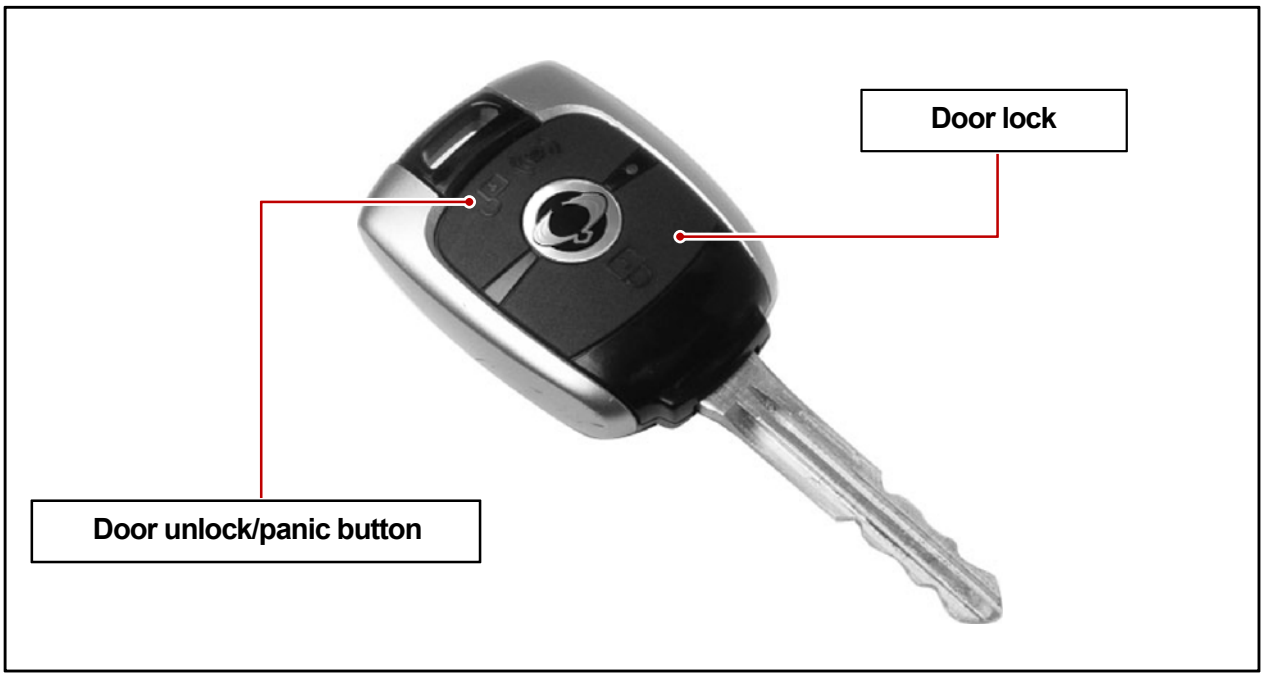


Modification basis	
Application basis	
Affected VIN	

10) Keyless Entry

▶ Transmitter (REKES key)

When the user operates the switch of the remote control key, the vehicle control messages formatted by its CPU are sent to the main unit wirelessly. The, the CPU control the vehicle and the main unit controls the vehicle operation.



▶ Door unlock/panic button

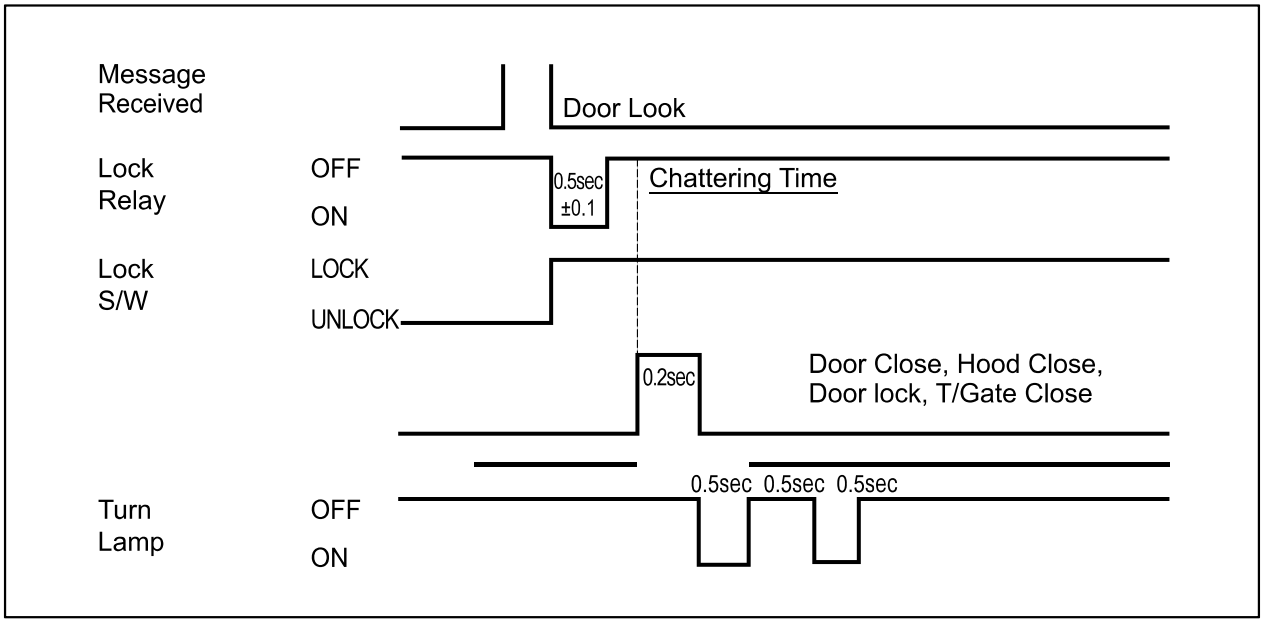
1. Unlocking door and tailgate (briefly press)
- If you press this button, it unlocks all doors and the tailgate and deactivates the theft deterrent mode. When the theft deterrent mode is deactivated, the emergency hazard lights blink once.
- If the door, tailgate or engine hood is not opened within 30 seconds after unlocking the door with the
- remote control key in theft deterrent mode, the door is locked automatically, hazard warning flasher blinks twice and buzzer sounds once. (entering into theft deterrent mode)
  Panic function (press and hold for more than 2 sec)
2. When pressing (over 2 sec) the button, the hazard warning flasher blinks and buzzer sounds for
- about 30 seconds.
  Press the UNLOCK or PANIC button to deactivate this function.
-

▶ Door lock

1. Locking door and tailgate (briefly press)
- If you press this button, all doors and the tailgate are locked and the theft deterrent mode is activated.
- When the theft deterrent mode is activated, the hazard warning flasher blinks twice. However, when pressing this button once again within 4 seconds, the hazard warning flasher blinks twice and buzzer sounds once.

▶ Remote door lock

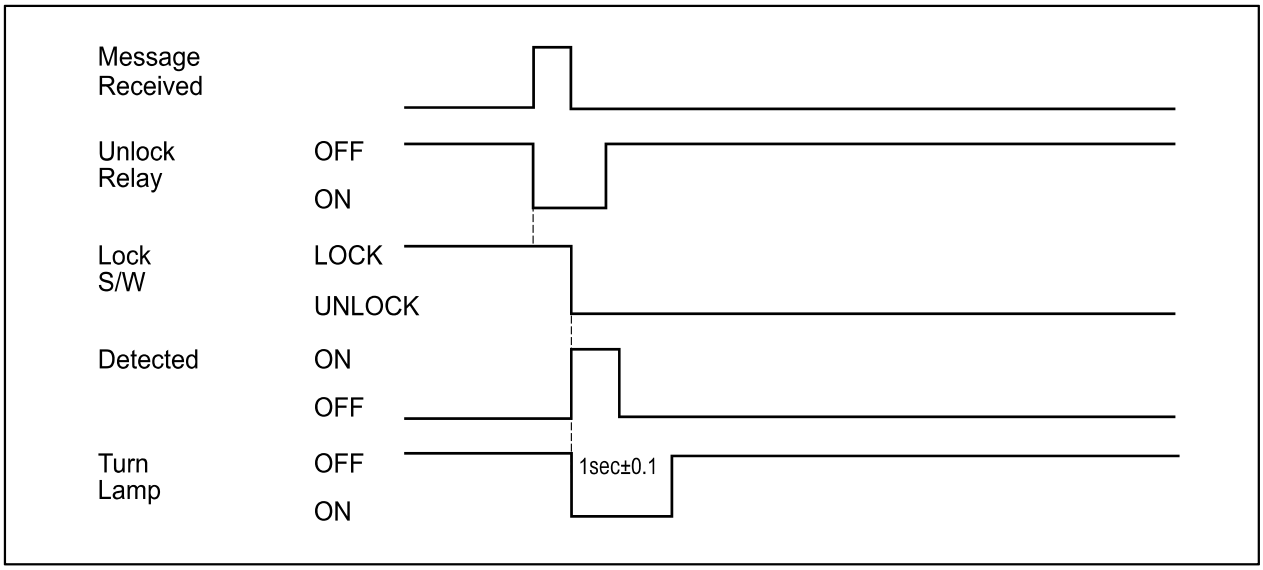
1. When briefly pressing (below 0.5 sec) the LOCK button on the transmitter, the doors are locked.
2. The BCM sends the door lock signal immediately after receiving the door lock message from the transmitter. When door close, hood close and door lock status is detected, it outputs the turn signal lamp signal.
3. Only when door close, hood close and door lock conditions are satisfied after door lock is performed, the turn signal lamp signal is outputted.
4. The REKES operation is not available when the ignition key is in the key switch. Also, it is not possible to use the switches on the remote control key for 1 second after removing the ignition key from the ignition switch to avoid unintended operation.
5. If any of doors could not be locked when pressing the LOCK switch, the system performs the unlock operation.



Modification basis	
Application basis	
Affected VIN	

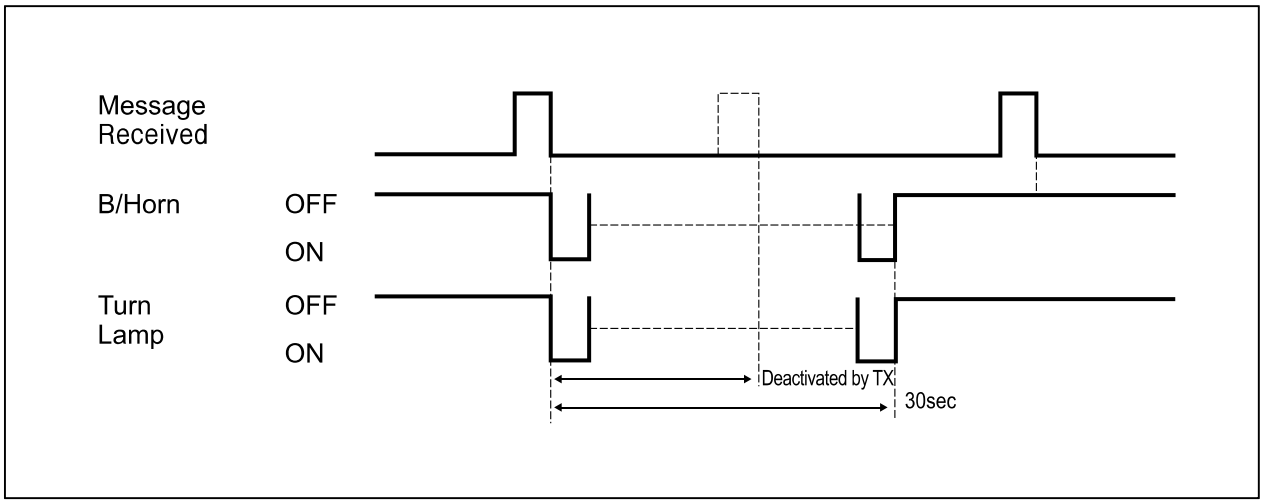
▶ Remote door unlock

1. When briefly pressing (below 2.0 sec) the UNLOCK button on the transmitter, the doors are unlocked.
2. The door unlock relay is turned ON for 0.5 seconds when receiving the door unlock message from the transmitter.
3. The turn signal lamps blink only when all doors are successfully unlocked.
4. The REKES operation is not available when the ignition key is in the key switch. Also, it is not possible to use the switches on the remote control key for 1 second after removing the ignition key from the ignition switch to avoid unintended operation.



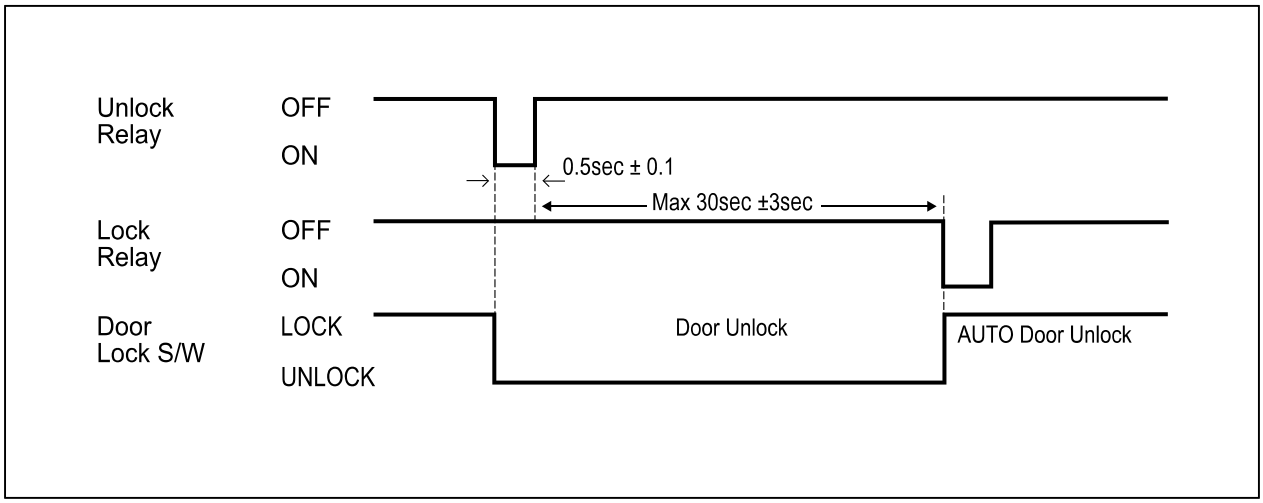
▶ Remote panic

1. When pressing (over 2.0 sec) the PANIC switch on the transmitter, the panic alarm is activated. When receiving the panic message from the transmitter, the horn sounds and the turn signal lamps
2. blink for 30 seconds (Panic alarm).



▶ After 30 seconds delay auto door lock

1. If a door or tailgate is not opened within 30 seconds after unlocking the doors with remote control key in theft deterrent mode, all doors will be automatically locked again (change to theft deterrent mode). If any door is not opened or the key is not detected within 30 seconds after receiving the unlock
2. signal, the lock signal is outputted and theft deterrent mode is activated.
   When entering into the theft deterrent mode, the turn signal lamps blink twice and the exterior buzzer sounds once for SKM the lamps blink twice and burglar alarm horn sounds once for REKES.



Modification basis	
Application basis	
Affected VIN	

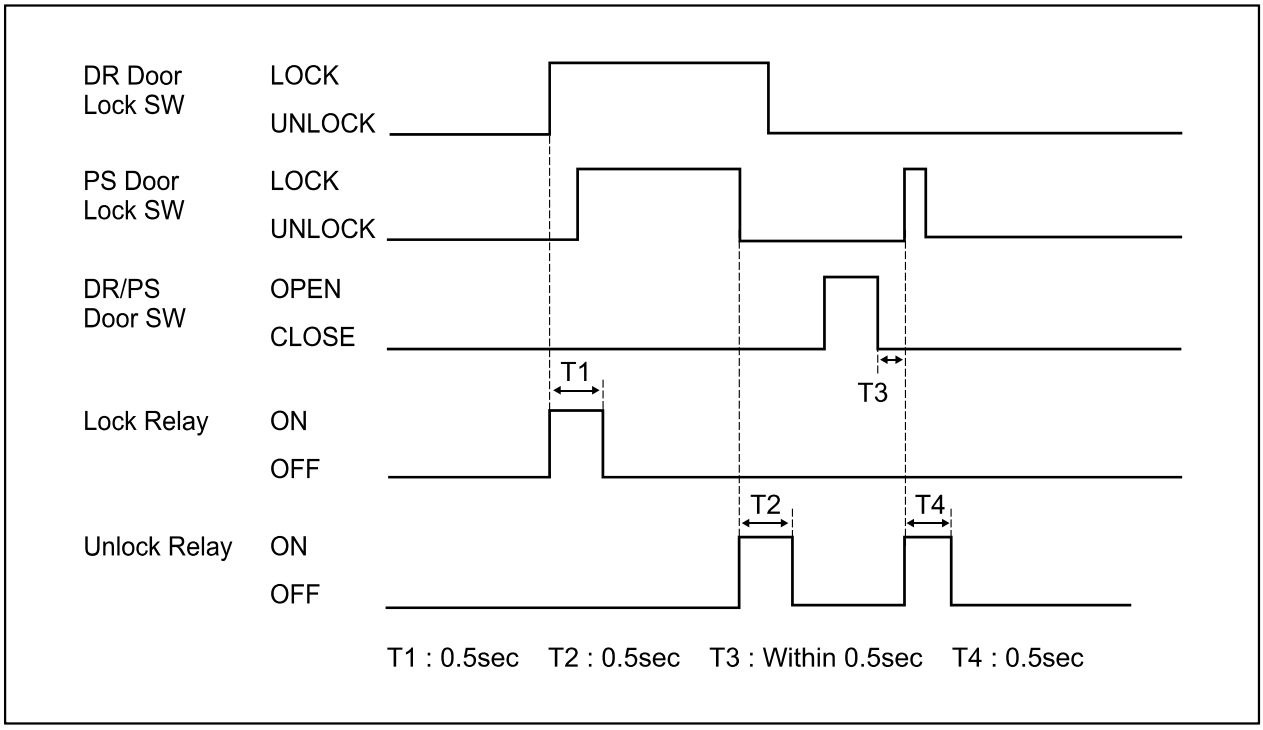
11) Door Lock/Unlock Control

The BCM with SKM receives wake-up source for driver door lock/unlock switch, passenger door lock/unlock switch, rear door (left/right) lock switch, central door lock/unlock switch status through the electric wire (hardwire).

- The status for key cylinder switch and latch position switch is received through the door lock/unlock switch.
  When door lock signal is outputted due to failure of the door knob switch and door open switch and automatic unlock signal is transmitted 5 times for 1 minute, BCM forcibly lock the doors without unlocking.
  However, door unlock command works normally and deactivates forcible unlock.

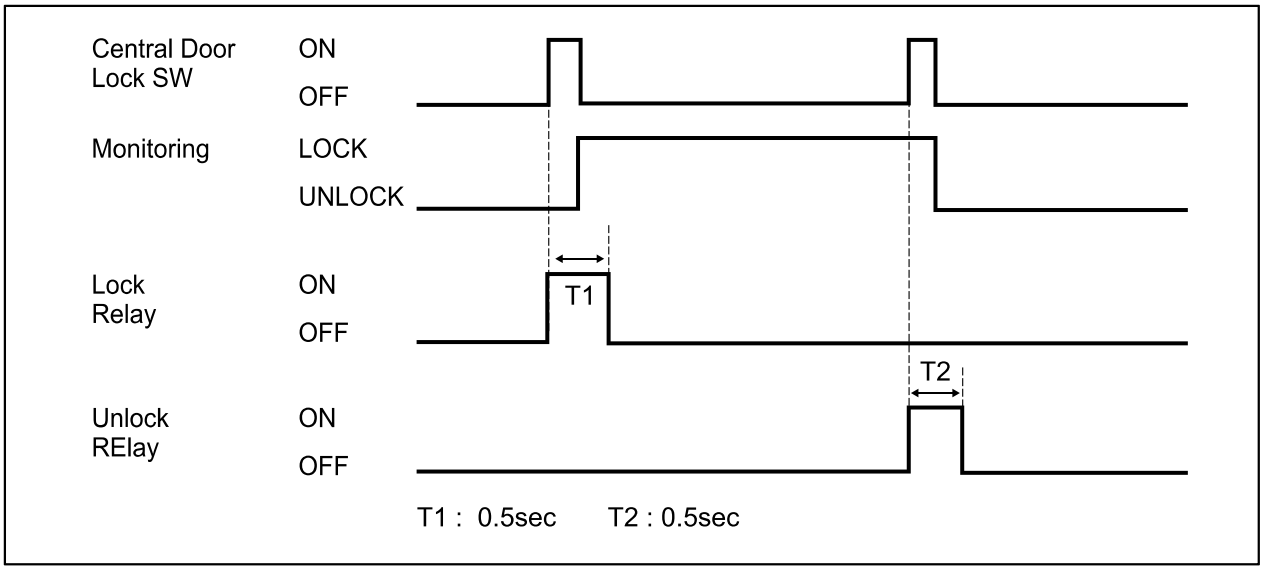
▶ Door lock/unlock control by door LOCK switch

1. When moving the driver or passenger door lock (knob) switch to LOCK from UNLOCK position, BCM sends the LOCK signal for 0.5 seconds.
2. When moving the driver or passenger door lock (knob) switch to UNLOCK from LOCK position, BCM (UNLOCK) operation by the door lock (knob) switch is not available when sending the LOCK
3. (UNLOCK) signal by any other method such as remote control key.
   When reconnecting the battery, the door lock (knob) switch is not operational regardless of the door
4. lock switch positions.
   All doors stay unlocked when receiving the door lock signal in 0.5 seconds after closing the doors.
5.



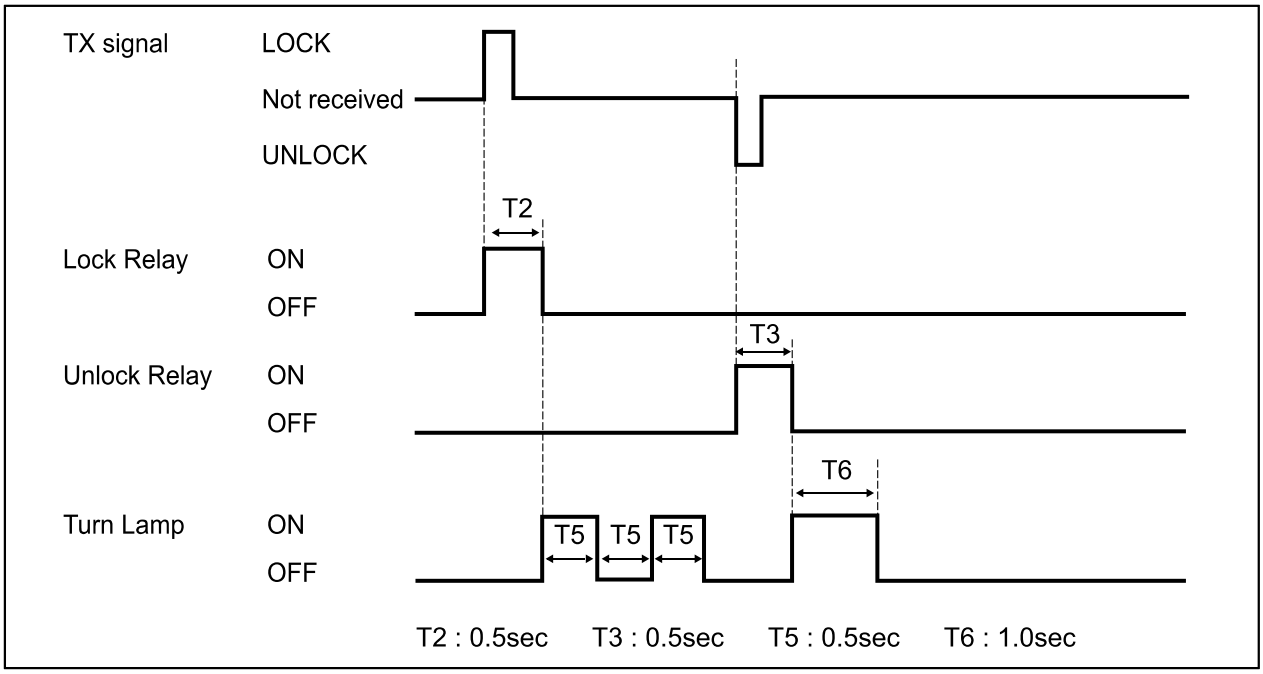
▶ Door lock/unlock control by central door lock switch

1. When pressing the central door lock/unlock switch, BCM sends the LOCK or UNLOCK signal according to the previous condition of driver door lock switch for 0.5 seconds.
2. The central door dock switch is not available when the system is in theft deterrent mode.
3. When turning the ignition off, all doors are automatically unlocked if any of the door lock (knob) switches is in LOCK position.
4. When pressing the central door lock switch with any door open, the system unlocks the doors immediately after locking them.



▶ Door lock/unlock control by REKES signal

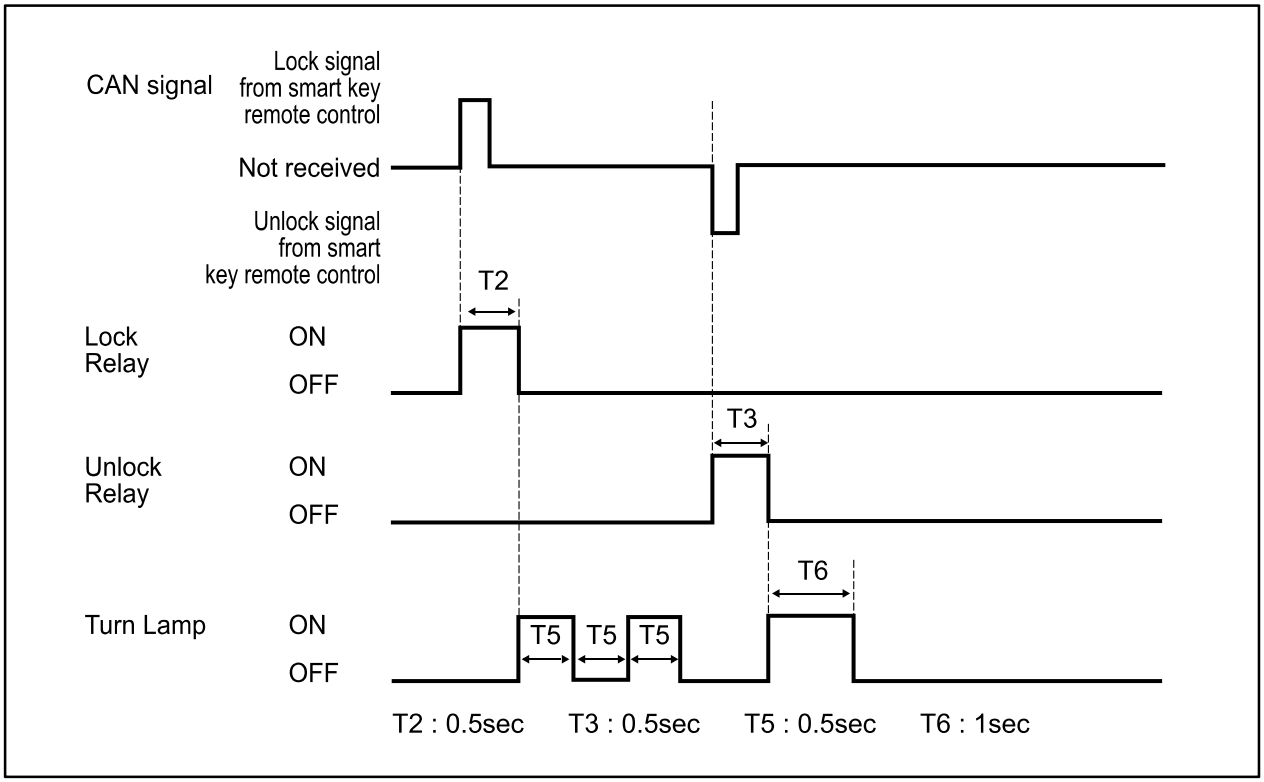
1. When receiving the door lock signal, BCM sends the LOCK signal for 0.5 seconds.
2. When receiving the door unlock signal, BCM sends the UNLOCK signal for 0.5 seconds.



Modification basis	
Application basis	
Affected VIN	

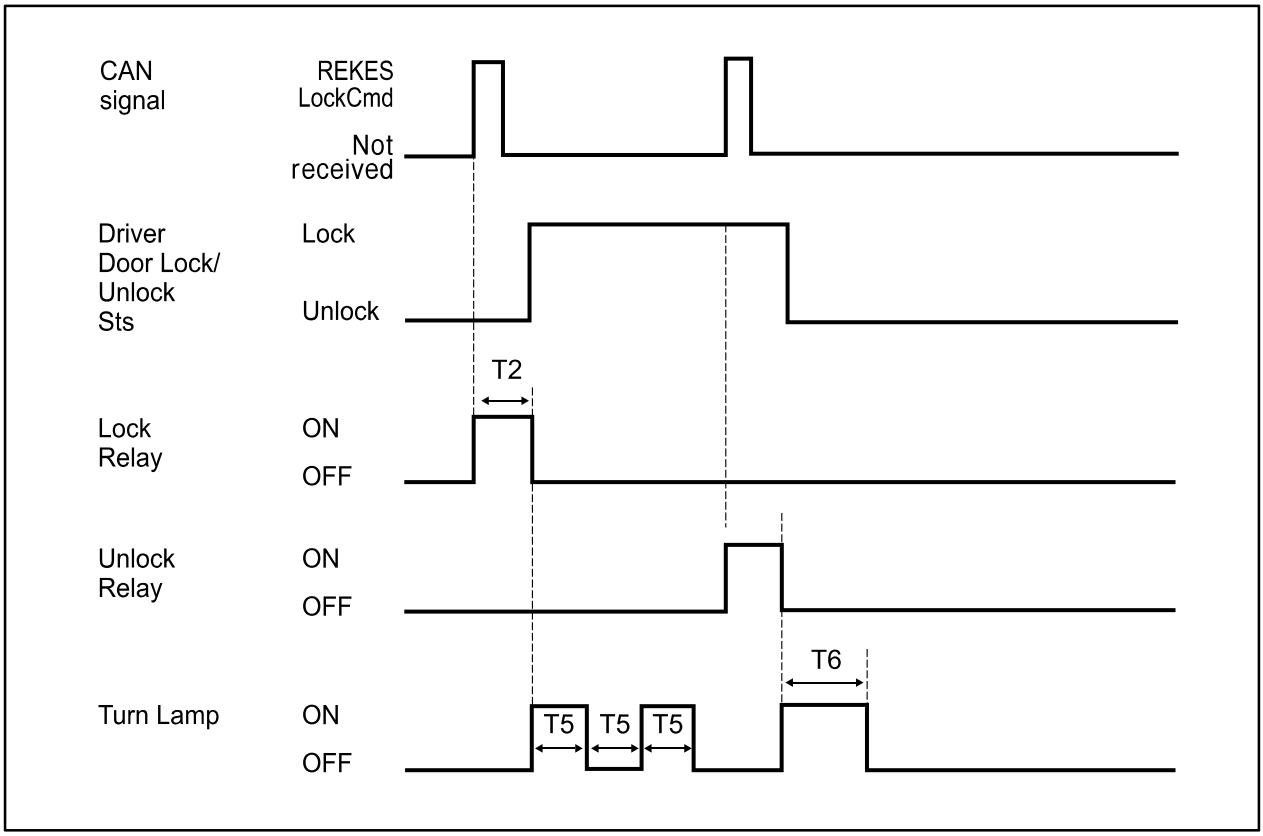
▶ Door lock/unlock control by SKM smart key's remote control

1. If the BCM receives the LOCK command through the BCAN communication (REKES lock signal) when pressing the door lock switch of the smart key's remote control with IGN OFF or ACC ON, it sends door lock signal for 0.5 seconds.
2. If the BCM receives the UNLOCK command through the BCAN communication when pressing the door unlock switch of the smart key's remote control with IGN OFF or ACC ON, it sends door unlock signal for 0.5 seconds.



▶ Lock/unlock control by SKM passive entry

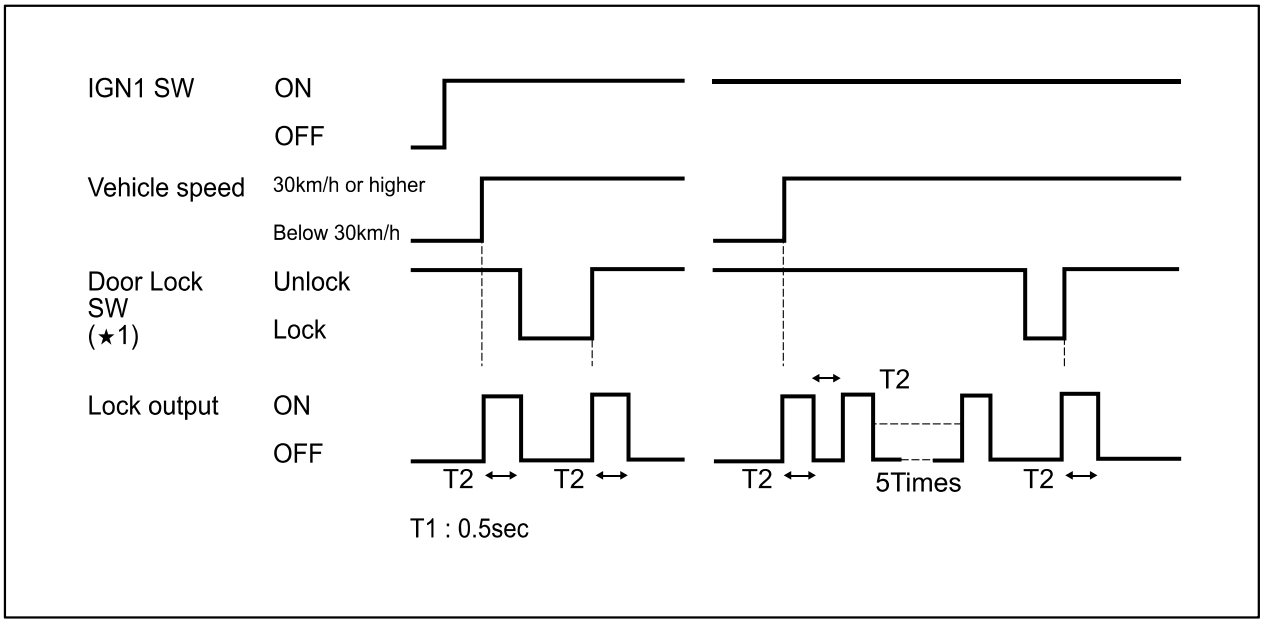
1. The SKM searches for the verified smart key, sends door lock or unlock signal to the BCM through the BCAN communication depending on the door status and sends the output for 0.5 seconds when operating the outside door handle switch with IGN OFF, ACC ON or IGN ON.
   (The BCM does not perform door lock if the driver door is unlocked when receiving the outside door handle switch signal with IGN ON.)
2. The BCM activates door lock output for 0.5 seconds if the driver door is unlocked after receiving door lock/unlock command, BCAN signal (outside door handle signal), with IGN OFF or ACC ON.



Modification basis	
Application basis	
Affected VIN	

▶ Auto door lock control

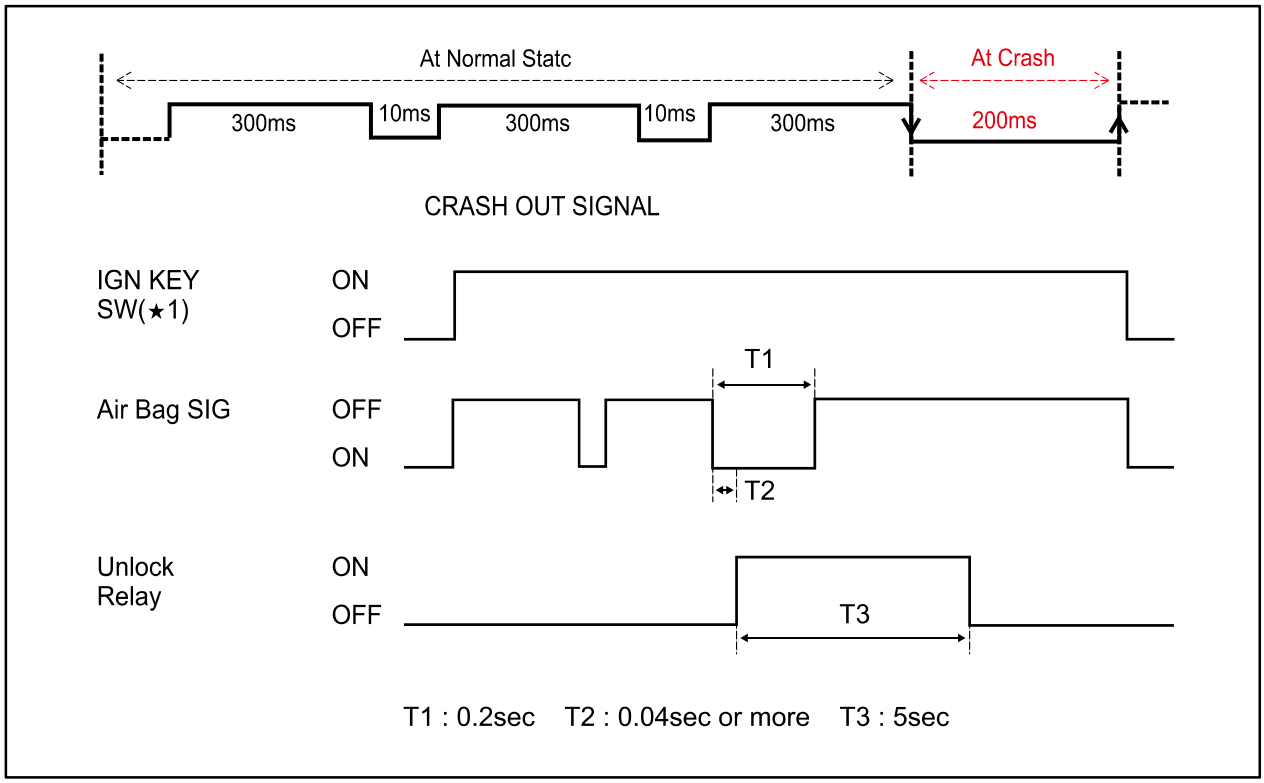
1. Door lock output is activated when the vehicle speed is maintained above 30 km/h with IGN1 ON. However, if all the doors are locked or fail, lock output is not activated.
2. If any of doors is not locked after Step (1), BCM activates the door lock output up to 5 times.
3. If the door is still unlocked, BCM considers the door as Fail.
4. If the failed door is changed from UNLOCK to LOCK, the fail record the side fascia panel.
5. If there is any failed door, the auto door lock function is not available.
   (Even though the vehicle speed is increased over 30 km/h again after decreased below 30 km/h, BCM does not send the auto door lock signal.)
6. When receiving the unlock signal for another door during Step (2), BCM sends the lock signal for the door up to 5 times.
7. The unlock output is activated automatically when door lock output conditions are met by this function or the IGN1 switch is turned to OFF from ON position (even though the lock output is not activated if the vehicle speed is maintained above 30 km/h under lock condition). (If the LOCK condition is established with the ignition switch ON, the system outputs UNLOCK signal unconditionally when turning the ignition switch to OFF position.)
8. However, whether the door lock output condition is met or not is initialized when the IGN1 switch is turned to OFF position.
9. When turning the ignition off, the fail record for a door will be initialized.
   If any of door lock switches is in LOCK position when turning the ignition off, all doors are unlocked.



(*1) Lock: All doors including tailgate are locked.
Unlock: All doors including tailgate are unlocked.

▶ Auto door unlock (crash unlock) control

1. The air bag collision signal input cannot be accepted within 7 seconds after turning the ignition key to "ON" position.
2. After the 7 seconds, the air bag signal is activated. If the air bag signal is turned ON (crash) from OFF, BCM sends the door unlock signal for 5 seconds after 0.04 seconds.
3. The unlock signal is sent for the remaining of the period even when turning OFF the ignition switch while receiving the unlock signal due to the crash.
4. The room lamps come ON when receiving the crash signal. (except when the front room lamp switch is in OFF position.)
5. The turn signal lamps also blink when receiving the crash signal.
6. This function is reset when disconnecting the battery.

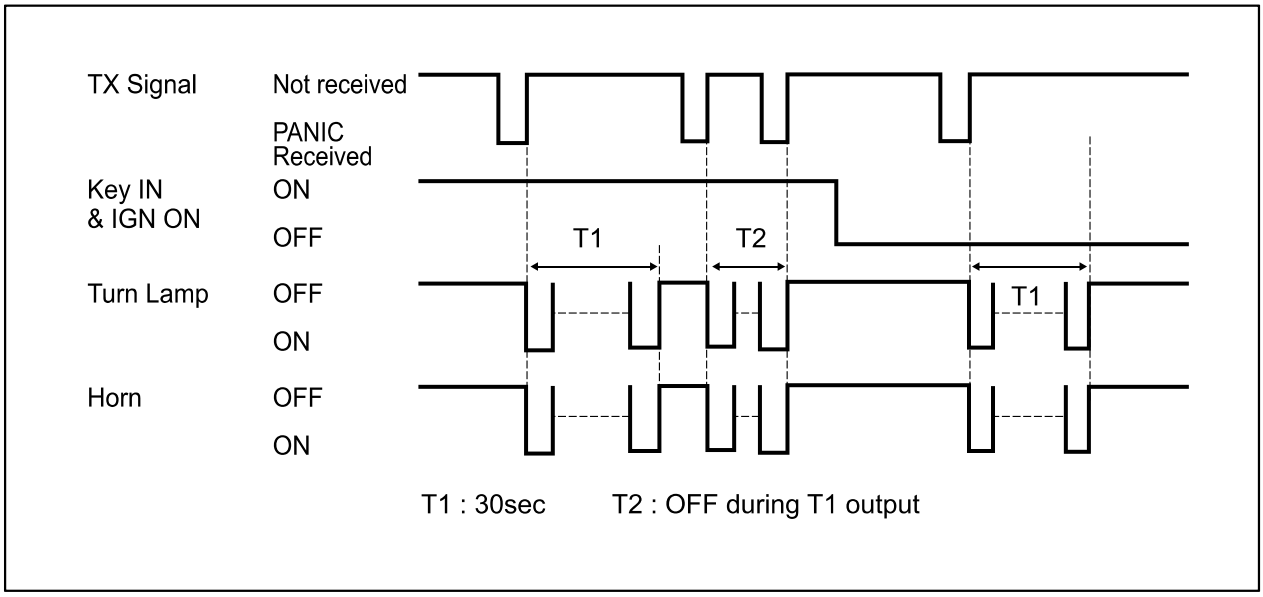


Modification basis	
Application basis	
Affected VIN	

12) Panic Alarm

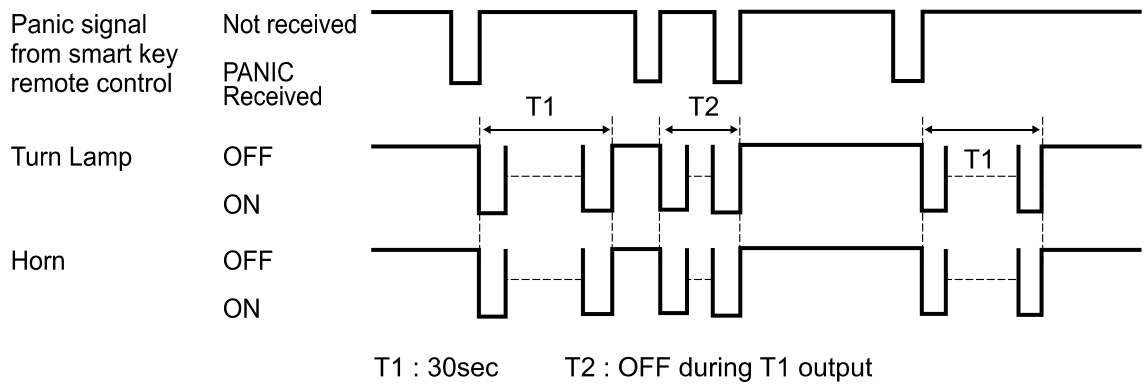
▶ **Panic alarm by REKES signal**

1. When receiving the panic signal with Power OFF, ACC and IGN ON, the horn and turn signal lamps operate for T1 with the interval of 0.5s ON/0.5s OFF.
2. When receiving the door lock or panic signal during the panic operation, the panic alarm stops. (other commands are overridden)
3. The theft deterrent functions are as below:
   - The theft deterrent alarm stops when receiving the panic alarm during its operation.
   - The panic alarm stops and then the theft deterrent alarm starts its operation when occurring the theft deterrent alarm conditions during panic alarm.
4. This function should be available regardless of the key status.
5. This function should be activated only when the ignition key is inserted (EU region).



▶ Panic alarm by SKM smart key's remote control

1. When the BCM receives "Panic command by smart key remote control" as a BCAN signal, it activates panic alarm by operating the horn and turn signal lamp for 30 seconds with a interval of 0.5s ON/0.5s OFF. However, the BCM used in EU region is operated when receiving the panic command from the smart key remote control and the signal that the smart key is in the vehicle with Power OFF, ACC and IGN ON.
2. The BCM stops the panic function and operates the function depending on the signal in the event of following commands during turn signal lamp and horn operation by the "Panic command from smart key remote control".
   - Stops panic function activated by "Panic command from smart key remote control" through BCAN signal
   - Panic function is activated when receiving other command
3. The panic alarm stops and then the theft deterrent alarm starts its operation when occurring the theft deterrent alarm conditions during panic alarm.
4. All the functions are controlled by SKM and operated by signal from SKM.



Modification basis	
Application basis	
Affected VIN	

13) Headlamp

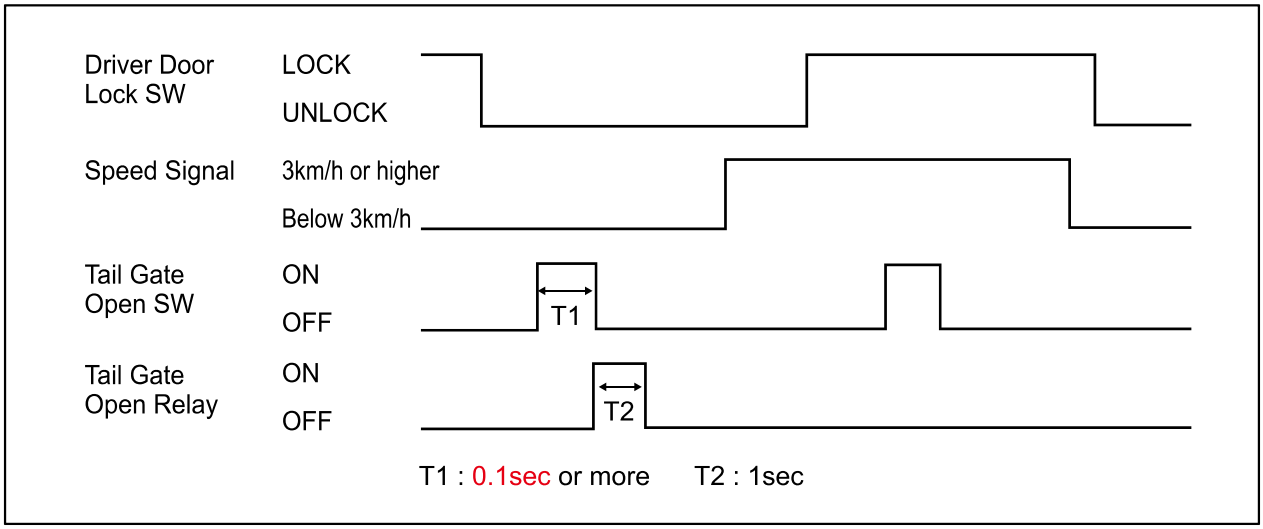
▶ **Coming home lighting control**

1. The low beam keeps on for 30 seconds when the ignition switch is turned to ON from OFF position with the headlamp ON.
2. Coming home lighting OFF condition
   - 3 minutes after all doors and tailgate are open and closed (lighting goes off 30 seconds after without extension when the closed doors are open)
   - When receiving REKES and passenger door lock signals (close, open, close) twice during coming home lighting operation
   - Lighting goes off during its operation when headlamp and AUTO light switch are turned to other position than ON
   - Lighting goes off when ignition switch is turned to ON position
3. This function can be activated or deactivated with the diagnostic device. (default setting: active)

14) Tailgate

▶ Tailgate control in BCM without SKM

1. When pressing the tailgate switch for more than 0.1 second with driver door unlocked and vehicle speed below 3 (±0.1) km/h, the tailgate open relay is turned ON for about 1 second, with power OFF, ACC ON or IGN ON. However, it is turned ON when the vehicle speed is below 3 (±0.1) km/h, with IGN ON.
2. The tailgate open relay is turned OFF immediately after the driver door is locked or the vehicle speed goes over 3 km/h with IGN ON during its operation. However, the BCM does not operate if the tailgate open switch is pressed when the vehicle speed is above 3 km/h.



- Tailgate open: REKES unlock (disarmed deterrent mode) → Tailgate open signal → Tailgate open

▶ Tailgate control in BCM with SKM

1. When pressing the tailgate switch for more than 0.1 second with driver door unlocked and vehicle speed below 3 (±0.1) km/h, the tailgate open relay is turned ON for about 1 second.
2. The tailgate open relay is turned OFF immediately after the driver door is locked or the vehicle speed goes over 3 km/h during its operation.
3. When the tailgate switch on smart key is pressed in theft deterrent mode or with the smart key detected by the exterior antenna, the SKM verifies the smart key and disarms the tailgate only. When the tailgate is open and closed, the system enters into the theft deterrent mode again. If the tailgate switch is not operated for 30 seconds, the system also does so.
4. The BCM checks that the verified smart key is in the luggage room 1 second after when the closed tailgate is detected by the tailgate open switch with power OFF.
   If there is a verified smart key in the luggage room when the tailgate is open and closed in theft deterrent mode, the external buzzer sounds for 5 seconds.
   When the driver press the tailgate open switch in order to look for the smart key, the BCM deactivates lock so that the tailgate can be opened even though the driver door is locked. (maintains standby for opening without verification)

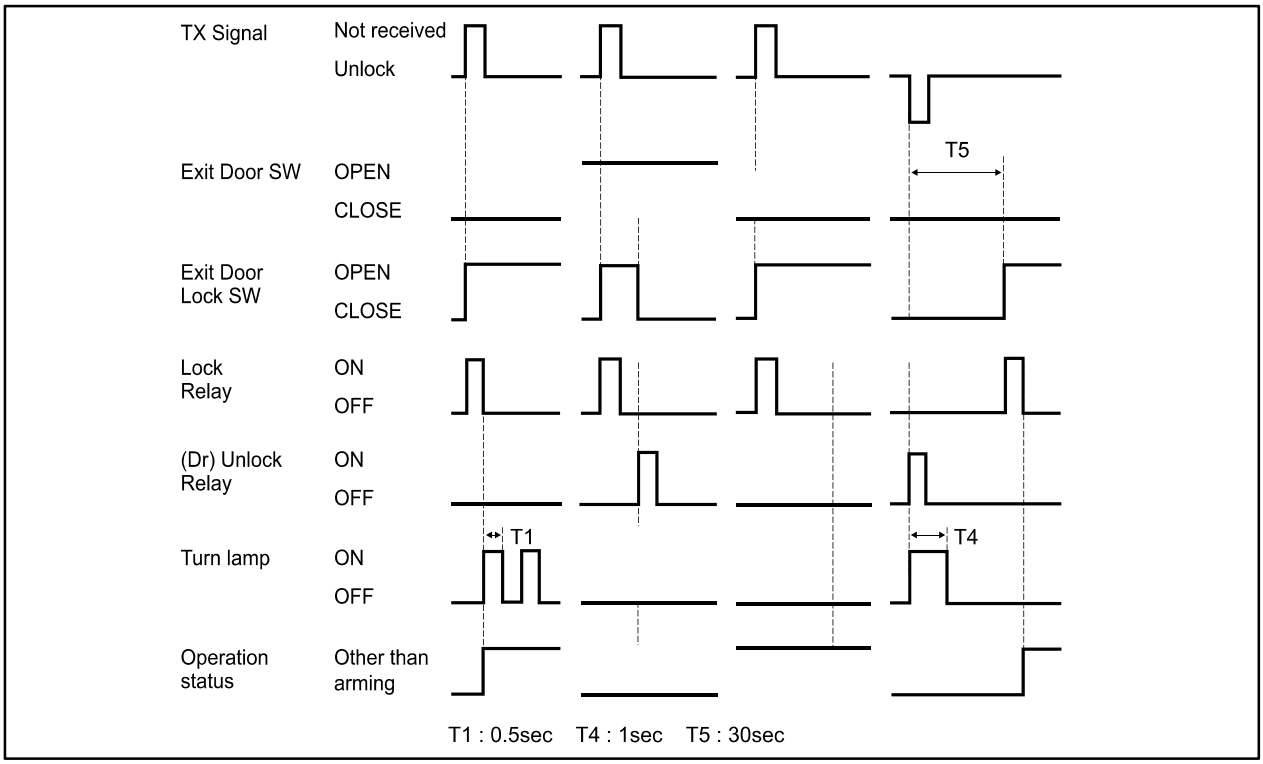
Modification basis	
Application basis	
Affected VIN	

15) Theft Deterrent Alarm

▶ Theft deterrent alarm control in BCM without SKM

1. Entering into theft deterrent mode by REKES remote control
   - When receiving the door lock signal with the key removed, all doors including tailgate and engine hood closed, all doors are locked and the theft deterrent mode is activated. At this moment, the turn signal lamps blink twice.
   - When pressing the lock switch on remote control key again in 4 seconds, the turn signal lamps blink twice and the horn sounds once in the theft deterrent mode. In other words, when pressing the door lock button once, all the doors are locked and the turn signal lamps only blink twice, and another press in 4 seconds makes the turn signal lamps blink twice and alarm horn sound once.
   - When receiving the door lock signal with any door (except tailgate and engine hood) open, the doors are unlocked immediately after locking them first.
   - When receiving the door lock signal with the tailgate or engine hood open, the doors are closed if they are open, but the theft deterrent mode is not activated. However, when closing the opened tailgate or engine hood, the theft deterrent mode is activated with two blinks of turn signal lamps.
   - If a door or tailgate is not opened within 30 seconds after unlocking the doors with remote control key in theft deterrent mode, all doors will be automatically locked again (re-lock operation). When entering into the theft deterrent mode, the turn signal lamps blink twice and the horn sounds once.
   - The theft deterrent mode can be activated only when the above conditions are satisfied.
     Ex) The theft deterrent mode cannot be activated when locking the doors with key hole on door.

-



2. Disarming by REKES remote control

- When unlocking the doors or turning the ignition switch to ON position.
- When receiving the door unlock signal in theft deterrent mode, all doors are unlocked and the turn signal lamps blink once (the horn does not sound).
- When receiving the door unlock signal with the theft deterrent mode disarmed, the turn signal lamps blink once (the horn does not sound).

3. In theft deterrent mode

BCM observes the conditions below continuously:

- Battery connection (B+)
- Front/rear door open
- Tailgate open
- 4 doors lock/unlock
- Engine hood open

4. Activation of theft deterrent alarm

- When any of doors, tailgate or engine hood is open in theft deterrent mode
- When unlocking the door lock switch in theft deterrent mode
- When opening a door after completion of theft deterrent alarm (for 30 seconds)
- Horn and the turn signal lamps operate for 30 seconds with the interval of 0.5s ON/0.5s OFF.

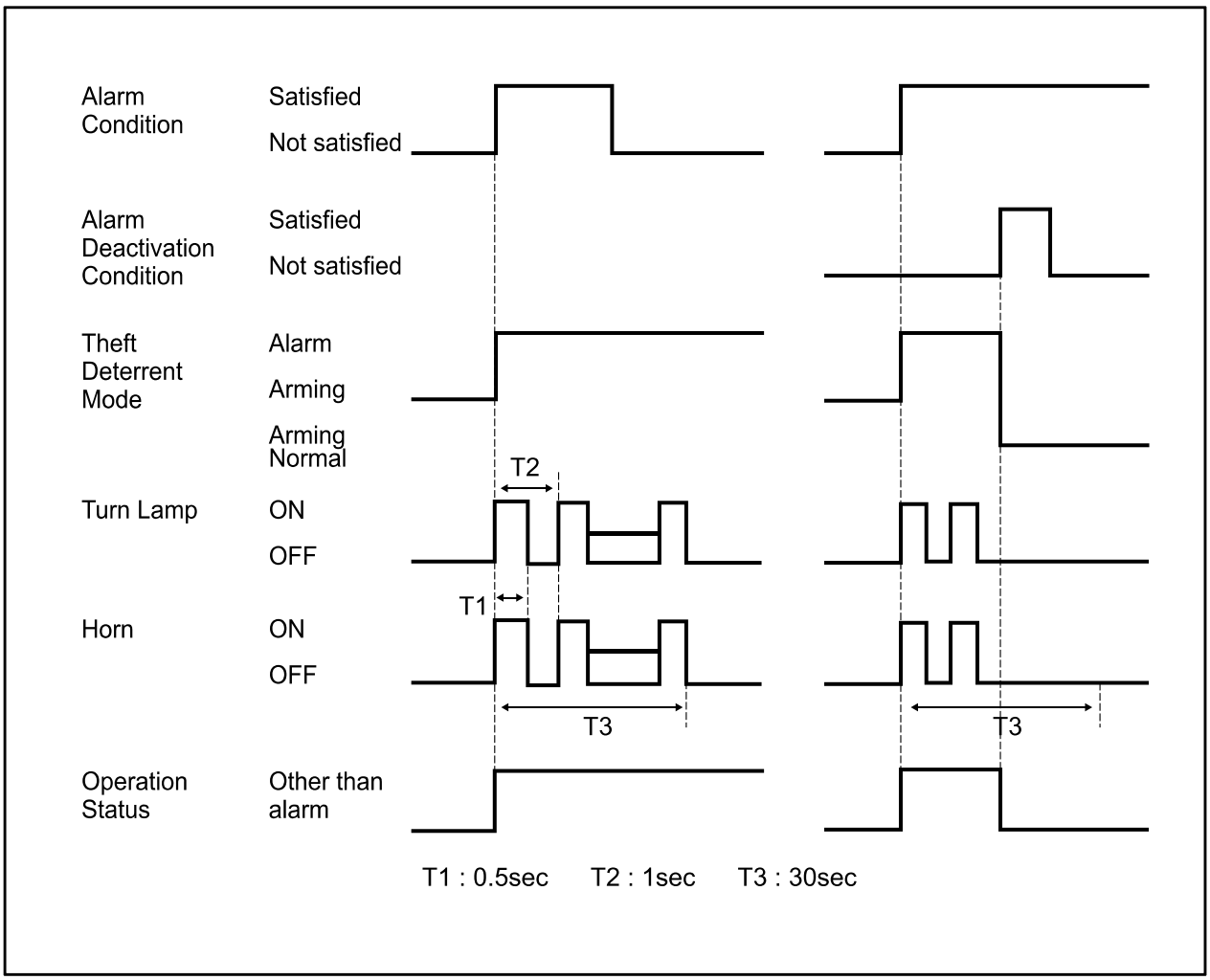
5. Disarming conditions of theft deterrent mode

- When pressing any switch (lock, unlock, panic) on the remote control key during the theft deterrent alarm, the alarm stops its operation.
- When turning the ignition switch to ON position during the theft deterrent alarm, the alarm stops its operation.
  (For vehicle with immobilizer system, the alarm stops after completion of authorization. For vehicle without immobilizer system, the alarm stays ON for 30 seconds)
- When turning the ignition switch to ON position during the theft deterrent alarm, the alarm stops and the theft deterrent mode is deactivated after 30 seconds (remaining time).
- If there is not any disarming commend, the alarm stays ON for 30 seconds and the theft deterrent mode continues.

6. Operation when disarming

- The horn and the turn signal lamps stop their operation.

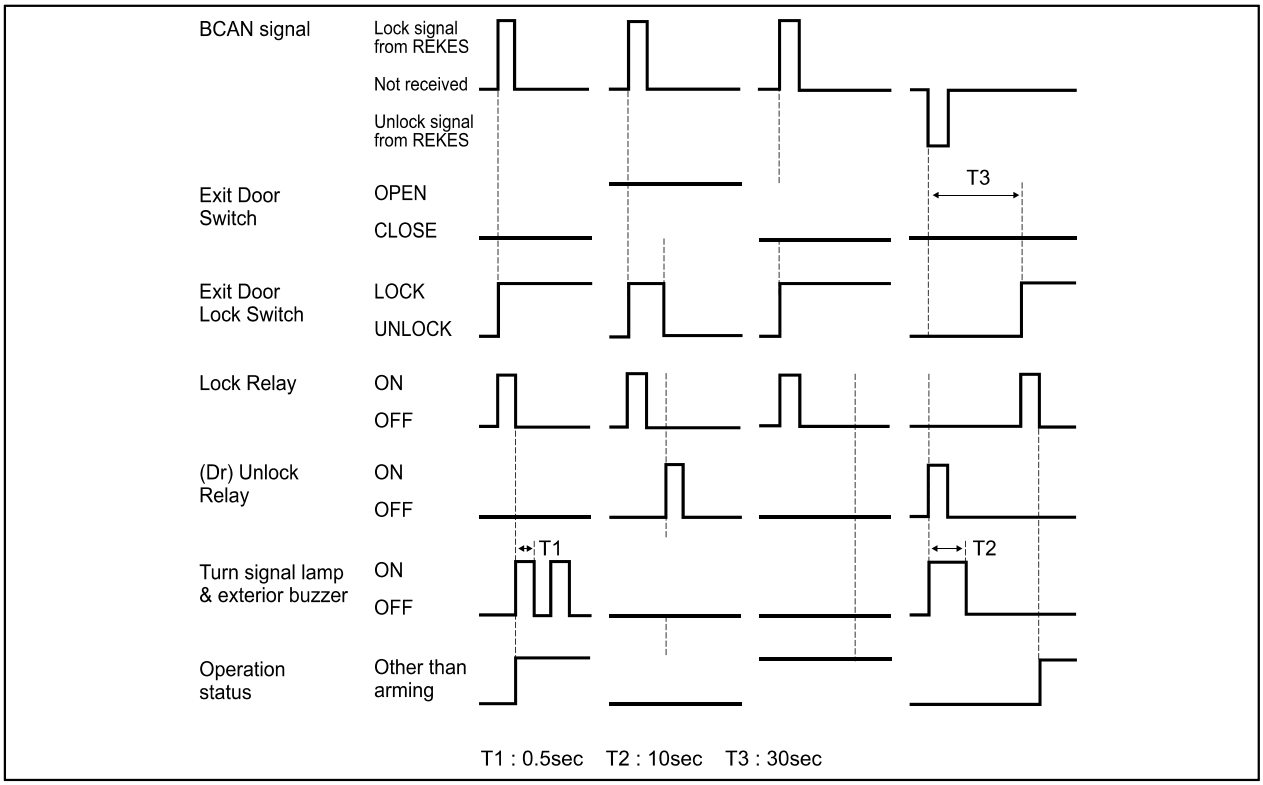
Modification basis	
Application basis	
Affected VIN	



- The theft deterrent/alarm status is stored in the EEPROM, and monitoring is followed by operation when connecting the battery.

▶ Theft deterrent alarm control in BCM with SKM

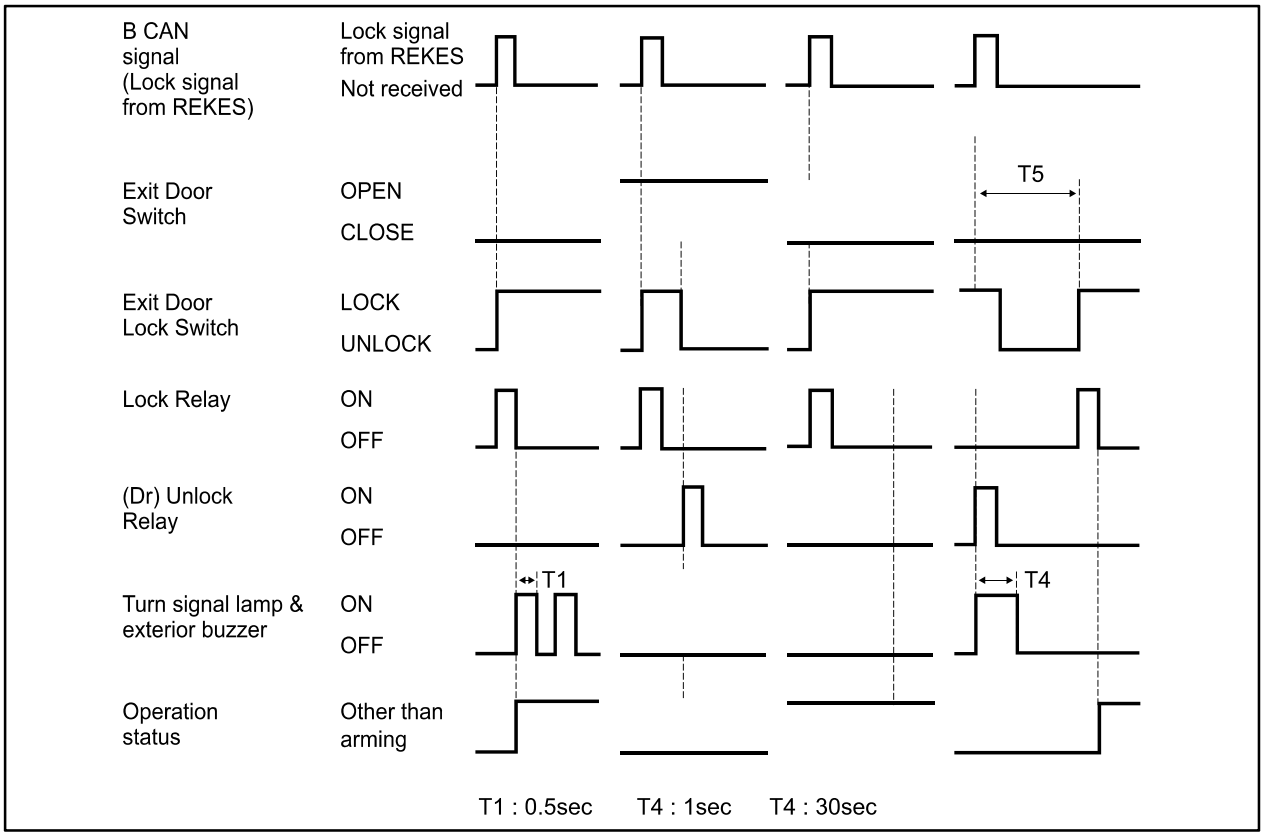
1. Entering into theft deterrent mode by smart key remote control
   - When receiving the door lock signal from the smart key remote control with power OFF or ACC ON and tailgate and engine hood closed, the doors are locked and the theft deterrent mode is activated. At this time, the turn signal lamps blink twice and the exterior buzzer sounds once at interval with 50 ms ON/50 ms OFF. (SKM turns off the vehicle and sends the signal, when ACC ON)
   - The BCM unlock the doors immediately after locking them first without operating turn signal lamp and exterior buzzer and the system does not enter into theft deterrent mode, if the door lock signal is received from the smart key remote control when the driver door is unlocked and any of doors is open.
   - The BCM locks all the doors and system does not enter into theft deterrent mode if all the doors are closed when the door lock signal is received from the smart key remote control with the tailgate and engine hood open. However, if the tailgate and engine hood is closed, the turn signal lamps blink twice, exterior buzzer sounds once and theft deterrent mode is entered.
     If all the doors, tailgate or engine hood is open or the ignition switch is not turned to ON position
   - within 30 seconds after receiving the door unlock signal from the smart key remote control, the doors are locked, turn signal lamps blink twice, exterior buzzer sounds once and theft deterrent mode is re-activated.
     The theft deterrent mode can be activated only when the above conditions are satisfied, excepting
   - manual lock.
     Ex) The theft deterrent mode cannot be activated when locking the doors with key hole on door.



Modification basis	
Application basis	
Affected VIN	

2. Entering into theft deterrent mode by SKM passive entry

- When receiving the signal from the outside door handle switch with power OFF or ACC ON, tailgate and engine hood closed and driver door unlocked, the doors are locked and the theft deterrent mode is activated. At this time, the turn signal lamps blink twice and the exterior buzzer sounds once at interval with 50 ms ON/50 ms OFF. (SKM turns off the vehicle and sends the signal, when ACC ON)
- The BCM unlock the doors immediately after locking them first without operating turn signal lamp and exterior buzzer and the system does not enter into theft deterrent mode, if the door lock signal is received from the outside door handle switch when the driver door is unlocked and any of doors is open.
- The BCM locks all the doors and system does not enter into theft deterrent mode if all the doors are closed when the door lock signal is received from the outside door handle switch with the tailgate and engine hood open. However, if the tailgate and engine hood is closed, the turn signal lamps blink twice, exterior buzzer sounds once and theft deterrent mode is entered.
  If all the doors, tailgate or engine hood is open or the ignition switch is not turned to ON position
- within 30 seconds after receiving the door unlock signal from the outside door handle switch with the driver door locked, the doors are locked, turn signal lamps blink twice, exterior buzzer sounds once and theft deterrent mode is re-activated.
  The theft deterrent mode can be activated only when the above conditions are satisfied, excepting
- lock by smart key remote control signal.
  Ex) The theft deterrent mode cannot be activated when locking the doors with key hole on door.



3. Disarming

- If the door unlock signal is received from the smart key remote control with power OFF or the outside door handle switch signal is received with the driver door locked, the doors are unlocked, turn signal lamps blink once, exterior buzzer sounds twice at the intervals with 50 ms ON/450 ms OFF and theft deterrent mode is deactivated. When receiving the door unlock signal with the theft deterrent mode disarmed, the turn signal lamps blink and exterior buzzer sounds.
  When tailgate is open by tailgate open switch signal (only tailgate disarmed)
- When verified smart key is detected and manual tailgate is open by tailgate open switch signal
- (only tailgate disarmed)
  When ignition switch is turned to ON position
-

4. In theft deterrent mode
   BCM observes the conditions below continuously:

- Battery connection (B+)
- Front/rear door open
- Tailgate open
- 4 doors lock/unlock
- Engine hood open

5. Activation of theft deterrent alarm

- When any of doors, tailgate or engine hood is open in theft deterrent mode
- When unlocking the door lock switch in theft deterrent mode
- When opening a door after completion of theft deterrent alarm (for 30 seconds)
- Horn and the turn signal lamps operate for 30 seconds with the interval of 0.5s ON/0.5s OFF.

6. Warning cancellation requirements

- The theft deterrent alarm is deactivated by the following BCAN signals during its operation: (theft deterrent mode maintains)

  1) When door is unlocked by smart key remote control
  2) When door is locked by smart key remote control
  3) When tailgate is open by smart key remote control
  4) When passive door is unlocked due to smart key detection
  5) When tailgate is open due to smart key detection
  6) When panic alarm is activated by smart key remote control

- When turning the ignition switch to ON position during the theft deterrent alarm, the alarm stops immediately.
- When turning the ignition switch to ON position during the theft deterrent alarm, the alarm stops and the theft deterrent mode is deactivated after 30 seconds (remaining time).
- If there is not any disarming commend, the alarm stays ON for 30 seconds and the theft deterrent mode continues.

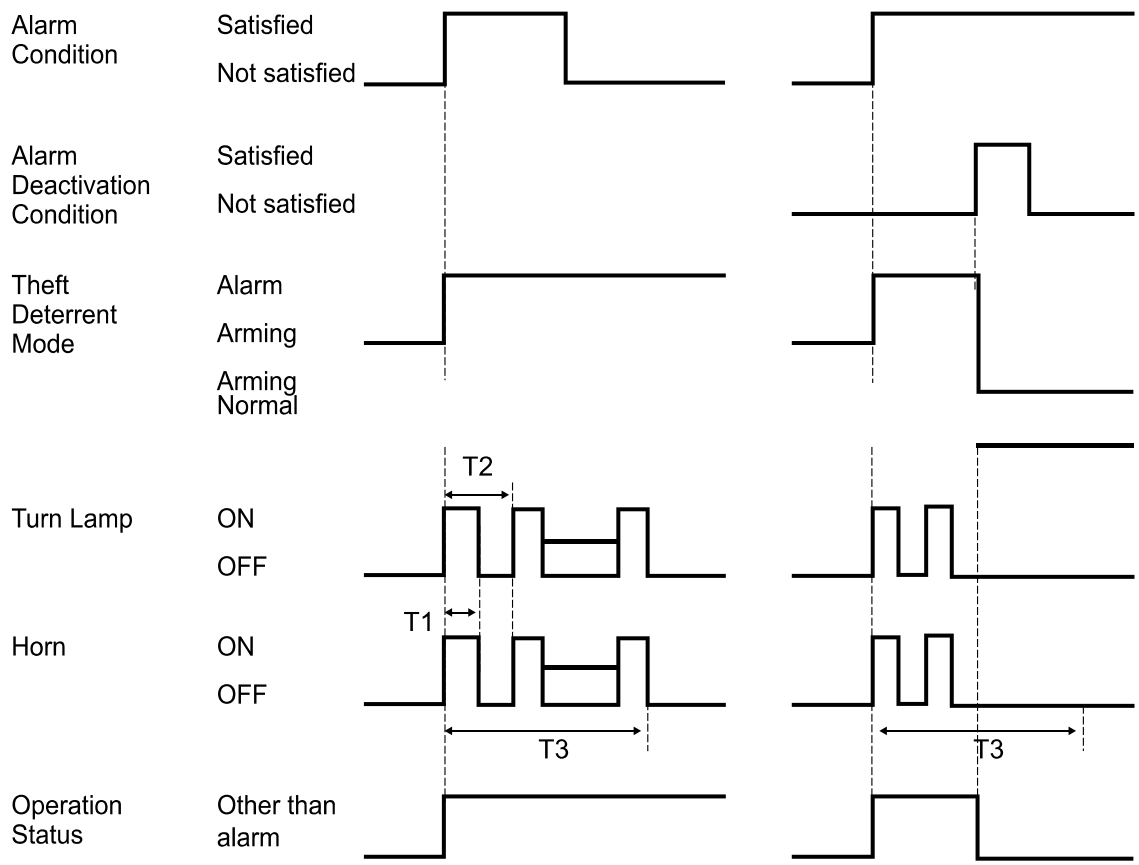
Modification basis	
Application basis	
Affected VIN	

7. Re-entering into theft deterrent mode after tailgate open

- If all the doors, excepting tailgate, are in theft deterrent mode and the BCM is received the signal indicating that the verified smart key is not in the vehicle when the tailgate is closed again, the system enters into the theft deterrent mode again in 1 second. At this time, the turn signal lamps blink twice and exterior buzzer sounds once by the BCM.

8. Operation when disarming

- The horn and the turn signal lamps stop their operation.

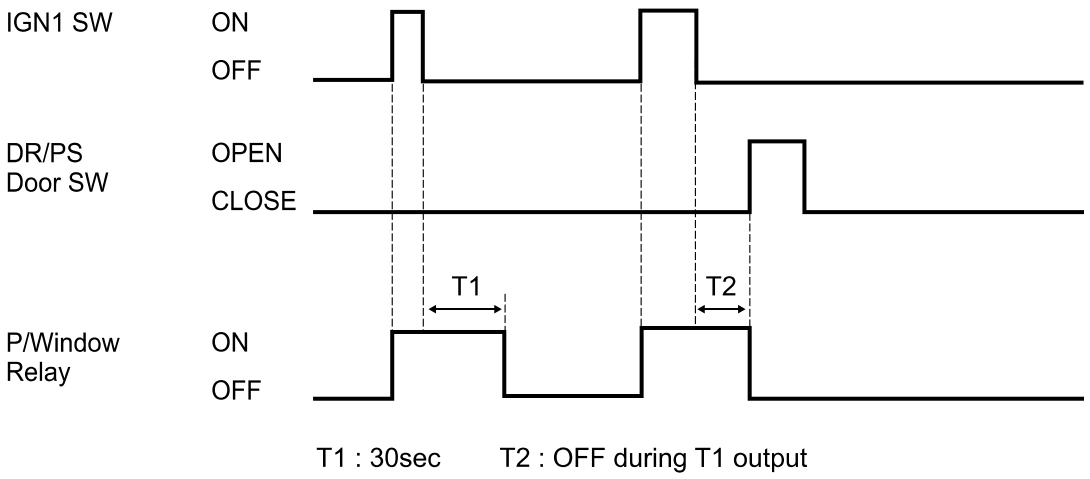


T1 : 0.5sec T2 : 1sec T3 : 30sec

* The theft deterrent/alarm status is stored in the EEPROM, and monitoring is followed by operation when connecting the battery.

16) Time Lag Power Window Control

1. When turning the ignition switch to ON position, the power window relay is turned ON.
2. The power window relay keeps ON for 30 seconds even when stopping the engine. However, the power window relay is turned OFF when opening a front door.
3. When locking the door (activation of theft deterrent mode), the power window relay is immediately turned OFF.



17) Sleep Mode

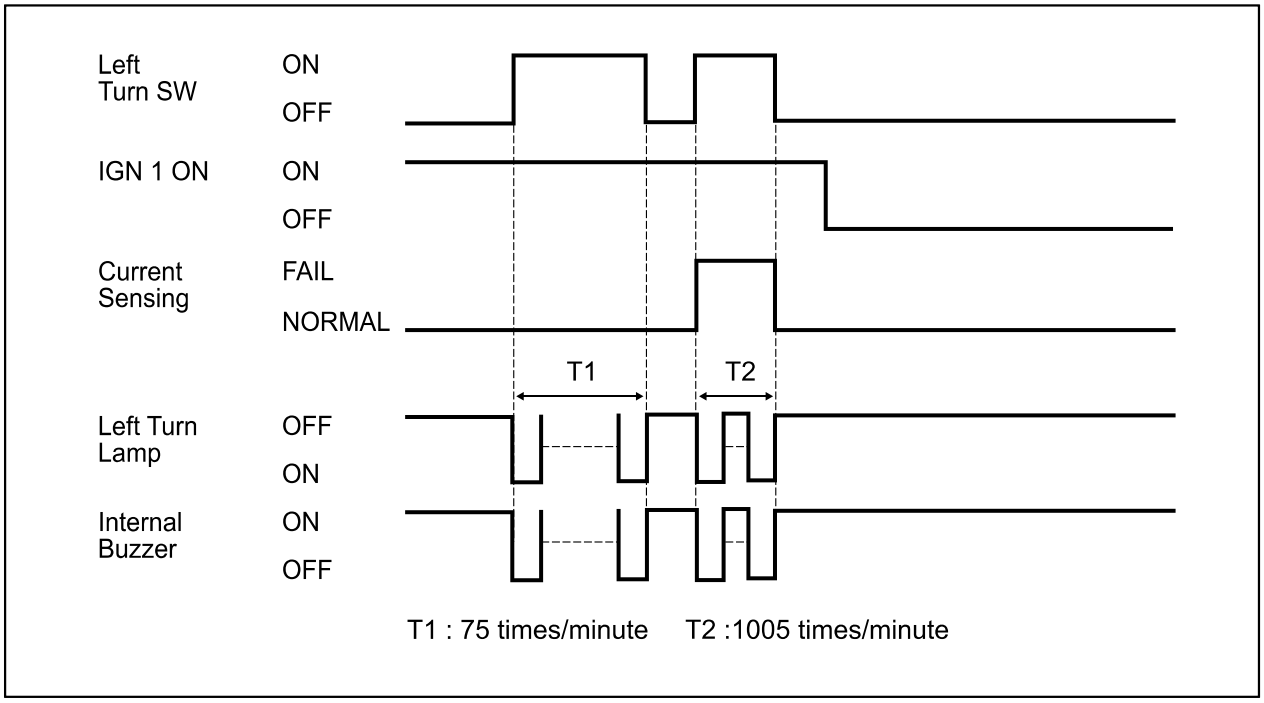
1. If the driver door/passenger door/rear doors/tailgate lock switch is not changed for 6 seconds with all driver door/passenger door/rear doors/tailgate closed, key removed, IGN1 and IGN2 OFF, the vehicle enters into sleep mode for system power down.
2. If any of conditions in Step (1) is not satisfied, the System Wake-up mode is activated.
3. When output such as room lamp, key hole illumination, tail lamps and power window is activating or all the doors keep closed for 30 seconds after door is unlocked for conditions in Step (1), the system is in normal mode. Then, if there is no change within 6 seconds with all output conditions and ready conditions released and all the doors closed, the sleep mode is activated.
   When turning on the overhead room lamp switch, the overhead room lamps come on for 10 minutes
4. and go off, and the sleep mode is activated after 6 seconds.
   When the coming home light OFF conditions are satisfied, the sleep mode is activated.
5. In this condition, when opening a door or inserting the ignition key into key hole, the sleep mode is
6. deactivated.

Modification basis	
Application basis	
Affected VIN	

18) Flasher (Blinking) Function

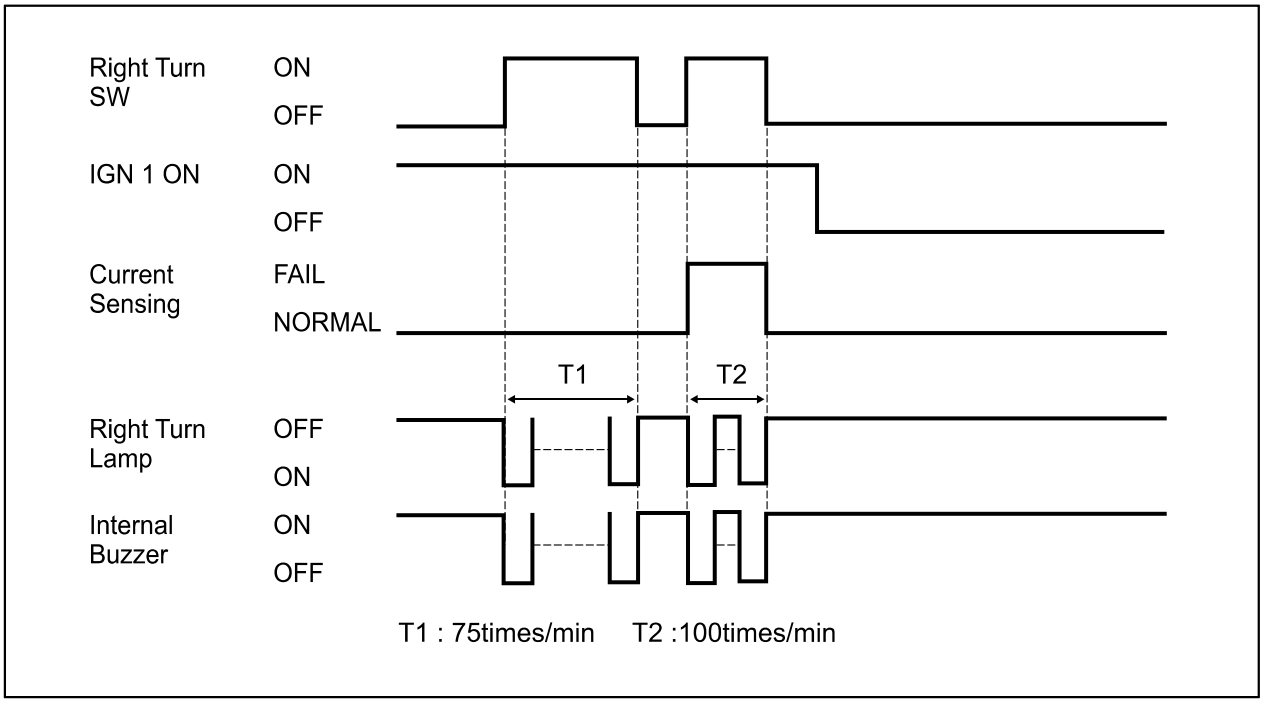
▶ **Turn signal lamp control**

1. When the BCM is received the multifunction switch signal, it operates the turn signal lamp and interior buzzer with the intervals of 400 ms ON/400 ms OFF for 75 times/min.
2. The turn signal lamps are operational only when IGN1 is ON.
3. If the turn signal lamp is defective during its operation, the turn signal lamp blinks with the intervals of 300 ms ON/300 ms OFF for 100/min and the interior buzzer sounds with same interval. Defective conditions by BCM: Open - below load of 3.0 A, Short - over load of 7.0 A (load means lamp
4. load here)
   When turning ON the turn signal switch, the lamp blinks 3 times by the BCM. When turning OFF the
5. switch during the operation, the turn signal lamp blinks 3 times and goes off.
   When turning OFF and then immediately ON the turn signal switch during auto blinking operation of 3
6. times, the turn signal lamp blinks additional 3 times.
   When turning ON another turn signal switch during the operation, currently operated turn signal lamp
7. stops immediately and another turn signal lamp starts blinking.



▶ Right turn signal lamp control

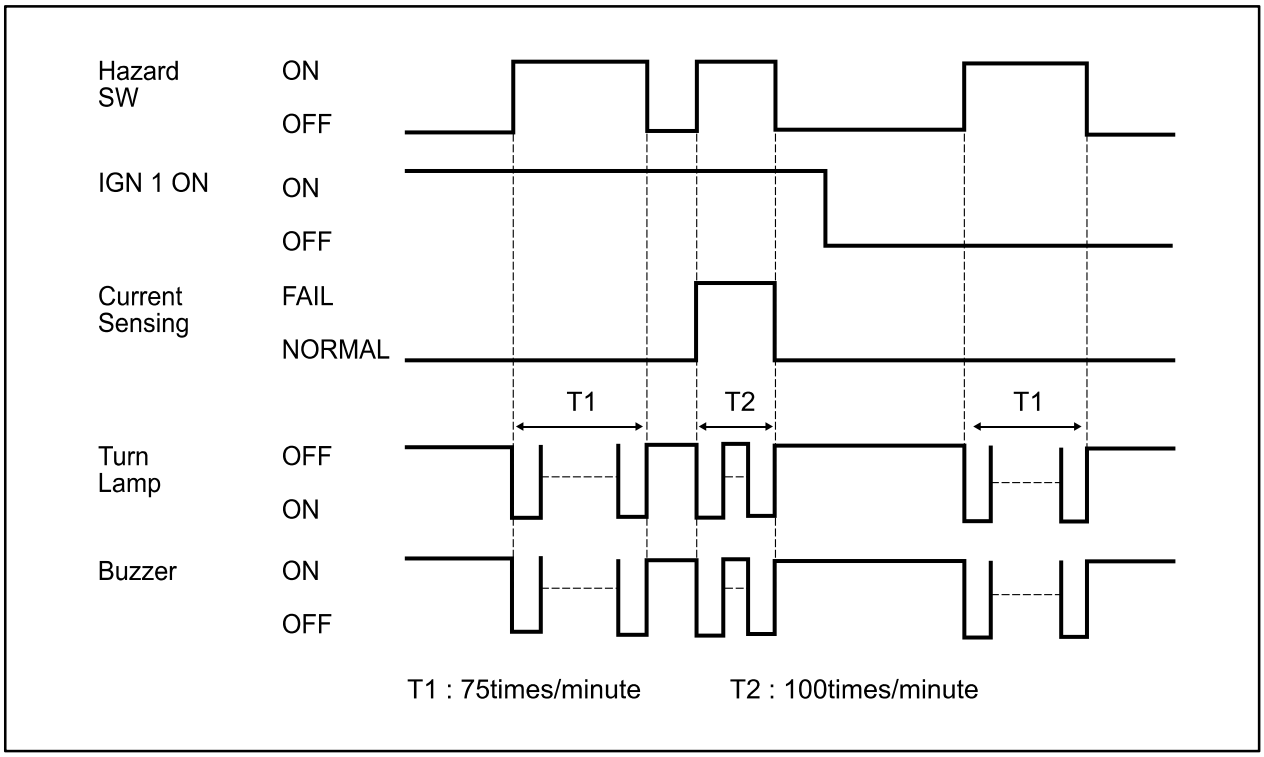
1. When the BCM is received the multifunction right turn signal lamp switch signal, it operates the right turn signal lamp and interior buzzer with the intervals of 400 ms ON/400 ms OFF for 75 times/min. When turning OFF the right turn signal switch during its operation, the turn signal lamp and buzzer stop the operation.
2. The turn signal lamps are operational only when IGN1 is ON.
3. If the turn signal lamp is defective during its operation, the turn signal lamp blinks with the intervals of 300 ms ON/300 ms OFF for 100/min and the interior buzzer sounds with same interval.
4. Defective conditions by BCM: Open - below load of 3.0 A, Short - over load of 7.0 A (load means lamp load here)
5. When turning ON the turn signal switch, the lamp blinks 3 times by the BCM. When turning OFF the switch during the operation, the turn signal lamp blinks 3 times and goes off.
6. When turning OFF and then immediately ON the turn signal switch during auto blinking operation of 3 times, the turn signal lamp blinks additional 3 times.
7. When turning ON the left turn signal switch during the right turn signal lamp operation, the right turn signal lamp stops immediately and the left turn signal lamp starts blinking.



Modification basis	
Application basis	
Affected VIN	

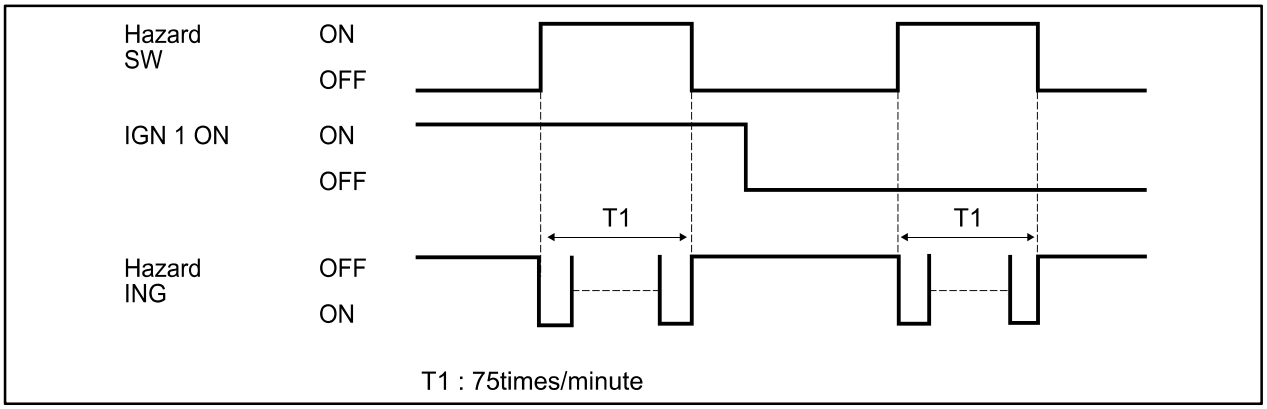
▶ Hazard flasher switch control

1. When pressing the hazard flasher switch, the left/right turn signal lamps blink with the intervals of 400 ms ON/400 ms OFF for 75/min and the interior buzzer sounds with same interval.
2. When pressing the hazard flasher switch again during its operation, the turn signal lamps and horn stop the operation.
3. This function is available if the battery is connected (B+).
4. If the turn signal lamp is defective during its operation, the left turn signal lamp blinks with the interval of 300 ms ON/300 ms OFF (100/min) and the interior buzzer sounds with same interval.
   The tolerance between left turn signal lamp and right turn signal lamp should be below 100 ms.
5. The hazard flasher has a priority over the turn signal lamp.
6. Priority of hazard flasher is as follows:
7. Seat belt reminder > Key reminder > Sunroof > Tail lamp > Hazard flasher > Turn signal lamp



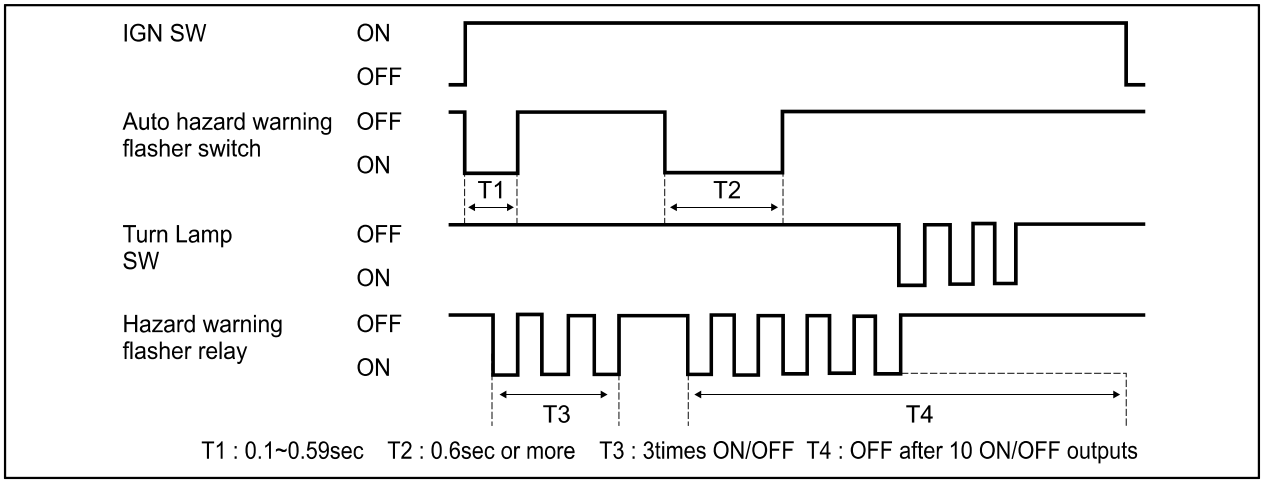
▶ Hazard flasher indicator control

1. When pressing the hazard flasher switch, the hazard flasher indicator blinks with the interval of 75/min.
2. When pressing the hazard flasher again switch during Step (1), the indicator stops its operation. This function is available if the battery is connected (B+).
3.



▶ Auto hazard flasher control

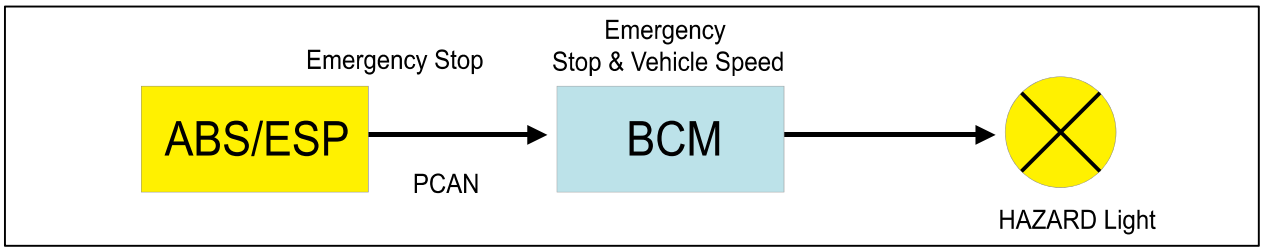
1. When the auto hazard flasher is operated for 0.1~0.59 seconds, the hazard flasher indicator blinks 3 times.
2. When the auto hazard flasher is operated for more than 0.6 seconds, the hazard flasher indicator blinks 10 times.
3. The hazard flasher has priority over the auto hazard flasher and both have the same flash frequency. This function is only available when the ignition key is in the "ON" position.
4. When the ignition switch is turned to OFF position during its operation, the auto hazard flasher stops
5. the operation.
   The hazard flasher stops operation as soon as the signal is received from the turn signal lamp (hazard
6. flasher) switch during this operation.
   If the turn signal lamp switch is turned on, the auto hazard flasher does not operate even though its
7. signal is received.



Modification basis	
Application basis	
Affected VIN	

▶ Emergency hazard flasher control (coupled with ABS)

1. System layout



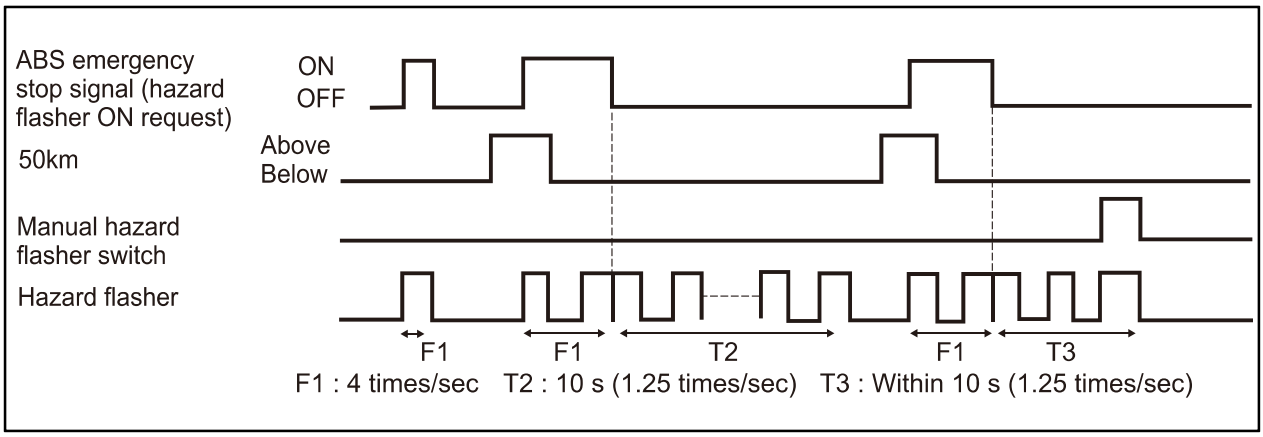
2. Operating conditions: When receiving the emergency hazard flasher ON signal from ESP and ABS. When receiving the emergency stop signal through PCAN communication it blinks with the interval of 4 Hz and when receiving the emergency stop OFF signal through PCAN communication it blinks with the interval of 1.25 Hz, normal operating speed.
However, the manual operation of the switch has a priority over this function.

   - Priority
     Manual hazard flasher > Emergency stop signal > Emergency auto hazard flasher > Auto hazard flasher
     (If emergency stop signal is received through PCAN communication during hazard flasher operation, the signal is overridden. If the emergency hazard flasher signal is received during multi-function automatic hazard flasher operation or multi-function automatic hazard flasher is received during emergency hazard flasher operation, emergency stop is performed.)
   - When the emergency stop signal is received, the hazard flasher blinks with the interval of 4 Hz, then returns to normal operation speed. After that, if the emergency stop signal is received again, the emergency hazard flasher blinks with the interval of 4 times/sec.

3. OFF conditions:

The BCM flashes the emergency auto hazard flasher with interval of 1.25 times/sec.:

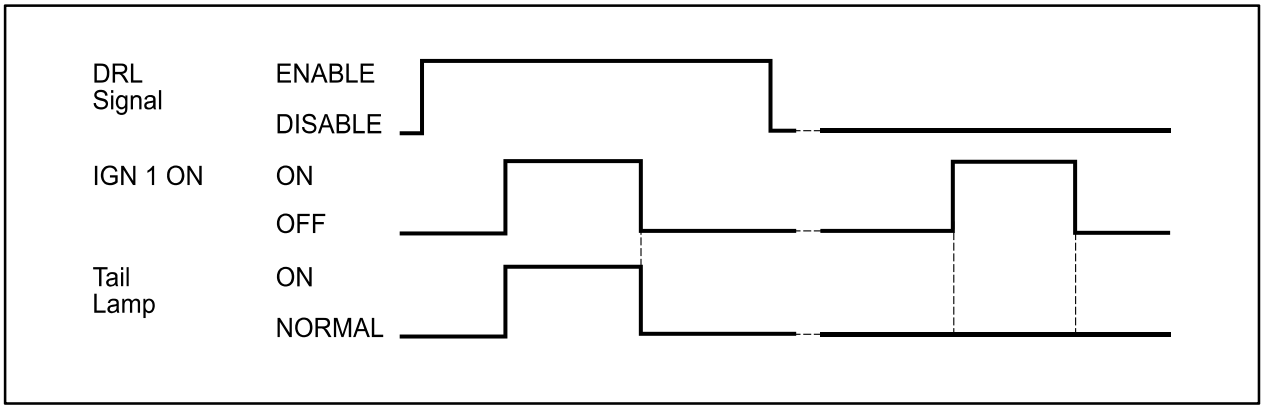
1) The emergency hazard flasher does not operate if the vehicle speed is over 50 km/h when the emergency stop signal is received.
2) The emergency hazard flasher operates if the vehicle speed is 50 km/h or lower when the emergency stop signal is received.
3) When vehicle speed increases more than 10 km/h above the speed when the signal is received during operation by emergency braking signal, the emergency hazard flasher stops operation.
4) When turning emergency hazard flasher switch OFF during operation by emergency braking signal, it stops operation.
5) It is deactivated automatically 10 seconds after if items 2) and 3) above are not met during operation by emergency braking signal.
6) If multi-function automatic hazard flasher signal is received during operation by emergency braking signal, it will be overridden.



Modification basis	
Application basis	
Affected VIN	

19) DRL (Daytime Running Light) Control

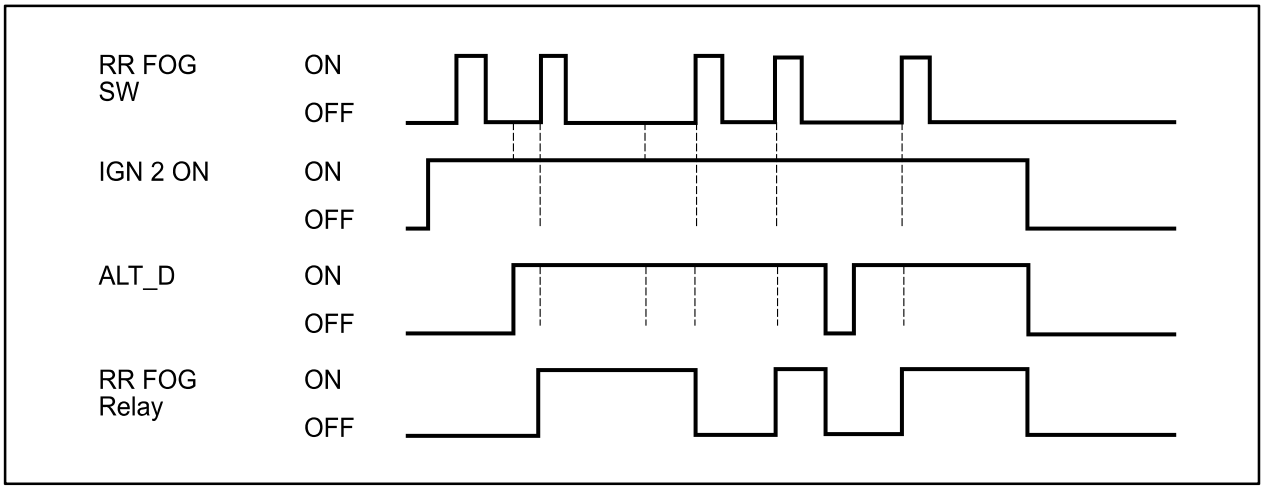
1. When receiving the DRL activation signal, the tail lamps are turned ON when turning the ignition switch to ON position, and the headlamps are turned ON when the engine speed is 300 rpm or higher.
2. When turning ON the tail lamp switch during engine running, the headlamps are turned OFF.
3. The headlamps do not come ON when the engine speed is above 300 rpm with the tail lamp switch ON.
4. The auto light sensor is not available in the vehicle with DRL system.
5. If there is no DRL activation signal, the light system operates in normal conditions.



20) Fog Lamp Control

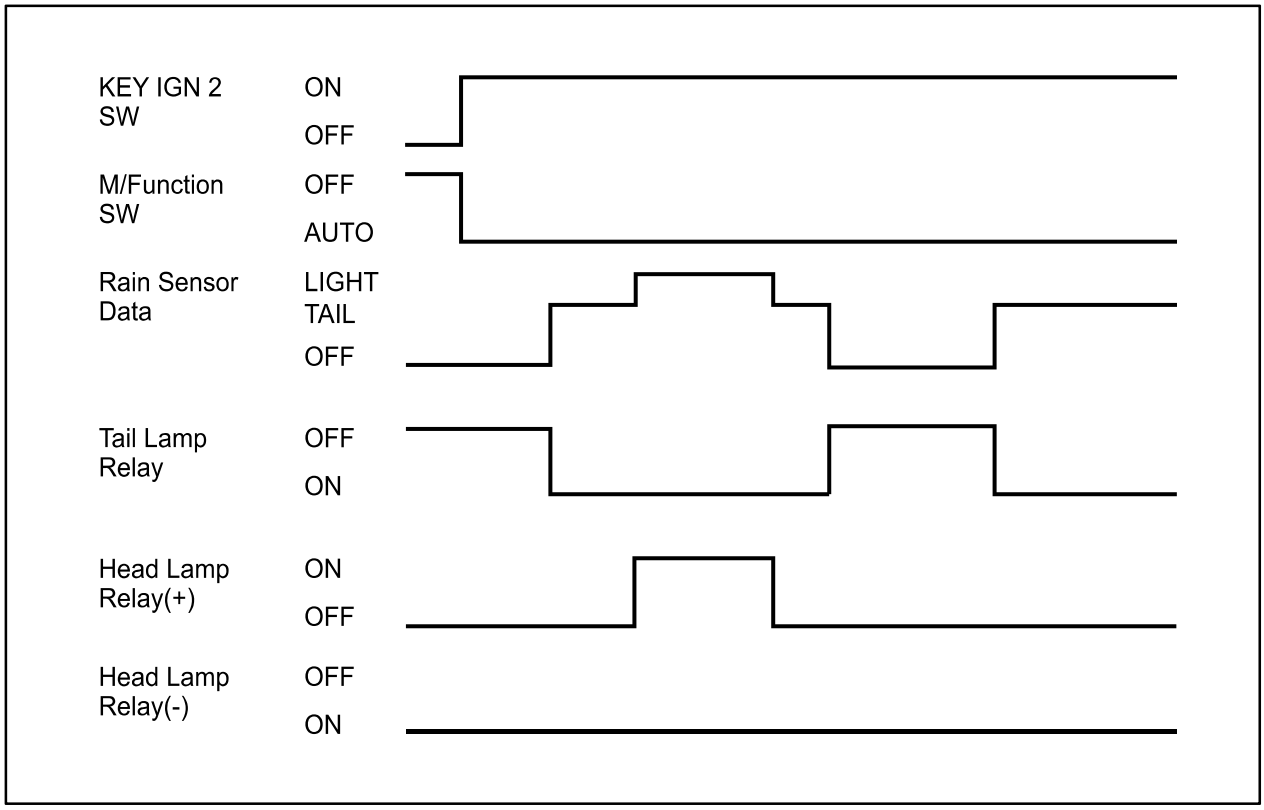
(The rear fog lamps are applied to only EU region)

1. When pressing the rear fog lamp switch with IGN2 ON (headlamp ON condition), the rear fog lamps are turned ON. When pressing the rear fog lamp switch again during the operation, the rear fog lamps are turned OFF.
2. The rear fog lamps do not come ON when the IGN2 switch is turned to OFF position or the light switch is OFF.
3. The rear fog lamps should not automatically come on again if they have been turned OFF by any other way other than the switch.



21) Auto Light Control (LIN)

1. The BCM communicates with the auto light sensor when turning the ignition switch to ON position, and controls the tail lamps and the headlamps depending on the LIN data with the light switch AUTO.

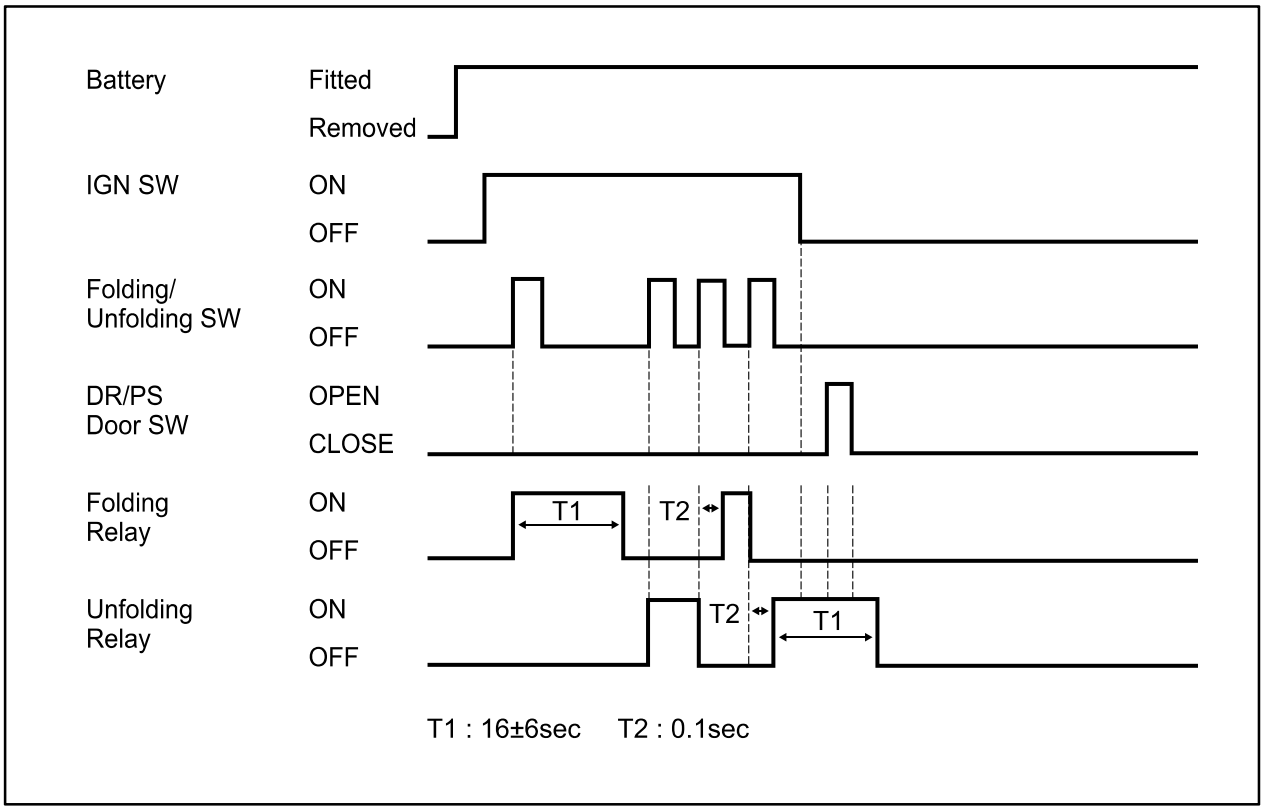


Modification basis	
Application basis	
Affected VIN	

22) Outside Mirror Folding/Unfolding Control

▶ **Folding/unfolding control**

1. When pressing the mirror folding/unfolding switch with IGN ON, the mirrors are folded or unfolded according to the mirror condition. If the outside rearview mirror was folded, the mirror should be unfolded, and vice versa. Folding/unfolding output is activated for 16±6 seconds.
2. This operation time should be completed even when the ignition switch is turned to OFF position during its operation.
3. At first time pressing the mirror folding/unfolding switch after reconnecting the battery, the mirror folding operation is performed.
4. You can control the mirror position within the first 30 sec. after turning the ignition OFF. In other words, this control must be available for 30 seconds (time lag period) after turning the ignition switch to OFF position. Folding/unfolding is completed when time lag of 30 seconds elapse during operation.
5. When receiving the folding/unfolding signal during the mirror folding/unfolding operation, the output should be activated after having time lag of 0.1 second.
   The folding/unfolding operation is performed regardless of the vehicle speed.
   Manual operation
   - Mirror unfolded → Mirror folding/unfolding signal from switch → Mirror folding
   - Mirror folded → Mirror folding/unfolding signal from switch → Mirror unfolding



▶ **Auto folding/unfolding control**

1. Setting
   - Set auto folding function: When pressing the mirror folding switch for over 3 seconds, the auto folding function is set and the internal buzzer sounds once (ON: 0.1 sec, OFF: 0.2 sec).
     Release auto folding function: When pressing the mirror folding switch for over 3 seconds, the
   - auto folding function is set and the internal buzzer sounds twice (ON: 0.1 sec, OFF: 0.2 sec).

2. Auto folding sequence
   - When receiving the LOCK signal from the REKES, the system operates in the sequence of "Door lock → Theft deterrent mode activation → Mirror folding" for BCM without SKM.
   - When receiving the outside door handle switch signal or door lock signal from the smart key remote control, the system operates in the sequence of Door lock → Theft deterrent mode activation → Mirror folding" for BCM with SKM.
3. Auto unfolding sequence
   - When receiving the UNLOCK signal from the REKES, the system operates in the sequence of "Door unlock → Theft deterrent mode deactivation → Mirror unfolding" for BCM without SKM.
   - When receiving the outside door handle switch signal or door unlock signal from the smart key remote control, the system operates in the sequence of Door unlock → Theft deterrent mode deactivation → Mirror unfolding" for BCM with SKM.
4. When the auto folding function is set, the automatic unfolding is not available if the mirrors have been folded manually.
   (The outside rearview mirror will be folded automatically if the auto folding function is set.)
5. The factory setting is the enabling the auto folding function.

23) Approach (Puddle) Lamp Control

▶ **Without SKM**

1. Approach lamp ON
   - When receiving the UNLOCK signal in the theft deterrent mode, the approach lamps come ON for 30 seconds.
   - When turning the ignition switch to OFF from ON position and opening the driver door, the approach lamps come ON.
2. Approach lamp OFF
   - When receiving the door lock signal with the approach lamps ON, the lamps go OFF (reactivation of theft deterrent mode).
   - When turning the ignition switch to ON position with the approach lamps ON, the lamps go OFF. The approach lamps go OFF after 30 seconds.
   -

Modification basis	
Application basis	
Affected VIN	

▶ **With SKM**

1. Approach lamp ON

- When turning the ignition switch to OFF from ON position and opening the driver door, the approach lamps come ON.
- When receiving the UNLOCK signal from the smart key remote control or outside door handle switch signal in the theft deterrent mode, the approach lamps come ON for 30 seconds. When receiving the AUTO approach signal in the theft deterrent mode, the approach lamps
- come ON for 30 seconds.

2. Approach lamp OFF

- When receiving the door lock signal from the smart key remote control or outside door handle switch signal with the approach lamps ON, the lamps go OFF (reactivation of theft deterrent mode).
- When turning the ignition switch to ON position with the approach lamps ON, the lamps go OFF. The approach lamps go OFF after 30 seconds.
-

24) Buzzer Control

Priority are as follows:

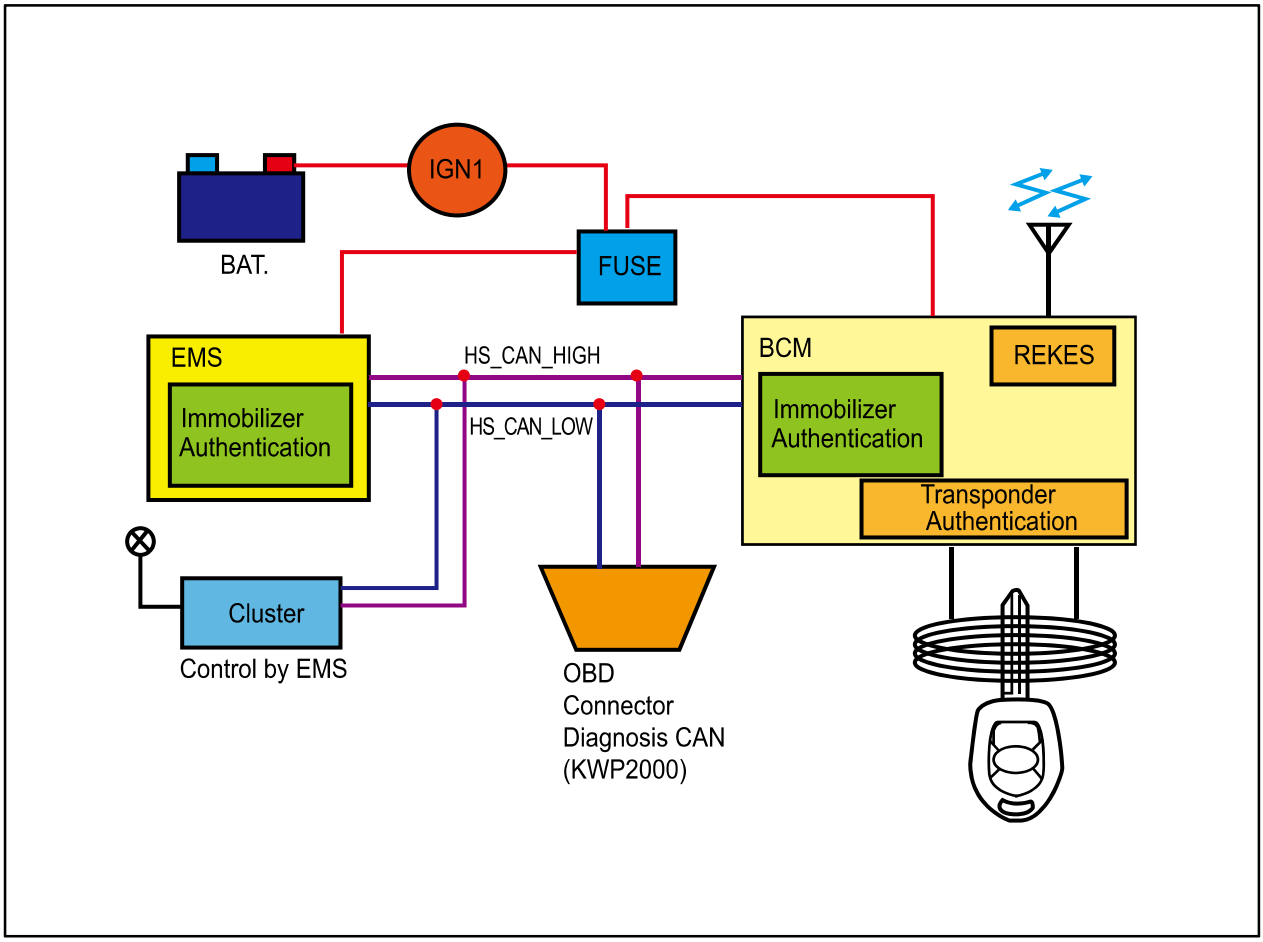
Buzzer Priority in BCM					Warning command from SKM			
			For BCM without SKM	For BCM with SKM				For BCM with SKM
1	REKES lock alarm	Exterior	Horn	1	1	Key-OFF alarm	Exterior	1
2	REKES unlock alarm	Exterior			2	Smart key reminder warning	Exterior	
3	Panic alarm	Horn	2	2	3	Smart key verification failure warning	Interior	5
4	Theft deterrent alarm	Horn	1	1	4	Transponder verification failure warning	Interior	
5	Seat belt reminder alarm	Interior	3	1	5	Smart key battery discharge warning	Interior	
6	SWR alarm	Interior	4		6	Gear position warning	Interior	
7	sun roof alarm	Interior	6	2	7	SKM error warning	Interior	
8	Tail lamp alarm	Interior	7		8	Brake warning	Interior	
9	Hazard flasher alarm	Interior	8	4	9	Clutch warning	Interior	
10	Turn signal lamp alarm	Interior	9		10	Smart key holder reminder warning	Interior	3
11	Auto folding setting	Interior	10	6				
12	Key reminder	Interior	5	-				

2. IMMOBILIZER/REMOTE CONTROL KEY CODING

1) System Overview

While the communication between BCM/SKM and ECU is based on the CAN communication, the communication between transponder and BCM/SKM is based on LF (Low frequency) and RF (Radio frequency). When the ignition switch is turned to ON position, the BCM checks the verified transponder according to the immobilizer verification procedure, if correct, allows the vehicle to start the engine. The immobilizer indicator comes on during the communication and if the verification is carried out successfully the indicator goes off.
If there is something wrong in the system, the indicator blinks.

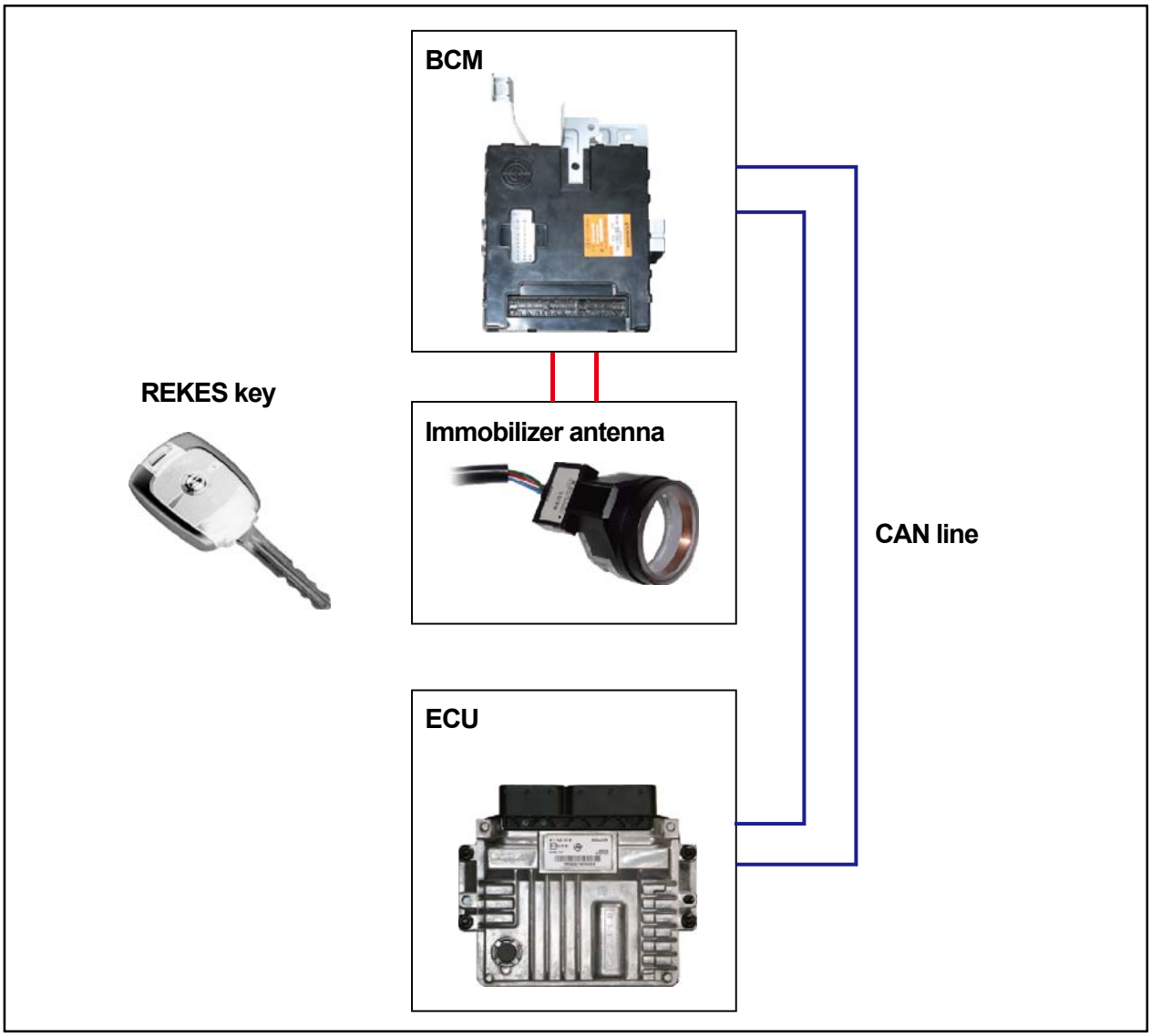
2) System Layout



Modification basis	
Application basis	
Affected VIN	

3) Operation of Immobilizer

When the ignition switch is turned to the ON position with REKES key, the BCM checks the crypto code of the inserted key using the immobilizer antenna and sends whether the engine is startable or not to the engine ECU through the CAN communication so that the engine can be started.

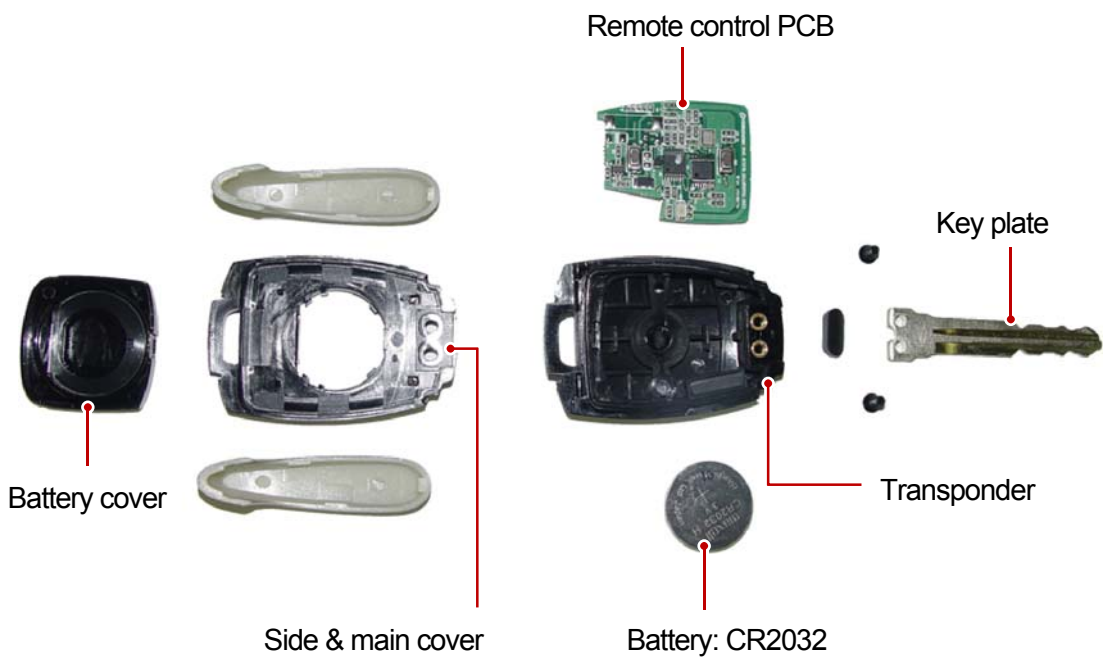


CAUTION

For the vehicle with the immobilizer, there can be a problem in starting the vehicle or the system error:

- When two or more immobilizer keys come into contact with (each) other(s).
- When the key is close to any device sending or receiving electromagnetic fields or waves other than Ssangyong products.
- When the key is close to any electronic or electric devices such as lighting equipment, security keys or security cards.
- When the key is close to a magnetic or metal object or a battery.

4) Components of REKES Key



▶ **How to replace battery**

Remove the battery cover using a flat screwdriver to replace the battery.

▶ **How to replace transponder**

- Remove battery cover and battery
- Remove rubber cover and screw then remove key plate
- Remove side cover and main cover
- Replace transponder

CAUTION

- Do not drop or shock to the transponder in the key as it may be damaged.
- With a damaged transponder, the engine cannot be started.
- When you erase the code or register an extra key, please attend on the site.
- In any cases, the immobilizer system can not be removed from the vehicle. If you attempt to remove it and damage the system, starting will be impossible, so never attempt to remove, damage or modify it.
- The remote engine starter cannot be installed to the vehicle equipped with the immobilizer system.

Modification basis	
Application basis	
Affected VIN	

SMART KEY MODULE

8712-03

GENERAL INFORMATION

1. SPECIFICATIONS

Item	Specification
Rated voltage	DC 12 V
Operating voltage	DC 6.0V ~ 16.0V DC 6.0V ~ 18.0V(CAN)
Operation temperature	−30°C to +80°C
Modulation method	FSK
Dark current	5.5 mA + Auto A/P (12 mA)
Maximum humidity	95%
Range	10 m or more (OPEN SITE)
Voltage drop	1.0 V or less
Receive frequency	433.920±0.015 MHz(EU) 315,000±0.015 MHz(GER)
Bandwidth	15 KHz ± 2 KHz or less

OVERVIEW AND OPERATING PROCESS

1. SYSTEM LAYOUT

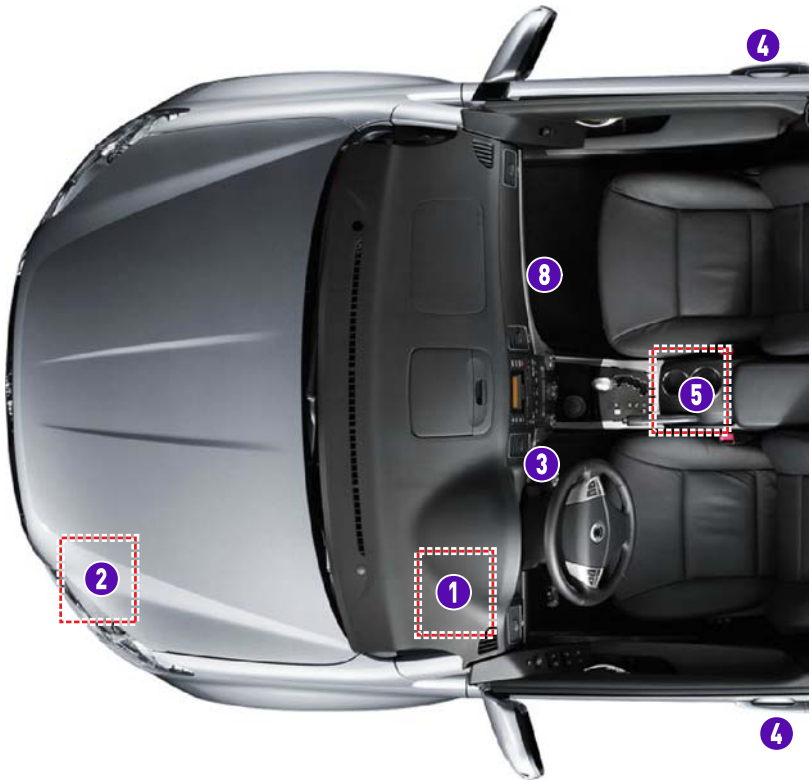
The vehicles with smart key system are equipped with the SKM (Smart Key Module) unit. The SKM, which does not use the traditional key or remote controller to access the vehicle, provides 3 functions. The passive UNLOCK function unlocks the door after confirming the smart key information and the driver's door conditions when the driver carrying a smart key touches the door handle. The passive START function starts the engine when the START switch is pressed by the driver sitting on the driver's seat. The passive LOCK function locks the door when the door handle switch is pressed by the driver after exiting the vehicle.

1 SKM unit



2 Buzzer





3 Start switch



4 Outside door handle switch and antenna



Modification basis	
Application basis	
Affected VIN	

Smart key



8 Slot





7 Rear bumper antenna



5 Front interior antenna

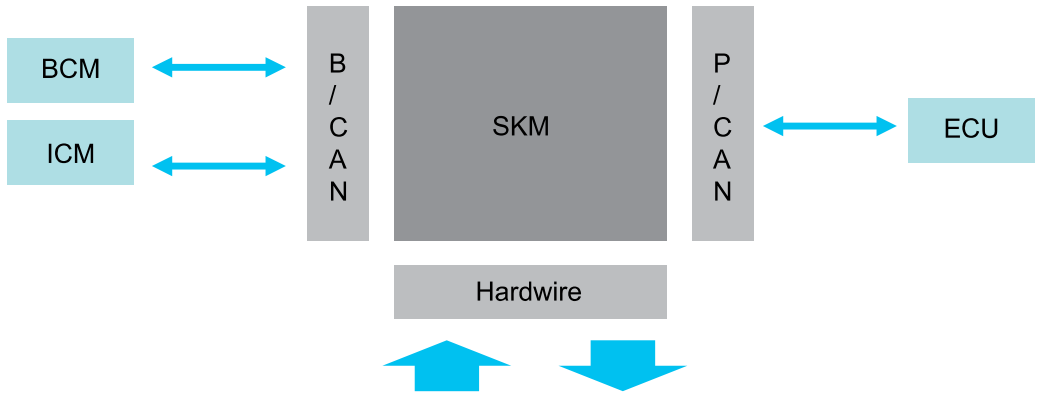


6 Rear interior antenna



Modification basis	
Application basis	
Affected VIN	

2. INPUT/OUTPUT DIAGRAM



Hardwire Input Signal	Hardwire Output Signal
1. Clutch (P/N switch) signal 2. Brake switch signal 3. Door handle trigger switch signal 4. Immobilizer communication 5. Start button signal 6. Smart key detection switch signal	1. ACC relay operating voltage (12 V) 2. IGN1 relay operating voltage (12 V) 3. IGN2 relay operating voltage (12 V) 4. IMMO operating voltage/ground 5. LF exterior antenna operating voltage 6. Start switch illumination/indicator

▶ Major functions

1.2. Passive LOCK/UNLOCK by outside door handle switch
3.4. Passive UNLOCK by tailgate open switch
5.6. Passive START by START switch
7.8. Engine ECU and High speed CAN communication
BCM, Instrument cluster and Low speed CAN communication
RF communication for REKES operation
Smart key system warning function
Smart key registration (up to 3 keys)

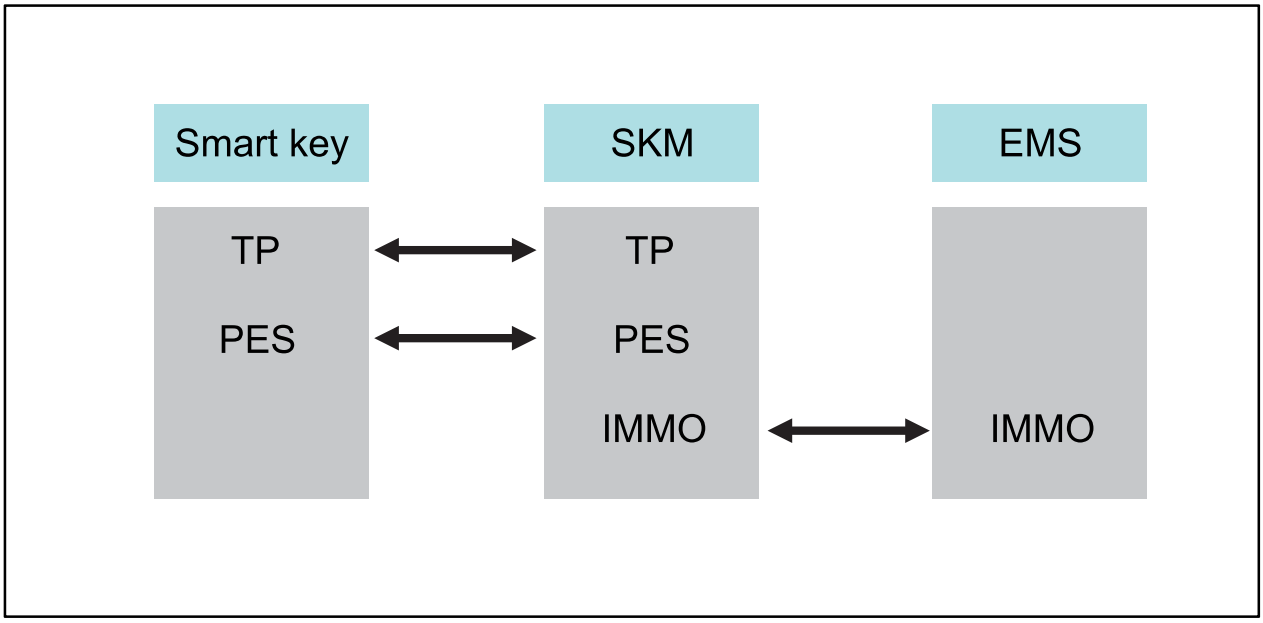
Modification basis	
Application basis	
Affected VIN	

3. OPERATIONS

1) Coding

(1) Coding process

▶ **Coding for each unit**



(2) Operation with/without smart key/EMS registration

	Passive LOCK/UNLOCK	Ignition status change	STARTING THE ENGINE
New	-	O	10 times
Smart key registration	O	O	-
EMS REGISTRATION	-	-	-
Smart key & EMS registration	O	O	O

(3) Coding after replacing components

- When replacing smart key and SKM: Register smart key and EMS
- When replacing EMS: Register EMS

(4) VIRGIN power control

If the SKM is not coded at all, the power control is performed as follows:

▶ Power control

The coding is available only when the ignition status is IGN1 ON.

▶ Engine start

If the SKM is in Virgin condition, the engine cranking can be performed up to 10 times.

▶ Virgin control by TM & EMS

If there is no variant code value from the EMS and no value is stored in the inactive memory area after the ignition status is changed to IGN ON, the START signal is not sent.

- No variant code in memory: IGN ON -> Check variant code -> Operate START switch -> Check ignition status -> Request START
- Variant code stored in memory: Normal operation

Modification basis	
Application basis	
Affected VIN	

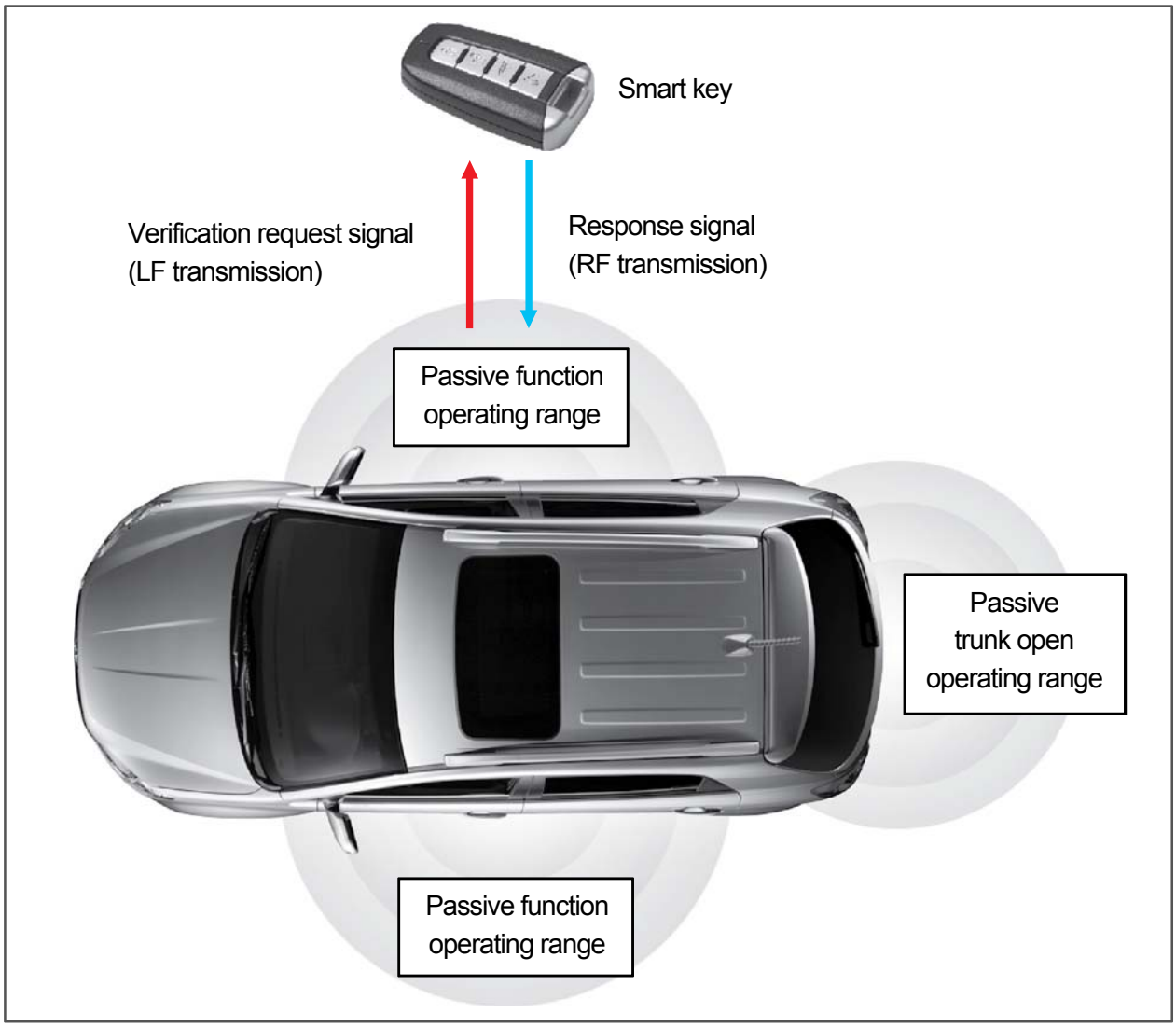
2) Smart Key Function

The passive LOCK/UNLOCK is performed by the input from the outside door handle switch.
(For driver's door LOCK/UNLOCK)

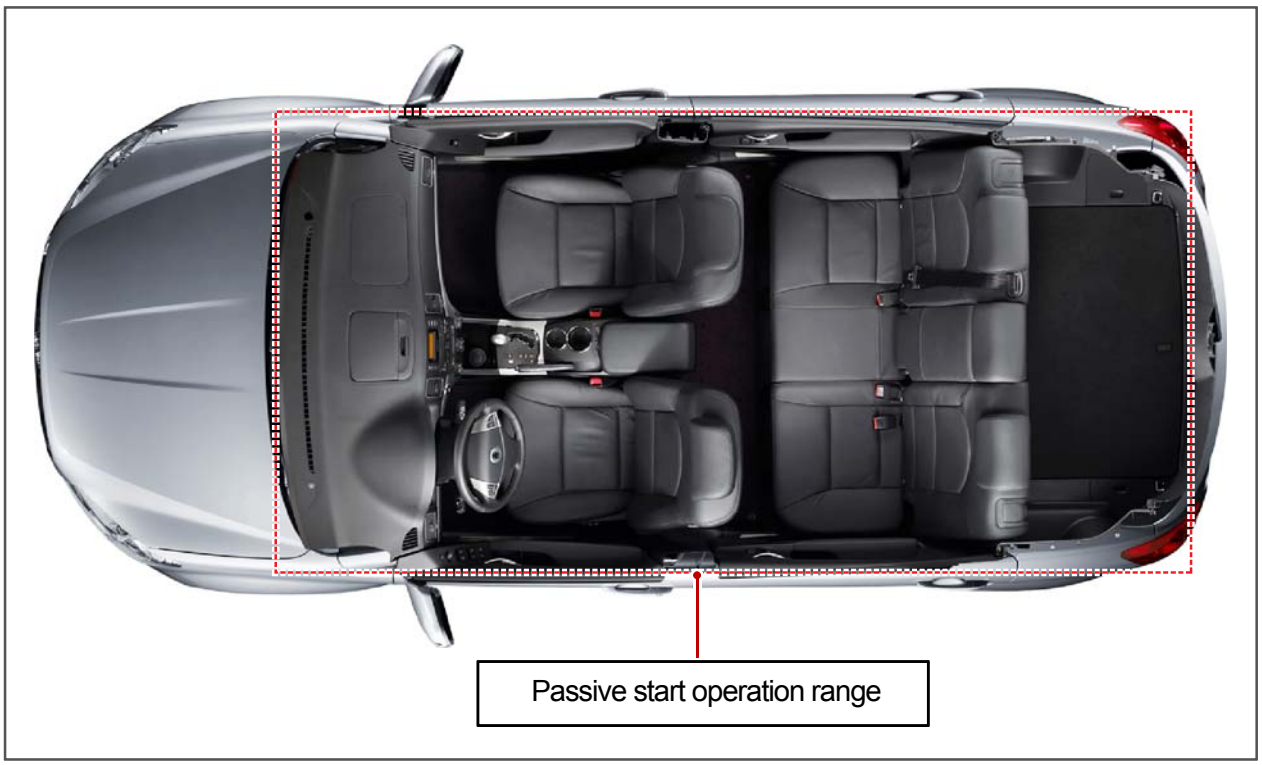
- Searching for a smart key signal from the outside the vehicle is prioritized in theft deterrent mode. Searching for a smart key signal from the inside is prioritized when the theft deterrent mode is deactivated.
- The smart key verification is performed only for the driver's or passenger's door which has received the input from the corresponding door handle switch. If a verified smart key is found, the passive entry function is performed.
- A maximum of 3 keys can be registered.

(1) Passive entry actuation area

▶ **Passive entry actuation area**



- Passive function actuation area: Within 1 m from the door handle
- Passive tailgate open actuation area: Within 1 m from the bumper

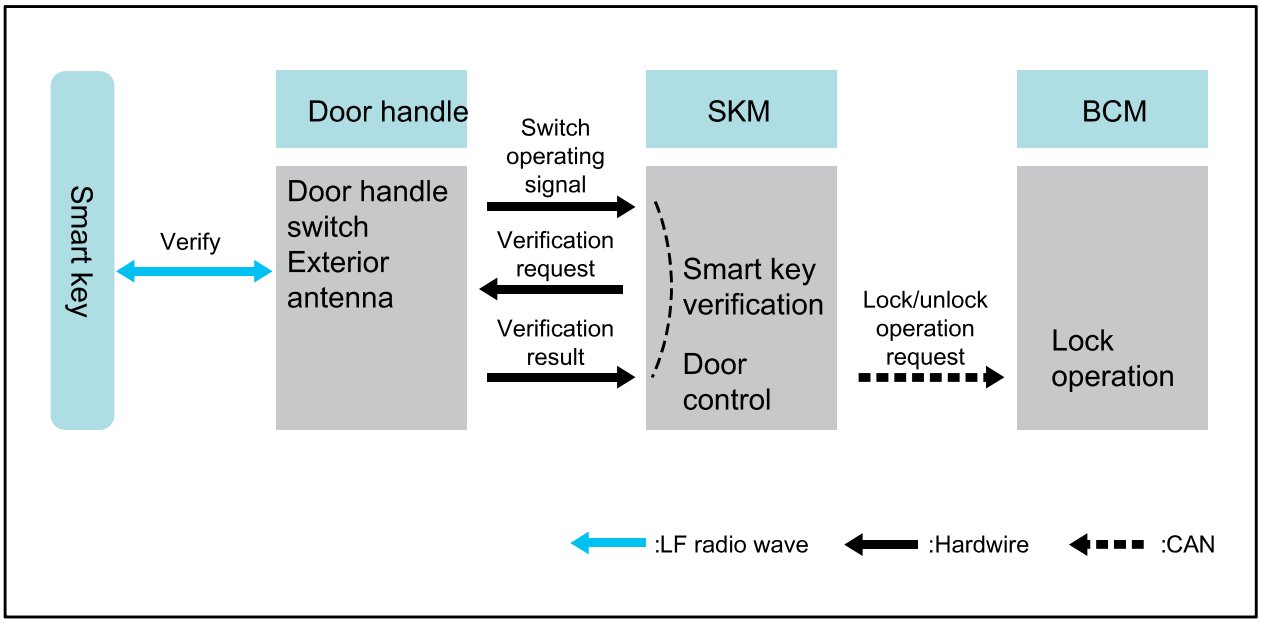


- Passive START actuation area: Vehicle interior

Modification basis	
Application basis	
Affected VIN	

(2) Passive LOCK

When the system searches for a smart key by the input from the outside door handle switch, the SKM sends the passive LOCK signal to the BCM if all the doors are closed and a normal smart key is found outside the vehicle.



▶ Passive LOCK hardware control

1. The SKM sends the door LOCK/UNLOCK signal to the BCM through the BCAN network when a smart key is verified after the signal from the driver/passenger outside door handle switch is received through the hardware.
2. The SKM sends the signal to the BCM and instrument cluster when the warning and indicator display conditions are met.

▶ Passive LOCK by outside door handle switch

When the ignition status is OFF, ACC ON or IGN ON, the SKM performs the verification procedure if the LOCK signal is received from the driver/passenger door handle switch.

1. When the outside door handle switch is operated, the SKM verifies if a smart key is outside the vehicle using the corresponding exterior antenna.
2. The SKM sends the signal for [Passive LOCK command] to the BCM through the BCAN if a smart key is identified as being outside the vehicle.
3. If no smart key is verified as being outside the vehicle, this process is stopped and restarted when the next signal is received from the outside door handle switch.
4. When the driver's door is unlocked with the ignition status ACC ON, the SKM changes the ignition status to OFF and sends the signal for [Passive LOCK command] to the BCM through the BCAN to lock the door. The BCM ignores the signal if the ignition status is IGN ON.

- The SKM recovers the deactivated smart key function inside the vehicle when it receives the theft deterrent deactivation signal from the BCM through the BCAN communication.

▶ Interruption of door LOCK & Smart key function by outside door handle switch

1. When the door LOCK signal is received from the driver/passenger door handle switch with the ignition status OFF or ACC ON, the SKM identifies the verified smart key and sends the passive LOCK signal to the BCM through the BCAN if the ignition is turned to OFF.
2. The SKM receives the theft deterrent mode information signal from the BCM through the BCAN.
3. If there is any verified smart key in the vehicle, the function of the verified smart key is interrupted.

▶ Searching for other keys

When the ignition status is IGN ON or ACC ON, the SKM starts to verify the smart key if any door is opened and then closed. If one or more smart keys are verified as being in the vehicle, the smart key verification procedure is stopped. If no verified smart key is identified as being in the vehicle, the SKM sends the signal which identifies that there is no verified key inside the vehicle to the BCM and instrument cluster through the BCAN (Smart key not identified warning).

▶ Smart key search mode

1. The system first identifies the last smart key used, and then identifies all the other registered smart keys until a normal smart key is verified.
2. The system identifies the smart keys by using the outside door handle antenna on the door handle switch which has sent the signal.
3. Smart key search input: The last door is opened and then closed. Outside door handle switch, Brake switch, START switch (Tailgate open request)

Modification basis	
Application basis	
Affected VIN	

(3) Passive UNLOCK

When the system searches for a smart key by the input from the outside door handle switch, the SKM sends the passive UNLOCK signal to the BCM if all the doors are closed and a normal smart key is found outside the vehicle.

▶ Passive UNLOCK hardware control

1. The SKM sends the door LOCK/UNLOCK signal to the BCM through the BCAN network when a smart key is verified after the signal from the driver/passenger outside door handle switch is received through the hardware.

▶ Passive UNLOCK by outside door handle switch

When the ignition status is OFF, ACC ON or IGN ON, the SKM starts to verify the smart key if below conditions are met.
When the driver or passenger door handle switch is operated, the SKM verifies if a smart key is outside the vehicle using the corresponding antenna.

1. When the outside door handle switch is operated, the SKM verifies if a smart key is outside the vehicle using the corresponding exterior antenna.
2. The SKM sends the signal for [Passive UNLOCK command] to the BCM through the BCAN if a smart key is identified as being outside the vehicle.
3. If no smart key is identified as being outside the vehicle, this process is stopped and restarted when the next signal is received from the outside door handle switch.
4. When the driver's door is locked with the ignition status ACC ON or IGN ON, the SKM sends the signal for [Passive UNLOCK command] to the BCM through the BCAN to unlock the door without changing the ignition status to OFF.

▶ Smart key search mode

1. The system first identifies the last smart key used, and then identifies all the other registered smart keys until a normal smart key is verified.
2. The system identifies the smart keys by using the outside door handle antenna on the door handle switch which has sent the signal.
3. Smart key search input: The last door is opened and then closed. Outside door handle switch, Brake switch, START switch (Tailgate open request)
4. Exceptional mode
   When operating the door handle switch, the system changes the smart key searching conditions in vehicle inside and outside according to the theft deterrent mode.
   - Searching sequence when disarmed by BCM: Inside > Outside
   - which function is restricted when the BCM is in theft deterrent mode.

(4) Passive tailgate open

When a normal smart key is found by the signal from the tailgate open switch, the system sends the tailgate open control signal to the BCM.

▶ Passive tailgate open hardware input/output control

1. The SKM receives the tailgate open switch signal from the BCM through the BCAN communication. The SKM sends the tailgate open output signal to the BCM through the BCAN communication.
2.

▶ Tailgate open switch control

Tailgate closed -> open

When the ignition status is OFF, ACC ON or IGN ON, the SKM starts to verify the smart key in the tailgate open actuation area after receiving the tailgate open signal for [tailgate open request] from the BCM through the BCAN.

1. The SKM sends the signal for [Passive tailgate open] to the BCM through the BCAN to open the tailgate and deactivate the theft deterrent mode if a smart key is identified as being outside the vehicle. If no smart key is identified as being outside the vehicle, this process is stopped and restarted when
2. the next tailgate open request signal is received.

Tailgate open -> closed

- When the tailgate is closed with all the other doors are closed, the SKM sends the signal for [smart key inside the vehicle] through the BCAN if there is a verified smart key inside the vehicle.
  When the tailgate is opened and then closed in theft deterrent mode, the signals for [external buzzer] and [smart key detect warning] are sent for 10 sec. through the BCAN if there is a verified smart key inside the vehicle.

▶ Smart key search mode

1. The system first identifies the last smart key used, and then identifies all the other registered smart keys until a normal smart key is verified.
2. If the tailgate antenna identifies a normal smart key, the system searches for a smart key in inside area of the tailgate and inside the vehicle.
3. The tailgate is opened only when a valid smart key is found within the tailgate antenna range, and the tailgate is not operated by a smart key in inside area of the tailgate.
4. Smart key search input: The last door is opened and then closed. Outside door handle switch, Brake switch, START switch (Tailgate open request)

Modification basis	
Application basis	
Affected VIN	

(5) Puddle (approach) lamp control

The SKM sends the signals for [AUTO approach], [REKES UNLOCK] and [Passive UNLOCK] through the BCAN to control the puddle (approach) lamp by AUTO puddle (approach) lamp ON, REKES UNLOCK and Passive entry UNLOCK.

▶ AUTO puddle (approach) lamp ON

Default setting is AUTO approach.
The AUTO approach function can be turned ON or OFF using a diagnostic device.

▶ Operating condition

- When the driver approaches the vehicle in theft deterrent mode (within 1 m), the SKM sends the puddle lamp operation signal through the BCAN if a smart key is identified.
- The SKM starts to search for a smart key 30 sec. after the vehicle has entered the theft deterrent mode.

▶ Continuous operation

- When a smart key is identified within 1 m from the vehicle in theft deterrent mode, the SKM sends the puddle lamp operation signal (10 min. timer activated) through the BCAN. If a smart key is continuously found within 10 min. the SKM sends the puddle lamp signal again for continuous operation (up to 2 times within 10 min.)
- The SKM starts to search for a smart key 30 sec. after sending the 1st puddle lamp operation signal. If a smart key is found, the SKM sends the 2nd operation signal.

▶ Reset conditions

- 10 min. timer terminated
- Re-entering theft deterrent mode after deactivation

▶ Standby mode operation

	Duration	Function	Time (s)
1st	within 5 days	Normal monitoring time	1.25
2nd	within 5 to 14 days	Increasing monitoring time	1.5
3rd	14 days or more	Vehicle is stationary.	

▶ Stop/Standby operation reset condition:

REKES or Passive door LOCK/UNLOCK

▶ Puddle (approach) lamp ON by REKES UNLOCK & Puddle (approach) lamp ON by Passive entry UNLOCK

The SKM sends the signals for [REKES UNLOCK] and [Passive UNLOCK] to control the puddle (approach) lamp ON function by REKES UNLOCK and Passive entry UNLOCK in theft deterrent mode.

(6) Limitations/Interruption of smart key function

The SKM searches for a smart key inside the vehicle when it receives the information on entering the theft deterrent mode from the BCM. If a normal smart key is identified, the SKM memorizes this as a function-limited key (Silent Smart Key) or a function interrupted key (Deactivation Smart Key) according to the conditions.

▶ **Function limitation**

- If a smart key, which outputs the door LOCK signal, is found inside the vehicle, the SKM memorizes all the smart keys inside the vehicle as function limited keys (Silent Smart Key).
- The function limited smart key provides the passive START, ignition status change and REKES functions except the passive UNLOCK function.

▶ **Function interruption**

- If no smart key, which outputs the door LOCK signal, is found inside the vehicle, the SKM memorizes all the smart keys inside the vehicle as function interrupted keys (Deactivation Smart Key).
  The function interrupted smart key is not available for the passive LOCK/UNLOCK, passive START,
- ignition status change and REKES functions.

▶ **How to deactivate function limited/interrupted smart key**

- Deactivate the theft deterrent mode.

Modification basis	
Application basis	
Affected VIN	

3) REKES Control Function

When the SKM receives the REKES signals by the buttons on the smart key, it transmits the corresponding signals through the BCAN.

Switch	Stage	Remark
LOCK	1 step	100 ms: 1 step CMD 1500 ms: 2 step CMD 1000 ms: 3 step CMD
unlocked	1 step	
Tailgate open	3 step	
PANIC	3 step	

(1) REKES LOCK

When the SKM receives the signal for [REKES LOCK] by the LOCK button on the smart key, it transmits this signal through the BCAN.

- The SKM receives the signal for [REKES LOCK] 0.1 sec. after the LOCK button on the smart key is turned ON, and it transmits this signal through the BCAN.
- When the REKES LOCK signal is received with the ACC ON, the ACC is turned OFF and the signal for [REKES LOCK] is sent.

(2) REKES UNLOCK

When the SKM receives the signal for [REKES UNLOCK] by the UNLOCK button on the smart key, it transmits this signal through the BCAN.

- The SKM receives the signal for [REKES UNLOCK] 0.1 sec. after the UNLOCK button on the smart key is turned ON, and sends this signal through the BCAN.

(3) Remote keyless tailgate open

When the SKM receives the signal for [REKES tailgate open] by the tailgate open button on the smart key, it transmits this signal through the BCAN.

▶ **Remote keyless tailgate open**

- The SKM receives the tailgate open signal 1 sec. after the tailgate open button on the smart key is turned ON with the ignition status OFF, ACC or IGN ON, and it transmits the signal for [REKES tailgate open] through the BCAN.

(4) Remote keyless panic

The SKM transmits the signals for [REKES panic] by the panic button of the smart key to the BCM.

▶ Remote keyless panic

The SKM receives the REKES panic signal 1 sec. after the panic button on the smart key is turned ON with the ignition status OFF, ACC or IGN ON, and it transmits this signal through the BCAN.

▶ Panic siren mode by REKES panic control

When the SKM receives the panic signal with the ignition status OFF, ACC ON or IGN ON, the SKM transmits the REKES panic signal through the BCAN.

Modification basis	
Application basis	
Affected VIN	

4) Smart Key Verification Time Control

(1) Pre-verification timer

When the operation signal from the START switch is received, the START & power control functions can be performed without smart key verification.

Condition	SKM operation
- when door closed signal is input with - B+ or ACC ON - when brake is applied with - B+ or ACC ON - when START switch is operated with - B+ - when smart key is inserted into slot & brake switch is operated or START switch is operated with - B+	Once the vehicle interior verification is completed, 30 sec. pre-verification timer is started
when the ignition is turned OFF with IGN ON and engine running	30 sec. pre-verification timer is started without re-verification
Timer deactivation conditions: after 30 sec. has passed, IGN ON, Outside door handle switch ON, entering theft deterrent mode when door condition is changed	

(2) Immobilizer verification timer

The immobilizer verification status indicates that it is possible to respond to the request message sent from the EMS to deactivate the immobilizer. The SKM verified a smart key and the engine can be started.

▶ Entry conditions

The 30-second immobilizer verification time is started when:

- the ignition status is changed to IGN by the START switch while the pre-verification timer is activated.
  the ignition status is changed to IGN by the smart key verification while the pre-verification timer is
- stopped; the SKM verified a smart key by the brake switch signal while the immobilizer verification timer is stopped or the ignition status is IGN ON.
  the SKM verified a smart key successfully if the immobilizer verification timer is stopped with IGN
- ON/immobilizer verification /brake switch ON.

▶ Deactivation condition

- IGN1 OFF
- 30 sec. has passed after immobilizer verification
- Any door is opened and then closed when all doors are closed & smart key out

* When the engine starts to run, the immobilizer verification status is determined, and the immobilizer will not be deactivated until the ignition status is changed to IGN/ACC/OFF.

* The immobilizer is not deactivated when the key out warning condition is met while the engine is running. (when the RND is received by the EMS reset while the engine is running)
When attempting to start the engine without immobilizer verification, the system performs smart key

* verification procedures, and sends the engine start request to EMS only when the verification result is normal.

5) Start & Power Mode Control

The smart key system performs the smart key verification inside the vehicle to operate the 'Passive/Emergency start' and 'Power mode control'. It performs the following functions according to the verification result.

- Power mode control: Ignition status change
- Immobilizer communication with EMS
- Start request transmission to EMS

(1) Hardware interface

▶ **Replace the input shaft speed sensor with EMM or A/T and perform the TCU initialization and coding work.**

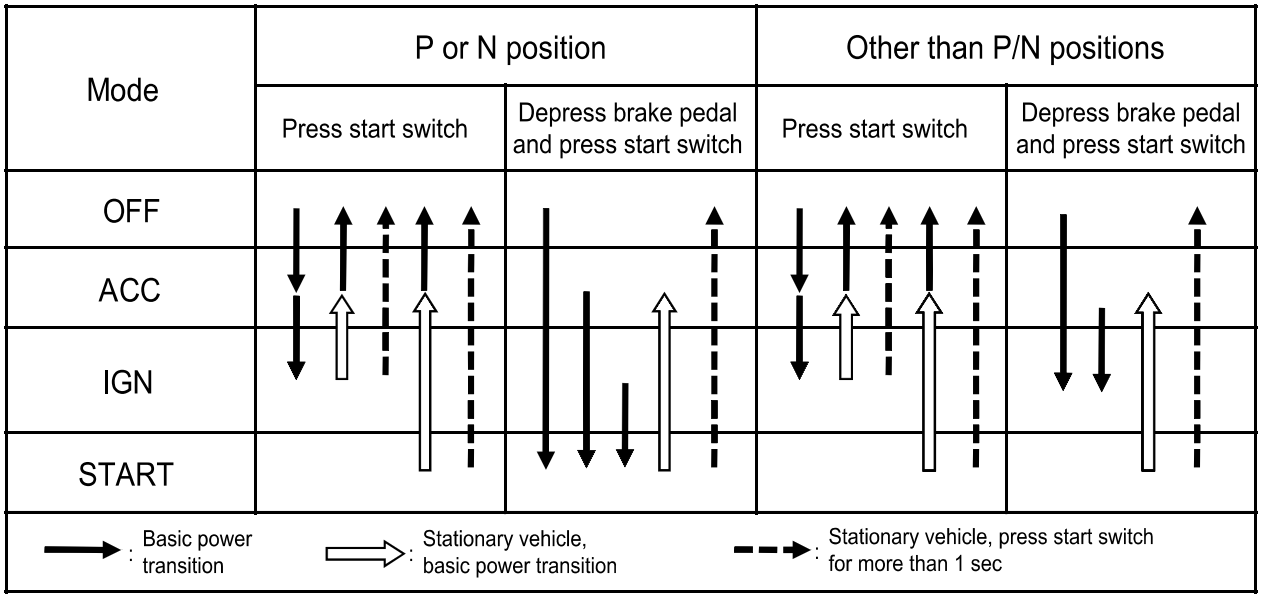
1. Start button
   - The SKM receives the signals from the START button and changes the ignition status or stars/stops the engine.
2. Immobilizer holder antenna
   - The SKM communicates with immobilizer antenna to verify the smart keys.

▶ **Output**

1. ACC relay
   - The SKM operates the ACC relay.
2. IGN1 relay
   - The SKM operates the IGN1 relay.
3. IGN2 relay
   - The SKM operates the IGN2 relay.
4. START ready display
   - The SKM operates the START ready display.
5. ACC status display
   - The SKM operates the ACC status display.
6. ON status display
   - The SKM operates the ON status display.
7. LF antenna
   - The SKM controls the LF antenna outputs.

(2) Ignition status change

1. The ignition status is changed to OFF, ACC ON, IGN ON and engine cranking by one START/STOP button.
2. The SKM cuts the power for IGN2 and ACC relays while the engine is cranking as cutting the electric load is necessary.
3. The SKM monitors the brake pedal status through the hardware signals.
4. The ignition status change is available when the engine START/STOP button is pressed.
5. The SKM uses the EMS (engine condition) and ABS/ESP (FR vehicle speed) signals sent through the P-CAN bus (High Speed CAN).
6. When the smart key battery is discharged and the driver inserts the smart key into the immobilizer slot in emergency mode, the smart key verification is performed if the brake or START switch is pressed
7. before the ignition status is changed (ACC ON, IGN ON).
   Ignition status change during driving
   - When the engine START/STOP switch is pressed for 3 sec. or more at more than 3 km/h, the ignition status is changed from IGN to ACC.
     If the engine START/STOP switch is pressed again, the ignition status is changed from ACC to IGN.
   - The 4 vehicle speeds are abnormal (CAN signal timeout, abnormal signal):
     If the engine START/STOP switch is pressed for 3 sec., the ignition status is changed from IGN to ACC. If the switch is pressed again, the ignition status is changed from ACC to OFF (DTC set).
8. The SKM changes the ignition status as follows:



9. When the ignition status is changed, the SKM communicates according to the body network conditions as follows:
   - OFF → ACC: Keep communicating for 5 sec.
   - OFF → IGN: Keep communicating
   - ACC → IGN: Keep communicating
   - IGN → Cranking: Keep communicating
   - Cranking→ IGN: Keep communicating
   - IGN → ACC: Keep communicating for 5 sec.
   - ACC → OFF: Keep communicating for 5 sec.
   - IGN → OFF: Keep communicating for 5 sec.

(3) Engine start

1. When the START button is pressed with the brake pedal applied and gear selector lever in P or N position, the SKM performs the immobilizer verification and sends the engine START request signal to the EMS if a normal coded smart key is found.
2. When the .engine start request signal from the START switch is received, the SKM sends the start request signal through the PCAN and the smart key location signal through the BCAN to crank the engine.
3. The SKM cuts the power for IGN2 and ACC relays while the engine is cranking as cutting the electric load is necessary.
4. The SKM receives the engine start status signal from the EMS through the PCAN.
5. The SKM turns on the ACC/IGN2 relays after the engine cranking and sends the signal for [IGN after starting] through BCAN.
6. When the START button is pressed and engine cranking request1 signal is sent, the EMS cranks the engine after checking the engine warming up. If the engine cranking request2 signal is sent, the EMS cranks the engine without checking the engine warming up.
   - Engine cranking request1:
     When the START switch is pressed briefly under a normal condition
   - Engine cranking request2:
     When the START switch is pressed once again while the engine cranking request1 signal is sent, OR When the START switch is pressed for 3 sec. or more
7. Starting engine while driving
   - The engine start request signal is sent when the START switch is pressed, provided that the vehicle speed is less than 10 Km/h or no vehicle speed signal is input, the gear selector lever is in N position and the brake switch is ON with IGN ON (30 sec. verification is not required).
   - The engine start request signal is sent regardless of the brake signal when the START switch is pressed, provided that the vehicle speed is 10 Km/h or more and the gear selector lever is in N position with IGN ON (30 sec. verification is not required).

Modification basis	
Application basis	
Affected VIN	

*- Except brake switch signal input
For the vehicles with A/T, when the START switch is pressed for 10 sec. or more, the ignition status is changed to IGN ON and the engine start request signal is sent regardless of the brake signal, provided that the initial ignition status is ACC ON and the gear selector lever is in P or N position.

(4) Engine stop

1. When the START button is pressed at the vehicle speed of 3 km/h or less, the SKM turns off the IGN relay to stop the engine.
2. When the vehicle speed is 3 km/h or more or no speed signal is input, the SKM performs the following functions:
   - When the START switch is pressed for 3 sec. or more at more than 3 km/h, the ignition status is changed from IGN to ACC.
     If the switch is pressed again, the ignition status is changed from ACC to IGN.
   - When the START switch is pressed for 3 sec. or more with no vehicle speed signal (CAN signal timeout, abnormal signal), the ignition status is changed from IGN to ACC. If the switch is pressed again, the ignition status is changed from ACC to OFF.
3. When the START button is pressed and held with IGN ON, the ignition status is changed to OFF. When the START button is pressed briefly, the ignition status is changed to ACC ON.

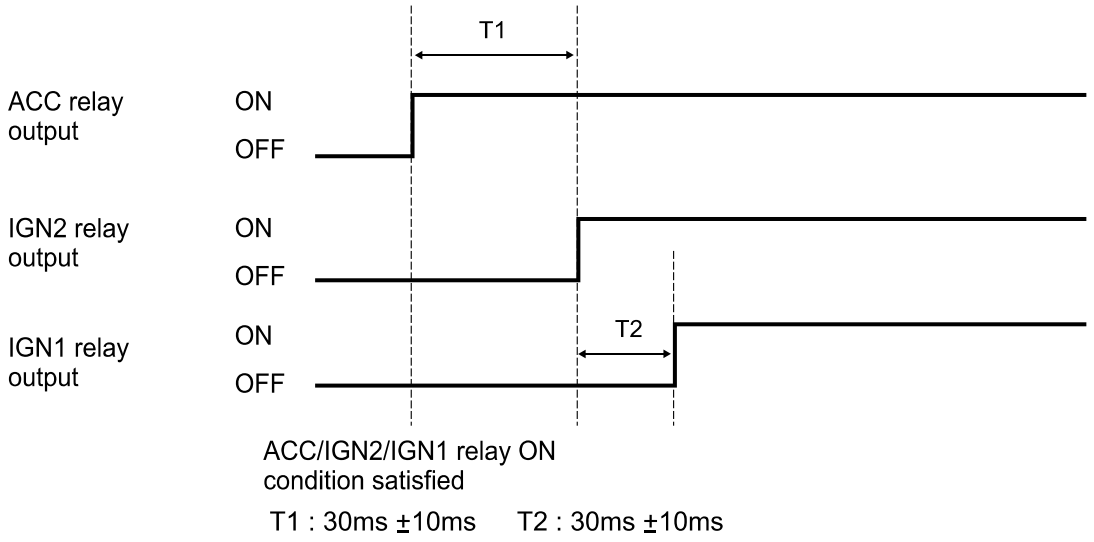
(5) ACC ON/Power OFF

The SKM changes the ignition status to OFF from ACC ON when:

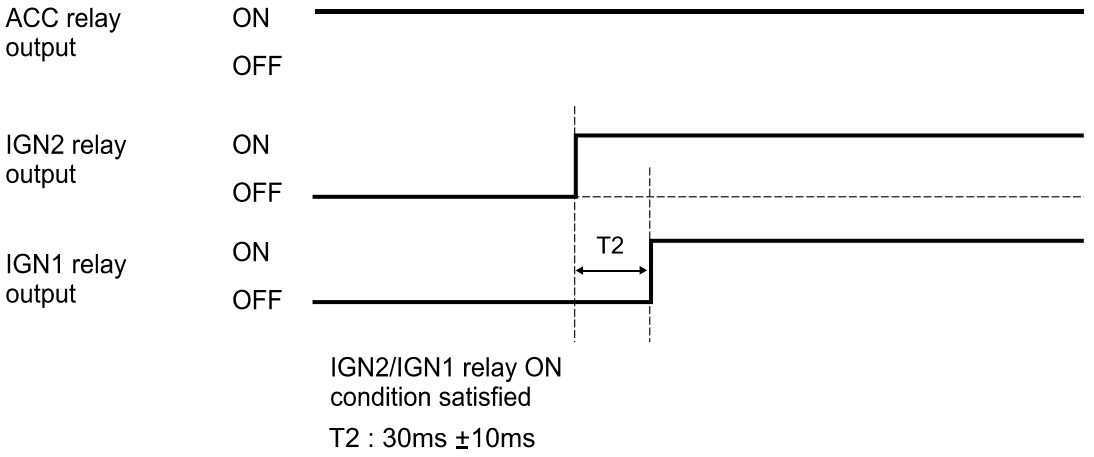
1. the engine START/STOP button is pressed with the brake pedal released after the ignition status is changed from IGN ON to ACC ON.
2. the REKES LOCK or passive LOCK is operated with ACC ON.
3. the BCM sends the driver's door open signal.
4. 12 minutes have passed with ACC ON.

6) Power Relay Control

(1) OFF to engine starting

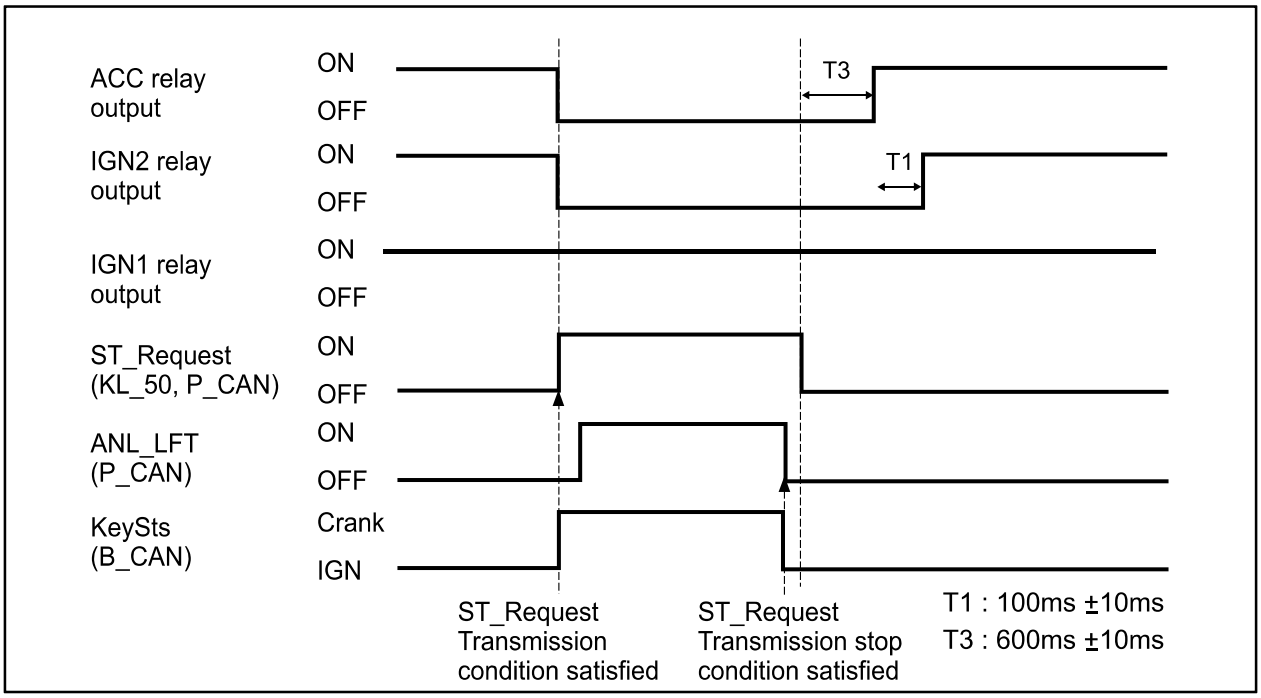


(2) ACC to IGN

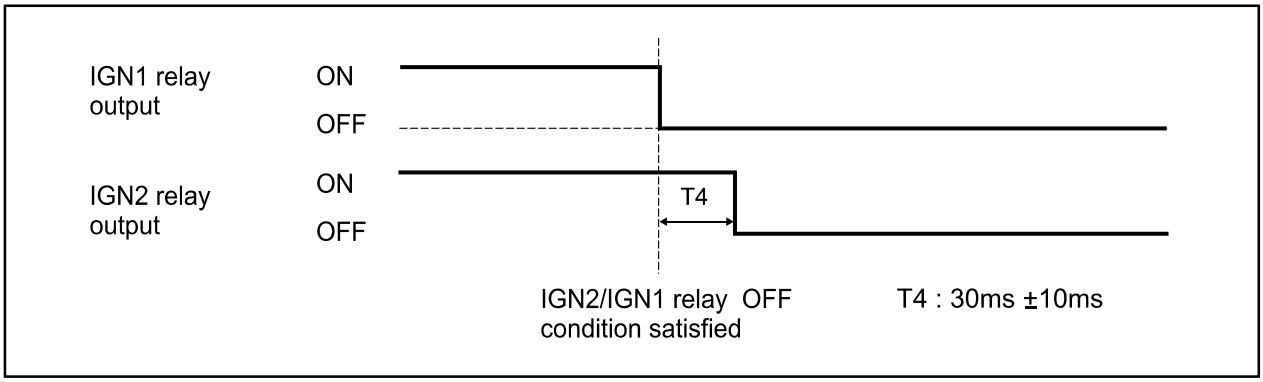


Modification basis	
Application basis	
Affected VIN	

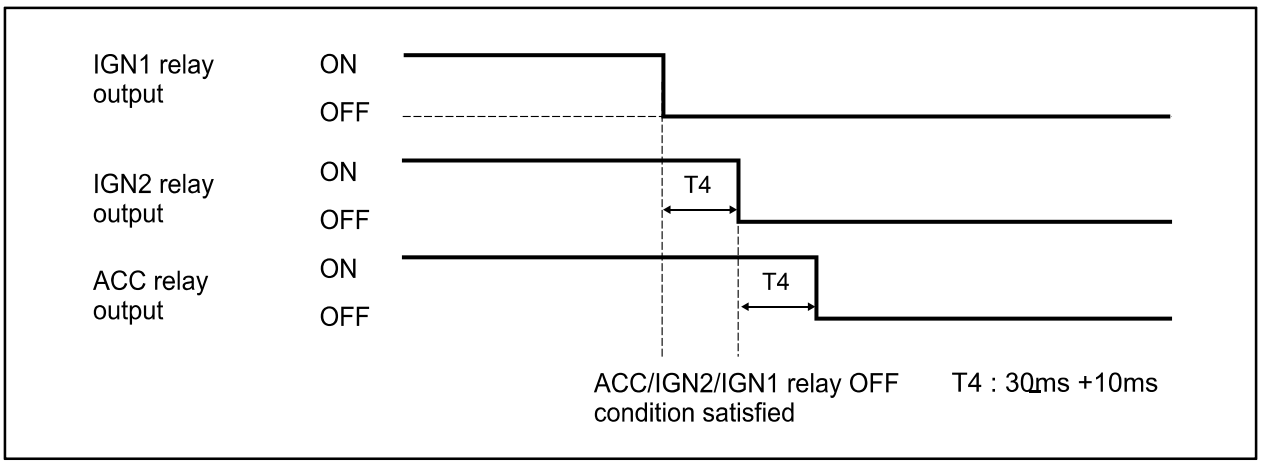
(3) IGN to starting



(4) IGN/engine ON to ACC



(5) IGN/engine ON to OFF



7) START Switch Control

(1) START switch indicator

▶ Ignition status indicator on START switch

Status	Turning on conditions
OFF	IGN OFF, IGN ON & engine ON
Green	Engine can be started by START switch operation/Engine is cranking (IGN OFF & brake switch ON, ACC ON & brake switch ON, IGN ON & brake switch ON, etc.)
Yellow	ACC ON
Red	IGN ON & engine OFF or error

▶ START switch indicator output

Ignition status	Power OFF		ACC ON	IGN ON (STOP)	IGN ON	START	Error	Remark
	Door Close	Door Open						
Indica-tion								
Indicator status	OFF	OFF	Orange	Red	OFF	Green	Red	
	OFF	OFF	ON	ON	OFF	ON	Flashing	
Illumina-tion	OFF	TIME	Controlled by SKM					LED
	Engine START/STOP							

* When an error occurs, the indicator is illuminated for 0.5 sec. and goes off for 0.5 sec., and then flashes for 10 sec.
* When all the doors are closed with B+, the LED does not flash.

▶ Start switch indicator control

- Door coupled function

1. When the driver's door is opened, the switch indicator comes on (the indicator remains on while the door is open).
2. The indicator goes off immediately when the interior lamps are turned off.
3. The indicator goes off after the driver's door is closed and 10 sec. ON timer is activated.
4. The indicator is reset when the driver's door is opened.

- Tail lamp coupled function

8) SKM Warning Control

(1) Smart key not found warning (Key out warning)

If no verified smart key is identified as being in the vehicle with IGN ON or ACC ON, the SKM sends the signal, which identifies that there is no verified key inside the vehicle, to the BCM and instrument cluster through the BCAN (Smart key not found warning). This warning continues for up to 10 sec. until the warning condition is deactivated.
The SKM stops the warning immediately after the warning condition is deactivated.

▶ **Smart key not found warning with ACC ON**

- **Initial condition:**
  <ACC ON> & <Doors open except driver's door> & <Tailgate open> & <Smart key out>
- **Operation by driver**
  Doors: <Doors open except driver's door> & <Tailgate open>→ <All doors closed> & <Tailgate closed>
- **SKM operation**
  1. The SKM starts to identify a smart key by using the interior antenna after confirming that all the doors are closed through CAN communication.
  2. If no smart key is found it sends the signal for [Smart key not found warning].
     * No cyclic smart key searching after transmission
  3. If a smart key is found, no operation is performed.
     - Smart key not found warning deactivation conditions
     If below conditions are met, the SKM sends the signal for [Smart key not found warning] to deactivate the warning.
     : <ACC off> OR <IGN1 on> OR <Smart key in>

▶ **Smart key not found warning with IGN/ENGINE ON**

- **Initial condition:**
  <IGN1 ON> & <Door open> & <Tailgate open> & <Smart key out>
- **Operation by driver**
  Door: <Door open> & <Tailgate open> → <All doors closed> & <Tailgate closed>
- **SKM operation**
  1. The SKM starts to identify a smart key by using the interior antenna if the [Smart key not found warning] signal is not output.
     a. If no smart key is found it sends the signal for [Smart key not found warning].
     b. If a smart key is found, no operation is performed.
  2. The SKM searches for a smart key inside the vehicle at 3 sec. intervals while the [Smart key not found warning] signal is output.
     a. If no smart key is found it sends the signal for [Smart key not found warning].
     b. If a smart key is found it sends the signal for [Smart key not found warning deactivation] signal to deactivate the key out warning.

- **Smart key not found warning deactivation conditions**
  If below conditions are met, the SKM sends the signal for [Smart key not found warning deactivation] to deactivate the warning.
  1. A smart key is found while the smart not found warning signal is output.
  2. <IGN1 off> OR <Smart key in>

(2) Smart key detection warning

When a valid smart key sends the LOCK signal from outside of the vehicle or the outside door handle switch is pressed with no smart key outside, the smart key detection warning signal is output, provided that all the doors or the tailgate is closed with IGN OFF or ACC ON and a smart key is in the vehicle.

▶ Smart key detection warning conditions

1. Deactivation warning

When a valid smart key sends the LOCK signal from outside of the vehicle, the SKM sends the signals for [external buzzer] and [smart key detection warning] to the BCM and instrument cluster through the BCAN to inform the driver of the existence of a verified key inside the vehicle, provided that all the doors or the tailgate is closed with IGN OFF or ACC ON and a smart key is in the vehicle.

2. Smart key inside vehicle warning

If a smart key including immobilizer slot is identified as being in the vehicle after the outside door handle switch is pressed, the SKM sends the signals for [external buzzer] and [smart key detection warning] to the BCM and instrument cluster through the BCAN to inform the driver of the existence of a verified key inside the vehicle.

- These 2 warnings (external buzzer, smart key detection warning) continue for up to 10 sec. until the warning conditions are deactivated under the above conditions.
  The SKM stops these warnings immediately after the warning conditions are deactivated.

▶ Smart key detection warning deactivation conditions

1. Function stop warning deactivation conditions

  - When theft deterrent deactivated
    The SKM sends the signals for [external buzzer] and [smart key detection warning deactivation].
  - Smart key inside vehicle warning deactivation conditions
    When the door is opened and then closed and no smart key is found, the SKM sends the signals for [external buzzer] and [smart key detection warning deactivation].

Modification basis	
Application basis	
Affected VIN	

(3) Smart key verification fail warning

When the verification is requested for ignition status change or engine starting and no verified smart key is in the vehicle, the SKM sends the [smart key verification status] signal, which indicates that the verification has failed, for up to 10 sec. until the verification fail conditions are deactivated.

- Normally, the smart key verification warning is one of the smart key fail conditions.

▶ **Verification fail detection and transmission conditions**

- When the ignition status is changed after a smart key is verified by the START switch ON input, the SKM sends the verification status for 10 sec.

* Ignition status change
(OFF ->ACC) / (OFF ->IGN)/(ACC ->IGN) / (IGN -> engine ON)

- If above conditions are met again, the SKM re-verifies a smart key and sends the verification status for another 10 sec.
- When the ignition status is changed by the transponder verification while the smart key status is sent through the BCAN, the SKM sends the smart key verification signal and also sends the transponder verification signal for 10 sec.

(4) Smart key battery discharge warning

If low smart key battery is detected during the verification process for ignition status change or engine start, the SKM sends the signal for [smart key battery low voltage warning] to the BCM and instrument cluster through the BCAN for up to 10 sec. until the warning condition is deactivated.

▶ **Smart key battery discharge confirmation and deactivation**

- If the smart key battery low voltage is confirmed, the SKM sends the smart key battery low voltage warning signal.
- If the smart key battery is in normal condition, the SKM sends the smart key battery low voltage warning deactivation signal.

* The smart key is the last used key.

(5) Transponder verification fail warning

If a verified smart key is not found by the key verification process, the SKM sends the information that indicates the key is not verified to the instrument cluster through the BCAN for up to 10 sec. until the verification fail condition is deactivated.

- The SKM sends the transponder verification warning when the verification has failed with the smart key inserted into the immobilizer holder.

▶ **Transponder verification fail detection and transmission conditions**

- When the ignition status is changed after the transponder is verified by the START switch ON input, the SKM sends the transponder verification status for 10 sec.

* Ignition status change
  (OFF ->ACC) / (OFF ->IGN)/(ACC ->IGN) / (IGN -> engine ON)

- If above conditions are met again, the SKM re-verifies the transponder and sends the verification status for another 10 sec.
- When the ignition status is changed by a smart key verification while the transponder verification is processed, the SKM sends the signal for [transponder verification fail], and sends the smart key verification status for 10 sec.

(6) Transmission position warning

When the gear selector lever is in a position other than P or N with IGN ON and engine started, the SKM sends the [gear position warning] signal to the instrument cluster through the BCAN for up to 10 sec. until the operating conditions are deactivated.

▶ Transmission position warning deactivation

- When re-attempting to start with IGN1 ON and transmission in P or N

(7) SKM error alert

The SKM sends the SKM error alert signal to the instrument cluster through the BCAN for up to 10 sec. when an in ignition status related error or passive entry system error occurs.

▶ SKM error transmission conditions

When any of the following errors is detected and a DTC is set, the SKM sends the error alert signal for 10 sec.

1. B+ (power) low voltage
2. B+ (logic) low voltage
3. ACC ON fail
4. ACC OFF fail
5. IGN1 ON fail
6. IGN1 OFF fail
7. IGN2 ON fail
8. IGN2 OFF fail
9. Short circuit in START switch

The SKM sends the corresponding signal only once for 10 sec. when any of the above errors is detected with IGN OFF/ON. It sends the signal again when a new error occurs.

Modification basis	
Application basis	
Affected VIN	

(8) Brake not working alert

The SKM sends the brake not working alert signal for 10 sec. every time the ignition status is changed after the 1st cycle (OFF-ACC-IGN-ACC-OFF) while the brake is not operated.

▶ **Warning cancellation requirements**

- when the brake pedal is depressed, the system is reset and alert deactivation signal is sent.
- when the 10 min. timer is terminated

(9) Clutch not working alert

The SKM sends the clutch not working alert signal for 10 sec. every time the ignition status is changed after the 1st cycle (OFF-ACC-IGN-ACC-OFF)
while the clutch is not operated.

▶ **Warning cancellation requirements**

- when the clutch pedal is depressed, the system is reset and alert deactivation signal is sent.
- when the 10 min. timer is terminated

(10) Smart key slot detection alert

▶ **Warning transmission conditions**

- The SKM sends the smart key slot detection alert signal for 10 sec. when a smart key inserted into the slot is detected with IGN OFF and the driver's door open.

▶ **Warning cancellation requirements**

- when the smart key is removed, the alert deactivation signal is sent.
- when the 10 min. timer is terminated

(11) SKM alert priority

1	Smart key out alert	EXTERIOR	1
2	Smart key reminder alert	EXTERIOR	
3	Smart key verification fail alert	INTERIOR	2
4	Transponder verification failure alarm	INTERIOR	
5	Smart key battery low voltage alert	INTERIOR	
6	Transmission position alert	INTERIOR	
7	SKM error alert	INTERIOR	
8	Brake alert	INTERIOR	
9	Clutch alert	INTERIOR	
10	Smart key slot reminder alert	INTERIOR	1

INSTRUMENT CLUSTER 8010-01

GENERAL INFORMATION

1. SPECIFICATION

Pin No.	Specification
Rated voltage	DC 13.5 V
Operating voltage	DC 9 V ~ 16 V
CAN operating voltage	DC 7 V ~ 18 V
Inspection voltage	DC 13.5 V
Operating temperature	−30℃ ~ +80℃
Storage temperature	−40℃ ~ +85℃
Dark current	IGN OFF: 1 mA, 12 V Measurement condition (at 25℃): 60 seconds after that ignition is turned off and stabilized data get IGN ON: Max. 2 A, 12 V Measurement condition (at 25℃): during DTC check mode

2. MAJOR CHANGES

1) Steering wheel heating indicator added

SVC class	
Previous	**Current**
	
One indicator added since steering wheel heating function is equipped.	

2) Pre-warning indicator rearranged

SVC class	
Previous	**Current**
	
Rearranged pre-warning indicator which comes on and goes off when turning ignition on.	

3) Winter mode indicator added(DSL only)

STD class	
Previous	**Current**
	
Winter mode indicator added (one green LED)	

Modification basis	
Application basis	
Affected VIN	

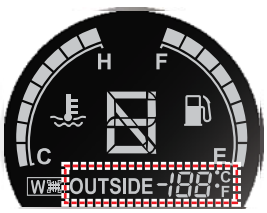
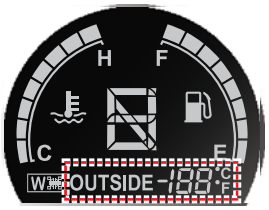
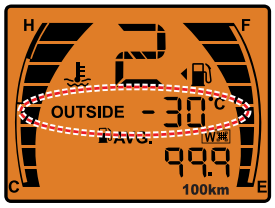
SVC class

This is displayed for 2 seconds when activating winter mode, displayed for 2 seconds when deactivating winter mode and displayed for 4 seconds when starting engine and driving off (DOT LCD message).

4) Warning lamps according to ISO standards

Both SVC and STD class	
Previous	**Current**
	
Warning lamp symbols fulfil ISO standards used on all models (e.g. 4WD CHECK indicator symbol)	

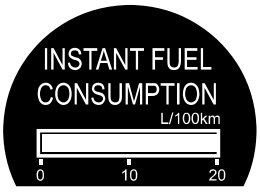
5) Ambient temperature display

Previous		Current	
Automatic	SVC class	Automatic	SVC class
			
		Manual	STD class
			
Ambient temperature also displayed on vehicle with manual A/C control switch			

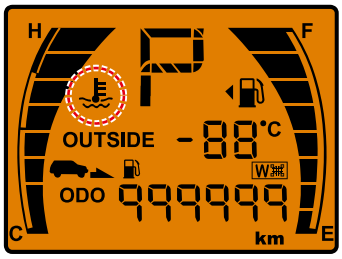
6) Average fuel economy reset and calibrated automatically when refilling

Both SVC and STD class	
Previous	**Current**
Reset by user	Reset by user and automatic reset when refilling

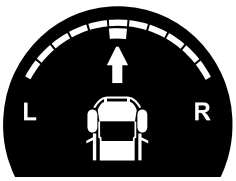
7) Instant fuel consumption display changed

SVC class	
Previous	**Current**
	
Changed from figure type to bar graph type.	

8) Pre-warning indicator for engine overheat removed

SVC class	STD class
	
Pre-warning indicator for engine overheat is removed.	

9) TDMS logic changed

SVC class			
Current			
EPS warning lamp		TDMS display	LCD not displayed
	EPS warning lamp comes on		LCD screen is not displayed.
TDMS (Tier Direction Management System) is not displayed when EPS warning lamp comes on.			

Modification basis	
Application basis	
Affected VIN	

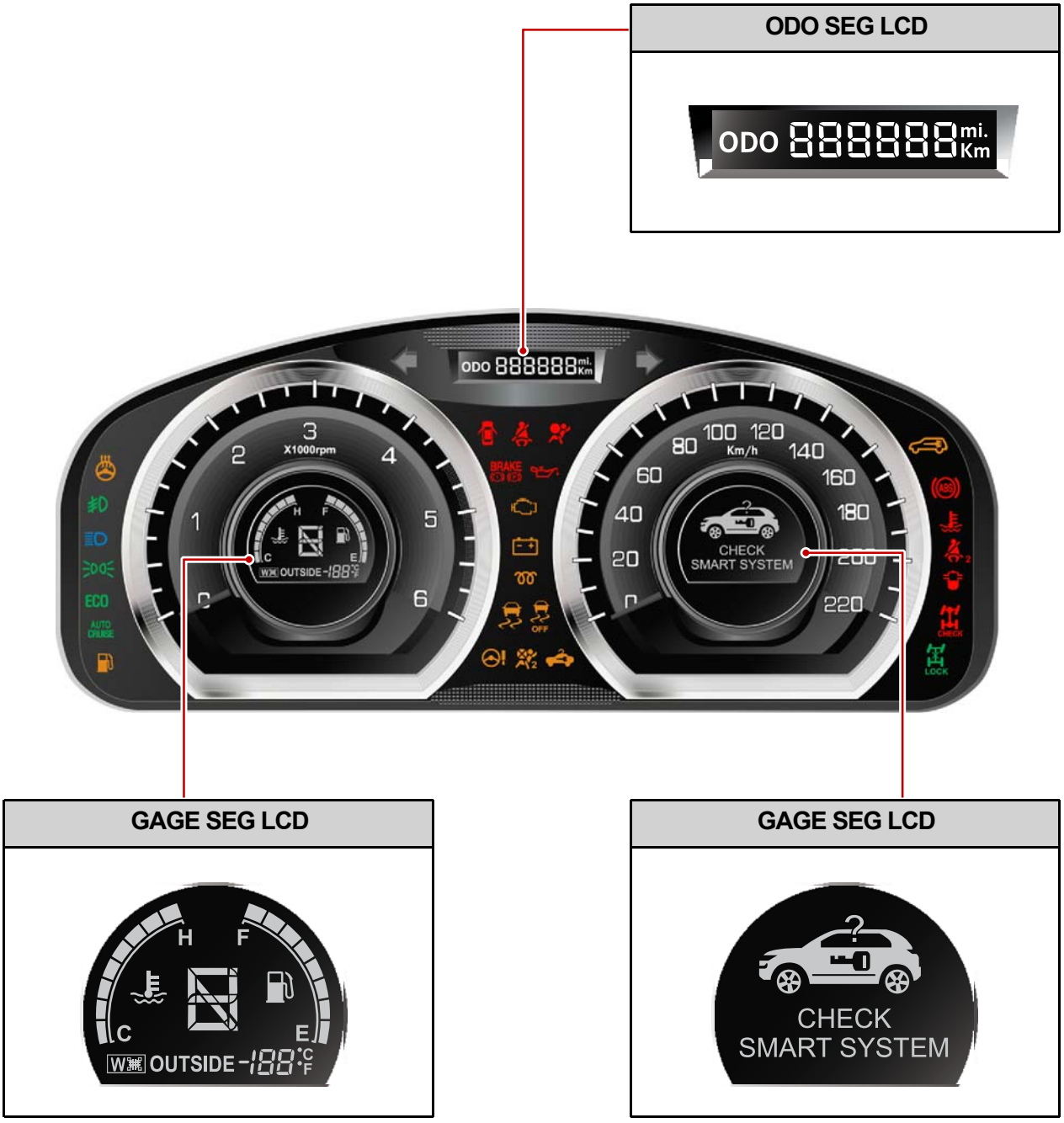
OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

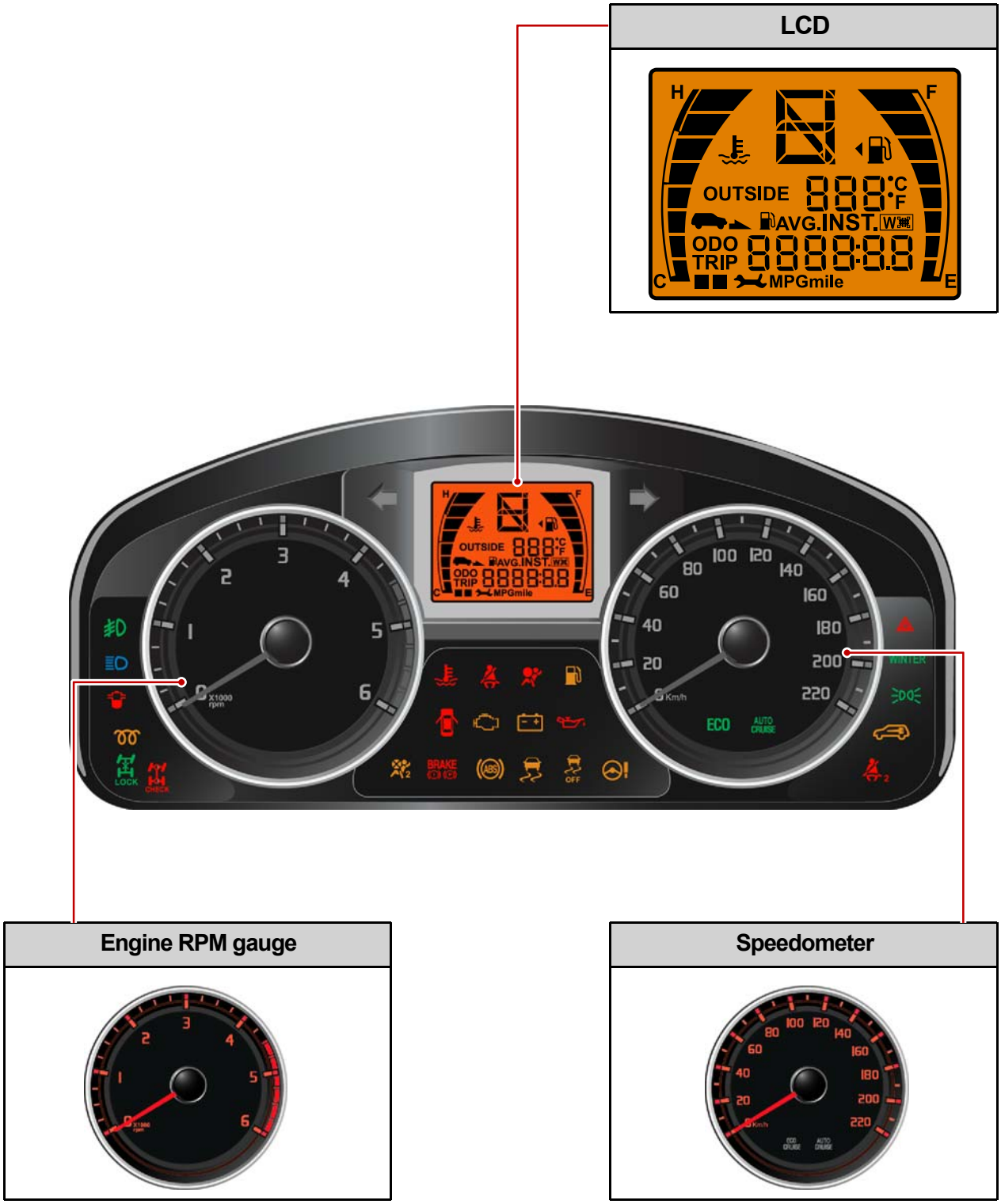
There are two types in the instrument cluster used for KORANDO C: SVC (super vision) and STD (standard). While the SVC type has three LCD screens - <DOT LCD>, <GAGE SEG LCD> and <ODO SEG LCD>, the STD type has one LCD screen.

2. LAYOUT

▶ **SVC**



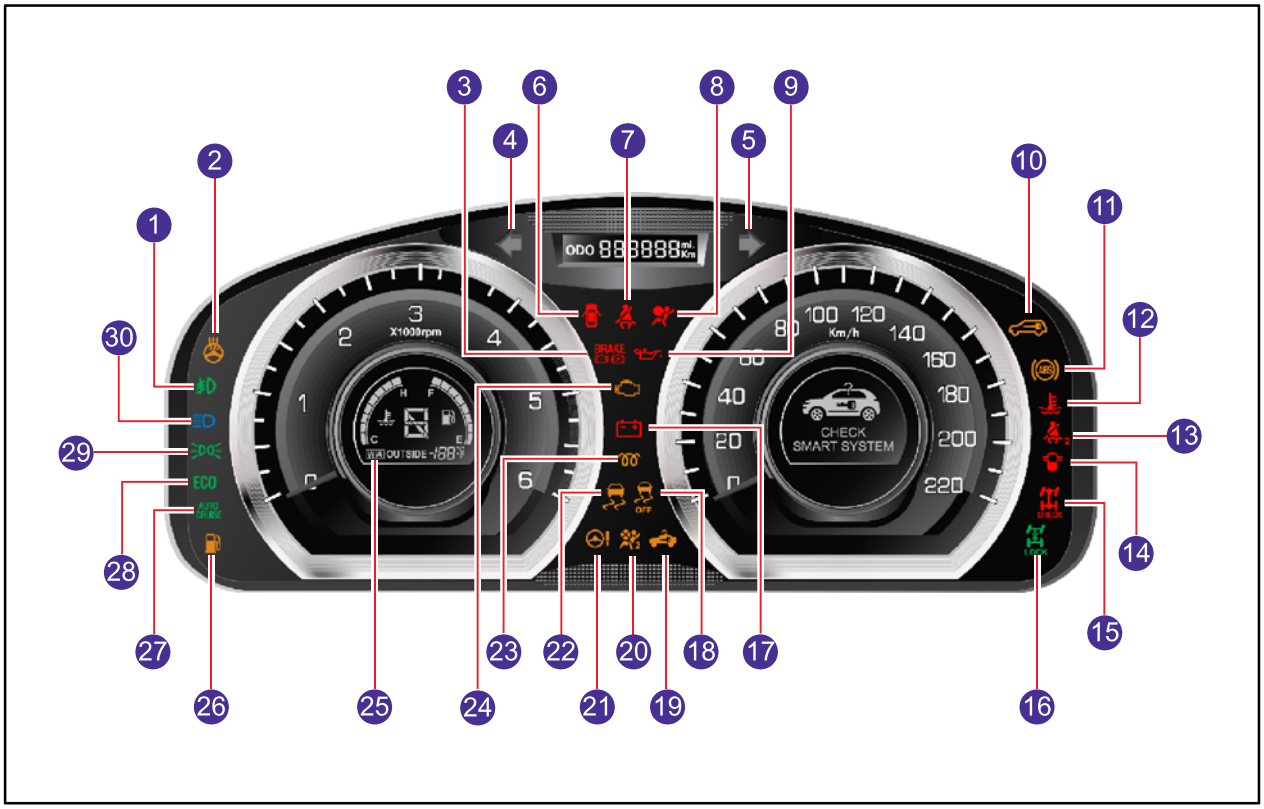
▶ **STD**



Modification basis	
Application basis	
Affected VIN	

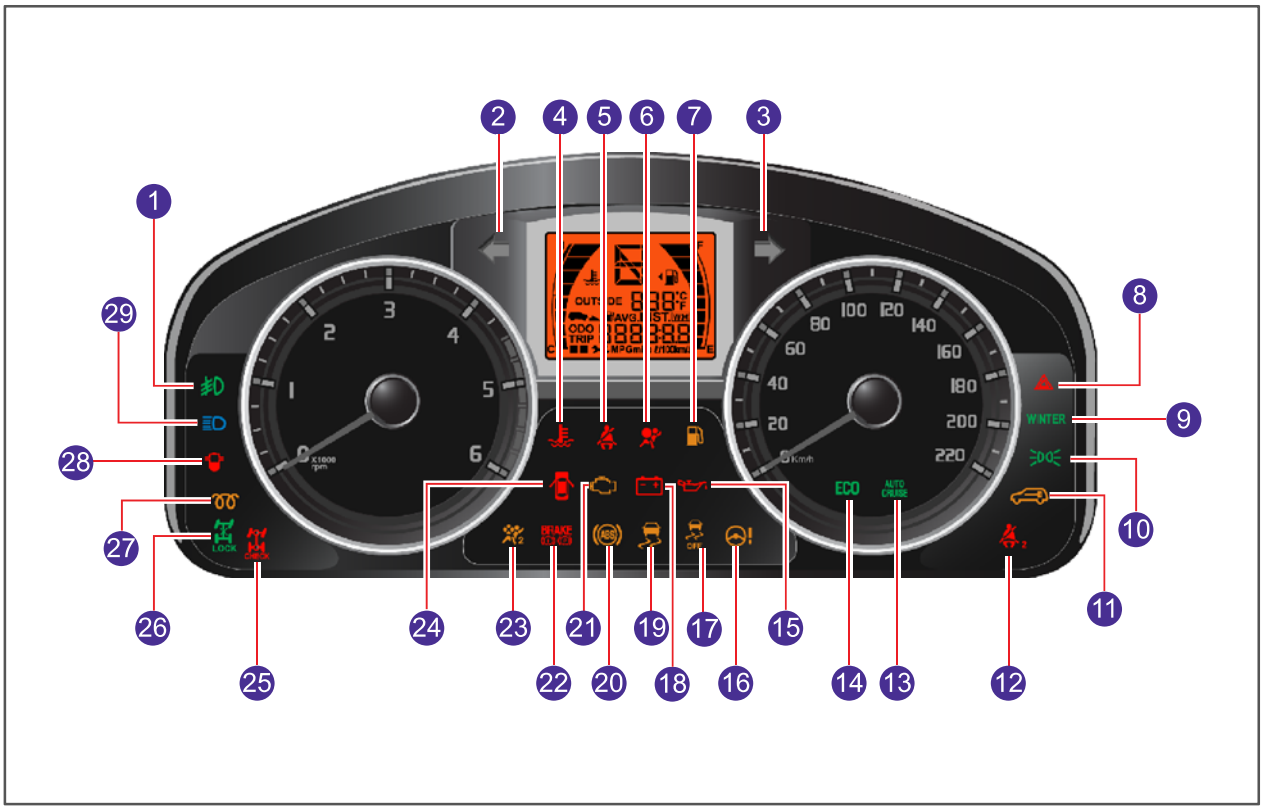
3. Description of Warning Lamps & Indicators

1) SVC



NO.	Symbol	Description	NO.	Symbol	Description	NO.	Symbol	Description
1		FRT FOG	11		ABS	21		EPS
2		STEERING WHEEL HEATING INDICATOR	12		TEMP HIGH	22		ESP
3	BRAKE	PARKING BRAKE (BRAKE FLUIDE)	13		PASSENGER SEAT BELT	23		GLOW
4		TURN-L	14		FUEL FILTER	24		ENGINE CHECK
5		TURN-R	15	CHECK	4WD CHECK	25		WINTER MODE
6		DOOR OPEN	16	LOCK	4WD LOCK	26		LOW FUEL WARNING
7		DRIVER SEAT BELT	17		CHARGE	27	AUTO CRUISE	AUTO CRUISE
8		AIR BAG	18	OFF	ESP OFF	28	ECO	ECO
9		OIL LEVEL OIL PRESSUR	19		SMART KEY	29		SIDE LIGHT
10		IMMOBILIZER	20		PASSENGER AIR BAG DISABLE INDICATOR	30		HIGH BEAM

2) STD



NO.	Symbol	Description	NO.	Symbol	Description	NO.	Symbol	Description
1		FRT FOG	11		IMMOBILIZER	21		ENGINE CHECK
2		TURN-L	12		PASSENGER SEAT BELT	22	BRAKE	PARKING BRAKE (BRAKE FLUIDE)
3		TURN-R	13	AUTO CRUISE	AUTO CRUISE	23		PASSENGER AIR BAG DISABLE INDICATOR
4		TEMP HIGH	14	ECO	ECO	24		DOOR OPEN
5		DRIVER SEAT BELT	15		OIL LEVEL OIL PRESSUR	25	CHECK	4WD CHECK
6		AIR BAG	16		EPS	26	LOCK	4WD LOCK
7		LOW FUEL WARNING	17	OFF	ESP OFF	27		GLOW
8		HAZARD	18		SIDE LIGHT	28		FUEL FILTER
9	WINTER	WINTER MODE	19		ESP	29		HIGH BEAM
10		SIDE LIGHT	20	ABS	ABS			

Modification basis	
Application basis	
Affected VIN	

3) Details of Warning Lamps and Indicators

▶ Headlamp high beam indicator

Indicator (blue)	This lamp comes on when the headlamp high beam is operated.
	

▶ Front fog lamp indicator

Indicator (green)	This indicator comes on when the fog lamp switch is operated after the tail lamps comes on.
	

▶ Side light indicator

Indicator (green)	This indicator comes on when the tail lamp is switched on.
	

▶ Glow indicator(DSL only)

Indicator (amber)	This indicator comes on when the ignition switch is turned to the "ON" position and will go off when the glow plugs are sufficiently heated.
	

▶ Fuel filter indicator(DSL only)

Indicator (red)	This indicator comes on when the water level in the fuel filter exceeds a certain level.
	

▶ Low fuel level warning lamp

Warning lamp (amber)	This lamp comes on if the fuel level is approx. 10 ℓ or below. However, the fuel level may change slight depending on vehicle condition, inclination of the road, etc. Also, it blinks if there is a short or open circuit between the fuel level sensor and cluster.
	

▶ Engine overheat warning lamp

Warning lamp (red)	When the coolant temperature is 120˚C or higher, this lamp blinks at an interval of 1 second, a message is displayed, the warning sounds once through the speaker and the buzzer sounds at an interval of 0.5 seconds.
	

▶ Door ajar

Warning lamp (red)	This lamp comes on when any door is open or not closed completely. (both STD and SVC class)
	

▶ Seat belt reminder

Warning lamp (red)	This lamp comes on when the ignition switch is pressed ON. It keeps coming on if the driver's seat belt is not fastened.
	

▶ Air bag

Warning lamp (red)	This lamp comes on when the ignition switch is pressed to the ON mode. Then, it goes off if the system is normal. If this lamp stays on while driving, it means that the air bag system is faulty.
	

Modification basis	
Application basis	
Affected VIN	

▶ ESP

Indicator (amber)	This indicator comes on when the ESP system is faulty.
	

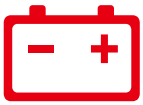
▶ ESP OFF indicator

Indicator (amber)	This indicator comes on when pressing the ESP OFF switch.
	

▶ Engine check warning lamp

Indicator (amber)	This lamp comes on if any sensor or device related to the engine control is defective.
	

▶ Battery charge warning lamp

Indicator (red)	This lamp comes on when the start switch is ON or when the battery level is low. (For EEM, warning lamp is controlled according to CAN signal)
	

▶ Engine oil level warning lamp

Indicator (red)	- This lamp comes on when the ignition switch is turned to "ON" position, and then goes off if the engine oil level is normal. - If the engine oil level warning lamp comes on while driving, check the engine oil level and oil leakage.
	

▶ Brake warning lamp (brake fluid)

Indicator (red)	
	- This lamp comes on when the parking brake is applied or the brake fluid is insufficient. - If this lamp doesn't go off after the parking brake is released, check the brake fluid level first and then fluid leakage.

▶ ABS warning lamp

Indicator (amber)	
	- This warning light comes on when the ignition switch is turned to ON and should go out if the system is normal

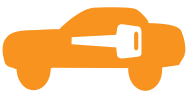
▶ Passenger air bag disable indicator

Indicator (amber)	
	This indicator comes on when the passenger air bag OFF switch is operated.

▶ EPS

Indicator (red)	
	This indicator comes on when the EPS system is faulty.

▶ Immobilizer indicator

Indicator (amber)	
	This indicator comes on the immobilizer (transponder) is not certified.

Modification basis	
Application basis	
Affected VIN	

▶ Hazard indicator

Indicator (red)	This indicator comes on when the hazard warning flashers are switched on. (applies to STD class)
	

▶ ECO indicator

Indicator (green)	This indicator comes on when the ECO cruise system is activated. This indicator goes off when the brake pedal is depressed. (ECO deactivated)
	

▶ Cruise control indicator

Indicator (green)	This indicator comes on when the cruise control system is activated. This indicator goes off when the brake pedal is depressed. (auto cruise deactivated)
	

▶ 4WD LOCK indicator

Indicator (green)	This warning lamp comes on when the 4WD LOCK switch is pressed. This indicator goes off when pressing the switch again.
	

▶ 4WD check warning lamp

Indicator (red)	This warning lamp comes on when the 4WD system is defective.
	

▶ Passenger seat belt reminder

Indicator (red)	This indicator comes on when the ignition switch is turned to the "ON" position and goes off when the passenger's seat belt is fastened.
	

▶ Left turn signal indicator

Indicator (green)	The left turn signal indicator blinks if the light switch is pushed down to the left, and both turn signal indicators blink if the hazard warning flasher switch is pressed.
	

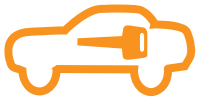
▶ Right turn signal indicator

Indicator (green)	The right turn signal indicator blinks if the light switch is pushed up to the right, and both turn signal indicators blink if the hazard warning flasher switch is pressed.
	

▶ Winter mode indicator(DSL only)

Indicator (red)	When the mode switch is pressed, the winter mode is selected and the winter mode indicator comes on on the instrument cluster. The winter mode is used to start off on a slippery road with the 2nd gear. If the switch is pressed again, the winter mode is deactivated and system returns to standard mode.
	

▶ Smart key warning lamp

Indicator (amber)	This lamp comes on when the uncertified transponder or smart key is detected, SKM system is defective or there is no smart key in the vehicle.
	

Modification basis	
Application basis	
Affected VIN	

▶ Winter mode indicator(DSL only)

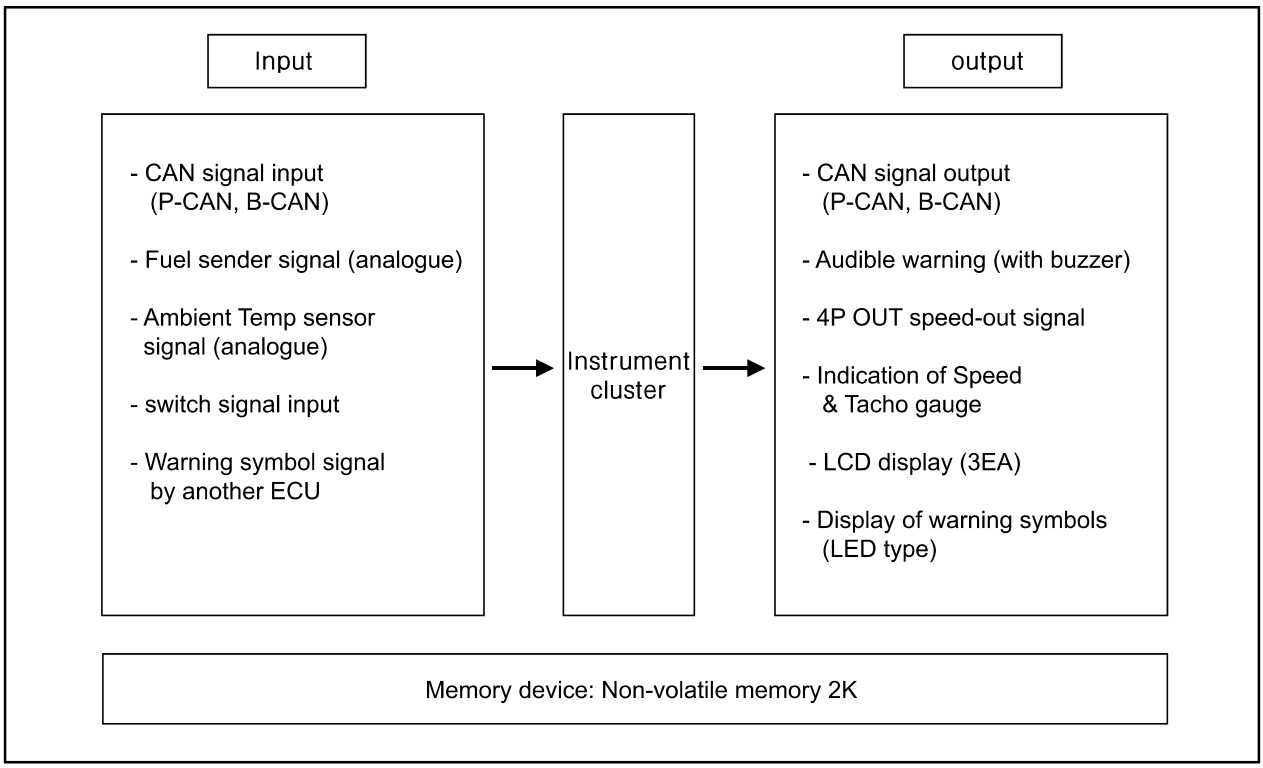
Indicator (green)	This indicator comes on when the winter mode switch is switched on and goes off when the switch is off. This comes on together with the winter mode display on the LCD screen. (applies to STD class)
WINTER	

▶ Steering wheel heating indicator

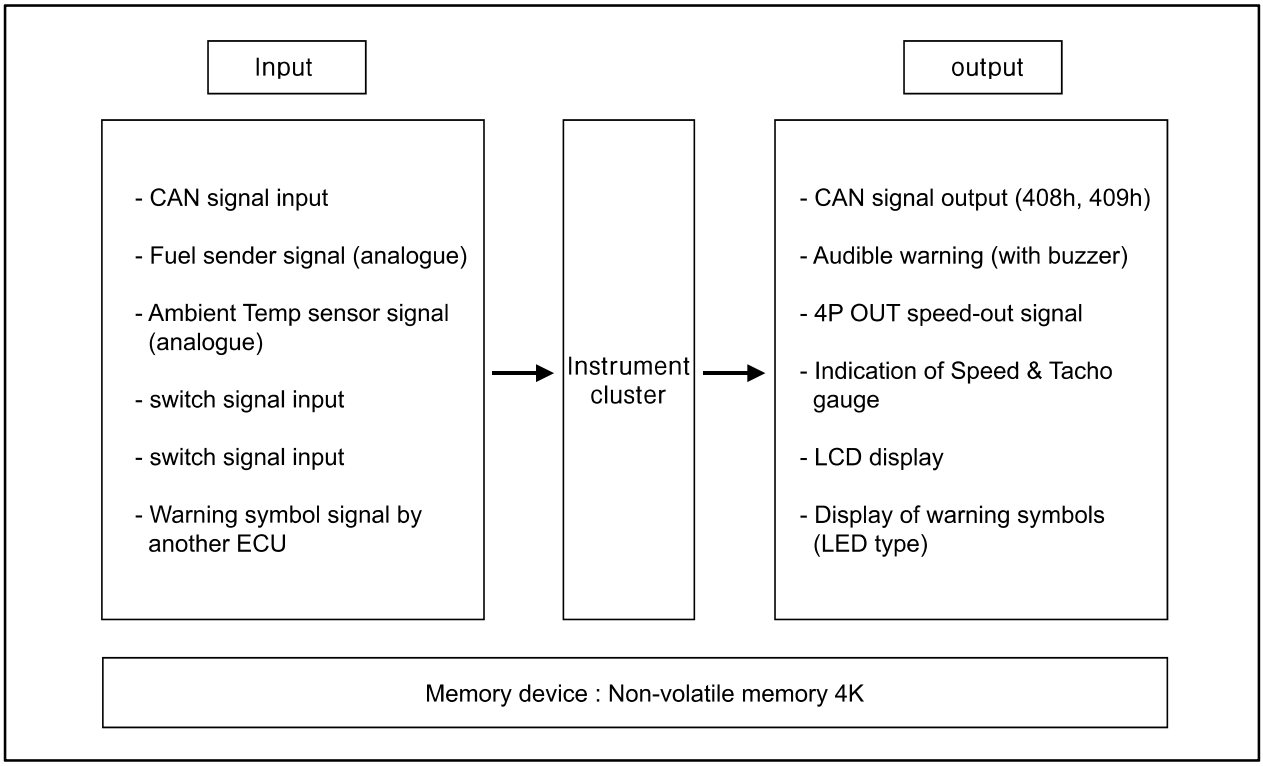
Indicator (amber)	This indicator comes on when the steering wheel heating switch is operated with the ignition switch turned on and the engine running. (applies to SVC class)
	

4. OPERATING PROCESS

1) SVC



2) STD

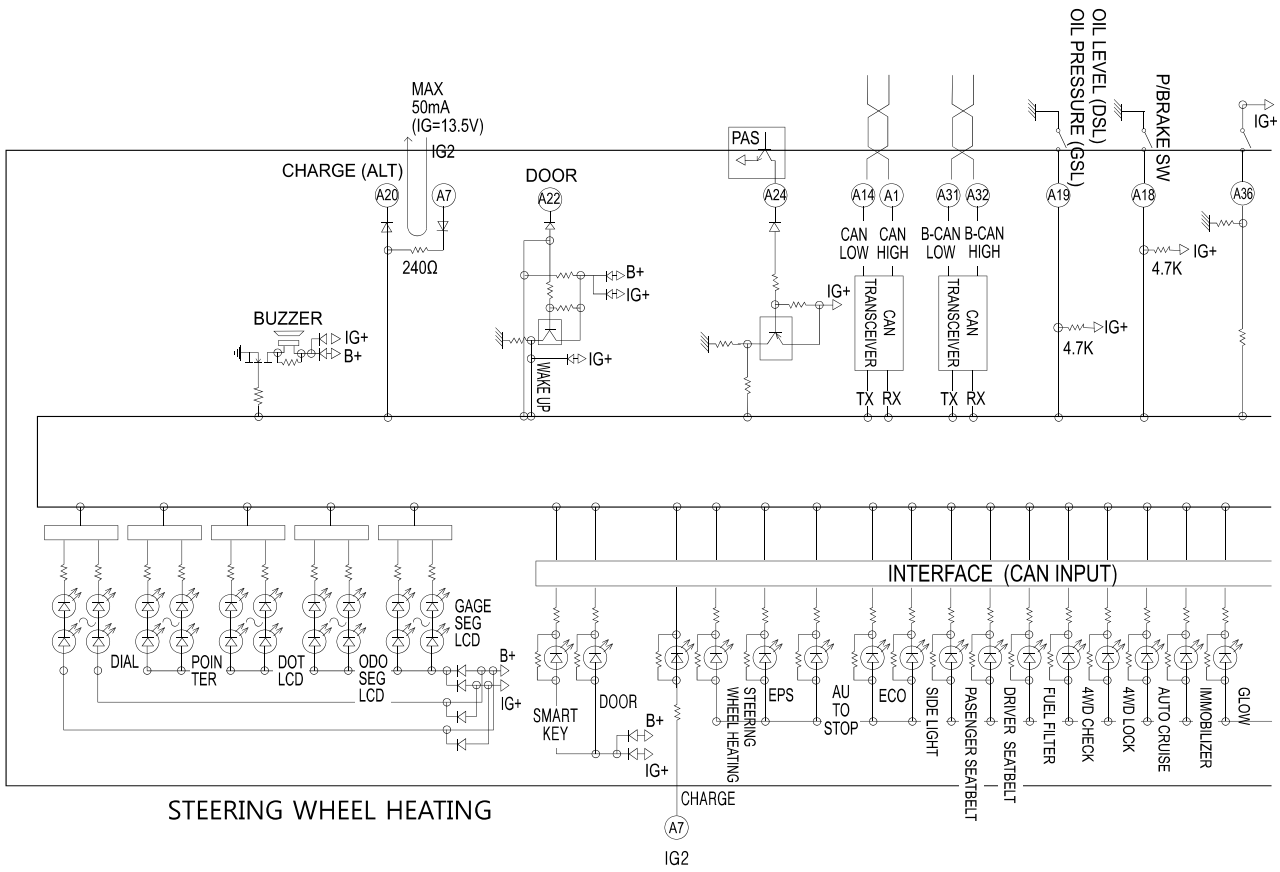


Modification basis	
Application basis	
Affected VIN	

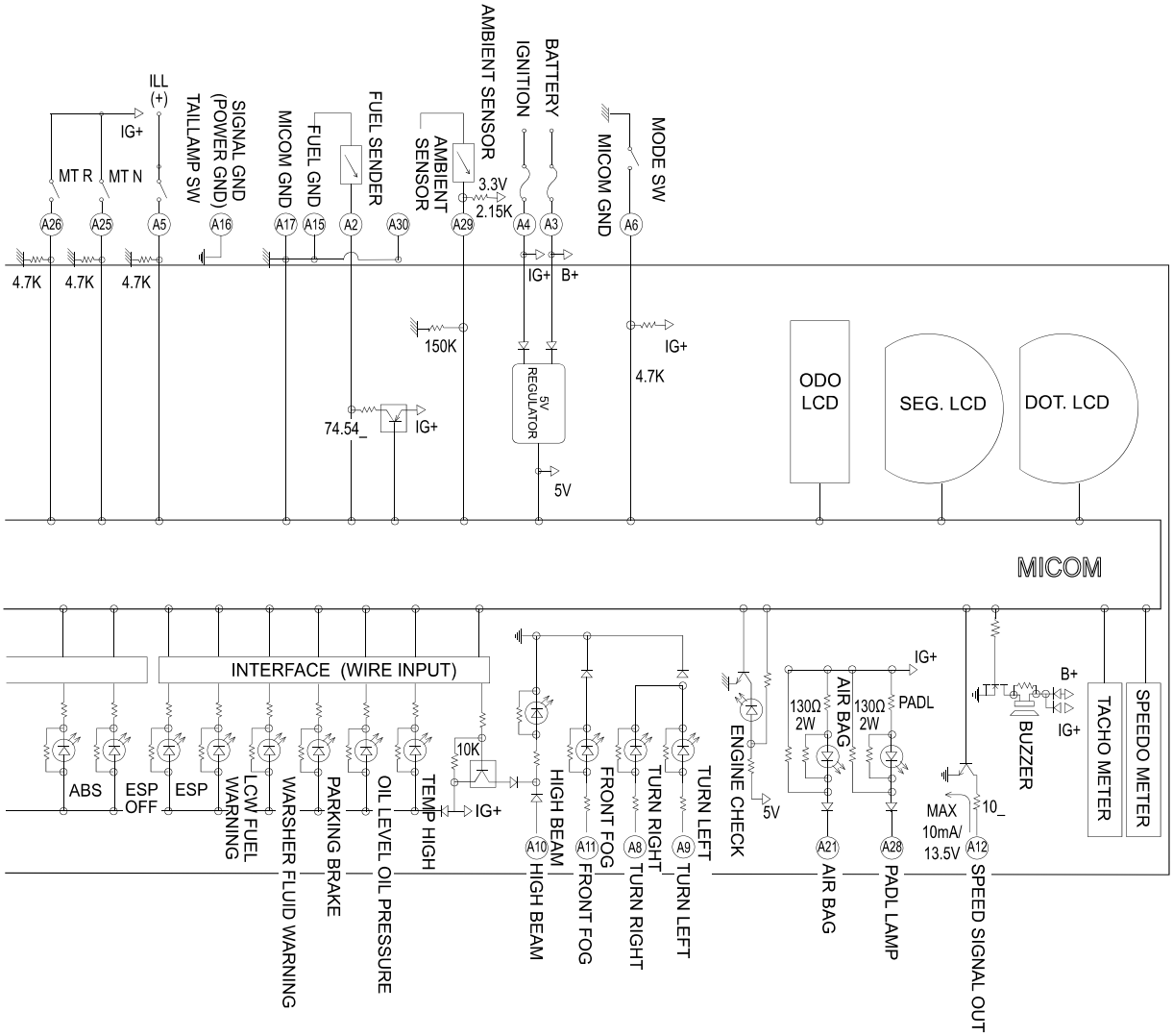
Memo

3) Block Diagram

▶ **SVC**

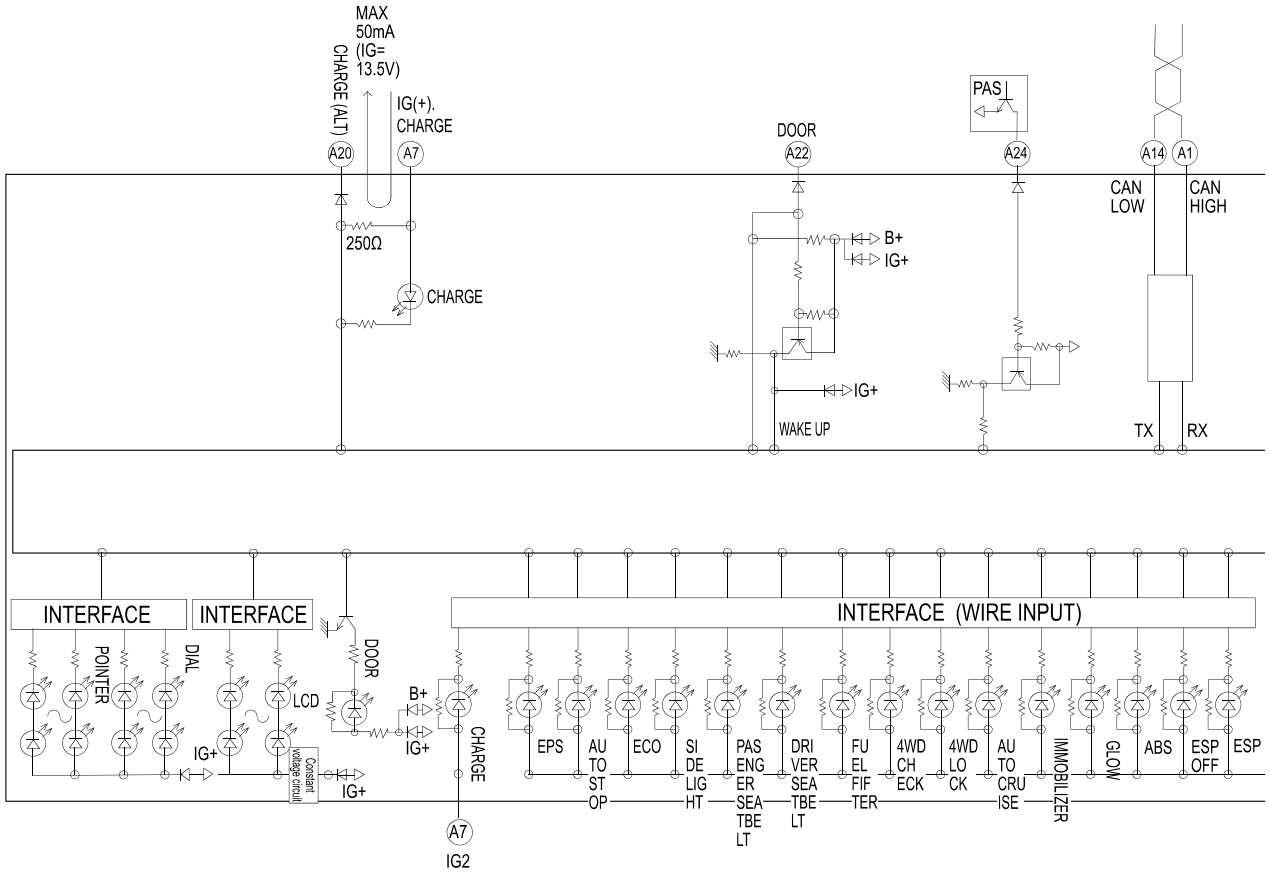


Modification basis	
Application basis	
Affected VIN	

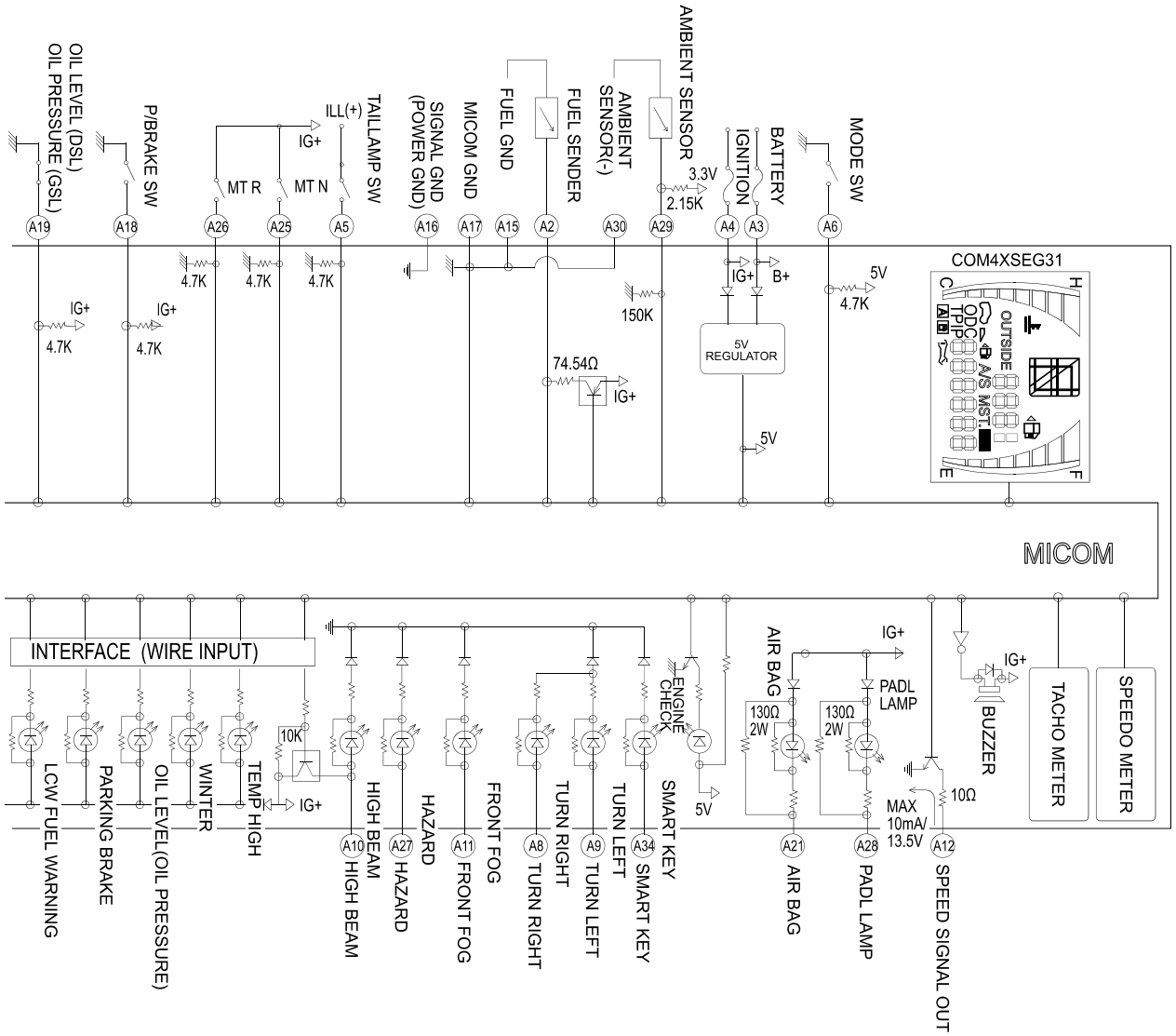


Modification basis	
Application basis	
Affected VIN	

▶ STD



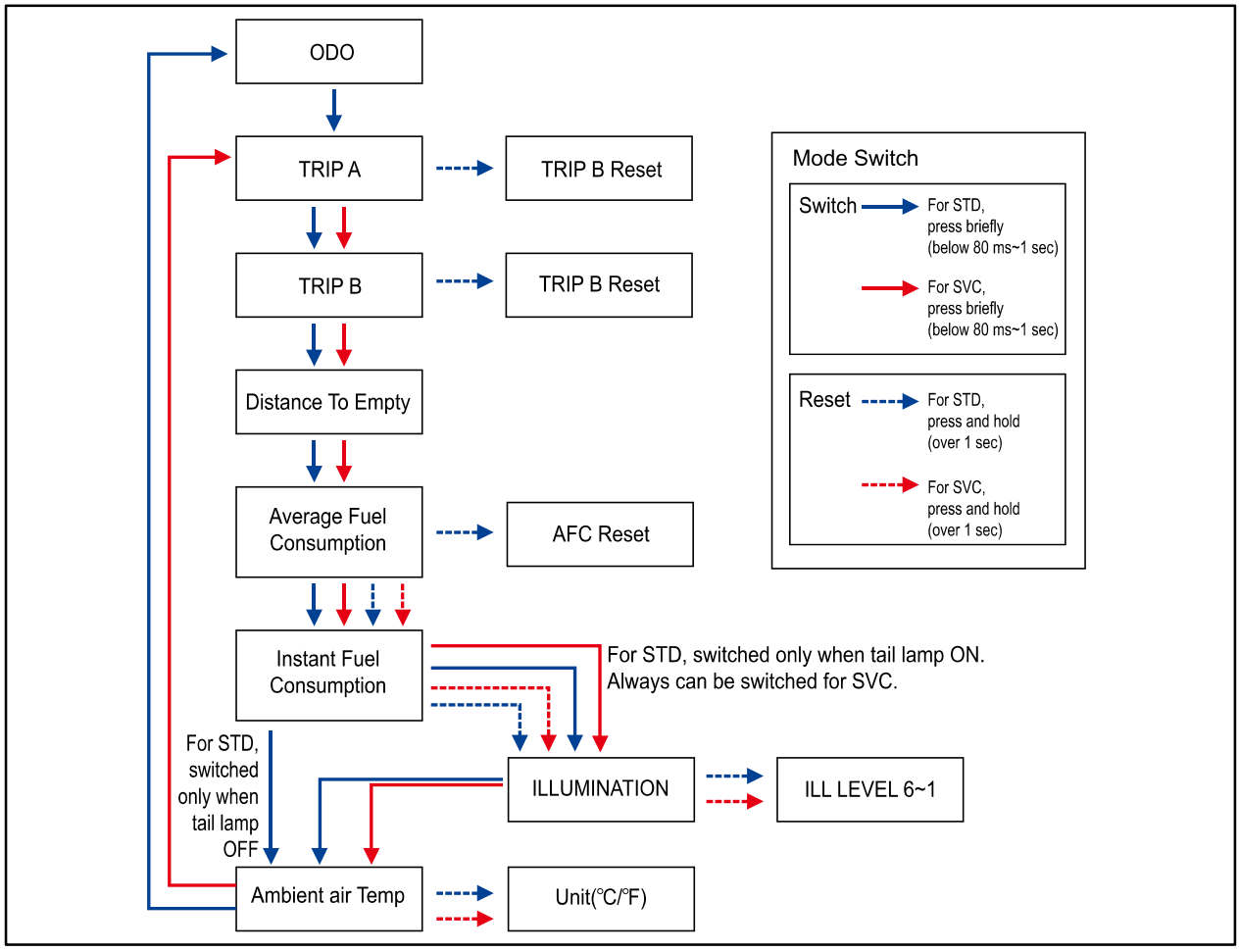
Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

4) Display Sequence

▶ **Display sequence for STD main LCD & SVC DOT LCD**



Operating time of Trip switch	Function	
Below 1 second (60 to 980 ms)	STD	Mode change (ODO → TRIP A → TRIP B → DTE → AFC → IFC → ILLUMINATION → OUT TEMP)
	SVC	Mode change (TRIP A → TRIP B → DTE → AFC → IFC → ILLUMINATION → OUT TEMP)
Over 1 seconds	Reset function (Trip A, B, AFC) (Illumination (6 to 1 level), unit of outside temperature (℃ ↔ ℉))	
Over 3 seconds - Ready	Mode change (Illumination → OUT TEMP → ODO)	

* If the Trip/Reset switch is not pressed within 3 seconds after getting into the illumination mode and the ambient air temperature mode, the LCD changes to next mode.

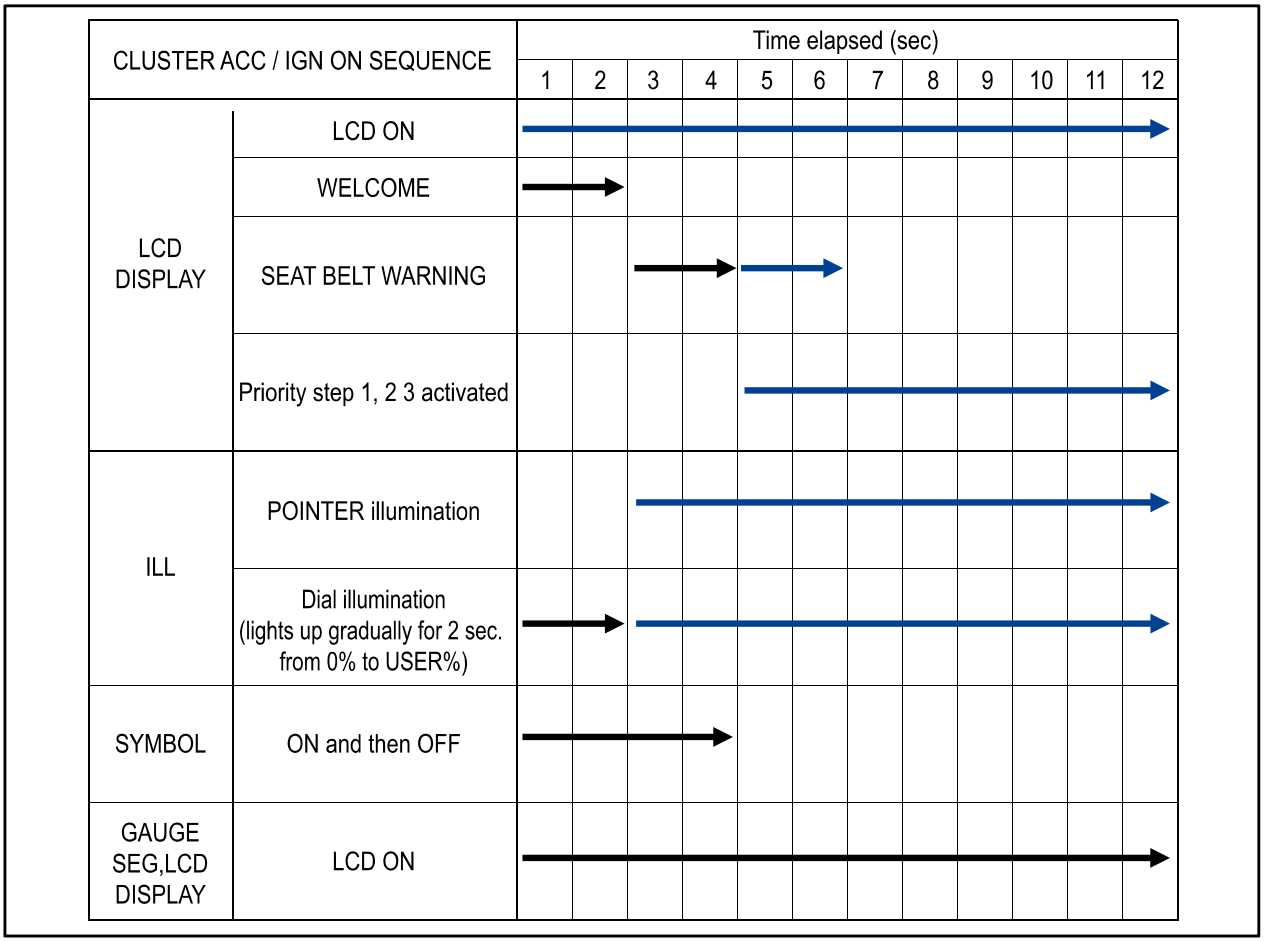
* The factory-setting mode is DTE (Distance To Empty) mode.

Modification basis	
Application basis	
Affected VIN	

5) Illumination & Brightness

(1) Operations for Power Supply

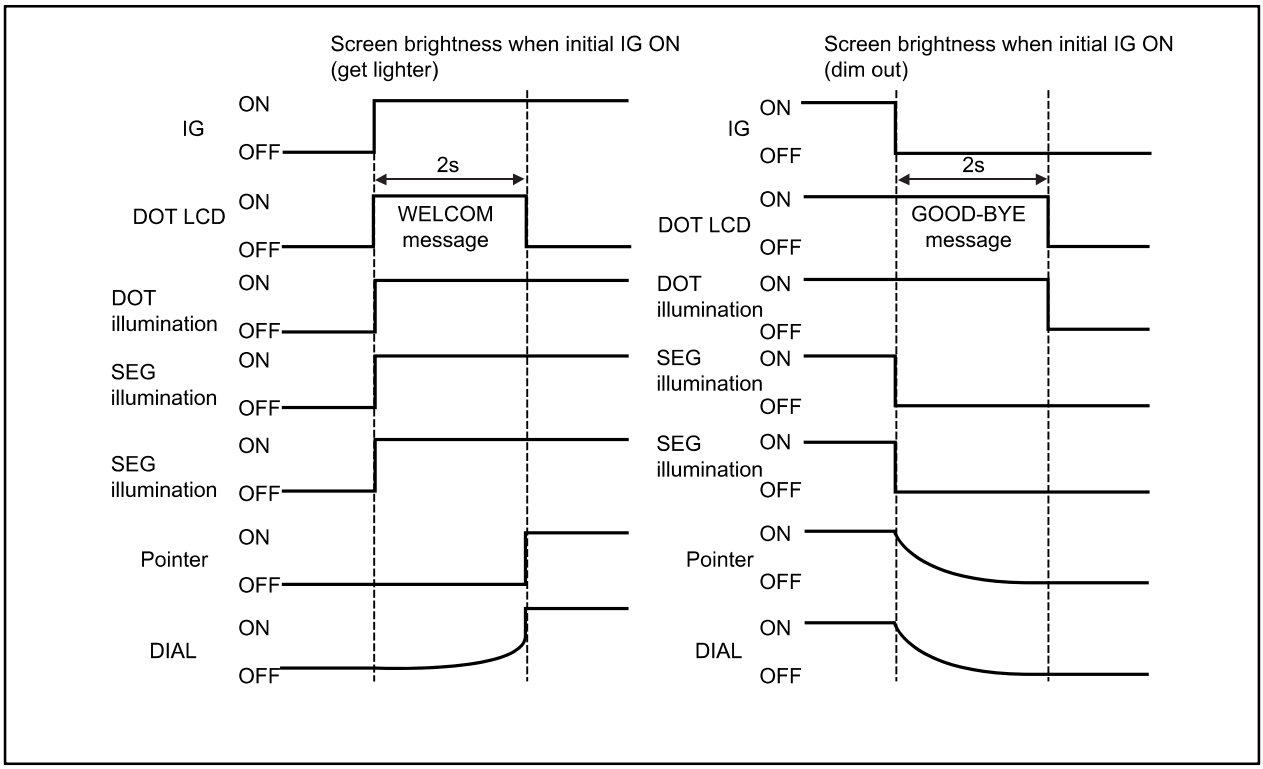
▶ Operations for power supply in SVC



1. When the ignition switch is turned to ON position, the message "WELCOME" is displayed for 2 seconds on the DOT LCD and the seat belt reminder comes on for 4 seconds. However, if a signal with higher priority is received, the seat belt reminder comes on only for 2 seconds to display it.
2. The pre-warning (system check) indicator comes on for 4 seconds and goes off 0.4 seconds after that the ignition is switched on.
3. All input signals can be input 4 seconds after the pre-warning (system check) indicator starts illuminating.
4. Only the symbol and DOT LCD are illuminated initially, if the SKM (Smart Key Module) or door (B-CAN) signal is received while B+ power is supplied.
5. If the ignition is switched on with the LCD illuminated, the DOT LCD and the symbol follow the side fascia panel.
6. When the step 1, 2 and 3 are performed after 4 seconds, the seat belt warning lamp is deactivated in advance.

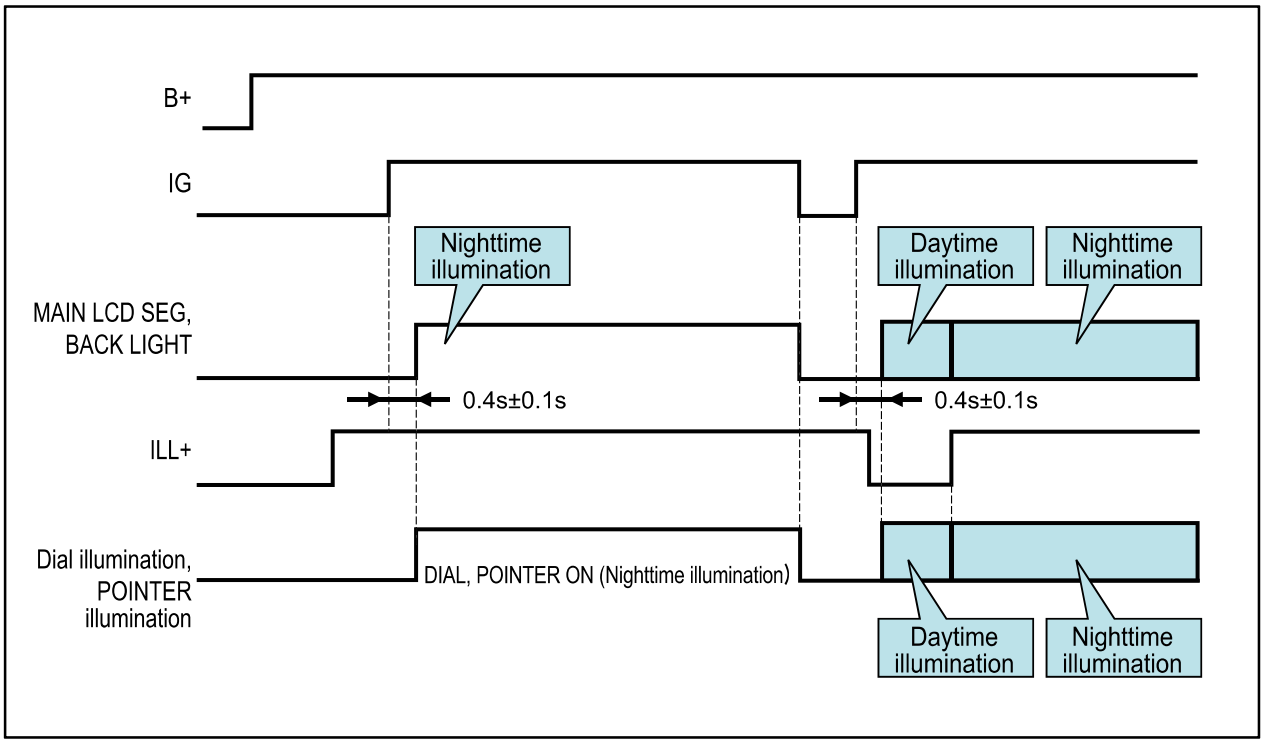
Dial light ON condition: Lights up gradually for 2 seconds when the ignition is switched on.

7. When the ignition is switched off, the message "GOOD-BYE" is displayed for 2 seconds and disappears.
   The other LCDs go off as soon as the ignition is switched off.
   The dial and pointer dim down for 2 seconds and go off at the same time when the DOT LCD goes off.



Modification basis	
Application basis	
Affected VIN	

▶ Operations for power supply in STD



- The operation input before the LCD backlight is illuminated, right after the ignition is turned OFF or ON, is ignored.
- The LCD backlight and other lamps are illuminated 0.4 ±0.1 second after the ignition ON is detected.
- The LCD display, LCD backlight, dial lamp and indicator lamp are turned on or off by the ignition switch ON/OFF operation.

(2) Illumination Level

▶ **Brightness in SVC**

Operating power		Illumination previous	DOT LCD		ODO, GAGE LCD		Dial pointer	
			Day	Night	Day	Night	Day	Night
B+ (B-CAN Wake UP)	After	-	Level 6	Level 6	OFF (however, level 6 for initial operation with B+ & IGN1 ON)			
	After 1st time		Maintains previous level	Maintains previous level	OFF (however, maintains previous level for initial operation with B+ & IGN1 ON)			
IGN1		Level 1	25%	5%	25%	5%	25%	5%
		Level 2	40%	12%	40%	12%	40%	12%
		Level 3	55%	19%	55%	19%	55%	19%
		Level 4	70%	26%	70%	26%	70%	26%
		Level 5	85%	33%	85%	33%	85%	33%
		Level 6	100%	40%	100%	40%	100%	40%

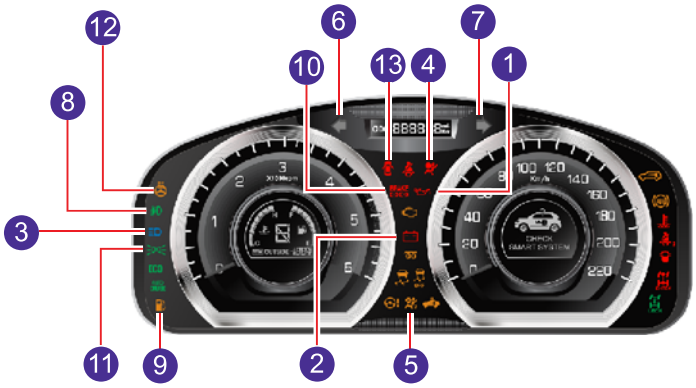
▶ **Brightness in STD**

Operating power	Illumination level	Main LCD		Dial pointer	
		Day	Night	Day	Night
B+ (B-CAN Wake UP)	-	OFF	OFF	OFF	OFF
IGN1	Level 1	100%	20%	100%	20%
	Level 2	100%	30%	100%	30%
	Level 3	100%	40%	100%	40%
	Level 4	100%	50%	100%	50%
	Level 5	100%	60%	100%	60%
	Level 6	100%	70%	100%	70%

6) System Analysis

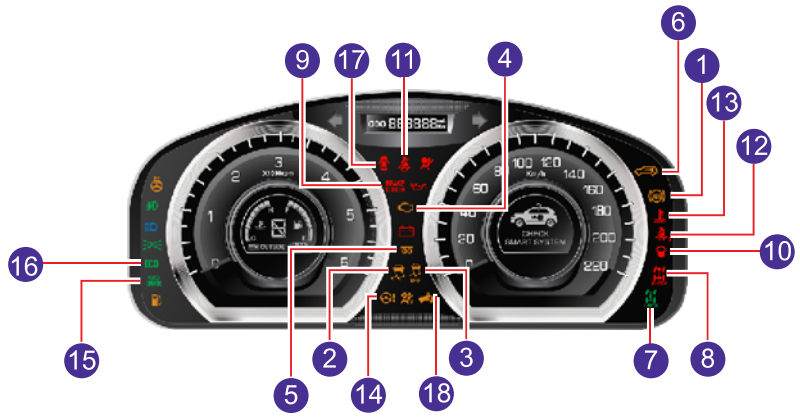
(1) SVC

▶ Symbols in SVC



NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	SIGNAL SOURCE	Signal Value	Operation STATE
1	OIL LEVEL (4s±0.2s)		RED	By micom	Oil level Switch	1) OPEN for 60 sec. or longer 2) TACHO: 1000 RPM or less 3) engine coolant temperature: 50°C or higher 4)Warning lamp OFF when oil level switch OFF	IGN ON
	OIL PRESSURE				Oil Pressure Switch	GROUND	IGN ON
2	CHARGE		RED	By micom	Alternator	GROUND	IGN ON
3	HIGH BEAM		BLUE	By micom	High-beam Switch	H/B(+) : HIGH	IGN ON
4	AIR BAG		RED	By wire	SDM	GROUND	IGN ON
5	PADL		AMBER	By wire	SDM	GROUND	IGN ON
6	TURN-L		GREEN	By micom	BCM	HIGH	B+/IGN ON
7	TURN-R		GREEN	By micom	BCM	HIGH	B+/IGN ON
8	FRT FOG		GREEN	By micom	Front Fog Switch	HIGH	B+/IGN ON
9	LOW FUEL WARNING		AMBER	By micom	FUEL SENDER	Analogue signal	IGN ON
10	PARKING BRAKE (BRAKE FLUIDE) (4s±0.2s)	BRAKE	RED	By micom	P/BRAKE SW	GROUND (Circuit input signal takes priority over CAN signal.)	IGN ON
11	SIDE LIGHT		GREEN	By micom	ILL	HIGH	IGN ON
12	STEERING WHEEL HEATING(SVC)		AMBER	By micom	Steering wheel heating	HIGH	IGN ON
13	DOOR OPEN (ALL SVC)		RED	By micom	Door switch	GROUND	B+/IGN ON

▶ Symbols in SVC (via CAN)



NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	TIMEOUT (3.5Times)
1	ABS (4s±0.2s)		AMBER	By micom	ON
2	ESP (4s±0.2s)		AMBER	By micom	ON
3	ESP OFF (4s±0.2s)	OFF	AMBER	By micom	OFF
4	EINGINE CHECK (4s±0.2s)		AMBER	By micom	HOLD
5	GLOW		AMBER	By micom	OFF
6	IMMOBILIZER		AMBER	By micom	OFF
7	4WD LOCK (4s±0.2s)	LOCK	GREEN	By micom	OFF
8	4WD CHECK (4s±0.2s)	CHECK	RED	By micom	HOLD
9	EBD	BRAKE	RED	By micom	OFF
10	FUEL FILTER (4s±0.2s)		RED	By micom	OFF
11	DRIVER SEAT BELT		RED	By micom	OFF

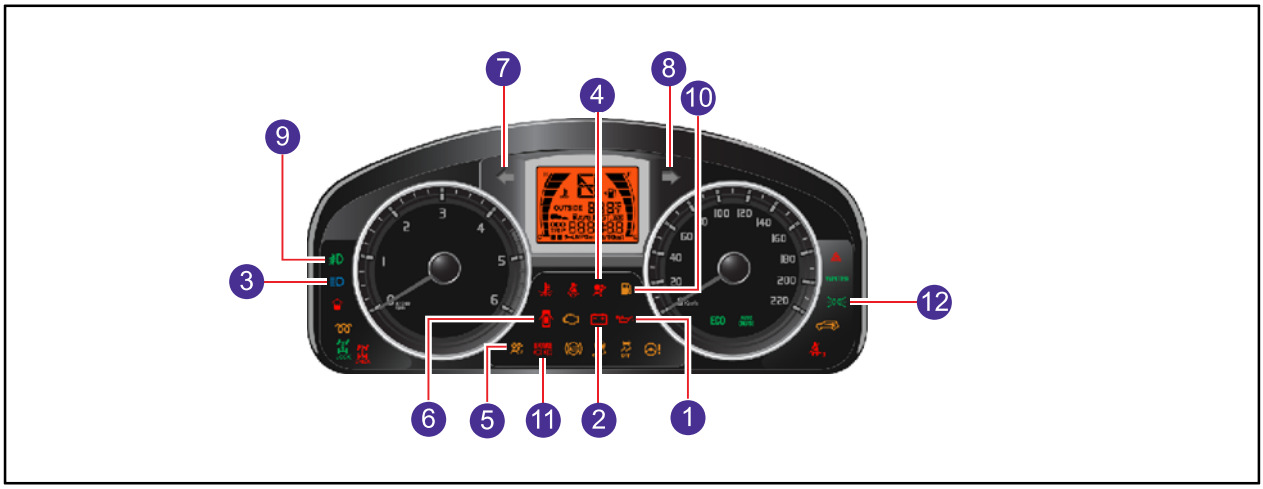
Modification basis	
Application basis	
Affected VIN	

NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	TIMEOUT (3.5Times)
12	PASSENGER SEAT BELT		RED	By micom	OFF
13	TEMP HIGH (Pre-warning removed)		RED	By micom	OFF
14	EPS (4s±0.2s)		AMBER	By micom	ON
15	AUTO CRUISE		GREEN	By micom	OFF
16	ECO		GREEN	By micom	OFF
17	DOOR OPEN (Operates regardless of interior lamp ON signal)		RED	By micom	HOLD
18	SMART KEY		AMBER	By micom	OFF

The pre-warning is performed for 4 seconds after turning the ignition switch to ON position. BCM checks that the warning lamps (ABS, ESP, ESP OFF, 4WD CHECK, 4WD LOCK) are matched with CAN signals.
The pre-warning is performed by the variant code.

- The pre-warning of the MICOM control warning is performed 400 ms after turning the ignition switch to ON position.
- IGN ON detecting time: 40~80 ms after turning ignition switch to ON position

(2) STD



▶ Symbols in STD

NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	SIGNAL SOURCE	Signal Value	Operation STATE
1	OIL LEVEL (4s±0.2s)		RED	By micom	Oil level Switch	1) OPEN for 60 sec. or longer 2) TACHO: 1000 RPM or less 3) engine coolant temperature: 50°C or higher 4)Warning lamp OFF when oil level switch OFF	IGN ON
	OIL PRESSURE				Oil Pressure Switch	GROUND	IGN ON
2	CHARGE		RED	By micom	Alternator	GROUND(Other than EEM)	IGN ON
3	HIGH BEAM		BLUE	By wire	High-beam Switch	H/B(+) : HIGH	IGN ON
4	AIR BAG		RED	By wire	SDM	GROUND	IGN ON
5	AIR BAG		AMBER	By wire	SDM	GROUND	IGN ON
6	DOOR OPEN (ALL SVC)		RED	By micom	Door switch	GROUND	B+/IGN ON
7	TURN-L		GREEN	By micom	BCM	HIGH	B+/IGN ON
8	TURN-R		GREEN	By micom	BCM	HIGH	B+/IGN ON

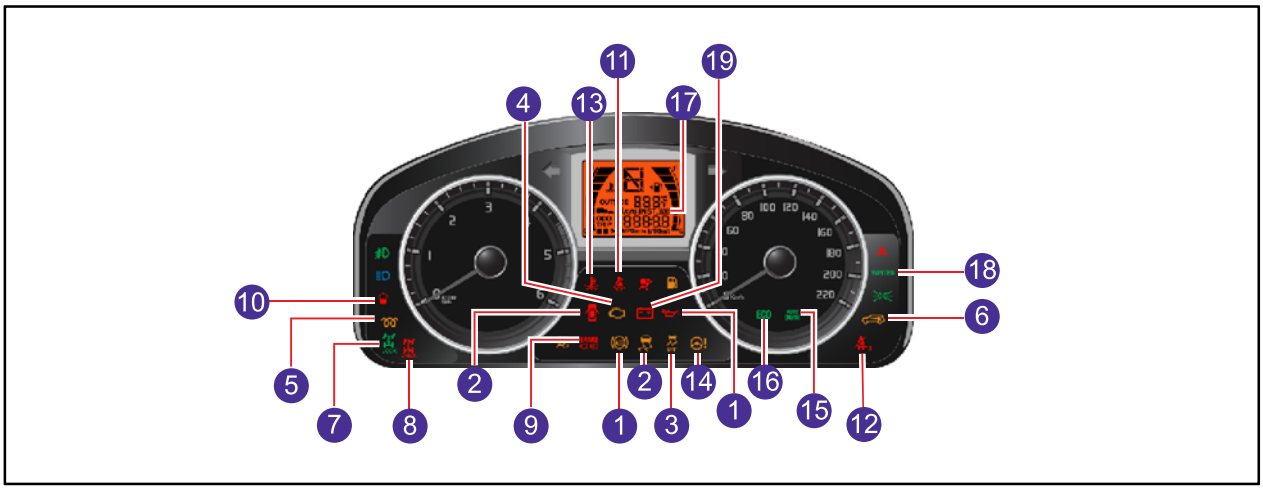
Modification basis	
Application basis	
Affected VIN	

NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	SIGNAL SOURCE	Signal Value	Operation STATE
9	FRT FOG		GREEN	By micom	Front Fog Switch	HIGH	B+/IGN ON
10	LOW FUEL WARNING		AMBER	By micom	FUEL SENDER	Analogue signal	IGN ON
11	PARKING BRAKE (BRAKE FLUIDE) (4s±0.2s)		RED	By micom	P/BRAKE SW & BRAKE OIL LEVEL SENSOR	GROUND (Circuit input signal takes priority over CAN signal.)	IGN ON
12	SIDE LIGHT		GREEN	By micom	ILL	HIGH	IGN ON

The pre-warning is performed for 4 seconds after turning the ignition switch to ON position. BCM checks that the warning lamps (ABS, ESP, ESP OFF, 4WD CHECK, 4WD LOCK) are matched with CAN signals.
The pre-warning is performed by the variant code.

- The pre-warning of the MICOM control warning is performed 400 ms after turning the ignition switch to ON position.
- IGN ON detecting time: 40~80 ms after turning ignition switch to ON position

▶ Symbols in STD (via CAN)



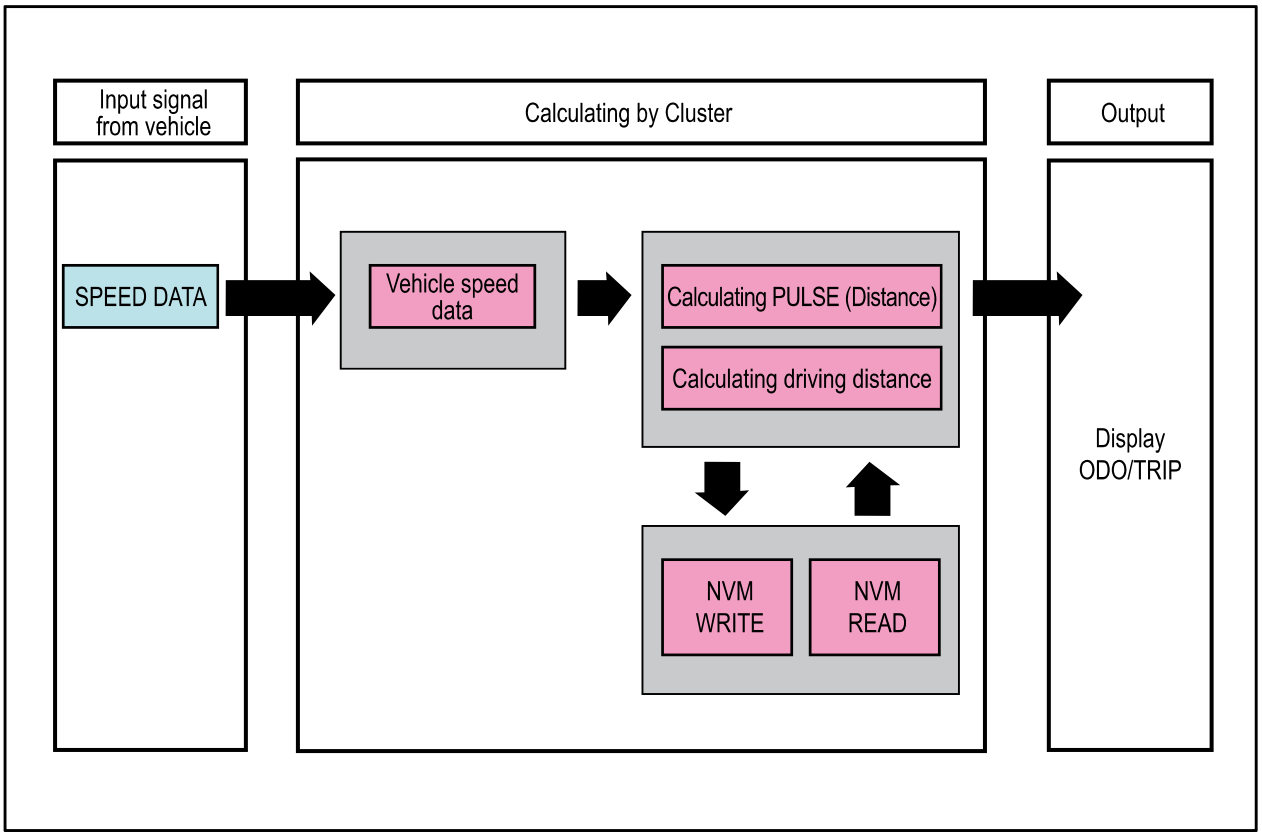
NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	TIMEOUT (3, 5Times)
1	ABS (4s±0.2s)		AMBER	By micom	ON
2	ESP (4s±0.2s)		AMBER	By micom	ON
3	ESP OFF		AMBER	By micom	OFF
4	EINGINE CHECK (4s±0.2s)		AMBER	By micom	HOLD
5	GLOW		AMBER	By micom	OFF
6	IMMOBILIZER		AMBER	By micom	OFF
7	4WD LOCK		GREEN	By micom	OFF

Modification basis	
Application basis	
Affected VIN	

NO	NAME / Pre-Warning	SYMBOL	COLOR	CTRL	TIMEOUT (3, 5Times)
8	4WD CHECK (4s±0.2s)		RED	By micom	HOLD HOLD
9	EBD		RED	By micom	ON
			AMBER	By micom	ON
10	FUEL FILTER (4s±0.2s)		RED	By micom	OFF
11	DRIVER SEAT BELT		RED	By micom	OFF
12	PASSENGER SEAT BELT		RED	By micom	OFF
13	TEMP HIGH (Pre-warning removed)		RED	By micom	OFF
14	EPS (4s±0.2s)		AMBER	By micom	ON
15	AUTO CRUISE		GREEN	By micom	OFF
16	ECO		GREEN	By micom	OFF
17	WINTER MODE		LCD	By micom	OFF
18	WINTER		GREEN	By micom	OFF
19	CHARGE		RED	By micom	ON

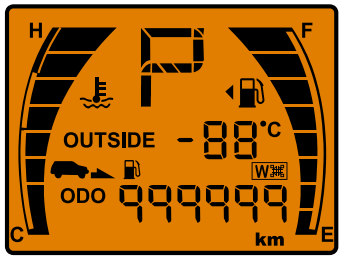
7) Odometer (ODO) and Trip Meter (TRIP)

The total driving distance (0 to 999,999 km or 0 to 999,999 miles) and the trip distance (0.0 to 999.9 km or 0.0 to 9,999.9 miles) are calculated by using the value of pulse per 1 km which is programmed in the EEPROM.
Applicable maximum driving speed is 300 km/h. If the vehicle speed goes over the limit, ODO and Trip meter does not operate any more and the pointer indicates the maximum km/h (MPH). The pulse count information is sent from the speed module according to the speed CAN data that matches the speed frequency.

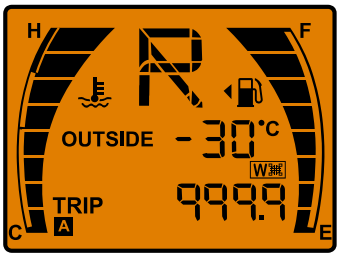
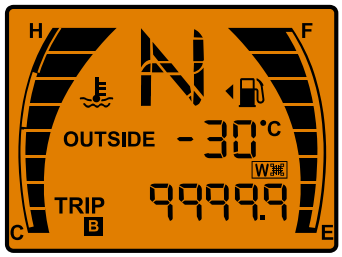


Modification basis	
Application basis	
Affected VIN	

▶ STD Class Odometer Display & Data Storage

Function	Signal	Remark	
Input data	Speed signal	 <STD>	 <SVC>
Display type	6 digits LCD		
Display range	0~999999 km(mile) Hold		
Resolution	1 km (mile)		
Maximum Odo value	If the signal indicating actual vehicle speed above 300 km/h is received, the data is not accumulated.		

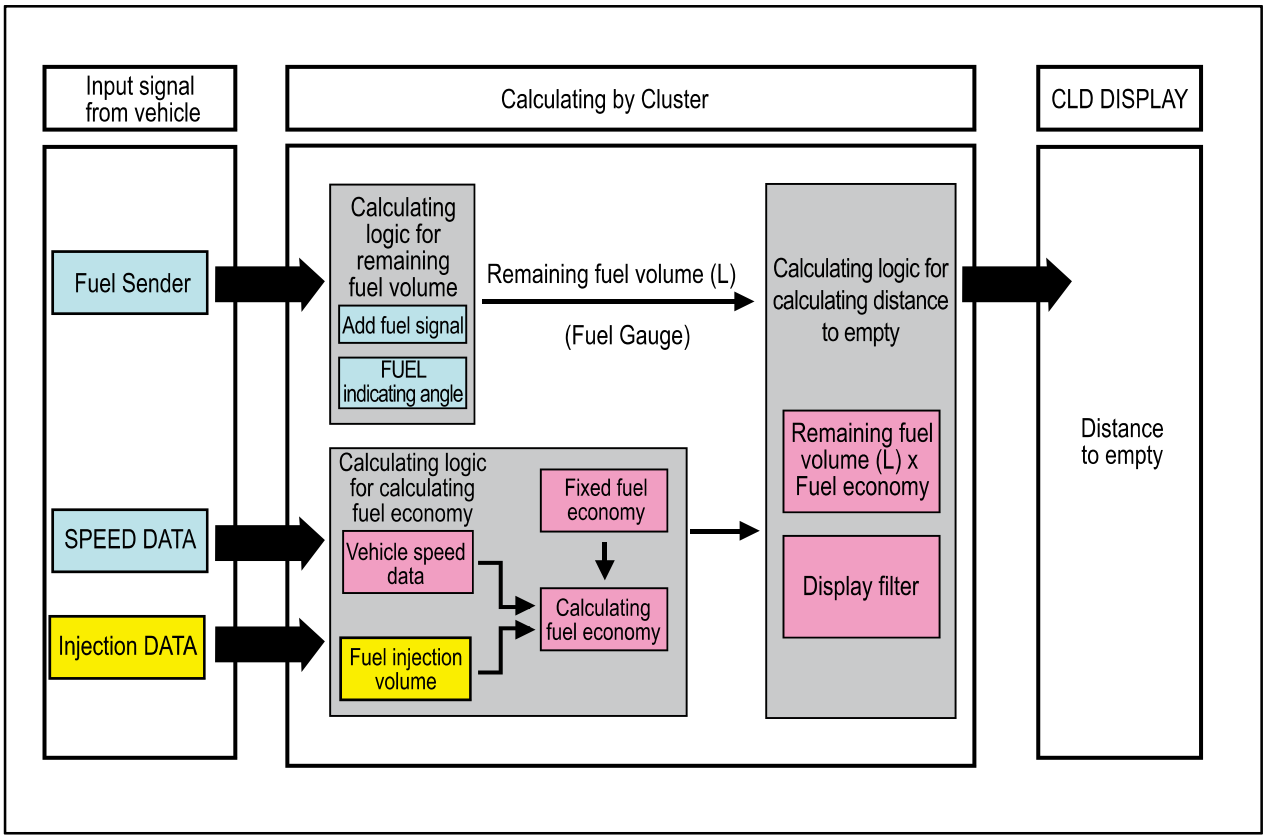
▶ STD Class Tripmeter Display

Function	Signal	Remark	
Input data	Speed signal	  <STD>	  <SVC>
Display type	4 digits LCD		
Display range	A: 0.0 ~ 999.9 km (mile) B: 0.0 ~ 9999.9 km (mile)		
Resolution	0.1 km (mile)		
Maximum Odo value	A: 0.0 → 999.9 → 0.0 km B: 0.0 → 9999.9 → 0.0 km		
IGN OFF	Memorize and maintain previous trip distance		
Data clear	Supply B+ voltage for the first time Press and hold mode switch for more than 1 sec.		
Maximum Odo value	If the signal indicating actual vehicle speed above 300 km/h is received, the data is not accumulated.		

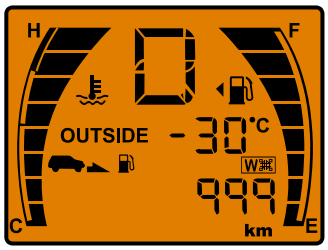
8) Display Mode

(1) DTE (Distance To Empty) Mode

The DTE (distance to empty) function is an estimation on how much further the vehicle can be driven with the fuel remaining in the tank, based on the previous driving pattern (fuel economy).



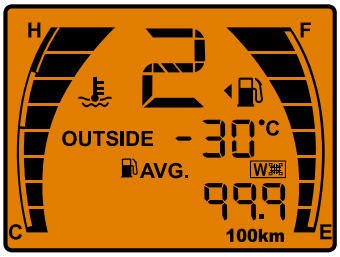
▶ STD Class Odometer Display & Data Storage

Function	Signal	Remark	
Display type	3 digits LCD		
Display range	50 km ~ 999 km (30 miles ~ 999 miles)		
Resolution	1 km (mile)		
Display interval	every 1 seconds	<STD>	<SVC>

Modification basis	
Application basis	
Affected VIN	

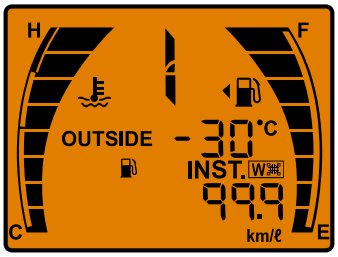
(2) Average Fuel Consumption Mode

The LCD display indicates average fuel consumption calculated based on total driving distance and total fuel consumption since B+ power supply or data reset.

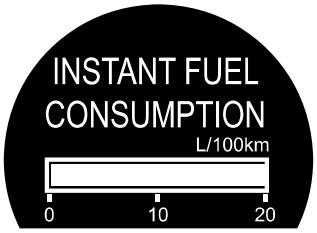
Function	Signal	Remark	
Display type	3 digits LCD		
Display range	0.0 km ~ 99.9 km (0 miles~99.9 miles)		
Resolution	0.1 km (mile)		
Display interval	every 10 seconds		
Data clear	- Disconnect B+ voltage - Press and hold Reset switch for more than 1 sec. - Reset automatically when refilling	 <STD>	 <SVC>

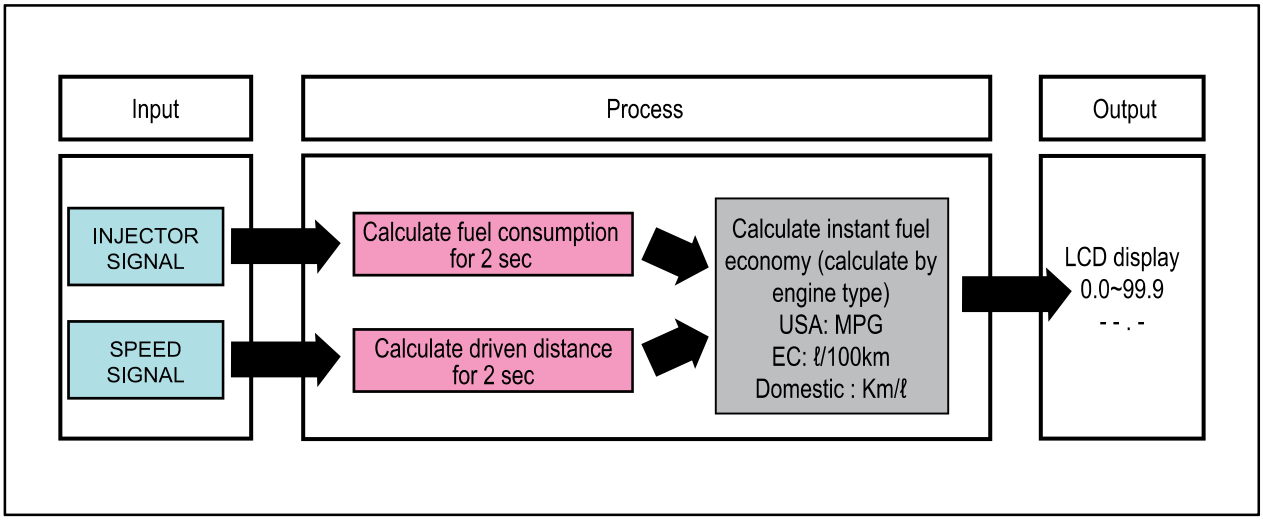
(3) Instant Fuel Consumption Mode

The LCD display indicates the instant fuel consumption (for 2 seconds) calculated based on driving distance and fuel consumption for last 2 seconds.

Function	Signal	Remark
Display type	3 digits LCD	 <STD>
Display range	0.0 ~ 99.9 (MPG, ℓ/100 km, km/ℓ)	
Resolution	0.1 km (mile)	
Display interval	every 2 seconds	

- When the ignition is switched on and the vehicle is drived more than 10 km, average fuel consumption is displayed at every 200 ms, based on the fuel consumption and driving distance for 600 ms.

Function	Signal	Remark
Display type	DOT BAR TYPE(92DOT)	 <SVC>
Display range	0.0 ~ 20(ℓ/100km, km/ℓ)/ 0.0 ~ 50(MPG)	
Resolution (DOT)	0.2174(ℓ/100km, km/ℓ per Bar), 0.5435(MPG per Bar)	
Display interval	every 200ms(25℃)	

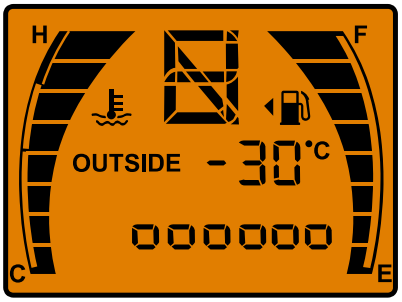


Modification basis	
Application basis	
Affected VIN	

(4) Illumination Mode

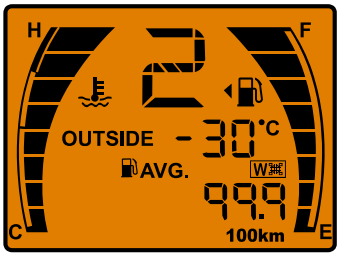
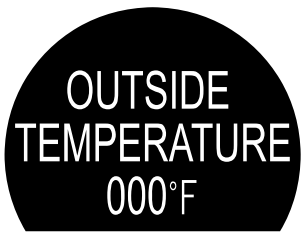
▶ **TRIP/RESET switch**

- Press for less than 1 second: change to next mode
- Press for more than 1 second:
  : Enter into illumination level mode
  → Level changes by 1 step up and down when pressing the switch for more than 1 second on consecutively illumination mode
  (e.g. Level 4 → 5 → 6 → 5 → 4 → 3 → 2 → 1)
- If the Trip/Reset switch is not pressed within 3 seconds after getting into the illumination mode, the LCD changes to next mode.

SVC class instrument cluster	STD class instrument cluster
 <STD>	 <SVC>

(5) Ambient Air Temperature Mode

- The ambient air temperature is calculated and displayed.
- This is displayed on both STD and SVC class, regardless of FATC type (automatic or manual).
- For SVC class, the driver set only the unit between ℃ and °F on the DOT LCD, the ambient temperature is displayed on the SEG LCD.

Function	Signal	Remark	
Display type	3 digits LCD	 <STD>	 <SVC>
Display range	- −30℃ ~ 90℃ (−22°F~ 194°F) - −31℃ ~ −33℃ : maintain 30℃ - 91℃~93℃ : maintain 90℃		
Resolution	1℃(1°F)		

9) Buzzer

▶ **Specifications**

Function	Signal
Part name	PKM17EPP-2002-B0 (MURATA, Piezoelectric Sound Components)
Permitted input voltage	25 VP-P or less
Operating temperature	−20˚C to +70˚C
Storage temperature	−30˚C to +80˚C
Sound pressure level	70 dB/min (3 Vp-p, 2 kHz, square wave, 10 cm)
Capacitance	10.9 nF ±30% (120 Hz)

▶ **Output**

Pin No.	Middle East (STD only)	Except Middle East	Buzzer		Priority
			ON_Time	OFF_Time	
PAS	O	O	-	-	0
Over speed warning	O	X	500 ms	200 ms	1
ESP	O	O	100 ms	100 ms	2
Temperature warning	O	O	500 ms	500 ms	3
Fuel filter	O	O	500 ms	500 ms	4
Parking brake	O	O	2.8 s	1.5 s	5

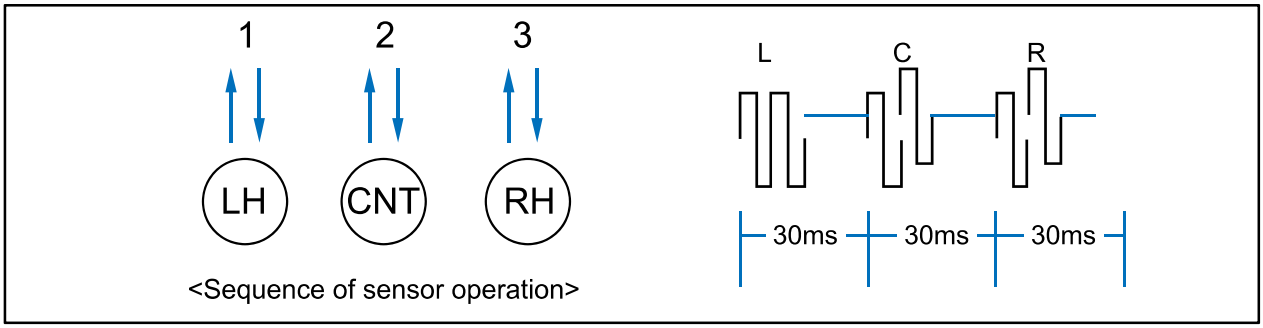
NOTE

- Modulating frequency: 1.96 kHz
- If the signal with higher priority is activated during the operation of signal with lower priority, the current operation should be completed before starting the operation with higher priority.
- If there are multiple signals at a time, the operation should be completed by the priority.

10) PAS (Parking Aid System)

(1) Sensor Operating Process

The ultrasonic sensors transmit ultrasonic waves and receive the reflected waves from an obstacle to detect it in the following order: L → C → R.



<Sequence of sensor operation>

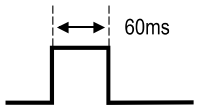
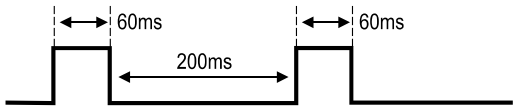
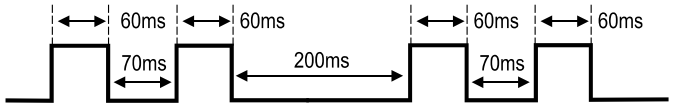
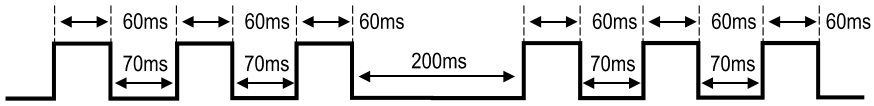
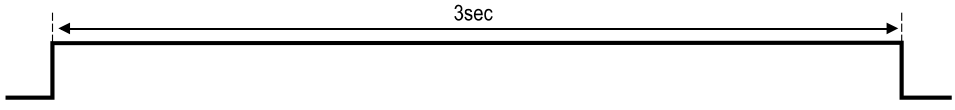
(2) Self Diagnosis Mode

▶ **Operating conditions**

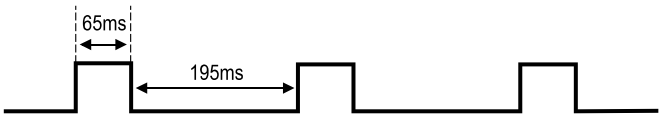
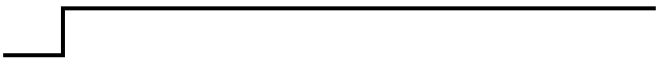
Self diagnosis is performed once when the ignition is switched on (gear shift lever in "R" position). If the system is defective (Fail) due to open sensor or communication problem, the information for the failed sensor is sent to the instrument cluster.

- Fail condition (However, no obstacle should be within 30 cm)
  1. The signal wire is open
  2. The power wire (+ and -)is open

▶ **Buzzer interval during self diagnosis**

MODE	Alarm interval (msec)
Normal	
LEFT	
CENTER	
RIGHT	
2 or more sensors	

▶ **Buzzer interval when measuring distance**

Step	L / R	CENTER	Alarm Interval (msec)
Step 1	80~100 (cm)	80~120 (cm)	
Step 2	50~80 (cm)		
Step 3	25~50 (cm)		
Tolerance	±10 (cm)		±10 (cm)

- Exception/error handling

1. Timeout processing time for buzzer interval after measuring distance/self diagnosis: 600 ms
   - If timeout is reached, the PAS returns to undetected condition.
2. Process while re-inputting
   After timeout, the process is performed normally if the signal required for display is received from beginning to end.
   (not detectable if the signal is received in the midst of process)

▶ DOT LCD message display

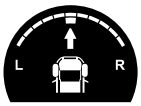
Pin No.	Message	Operating condition
Ambient temperature: indicates air temperature outside control		TRIP switch
Trip A		Reset: Press and hold the Trip switch for more than 1 second
Trip B		Reset: Press and hold the Trip switch for more than 1 second
Distance to empty: indicates a distance can be driven with the fuel remaining control		Factory-setting mode
Average fuel consumption: indicates average fuel control		Reset: Press and hold the Trip switch for more than 1 second
Instant fuel consumption: indicates fuel consumption for a short periods		TRIP switch
Illumination brightness: indicates tail lamp brightness control		Brightness control: Press and hold the Trip switch for more than 1 second
Start-up screen		Displayed for 2 seconds right after ignition is switched on
Driver's seat belt reminder		Displayed for 4 seconds after 'WELCOME' screen

Pin No.	Message	Operating condition
Smart key warning		This message comes on the LCD display, if the smart key is not in the vehicle when the door is open and closed in the ignition ON or ACC mode.
		This message comes on the LCD display for approx. 10 seconds, if the ignition switch is pressed when the smart key is not in the vehicle.
		This message comes on the LCD display for approx. 10 seconds, if the smart key verification fails after inserting the smart key into the key holder.
		This message comes on the LCD display for approx. 10 seconds with warning sound if the smart key is in the key holder when the driver door is open with ignition OFF.
		This message informs the driver that the brake pedal should be depressed and the ignition switch be pressed in order to start the engine, if the ignition is switched to ACC mode for more than one time when the driver keeps pressing the ignition switch without depressing the brake pedal.
		This message informs the driver that the clutch pedal should be depressed and the ignition switch be pressed in order to start the engine, if the ignition is switched to ACC mode for more than one time when the driver keeps pressing the ignition switch without depressing the clutch pedal.
		This message comes on for approx. 10 seconds to inform the driver that the ignition switch should be pressed with the shift lever in P in order to start the engine.
		This message comes on for approx. 10 seconds to inform the driver that the verified smart key is in the vehicle, if the driver locks the door using another verified smart key with all the doors closed.

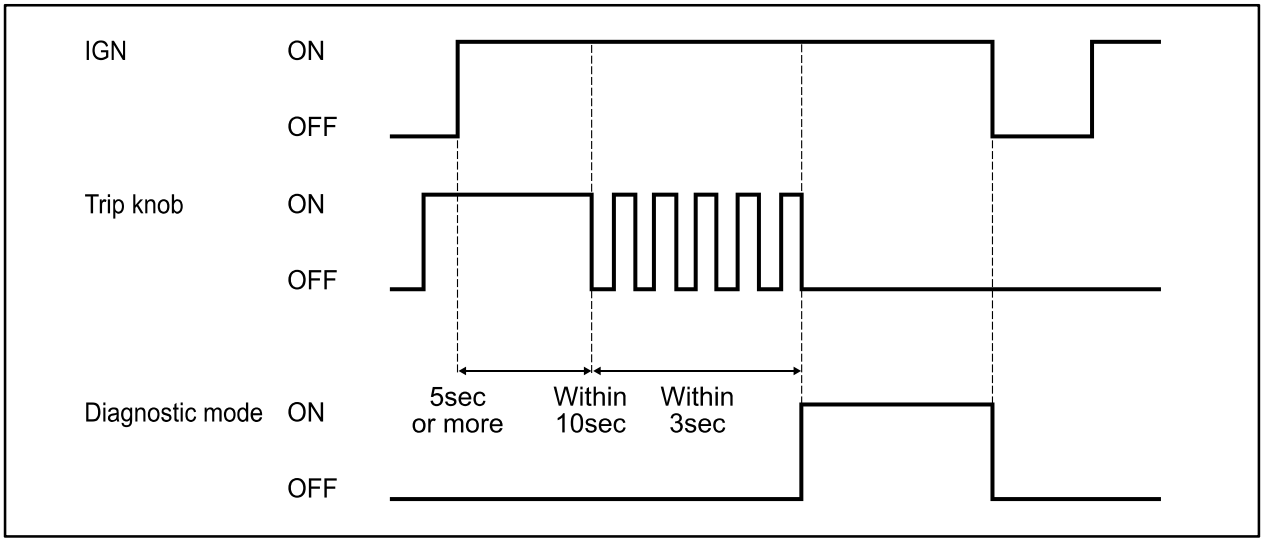
Pin No.	Message	Operating condition
Smart key warning		This message comes on for 10 seconds if incorrect signal on vehicle power control, ignition switch or gear shift position is received or the signal is not received from the SKM after the smart key is verified.
		This message comes on for approx. 10 seconds if the low smart key battery is detected when the ignition switch is pressed or the engine is started.
Door		This message comes on to inform the driver that any of the doors is open or closed. While the door/tailgate is displayed in 4 steps, the hood displayed in 3 steps.
		
Parking aid system		If any obstacle is detected in the rear of the vehicle when the shift lever is moved to "R" position with IGN ON, each sensor shows its position and distance.
		If any error is detected during initial diagnosis, it is displayed as "?". Other than that is operated in the same way as the PAS distance measurement mode.
Cruise control		This message comes on when the cruise control system is activated.
		This message comes on when the cruise control system is deactivated.
		This message comes on when the cruise switch is moved to the ECO position.

Pin No.	Message	Operating condition
Cruise control		This message comes on when the ECO cruise mode is deactivated.
EMS		This message comes on when the engine is faulty.
Lamp		This message comes on when the tail lamps are ON with the ignition in the "OFF" or "ACC" position.
SUNROOF SYSTEM		For the vehicle with SKM, this message comes on when the sunroof is open with the ignition in the "OFF" or "ACC" position. For the vehicle without SKM, this comes on when the sunroof is open with the ignition in the "OFF" position and the key removed.
Low fuel level		This message comes on when the remaining fuel is insufficient.
ESP check		This message comes on when the ESP system is faulty.
ABS check		This message comes on when the ABS system is faulty.
Engine oil level check		This message comes on when the engine oil level is low.

Modification basis	
Application basis	
Affected VIN	

Pin No.	Message	Operating condition
Winter mode (SVC class)	  	- The message "SET WINTER MODE" is displayed on the LCD display when the winter mode is activated. The message "RELEASE WINTER MODE" is displayed when it is deactivated. - The message "WINTER MODE" is displayed when the vehicle starts off with the winter mode set.
Tire alignment (applies to vehicle with EPS)	<Level 0>  <Level 1>  <Level 2>  <Level 3>  <Level 4>  <Level 5> 	- This message helps the driver to predict the driving direction since the tire alignment is displayed on the instrument cluster. - The images on the left show that the tires are aligned to the left. When the tires are aligned to the right, the image is symmetrical vertically. - Tire alignment is displayed between level 0 and level 5 depending on the alignment degree when the ignition switch is turned to "ON" position from "OFF" position with the shift lever in "P" or "N" position. While the images up to level 2 comes on for 5 seconds, the images from level 3 stay on. These messages are not displayed when the EPS - check message is displayed.
CAN scan		(This message goes off when all the CAN signal inputs are normal)

5. SELF DIAGNOSIS



1. Self diagnosis for gauge

- Speedometer: Check the whole speed range (minimum to maximum).
- Tachometer: Check the whole rpm range (minimum to maximum).

2. Self diagnosis for symbols

- All symbols ON
  (except the wired type symbols: air bag, passenger air bag, turn signal indicators, hazard warning lamp, high beam, front fog lamp)

3. ETC

- When entering into the self diagnosis mode, the instrument cluster illumination output will be 100%. All the remaining segments are ON.
- The spanner symbol goes off if CAN messages to the instrument cluster are OK. If not, it blinks.
- The mode and illumination switch inputs are overridden.

-

4. Diagnosis mode deactivation condition

- The diagnosis mode is deactivated when the ignition switch is turned to "OFF" position or the engine is running.

6. VARIANT CODING

- The instrument cluster enables all functions by receiving the vehicle's variant codes through CAN communication when turning the ignition switch to ON position.
- The systems verified by variant code performs the pre-warning and time-out operation. If not confirmed, all data for the systems, even exiting in CAN network, are overridden.

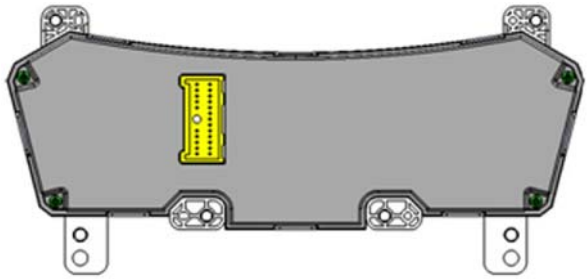
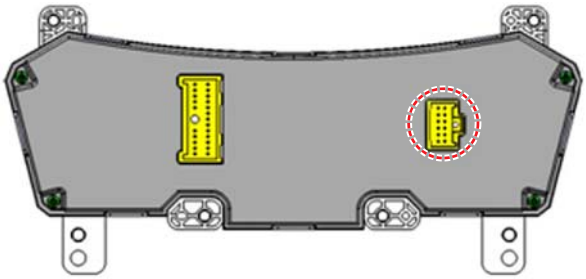
Modification basis	
Application basis	
Affected VIN	

Switch

8510-00

GENERAL INFORMATION

1. MAJOR CHANGES

Manual air conditioner controller	
Previous	**Current**
	
Driving circuit for the ambient temperature sensor added to the manual air conditioner controller for ambient temperature display on the instrument cluster	



Lower main panel switch	
Previous	**Current**
	
Changed layout due to addition of steering wheel heating switch	

Modification basis	
Application basis	
Affected VIN	

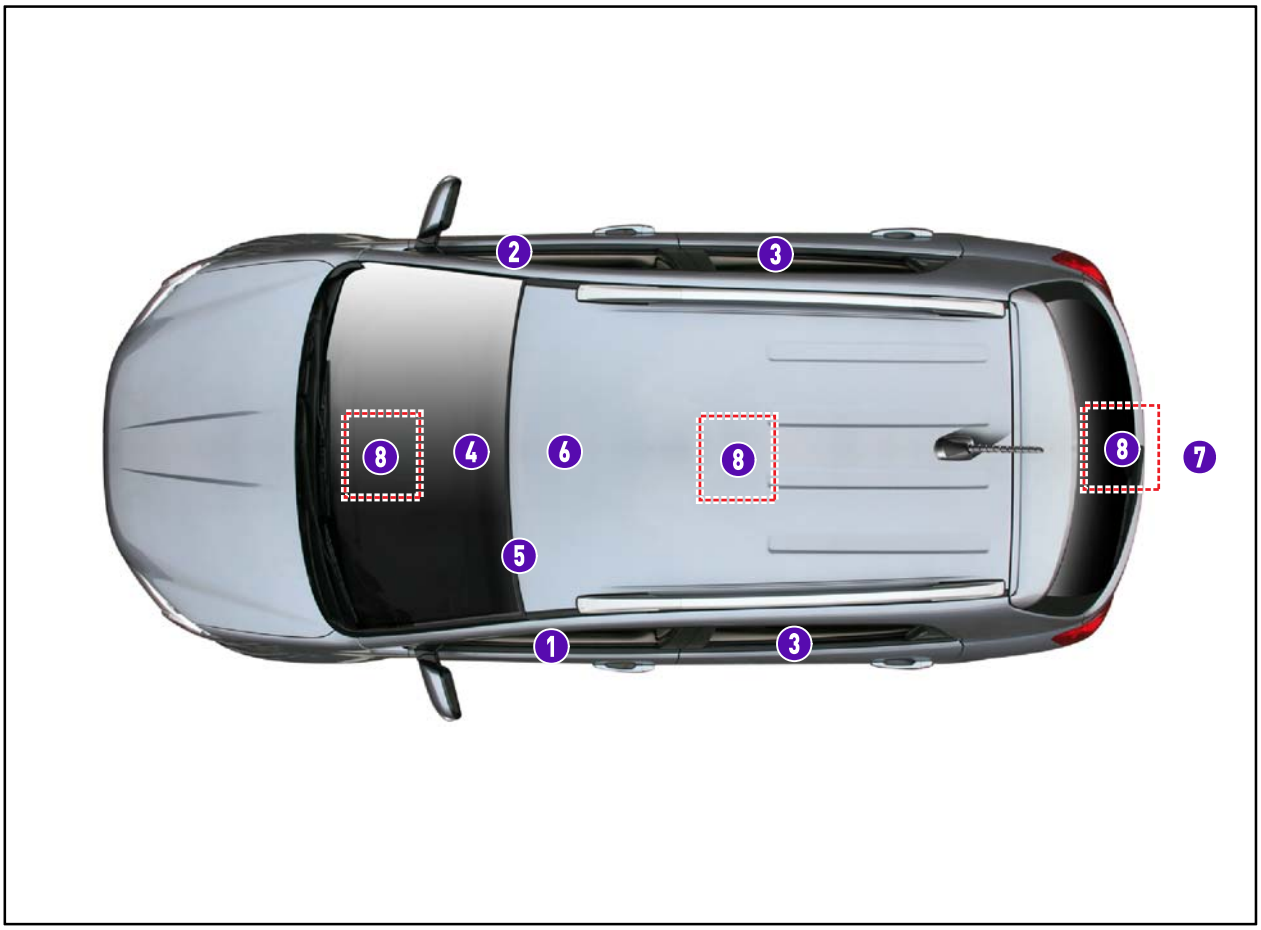
Audio remote control switch	
Previous	**Current**
	
Bluetooth handsfree function added and button logo design changed	

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

1) Mounting Locations



1. Door panel switch (driver)
2. Door panel switch (passenger)
3. Door panel switch (rear)
4. IP panel switch
5. Steering wheel switch
6. Front console switch
7. Trunk switch
8. Headlining switch

▶ Switch layout

Steering wheel remote control switch

1



Start/stop switch

2



Passenger door switch

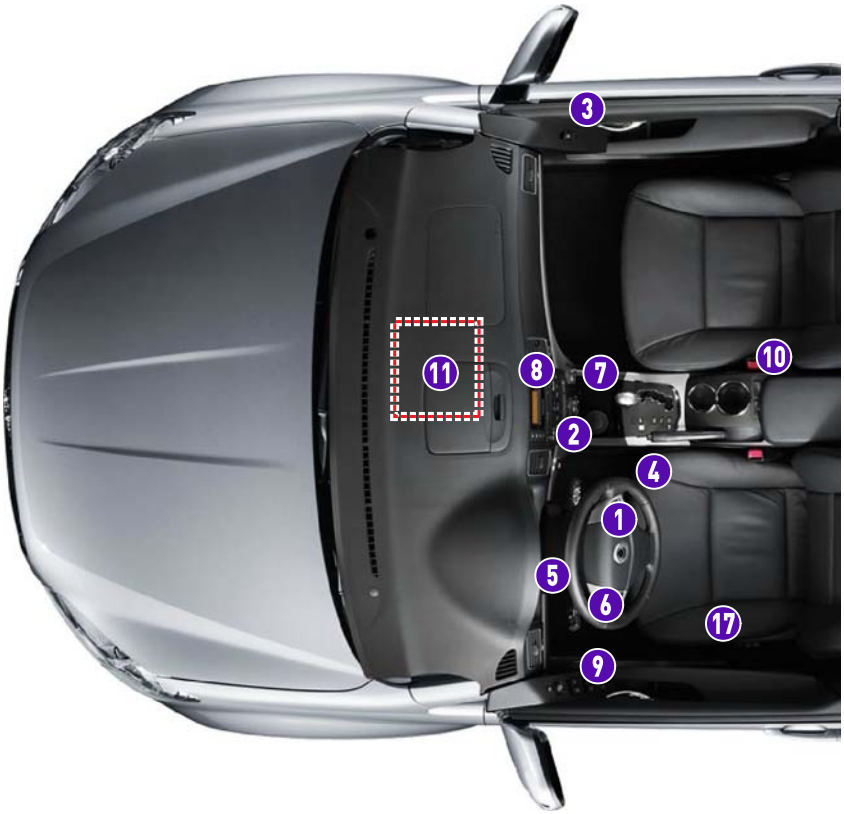
3



Cruise control switch

4





Multifunction switch

5



Lower main panel switch

6



FATC switch

7



Hazard warning switch bezel assembly

8



Drive door main switch & outside mirror switch

9



Modification basis	
Application basis	
Affected VIN	

Front seat heated wire switch (DLX)



Front seat heated wire switch (STD)



Overhead console switch



Center room lamp switch





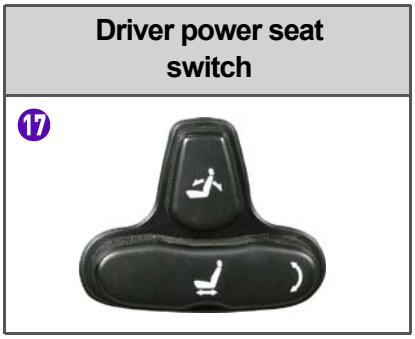
Luggage lamp switch



Tailgate switch



Driver power seat switch



Rear door switch (RH)



Rear door switch (LH)



Modification basis	
Application basis	
Affected VIN	

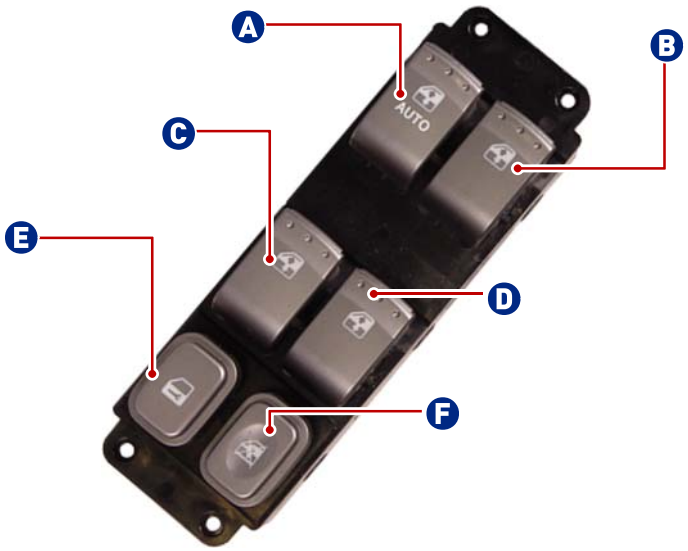
2. SWITCH CLUSTER ON DOOR TRIM

1) Driver Door Switches

(1) Power window main switch



Power window main switch



A Driver door window switch	D Rear RH window switch
B Passenger door window switch	E Door lock/unlock switch
C Rear LH window switch	F Window lock switch

Modification basis	
Application basis	
Affected VIN	

Driver door window switch

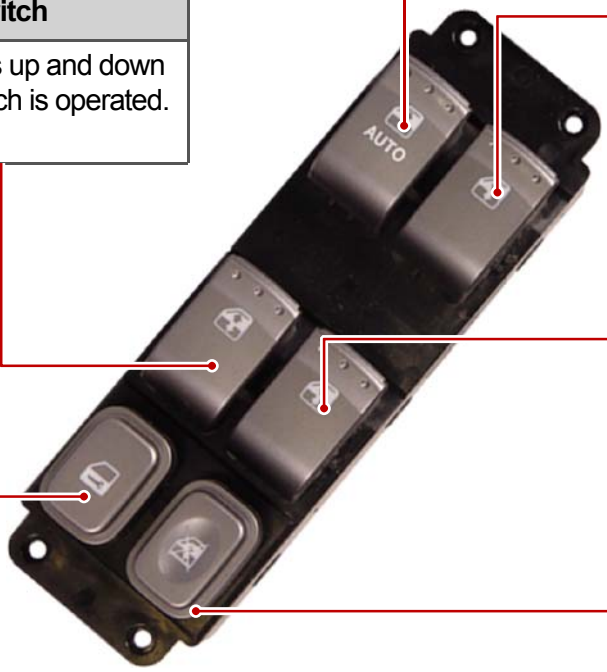
The driver's door window switch has Auto down/Auto up function. The window can be controlled within 30 seconds by activating the power window relay even after turning off the ignition switch.
However, if any of front doors is opened or the Lock switch on the remote control key is pressed (theft deterrent mode is activated) during the delaying period, the delaying time is immediately canceled (power window relay is deactivated).
There are two variants of this: only auto down and anti-trap (auto down and auto up).

Rear LH window switch

The window is up and down while this switch is operated.

Passenger door switch

The window is up and down while this switch is operated.



Rear RH window switch

The window is up and down while this switch is operated.

Door lock/unlock switch

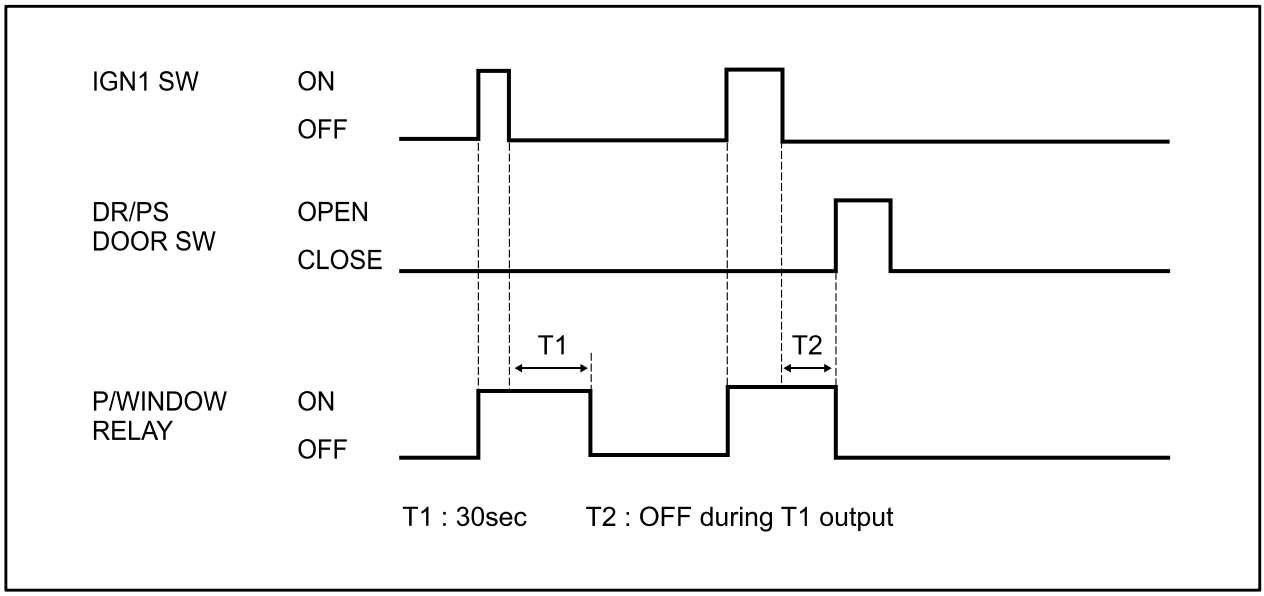
When the door lock/unlock switch is pressed while all doors including the tailgate are locked, all doors will be unlocked. When the switch is pressed again, all doors will be locked.

Window lock switch

If the window lock switch is pressed down, only driver window is operative. Passenger and rear windows cannot be operated by their switches.

▶ Time lag power window control

1. When turning the ignition switch to ON position, the power window relay is turned ON.
2. The power window relay keeps ON for 30 seconds even when stopping the engine. However, the power window relay is turned OFF when opening a front door.
3. When locking the door (activation of theft deterrent mode), the power window relay is immediately turned OFF.



Modification basis	
Application basis	
Affected VIN	

▶ Function of door lock/unlock switch

There are 5 actuators in door lock/unlock system (including tailgate). All of them can control the corresponding door lock and unlock separately. But, the driver door lock switch can control all door locks. The BCM controls the lock/unlock switch using the door lock/unlock relay. This is a same control type with Auto door lock function that locks the doors when the vehicle speed exceeds 30 km/h. (see circuit diagram)

Door lock/unlock switch



A Door lock/unlock switch

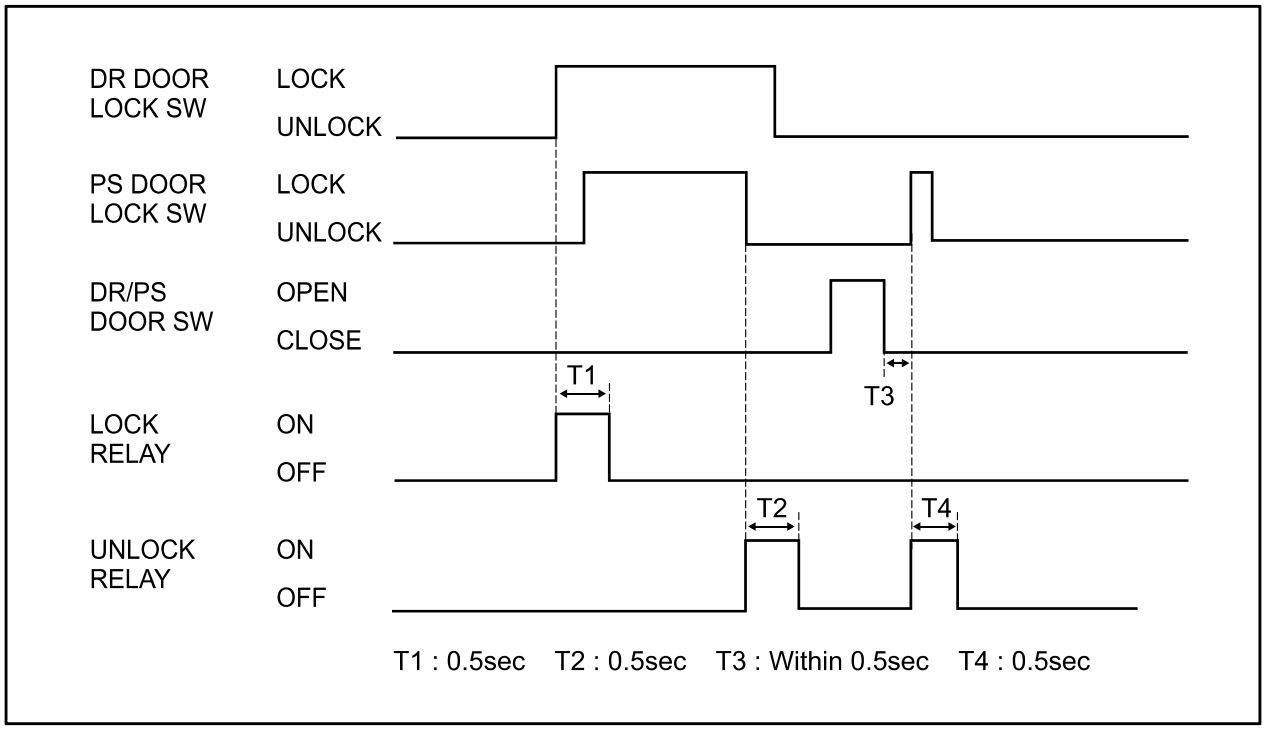
When the door lock/unlock switch is pressed while all doors including the tailgate are locked, all doors will be unlocked. When the switch is pressed again, all doors will be locked.

▶ Door lock/unlock relay (integrated in BCM)



▶ Door lock/unlock control by door LOCK switch

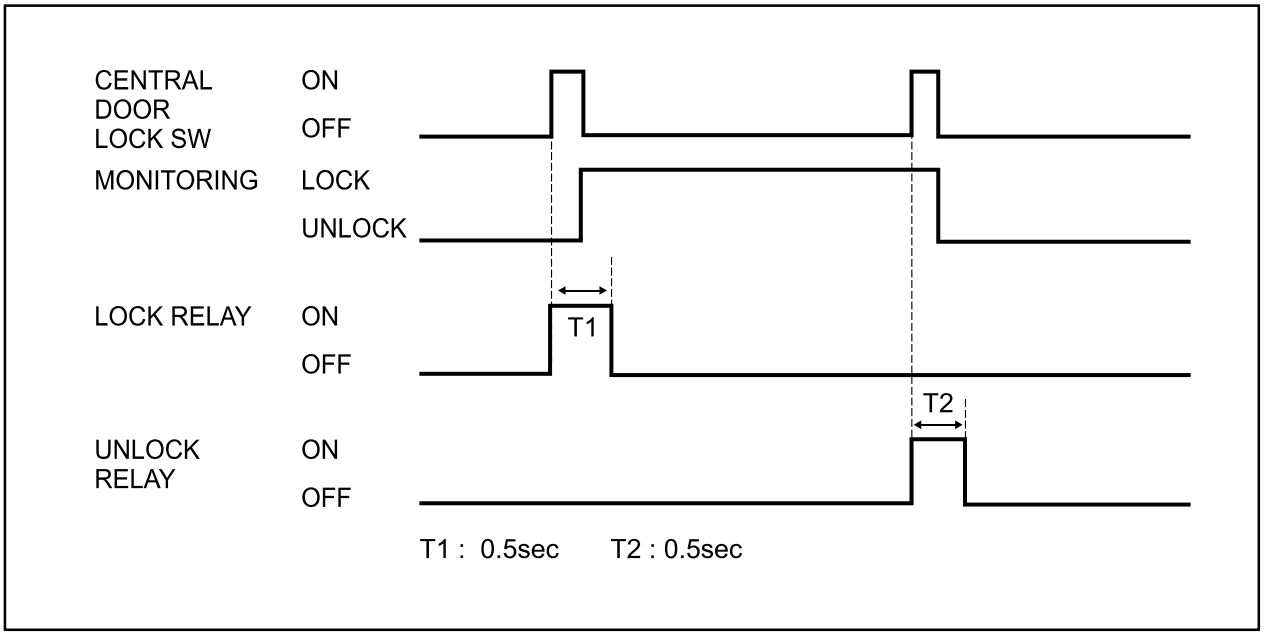
1. When moving the driver or passenger door lock (knob) switch to LOCK from UNLOCK position, BCM sends the LOCK signal for 0.5 seconds.
2. When moving the driver or passenger door lock (knob) switch to UNLOCK from LOCK position, BCM sends the UNLOCK signal for 0.5 seconds.
3. The LOCK (UNLOCK) operation by the door lock (knob) switch is not available when sending the LOCK (UNLOCK) signal by any other method such as remote control key.
4. When reconnecting the battery, the door lock (knob) switch is not operational regardless of the door lock switch positions.
5. All doors stay unlocked when receiving the door lock signal in 0.5 seconds after closing the doors.



Modification basis	
Application basis	
Affected VIN	

▶ Door lock/unlock control by central door lock switch

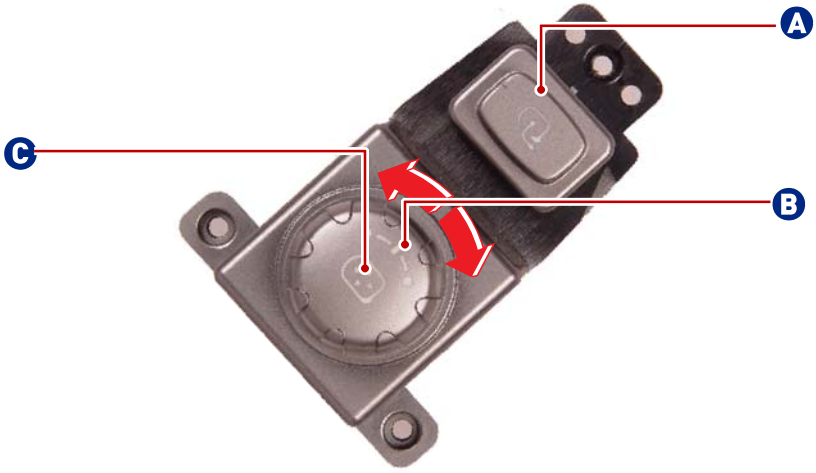
1. When pressing the central door lock/unlock switch, BCM sends the LOCK or UNLOCK signal according to the previous condition of driver door lock switch for 0.5 seconds.
2. The central door dock switch is not available when the system is in theft deterrent mode.
3. When turning the ignition off, all doors are automatically unlocked if any of the door lock (knob) switches is in LOCK position.
4. When pressing the central door lock switch with any door open, the system unlocks the doors immediately after locking them.



(2) Outside Mirror Switch



Outside rearview mirror switch



A Outside mirror folding/unfolding switch

The outside mirrors are folded/unfolded whenever pressing this switch.

B Mirror selection switch

LH: Driver side mirror
RH: Passenger side mirror

C Mirror aiming switch

Adjust the selected mirror up, down, left, or right by pressing the corresponding edges of the switch to get a desired view.

Modification basis	
Application basis	
Affected VIN	

The outside mirror folding switch is self return type and the aiming switch is seesaw and self return type. Do not fold or unfold the outside rearview mirrors manually. It may cause a malfunction of the mirror folding system.

▶ **Auto folding/unfolding control**

1. Setting
   - Set auto folding function: When pressing the mirror folding switch for over 3 seconds, the auto folding function is set and the internal buzzer sounds once (ON: 0.1 sec, OFF: 0.2 sec).
   - Release auto folding function: When pressing the mirror folding switch for over 3 seconds, the auto folding function is set and the internal buzzer sounds twice (ON: 0.1 sec, OFF: 0.2 sec).

2. Auto folding:
   - When receiving the LOCK signal from the REKES, the system operates in the sequence of "Door lock → Theft deterrent mode activation → Mirror folding" for BCM without SKM.
   - When receiving the outside door handle switch signal or door lock signal from the smart key remote control, the system operates in the sequence of Door lock → Theft deterrent mode activation → Mirror folding" for BCM with SKM.
3. Auto unfolding sequence
   When receiving the UNLOCK signal from the REKES, the system operates in the sequence of "Door unlock → Theft deterrent mode deactivation → Mirror unfolding" for BCM without SKM.
   When receiving the outside door handle switch signal or door unlock signal from the smart key remote control, the system operates in the sequence of Door unlock → Theft deterrent mode deactivation → Mirror unfolding" for BCM with SKM.
4. When the auto folding function is set, the automatic unfolding is not available if the mirrors have been folded manually.
   (The outside rearview mirror will be folded automatically if the auto folding function is set.)
5. The factory setting is the enabling the auto folding function.

▶ **Folding/unfolding control**

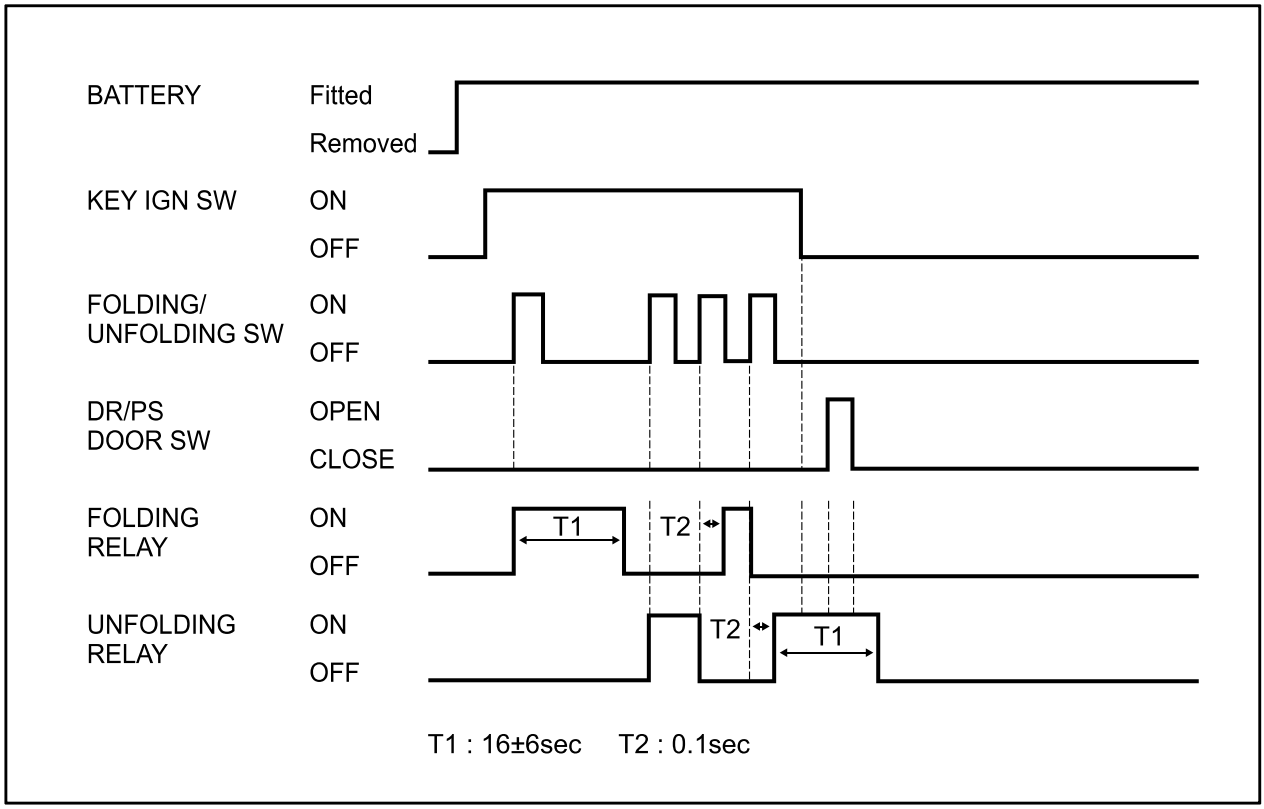
1. When pressing the mirror folding/unfolding switch with IGN ON, the mirrors are folded or unfolded according to the mirror condition. If the outside rearview mirror was folded, the mirror should be unfolded, and vice versa. Folding/unfolding output is activated for 16±6 seconds.
2. This operation time should be completed even when the ignition switch is turned to OFF position during its operation.
3. At first time pressing the mirror folding/unfolding switch after reconnecting the battery, the mirror folding operation is performed.
4. You can control the mirror position within the first 30 sec. after turning the ignition OFF. In other words, this control must be available for 30 seconds (time lag period) after turning the ignition switch to OFF position. Folding/unfolding is completed when time lag of 30 seconds elapse during operation.
5. When receiving the folding/unfolding signal during the mirror folding/unfolding operation, the output should be activated after having time lag of 0.1 second.

The folding/unfolding operation is performed regardless of the vehicle speed.

Manual operation

- Mirror unfolded → Mirror folding/unfolding signal from switch → Mirror folding
- Mirror folded → Mirror folding/unfolding signal from switch → Mirror unfolding

▶ **Operation curve**

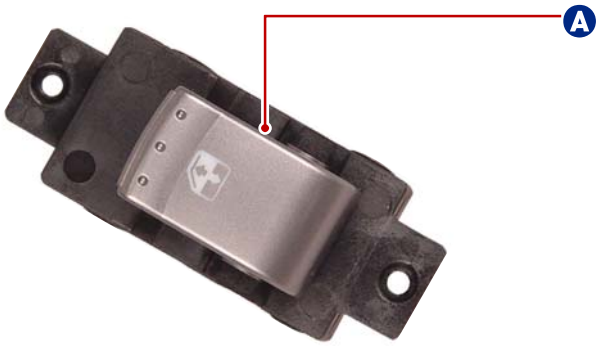


Modification basis	
Application basis	
Affected VIN	

2) Passenger Door Switches



Passenger side door trim switch

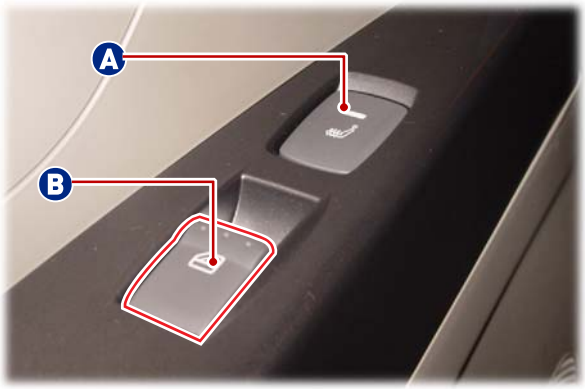
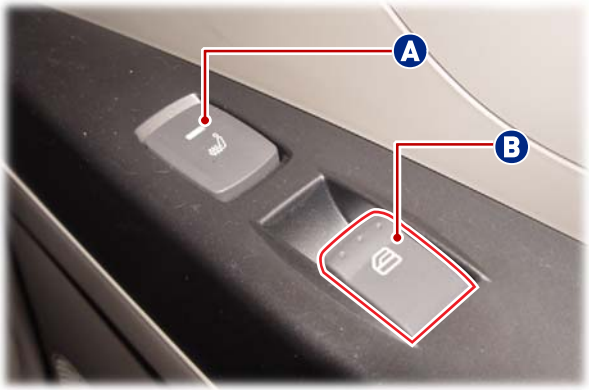


A Power window sub switch

The window is up and down while this switch is operated manually.

3) Rear Door Switches



Rear door switch (LH)	Rear door switch (RH)
	

A Warmer switch

Press the switch to heat the seat and press again to stop the seat heating. During heating, the indicator light on the switch comes on.

B Power window switch

The window is up and down while this switch is pressed.

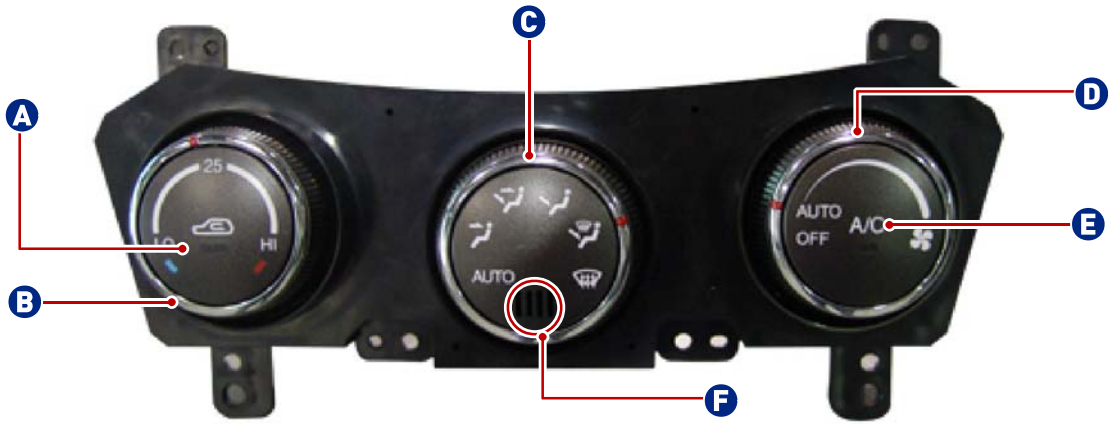
Modification basis	
Application basis	
Affected VIN	

3. SWITCH CLUSTER ON INSTRUMENT PANEL

1) FATC Switches



FATC switch



A Air source mode switch	D Fan speed dial
B Temperature dial	E A/C switch
C Mode dial	F In-car temperature sensor

Modification basis	
Application basis	
Affected VIN	

Temperature dial	Air source mode switch
In full AUTO mode, the FATC receives various signals such as the indoor temperature, ambient temperature, engine coolant temperature, sunlight, from different sensors to control the A/C compressor, mode door, intake actuator assembly, air mix door, blower motors, etc. to keep indoor environments fresh.	When you press this switch, recirculation indicator comes on and the system is changed into the recirculation mode. (However, under defroster mode or defroster/floor mode, it stays in the fresh air mode.)

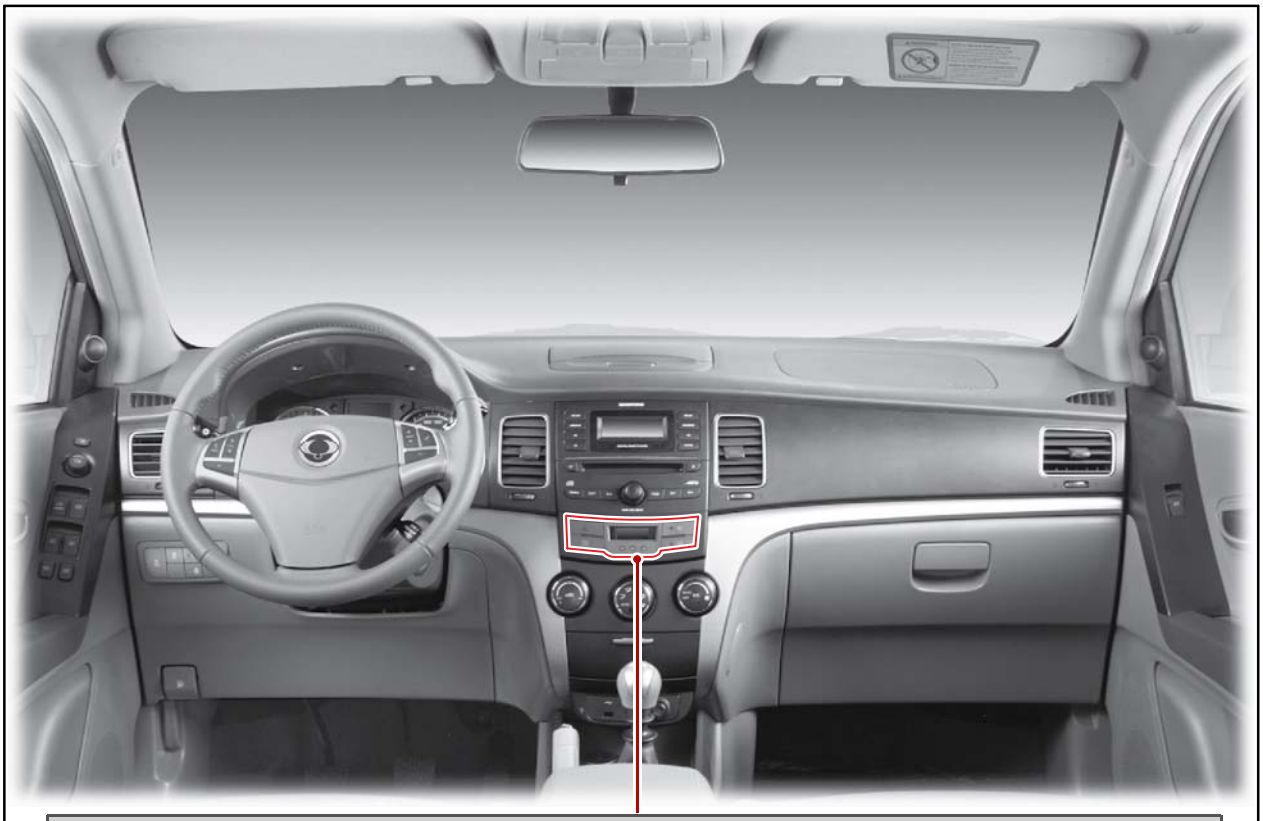


Mode dial	Fan speed dial	A/C switch
You can choose a desired mode from the 5 modes by turning the mode as required. The dial indicator for the selected mode comes on to inform the operator.	In full AUTO mode, the blower motor is controlled automatically according to the set temperature. The blower motor speed can also be controlled manually.	When pressing this switch, the air conditioner operates in manual mode and A/C ON indicator comes on. The A/C starts automatically when the defroster mode is selected.

Modification basis	
Application basis	
Affected VIN	

2) Center Fascia Switch

The center fascia switch contains the hazard warning flasher switch, windshield heated wire switch, digital clock, rear glass heated wire switch and trip switch.



Center fascia switch



- **A** Hazard warning flasher switch
- **B** TRIP reset switch
- **C** Digital clock
- **D** Rear glass & outside mirror heated wire switch
- **E** Windshield heated wire

Modification basis	
Application basis	
Affected VIN	

Hazard warning flasher switch

When this switch is pressed, the hazard warning flashers blink.

Windshield heated glass switch

This is to prevent the windshield wiper blades from being frozen.
The heated wire operates for about 12 minutes. Press the switch again to stop the operation.
The indicator in the switch comes on when in use.



TRIP/Reset switch

Whenever pressing this button, the information is displayed in the following order: Odometer, Trip A, Trip B, Distance to empty, Average fuel consumption, Instant fuel consumption, Illumination level, Ambient air temperature (for STD); Trip A, Trip B, Distance to empty, Average fuel consumption, Instant fuel consumption, Illumination level, Ambient air temperature (for SVC). Press and hold this button to initialize (reset) Trip A/Trip B and average fuel consumption, adjust illumination level or change the unit of temperature.

Rear glass/outside mirror heated wire switch

Press this switch to turn on the tailgate and outside rearview mirror heated wire. The heated wire operates for about 12 minutes. Press the switch again to stop the operation.
The heated glass will operate for about 6 minutes when the switch is pressed again within 10 minutes after completion of its first operation cycle.
The indicator in the switch comes on when in use.

Modification basis	
Application basis	
Affected VIN	

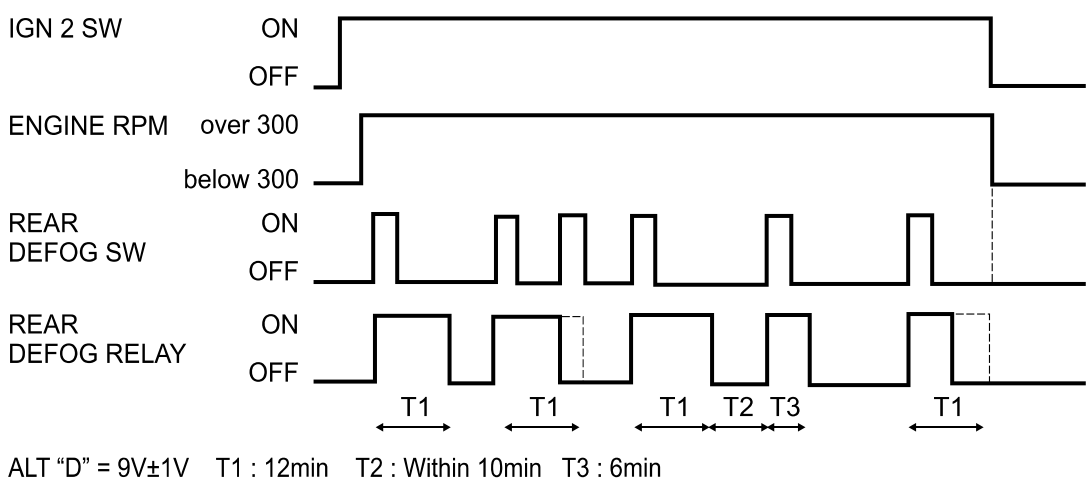
(1) Rear glass/outside mirror heated wire switch

▶ Overview

The rear glass/outside mirror heated wire is operated by BCM.
The heated wire operates for about 12 minutes when the switch is pressed with the engine started.
Press the switch again to stop the operation.
The output is "ON" only for 6 minutes when turning on the rear defogger switch within 10 minutes after completion of output for 12 minutes. This can be done only once.
This function is available only when the engine is running.



▶ Operation curve



ALT "D" = 9V±1V T1 : 12min T2 : Within 10min T3 : 6min

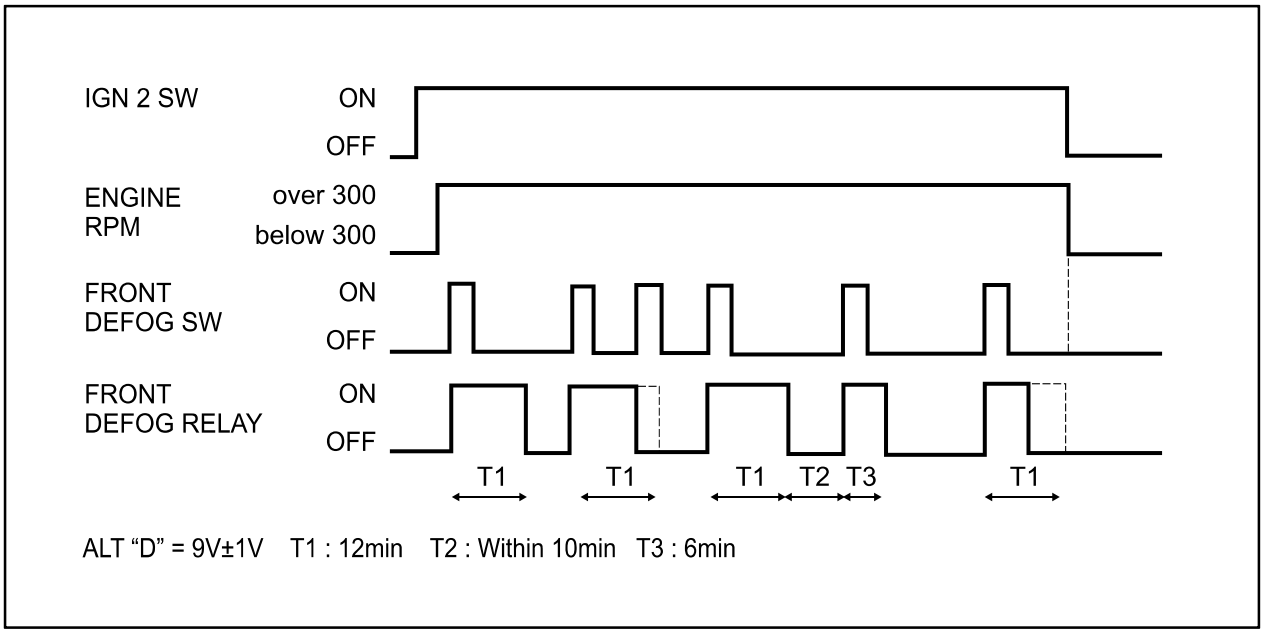
Modification basis	
Application basis	
Affected VIN	

(2) Windshield heated wire switch

The windshield glass/outside mirror heated wire is operated by BCM.
The heated wire operates for about 12 minutes when the switch is pressed with the engine started.
Press the switch again to stop the operation.
The output is "ON" only for 6 minutes when turning on the rear defogger switch within 10 minutes after completion of output for 12 minutes. This can be done only once.
This function is available only when the engine is running.



▶ **Operation curve**



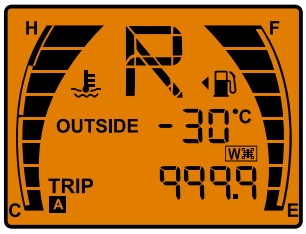
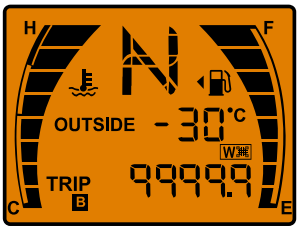
ALT "D" = 9V±1V T1 : 12min T2 : Within 10min T3 : 6min

Modification basis	
Application basis	
Affected VIN	

(3) Trip switch

Whenever pressing this button, the information is displayed in the following order: Odometer, Trip A, Trip B, Distance to empty, Average fuel consumption, Instant fuel consumption, Illumination level, Ambient air temperature (for STD); Trip A, Trip B, Distance to empty, Average fuel consumption, Instant fuel consumption, Illumination level, Ambient air temperature (for SVC). Press and hold (for more than 1 sec) this button to initialize (reset) Trip A/Trip B and average fuel consumption, adjust illumination level or change the unit of temperature.

Display

STD class instrument cluster		SVC class instrument cluster	
			
TRIP A	TRIP B	TRIP A	TRIP B

▶ **Description**



Mode Switch	Detecting time	Function	
Briefly and hold	Below 1 second (60 to 980 ms)	STD	- Mode change (Odo→Trip A→Trip B→DTE →Average fuel consumption→Instant fuel consumption →Illumination level→Ambient air temperature)
		SVC	- Mode change (Trip A→Trip B→DTE→Average fuel consumption →Instant fuel consumption→Illumination level →Ambient air temperature)
Press and hold	Over 1 seconds	- Reset (Trip A, B, average fuel consumption) - Change (Illumination level (6 to 1), temperature unit (℃↔°F))	
Not press	Over 3 seconds	- Mode change (Illumination level→Ambient air temperature→Odo)	

3) Lower Main Panel Switch



Lower main panel switch



A 4WD LOCK switch	**D** Rear fog lamp switch(EU ONLY)
B ESP OFF switch	**E** HLLD(Headlamp Leveling Device)
C Steering wheel heating switch	

Modification basis	
Application basis	
Affected VIN	

4WD LOCK switch

This switch is of push lock type, which enables to increase/decrease the torque to the rear wheels in AWD mode.

Rear fog lamp switch (EU ONLY)

This switch is of push return type, which sends ON/OFF signal to the BCM so that the BCM can switch on the lamps by activating the rear fog lamp relay.



ESP OFF switch

The ESP OFF switch is of push return type, which is used to stop or resume the ESP function.

HLLD (Headlamp Leveling Device)

The headlamp aiming can be adjusted by using this dial-type switch.

Steering wheel heating switch

This switch is of push return type, which is used to activate or deactivate the steering wheel heating function.

4) Power Seat Switch Assembly

(1) Power seat switch (Driver side)



Power seat switch	
	
Ⓐ Seat sliding Ⓑ Seatback reclining	Ⓒ Seat height adjustment

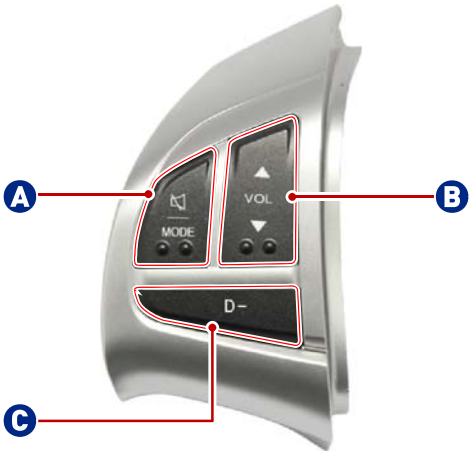
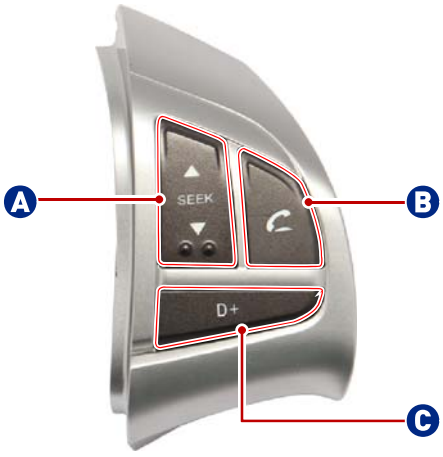
Seat sliding	Seatback reclining	Seat height adjustment
		

Modification basis	
Application basis	
Affected VIN	

4. STEERING WHEEL SWITCH

1) Audio Remote Control Switch



Audio remote control switch (LH)	Audio remote control switch (RH)
	
A MUTE & MODE switch B Volume UP/DOWN switch C Tip switch (D-)	A SEEK UP/DOWN switch B Handsfree switch C Tip switch (D+)

MUTE & MODE switch
To eliminate the sound (MUTE), briefly press this switch. To change the audio mode (Radio-CD-USB-AUX-Radio), press and hold this switch.

SEEK UP/DOWN switch
- CD mode Select next/previous track and - FF/REW Radio mode Change frequency UP or DOWN Press and hold to auto search



Volume UP/DOWN switch
Increases/decreases volume

Handsfree switch
To make/receive/end a call, press and hold this switch.

Tip switch (D-)
Gear change switch -Change down

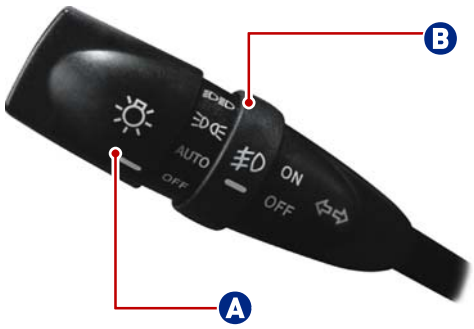
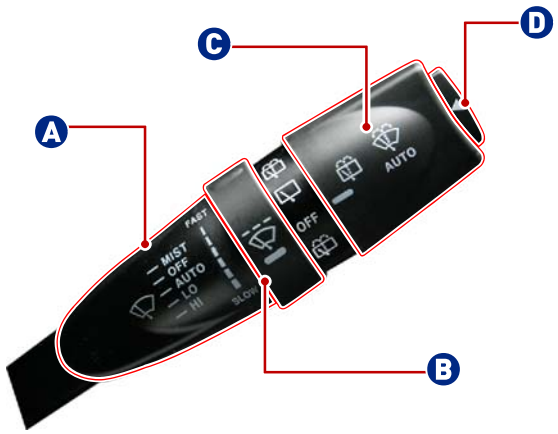
Tip switch (D-)
Gear change switch -Change up

Modification basis	
Application basis	
Affected VIN	

2) Multifunction Switch

The multifunction switch contains the auto washer and wiper switch, front fog lamp switch and auto hazard warning flasher switch. For the vehicle with air bag, since the contact coil is fitted to the upper part of the multifunction switch and ESP steering wheel angle sensor is fitted to upper part of the contact coil, pay attention to when removing and fitting or checking the wiring.



Multifunction light switches	Multifunction wiper switches
	
Ⓐ Light switch Ⓑ Front fog lamp switch	Ⓐ Front wiper switch Ⓑ Wiper speed dial Ⓒ Rear wiper switch Ⓓ Front auto washer switch

▶ Light switch



Headlamps ON

Headlamp, side-marker, tail, license plate, fog, and instrument cluster lamps come on.

Tail lamp ON

Side-marker, tail, license plate, fog, and instrument cluster lamps come on.

Automatic light ON

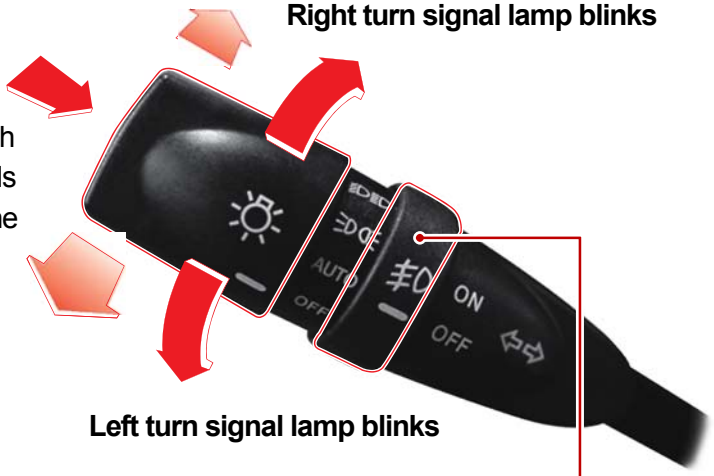
Head- and tail lamps automatically turn on or off based upon the intensity of the sunlight analyzed by the automatic light sensor.

Lights OFF

Right turn signal lamp blinks

High beam ON

To turn on the headlamp high beam, push the lever towards the instrument cluster with the headlamp low beam on.



Passing

Regardless of the position of the light switch, when holding the lever toward the steering wheel, the headlights are on high beam during the hold.

Left turn signal lamp blinks

Front fog lamp switch

To turn on the fog lights, turn this switch while the tail lamps or headlamps are turned on.

Modification basis	
Application basis	
Affected VIN	

▶ Wiper switch

Auto washer switch

If pressing the switch when the wiper switch turns to the "OFF" position, washer fluid is sprayed once and wiper operates 4 times.
After a while, washer fluid is sprayed once more and the wiper operates 3 times.

MIST

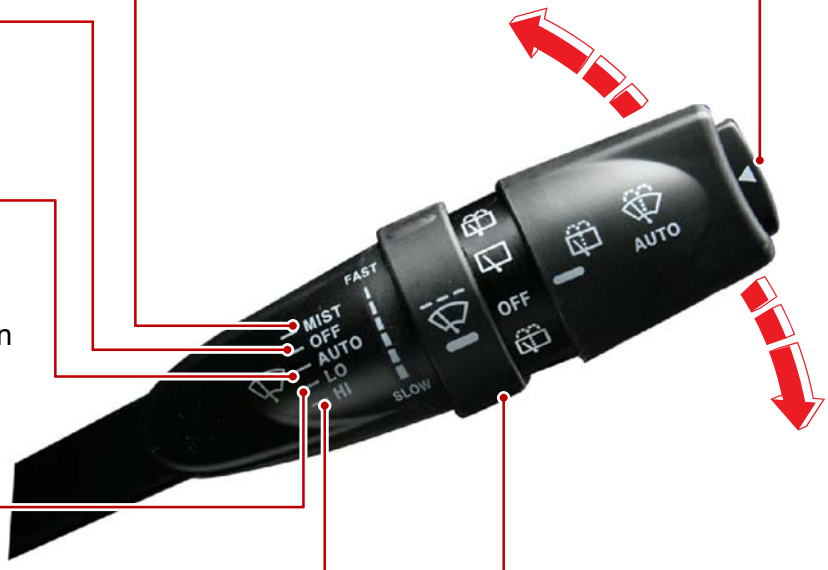
The wiper operates for 1 cycle when pushing up the lever. The lever will return to the "OFF" position when released.

OFF

Stop the operation.

AUTO

Wiper speed controls automatically according to the vehicle speed or amount of rain (rain sensing wiper).



LO

Wiping speed gets slower when placing the pointer at the "LO" position.

HI

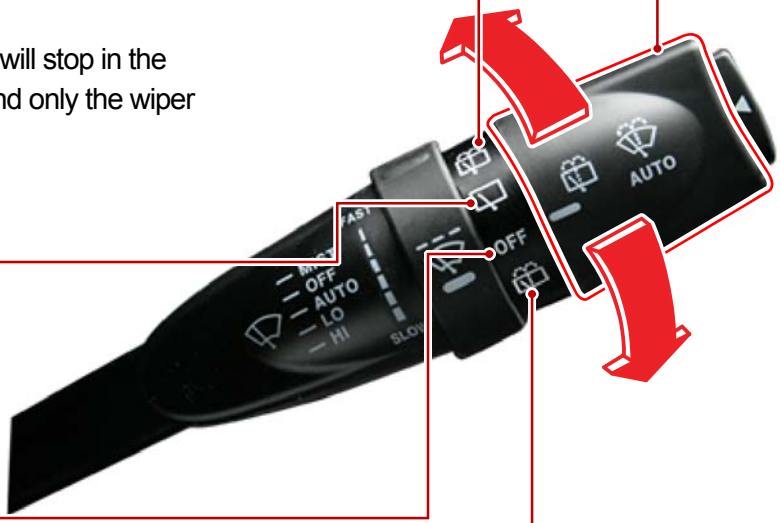
Wiping speed gets faster when placing the pointer at the "HI" position.

Wiping speed control switch

When turning to FAST, wiping speed gets faster and when turning to SLOW, wiping speed gets slower.

Rear wiper switch

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate.
When the switch is released, it will stop in the Rear Wiper Operation mode and only the wiper will keep operating.



Rear wiper operation

OFF

Rear wiper stops

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the “OFF" position and turn off the wiper and washer.

Modification basis	
Application basis	
Affected VIN	

3) Cruise Control Switch

The cruise control is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal. The cruise control switch is fitted to the bottom right section of the steering wheel. When this switch is operated, the AUTO CRUISE or ECO lamp on the instrument cluster comes on.

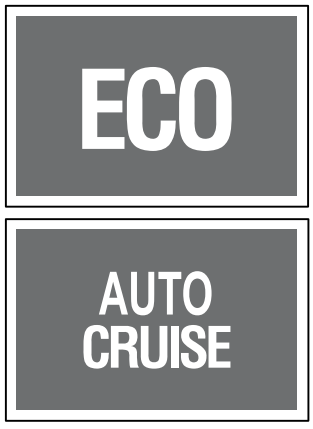
The cruise control switch has a fivefold switch in it. The engine ECU can determine the current driving condition since the resistance varies depending on the operation of the switch.

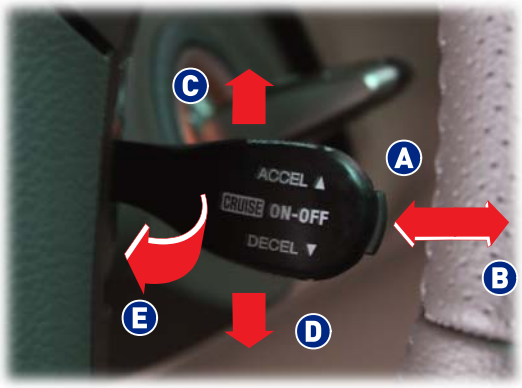
The cruise control system is operated at vehicle speed of between 38 km/h and 150 km/h. The manual transmission is operated in the range of 3rd gear or higher.

This function can be used at the following traffic condition. (It is important to be careful for using this function)



Cruise control switch





- A Cruise control (ON)
- B Cruise control (OFF)
- C Cruise control (Acceleration)
- D Cruise control (Deceleration)
- E Cruise control (Reset)

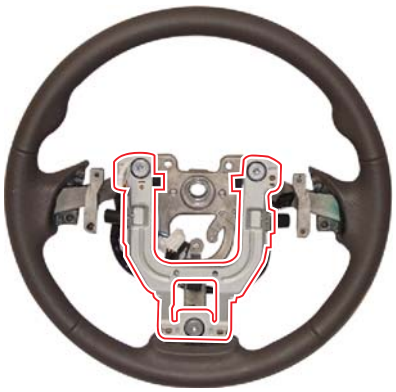
Modification basis	
Application basis	
Affected VIN	

4) Horn Switch

Two horns are installed in the radiator grille at the bottom of both sides (one on each side). There is another horn installed at the bottom of the battery tray side in the engine compartment for theft alarm. Operating the horn switch on the steering wheel applies the power to the horn relay to operate both horns (Dual horn).
The theft deterrent horn is controlled by the BCM in armed mode regardless of the horn relay operation.



Horn switch



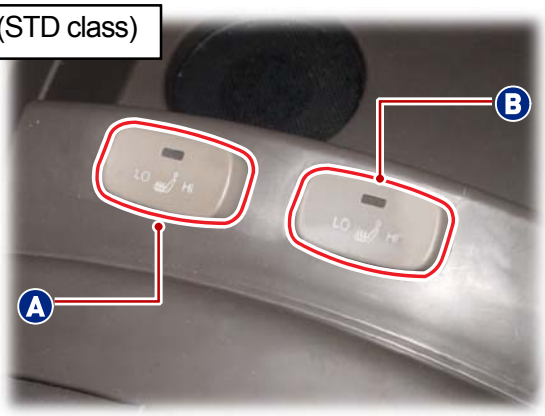
Modification basis	
Application basis	
Affected VIN	

5. SEAT WARMER SWITCH

The front and rear seat warmer switches are designed to control (LO or HI) the seat temperature. Press the "HI (High temperature)" or "LO (Low temperature)" on the seat warmer switch to heat the seat and seatback. When the temperature reaches 40 ±5℃, the thermistor integrated in seat connects and cuts the power to keep the temperature stable. There is no separate seat warmer unit to control the heating temperature of the seat heated wire.

Front seat warmer switch

(STD class)



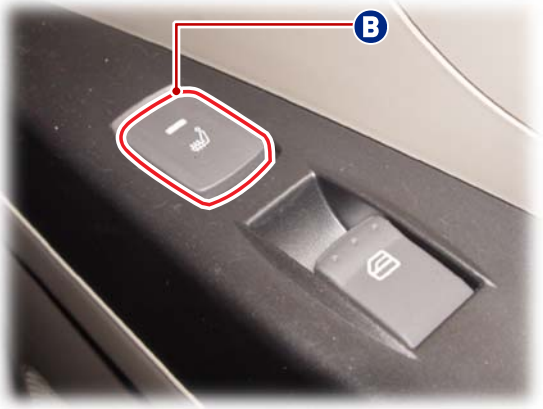
A Driver seat warmer switch

B Passenger seat warmer switch

Rear seat warmer switch



A Rear LH seat warmer switch



B Rear RH seat warmer switch

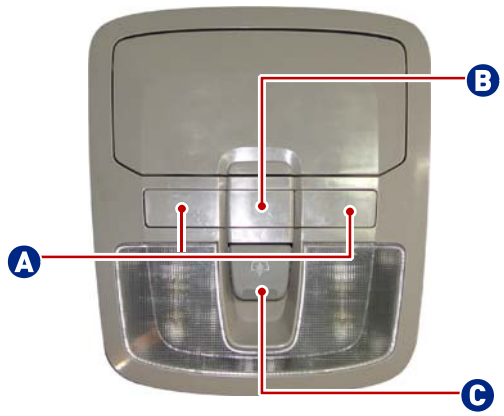
Modification basis	
Application basis	
Affected VIN	

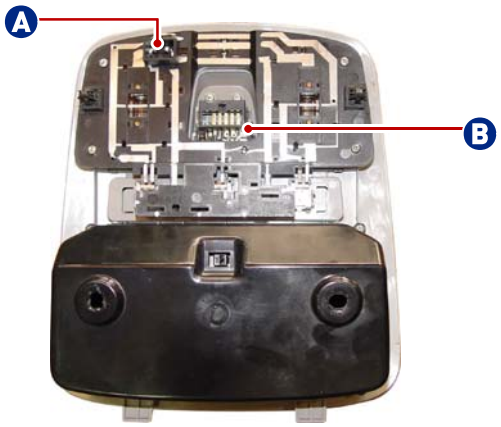
6. OVERHEAD CONSOLE SWITCH

- The front room lamp is controlled by the BCM.
- The front room lamp comes on when opening the driver or passenger door. (door coupled operation switch ON)
- When closing the driver or passenger door, the front room lamp comes on for 2 seconds and then dims down for 3 seconds. (door coupled operation switch ON)
- The front room lamp turns on/off depending on the operation of the front room lamp ON/OFF switch (spot switch).



Overhead console switch



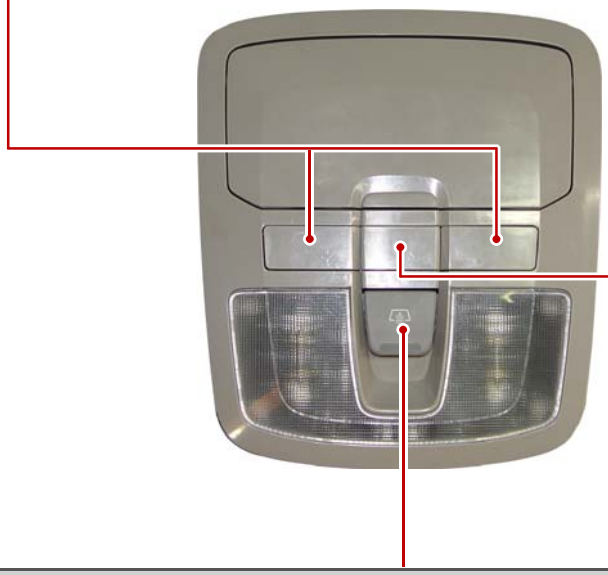


A Front room lamp switch B Door coupled operation switch C Sunroof switch	A Front room lamp connector B Sunroof connector

Modification basis	
Application basis	
Affected VIN	

Front room lamp switch
The driver/passenger room lamps turns on when pressing in these switches.

Door coupled operation switch
The front room lamp and center room lamp come on when opening a door with this switch pressed in.



Sunroof switch

▶ **Push up the switch briefly: 2-step auto sliding open**

When pushing up the switch briefly, the sunroof is automatically opened. Opening is carried out in 2 steps. In first step, the area 5 cm behind the sunroof is not opened. Push up the switch once again in order to open the sunroof completely. The sunroof operation stops if you operate the switch during its operation.

▶ **Push up and hold the switch: manual sliding open**

The sunroof is opened as long as pushing up the switch.

▶ **Pull down the switch briefly: auto sliding close**

When pulling down the switch briefly, the sunroof is automatically closed. To stop the closing sunroof, operate the switch to either direction.

▶ **Pull down and hold the switch: manual sliding close**

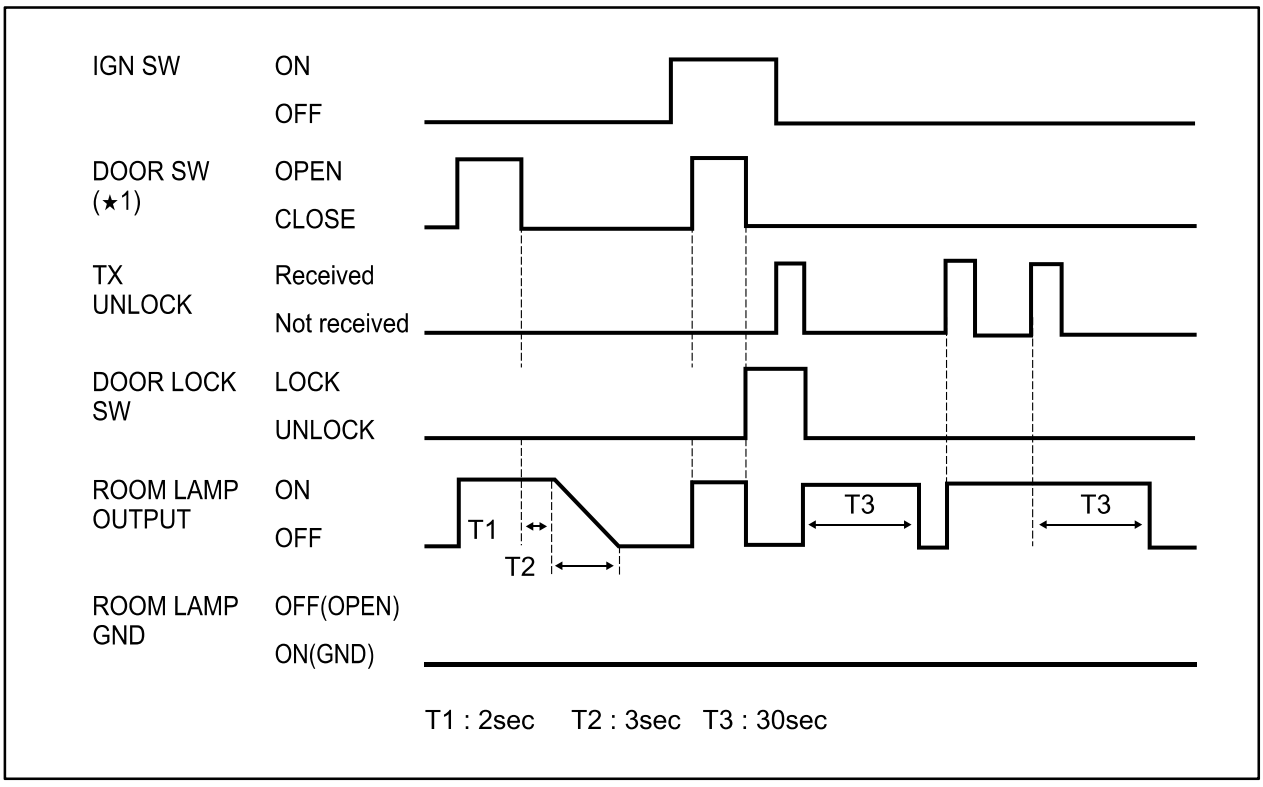
The sunroof is closed as long as pulling down the switch.

▶ Door coupled room lamp operation and dimming control

When opening any of doors while the room lamp switch in overhead console is pressed in ("Door" coupled position), the front and center room lamps come on. If the key is removed and door stays open, the room lamps automatically goes off after 10 minutes. The sleep mode will be deactivated when the door is locked or closed with the lamp OFF automatically.

1. When closing the door with IGN ON, the room lamps go off immediately.
2. When closing the door with IGN OFF, the room lamps stay on for 2 seconds more and are dimmed out the side fascia panel.
3. When turning the ignition switch to ON position during dimming out operation, the room lamps go off immediately.
4. When receiving the door unlock signal with IGN OFF, key removed and door closed, the overhead console room lamp/center room lamp come on for 30 seconds.
   For specification with the SKM, the lamps come on by the REKES unlock or passive unlock signal.
   When receiving the door unlock signal again while the lamps stay on by the REKES or passive unlock
5. signal, the overhead console/center room lamps stays on for 30 seconds more. (the lamps stay on when receiving door unlock signal)
   When opening a door during the coupled operation and dimming operation, the room lamps stays
6. ON. When closing it again, the lamps stay on for 2 seconds more and are dimmed out for 3 seconds. While the room lamps dim out when the driver/passenger/rear doors are open and closed, they go off immediately when entering into the theft deterrent mode.
7. The room lamps come on when AUTO approach signal is received.

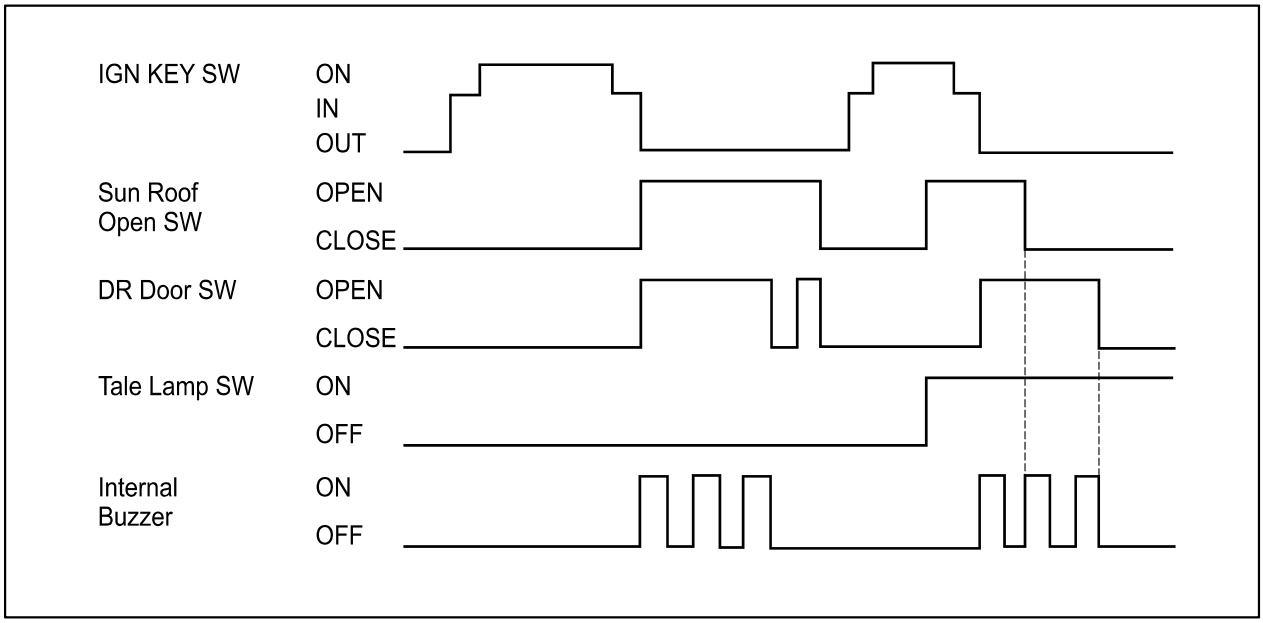
8.



Modification basis	
Application basis	
Affected VIN	

▶ Sunroof warning control

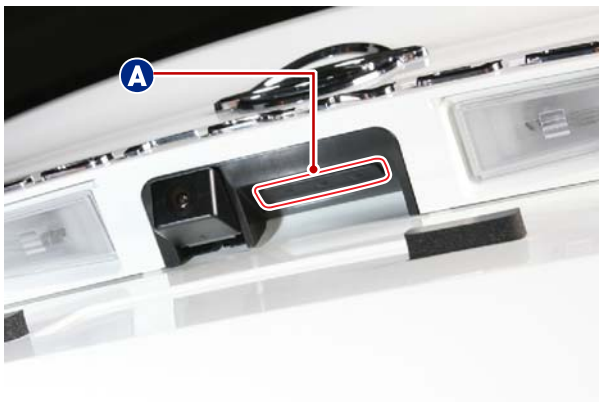
1. When removing the ignition key with the sunroof open (without SKM) or when opening the driver door with IGN OFF or ACC and sunroof open (with SKM), the indoor buzzer sounds for 10 seconds with the interval of 0.02s ON/1.58s OFF.
2. When opening and closing the driver door or closing the sunroof during indoor buzzer operation, the buzzer stops its operation immediately.
3. When closing the driver door or sunroof and opening again during warning operation, the sunroof warning does not work. If the condition is met after the ignition switch is turned to "ON" position again, the indoor buzzer sounds for 10 seconds with the interval of 0.02s ON/1.58s OFF.
   The sunroof warning has a priority over the tail lamp ON warning.
4.



7. TAILGATE SWITCH



Tailgate open switch



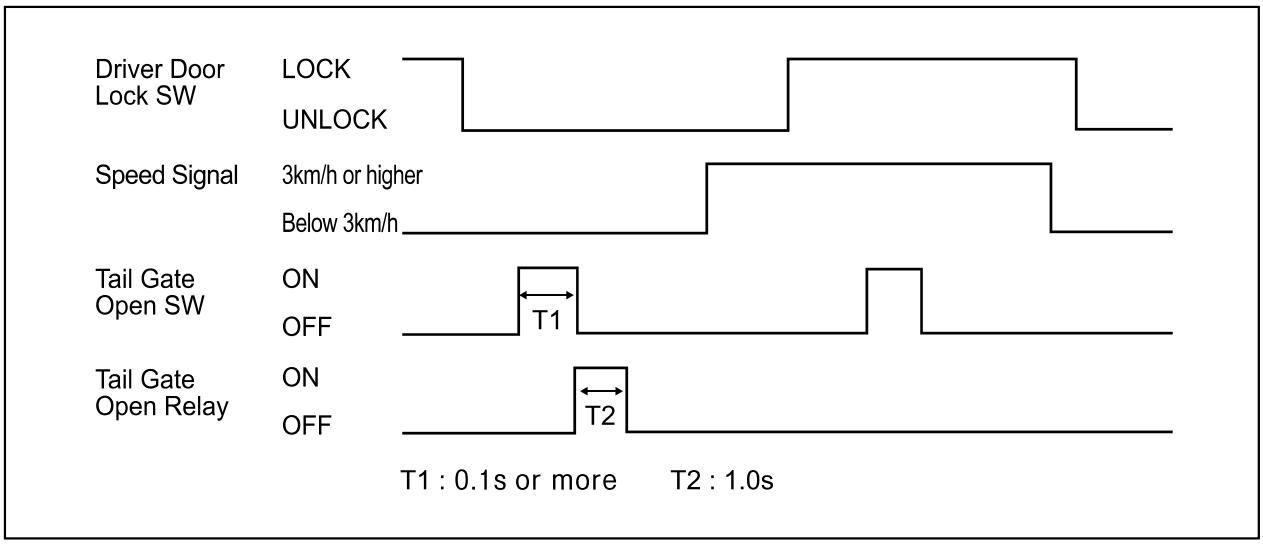
A Tailgate open switch

Modification basis	
Application basis	
Affected VIN	

▶ Tailgate open

Without SKM

1. When pressing the tailgate switch for more than 0.1 second with driver door unlocked and vehicle speed below 3 (±0.1) km/h, the tailgate open relay is turned ON for about 1 second, with power OFF, ACC ON or IGN ON. However, it is turned ON when the vehicle speed is below 3 (±0.1) km/h, with IGN ON.
2. The tailgate open relay is turned OFF immediately after the driver door is locked or the vehicle speed goes over 3 km/h with IGN ON during its operation. However, the BCM does not operate if the tailgate open switch is pressed when the vehicle speed is above 3 km/h.



- Tailgate open: REKES unlock (disarmed deterrent mode) → Tailgate open signal → Tailgate open

With SKM

1. When pressing the tailgate switch for more than 0.1 second with driver door unlocked and vehicle speed below 3 (±0.1) km/h, the tailgate open relay is turned ON for about 1 second.
2. The tailgate open relay is turned OFF immediately after the driver door is locked or the vehicle speed goes over 3 km/h during its operation.
3. When the tailgate switch on smart key is pressed in theft deterrent mode or with the smart key detected by the exterior antenna, the SKM verifies the smart key and disarms the tailgate only. When the tailgate is open and closed, the system enters into the theft deterrent mode again. If the tailgate switch is not operated for 30 seconds, the system also does so.
4. The BCM checks that the verified smart key is in the luggage room 1 second after when the closed tailgate is detected by the tailgate open switch with power OFF.
   If there is a verified smart key in the luggage room when the tailgate is open and closed in theft deterrent mode, the external buzzer sounds for 5 seconds.
   When the driver press the tailgate open switch in order to look for the smart key, the BCM deactivates lock so that the tailgate can be opened even though the driver door is locked. (maintains standby for opening without verification)

Lamp

8310-00

GENERAL INFORMATION

1. LAMP SPECIFICATIONS

1) Exterior Lamps

Item			Type	Amount
Front lamp	Headlamp (high beam/low beam)		BULB: H4	2 EA
	Turn signal lamp		BULB: PY21W	2 EA
	Position lamp		BULB: W5W	2 EA
	Fog lamp	FRT	BULB: H27W/2	2 EA
		RR	BULB: H21W/2	2 EA
Rear lamp	Stop lamp and tail lamp		BULB: 12V27/8W (Korea) P21/5W (Other countries)	2 EA
	Turn signal lamp		BULB: 12V27W (Korea) P21W (Other countries)	2 EA
	Backup lamp		BULB: 12V27W (Korea) P21W (Other countries)	2 EA
	Stop lamp/Rear fog lamp (Other countries)		BULB: 12V27W (Korea) P21W (Other countries)	2 EA
	High-mounted stop lamp		LED (Without spoiler) (With spoiler)	 12 EA 24 EA
	License plate lamp		BULB: W5W	2 EA
Side lamp	Side repeater lamp		LED	5 EA
	Puddle lamp		LED	2 EA

2) Interior Lamps

Item	Type	Amount
Front room lamp	BULB (10W-FESTOON)	2 EA
Center room lamp	BULB (10W-FESTOON)	1 EA
Luggage lamp	BULB (10W-FESTOON)	1 EA
Sun visor lamp	BULB (5W-FESTOON)	1 EA
Glove box lamp	BULB (5W-FESTOON)	1 EA
Door courtesy lamp	BULB (5W-WEDGGE)	1 EA

Modification basis	
Application basis	
Affected VIN	

2. AUTOMATIC LIGHT SENSOR SPECIFICATIONS

Pin No.	Specification
Operating voltage	9 V to 16 V
Load	Max. 200 mA (relay load)
Operating temperature	−30℃ to 85℃
Storage temperature	−40℃ to ±120℃
Mounting location	Top center of inner side of windshield glass

NOTE

▶ LED

- The LED stands for "Light Emitting Diode" or "Luminescent Diode." LED is a semiconductor diode that emits incoherent narrow-spectrum light when electrically biased in the forward direction of the p-n junction, as in the common LED circuit. In short, it is an element that converts electric signals into light signals. Yellow, blue, red and white LEDs are currently available.
  The followings are the advantages of LED.
- It is not glaring and doesn't have short circuit unlike the conventional lamps.
  It is semi-permanent and doesn't generate heat.
  Its power consumption is much lower than those of conventional bulbs.

▶ Luminous Intensity

- Luminous intensity is a measure for the amount of light which passes through the unit area per time unit. The SI unit of luminous intensity is the candela (cd), an SI base unit.

▶ Luminance

- Luminance describes the amount of light that passes through or is emitted from a particular area, and falls within a given solid angle. It is measured in sb or nt.

▶ Intensity of illumination

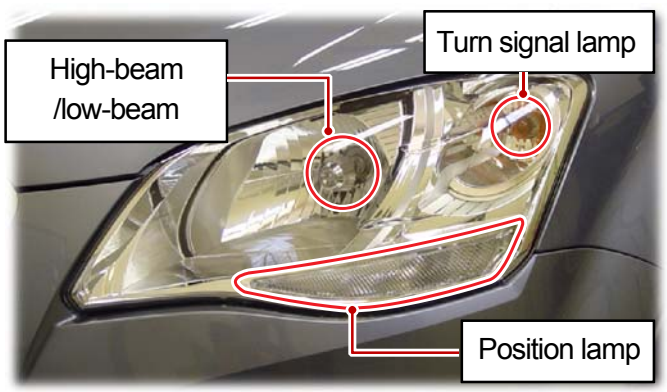
- This indicates the amount of light reaching a given area. Measuring unit is lux (lx) and it is not directly proportional to the brightness of the area as the reflection rate is not included.

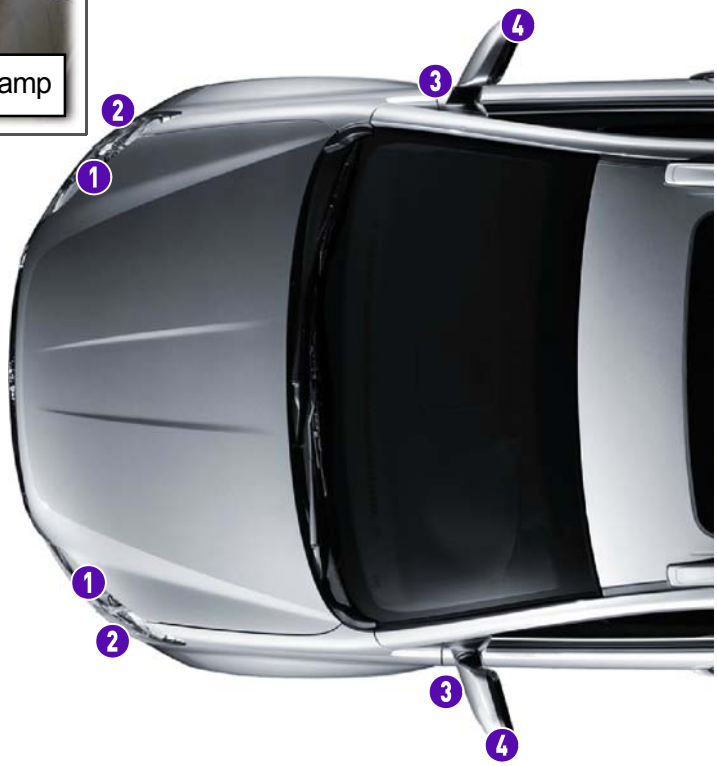
OVERVIEW AND OPERATING PROCESS

1. EXTERIOR LAMP

1) Layout

1 Headlamp





2 Front fog lamp



3 Puddle (approach) lamp

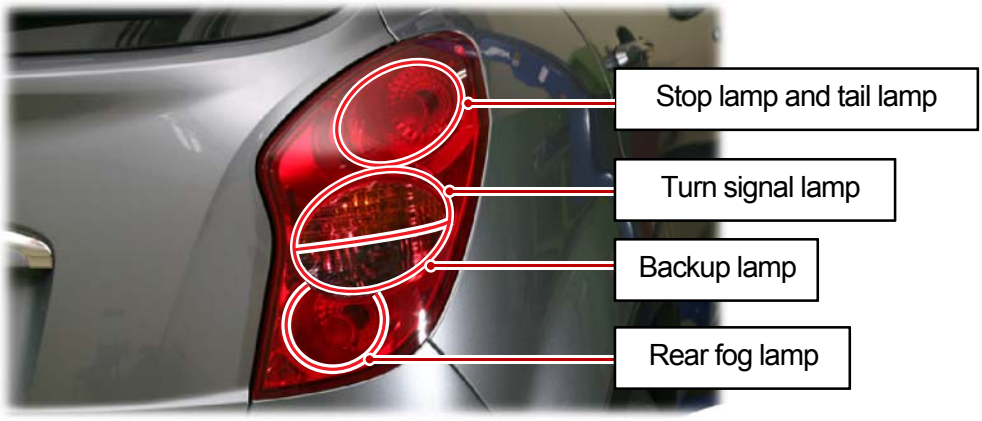


4 Side repeater lamp



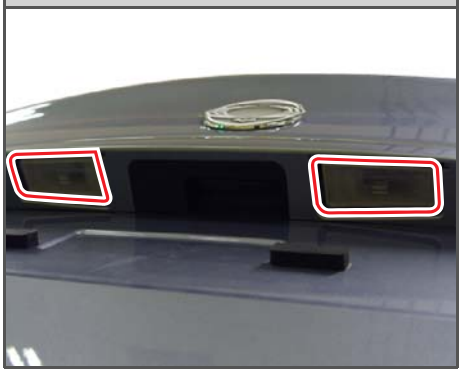
Modification basis	
Application basis	
Affected VIN	

5 Rear combination lamp





6 License plate lamp

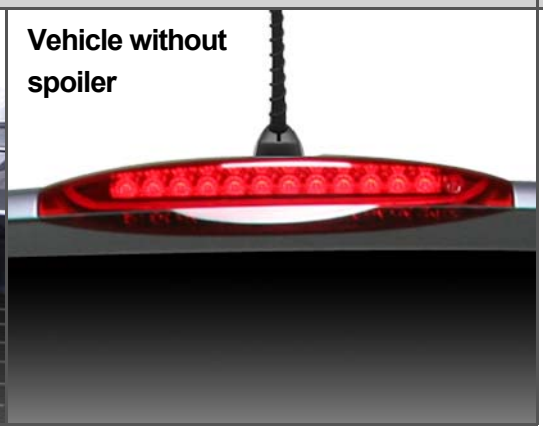


7 High mounted stop lamp

Vehicle with spoiler



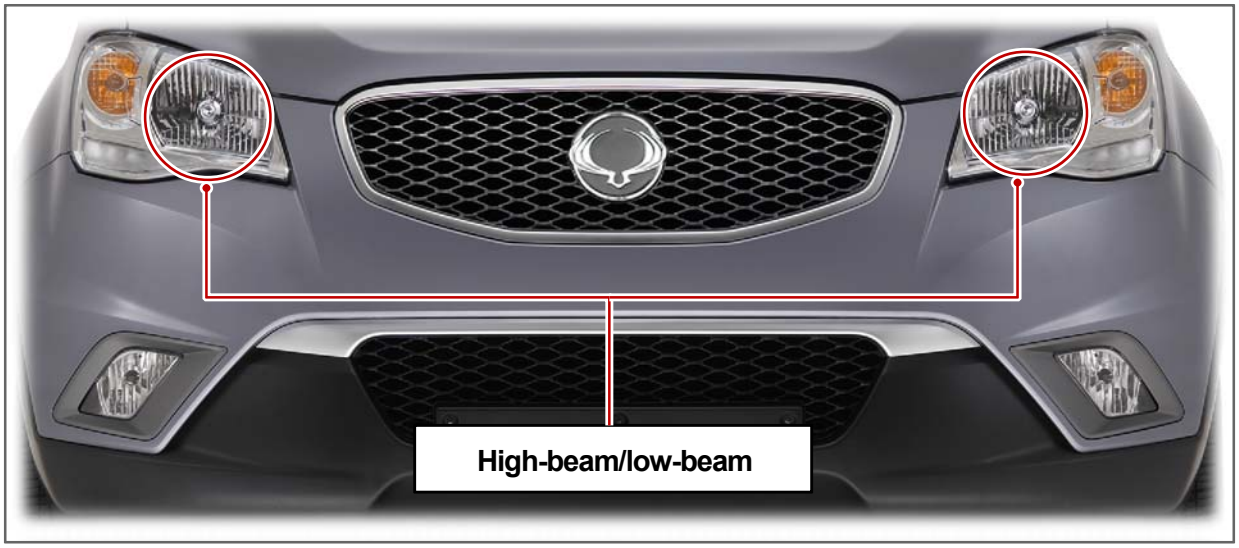
Vehicle without spoiler



Modification basis	
Application basis	
Affected VIN	

2) Operation

(1) Headlamp



Most of the functions of the headlamp is controlled by the multifunction switch. The functions performed by REKES or SMART key are controlled by the BCM.
The BCM controls the headlamp and tail lamp by using the data sent through the LIN communication from the automatic light sensor when the multifunction switch is in AUTO position.

▶ Control by BCM

1. Coming home lighting control

- The headlamp is illuminated for 30 sec. when the ignition switch is turned on and then off with the multifunction switch in ON or AUTO.
- The headlamp is turned off right after the ignition is turned on. And when all the doors (including tailgate) are closed the headlamp is illuminated for 30 sec.; and all the doors are open, the headlamp is illuminated for 3 minutes.
- This function can be deactivated or activated with a diagnostic equipment.

NOTE

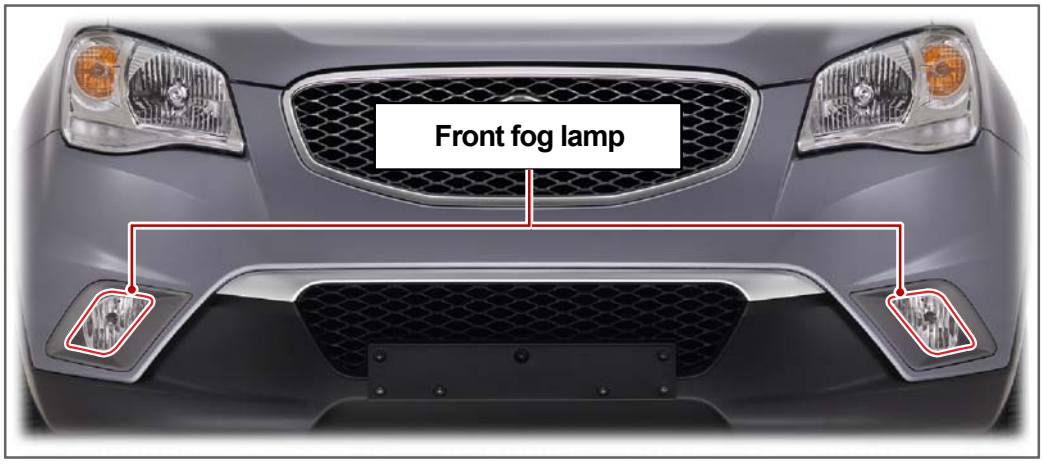
▶ DRL (Day Time Running Light)

DRL is the function to turn on the high beam and tail lamp without any intervention from the light switch. DRL turns off the lamps when turning off the light switch. This is an additional safety device to prevent the accident.

Modification basis	
Application basis	
Affected VIN	

(2) Fog lamp

▶ **Front**

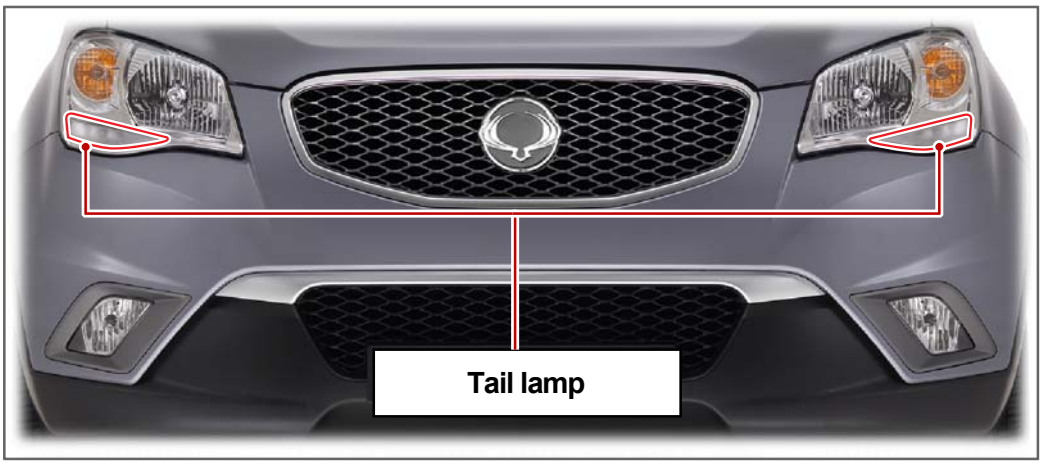


▶ **Rear**
(EU only)

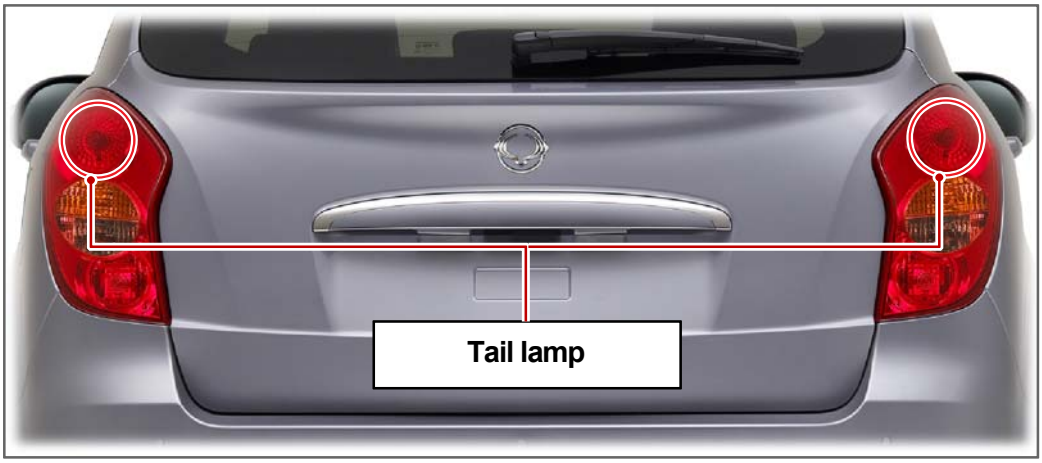


(3) Tail lamp

▶ **Front**



▶ **Rear**



The tail lamp is operated by the BCM when the BCM receives a signal from the multifunction switch.

▶ **Tail lamp warning**

1. The buzzer sounds for 10 seconds with the interval of 0.02 s ON and 1.38 s OFF when opening the driver door with the key removed (without SKM)/with IGN OFF or ACC (with SKM) and tail lamp ON. The buzzer stops its operation when turning off the tail lamp or closing the driver door during buzzer
2. operation. The buzzer stays ON when turning the tail lamp on again after turning it off during buzzer operation.

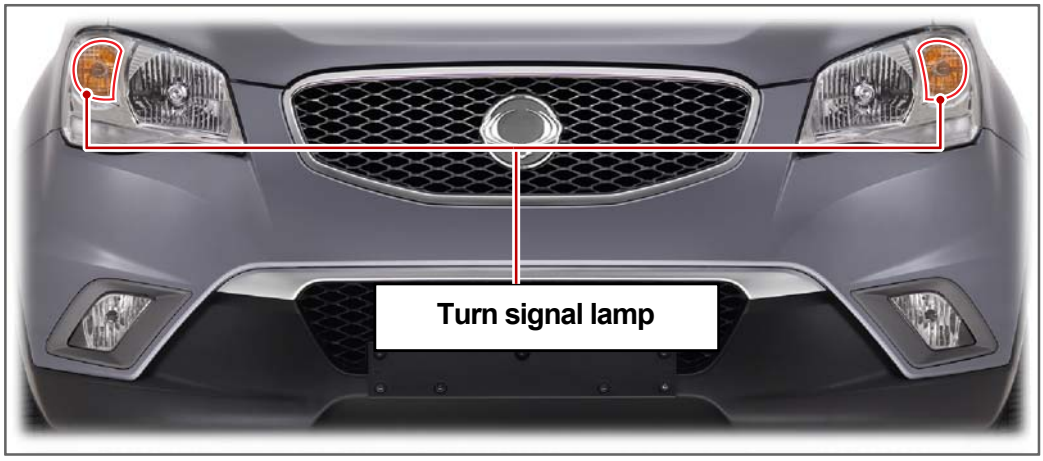
▶ **Tail lamp auto turn-off**

- When opening and closing the driver door after turning off the ignition with the tail lamp ON, the tail lamps go off automatically.
- The tail lamps come on again when inserting the ignition key (without SKM) and turning on the ignition (with SKM) after tail lamp auto OFF.
- The tail lamp should not go off when turning on the tail lamp switch with the ignition key removed (without SKM) and with power off or ACC ON (with SKM).

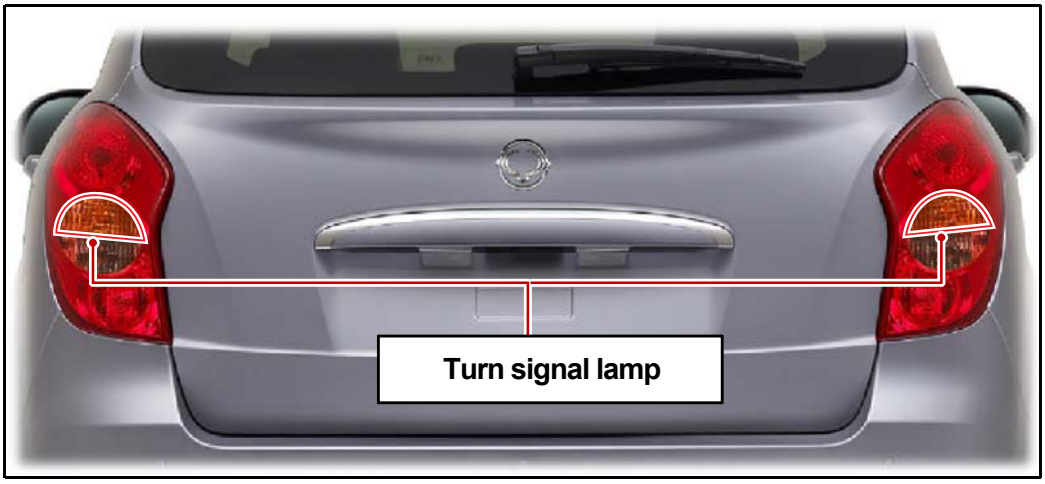
Modification basis	
Application basis	
Affected VIN	

(4) Turn signal lamp / Side repeater lamp

▶ **Front**



▶ **Rear**



The turn signal lamp is operated by the BCM when the BCM receives a signal from the multifunction switch. The BCM cycles the turn signal lamp and buzzer (ON/OFF) 75 times per minute.
The turn signal lamps are operational only when IGN1 is ON.
If the turn signal lamp fails while it is illuminated, the BCM cycles the lamp and buzzer 100 times per minute.
The BCM determines that there is an open circuit if the load is 3.0 A or less, and there is a short circuit if the load is 7.0 A or more.
When turning ON the turn signal switch, the lamp blinks 3 times by the BCM. When turning OFF the switch during the operation, the turn signal lamp blinks 3 times and goes off.
When turning OFF and then immediately ON the turn signal switch during auto blinking operation of 3 times, the turn signal lamp blinks additional 3 times.
If one of the turn signal lamp is flashing and the other lamp switch is turned on, the lamp for the activated switch flashes.

(5) Auto light (LIN)

Auto light switch	Automatic light sensor unit
	

The auto light sensor unit is installed to the back side of the ECM mirror located upper center of the windshield, and detects the illuminance change. The BCM communicates with the auto light sensor when the ignition is turned on, and turns on or off the tail lamp and headlamp automatically according to the signals from the sensor when the multifunction switch is set to AUTO light.
The BCM communicates with the rain sensor even if the multifunction switch is in tail lamp.

(6) Side repeater lamp

Side repeater lamp	
	

The side repeater lamp is operated by the BCM when the BCM receives a signal from the multifunction switch.
The BCM cycles the side repeater lamp and buzzer (ON/OFF) 75 times per minute.
The side repeater lamp operates only when IGN1 is ON.
If the side repeater lamp fails while it is illuminated, the BCM cycles the lamp and buzzer 100 times per minute.
The lamp automatically flashes 3 times when the multifunction switch is turned on. If the switch is turned off
during this operation, the lamp flashes 3 times and then goes off.
If the switch is turned off and then on during the 3 times of automatic flashing, the lamp flashes 3 more times.

Modification basis	
Application basis	
Affected VIN	

(7) Puddle (approach) lamp

Approach (puddle) lamp	
	

▶ Lamp control for models without SKM

1. Approach lamp ON
   - When receiving the UNLOCK signal in the theft deterrent mode, the approach lamps come ON for 30 seconds.
   - When turning the ignition switch to OFF from ON position and opening the driver door, the approach lamps come ON.
2. Approach lamp OFF
   - When receiving the door lock signal with the approach lamps ON, the lamps go OFF (reactivation of theft deterrent mode).
   - When turning the ignition switch to ON position with the approach lamps ON, the lamps go OFF. The approach lamps go OFF after 30 seconds.
   -

▶ Lamp control for models with SKM

1. Approach lamp ON
   - When turning the ignition switch to OFF from ON position and opening the driver door, the approach lamps come ON.
   - When receiving the UNLOCK signal from the smart key remote control or outside door handle switch signal in the theft deterrent mode, the approach lamps come ON for 30 seconds.
     When receiving the AUTO approach signal in the theft deterrent mode, the approach lamps come
   - ON for 30 seconds.

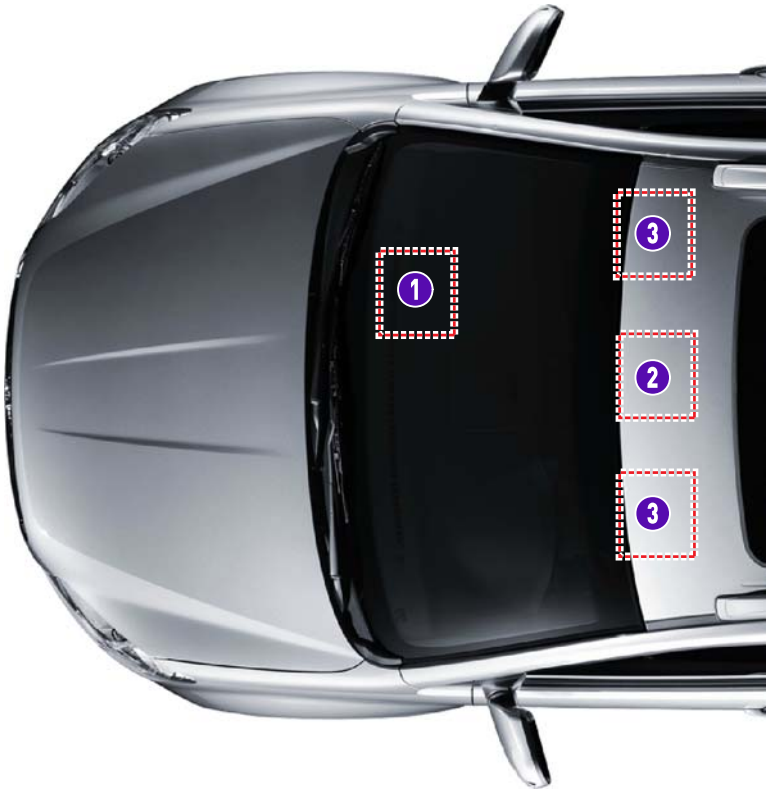
2. Approach lamp OFF
   - When receiving the door lock signal from the smart key remote control or outside door handle switch signal with the approach lamps ON, the lamps go OFF (reactivation of theft deterrent mode).
   - When turning the ignition switch to ON position with the approach lamps ON, the lamps go OFF. The approach lamps go OFF after 30 seconds.
   -

2. INTERIOR LAMPS

1) Layout

1 Glove box lamp





2 Front room lamp



3 Sun visor lamp



Modification basis	
Application basis	
Affected VIN	



4 Center room lamp



5 Luggage lamp



6 Door courtesy lamp



2) Operation

(1) Front room lamp/Center room lamp

Front room lamp	Center room lamp
	

Operating the front room lamp and center room lamp switches illuminates the driver/passenger side lamps and center room lamp.

▶ **Room lamp control by door coupled room lamp operation**

1. If a door except the tailgate is opened after the ignition is turned off, provided that door coupled front room lamp switch is pressed, the front room lamp and center room lamp are illuminated for 2 sec. and then fade out for 3 sec.
   If a door except the tailgate is opened and then closed while the room lamp is fading out, the room lamp is illuminated for 2 sec. and then fades out for 3 sec. If the ignition is turned on, the room lamp goes off immediately.
2. The front room lamp and center room lamp are illuminated for 30 sec. when the door is unlocked by the REKES or passive door UNLOCK function with IGN OFF and the ignition key removed. If the REKES or passive door UNLOCK signal is received again, the room lamps are illuminated for another 30 sec.
3. The room lamp goes off immediately when the REKES or passive door LOCK signal is received or the ignition switch is turned to ON position.
4. If the room lamp is turned on after the ignition key is removed (door open or room lamp switch is pressed), it is turned off after 10 minutes by the BCM.
5. When the door open state is changed or the ignition is turned on after the room lamp has been turned off automatically, the battery saver feature is reset.

Modification basis	
Application basis	
Affected VIN	

(2) Luggage lamp

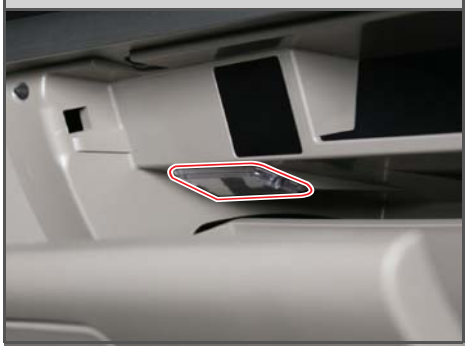
Luggage lamp



The luggage lamp is turned on when the tailgate is opened with the switch operated.
This lamp is not controlled by the BCM, unlike the front/center room lamp.

(3) Other interior lamps

Glove box lamp



The glove box lamp comes on when the glove box is opened after the tail lamp is illuminated.

Sun visor lamp



The sunvisor lamp comes on when the sunvisor vanity mirror cover is opened.

Courtesy lamp



The door courtesy lamp comes on when the driver's door or passenger's door is opened.

WIPER AND WASHER SYSTEM 7810-00

GENERAL INFORMATION

1. WIPER CONTROL

- ▶ **Wiper mist & washer coupled wiper**
- ▶ **Auto washer coupled wiper**
- ▶ **Rain sensor coupled wiper operation (LIN)**
- ▶ **Speed sensitive intermittent wiper**
- ▶ **Wiper low/high control**

2. CAUTIONS ON RAIN SENSOR

- When the wiper switch is in the AUTO position, the wiper will operate for 1 cycle if the initial engine start is made. This may cause the wiper blades to wear prematurely. Therefore, other than rainy days, set the switch to the OFF position. Especially during the winter time, check if the wiper blades are not frozen to the windshield.
  Operating the wiper with the blades frozen can damage the wiper motor.
- If you operate the wipers when the windshield is dry without spraying washer fluid, the windshield can be scratched and the wiper blades can wear prematurely. Use the wiper with the washer fluid when the windshield is dry.
- When it does not rain, turn the wiper switch to the OFF position.
- Turn the wiper switch to the OFF position before any car wash to avoid unwanted operation of the wipers.

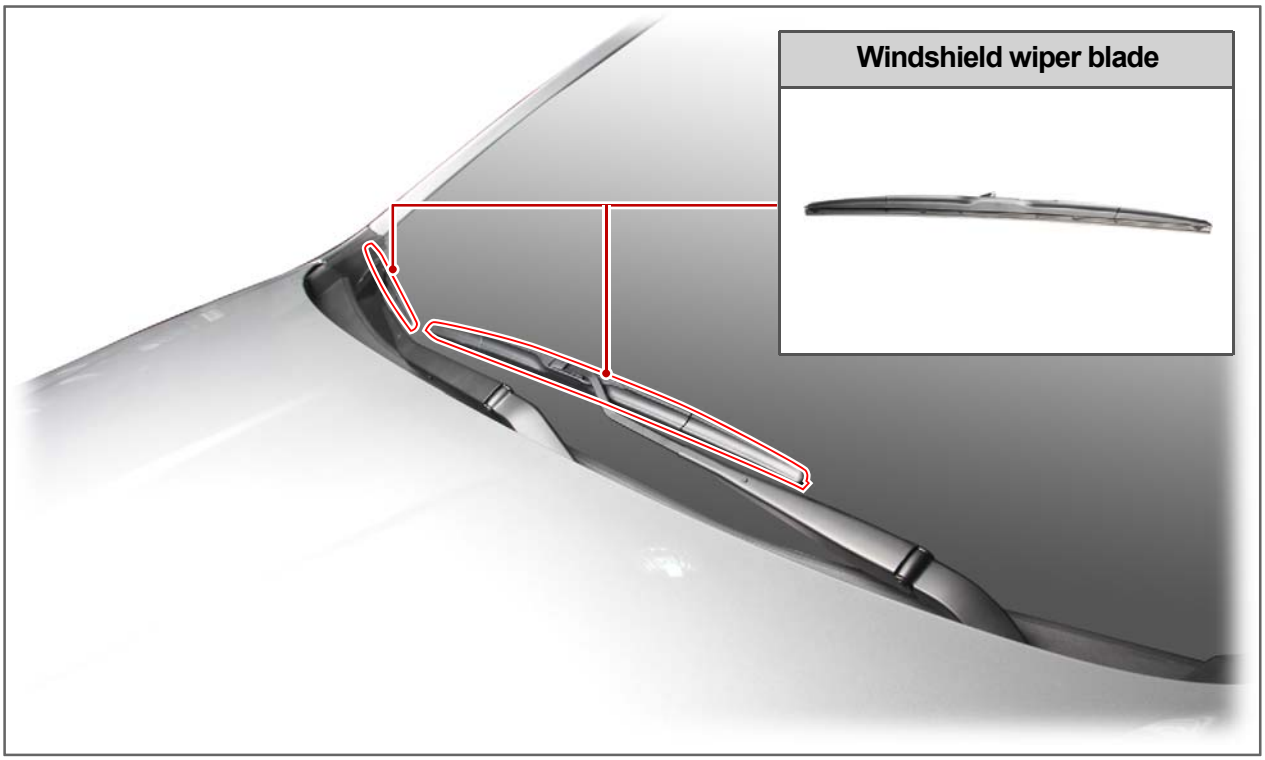
WARNING

When cleaning the windshield over the sensor with damp clothes, the wiper may operate suddenly. It could cause serious injury. Make sure to place the wiper switch to the OFF position and ignition switch OFF when not in use.

▶ **Irregular operation (abrupt operation)**

- Check if the sensor is off the position.
- Check if the rain sensor cover is securely installed.
- Check if the customer is familiar to how to control the wiper sensitivity.
  Check if the wiper sensitivity control is set to the FAST side (step 5).
- Check the wiper blade for wear.
- If the wiper blade cannot wipe the glass uniformly and clearly, it may cause the rain sensor to work irregularly. Therefore, in this case, replace the wiper blade with a new one.

3. MAJOR CHANGES



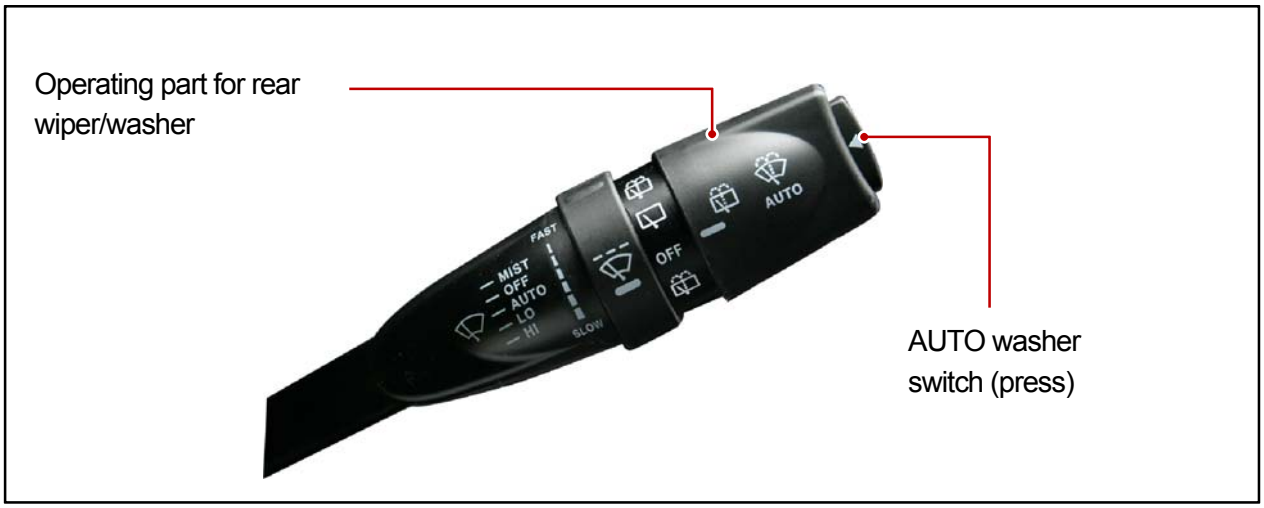
Wiper blade design and wiper arm pressure	
Previous	**Current**
	
Wiper arm pressure Driver side = 900 ± 50 g Passenger side = 600 ± 50 g	**Wiper arm pressure** Driver side = 950 ± 50 g Passenger side = 650 ± 50 g
Wiper blade design changed (blade size is the same) **Driver side:** 600 mm (24 in) **Passenger side:** 400 mm (16 in)	

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. WIPER AND WASHER SYSTEM

1) AUTO Washer Coupled Wiper Function



If you press the AUTO washer switch briefly with the ignition key ON and INT-AUTO switch "OFF", the washer motor is operated for about 2 seconds to spray washer fluid once after the switch is turned ON and the wiper relay is turned ON for 4 cycles. After that, the washer motor is operated for about 2 seconds to spray the washer fluid again and the relay is turned ON for 3 cycles and then the relay is turned OFF.

2) Rear Washer Fluid Supply System

The front washer fluid reservoir supplies the rear washer fluid without additional washer fluid reservoir.



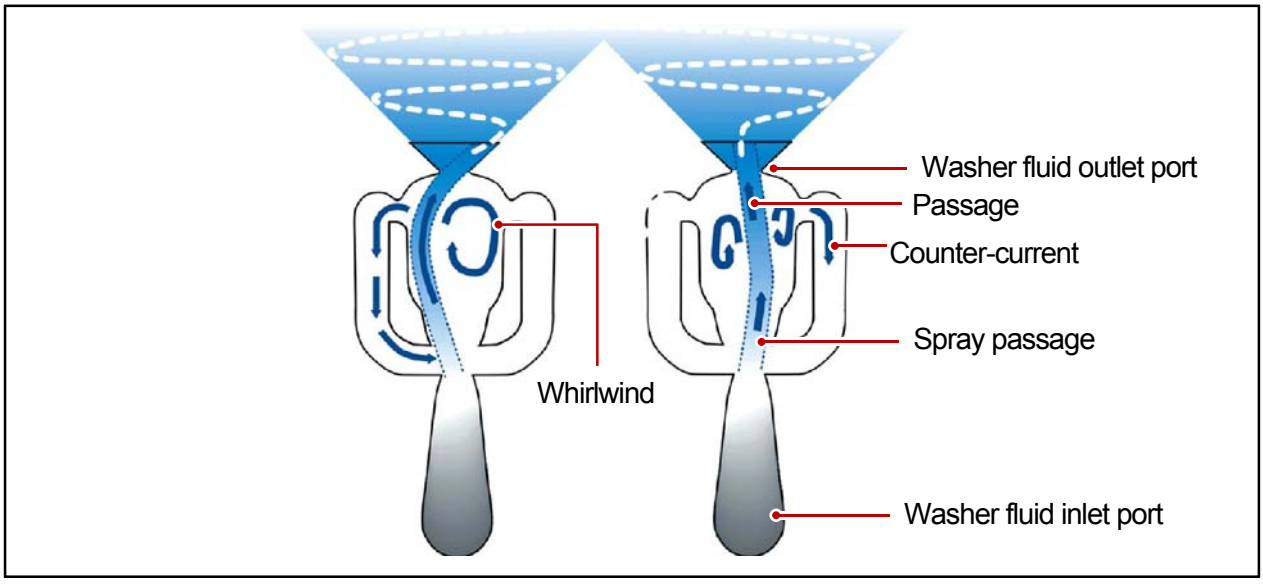
3) Fluidic Washer Nozzle

This vehicle has the fluidic washer nozzle, which is designed to use fluid movement occurring in the washer fluid spraying process.



* When installing the washer nozzle, make sure that the mounting surface is clean and free of dirt or debris, since the water may come into the engine compartment in accordance with a seamless contact condition between the mounting surface of the nozzle and the curved surface of the engine hood.

The inside of the nozzle is designed in a fan shape to change the spray direction continuously based on the time the fluid is sprayed. Refer to the figure below.



The spray direction is changed by means of the whirlwind and back flow generated while the washer fluid is passing through the nozzle.

Modification basis	
Application basis	
Affected VIN	

2. RAIN SENSING SYSTEM

In the rain sensing wiper operation system, the rain sensing unit only sends the information about the amount of rain drops to the BCM, and it does not operate the wiper directly. The wiper and washer are controlled by the BCM according to the driver's choice.

Rain sensing unit



This sensor emits infrared rays through LED and then detects the amount of rain drops by receiving the rays reflected off the sensing section (rain sensor mounting section on the windshield) with photodiode.

Multifunction wiper switch AUTO and sensitivity control



AUTO: Wiper operates automatically by rain sensor
FAST <-------> SLOW:
Auto delay/auto speed control.
A position that can control the sensitivity for the amount of rains on the windshield and transmit the wiping request signal accordingly.





▶ BCM

The rain sensor detects the amount of rain drops and sends the operating request signal to the BCM, which drives the wiper directly. At this moment, the BCM also sends the information on whether the wiper is in operation mode or whether the multifunction wiper switch is in AUTO position to the rain sensor.

BCM	Underhood Fuse Box
	

Modification basis	
Application basis	
Affected VIN	

Memo

3. SYSTEM LAYOUT (INCLUDING RAIN SENSOR)

WIPER AND WASHER SWITCH



Rain sensor unit



Wiper

Front wiper



Rear wiper





Rear washer hose and nozzle

For vehicles with rear spoiler



For vehicles without rear spoiler



Modification basis	
Application basis	
Affected VIN	

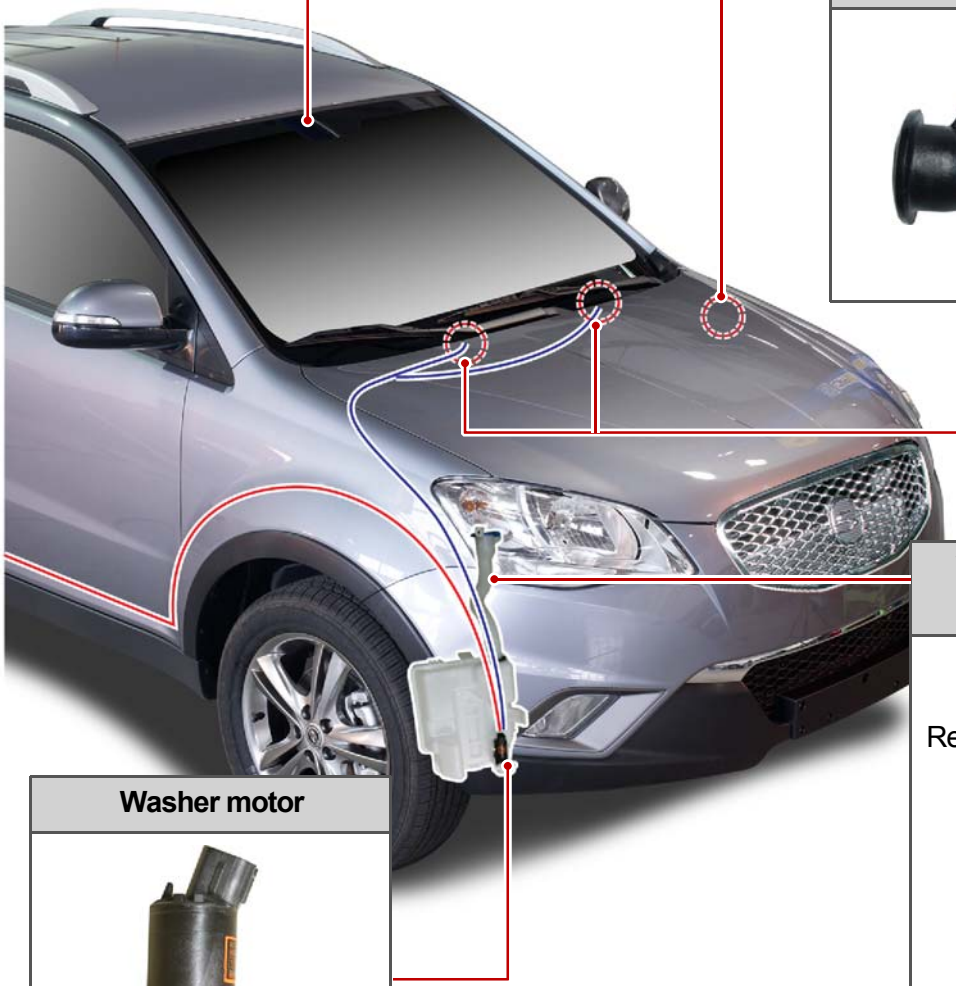
BCM





Front nozzle assembly





Washer fluid reservoir assembly



Washer motor



4. WIPER AND WASHER OPERATION

1) Windshield Wiper Control Function

MIST

The wiper operates for 1 cycle when pushing up the lever. The lever will return to the "OFF" position when released.

OFF

Stop the operation.

AUTO

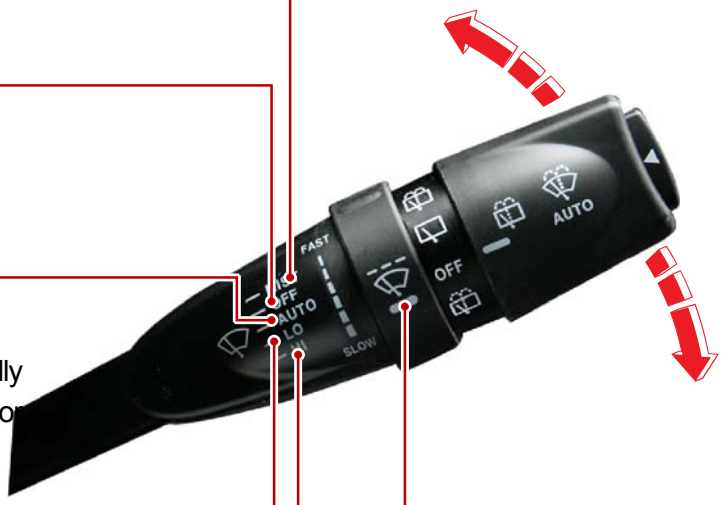
Wiper speed controls automatically according to the vehicle speed or amount of rain (rain sensing wiper).

LO

Wiping speed gets slower when placing the pointer at the "LO" position.

HI

Wiping speed gets faster when placing the pointer at the "HI" position.



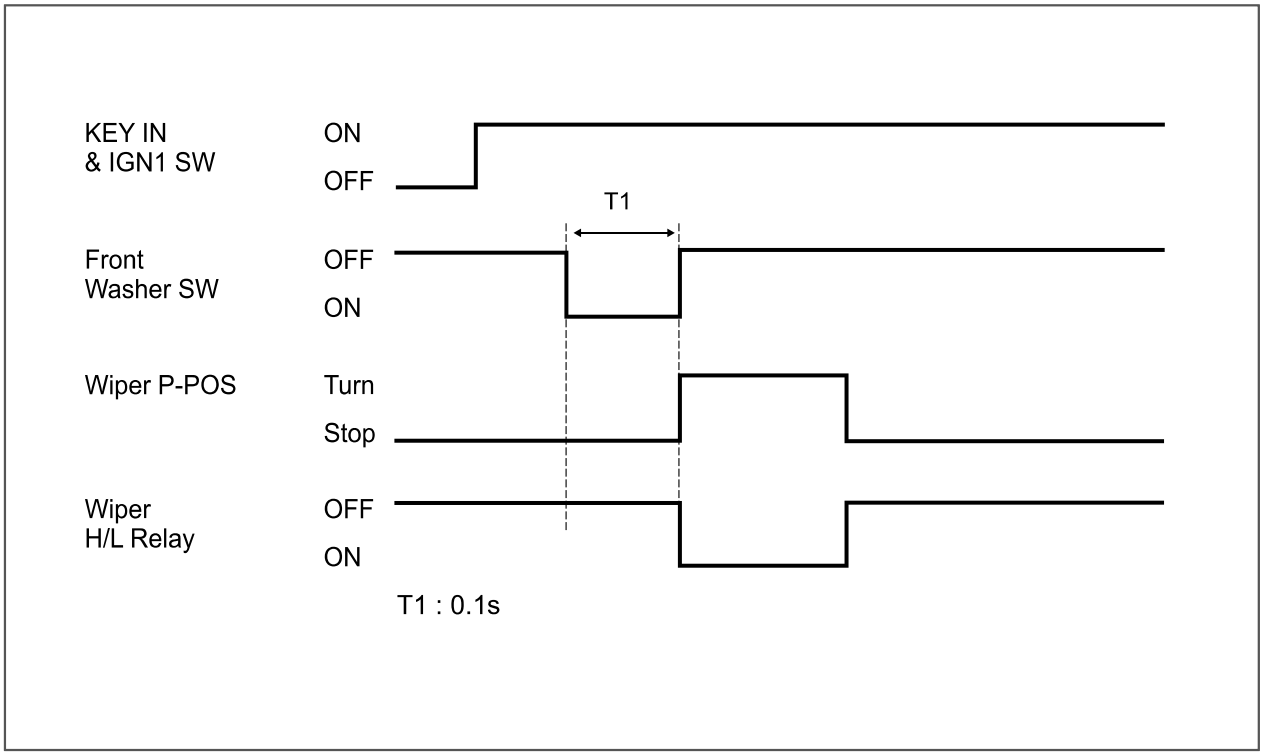
Wiping speed control switch

When turning to FAST, wiping speed gets faster and when turning to SLOW, wiping speed gets slower.

Modification basis	
Application basis	
Affected VIN	

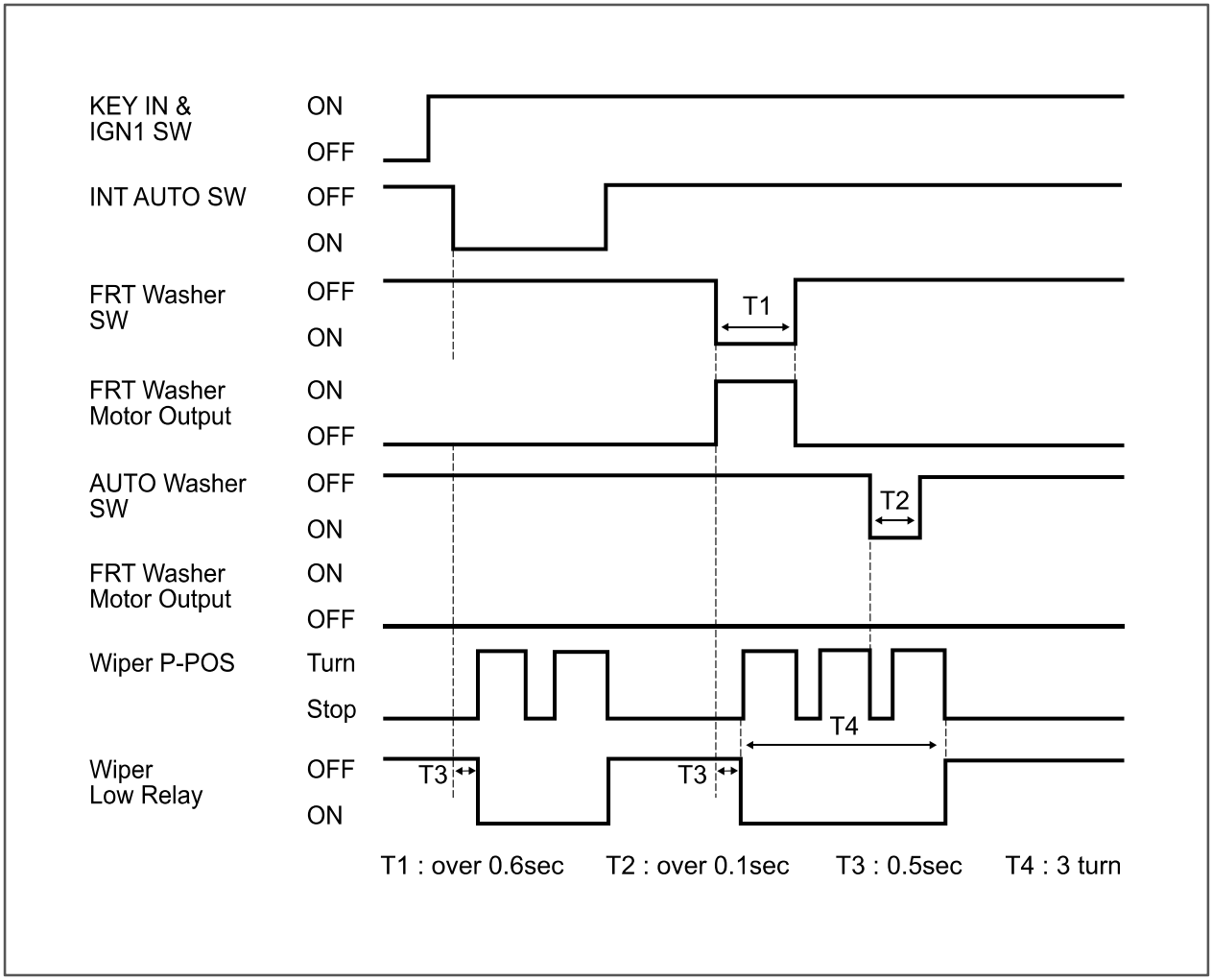
(1) Wiper mist

1. When the multifunction switch is pushed to the MIST position for 0.1 sec. or more with the IGN1 ON, the wiper relay is turned on after 0.1 sec. has passed. When the wiper returns to the park position, the wiper relay is turned off.
2. When the MIST switch signal is input the wiper is operated at high speed. When the switch is release from the MIST position, the wiper is operated at low speed.



(2) Wiper LO/HI control

1. The wiper LOW relay is turned on when the multifunction wiper switch is at the LO position. The wiper HIGH relay is turned on when the wiper switch is at the HI position. When the wiper switch is at the HI position, both the LOW relay (constant operation) and HIGH relay are operated.
2. The wiper motor returns to parking position and stops, even when turning off the ignition switch during wiper operation.
3. The wiper relay should stay ON in low/high wiper operation mode even if the parking signal for the wiper motor is not received. In INT/AUTO wiper operation mode, the wiper relay should be turned OFF after 5 seconds if there is no parking signal for the wiper for 3 seconds and informs the driver of parking position signal abnormality.
4. While the wiper operates at low/high speed, the front/rear washer switch can be operated but the auto washer switch cannot.
5. The wiper motor returns to parking position and stops when turning off the ignition switch during wiper operation in high mode.



Modification basis	
Application basis	
Affected VIN	

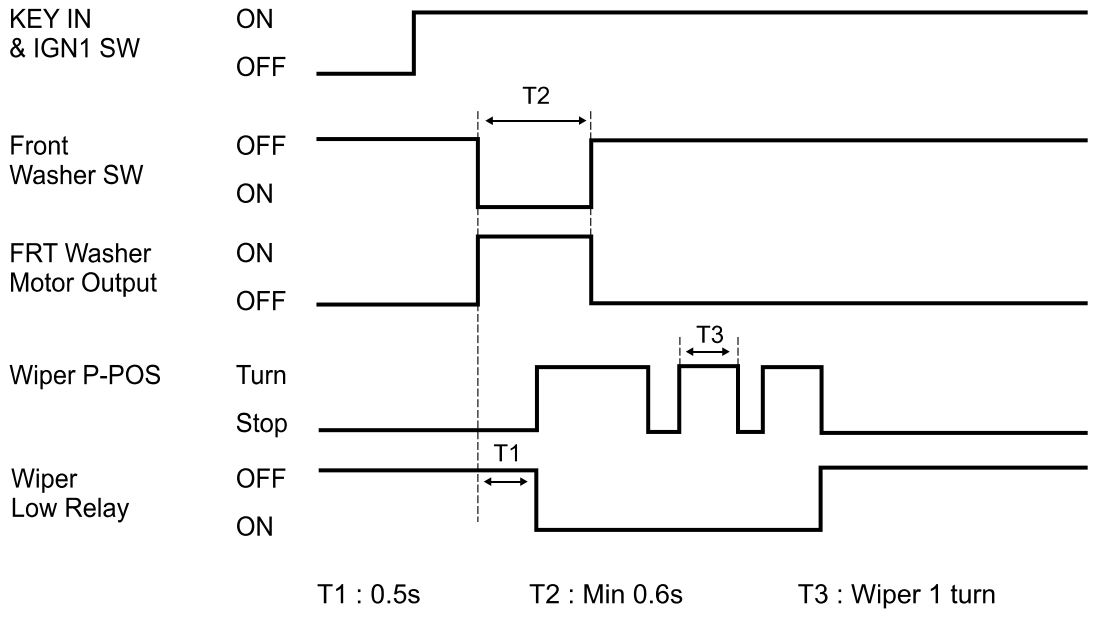
2) Windshield Washer Control Function

(1) Windshield washer coupled wiper

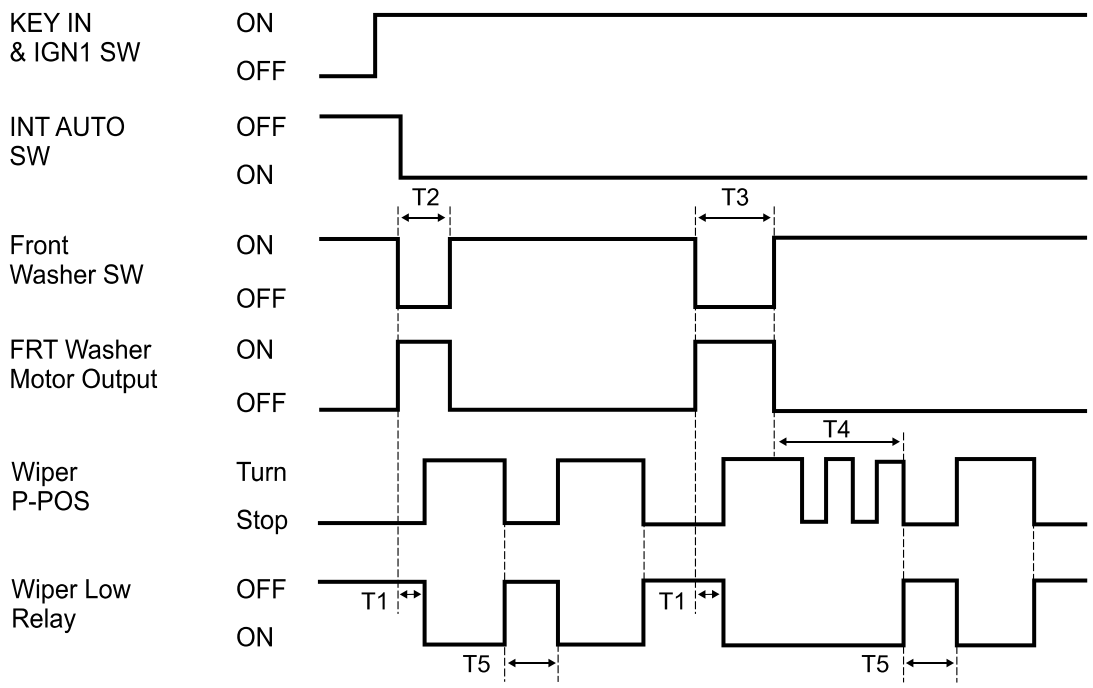


Wiper and Washer Coupled Operation
Pull the switch briefly (for less than 0.6 sec.)
: One wiping cycle
Pull and hold the switch for more than 0.6 sec.
: Three wiping cycles with washer fluid spray

1. When holding the front washer switch at ON position for more than 0.6 seconds with IGN ON, the wiper relay is activated 0.5 seconds after. The wiper stops after three more wipes since that the washer switch is turned to "OFF" position.



2. When holding the front washer switch at ON position for 0.1 to 0.59 seconds during the wiper operation by the intermittent/automatic wiper switch, the wiper will operate only once. When holding the washer switch for more than 0.6 seconds, the wiper relay is activated 0.5 seconds after. The wiper stops after three more wipes since that the washer switch is turned to "OFF" position.



T1 : 0.5s T2 : 0.1 ~ 0.59s T3 : Min 0.6s T4 : 3 Turn time T5 : Pause time

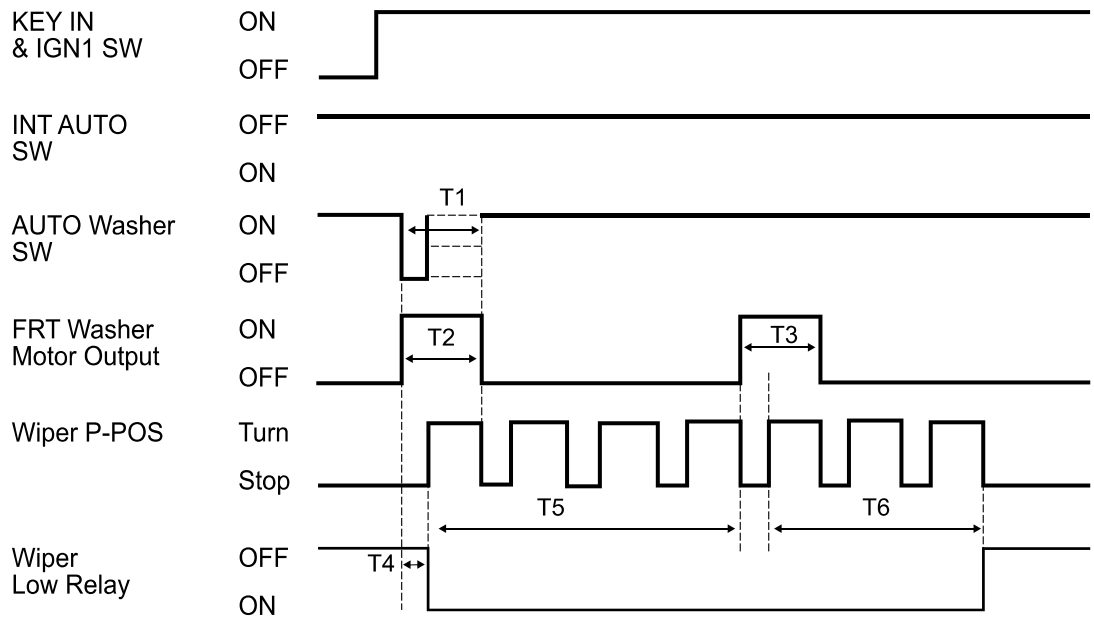
Modification basis	
Application basis	
Affected VIN	

(2) AUTO washer coupled wiper



Auto washer switch
If pressing the switch when the wiper switch turns to the "OFF" position, washer fluid is sprayed once and wiper operates 4 times.
After a while, washer fluid is sprayed once more and the wiper operates 3 times.

1. When the AUTO washer switch is operated with IGN ON and the INT/AUTO switch OFF, the washer motor is operated for 2 sec. and the wiper continues to cycle 4 times. And then the washer motor is operated for 2 sec. and the wiper continues to cycle 3 times before returning to park position.
2. The auto washer switch signal is overridden during speed sensitive intermittent wiper, washer coupled wiper or auto washer coupled wiper operation.
3. When turning the wiper switch to AUTO position during the operation of auto washer, the auto washer stops its operation and the intermittent/automatic wiping mode will be started.
4. The front and rear washer switch signal are overridden during the operation of auto washer. The input from the switch during the AUTO washer coupled wiper operation also is ignored.
5.



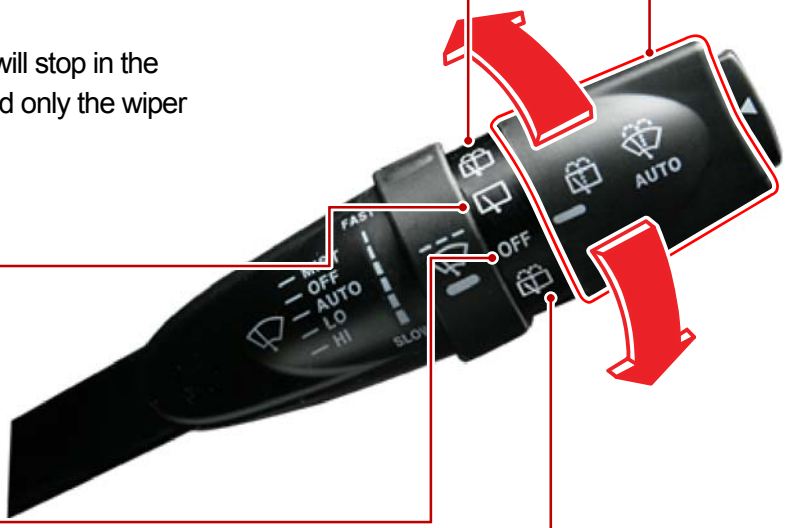
T1 : over 0.1sec T2 : 2sec T3 : 1.5sec T4 : 0.5sec T5 : 4 turn T6 : 3 turn

Modification basis	
Application basis	
Affected VIN	

3) Rear Wiper Control Function

Rear wiper switch

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate.
When the switch is released, it will stop in the Rear Wiper Operation mode and only the wiper will keep operating.



Rear wiper operation

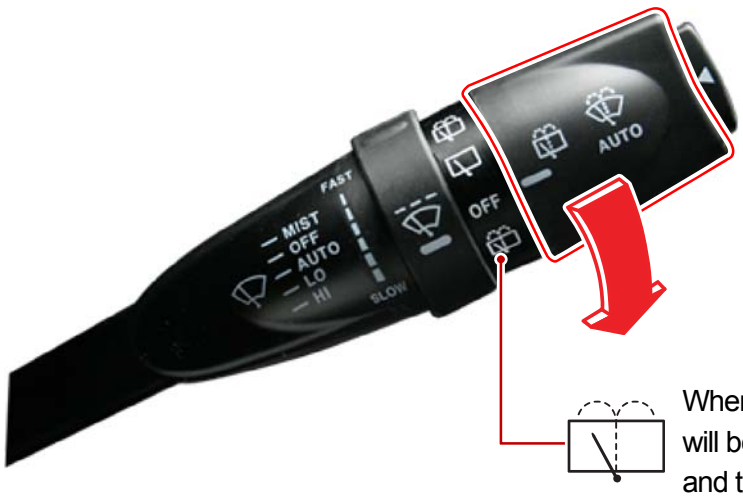
OFF

Rear wiper stops

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the “OFF position and turn off the wiper and washer.

Modification basis	
Application basis	
Affected VIN	

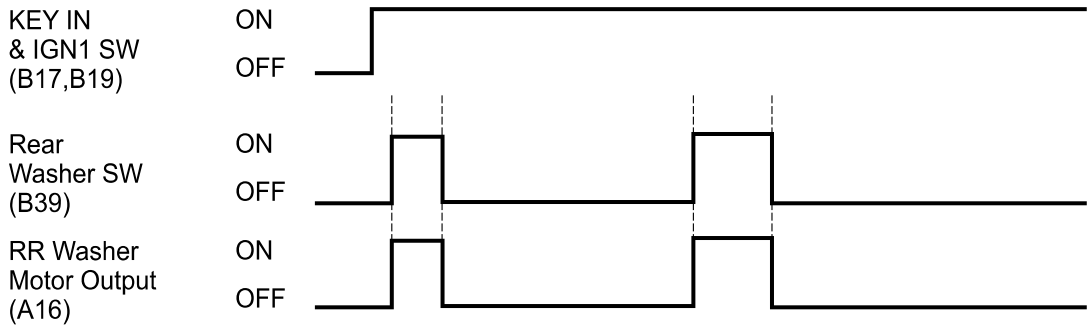
4) Rear Washer Control Function



When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the "OFF" position and turn off the wiper and washer.

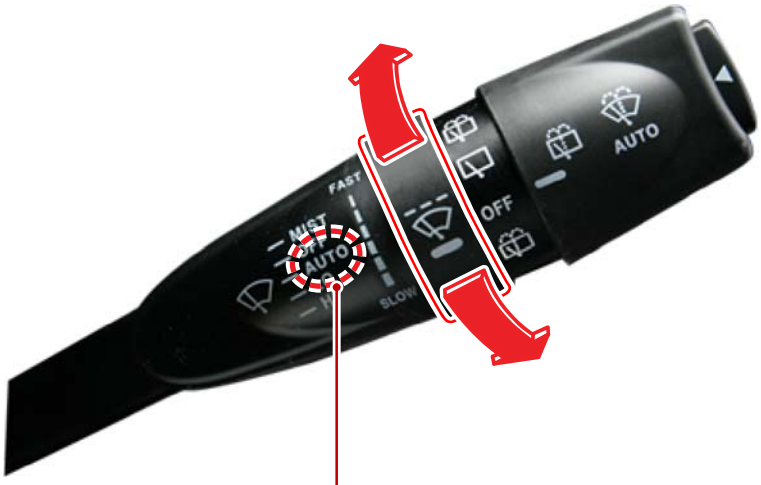
▶ Rear washer motor control

1. The rear washer motor is operated only when the rear washer switch is activated with the ignition key ON.
2. If the front washer or automatic washer switch signal is received during the rear washer switch operation, the washer motor stops and the front washer or automatic washer motor begins to operate.



5) Rain Sensor Coupled Wiper Control Function

AUTO operation and sensitivity control

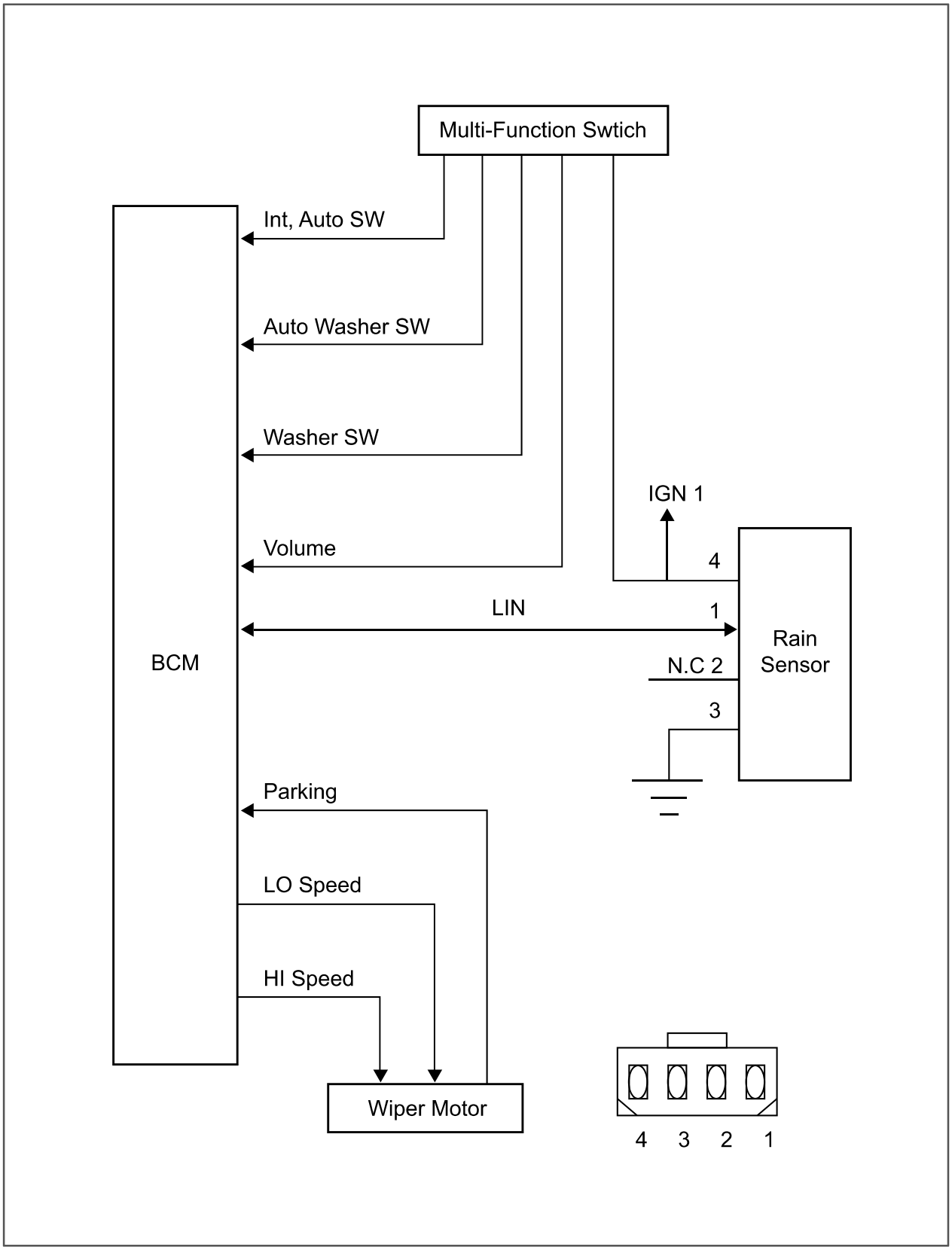


AUTO: Wiper operates automatically by rain sensor
FAST <----> Auto delay/auto speed control
A position that can control sensitivity against rains on the windshield and transmits wiping demand signal accordingly.

Modification basis	
Application basis	
Affected VIN	

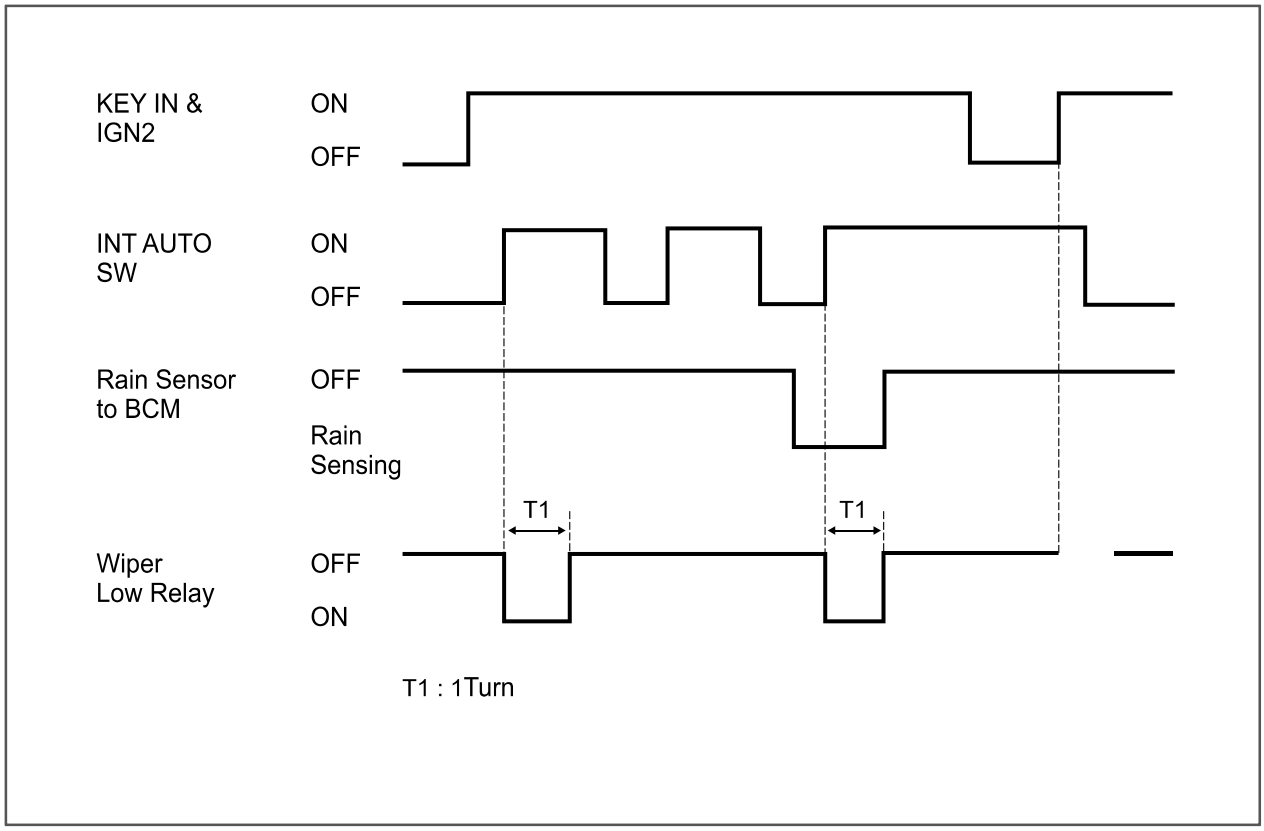
(1) Rain sensor coupled wiper operation (LIN)

▶ **System layout**



(2) Power-up reminder wiper

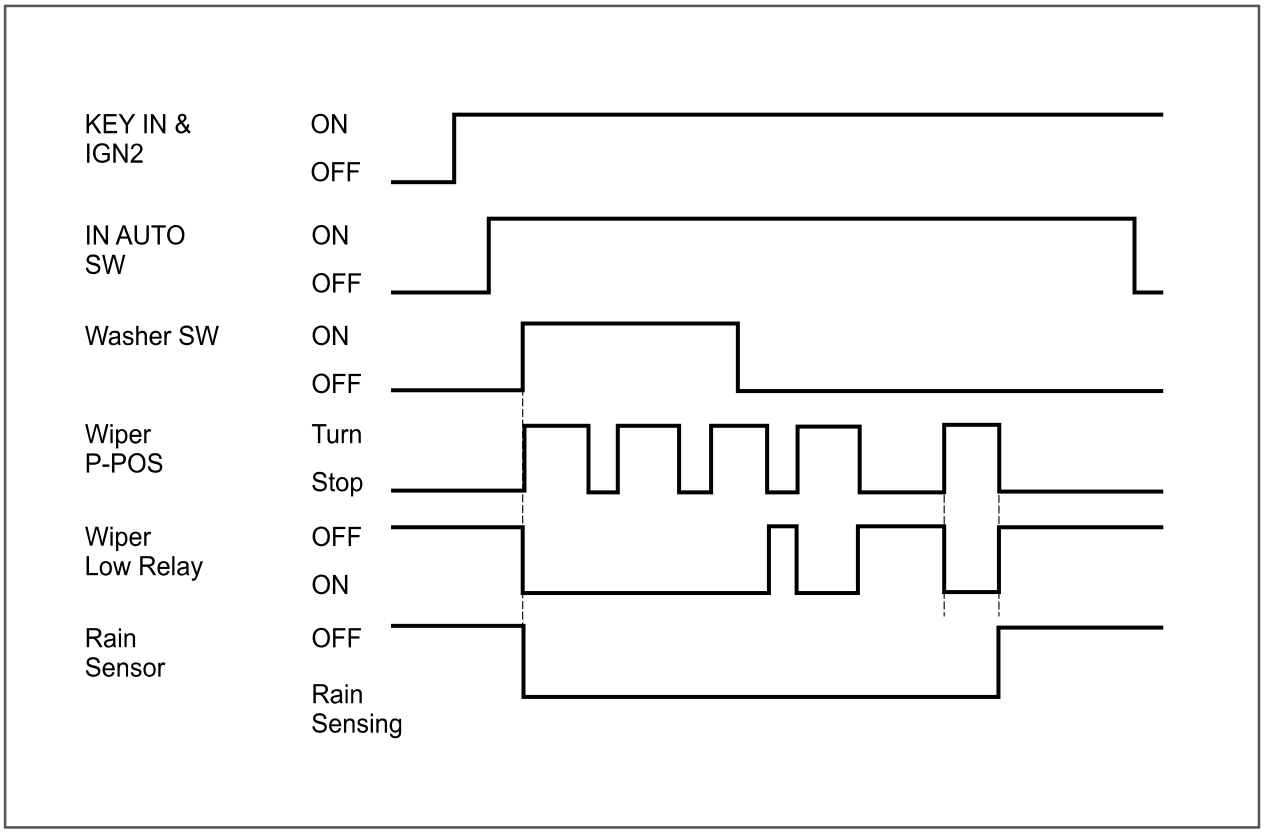
1. If the intermittent/automatic wiper switch is in "ON" position, the wiper motor does not operate even when turning the ignition switch to ON from OFF position.
2. When the INT/AUTO wiper switch is turned on from off with the ignition switch ON, the wiper is operated at low speed for the 1st cycle regardless of the rain sensor signals. After that, if the INT/AUTO wiper switch is turned on from off, the wiper cycles one time at low speed only when the rain sensor detects the presence of rain.



Modification basis	
Application basis	
Affected VIN	

(3) Washer coupled wiper operation during rain sensor coupled operation

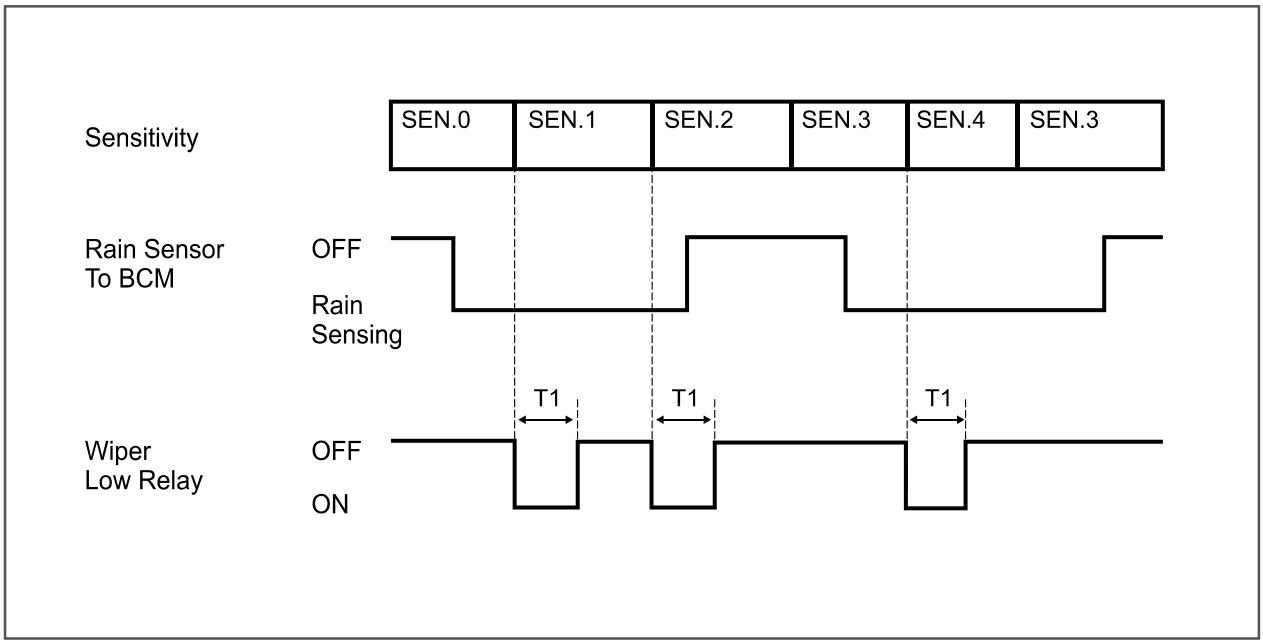
1. When the washer switch signal is received during intermittent operation coupled with rain sensor with IGN ON and intermittent/automatic
   washer switch operation, the wipers operate in washer coupled mode regardless of the communication with the rain sensor. However, if the washer switch
   signal is received the washer relay is activated and wiper relay remains activated,
   when the data coupled with rain sensor indicates continuous wiper operation.
2. Even though the wiping system is in washer coupled wiper mode, the operating data are sent to rain sensor.



(4) Sensitivity control (instant wiping)

1. When the wiping speed control switch is turned to "FAST" with IGN2 ON, intermittent/automatic wiper switch in "ON" position and wiper motor stop (parking position), the wiper motor operates one cycle at low speed.
   (only when the rain sensor detects raindrops)

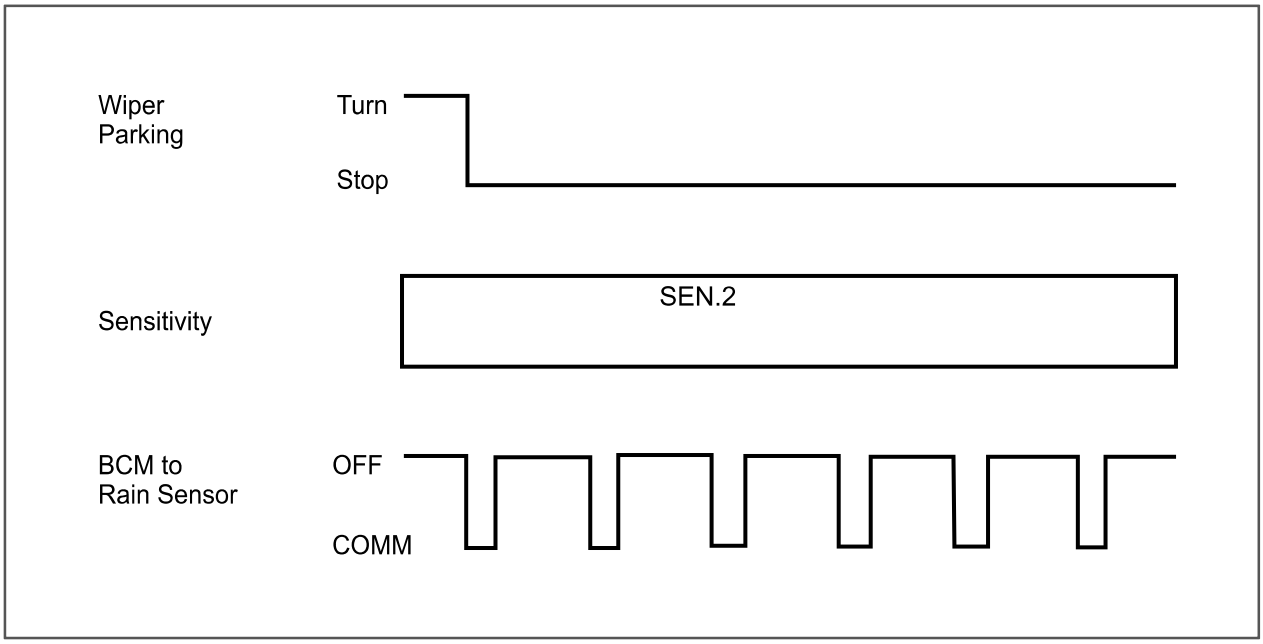
* If the wiping speed control switch is changed more than 2 stages within 2 seconds, the wiper motor operates only one cycle.



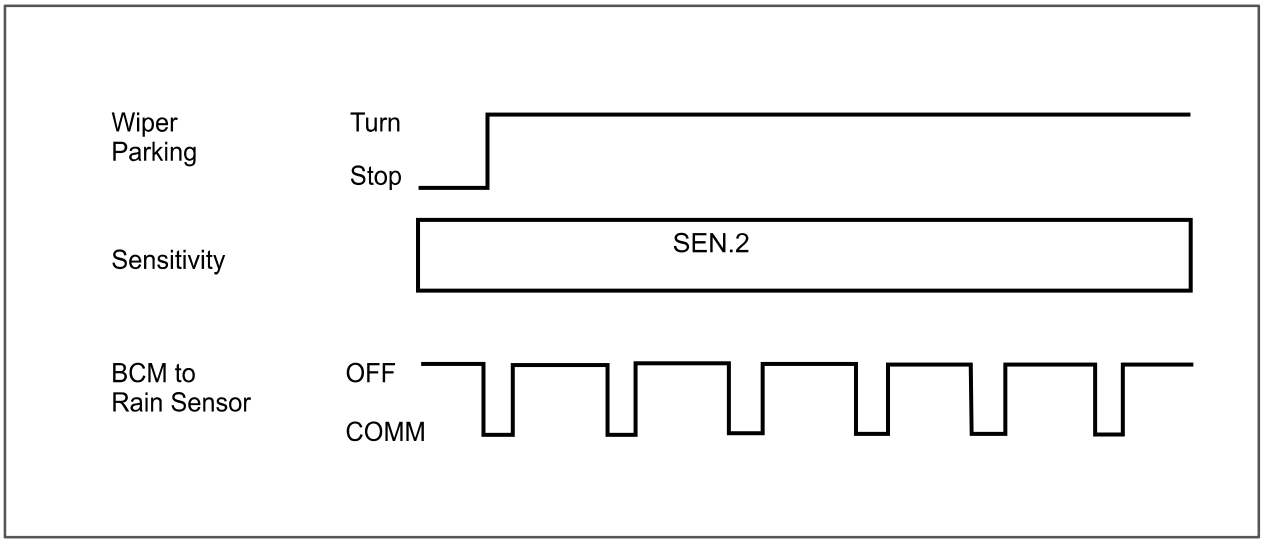
Modification basis	
Application basis	
Affected VIN	

(5) For abnormal wiper parking signal

1. The wiper system sends continuously the signal for current status when the wiper parking terminal is shorted to ground with IGN2 ON and intermittent wiper switch in "ON" position.
   * The wiper motor is operated only when there is a request from the rain sensor.

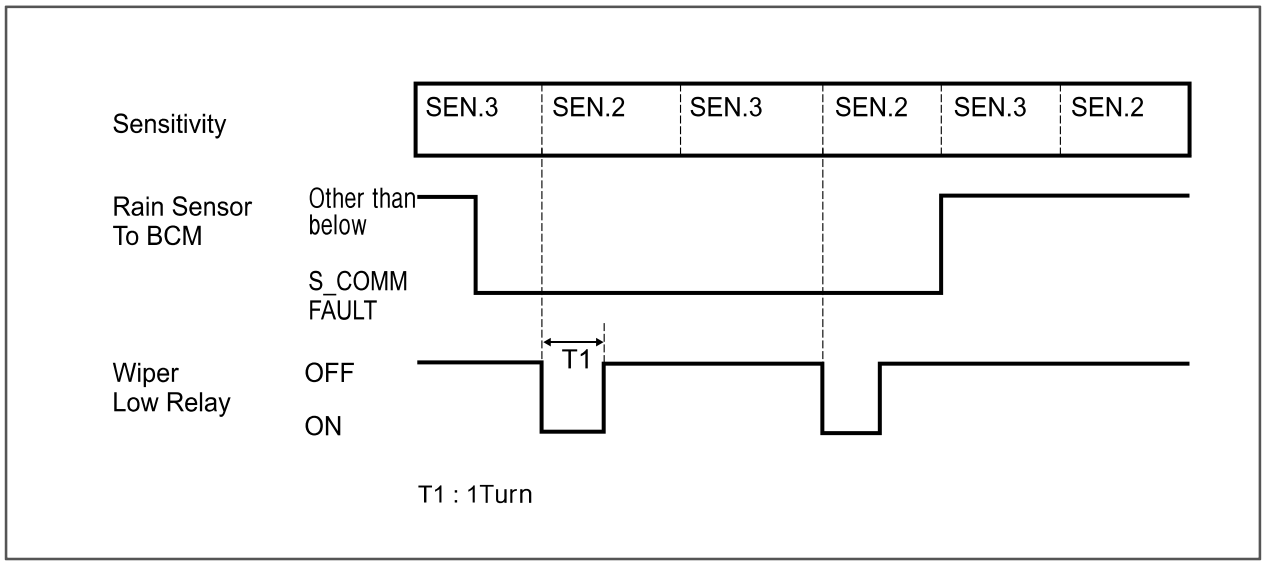


2. When the parking terminal is shorted to power with IGN2 ON and intermittent wiper switch in "ON" position, the wiper system sends the signal for current wiping status for 2 seconds. After that, it sends the current signal for parking status continuously.
   * The wiper motor is operated only when there is a request from the rain sensor.

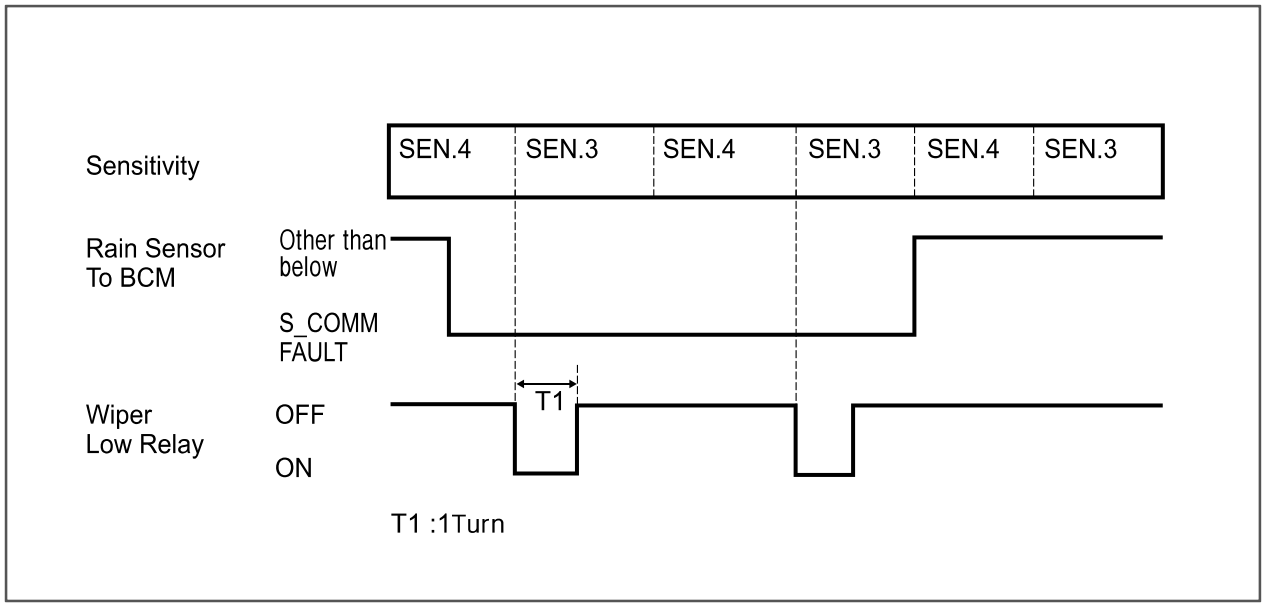


(6) For faulty rain sensor

1. When the wiper speed control switch is turned to step 2 from step 3 the wiper motor cycles one time at low speed, provided that the BCM receives a faulty sensor signal from the rain sensor unit with IGN ON and the INT/AUTO switch ON.



2. When the wiper speed control switch is turned to step 3 from step 4 the wiper motor cycles one time at low speed, provided that the BCM receives a communication error signal from the rain sensor unit with IGN ON and the INT/AUTO switch ON.

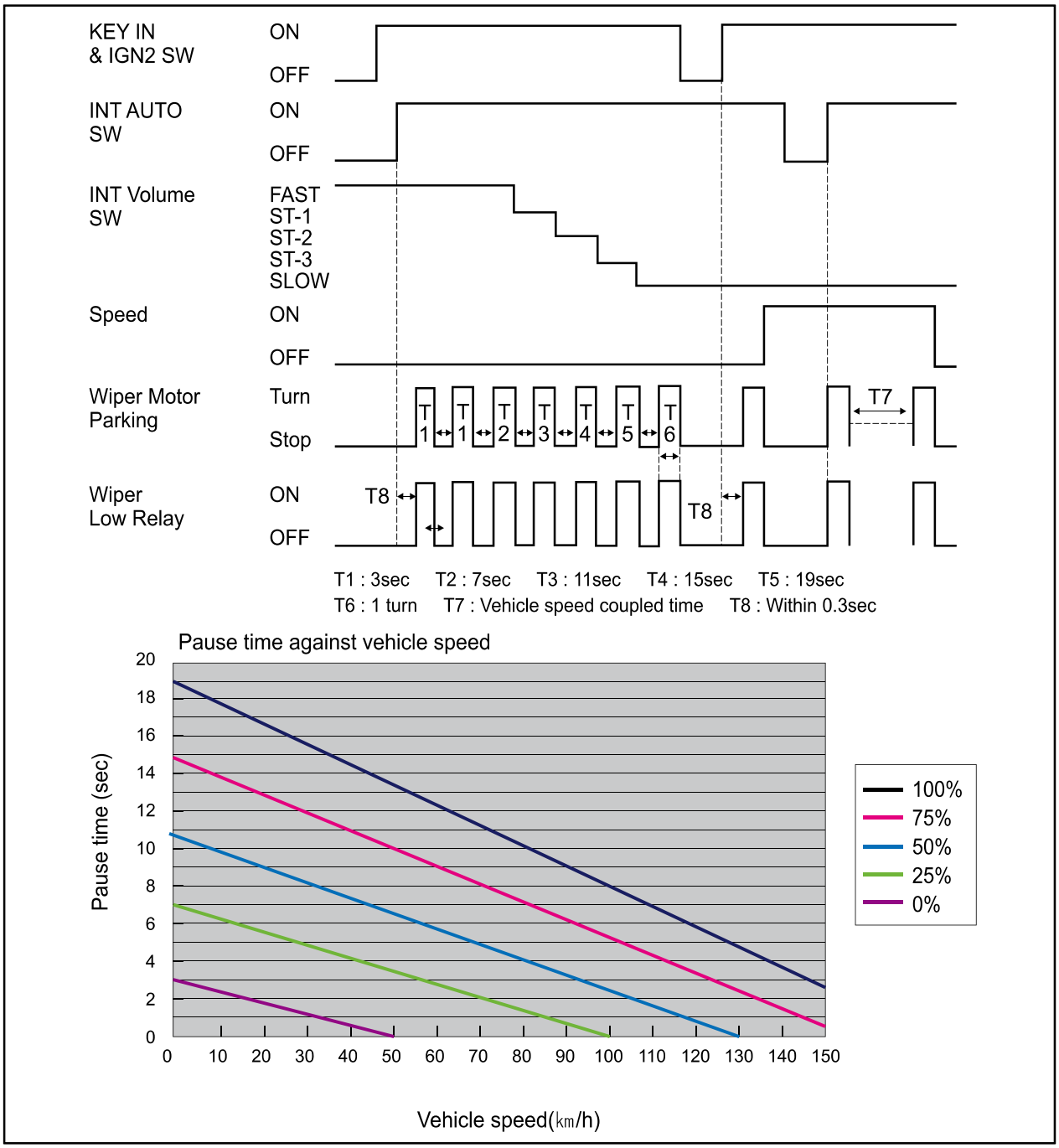


Modification basis	
Application basis	
Affected VIN	

(7) Speed sensitive intermittent wiper

For the vehicles without rain sensor, the BCM operates the wiper as follows:

1. When turning the ignition switch to ON from OFF position with the intermittent wiper switch in "ON" position, the wipers do not operate.
2. When turning the wiper switch to ON from OFF position after turning the ignition switch to ON position, the wipers operate one cycle.
3. The wiper's operation cycle depends on the vehicle speed (CAN communication with instrument cluster) and wiping speed the side fascia panel.
   - Wiping cycle: 3 ± 0.5 sec. (FAST) to 19 ± 2 sec. (SLOW)



▶ Speed sensitive intermittent wiper interval

SPEED / VIR	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
100%	19.00	17.90	16.80	15.70	14.60	13.50	12.40	11.30	10.20	9.10	8.00	6.90	5.80	4.70	3.60	2.50
75%	15.00	14.03	13.06	12.09	11.13	10.16	9.19	8.22	7.26	6.29	5.32	4.35	3.39	2.42	1.45	0.45
50%	11.0	10.16	9.33	8.49	7.66	6.82	5.99	5.15	4.32	3.48	2.65	1.81	0.98	0.14	0.00	0.00
25%	7.00	6.29	5.59	4.89	4.19	3.48	2.78	2.08	1.38	0.67	0.02	0.00	0.00	0.00	0.00	0.00
0%	3.0	2.43	1.86	1.29	0.72	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Modification basis	
Application basis	
Affected VIN	

PAS

8790-00

GENERAL INFORMATION

1. SPECIFICATION

Pin No.	Specification	Pin No.	Specification
Rated voltage	DC 12.0 V	Insulating resistance	No heat & fire due to current leak
Operating voltage	DC 9.0 V ~ 16.0 V	Max. permissible current	Unit: 100 mA or less
Operating temperature	−30℃ ~ +80℃		Sensor: 20 mA or less
Storage temperature	−40℃ ~ +85℃	Weight	Unit: 75.7 g±5 g
Maximum humidity	95%		Sensor: 38.7 g±5 g

2. CAUTIONS

▶ **Sensor Cannot Detect**

- When the sensor is frozen (operate normally when it's thawed)
- When the sensor is covered with foreign materials such as snow or condensation (if the foreign materials are removed, the sensor operates normally.)

▶ **Not defective but improperly working**

- When the sensing portion is frozen (operates normally after thawed)
- When reversing on rough roads, gravel roads, hills, or grass.
- When receiving other ultrasonic signals (metal sounds or air braking noises from heavy commercial vehicles).
- When there is heavy rainfall or water drops.
- When the sensor is covered with snow.

▶ **Certain obstacles that sensors cannot detect**

- Thin and narrow objects, such as wires, ropes, or chains
- Cotton, sponge, clothes, snow that absorb ultrasonic waves.

▶ **Weak Sensing Scopes**

- When the ambient temperature is too high or too low.
- When a 1 m or less long small object with a diagmeter of 100 mm or less is detected.

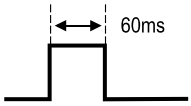
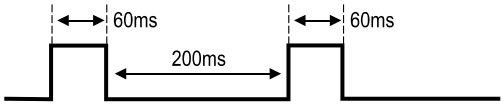
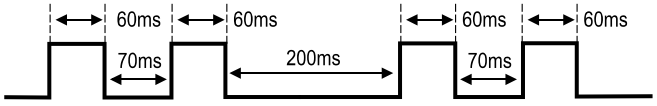
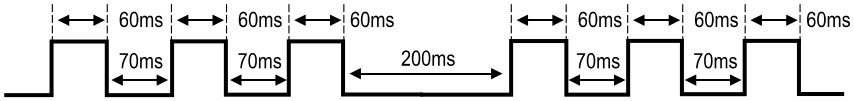
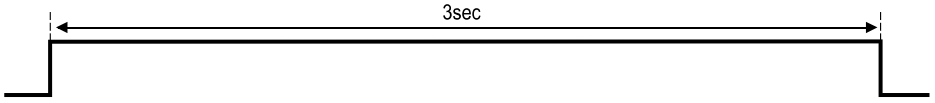
3. MAJOR CHANGES



Parking aid unit



Parking aid unit logic

MODE	Alarm interval (msec)
Normal	
LEFT	
CENTER	
RIGHT	
2 or more sensors	

Changed sensor self-diagnosis buzzer sound interval (65 ms → 60 ms)

Modification basis	
Application basis	
Affected VIN	

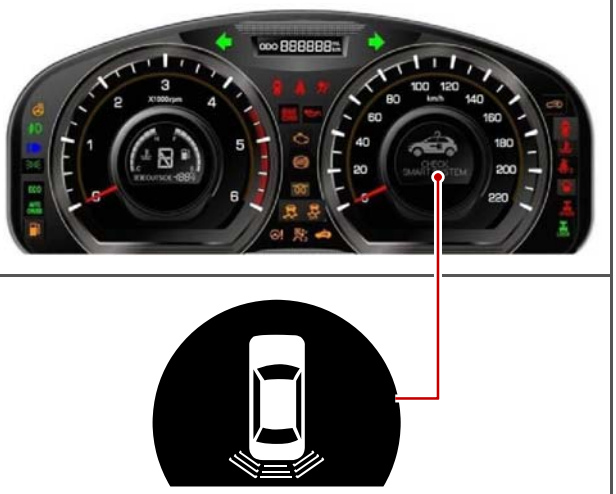
Memo

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

When the gear selector lever is shifted into "R", the parking aid system is activated and three sensors in the rear bumper detect the distance to any obstacle. The PAS detects the returning signals reflected to the obstacles at regular intervals when the vehicle is parked to indicate the display and alarm for the distance between the obstacles by phase so as to allow the driver easy parking by securing safe distance.

1 IP display (SVC only)





2 Buzzer for PAS



Buzzer sounds using instrument cluster buzzer

3 Rearview camera



4 Shift lever



Modification basis	
Application basis	
Affected VIN	

2. CONFIGURATION



Installation of PAS sensor



5 Parking aid unit



6 PAS sensor

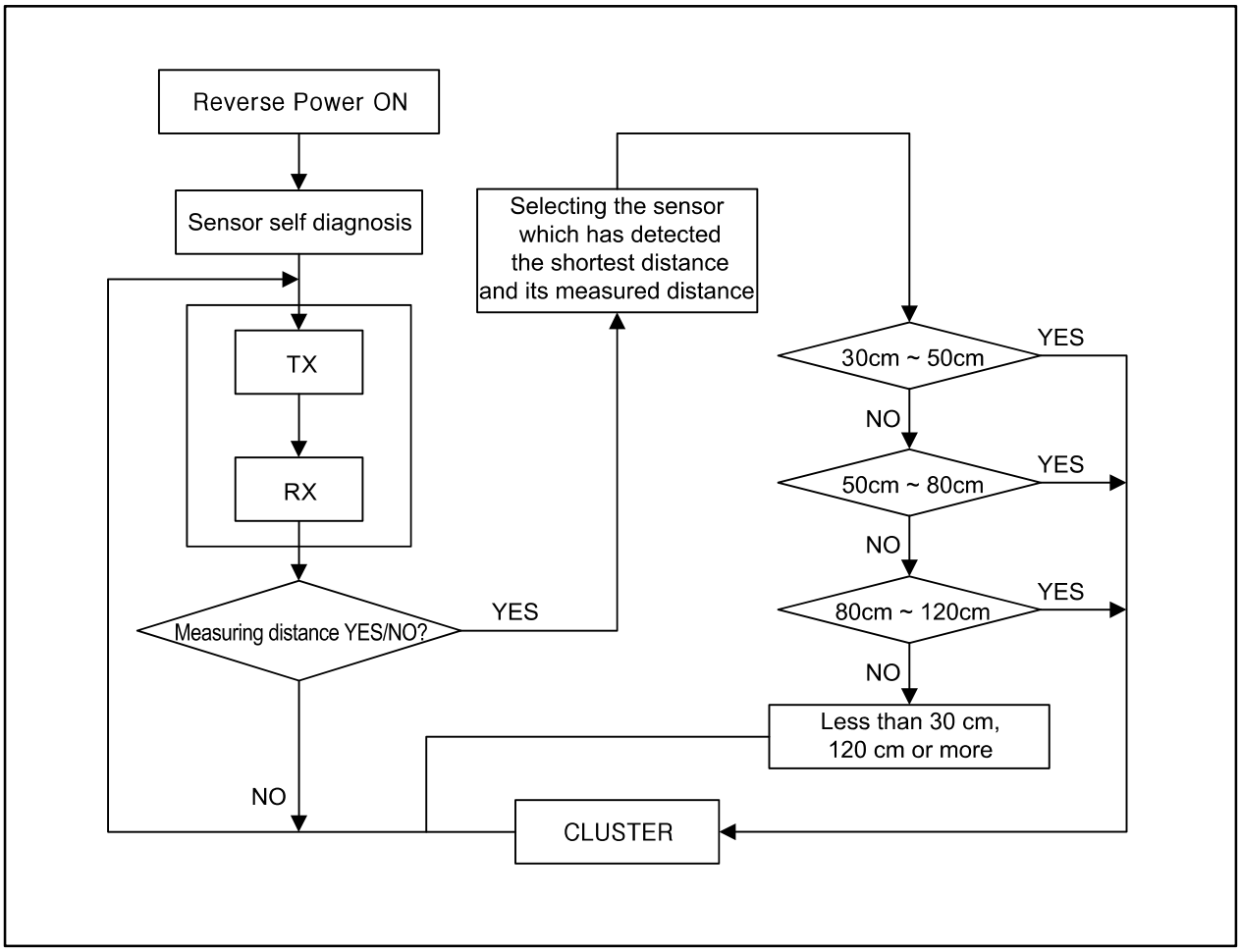


Modification basis	
Application basis	
Affected VIN	

3. OPERATING PROCESS

When PAS receives "R" signal, it starts to detect the obstacles behind vehicle after self diagnosis.
If the system detects the obstacle, the buzzer sounds according to the distance. If there is no obstacle, starts to detect the obstacles after self diagnosis again.

1) Block Diagram



Modification basis	
Application basis	
Affected VIN	

2) Rear PAS Sensor

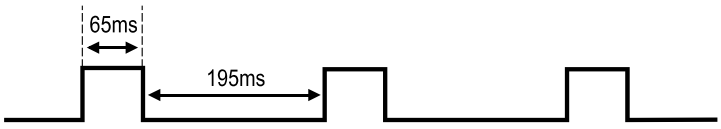
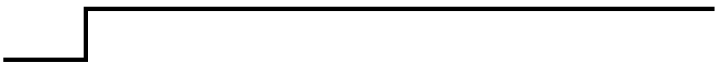
While reversing, if obstacles are within stage 1, the warning beep sounds with long intervals. If within stage 2, the warning beep sounds with short intervals and if within stage 3, the warning beep sounds continuously.

Sensor detection range

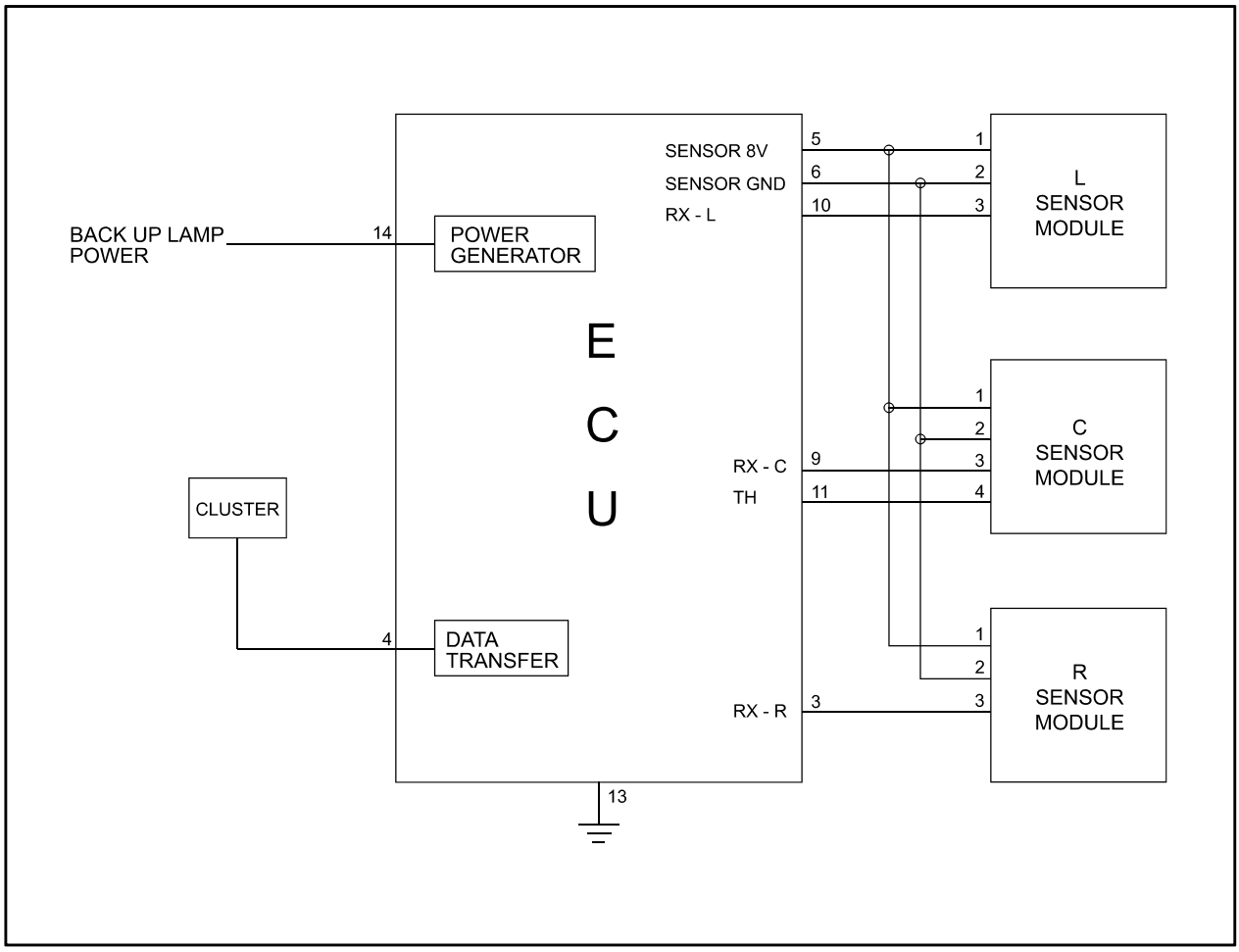


Within 20 cm from the ground
(Objects may not be detected in this range.)

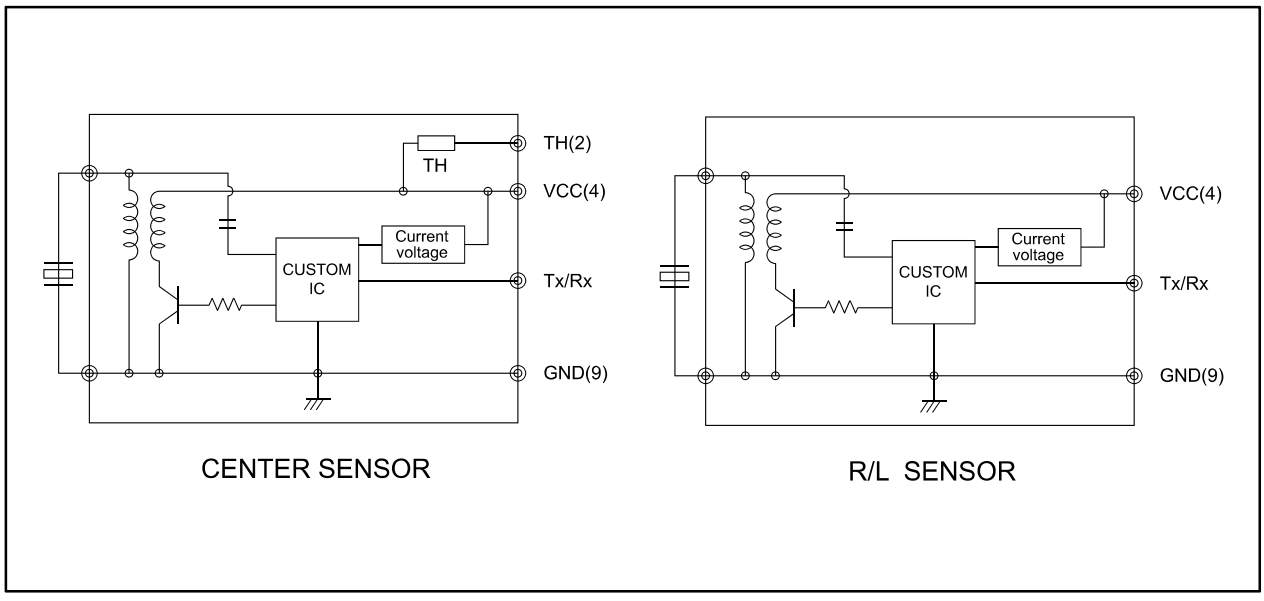
▶ **Buzzer interval when measuring distance**

Level	L / R	CENTER	Alarm interval (msec)
Level 1	80~100 (cm)	80~120 (cm)	
Level 2	50~80 (cm)		
Level 3	30~50 (cm)		
Tolerance	±10 (cm)		±10 (cm)

▶ Circuit diagram of ECU

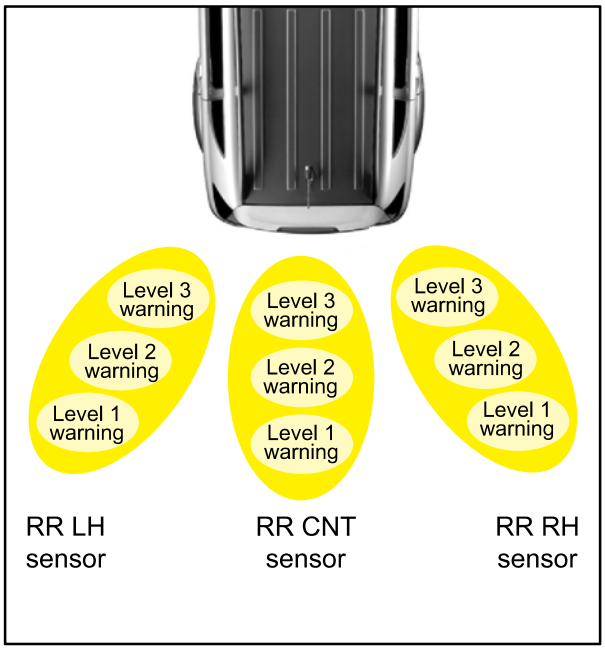


▶ Internal circuit diagram of sensors

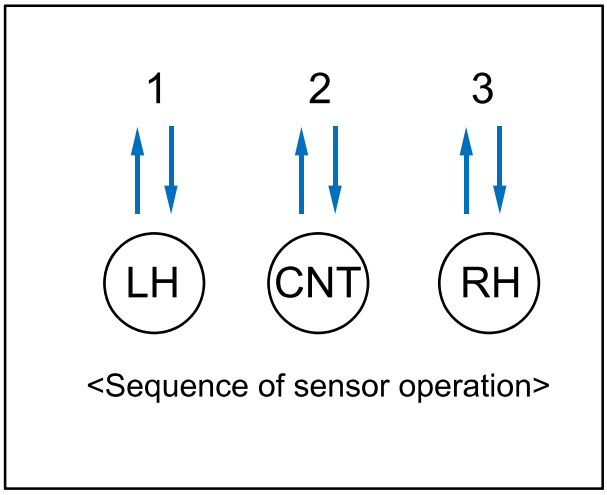


Modification basis	
Application basis	
Affected VIN	

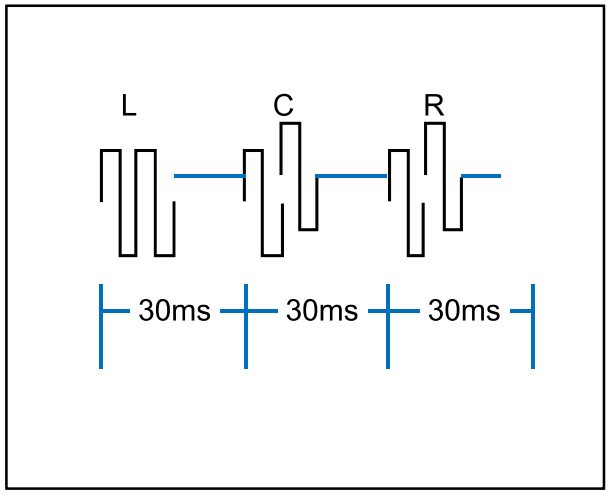
▶ Sensor operating sequence



The ultrasonic sensors transmit ultrasonic waves and receive the reflected waves from an obstacle to detect it in the following order: L → C → R.



<Sequence of sensor operation>

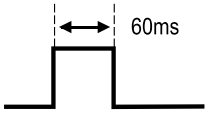
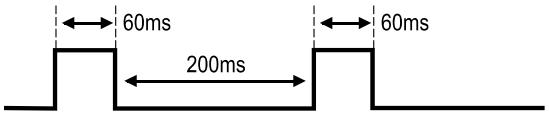
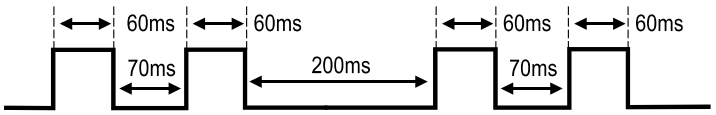
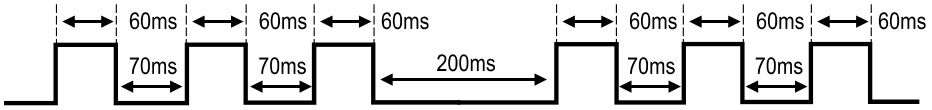
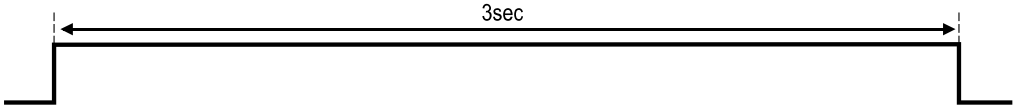


Modification basis	
Application basis	
Affected VIN	

4. OUTPUT SPECIFICATIONS FOR SENSOR SELF-DIAGNOSIS BUZZER SOUND

▶ **Buzzer interval during self diagnosis**

Self diagnosis is performed once when the ignition is switched on (gear shift lever in "R" position). If the system is defective (Fail) due to open sensor or communication problem, the information for the failed sensor is displayed as buzzer sound.
If it is normal, the warning buzzer sounds for 60 ms.

MODE	Alarm interval (msec)
Normal	
LEFT	
CENTER	
RIGHT	
2 or more sensors	

▶ **Conditions to "FAIL" in sensor diagnosis**

- Fail condition (However, no obstacle should be within 30 cm)
  1. The signal wire is open
  2. The power wire (+ and -)is open

▶ **Exception/error handling**

1. Timeout processing time for buzzer interval after measuring distance/self diagnosis: 600 ms
   - If timeout is reached, the PAS returns to undetected condition.
2. Process while re-inputting
   - After timeout, the process is performed normally if the signal required for display is received from beginning to end. (not detectable if the signal is received in the midst of process)

Modification basis	
Application basis	
Affected VIN	

AUDIO SYSTEM

8910-05

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification
General	Rated voltage		DC 14 V (Negative ground)
	Speaker		4 Ohm
	Output		45 W x 4 channels
	Current consumption		10 A (at maximum power)
MP3[WMA], CD	Sampling frequency		8 times oversampling
	DA converter		4 DAC system
	Pick-up type		Astigma 3-beam
	Light source		Semiconductor laser
	Wave length		780nm
	Frequency response		20Hz ~ 20kHz(± 3dB)
	Signal to noise ratio		≥50 dB
	Total harmonic distortion		≤1% (1kHz)
	Wow and flutter		Below measurable limits
	Channel separation		≥35dB
Radio	Frequency range	FM MW LW	87.5MHz ~ 108MHz 522kHz ~ 1,620kHz 144kHz ~ 290kHz
	Usable sensitivity	FM MW LW	≤18 dBu ≤35 dBu ≤35 dBu
	Signal to noise ratio	FM MW LW	≥45dB ≥40dB ≥40dB
	Stereo separation	FM	≥20dB
Bluetooth	Performance		Audio distribute profile (A2DP)

Unit	Description	Specification
USB MP3[WMA]	Frequency response	20Hz ~ 20kHz
	Total harmonic distortion	0.1 % (at 1kHz)
	Dynamic Range	85dB (at 1kHz)
	Signal-to-noise ratio	60dB (at 1kHz)
	Channel separation	54dB (at 1kHz)
Micro-pole antenna	Operating current	up to 150 mA
	Operating voltage	DC 10.5 ~ 16.0 V
	Operating temperature	−30˚C ~ +60˚C
	Storage temperature	−40˚C ~ +80˚C
	Input/output impedance	75Ω (FM)

Modification basis	
Application basis	
Affected VIN	

2. MAJOR CHANGES

Audio assembly	
CDP (MP3) + Bluetooth	**CDP(MP3) + RDS + Bluetooth**
	
The "CALL" button for Bluetooth system has been added.	

3. RDS (RADIO DATA SYSTEM) AUDIO

RDS (Radio Data System) is a broadcasting service which a growing number of FM stations are now providing. It allows the FM stations to send additional signals along with their regular programme signals. For example, the stations send their station names and information about what type of programme they broadcast, such as sports or music, etc.

When tuned to an FM station which provides the RDS service, the RDS indicator lights up, the station frequency (and then the station name if sent) is displayed.

Not all FM stations provide RDS service, nor do all RDS stations provide same services. If in doubt, check with local radio stations for details on RDS services in your area.

This machine can use the following RDS service.

PS (Programme Service name) / PTY (Programme Type) / TP (Traffic Program) / TA (Traffic Announcement) / AF (List of Alternative Frequencies) / RT (Radio Text)

This allows you to locate a specific type name of programme being broadcast.

OVERVIEW AND OPERATING PROCESS

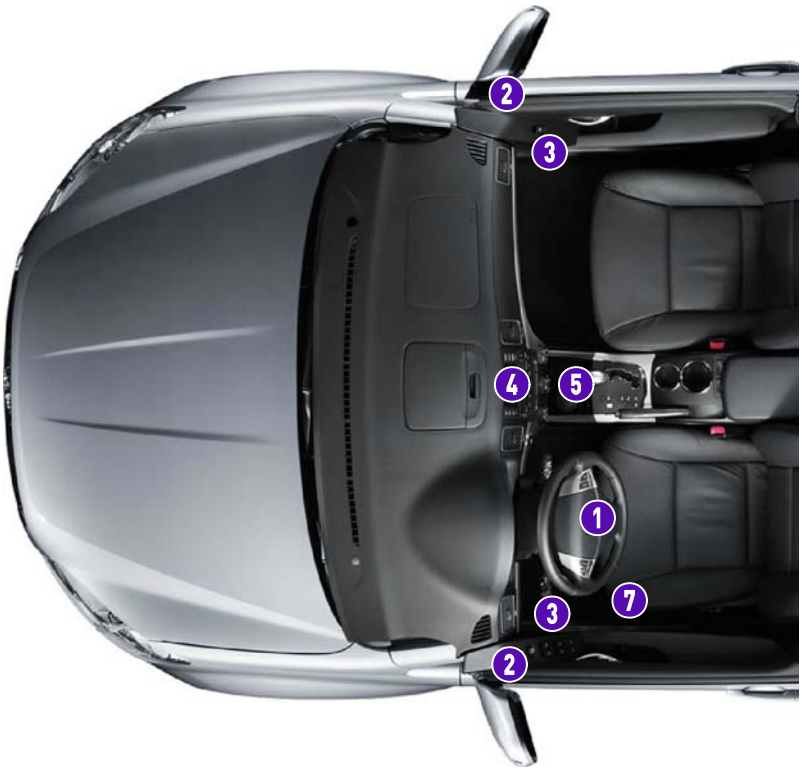
1. LAYOUT

- Audio
- CDP (MP3)
- Radio
- USB/AUX
- Bluetooth hands-free

Remote control switch on steering wheel

1





Front door tweeter speaker

2



Front door speaker

3



Modification basis	
Application basis	
Affected VIN	

Audio assembly

CDP (MP3) + Bluetooth	CDP(MP3) + RDS + Bluetooth
4 	



USB/AUX

5 

Hands-free microphone

7 

Rear door speaker

6 

Modification basis	
Application basis	
Affected VIN	

1) Audio Control Switch

▶ **CDP (MP3) + Bluetooth**



No.	Name
1	Power/Mute/Pause/Enter/Volume button
2	Station memory button (1~6) and Audio function button
3	Bluetooth hands-free CALL button
4	Bluetooth hands-free END button
5	Previous (≪) and Next (≫) button
6	SCAN/INFO button
7	BAND/AS button
8	SETTING button
9	Display window (LCD)
10	USB/AUX button
11	Disc Play button
12	Disc Eject button
13	Disc slot

Modification basis	
Application basis	
Affected VIN	

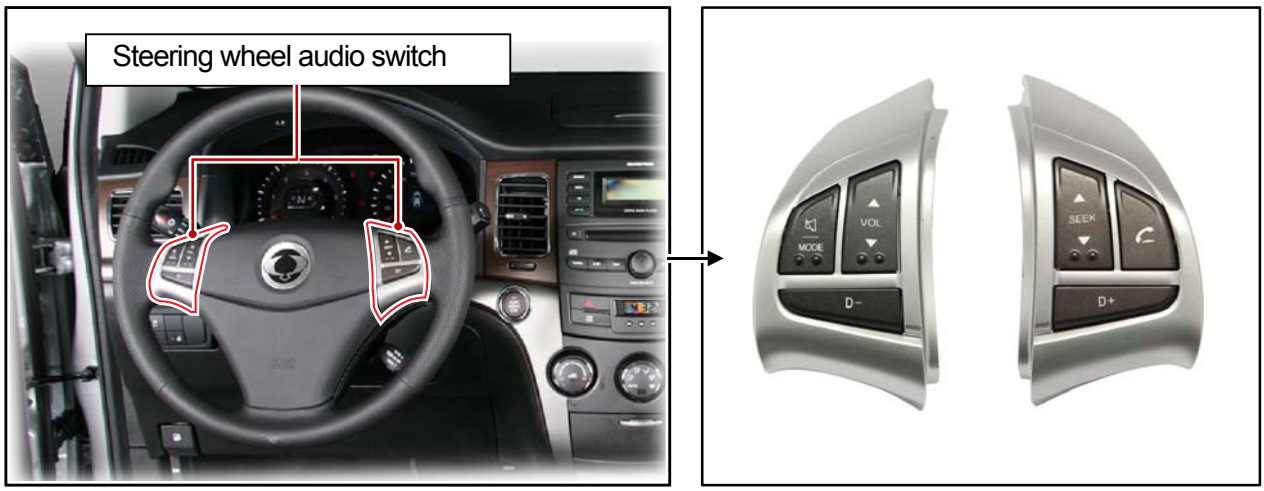
▶ **CDP (MP3) + RDS + Bluetooth**



No.	Name
1	Display window
2	RDS button
3	AF/TA button
4	SEEK button
5	CALL button
6	Disc slot
7	CD/AUX/USB button
8	POWER button with VOLUME dial
9	Station memory button (1~6)
10	BAND/AST button
11	SCAN / INFO button with dial
12	EQ/SOUND button
13	END button
14	Disc Eject button

2) Steering Wheel Audio Switch

If your vehicle has this feature, some audio controls can be adjusted at the steering wheel.
They include the following:



▶ **MUTE [ ]**
Press: to turn the system on, to mute on/off
Press and hold: to turn the system off

▶ **MODE**
Press: to select the functions (CD → USB → AUX → RADIO)
Press and hold: to select the bands (FM1→ FM2 → MW → LW)

▶ ▲VOLUME▼
Press to increase/decrease the volume.

▶ ▲SEEK▼
When listening to a station:
Press: to go to the next/previous preset station
Press and hold: to search the next/previous radio station (The radio seeks stations only with a strong signal that are in the selected band).
When playing a CD or USB:
Press: to go to the next/previous track:
Press and hold to fast forward/backward through the tracks.

▶ **PHONE [ ]**
During the standby:
Press: to make a call via voice-activated dialing function
Press and hold: to make a call via last call dialing function
When a call comes in:
Press: to receive the incoming a call
Press and hold: to reject the incoming a call
During a call
Press/Press and hold: to end a call

Modification basis	
Application basis	
Affected VIN	

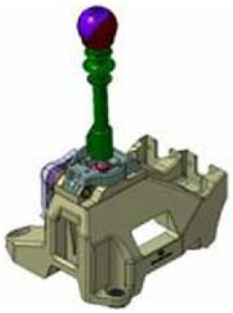
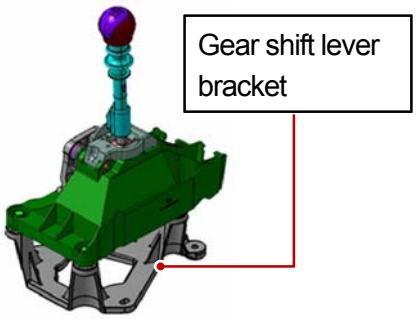
CHASSIS GENERAL

0000-00

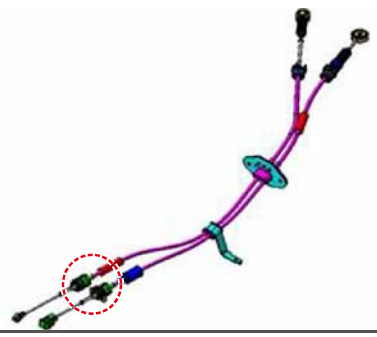
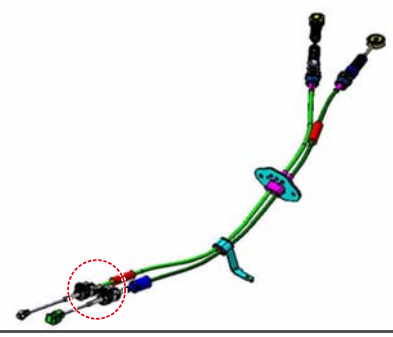
CHASSIS

1. MAJOR CHANGES

1) Gear Shift Lever and Cable (Manual Transaxle)

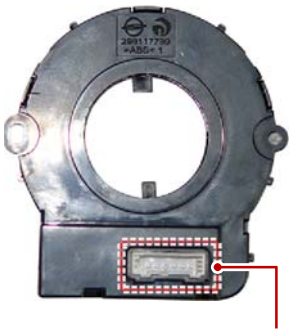
Gear shift lever assembly	
Old	**New**
	
The gear shift lever bracket has been changed to adopt the premium console.	



Gear shift cable assembly	
Old	**New**
	
The connection and socket to lever has been changed.	

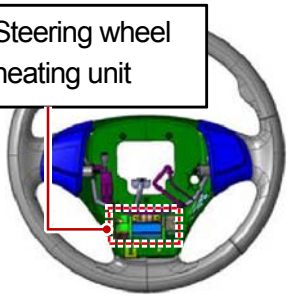
2) Steering Wheel Angle Sensor



SWAS: Steering Wheel Angle Sensor	
Old	**New**
 Sensor connector	 Sensor connector
1. The sensor has been changed due to newly adopted steering wheel heating system. 2. The location of sensor connector and the pin arrangement of connector have been changed.	

Modification basis	
Application basis	
Affected VIN	

3) Steering Wheel Heating System

Steering wheel heating unit	
Old	**New**
	
The steering wheel heated wire and the heating unit are installed in the steering wheel assembly.	



Lower main switch cluster
Old

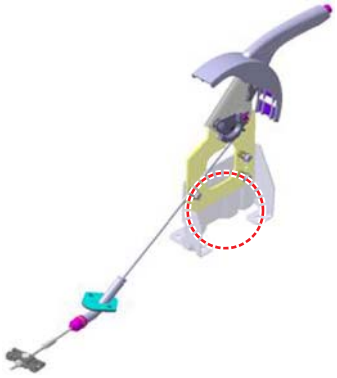
New

The steering wheel heating switch has been added on the lower main switch cluster.

▶ Specifications

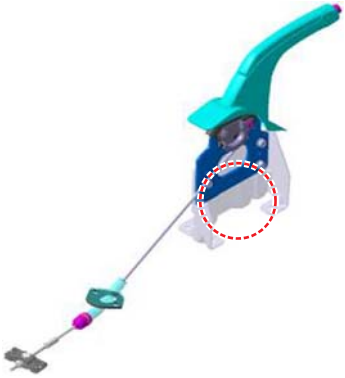
Description	Specification
Power consumption	Below 95W
Rated voltage	12V
Operating voltage	9V~16V
Rated current	6±2.0A

4) Parking Brake Lever Assembly

Parking brake lever assembly (Automatic transaxle equipped vehicle)	
Old	**New**
	
The parking brake lever bracket has been changed to adopt the premium console.	





Parking brake lever assembly (Manual transaxle equipped vehicle)	
Old	**New**
	
The parking brake lever bracket has been changed to adopt the premium console.	

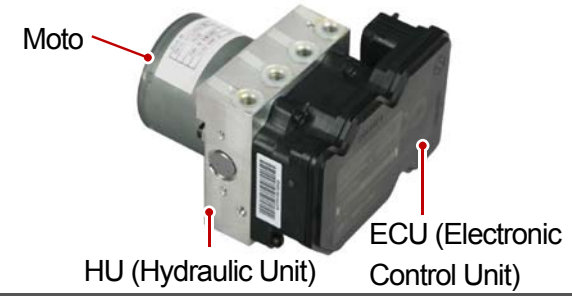
Modification basis	
Application basis	
Affected VIN	

Memo

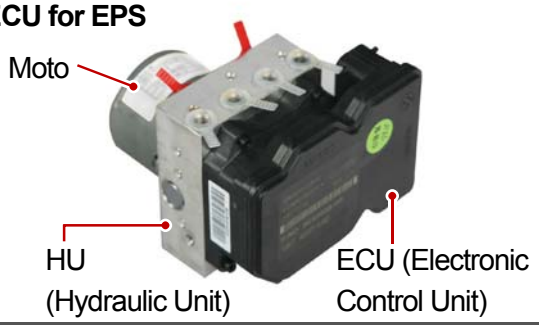
2. MOUNTING LOCATIONS (CHASSIS)

HECU (Hydraulic & Electronic Control Unit)

HECU for ABS

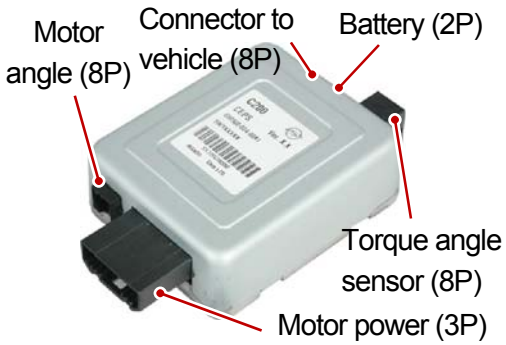


HECU for EPS

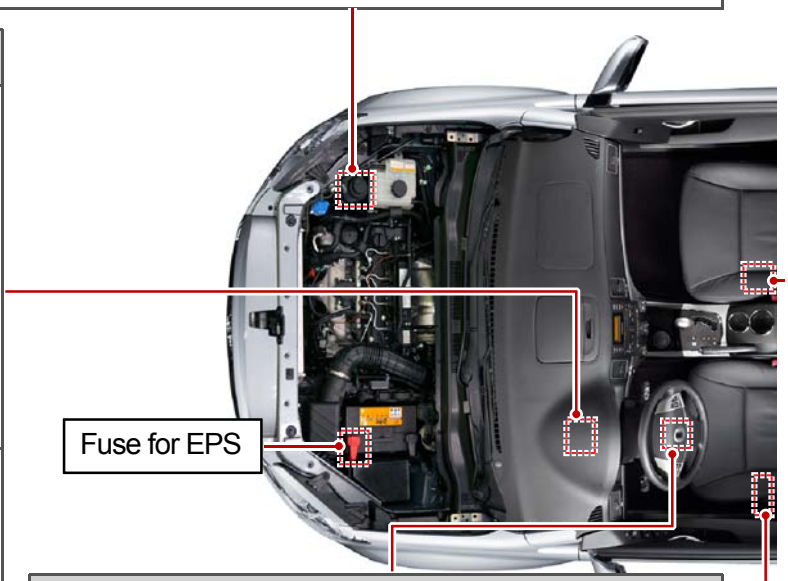


The HECU (Hydraulic & Electronic Control Unit) determines the slip conditions of vehicle wheels by calculating each wheel's speed and the increment/decrement of speed based on the information detected by the sensors, and controls the pumping and boosting/reducing/keeping pressure by operating the valve and motor of HECU.

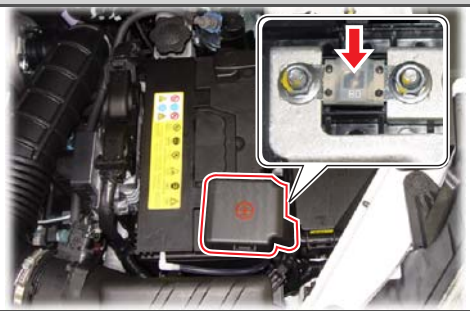
EPS unit



The ECU controls the electric power steering system depending on the driving conditions, based on the signals from the torque and angle sensor.



Fuse for vehicle with EPS



The vehicle with EPS has EPS fuse (80A) mounted to the positive (+) terminal of the battery not in the fuse box.

Steering wheel angle sensor (SWAS)



The steering wheel angle sensor is mounted between the steering column and the steering column shaft. It is commonly used by the ESP (Electronic Stability Program) system. And it receives signals of the steering wheel angle sensor from the ESP HECU (Hydraulic & Electronic Control Unit).

Modification basis	
Application basis	
Affected VIN	

Sensor cluster

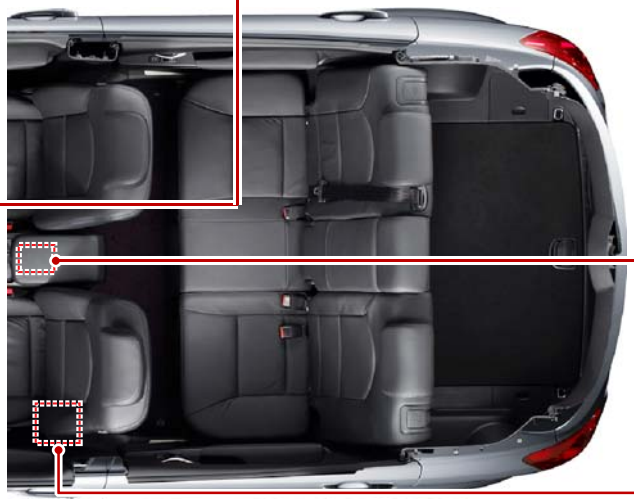


The sensor cluster is linked to the sensors on the unit board and CAN interface. And they are housed in one case and mounted to the body.

TGS Lever assembly



The TGS communicates with TCU (Transmission Control Unit), ECU, ESP HECU and instrument cluster to let the driver select the desired transmission gear and to maintain the desired driving condition. Also, the tip switch is installed on the lever knob and the steering wheel so that the driver select the gear manually when the shift lever is in "M".



G-sensor(4WD, ABS)



For the vehicle with the ABS, a speed difference between the wheels is not noticeable as all the wheels are slipping during abrupt braking. Therefore, the vehicle needs the speed information from other sensors other than the wheel speed sensor. The longitudinal acceleration sensor (G-sensor) is used for this case. It controls the ABS by using the signals from the sensor during abrupt braking and acceleration.

E-coupling unit



The E-coupling unit is a control unit which determines the magnetic force by considering CAN signals (wheel speed, engine torque, pedal opening, ABS/ESP CAN signals, etc.) from other ECUs.

TCU unit



The transmission control unit (TCU) is installed under the driver seat, and controls the transmission. The TCU is operated by the ignition power supply and receives and processes the following information from the inner sensors through CAN buses.

3. CHASSIS COMPONENT LAYOUT

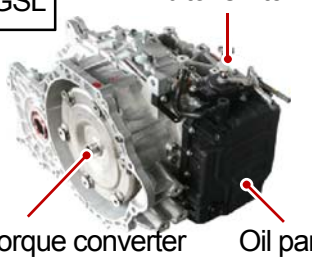
1) 4WD Vehicle With Automatic Transmission

A/T assembly

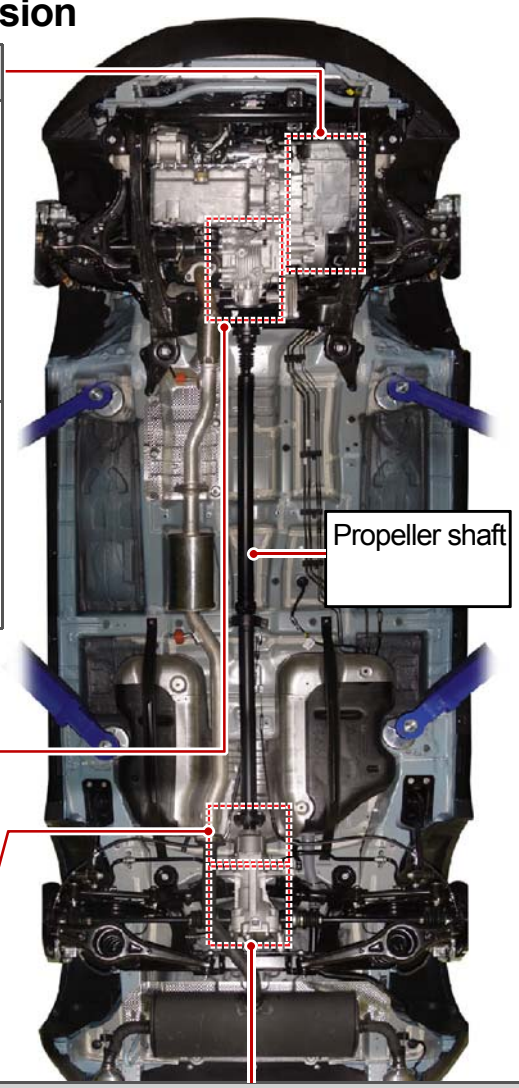
DSL



GSL



Automatic transmission is available as 4WD- and 2WD-type, and provides 6 speeds for forward travel and 1 reverse travel. It is also equipped with the torque converter with inner lock-up clutch and electronically controlled solenoid which controls all hydraulic functions.



PTU (Power Transfer Unit)



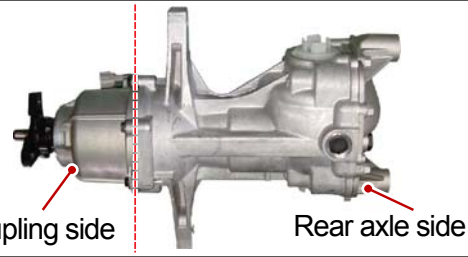
The PTU is a device that transfers the power generated from the engine to the rear axle through propeller shaft and E-coupling by changing the power flow direction by 90° in the front wheel drive type 4WD vehicle.

E-coupling control unit (E-Coupling ECU)



The E-coupling unit is a control unit which determines the magnetic force by considering CAN signals (wheel speed, engine torque, pedal opening, ABS/ESP CAN signals, etc.) from other ECUs.

Rear axle assembly

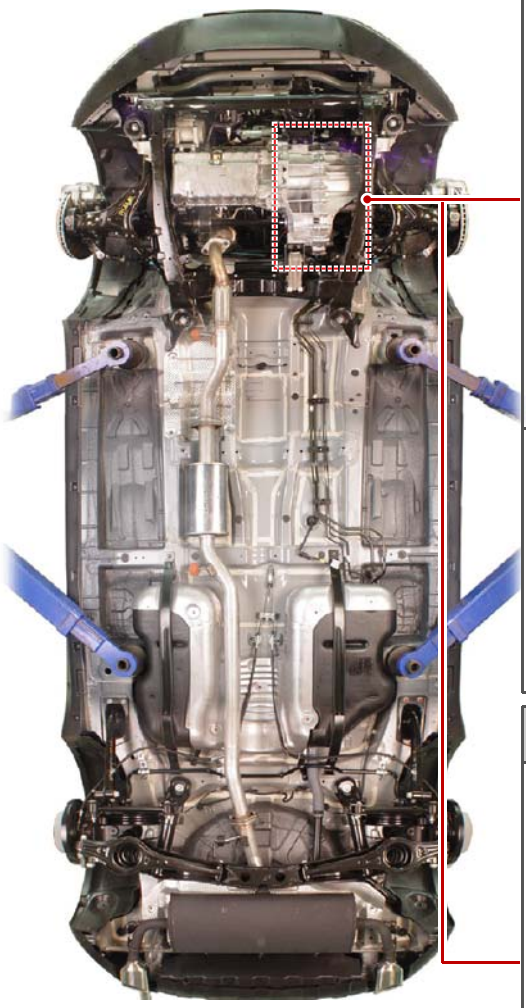


The rear axle installed in this car is a removable axle, called IRDA (Independent Rear Differential Axle). The rear differential carrier is installed directly on the sub frame, and there is an independent suspension that allows each wheel on the same axle to move vertically independently of each other with the universal joint and the slip joint.

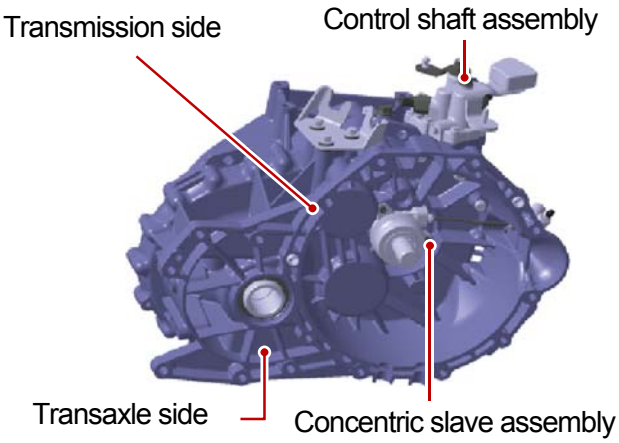
Modification basis	
Application basis	
Affected VIN	

2) 2WD Vehicle With Manual Transmission

The 2WD vehicle with manual transmission is a front wheel drive type vehicle that doesn't have PTU, propeller shaft, E-coupling and rear axle which are applied to 4WD vehicle. Its under structure is very simple.

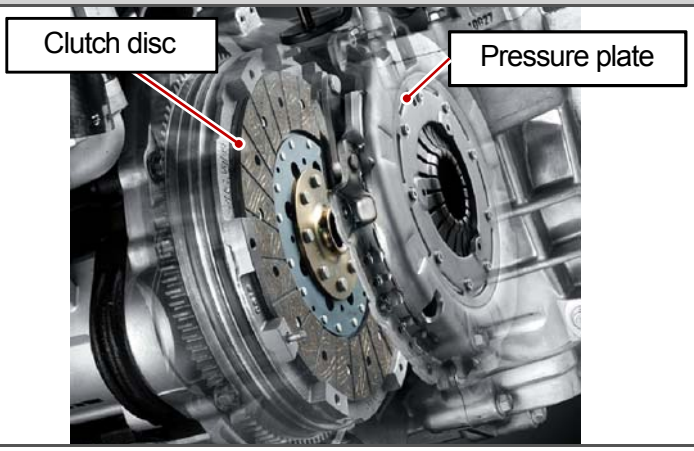


M6LF1 manual transmission



M6LF1 manual transmission is a model modified from the one that used in other vehicle so that it can be applied to FF (Front engine-Front wheel driving) type vehicle, and has an axle in one piece. The engine torque and gear ratio of this transmission have been optimized to maximize driving performance. It provides 6 speeds for forward travel and 1 reverse travel.

Clutch assembly



M6LF1 manual transmission is a model modified from the one that used in other vehicle so that it can be applied to FF (Front engine-Front wheel driving) type vehicle, and has an axle in one piece. The engine torque and gear ratio of this transmission have been optimized to maximize driving performance. It provides 6 speeds for forward travel and 1 reverse travel.

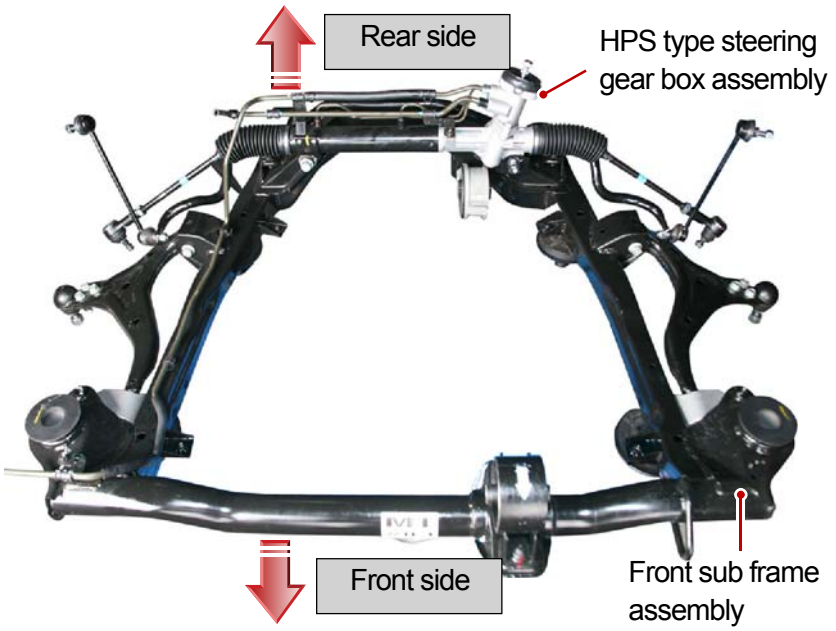
Manual gear selector lever



Modification basis	
Application basis	
Affected VIN	

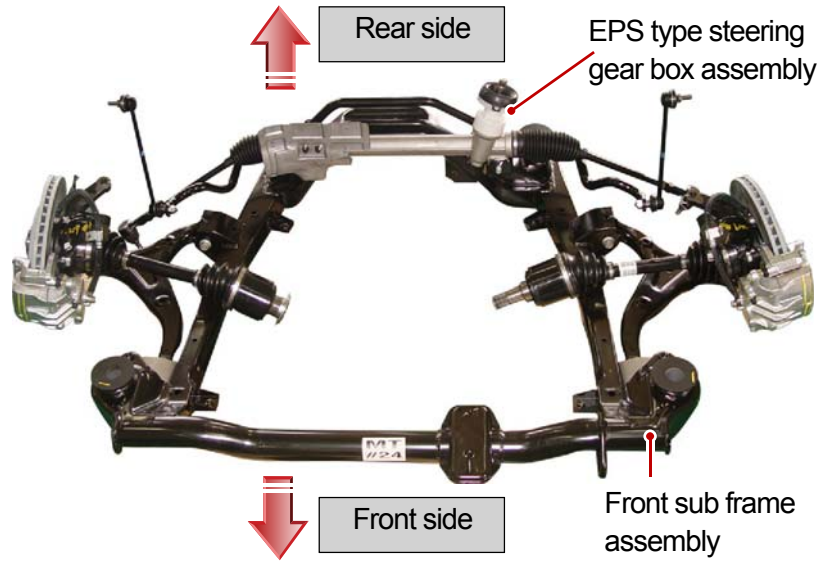
4. SUB FRAME AND STEERING GEAR BOX LAYOUT

Front sub frame with HPS type steering gear box assembly

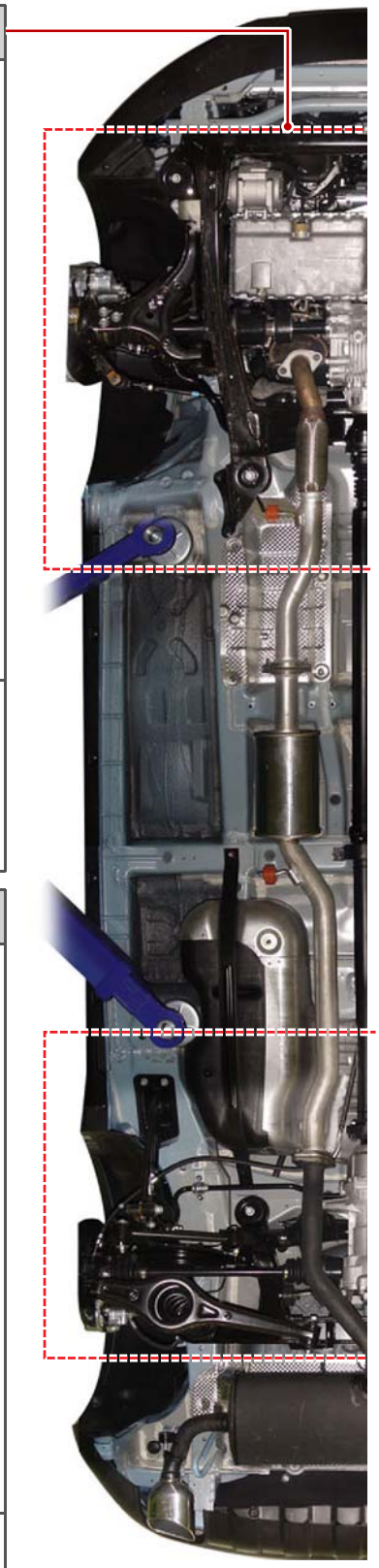


The front sub frame consists of 4 body bush mountings and 2 transmission bush mountings which reduce the vibration from the powertrain and road, and also control the torque. And the frame is equipped with hydraulic pressure pipe of the HPS type steering gear box.

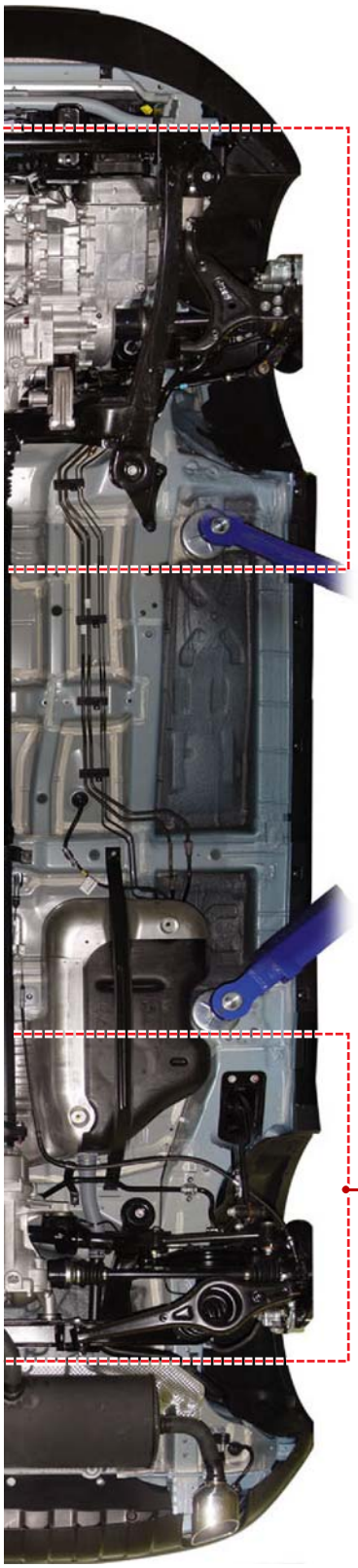
Front sub frame with EPS type steering gear box assembly



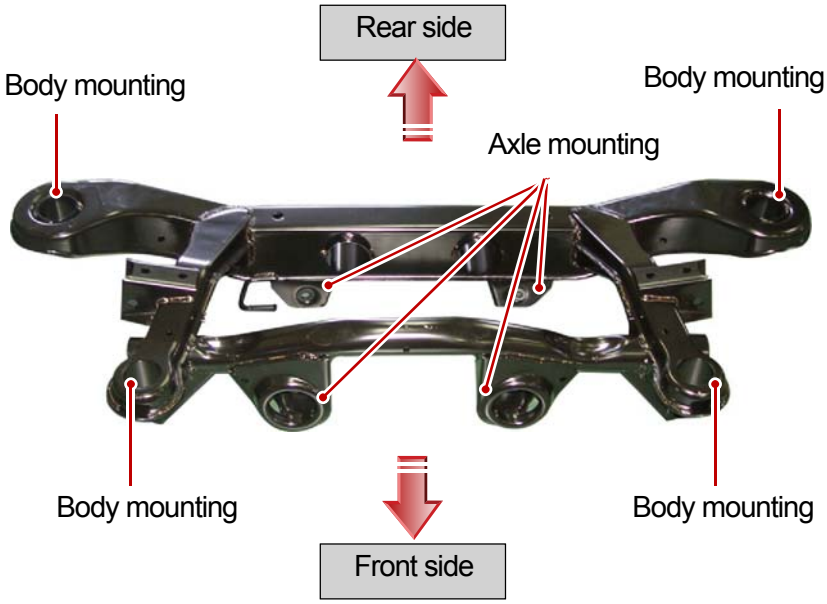
This kind of front sub frame system has the same mounting structure with the frame with HPS. But the EPS type steering gear box has no hydraulic pressure pipe since it is driven by the electric motor.



Modification basis	
Application basis	
Affected VIN	

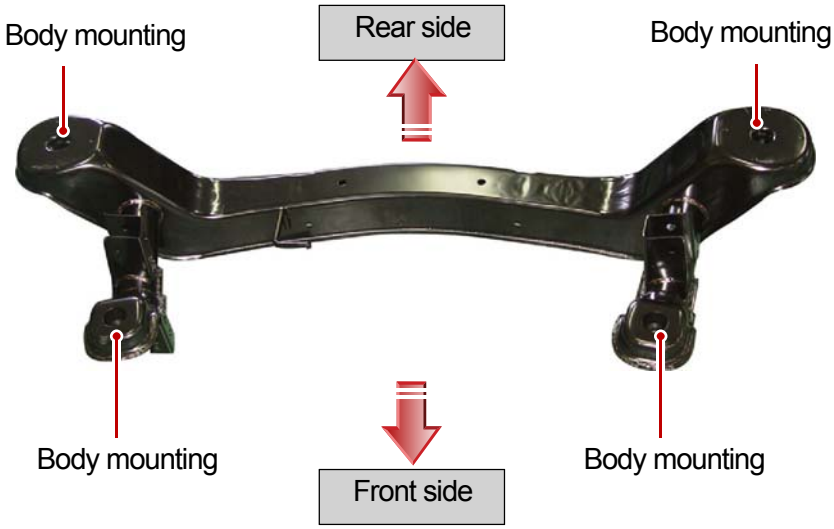


Rear sub frame assembly for 4WD



The rear sub frame for 4WD vehicle consists of 4 body (bush) mountings and 2 axle (direct) mountings which reduce the vibration from the powertrain and road, and also control the torque.

Rear sub frame assembly for 2WD



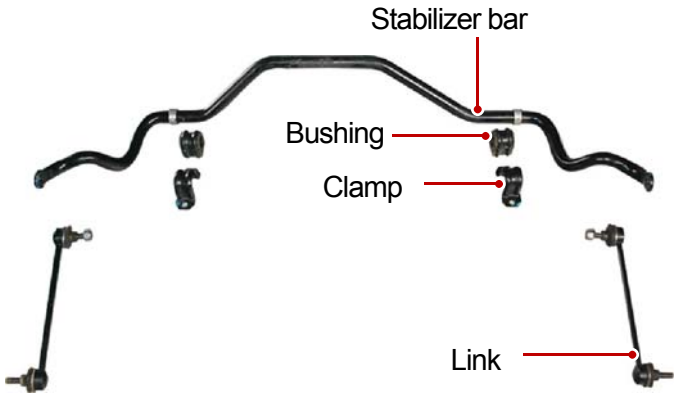
The rear sub frame for 2WD vehicle functions in the same way as the one for 4WD vehicle, but the structure is different from the one for 4WD. It consists of 4 body (bush) mountings.

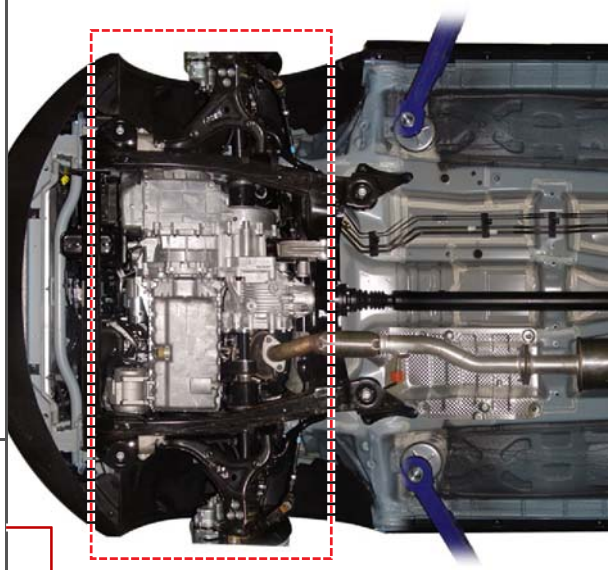
Modification basis	
Application basis	
Affected VIN	

5. FRONT SUSPENSION COMPONENT LAYOUT

Front suspension supports the vehicle weight and absorber the vibration from tires. And, in this type of suspension, the steering linkage tie rod is mounted on the knuckle. The Macpherson Strut suspension is an independent suspension which has a spring on the strut with a built-in shock absorber. The lower arm is installed on sub frame and large strut damper is installed on the knuckle to support the tire.

Stabilizer bar assembly

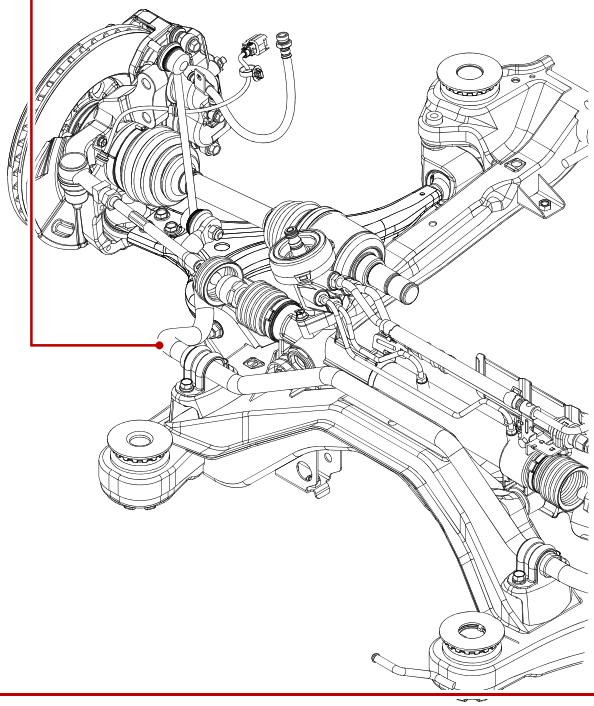




The stabilizer bar assembly is not activated if the left/right wheels move up/down simultaneously, but if both wheels move up/down differently it is activated with frame to minimize the tilting of the body.

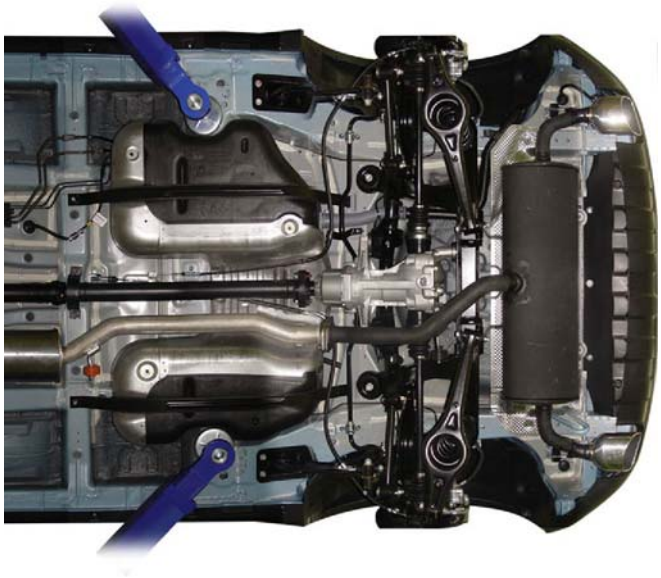
Lower arm assembly

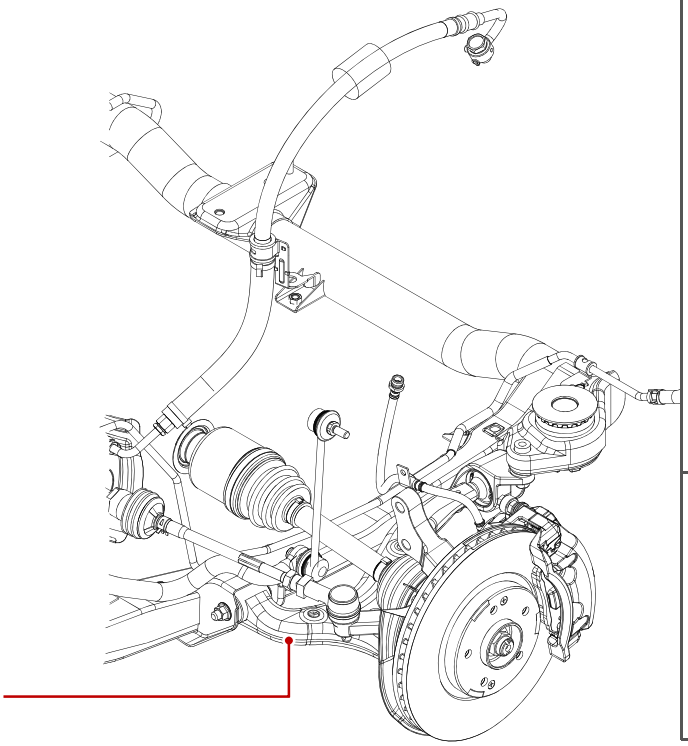




The lower arm assembly connects the frame and knuckle. It supports the load transferred to the tire knuckle, relieves the impact from the vehicle and ground conditions, and ensures driving stability.

Modification basis	
Application basis	
Affected VIN	





Front coil spring assembly

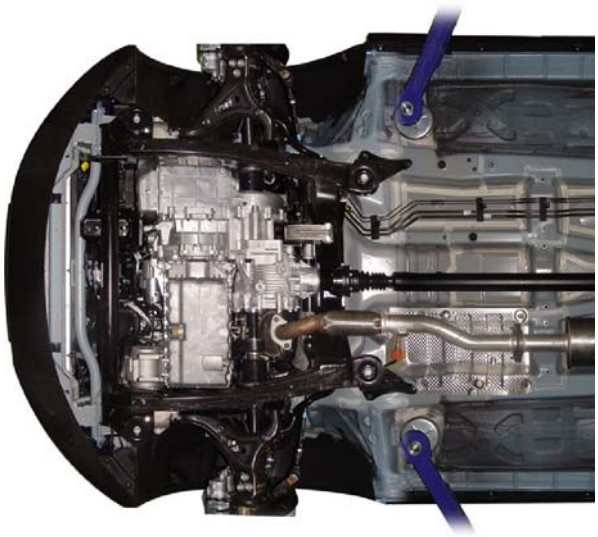


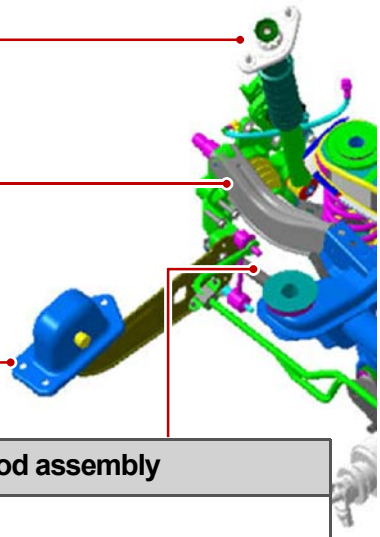
The coil spring is made by winding solid steel rod to form the coil shape. Its energy absorption rate per weight is higher than that of the leaf spring and it allows to absorb small vibration properly resulted in keeping the ride comforts. Therefore, it's difficult to make an effect on vibration damping because there is not any friction between coils.

Modification basis	
Application basis	
Affected VIN	

6. REAR SUSPENSION COMPONENT LAYOUT

Multi-link type suspension is the independent suspension. It provides good ride comfort and drivability by reducing the coil spring weight. Also, it increases the space for passenger compartment by lowering the floor.
This type of suspension consists of multiple links such as trailing arm, upper arm, lower arm and track rod.





Shock absorber assembly

This vehicle uses the gas shock absorber. This relieves the vertical vibrations of vehicle to provide ride comforts, prevents the spring break, enhances drivability, and extends the life span of steering components.



Upper arm assembly



Upper arm is installed between knuckle and sub frame and controls the lateral load and vehicle height.

Trailing arm assembly



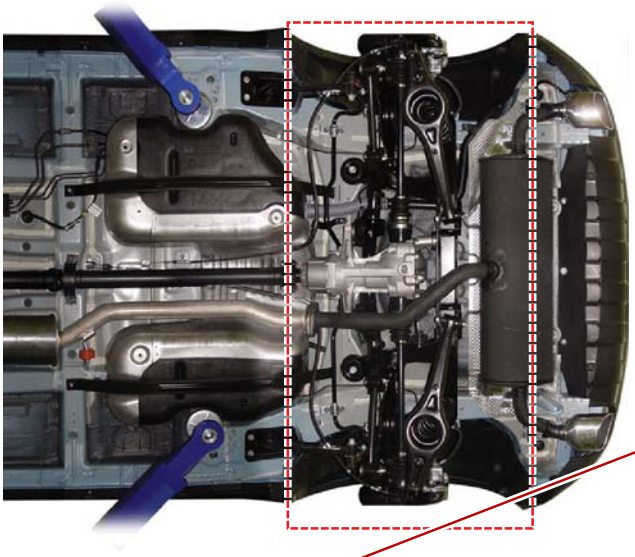
Trailing arm is installed between knuckle and vehicle body and controls the front and rear load.

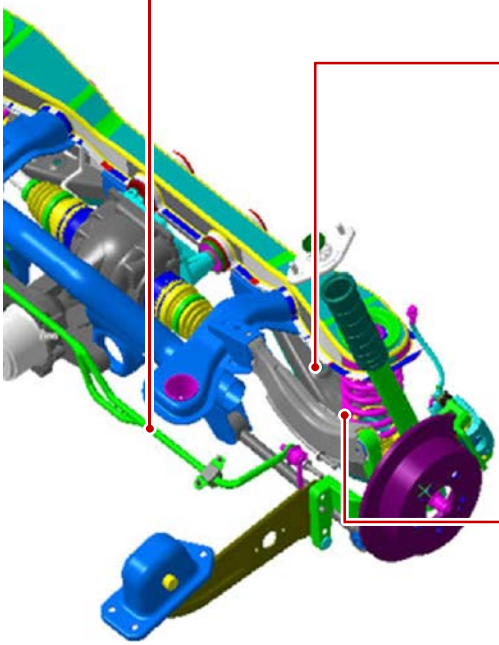
Track rod assembly



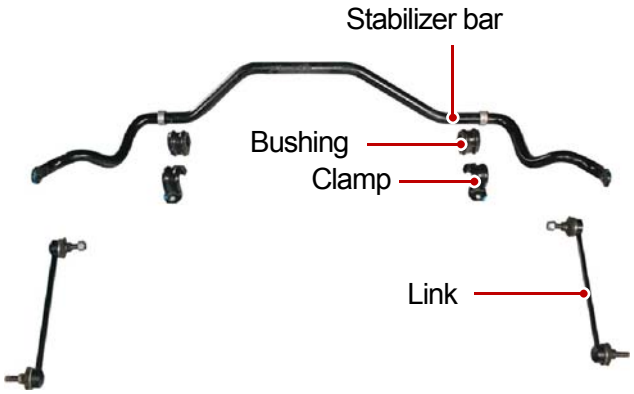
Track rod is installed between knuckle and rear sub frame and controls and compensates the lateral load.

Modification basis	
Application basis	
Affected VIN	





Stabilizer bar assembly



The stabilizer bar assembly is not activated if the left/right wheels move up/down simultaneously, but if both wheels move up/down differently it is activated with frame to minimize the tilting of the body.

Coil spring

Coil spring is installed between the coil spring link and body frame. It relieves the vibrations and impacts from wheels to vehicle body.



Lower arm assembly

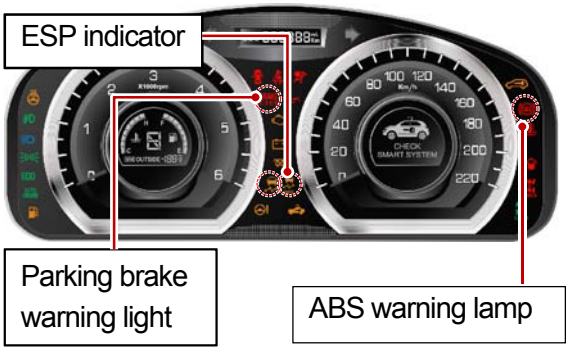


The lower arm is installed between knuckle and rear sub frame and relieves the load to coil spring from wheel. In other word, it controls the longitudinal load.

Modification basis	
Application basis	
Affected VIN	

7. BRAKE SYSTEM AND ESP SYSTEM LAYOUT

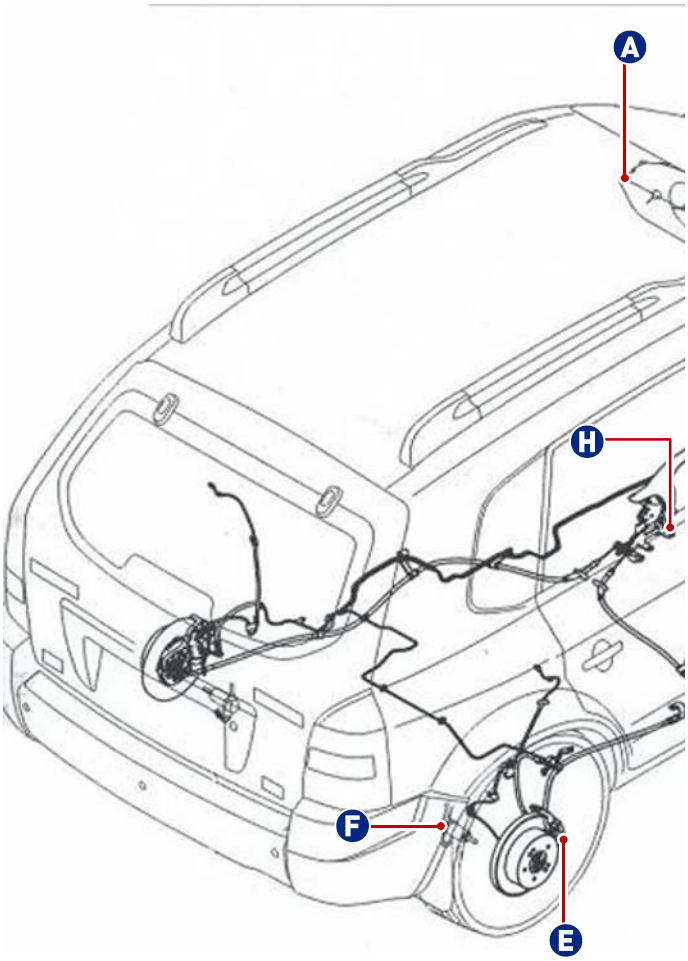
A. Indicators on instrument cluster



B. Master cylinder assembly



Description for master cylinder in this chapter is based on ABS/ESP equipped vehicle. For CBS, there is an extra pressure valve mounted to the master cylinder.

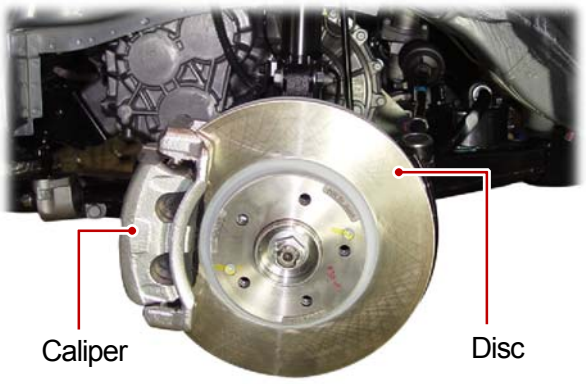


C. HECU assembly



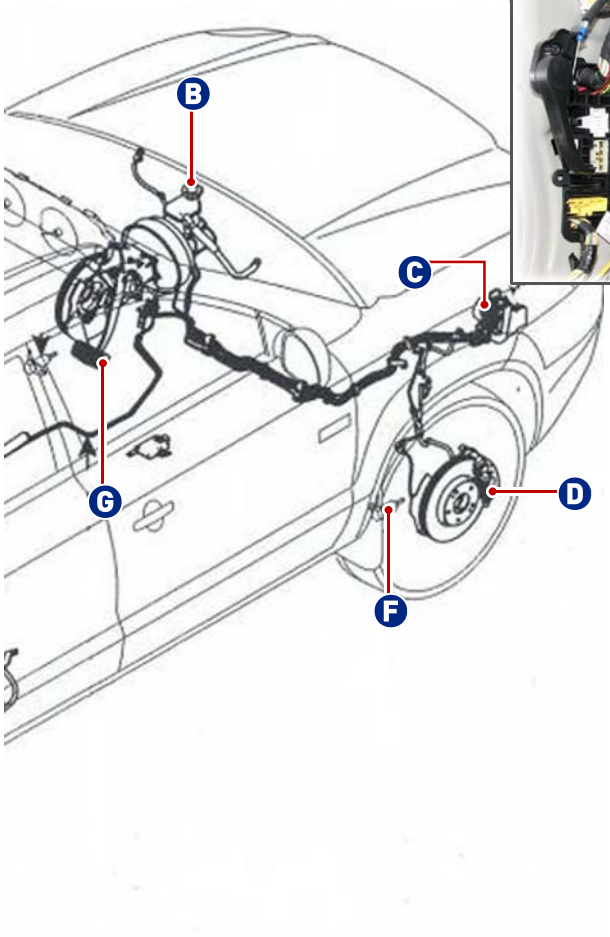
The HECU assemblies for ABS and ESP have similar appearance but they have different inner structure and connector connections from each other.

D. Front brake assembly

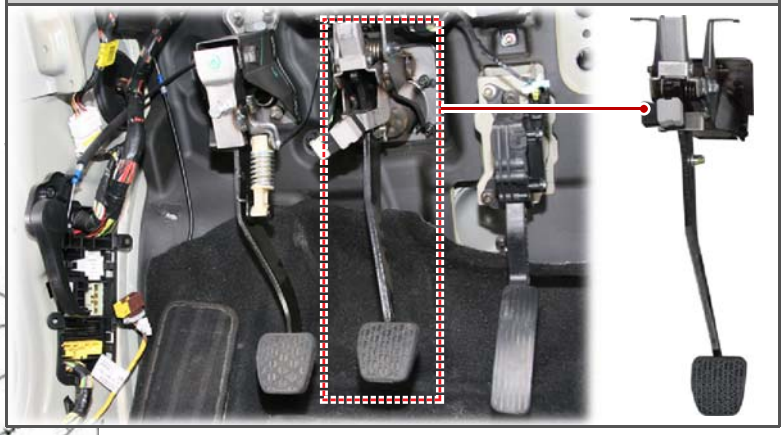


The disc brake for 4WD vehicle is the same with the one for 2WD vehicle.

Modification basis	
Application basis	
Affected VIN	



G. Brake pedal

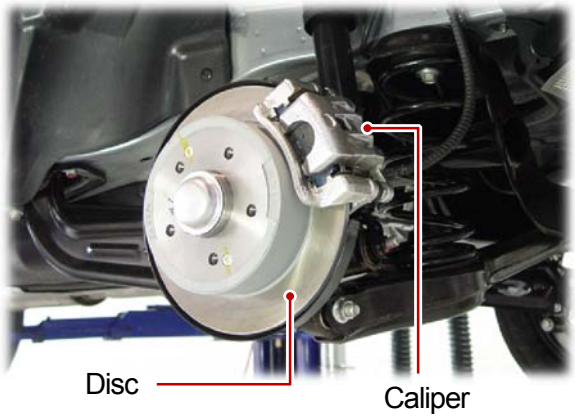


F. Parking brake

4WD and 2WD Front side	2WD Rear side
	

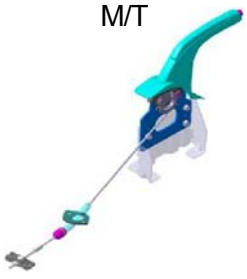
The wheel speed sensor for 4WD has the same structure and mounting location with the one for 2WD vehicle. But the rear side wheel speed sensor for 2WD vehicle has different sensor appearance and mounting status because the knuckle shape is different from the 4WD vehicle.

E. Rear brake assembly



The disc brake for 4WD vehicle has the same structure with the one for 2WD vehicle, but the appearance and knuckle shape is different from each other.

H. Parking brake

M/T	A/T
	

The parking brake is the mechanical device to hold the vehicle. When pulling up the lever, the parking brake cable between the lever and the rear drum brake trailing shoe pulls the parking brake lining to contact to drum.

8. STEERING SYSTEM LAYOUT

1) HPS (Hydraulic Power Steering)

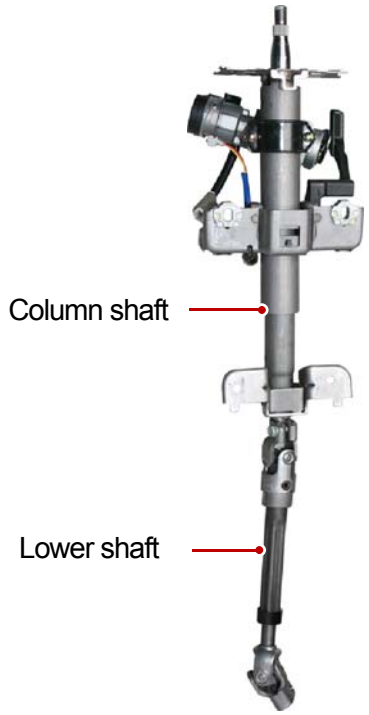
The hydraulic pump is a vane type pump and consists of the flow control valve and pressure relief valve.



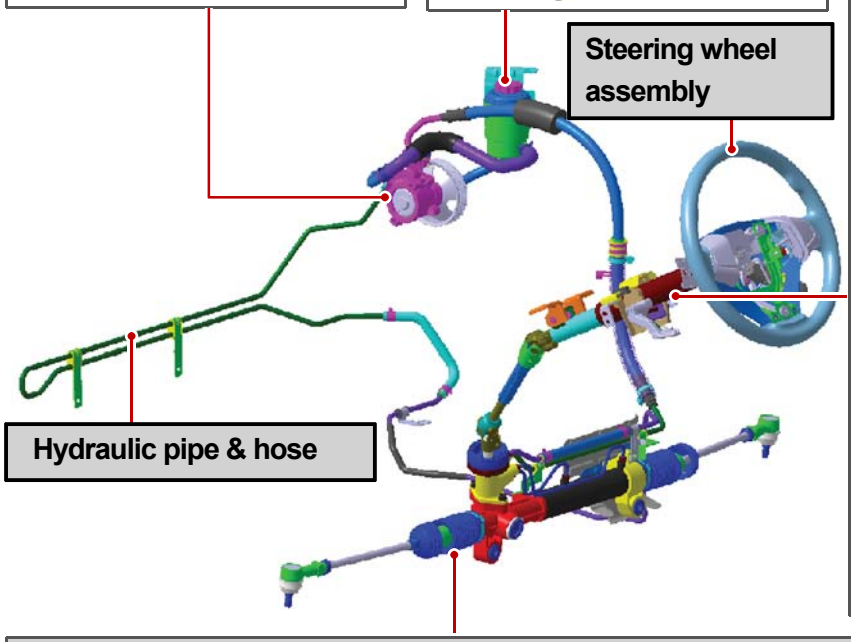
The oil reservoir sends the oil to the power steering pump and receives the oil from the power steering gear.



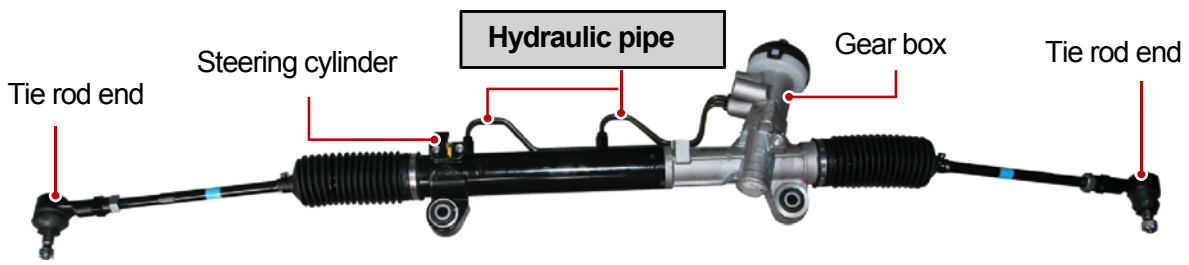
There is a shock absorber which is folded in the axial direction when the vehicle is crashed and a ignition switch assembly on the column shaft.



The lower shaft minimizes the torque change using a CV joint which has constant angular speed.



Steering gear box assembly



The steering gear box assembly consists of power cylinder and control valve. The power cylinder has a cylinder, piston and piston rod. The control valve directs the oil to one end face of the piston to enhance the steering force. There is a safety check valve which lets the driver steer manually when there is a malfunction in the hydraulic circuit.

Modification basis	
Application basis	
Affected VIN	

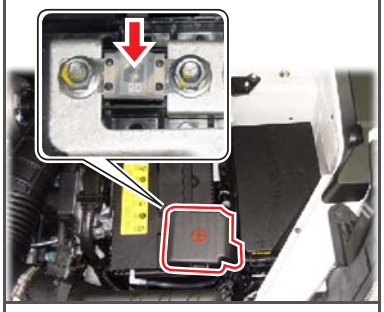
2) EPS (Electric Power Steering)

ECU



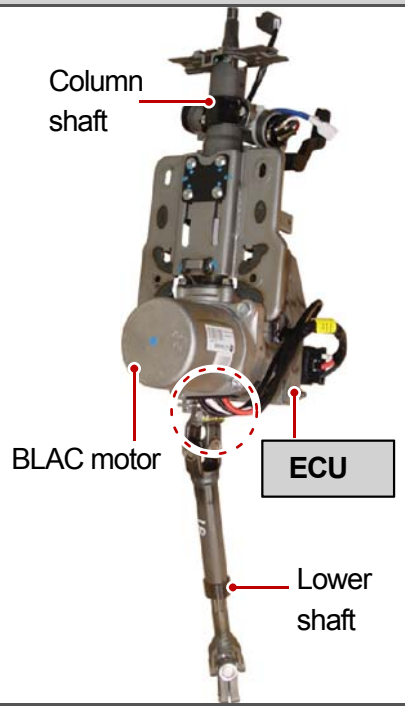
The ECU controls the electric power steering system depending on the driving conditions, based on the signals from the torque and angle sensor.

Fuse

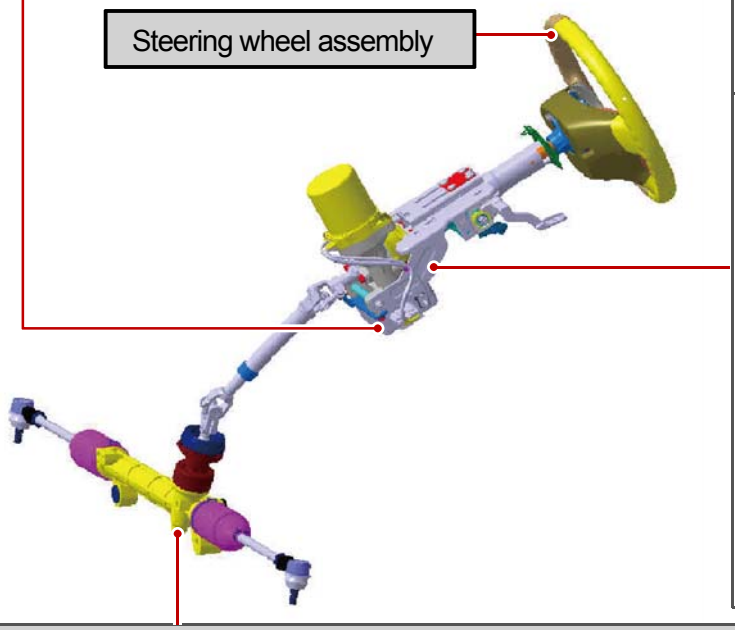


The vehicle with EPS has EPS fuse (80A) mounted to the positive (+) terminal of the battery, and this fuse supplies power to the EPS unit directly..

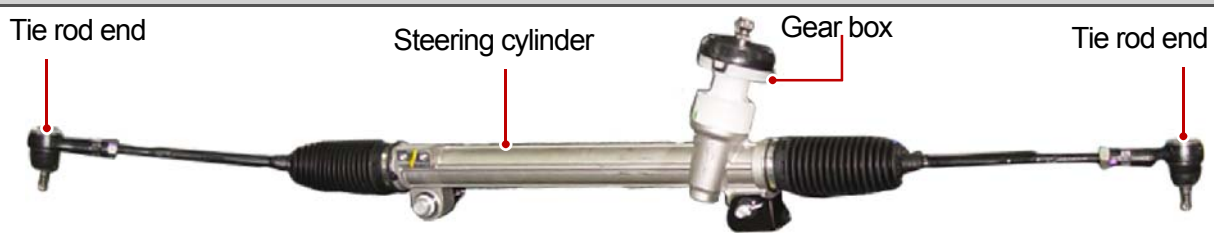
Colum shaft assembly



The column shaft assembly consists of BLAC motor, ECU, torque and angle sensors. The electric power steering (EPS) system uses the electric motor to assist the steering force. It functions independently regardless of whether the engine is running or not, unlike the existing hydraulic power steering.
The lower shafts functions in the same way as the hydraulic type.



Steering gear box assembly



When the driver turns the steering wheel, a torque is generated and the torque sensor and the steering angle sensor in the EPS system detect the rotation of the steering column to run the electric motor. At this time, the worm gear connected to the motor drives the helical gear mounted to the steering column to generate the assist torque for the steering column. This allows the driver to operate the steering wheel easier.

GENERAL INSTRUCTIONS

1. GUIDELINES FOR SERVICE WORKS

1) For Safety

To perform the service works easily ans safely, the service technicians must keep the proper working procedures and rules.
This manual provides the useful instructions to the service technicians so that they can perform the servive works with standard working process, skills, tips in time.
Please read this manual and follow the instructions carefully.

Signal words such as “WARNING”, “CAUTION” and “NOTE” have special meanings.

NOTE
indicates information to assist maintenance and instructions.

CAUTION
indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

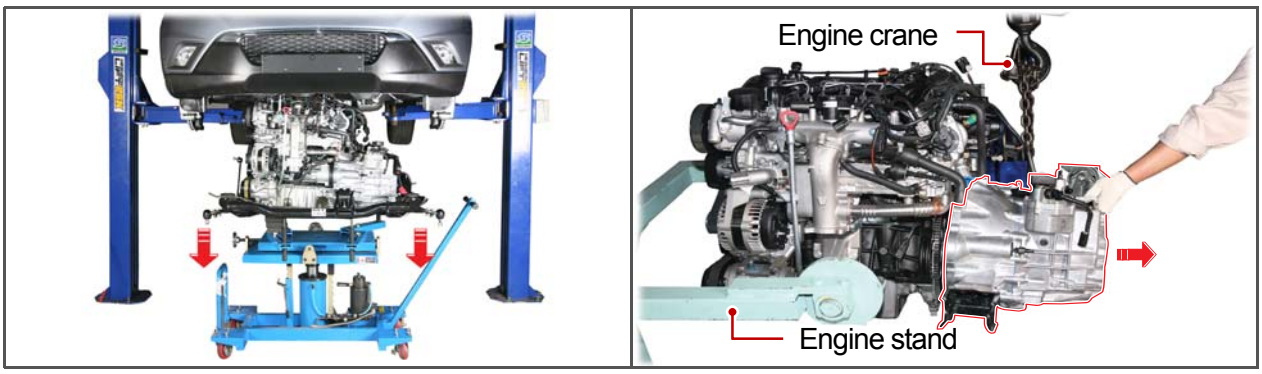
WARNING
indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

However, above references and cautions cannot be inclusive measures, so should have habits of paying attentions and cautions based on common senses.

Modification basis	
Application basis	
Affected VIN	

2) Equipment

- Korando is FF (Front Engine Front Drive) type vehicle, and engine and powertrain system are integrated into a module. Therefore, 2-post lift and general equipment are necessary when working on the engine and transmission.
- Major equipment: Engine and transmission jack, Engine stand, Engine crane, Transmission jack, Engine hanger



Remove the engine and transaxle as a set.

- Manual transaxle: Transaxle can be separated after removing the front module (sub frame, engine and transaxle).
- Automatic transaxle: Transaxle can be separated after removing the sub frame.

3) General Instructions

(1) Before lifting up the vehicle with a lift, correctly support the lifting points.
(2) When using a jack, park the vehicle on a level ground and place the wheel chocks under the tires. Position the jack under the frame and lift up the vehicle and then support with chassis stand before service work.
(3) Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
(4) If you have to work on vehicle, cover the seats and floor with protection covers to avoid any damage and contamination.
(5) Brake fluid and anti-freeze can damage the painted surface of body. So carefully handle them during service work.
(6) To improve the efficiency of service work, use only recommended and specified tools.
(7) Use only Ssangyong genuine spare parts.
(8) Never reuse the cotter pin, gasket, O-ring, oil seal, lock washer and self-locking nut. Replace them with new ones. If reused, normal functions cannot be maintained.
(9) Store the disassembled parts as a set based on disassembly order and unit.
(10) Pay particular attention not to miss or mix the fasteners.
(11) If necessary, especially for inspection, clean the removed parts completely.
(12) Apply the oil or grease on the running and sliding surfeces before installation. Use the specified sealant and gasket to prevent leakage if necessary.
(13) Tighten the fasteners to the specified tightening torque.
(14) As a final stage of service work, check if the serviced system is working properly and the problem has been eliminated clearly.

4) Basic Inspection

(1) Horn operation

- Listen for the horn sound when pressing the horn pad on the steering wheel.

(2) Brake operation

- Check if there is any abnormal noise, unusually long braking distance, or uneven braking force. If the brake warning lamp does not go out even after starting the engien or are flashing during driving, have the brake system checked immediately.
- Check the brake pipes and hoses for connection, oil leak, crack or interference after changing the position of tires. When replacing the tires, check the brake disc for surface condition and wear. Check the parking brake cable and brake operation. Shorten the checking interval if the parking
- brake is used frequently.

(3) Exhaust system

- Be aware to any changes in sound or smell from the exhaust system. These may be caused by leak or overheat. Have the exhaust system checked and repaired immediately.
- Inspect the exhaust system including catalytic converter. Inspect all the components and body frame near the exhaust system.

(4) Tires

- Unusual vibration of the steering wheel and seats or pulling to one side on the straight and level roads may indicates the uneven tire inflation pressure or poor wheel balance.

(5) Steering and suspension system

- Inspect the front and rear suspension and the steering system for damage, looseness or missing parts, signs of wear or lack of lubrication. Inspect the power steering line and the hoses for connection, leak, crack and chafing. Inspect the drive axle boot and seals for damage, tear or leak. Replace or repair the system if necessary.

(6) Engine oil

- Check the oil level when the engine is still warm and add the specified engine oil if necessary.

(7) Coolant

- Check the coolant level in the coolant reservoir, coolant conditions (contamination, foreign material), and hoses for damage and leak. Replace or add the Ssangyong genuine coolant, if needed.

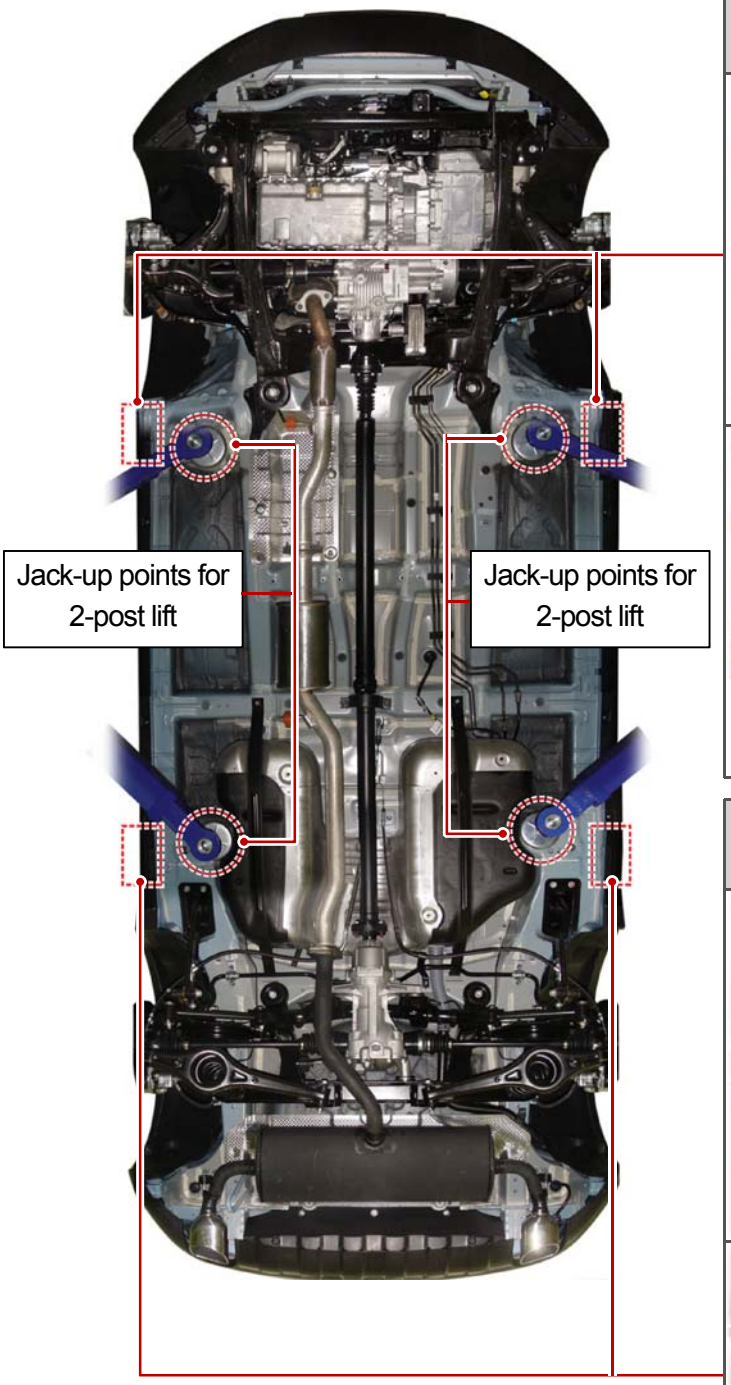
(8) Engine drive belt

- Check all drive belts on the engine for wear, crack and looseness. Retighten or replace the belt, if needed.

Modification basis	
Application basis	
Affected VIN	

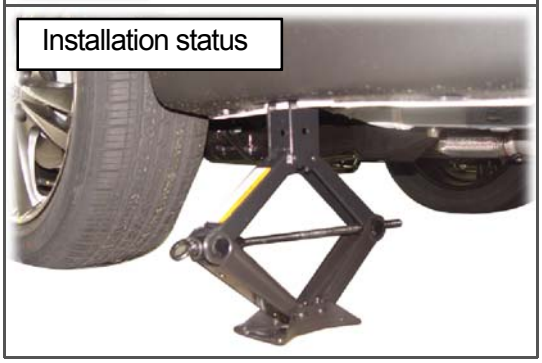
2. JACK-UP POINTS

▶ **Stand jack-up points and installation status (front side)**



Stand jack-up points and installation status (front side)





Stand jack-up points and installation status (rear side)

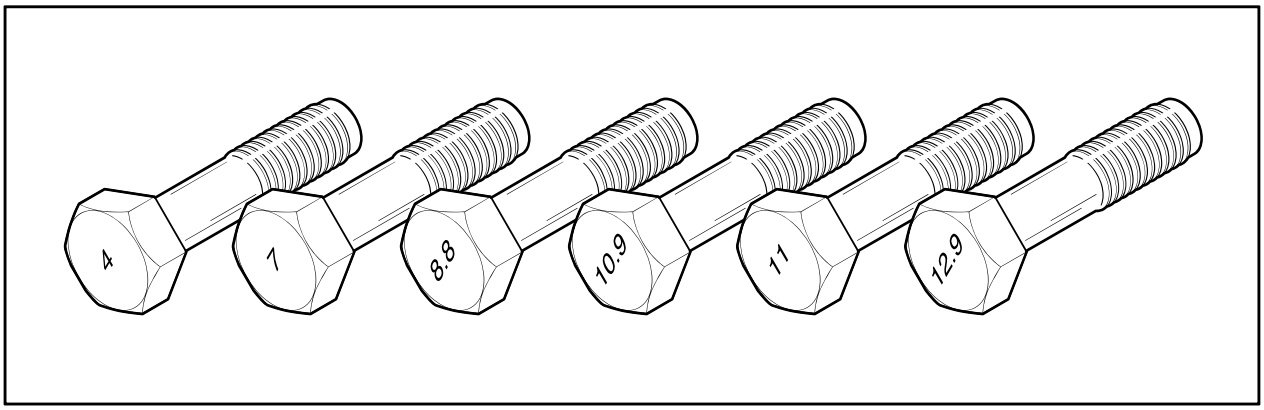




Modification basis	
Application basis	
Affected VIN	

3. STANDARD BOLTS SPECIFICATIONS

Bolt	Pitch	Tightening torque(kgf.cm)					
		Standard			Limit		
		4T	7T	9T	4T	7T	9T
M3	0.5	5	9	13	7	12	17
M4	0.7	12	20	30	16	27	40
M5	0.8	24	40	57	32	53	77
M6	1.0	41	68	99	55	91	130
M8	1.25	88	160	230	130	210	310
M10	1.25	190	330	470	260	430	620
	1.5	190	310	450	250	420	600
M12	1.25	350	580	840	460	770	1,100
	1.75	330	550	790	440	730	1,000
M14	1.5	550	910	1,300	730	1,200	1,900
M16	1.5	830	1,100	2,000	1,100	1,900	2,700
M18	1.5	1,200	2,000	2,900	1,600	2,700	3,800
M20	1.5	1,700	2,800	4,000	2,200	3,700	5,300
M22	1.5	2,300	3,800	5,400	3,000	5,000	7,200
M24	1.5	2,900	4,900	7,000	3,900	6,500	9,400
	2.0	2,800	4,700	6,800	3,800	6,300	9,100



1) Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2) Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max. allowable tightening torque if not required to do so. Determine extra proper tightening torque if tightens with washer or packing.
3) If tightens bolts on the below materials, be sure to determine the proper torque.
4)
   - Aluminum alloy: Tighten to 80 % of above torque table.
   - Plastics: Tighten to 20 % of above torque table.

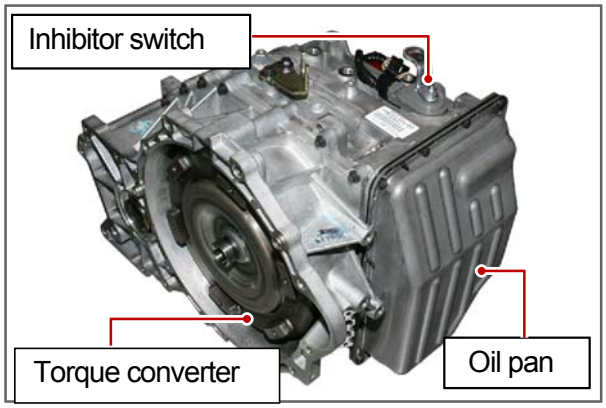
Modification basis	
Application basis	
Affected VIN	

DSI 6 SPEED AUTO TRANSAXLE

0000-00

GENERAL INFORMATION

1. GENERAL INFORMATION

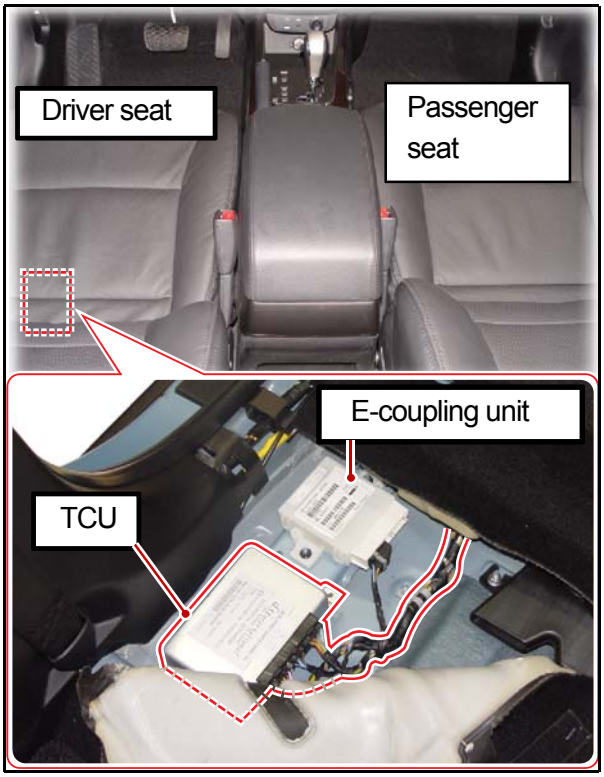


▶ **Automatic transaxle (M11)**

The Model 11 six speed automatic transaxle is available in two variants: four wheel drive and two wheel drive.

- Six forward speeds
- One reverse gear
- A toruqe converter with an integral converter lock-up clutch with slip control capabilities Electronic shift and pressure controls
- A single planetary gear-set
- A double planetary gear-set
- One hydraulically controlled brake bands
- Three multi-plate clutches
- One multi plate brake
- All hydraulic functions are directed by electronic
- solenoids to control:

1) Engagement feel
2) Shift feel
3) Shift scheduling
4) Modulated torque converter clutch applications

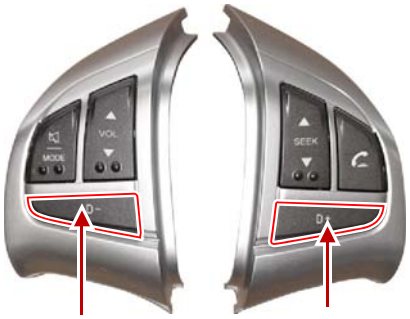


▶ **TCU (located under driver's seat)**

TCU is located under the driver's seat and controls the transaxle operations.
TCU is activated and deactivated by the ignition voltage, and connected to the transaxle through pin 26 in connector.
TCU receives and uses the signals from sensors and switches through CAN bus with analog and digital types.

▶ Tip switches on steering wheel

The shiftable gear can be adjusted by pressing the "UP (D+)" or "DOWN(D-)" switch when the gear selector lever is in "M" position.



▶ Meter cluster

This indicator shows the current position of the gear.





▶ Gear selector lever

Shift lock release button

If the selector lever cannot be moved from "P" or "N" position, try to move the lever while pushing down this button with finger. For safety, turn off the engine and depress the brake pedal before the attempt.

Lever positions

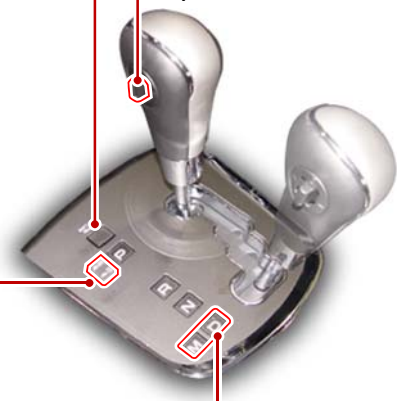
P : Park
R : reverse
N : Neutral
D : Drive

Mode switch

W: Winter mode (pressed "OUT")
S: Standard mode (pressed "IN")
Toggle the mode between winter mode and standard mode by pressing this switch.

Tip switch (manual shift switch)

The shiftable gear can be adjusted by moving this switch to forward and rearward when the gear selector lever is in "M" position.



Selection of Manual/Automatic Shift Function

D: Automatic shift according to the driving condition
M: Manual shift

Modification basis	
Application basis	
Affected VIN	

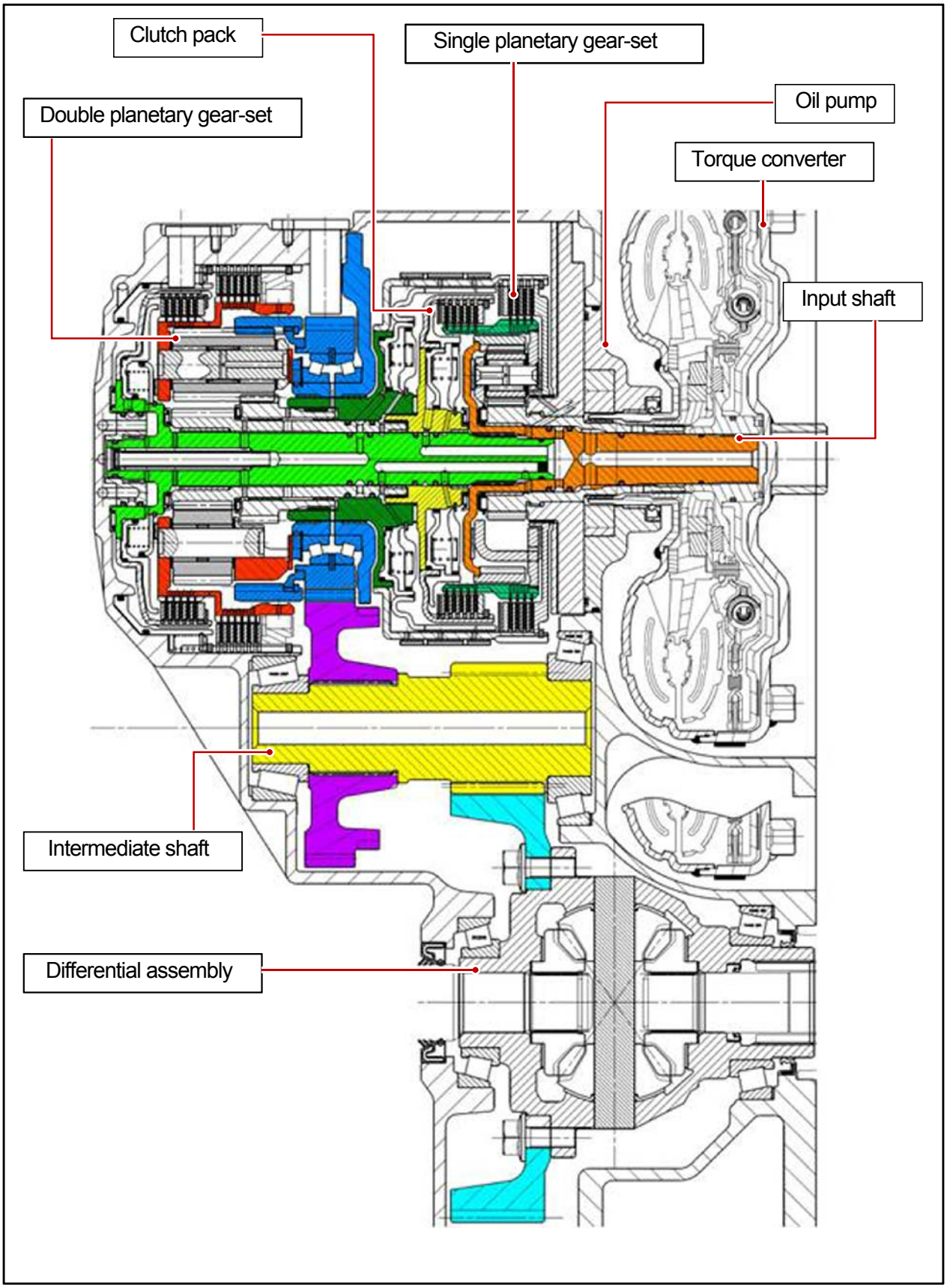
2. SPECIFICATIONS

1) Specifications

Descriptions		Specification
Gear ratio	1st gear	4.156
	2nd gear	2.375
	3rd gear	1.522
	4th gear	1.144
	5th gear	0.859
	6th gear	0.676
	Reverse gear	3.178
Oil	Type	Fuchs TITAN ATF 3292
	Capacity	approx. 7.5 L
	Change interval	EU: Inspect every 20,000 km or 12 months (But, change every 60,000 km under severe condition) General: Inspect every 15,000 km or 12 months (But, change every 60,000 km under severe condition)
Resistance of oil temperature sensor	-20	430.7 to 533.9 kΩ
	0	146.8 to 175.7 kΩ
	20	56.74 to 65.86 kΩ
	100	3.201 to 3.399 kΩ
Inhibitor switch	D	2.686 kΩ ±8%
	N	5.036 kΩ ±8%
	P	8.953 kΩ ±8%
	R	16.786 kΩ ±8%

Type/Weight	M11 6-speed automatic transaxle / approx. 102 kg (including ATF)
TORQUE	400 Nm
Overall length / Center length	367 mm / 205 mm

2) Sectional Diagram



Modification basis	
Application basis	
Affected VIN	

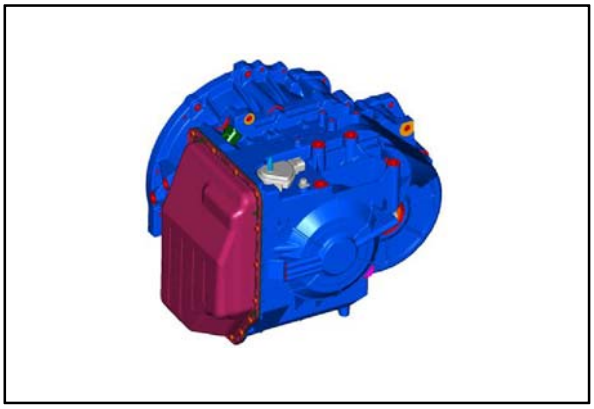
3. TIGHTENING TORQUE

Descriptions		Size x Numbers	Tightening torque (Nm)
Automatic transaxle	Engine side mounting bolt	17 mm X 4	85.0 to 100
	Oil pan and engine side mounting bolt	14 mm X 4	56.0 to 62.0
	Oil filler plug	16 mm	25.0 to 30.0
	Oil drain plug	Hexagon 5 mm	25.0 to 30.0
Valve body	Assembly mounting screw	T30 mm X 9	16.0
	Oil pan bolt	10 mm X 15	7.0 to 8.0
	VBS screw	T30 mm	4.0
	Valve body screw	T30 mm X 25	16.0
Torque converter	Mounting bolt	13 mm X 6	40.0 to 42.0
Cable	Link nut (switch side)	13 mm X 1	13.7 to 19.6
	Link nut (cable side)	12 mm X 1	14.7 to 22.5
	Mounting nut (floor side)	12 mm X 1	17.6 to 21.6
	Mounting nut (dash panel side)	12 mm X 2	17.6 to 21.6
TGS lever	Mounting nut	12 mm X 4	17.6 to 21.6
TCU	Mounting nut	8 mm X 2	5.0 to 6.0
Inhibitor switch	Mounting nut	12 mm X 2	3.9 to 7.8
Transaxle bracket	Left bracket	17 mm X 3	85.0 to 100
	Right bracket	17 mm X 4	85.0 to 100
	Upper bracket	17 mm X 4	85.0 to 100
Oil cooler pipe	Mounting bolt	10 mm X 2	Max.: 13.0
	Bracket mounting bolt	10 mm X 1	13.0

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW





Engine power reaches the transaxle via a torque converter with integral converter lock-up clutch. The six forward gears and one reverse gear are obtained from a single planetary set, followed by a double planetary set. This type of gear-set arrangement is commonly known as Lepelletier type gear-set.
The Model M11 6 speed automatic transaxle is electronically controlled. The control system is comprised of the following components:

- External transaxle control unit (TCU)
- Internal embedded memory module (EMM)
- Input and output speed sensors
- Valve body unit comprised of four ON/OFF solenoid valves and six variable bleed solenoids (VBS)
  Torque converter
-

TCU controls the oil pressure for various internal clutches and bands to select the gear. It also controls the electronic elements, shift pressure and torque converter slip. If the system is defective, TCU provides FMEC (Failure Mode Effect Control) to maintain the functionality of transaxle. This keeps the basic function of transaxle (gear selection) even when there are failure in controls and power supply.

There are selector shaft position sensor (inhibitor switch) and oil temperature sensor in transaxle. In manual mode, TCU receives the information from TGS (Transmission Gear Selector) through PCB (Printed Circuit Board) when driver selects the manual shift mode. TCU communicates with other electric control modules through CAN. In order to ensure a safe driving state and to prevent damage to the automatic transmission, TCU switches to Limp-Home mode in the event of critical faults.

Modification basis	
Application basis	
Affected VIN	

2. FEATURES

1) Advantages

▶ Early Downshift with Hard Braking and Skip Shifts

When heavy braking is detected, the transaxle downshifts early and skips gears to provide increased engine braking to provide gear selection for tip-in.

▶ Gear Hold going Uphill/Downhill

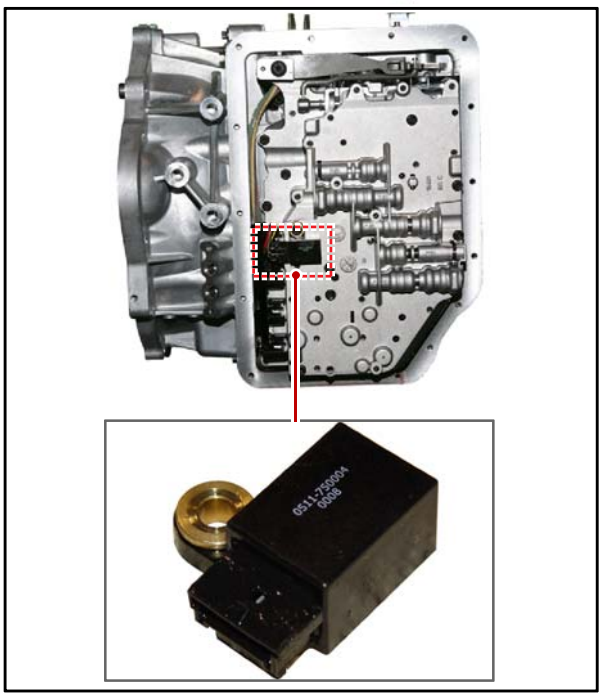
If the accelerator pedal is released when traveling uphill, upshifts are prevented to reduce busyness on grades. If the accelerator pedal is released when traveling downhill, upshifts are prevented to enhance engine braking.

▶ Drive and Reverse Engagement

A soft engagement feature avoids harsh take up of drive when selecting Drive or Reverse. This is achieved by limiting engine speed and engine torque which results in a rapid, but progressive engagement of either Drive or Reverse when moving from the Park or Neutral positions. Drive and Reverse engagements from either Park or Neutral are performed in less than 2.2 seconds. There is no drive engagement prevention strategy implemented on the transaxle system as there is sufficient engine strategy to protect the system. However, reverse engagement is prevented until engine speed is less than 1,400 rpm and the accelerator pedal position is less than 12% and vehicle speed is less than 10 km/h.

▶ Converter Clutch Lock-Up In All Gears

The transaxle features converter clutch lock-up in all gears. This feature provides improved fuel economy and vehicle performance. It also improves transaxle cooling efficiency when towing heavy loads at low speeds, e.g. in city driving or hill terrain.



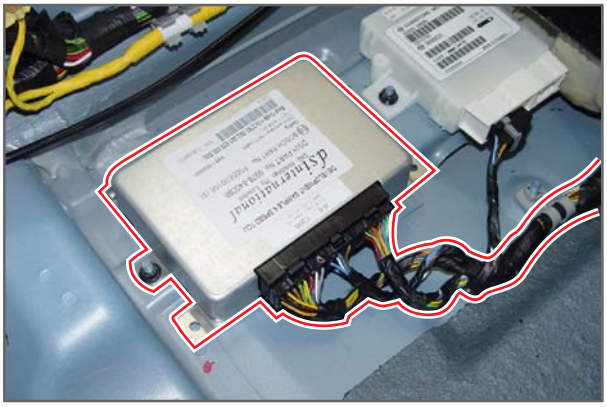
▶ Embedded Memory Module (EMM)

The embedded memory module (EMM) is matched to the transaxle's valve bodies during transaxle assembly to ensure refined shift quality. The EMM is used to store data such as valve body calibration data and valve body serial number. Upon installation, the TCU will download the data from the EMM and utilize this data in the operation of the transaxle.

2) Transaxle Cooling

The transaxle cooling system ensures rapid warm-up and constant operating temperature resulting in reduced fuel consumption and refined shift quality.
It also includes a cooler by-pass within the hydraulic system to allow sufficient lubrication to the transaxle drivetrain in the event of a blockage in the transaxle cooler.

3) Shift Strategy



▶ **Gear Change**

Transaxle gear change is controlled by the TCU. The TCU receives inputs from various engine and vehicle sensors to select shift schedules and to control the shift feel and torque converter clutch (TCC) operation at each gear change.

▶ **Coast down**

Coast down down shifts occur at 0% pedal when the vehicle is coasting down to a stop.

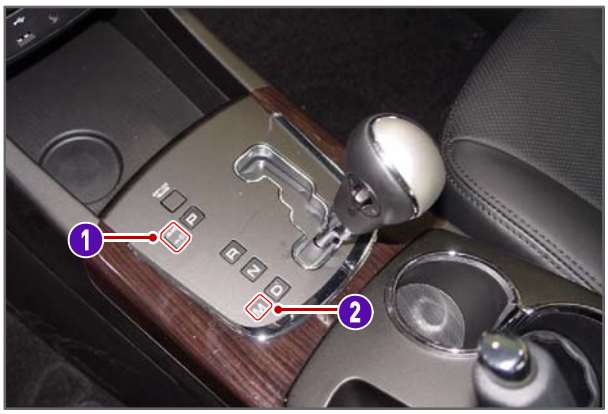
▶ **Torque Demand**

Torque demand down shifts occur (automatically) when the driver demand for torque is greater than the engine can provide at that gear ratio. If applied, the transaxle will disengage the TCC to provide added acceleration.

Modification basis	
Application basis	
Affected VIN	

3. MODES AND FUNCTIONS

1) Mode Switch



▶ **W: Winter mode (pressed "OUT")**

To select the winter mode, press the mode switch. The winter mode indicator (W) in the instrument cluster comes on. To return to standard mode, press the switch again. The indicator goes out. Use this mode to drive off smoothly on an icy and slippery road.

▶ **S: Standard mode (pressed "IN")**

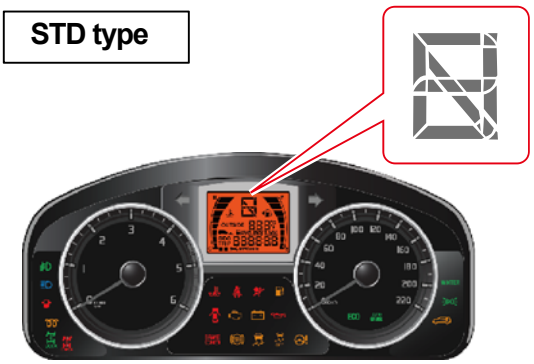
Use the standard mode in normal driving condition.

2) M Mode (Manual Mode)

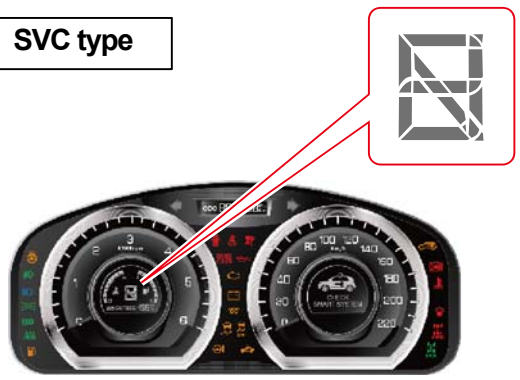


This allows the driver to define the highest possible gear by selecting "+" or "−" on the gear selector when the lever is in the "M" position. When the lever is first moved to the manual "M" position the transaxle will select the lowest possible gear.

STD type



SVC type



▶ 1st Gear State

- The 1st gear state will display on the instrument cluster. Unlike the normal 1st gear, engine braking will be available in this manual 1st state.

▶ 2nd Gear State

- The 2nd gear state will display on the instrument cluster. 2-1 automatic kick-down shifts are available. 2nd gear has engine braking available.

▶ 3rd Gear State

- The 3rd gear state will display on the instrument cluster. 3-2 and 3-1 automatic kick-down shifts are available. 3rd gear has engine braking available.

▶ 4th Gear State

- The 4th gear state will display on the instrument cluster. 4-3 and 4-2 automatic kick-down shifts are available. 4th gear has engine braking available.

▶ 5th Gear State

- The 5th gear state will display on the instrument cluster. 5-4 and 5-3 automatic kick-down shift is available. 5th gear has engine braking available.

▶ 6th Gear State

- The 6th gear state will display on the instrument cluster. 6-5 and 6-4 automatic kick-down shifts are available. 6th gear has engine braking available.

Modification basis	
Application basis	
Affected VIN	

4. LIMP HOME MODE

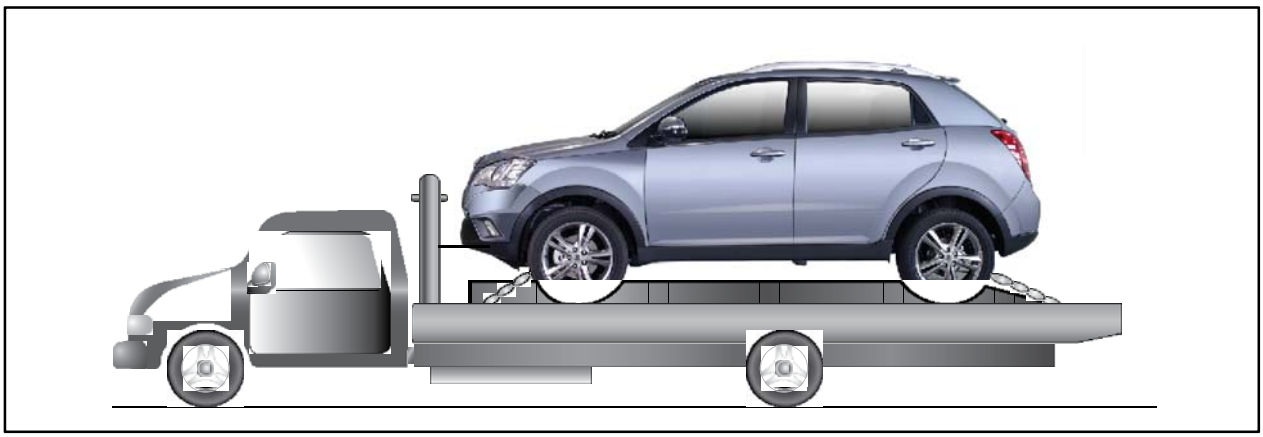
▶ When the transaxle is defective

1. In the event of a system fault, the TCU also provides for failure mode effect control (FMEC) to maintain maximum functional operation of the transaxle.
2. In the event of a total loss of control or electrical power, the basic transaxle functions (Park, Reverse, Neutral and Drive) are retained. The 4th and reverse gear ratios with the torque converter clutch in the unlocked state are the retained gear states the hydraulic system supports without any electrical assistance.
3. The TCU communicates with other vehicle electronic control modules by the controller area network (CAN). If a major fault develops, the transaxle may automatically operate in a "limp home" (failure) mode to enable the vehicle to be driven to an authorized dealer for repair.
4. The TCU also provides for transaxle diagnostics, which meet the requirements of OBD II legislation, monitoring all components which may effect vehicle emissions.

▶ When the transaxle overheats

1. Limp home mode may also be engaged if the battery charge falls below 8V.
2. If the transaxle overheats, the shift patterns will automatically change to enable improved transaxle cooling.
3. During transaxle overheat, the instrument cluster transaxle selector position display and the over temperature condition is indicated by flashing the “W(Winter)” indicator on the instrument cluster until normal transaxle operating temperature is reached.

▶ Towing the automatic transaxle equipped vehicle



CAUTION

- Flat-bed equipment is the best method of moving a disabled vehicle to avoid any damages.
- For AWD vehicle: The vehicle must be towed with a wheel lift and dollies or flatbed equipment with all the wheels off the ground.
  For 2WD vehicles: It is acceptable to tow the vehicle with the rear wheels on the ground without dollies and the front wheels off the ground. When being towed by a commercial towtruck and wheel dollies are not available, the front of the vehicle should be lifted, not the rear.

5. TRANSAXLE ELECTRONIC CONTROL SYSTEM

1) General Information

The transmission control unit (TCU) and its input/output network control the following transmission operations:

- Shift timing
- Line pressure
- Clutch pressure (shift feel)
- Torque converter clutch

also uses these signals when determining transaxle operating strategy. Using all of these input signals, the TCU can determine when the time and conditions are right for a shift, or when to apply or release the torque converter clutch. It will also determine the pressure needed to optimise shift feel. To accomplish this, the TCU operates six variable bleed control solenoids and four on/off solenoids to control transaxle operation.

2) TCU (Transmission Control Unit)



The transaxle control unit (TCU) is mounted under the driver's seat and controls the operation of the transaxle.
The TCU is activated and deactivated by the ignition power supply and is connected to the transaxle link harness by a 26 pin connector. The TCU processes information received from internal sensors and signals received across the CAN bus in analogue and digital forms such as:

- Transaxle input speed
- Transaxle output speed
- Accelerator pedal position
- Gear selector position
- Engine torque
- Engine speed
- Transaxle fluid temperature
- Brake pedal status
- Engine oil temperature
- Engine coolant temperature
- Ambient air temperature
- Barometric pressure

Modification basis	
Application basis	
Affected VIN	

This information is used by the TCU to decide which shift pattern to select and for shift energy management. Electro-hydraulic solenoid valves and variable bleed solenoids control the transaxle gear changes.
Six variable bleed solenoids and four on/off solenoids are used to direct transaxle fluid flow to control the fluid pressure within the three clutches and two bands. Separate pressure regulators are used exclusively for torque converter clutch control and main transaxle line pressure.
The TCU monitors all TCU inputs and outputs to confirm correct system operation. If a fault occurs the TCU is able to perform default action and inform the driver of the problem through the instrument cluster warning lights. Detailed information is available via trouble codes which can be read with the service tool.

3) Shift Map Selection

The driver can manually select between normal (S) and winter modes (W) via the mode switch. Depending on the transaxle temperature, uphill and downhill grades and altitude, shift maps will be selected by the TCU to suit the driving conditions. The following maps are available.

▶ Standard (Normal) Mode

Normal Mode is selected when the lever is in the D position with the mode switch in the normal (S) position and the transaxle is within normal temperature ranges. Shift schedule points are optimised for fuel efficiency and general driving conditions.

▶ Uphill and Downhill Mode

In this mode, depending on the load of the vehicle, adaptive shift maps are selected to progressively adjust the shift points and torque converter lock points.

▶ Altitude Mode

Shift points are automatically adjusted at higher altitudes to compensate for changes in engine torque where the torque produced by the engine is greatly reduced by the effects of reduced barometric pressure and temperature.

▶ Winter (W) Mode

When winter mode is selected, starting in second gear is facilitated and the WINTER mode indicator light is switched ON. To prevent wheel spin on slippery surfaces, the transmission will not allow first gear unless manually overridden.

▶ Warm up Schedule

Used typically when transaxle fluid temperature is below 20°C.
The torque converter will not lock-up below 20°C to assist in transaxle warm-up.

▶ Hot Mode

The hot mode is progressively applied between temperatures of 110° ~ 200°C. The torque converter lock-up is increased to prevent heat generation by the torque converter.

Above 110℃	the electrical radiator fans are switch ON
Above 130℃	the engine torque will be reduced and the W light on the instrument cluster will flash
Above 200℃	the transaxle will neutralise until the fluid temperature falls below 200°C as a final protection.

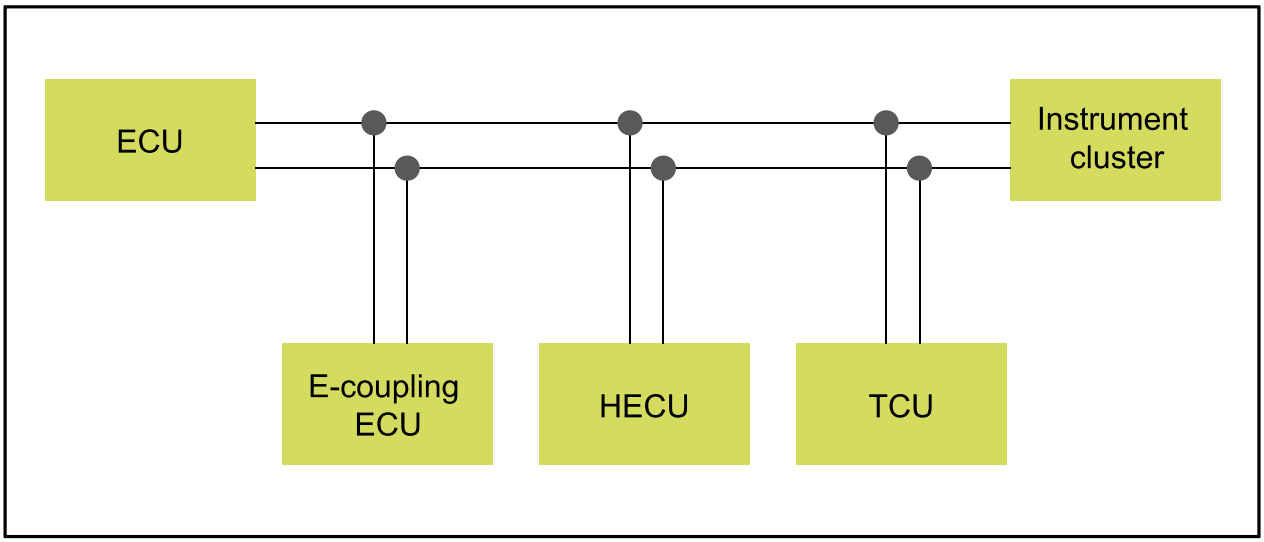
Activation of the hot mode inhibits other transmission performance features including uphill and downhill compensation and altitude compensation. Some degradation in shift feel may be experienced as the torque converter is not unlocked during shifting.

▶ Cruise Control Mode

When cruise control is activated the engine ECU may request the transaxle to downshift under trailing throttle conditions to increase engine braking.

6. CAN NETWORK

▶ **Schematic Diagram of Network Communication**



The TCU sends signals to be used by other vehicle systems via the CAN bus, such as:

- Selector lever position
- Selected gear state
- Manual mode activation
- Output torque
- Transaxle fluid temperature
- Engine torque reduction requests

7. POWER TRANSFER

Power transfer modes are as follow:

- Manual: 1st gear (position M)
- Drive: 1st gear
- Drive: 2nd gear
- Drive: 3rd gear
- Drive: 4th gear - limp home mode
- Drive: 5th gear
- Drive: 6th gear

1) Gear Selection and Engagement Element

Gear	Gear ratio	Engagement element (clutch/band)					
		C1	C2	C3	B1	B2	1-2 OWC
M1	4.156		ON			ON	
1st	4.156		ON				ON
2nd	2.375		ON		ON		
3rd	1.522		ON	ON			
4th	1.144	ON	ON				
5th	0.859	ON		ON			
6th	0.676	ON			ON		
Reverse	3.178			ON		ON	

Gear	ON/OFF solenoid valve				Variable bleed solenoid valve (VBS)					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
M1	ON				1	0	1			
1st	ON				1	0			0-1	
2nd	ON			ON	1	0		1	0-1	
3rd	ON		ON		1	0	1		0-1	
4th					0	0			0-1	
5th		ON			0	1	1		0-1	
6th		ON		ON	0	1		1	0-1	
Rev.	ON	ON	ON		1	1	1		0-1	

Modification basis	
Application basis	
Affected VIN	

2) Power Flowing Sequence

Engine →



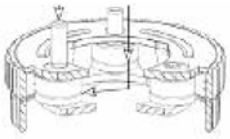
Torque converter

This is a fluid clutch. Transfers the power from engine to transaxle and amplifies the torque.

→ 

Input shaft

Transfers the power from torque converter to front planetary gear.

→ 

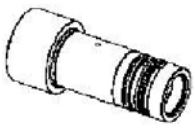
Front planetary gear

Generates the gear ratio and transfers the power.

→ 

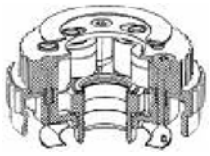
C2 clutch

Engaged by hydraulic pressure and transfers the power to C1 clutch.

→ 

Forwarding sun gear

Transfers the power from torque converter to rear planetary gear.

→ 

Rear planetary gear

Generates the gear ratio and transfers the power.

→ 

C1 clutch

Engaged by hydraulic pressure and transfers the power to C1 clutch.

→ 

Center support

Transfers the power from input shaft to intermediate shaft.

→ 

Intermediate shaft assembly

Changes the rotating direction and generates the final reduction rear ratio.

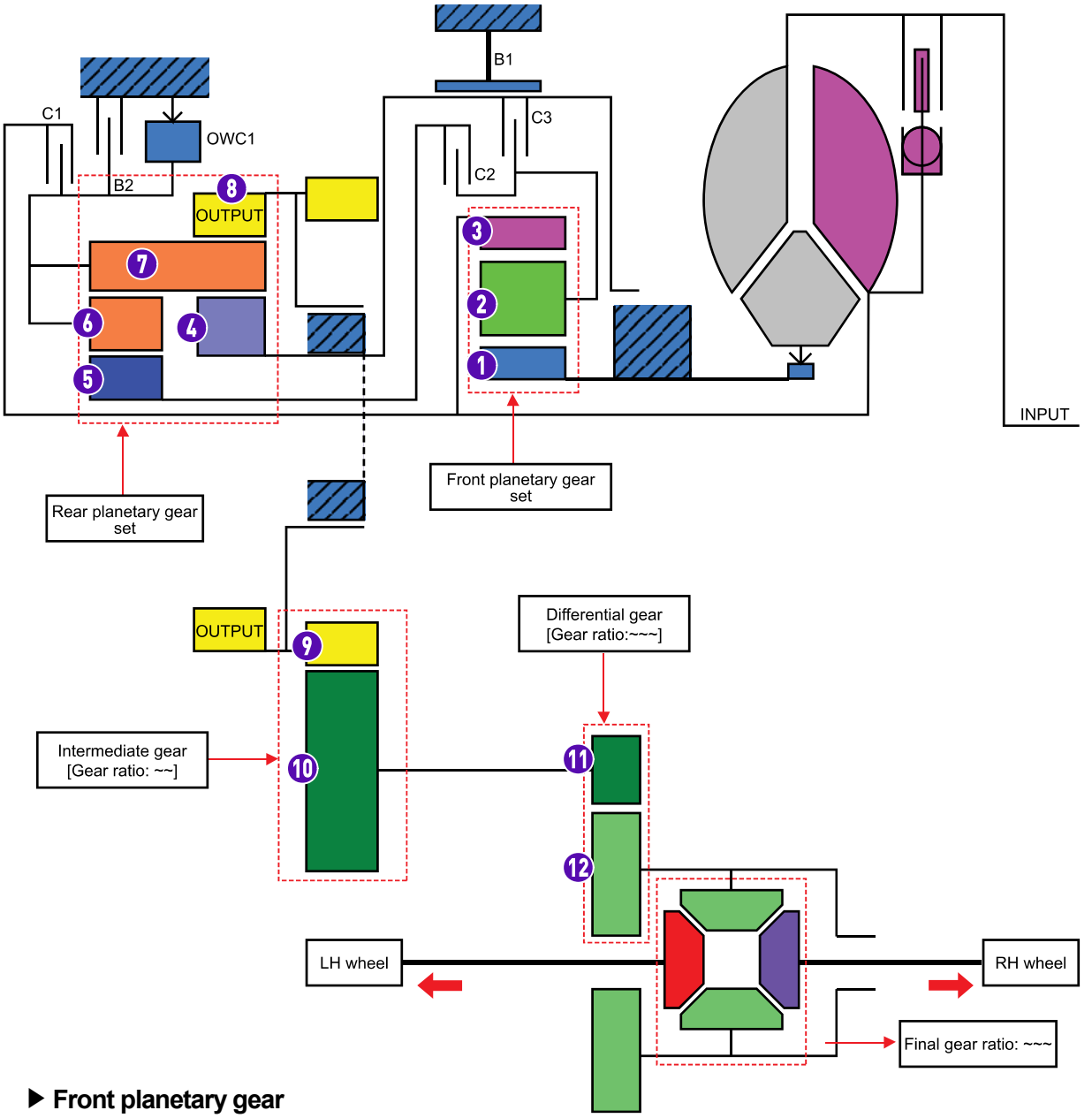
→ 

→ Universal joint

inal reduction and differential gear

Generates the final reduction gear ratio and performs the differential function.
Transfers the power to constant velocity shaft.

3) Power Flow



▶ **Front planetary gear**

1. Front sun gear (FSG)
2. Planetary hear pinion (PP)
3. Ring gear (Internal)

▶ **Rear planetary gear**

4. Forward sun gear (FSG)
5. Reverse sun gear (RSG)
6. Short pinion (SPP)
7. Long oinion (LPP)
8. Ring gear (RG)

▶ **Intermediate gear**

9. Drive gear
10. Driven gear

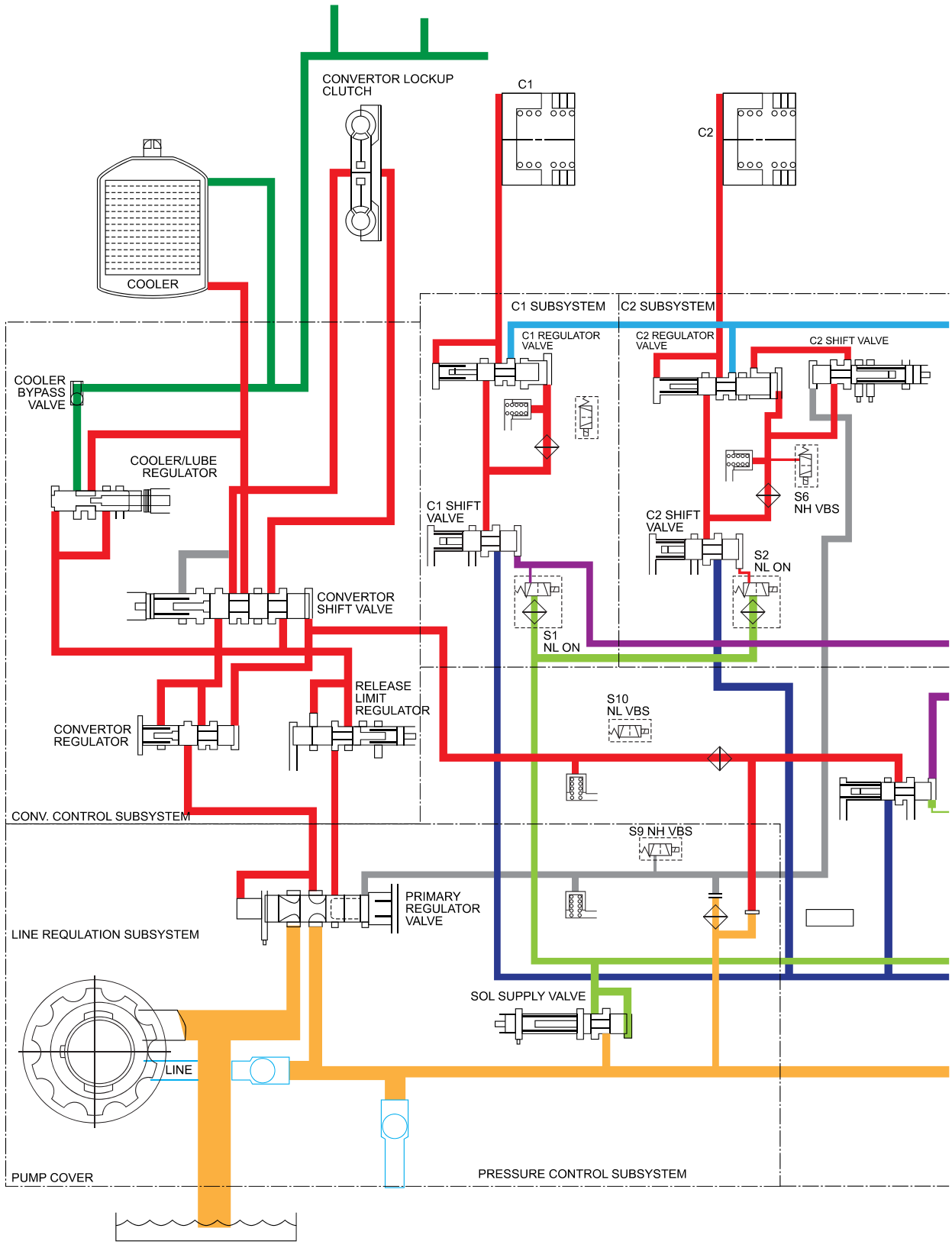
▶ **Differential gear**

11. Pinion
12. Differential

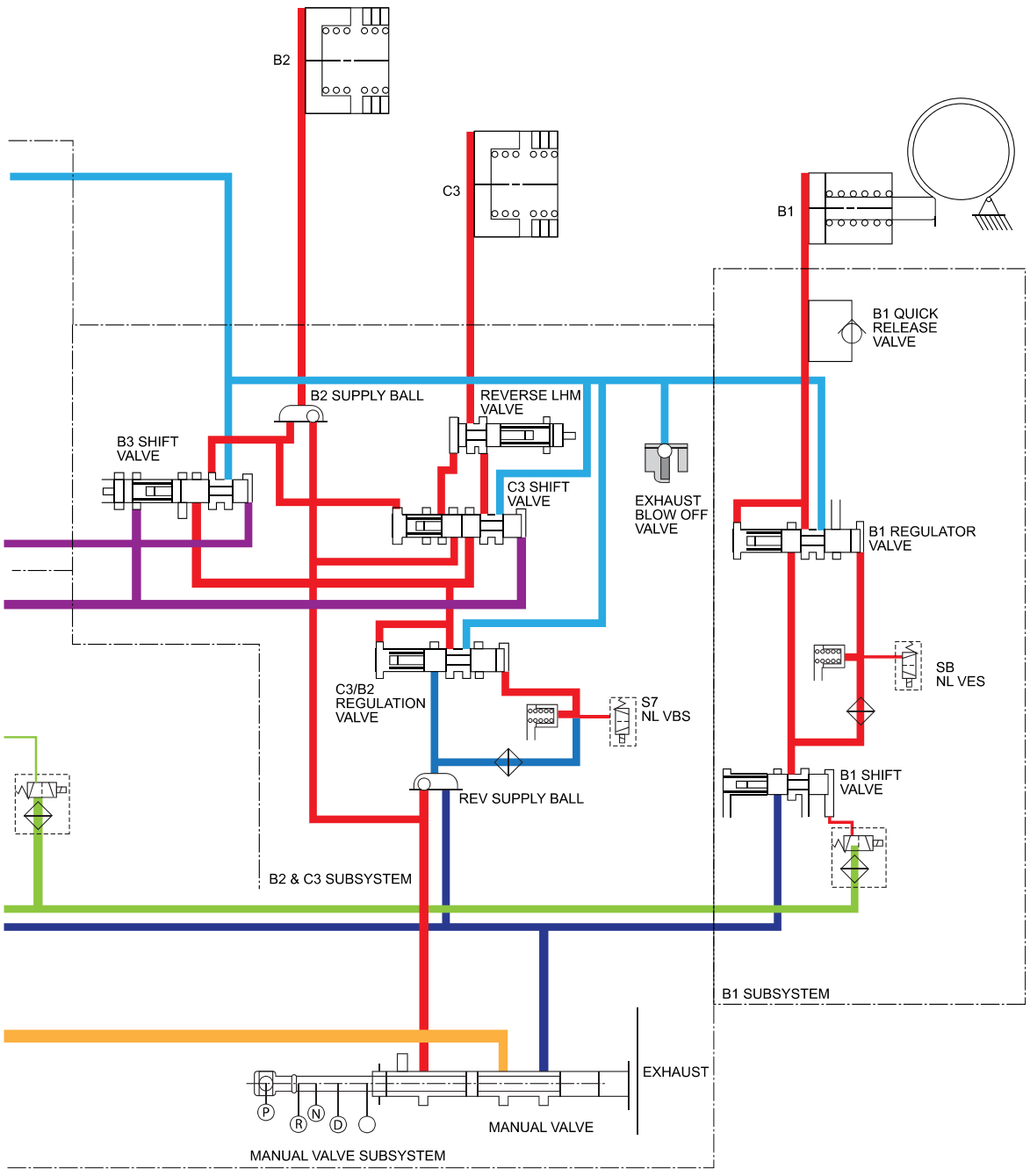
Modification basis	
Application basis	
Affected VIN	

Memo

3) Hydraulic Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

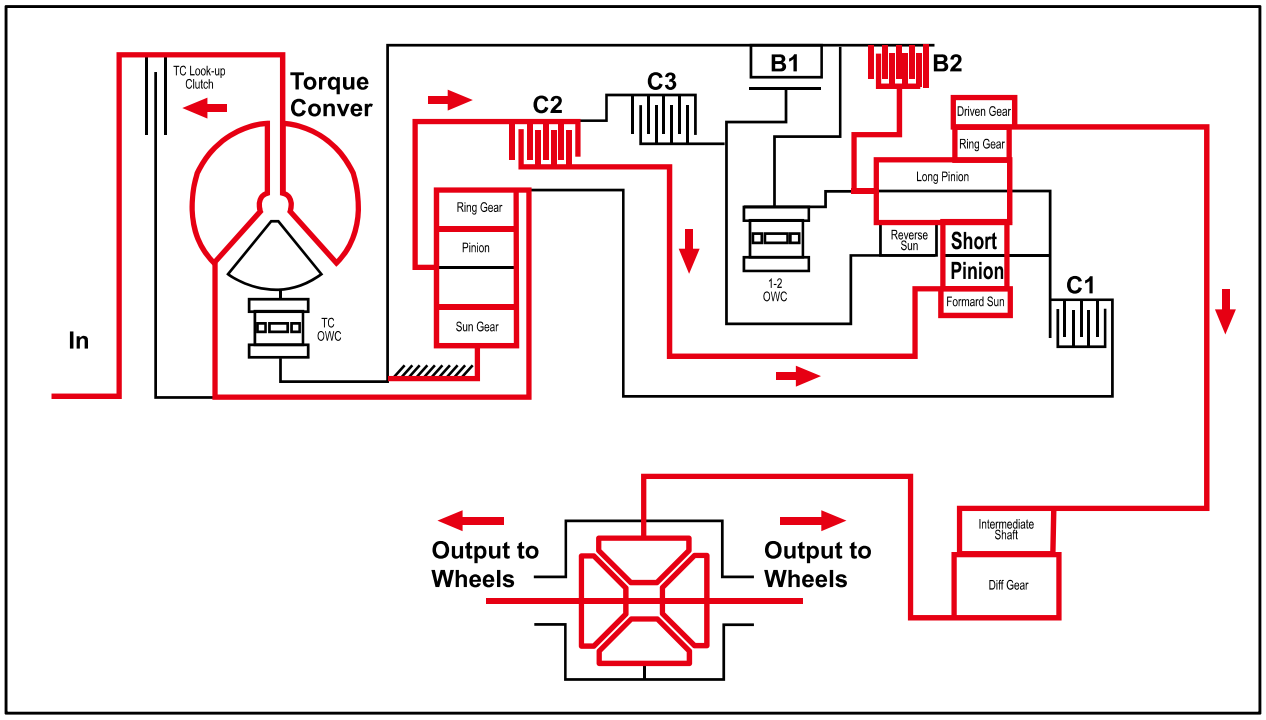


Modification basis	
Application basis	
Affected VIN	

4) Power Transfer in Each Gear

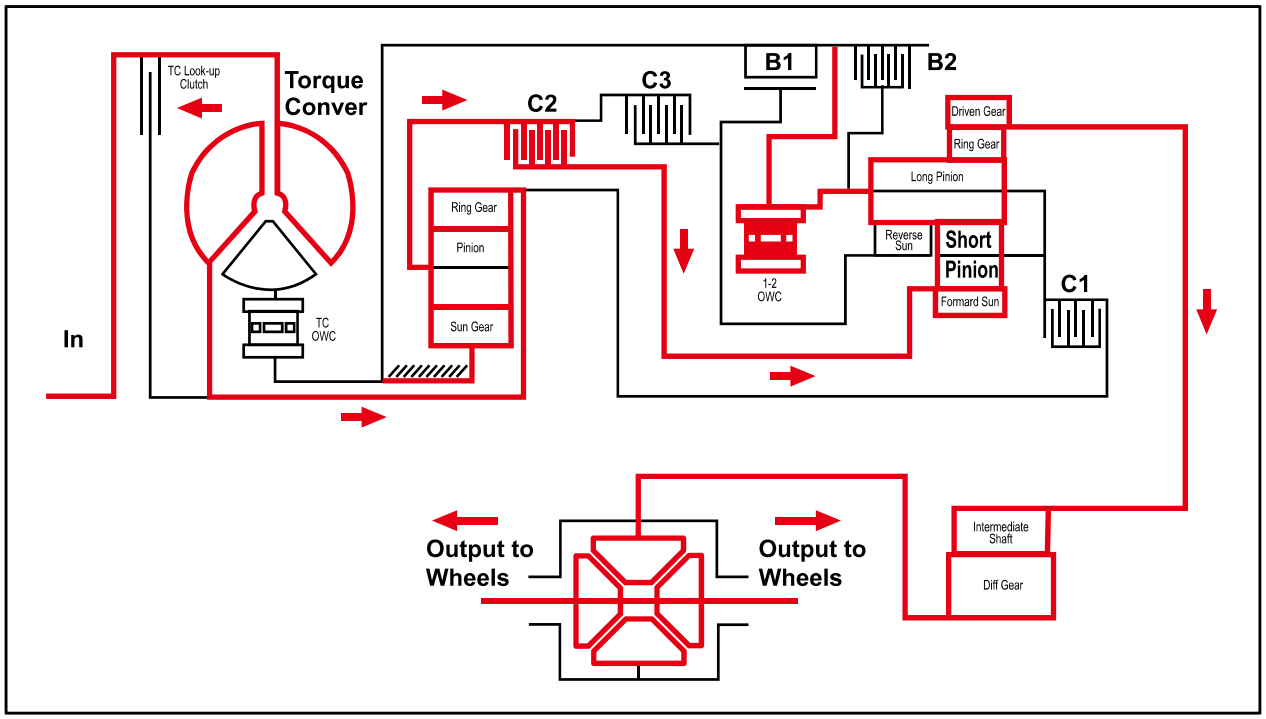
(1) Manual (position M) - 4.156 : 1

▶ **Power flow**



(2) Drive 1st Gear (1st Auto) - 4.156 : 1

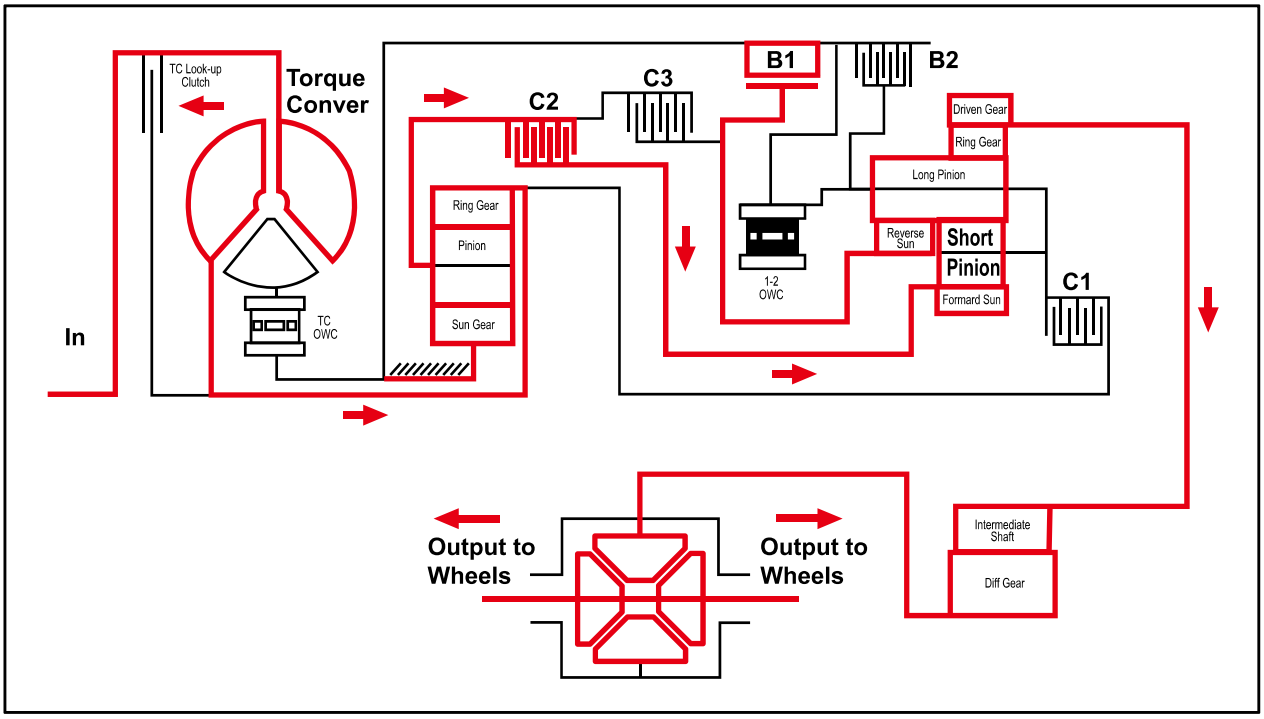
▶ **Power flow**



Modification basis	
Application basis	
Affected VIN	

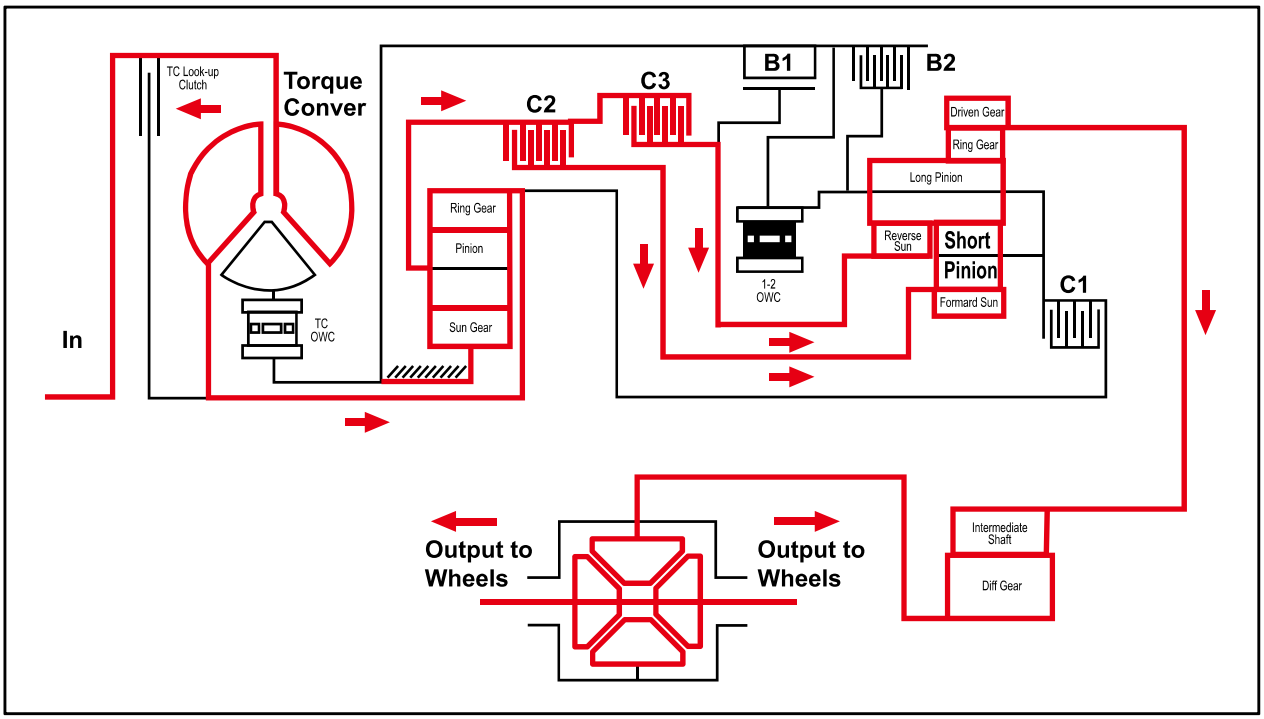
(3) Drive 2nd (2nd Auto) - 2.375 : 1

▶ **Power flow**



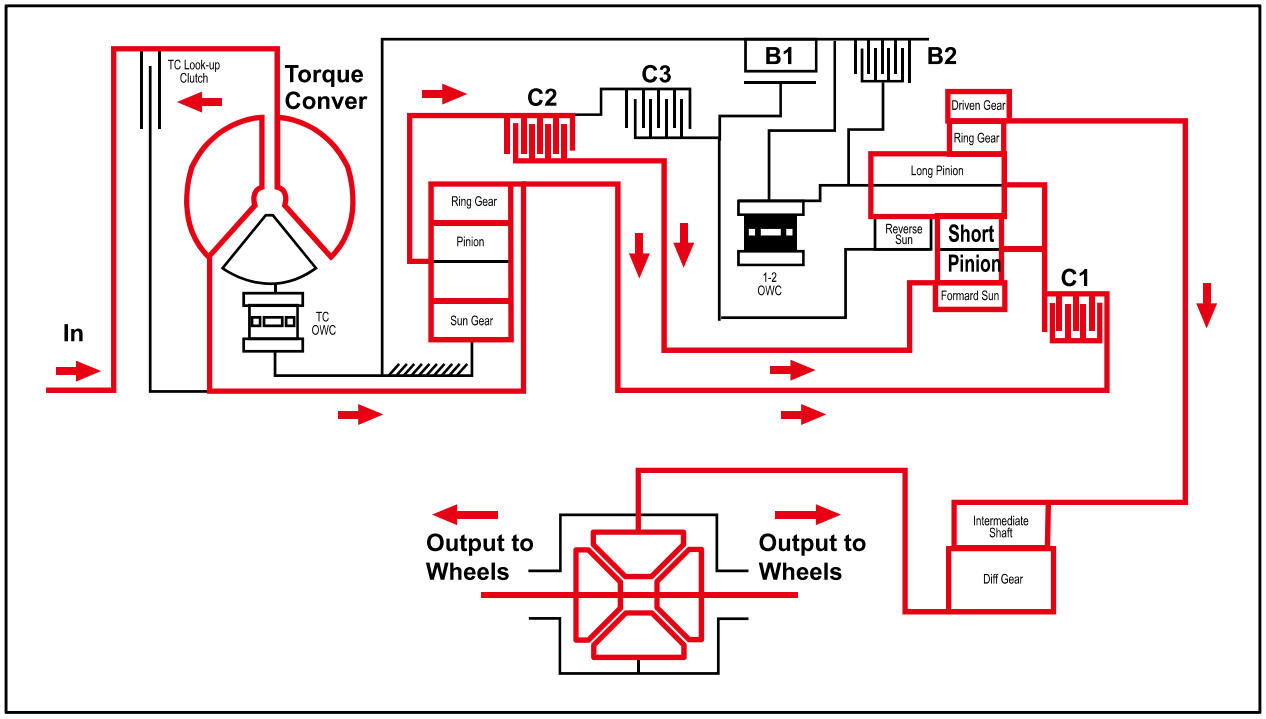
(4) Drive 3rd (3rd Auto) - 1.522 : 1

▶ **Power flow**



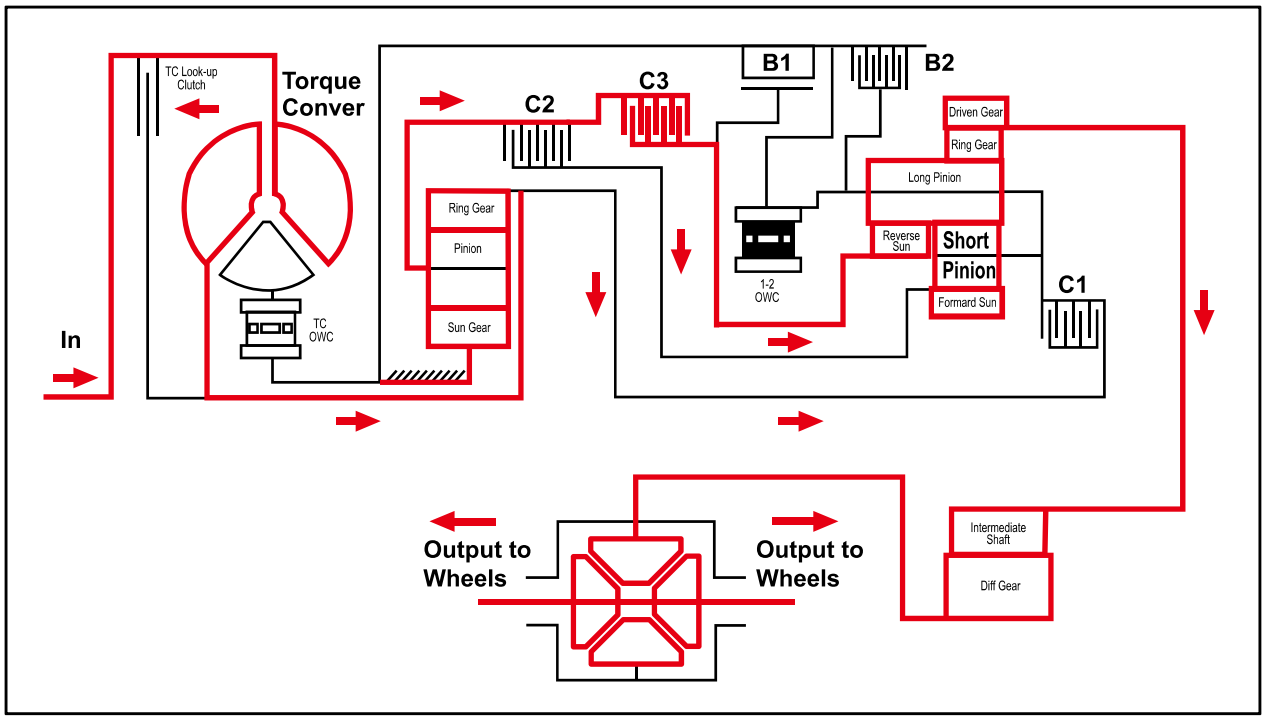
(5) Drive 4th (4th Auto) - 1.144 : 1

▶ **Power flow**



(6) Drive 5th (5th Auto) - 0.859 : 1

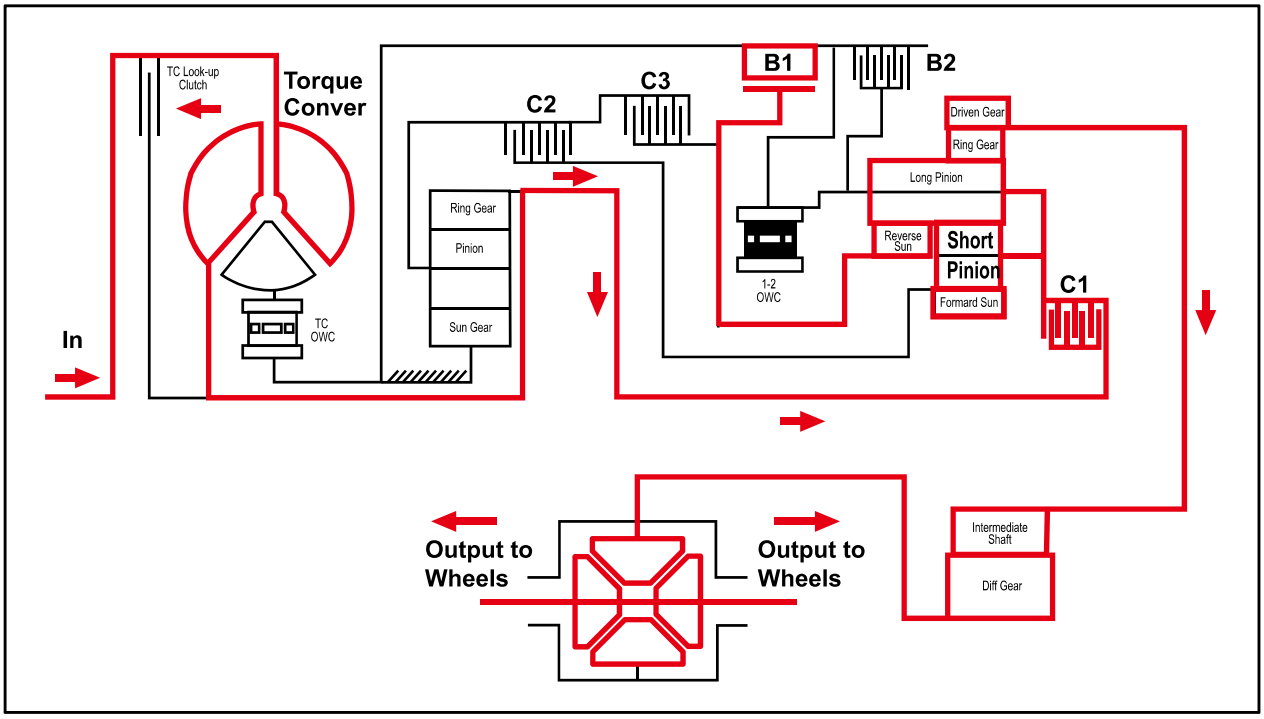
▶ **Power flow**



Modification basis	
Application basis	
Affected VIN	

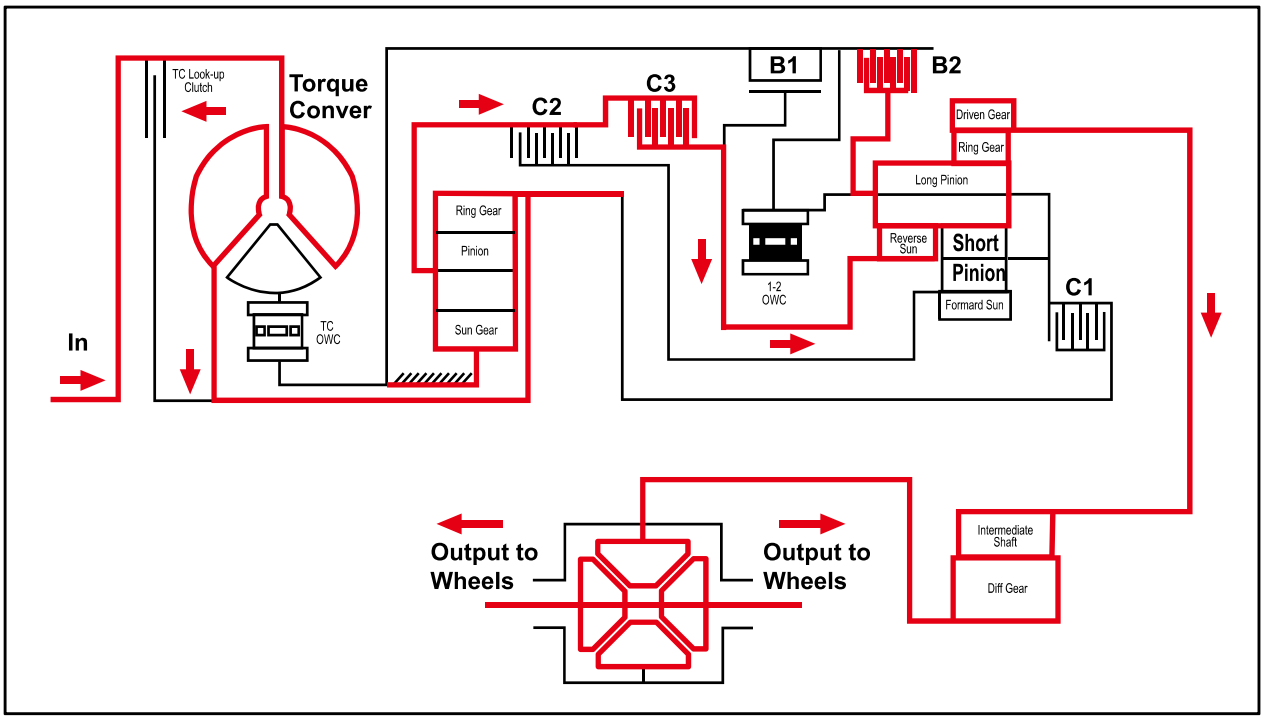
(7) Drive 6th (6th Auto) - 0.676 : 1

▶ **Power flow**



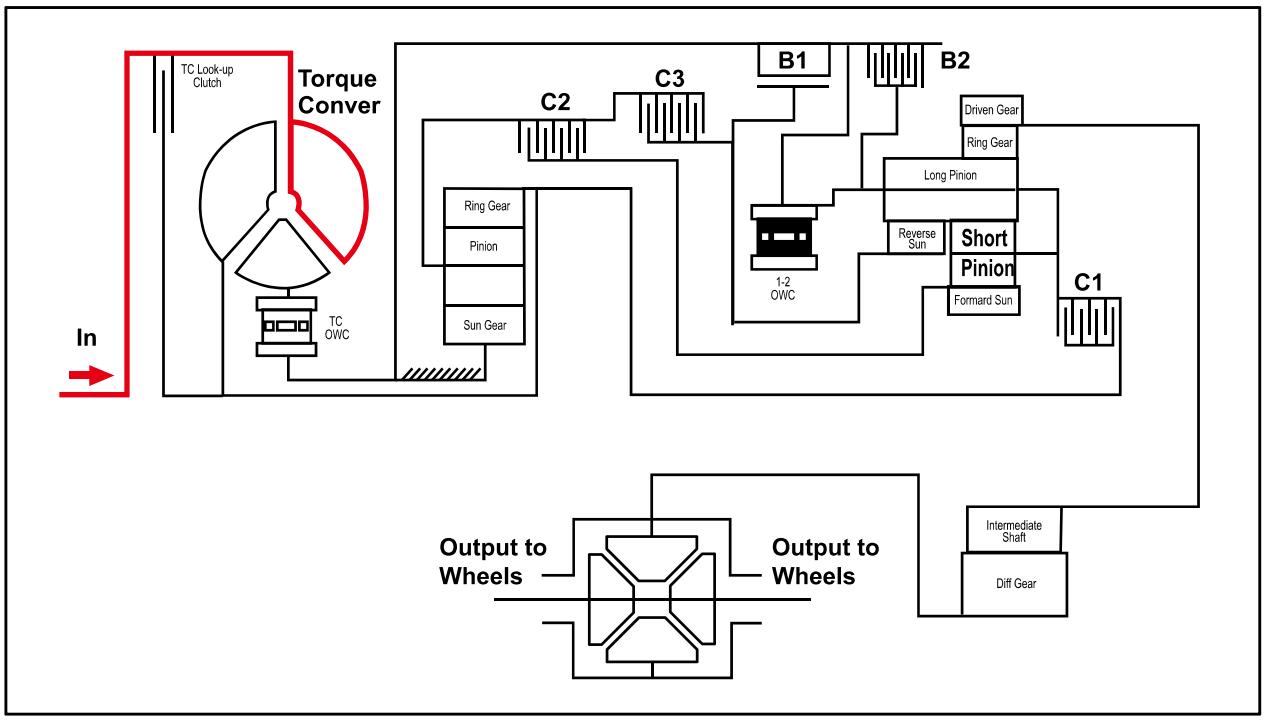
(8) Reverse - 3.178 : 1

▶ **Power flow**



(9) Neutral / Park

▶ Power flow



Modification basis	
Application basis	
Affected VIN	

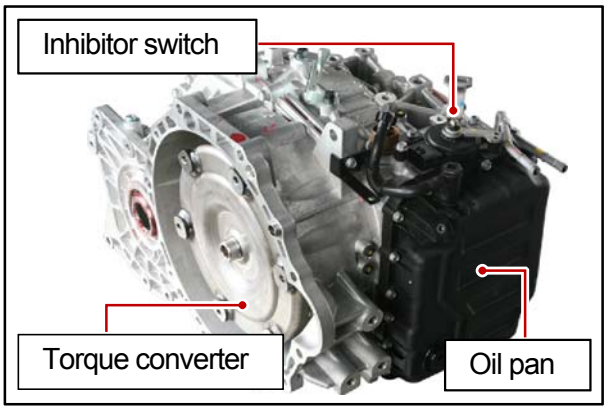
HPT 6 SPEED AUTO TRANSAXLE 3660-01

GENERAL INFRMATION

1. ABBREVIATION

No	Abbreviation	Name
1	DTC	Diagnostic trouble code
2	TCU	Transmission control unit
3	ATF	Automatic transmission fluid
4	DC	Damper clutch
5	PCSV	Pressure control solenoid valve
6	UD	Under drive
7	OD	Over drive
8	LR	Low reverse
9	LP	Line pressure
10	SOL	Solenoid
11	VFS	Variable force solenoid
12	PG-A	Input speed sensor
13	PG-B	Output speed sensor

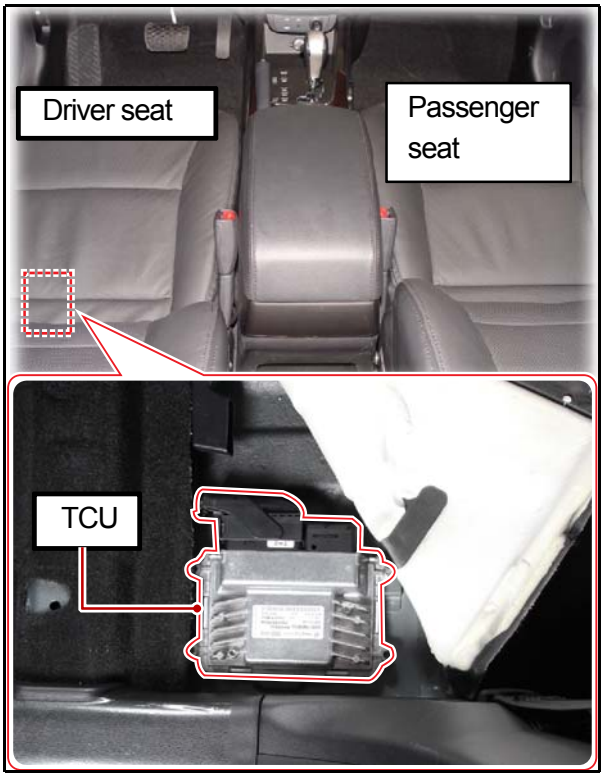
2. GENERAL INFORMATION



▶ Automatic transaxle (6F24)

The Model 6F24 six speed automatic transaxle is available in two variants: four wheel drive and two wheel drive.

- Six forward speeds
- One reverse gear
- A toruqe converter with an integral converter lock-up clutch with slip control capabilities
- Planetary gear-set (3EA)
- Clutches (2EA)
- Brake (3EA)
- O.W.C (1EA)
- All hydraulic functions are directed by electronic solenoids to control:
  1) Engagement feel
  2) Shift feel
  3) Shift scheduling
  4) Modulated torque converter clutch applications



▶ TCU (located under driver's seat)

TCU is located under the driver's seat and controls the transaxle operations.
TCU receives and uses the signals from sensors and switches through CAN bus with analog and digital types.

Modification basis	
Application basis	
Affected VIN	

▶ Tip switches on steering wheel

The shiftable gear can be adjusted by pressing the "UP (D+)" or "DOWN(D-)" switch when the gear selector lever is in "M" position.



▶ Meter cluster

This indicator shows the current position of the gear.





▶ Gear selector lever

Shift lock release button

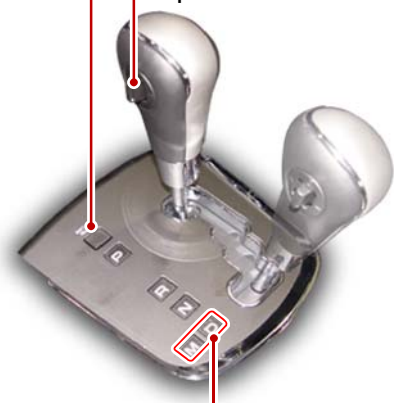
If the selector lever cannot be moved from "P" or "N" position, try to move the lever while pushing down this button with finger. For safety, turn off the engine and depress the brake pedal before the attempt.

Lever positions

P : Park
R : reverse
N : Neutral
D : Drive

Tip switch (manual shift switch)

The shiftable gear can be adjusted by moving this switch to forward and rearward when the gear selector lever is in "M" position.



Selection of Manual/Automatic Shift Function

D: Automatic shift according to the driving condition
M: Manual shift

3. SPECIFICATIONS

1) Specifications

Descriptions		Specification
Gear ratio	1st gear	4.212
	2nd gear	2.637
	3rd gear	1.800
	4th gear	1.386
	5th gear	1.000
	6th gear	0.772
	Reverse gear	3.385
Shift pattern		Variable
Shift range		4 Range (P-R-N-D) + Manual mode
Shift range valve		VFS : 6EA
Planetary gear		3EA (Front, Middle, Rear)
Clutch		2EA
Brake		3EA
O.W.C		1EA
Oil	Type	ATF SP-IV or SP-IV M
	Capacity	approx. 7.1 L
	Change interval	Maintenance free. However, under the severe conditions or commercially used, change the oil at every 100,000 km (EU: 90,000 km).
Resistance of oil temperature sensor	-20	Approx 15.6kΩ
	0	Approx 5.88kΩ
	20	Approx 2.51kΩ
	100	Approx 0.18kΩ
Type/Weight		6F24 6-speed automatic transaxle / approx. 86 kg (including ATF)
TORQUE		230 Nm
Overall length / Center length		373.1 mm / 204 mm
Weight	2WD	87.5kg
	4WD	88.5kg

Modification basis	
Application basis	
Affected VIN	

4. COMPONENTS

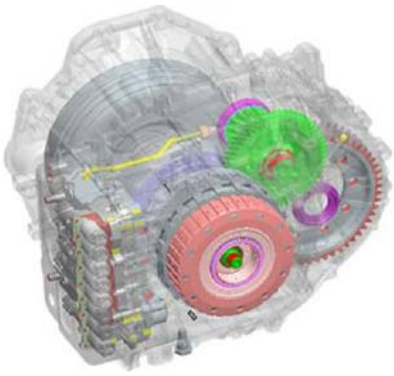
One-way clutch



Torque converter (with slip lockup)



HPT 6A/T (6F24)



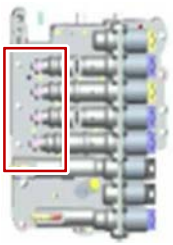
Harness



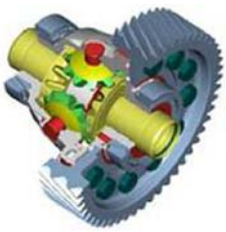
Oil pump



Valve body



Side gear



Driven gear



Modification basis	
Application basis	
Affected VIN	

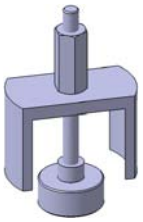
5. TIGHTENING TORQUE

Descriptions		Size x Numbers	Tightening torque (Nm)
TGS lever	Nut	12 mm X 4	17.6 ~ 21.6Nm
	Nut (manual control lever)	13 mm X 1	14.0 ~ 20.0Nm
TGS cable	Nut (floor)	12 mm X 1	17.6 ~ 21.6Nm
	Nut (dash panel)	12 mm X 2	17.6 ~ 21.6Nm
A/T bracket	Bolt (left bracket)	17 mm X 3	88.2 ~ 107.8Nm
	Bolt (right bracket)	17 mm X 4	88.2 ~ 107.8Nm
	Bolt (upper bracket)	17 mm X 4	88.2 ~ 107.8Nm
Automatic transaxle	Bolt (engine)	17 mm X 4 14 mm X 1	85.0 ~ 100.0Nm
	Bolt (start motor)	14 mm X 2	48.0 ~ 58.8Nm
	Bolt (oil pan)	14 mm X 4	56.0 ~ 62.0Nm
	Bolt (torque converter)	17 mm X 6	45.0 ~ 52.0Nm
	Eye bolt	22 mm X 1	3.0 ~ 5.0Nm
	Drain plug	24 mm X 1	34.0 ~ 44.0Nm
	Nut (range select lever)	14 mm X 1	17.6 ~ 24.5Nm
	Bolt (inhibitor switch)	10 mm X 2	9.8 ~ 11.7Nm
	Bolt (oil pan)	10 mm X 19	12.0 ~ 14.0Nm
	Bolt (solenoid harness)	10 mm X 6	9.8 ~ 11.7Nm
	Bolt (oil temperature sensor)	10 mm X 1	9.8 ~ 11.7Nm
	Bolt (input & output sensor)	10 mm X 2	9.8 ~ 11.7Nm
	Bolt (detent spring)	12 mm X 1	12.0 ~ 16.0Nm
	Bolt (valve body)	10 mm X 8	9.8 ~ 11.7Nm
	Bolt (V/B solenoid bracket)	H5 mm X 9	9.8 ~ 11.7Nm
	Bolt (torque converter housing)	12 mm X 20	28.0 ~ 35.0Nm
	Bolt (oil guide A)	10 mm X 3	9.8 ~ 11.7Nm
	Bolt (oil guide B)	10 mm X 1	5.0 ~ 7.0Nm
	Bolt (oil filter)	H5 mm X 2	9.8 ~ 11.7Nm

Modification basis	
Application basis	
Affected VIN	

Descriptions		Size x Numbers	Tightening torque (Nm)
Automatic transaxle	Bolt (oil lubrication pipe)	10 mm X 1	9.8 ~ 11.7Nm
	Bolt (oil pump)	12 mm X 7	20.0 ~ 26.0Nm
	Bolt (parking rod guide)	10 mm X 2	9.8 ~ 11.7Nm
	Bolt (U/D brake retainer)	T40 X 6	31.0 ~ 36.0Nm
	Bolt (U/D brake chamber)	T30 X 2	4.9 ~ 9.8Nm
	Bolt (rear cover)	12 mm X 13	28.0 ~ 35.0Nm

6. SPECIAL SERVICE TOLLS

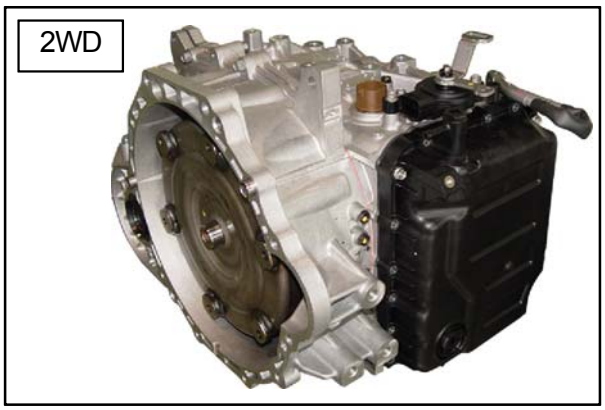
Part number	Name	Tool	How to use
00104-001(UD)	Remover & Installer - U/D brake return sprin		
00104-002(OD)	Remover& Installer - O/D clutch return spring		
00104-003(LR) (use with 00104-001)	Remover& Installer - L/R brake return spring		

* Special service tool Supplier: Tool & Tech

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW





The Model 6F24 6 speed automatic transaxle is electronically controlled. The control system is comprised of the following components:

- External transaxle control unit (TCU)
- Input and output speed sensors
- Six variable force solenoids(VFS) and two on/off solenoids
- Torque converter
- ATF temperature sensor

TCU controls the oil pressure for various internal clutches and brakes to select the gear. It also controls the electronic elements, shift pressure and torque converter slip. If the system is defective, TCU provides FMEC (Failure Mode Effect Control) to maintain the functionality of transaxle. This keeps the basic function of transaxle (gear selection) even when there are failure in controls and power supply.

There are selector shaft position sensor (inhibitor switch) and oil temperature sensor in transaxle. In manual mode, TCU receives the information from TGS (Transmission Gear Selector) through PCB (Printed Circuit Board) when driver selects the manual shift mode. TCU communicates with other electric control modules through CAN. In order to ensure a safe driving state and to prevent damage to the automatic transmission, TCU switches to Limp-Home mode in the event of critical faults.

2. FEATURES

1) Advantages

▶ **Early Downshift with Hard Braking and Skip Shifts**

When heavy braking is detected, the transaxle downshifts early and skips gears to provide increased engine braking to provide gear selection for tip-in.

▶ **Gear Hold going Uphill/Downhill**

If the accelerator pedal is released when traveling uphill, upshifts are prevented to reduce busyness on grades. If the accelerator pedal is released when traveling downhill, upshifts are prevented to enhance engine braking.

▶ **Drive and Reverse Engagement**

A soft engagement feature avoids harsh take up of drive when selecting Drive or Reverse. This is achieved by limiting engine speed and engine torque which results in a rapid, but progressive engagement of either Drive or Reverse when moving from the Park or Neutral positions. Drive and Reverse engagements from either Park or Neutral are performed in less than 2.2 seconds. There is no drive engagement prevention strategy implemented on the transaxle system as there is sufficient engine strategy to protect the system. However, reverse engagement is prevented until vehicle speed is less than 7 km/h.

Modification basis	
Application basis	
Affected VIN	

2) Transaxle Cooling

The transaxle cooling system ensures rapid warm-up and constant operating temperature resulting in reduced fuel consumption and refined shift quality.
It also includes a cooler by-pass within the hydraulic system to allow sufficient lubrication to the transaxle drivetrain in the event of a blockage in the transaxle cooler.

3) Shift Strategy



▶ Gear Change

Transaxle gear change is controlled by the TCU. The TCU receives inputs from various engine and vehicle sensors to select shift schedules and to control the shift feel and torque converter clutch (TCC) operation at each gear change.

▶ Coast down

Coast down down shifts occur at 0% pedal when the vehicle is coasting down to a stop.

▶ Torque Demand

Torque demand down shifts occur (automatically) when the driver demand for torque is greater than the engine can provide at that gear ratio. If applied, the transaxle will disengage the TCC to provide added acceleration.

3. MODES AND FUNCTIONS

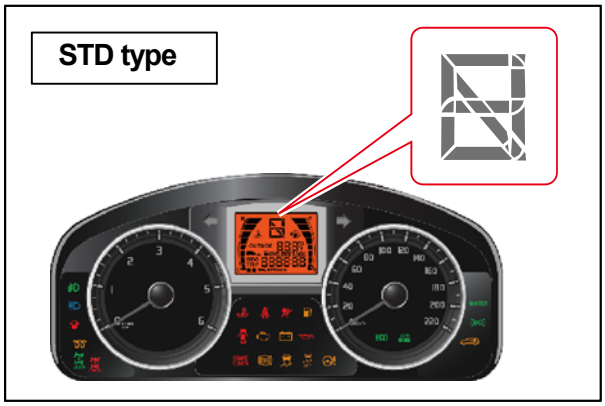


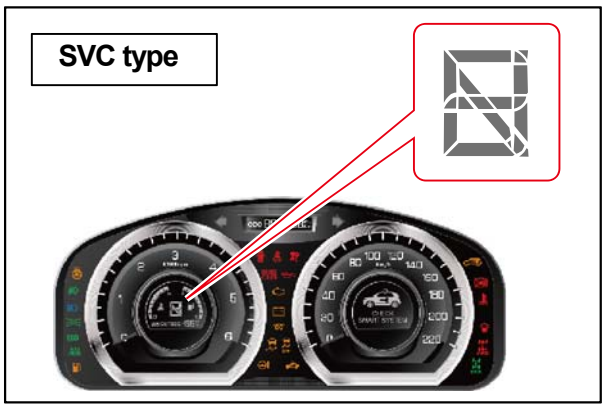
This allows the driver to define the highest possible gear by selecting “+” or “−” on the gear selector when the lever is in the “M” position. When the lever is first moved to the manual “M” position the transaxle will select one lower gear than current gear.

NOTE

When driving on a slippery road, push the tip switch forward into the "+" position in "M" position. This causes the transaxle to shift into the 2nd gear which is better for smooth driving on a slippery road.

Modification basis	
Application basis	
Affected VIN	





▶ 1st Gear State

- The 1st gear state will display on the instrument cluster. Unlike the normal 1st gear, engine braking will be available in this manual 1st state.

▶ 2nd Gear State

- The 2nd gear state will display on the instrument cluster. 2nd gear has engine braking available.

▶ 3rd Gear State

- The 3rd gear state will display on the instrument cluster. 3rd gear has engine braking available.

▶ 4th Gear State

- The 4th gear state will display on the instrument cluster. 4th gear has engine braking available.

▶ 5th Gear State

- The 5th gear state will display on the instrument cluster. 5th gear has engine braking available.

▶ 6th Gear State

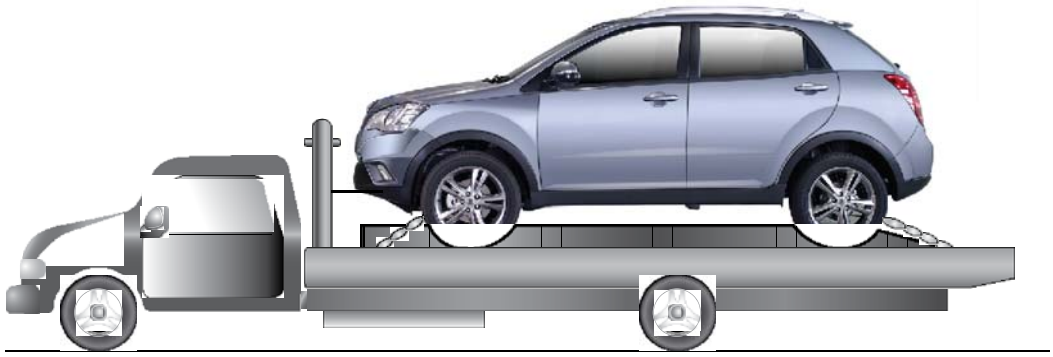
- The 6th gear state will display on the instrument cluster. 6th gear has engine braking available.

4. LIMP HOME MODE

▶ **When the transaxle is defective**

1. In the event of a system fault, the TCU also provides for failure mode effect control (FMEC) to maintain maximum functional operation of the transaxle. (There are 3 FMEC modes, mechanical limp-home mode, electrical limp-home mode, limp-home mode C.)
2. In the event of a total loss of control or electrical power, the basic transaxle functions (Park, Reverse, Neutral and Drive) are retained. The 4th and reverse gear ratios with the torque converter clutch in the unlocked state are the retained gear states the hydraulic system supports without any electrical assistance. (Mechanical limp-home)
3. If the speed sensor circuit is failed, the gear is fixed to 4th gear, but manual shifting (2nd↔3rd↔4th) is available.(Electrical limp home mode)
4. If the inhibitor switch signals are invalid, shifting to1st and 2nd gear is forbidden. (Limp-home C)
5. The TCU communicates with other vehicle electronic control modules by the controller area network (CAN). If a major fault is developed, the transaxle may not accomplish the intelligent shift control. The TCU controls the transaxle with preset values.
6. The TCU also provides for transaxle diagnostics, which meet the requirements of OBD II regulation, monitoring all components which may effect vehicle emissions.

▶ **Towing the automatic transaxle equipped vehicle**



CAUTION

- Flat-bed equipment is the best method of moving a disabled vehicle to avoid any damages.
- For AWD vehicle: The vehicle must be towed with a wheel lift and dollies or flatbed equipment with all the wheels off the ground.
  For 2WD vehicles: It is acceptable to tow the vehicle with the rear wheels on the ground without dollies and the front wheels off the ground. When being towed by a commercial towtruck and wheel dollies are not available, the front of the vehicle should be lifted, not the rear.

Modification basis	
Application basis	
Affected VIN	

5. TRANSAXLE ELECTRONIC CONTROL SYSTEM

1) General Information

The transmission control unit (TCU) and its input/output network control the following transmission operations:

- Shift timing
- Line pressure
- Clutch pressure (shift feel)
- Torque converter clutch

also uses these signals when determining transaxle operating strategy. Using all of these input signals, the TCU can determine when the time and conditions are right for a shift, or when to apply or release the torque converter clutch. It will also determine the pressure needed to optimise shift feel.

2) TCU (Transmission Control Unit)



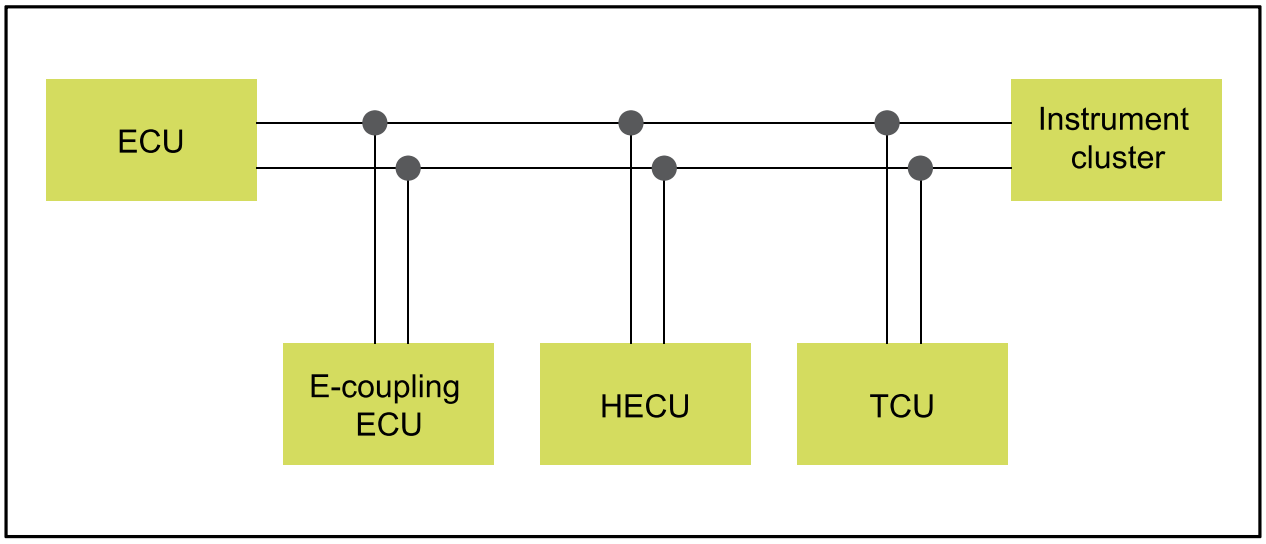
The transaxle control unit (TCU) is mounted under the driver's seat and controls the operation of the transaxle.
Internal sensors and signals received across the CAN bus in analogue and digital forms such as:

- Transaxle input speed
- Transaxle output speed
- Accelerator pedal position
- Gear selector position
- Engine torque
- Engine speed
- Transaxle fluid temperature
- Brake pedal status
- Engine oil temperature
- Engine coolant temperature
- Ambient air temperature
- Barometric pressure

The TCU monitors all TCU inputs and outputs to confirm correct system operation. If a fault occurs the TCU is able to perform default action and inform the driver of the problem through the instrument cluster warning lights. Detailed information is available via trouble codes which can be read with the service tool.

6. CAN NETWORK

▶ **Schematic Diagram of Network Communication**



The TCU sends signals to be used by other vehicle systems via the CAN bus, such as:

- Selector lever position
- Selected gear state
- Manual mode activation
- Transaxle fluid temperature
- Engine torque reduction requests

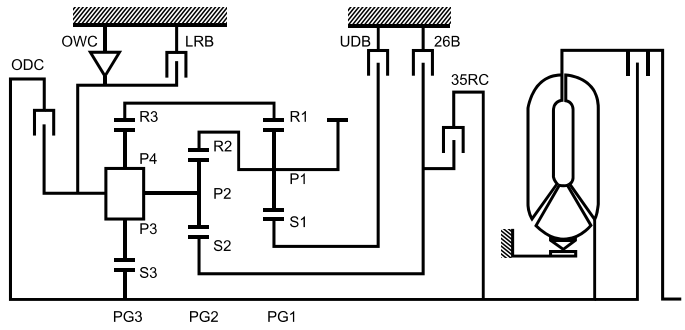
Modification basis	
Application basis	
Affected VIN	

7. POWER TRANSFER

Power transfer modes are as follow:

- Manual: 1st gear (position M)
- Drive: 1st gear
- Drive: 2nd gear
- Drive: 3rd gear
- Drive: 4th gear - limp home mode
- Drive: 5th gear
- Drive: 6th gear

1) Overview



Name	Component
C1	OVER DRIVE CLUTCH
C2	35R CLUTCH
B1	LOW & REVERSE BRAKE
B2	2/6 BRAKE
B3	UNDER DRIVE BRAKE
1F	1-2 ONE WAY CLUTCH

(1) Gear Selection and Engagement Element

GEAR	CLUTCH		BRAKE			OWC	Gear Ratio
	OD	35R	26	LR	UD		
1ST				△*	O	O	4.212
2ND			O		O		2.637
3RD		O			O		1.800
4TH	O				O		1.386
5TH	O	O					1.000
6TH	O		O				0.772
REV		O		O			3.385
N.P				O			

* Operation when vehicle speed under 5kph

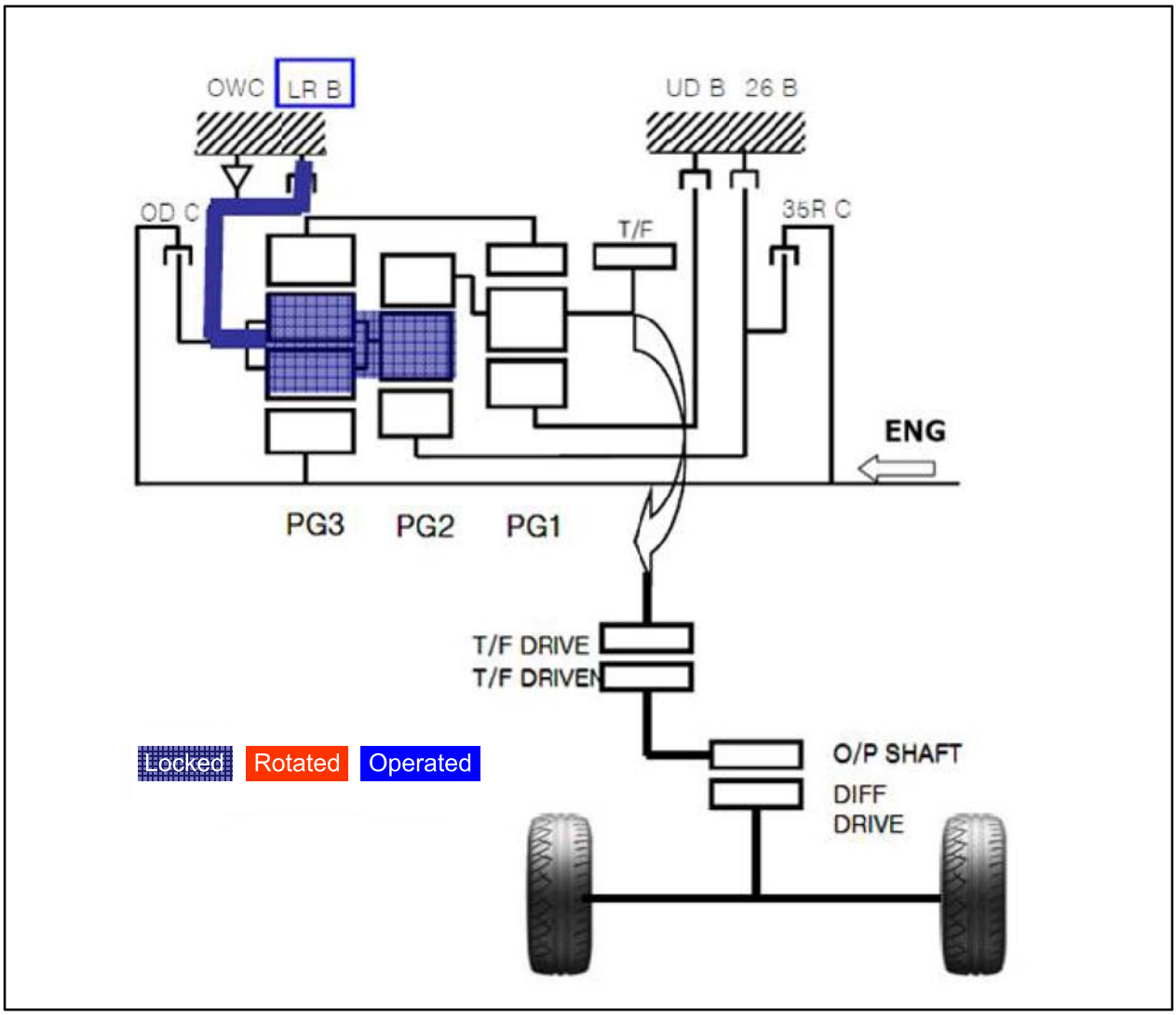
2) Operation in Each Gear Position

(1) Neutral/Park

- Lower & reverse brake (LR/B) operated → Overdrive (O/D) hub locked → Middle & rear (MID & REAR) P/C locked
- Input shaft rotated → Rear sun gear rotated → Rear inner pinion reverse rotated → Rear outer pinion rotated → Rear annulus gear rotated → Front annulus gear rotated → Front pinion rotated → Front sun gear reverse rotated → Underdrive (U/D) hub reverse rotated
- Input shaft rotated → Overdrive clutch (OD/C) retainer rotated
- Input shaft rotated → 35R clutch rotated

▶ **Power flow**

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
P.N					●	



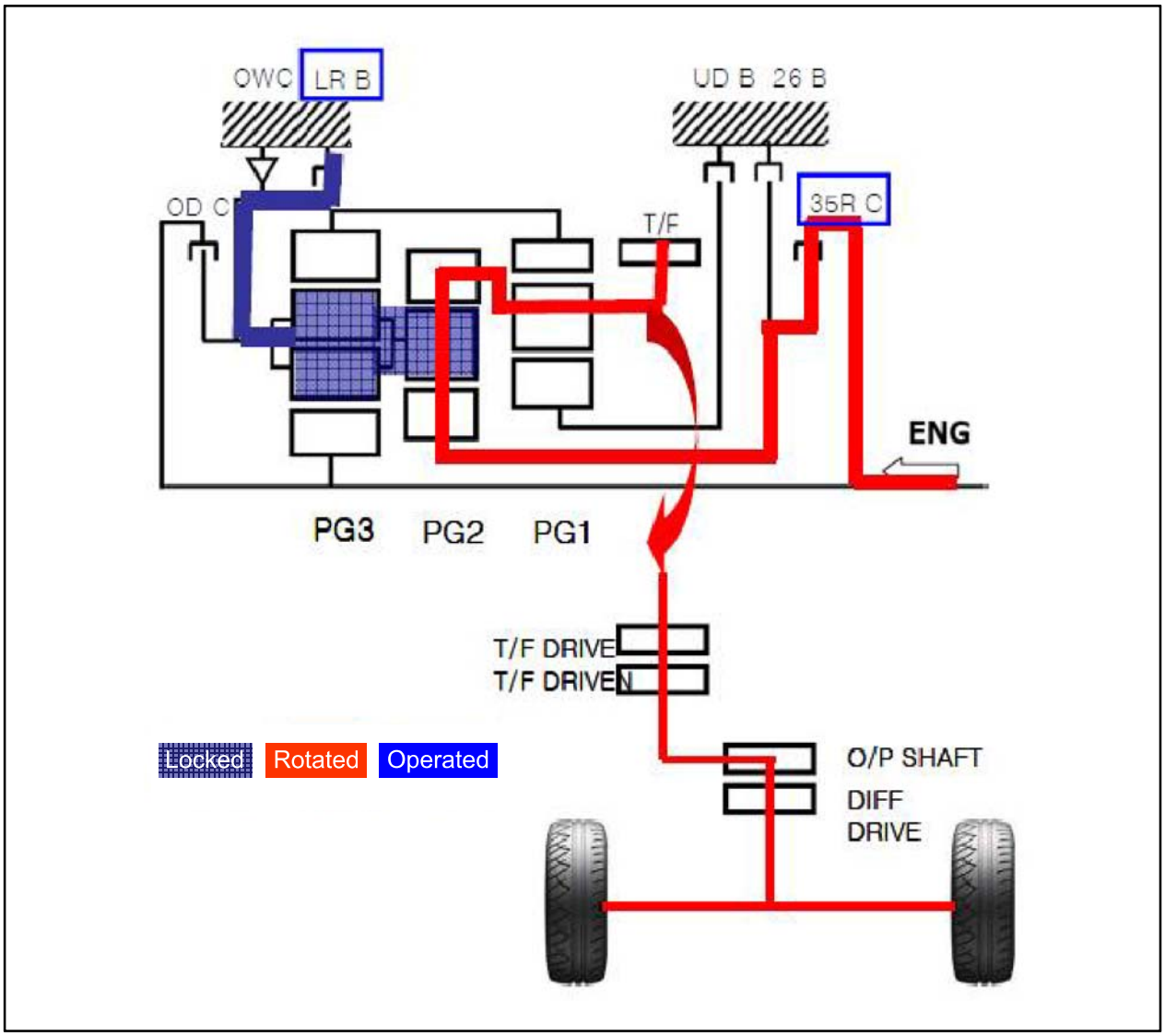
Modification basis	
Application basis	
Affected VIN	

(2) Reverse (3.385)

- Middle planetary gear locked, middle sun gear rotated
- When the sun gear rotates with the planetary gear locked in middle planetary gear set, the annulus gear (front planetary gear) rotates in reverse direction with decreased speed and the power flows through the front planetary gear.
- The rear planetary gear set reduces the rotating speed of rear & front annulus gears and the front planetary gear set rotates the front sun gear in reverse direction without load.

▶ Power flow

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
R	●				●	



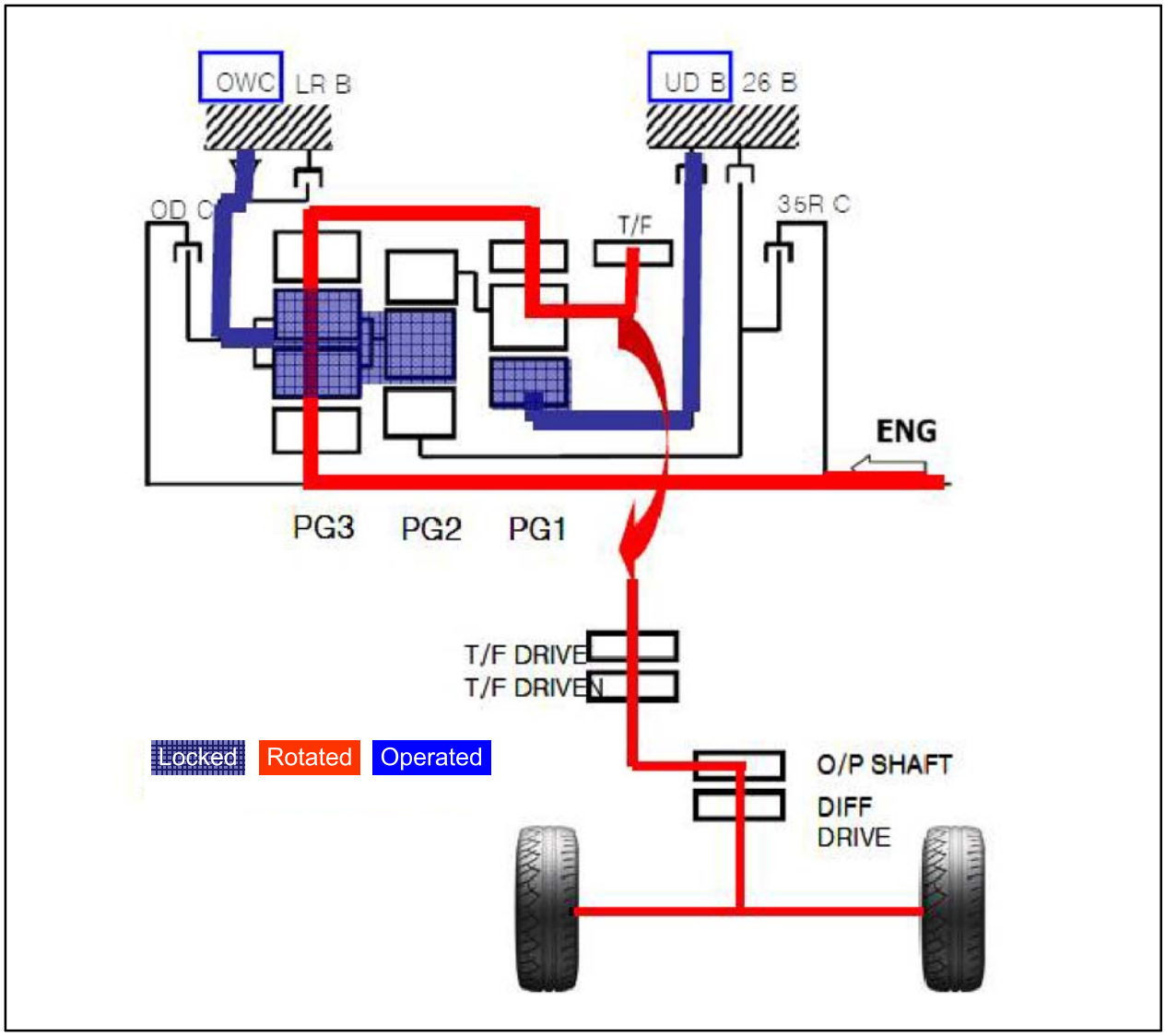
(3) 1st Drive Gear (4.212)

- Front sun gear and middle & rear planetary gears locked, and rear sun gear always rotated
- When the rear sun gear rotates, the rear planetary gear set reduces the speed at first, and then the reduced power is transferred to rear & front annulus gear. The power is secondarily reduced at front planetary gear locked with sun gear and flows to front planetary gear.
  At this moment, the middle sun gear rotates in reverse direction without load (idling) by the rotation of
- middle annulus gear integrated with front planetary gear.

▶ Power flow

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
1ST				●	○	●

O :Operated below 5 km/h of vehicle speed



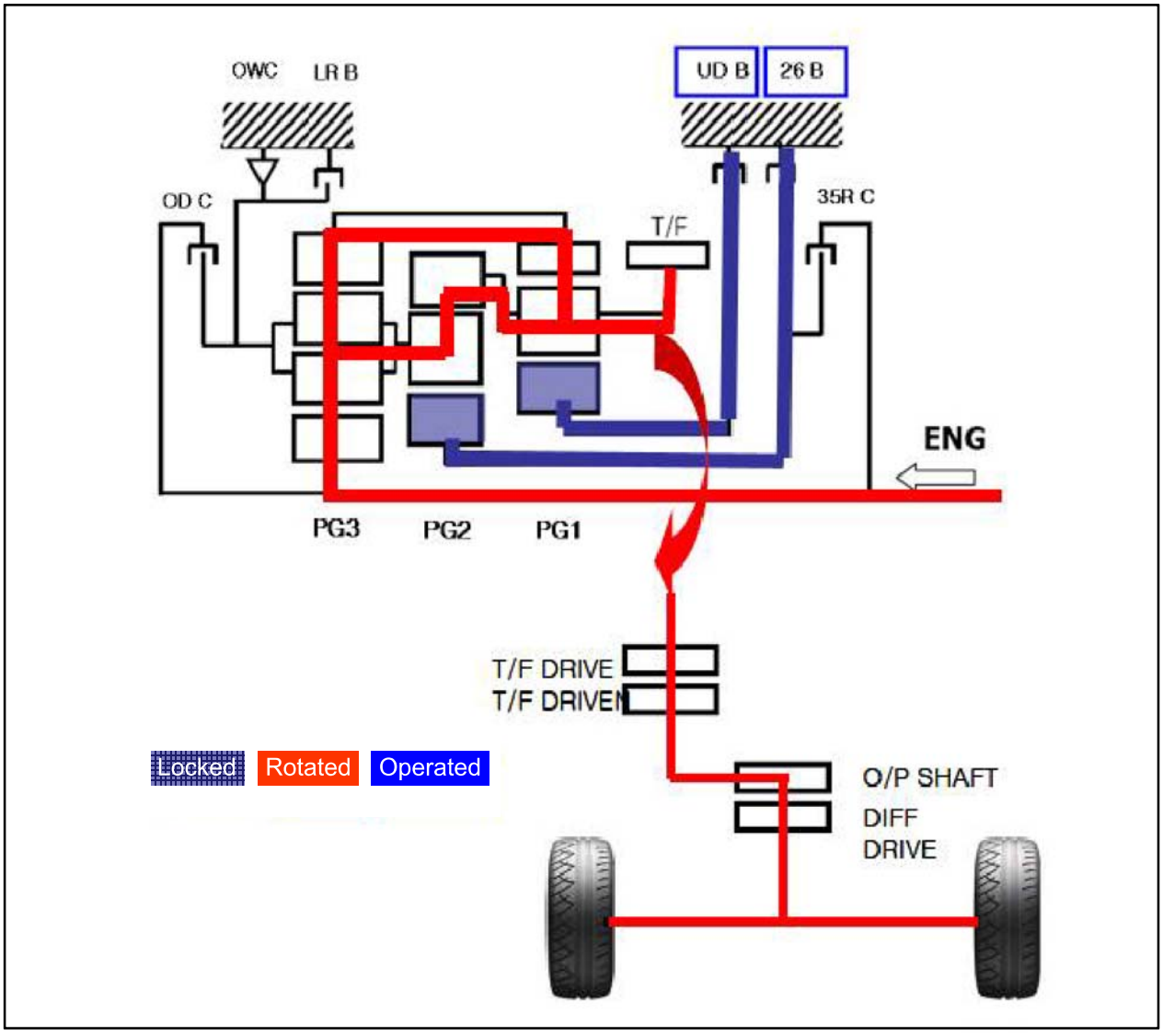
Modification basis	
Application basis	
Affected VIN	

(4) 2nd Drive Gear (2.637)

- Front sun gear and middle sun gear locked, rear sun gear always rotated
- When the sun gear rotates, the power is transferred to the rear & front annulus gears, and then the reaction power from the front planetary gear and middle annulus gear locked with sun gear is transferred to middle & rear planetary gear to circulate the power. Accordingly, the power flows through the front planetary gear while keeping the balance.

▶ Power flow

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
2nd			●	●		

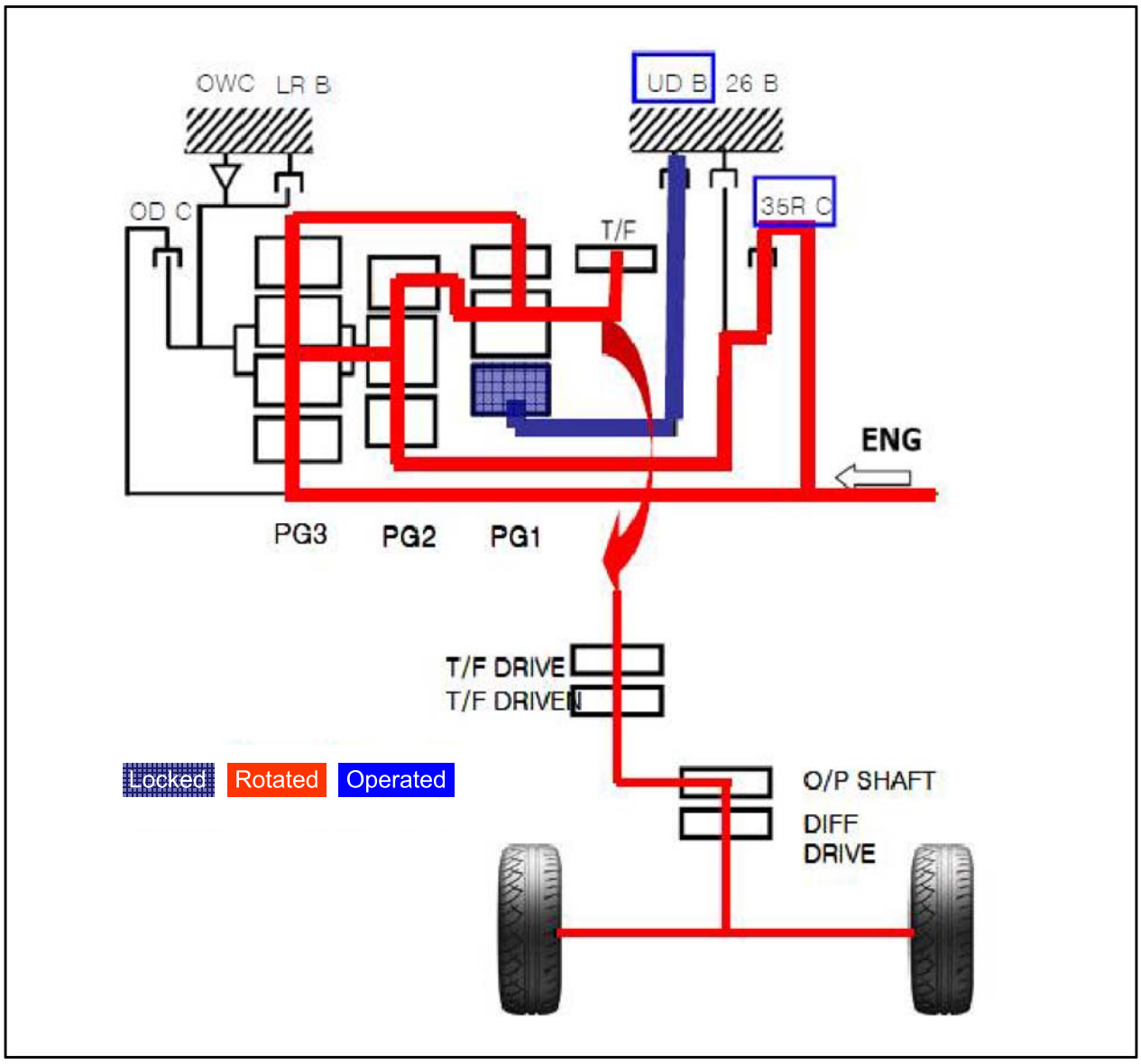


(5) 3rd Drive Gear (1.800)

- Front sun gear locked, middle & rear sun gear rotated
- When the middle sun gear and rear sun gear rotate, the power is transferred to the rear & front annulus gears, and then the reaction power from the front planetary gear and middle annulus gear locked with sun gear is transferred to middle & rear planetary gear to circulate the power. Accordingly, the power flows through the front planetary gear while keeping the balance.

▶ **Power flow**

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
3rd	●			●		



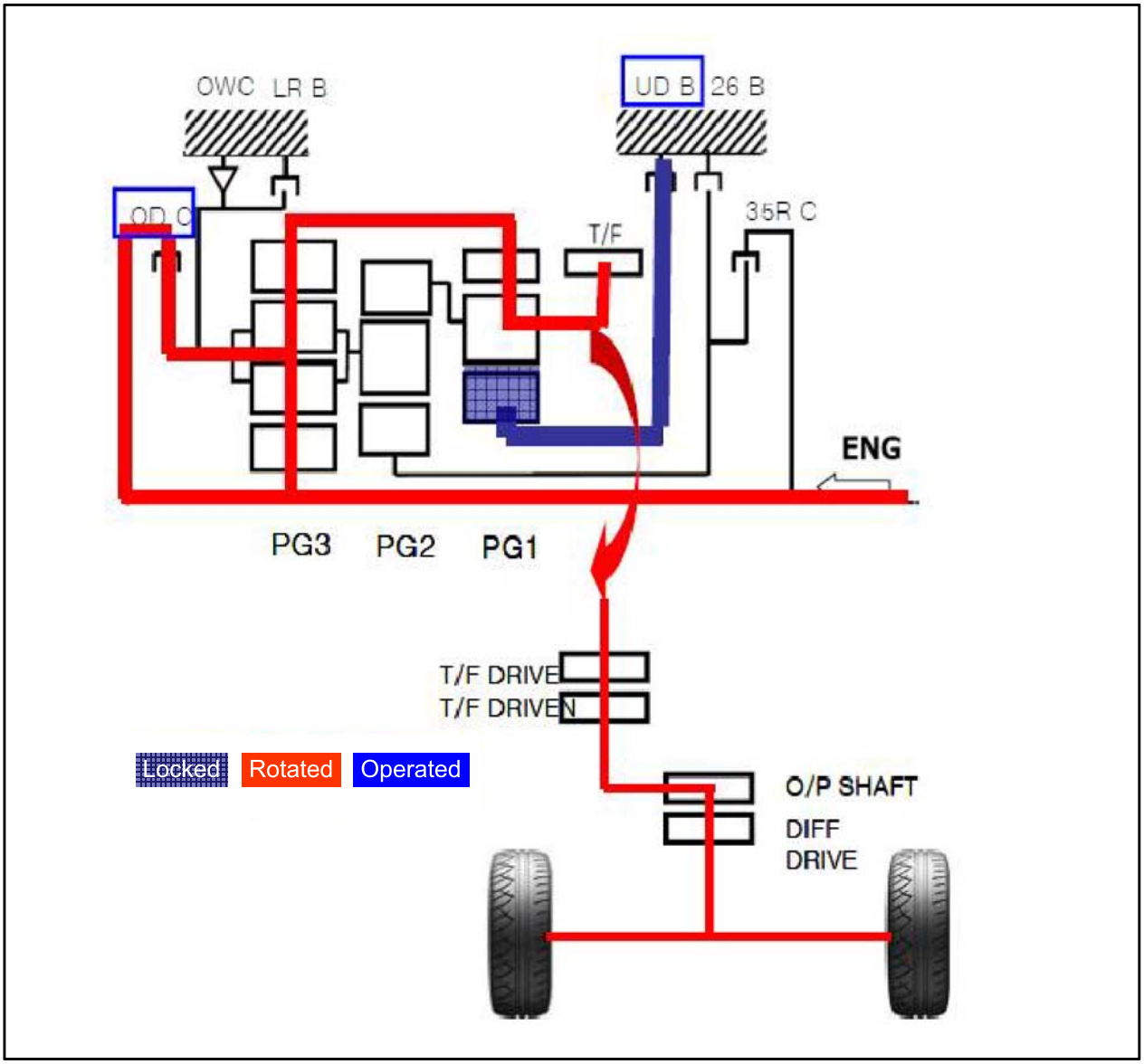
Modification basis	
Application basis	
Affected VIN	

(6) 4th Drive Gear (1.386)

- Front sun gear locked, rear planetary gear and rear sun gear rotated
- When the overdrive clutch (OD/C) operates, the carrier is engaged with sun gear in rear planetary gear set and the power with 1:1 ratio flows to the front planetary gear locked with sun gear after passing through the rear & front annulus gears.
- At this moment, by operation of speed-reduced annulus gears and carrier in 1:1 ratio, the middle sun gear in middle planetary gear set increases its speed without load (idling).

▶ Power flow

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
4th		●		●		

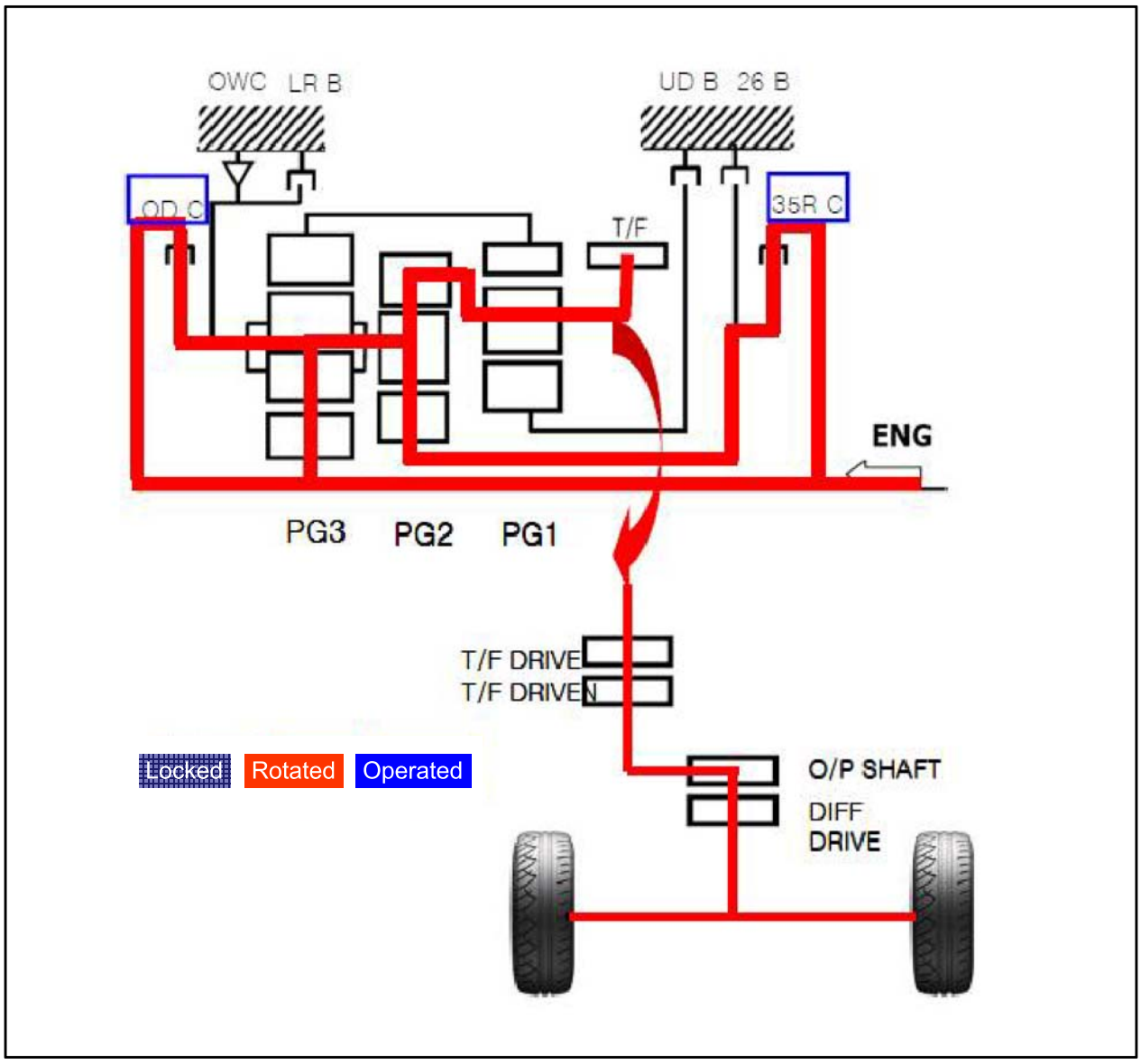


(7) 5th Drive Gear (1.000)

- Middle & rear planetary gears, middle sun gear and rear sun gear rotated
- The rotating ratio of 1;1 is transferred to middle annulus gear (front planetary gear) because the middle planetary gear and sun gear in middle planetary gear set rotate simultaneously.
- At this moment, the rear planetary gear set rotates in 1:1 ratio (same in 4th gear). However, the front planetary gear set is not related to that, and the front sun gear rotates without load (idling) in 1:1 ratio.

▶ **Power flow**

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
5th	●	●				



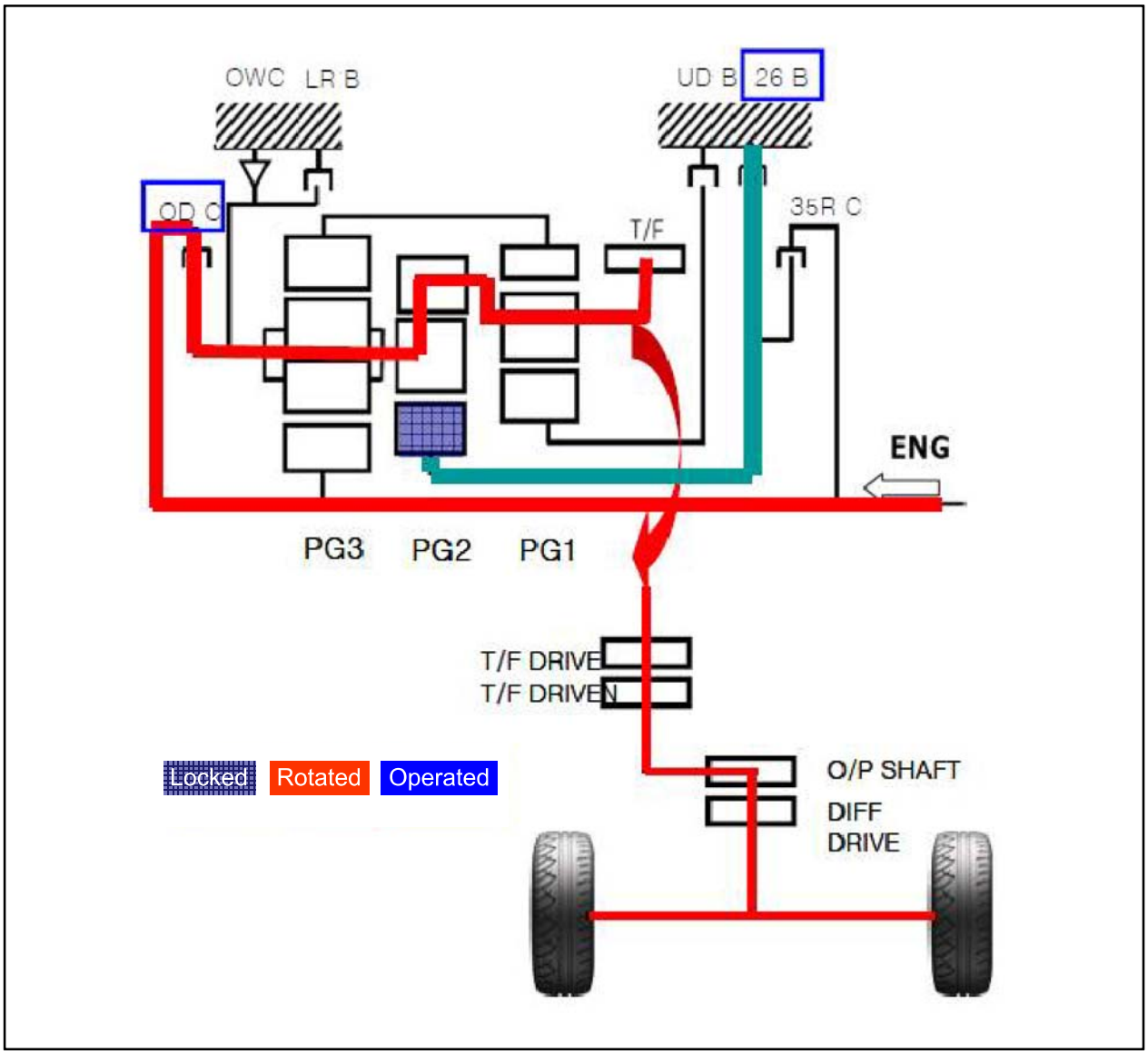
Modification basis	
Application basis	
Affected VIN	

(8) 6th Drive Gear (0.722)

- Middle planetary gear rotated, middle sun gear locked
- When the sun gear is locked in middle planetary gear set and the planetary gear rotates, the middle annulus gear increases the speed and the power is transferred to front planetary gear. The rear planetary gear set rotates in 1;1 ratio (same in 4th & 5th gears). However, the front
- planetary gear set is not related to that, and the front sun gear increases its speed without load (idling).

▶ Power flow

Description	35R C	OD C	26 B	UD B	LR B	O.W.C
6th		●	●			

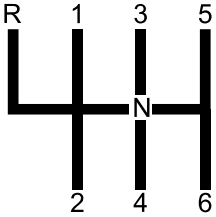


6-SPEED M/T

0000-00

GENERAL INFORMATION

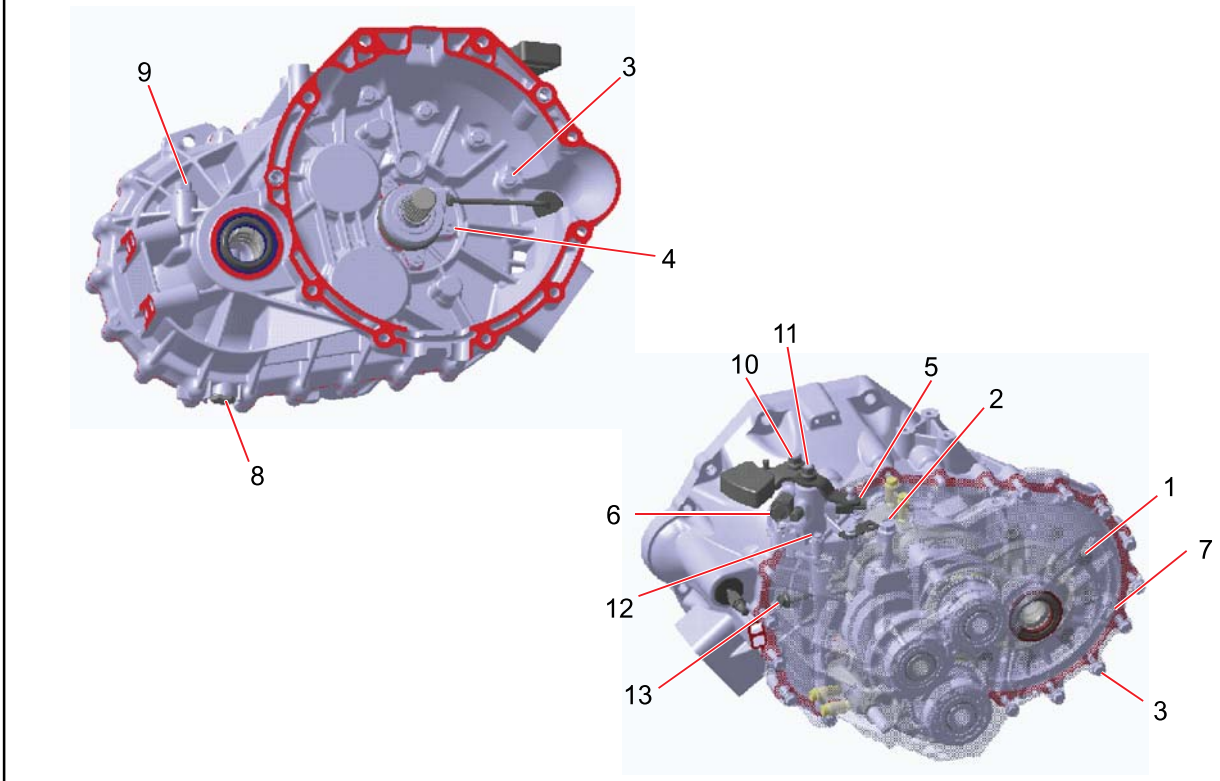
1. SPECIFICATION

Item		Specification			Remark
		D20DTF	D20DTF + Low CO_2	G20DF	
Model name		WM6F1			
Overall length		370 mm			
Distance between shafts		205 mm / 70 mm			
Weight (except transmission fluid)		62 kgf (2WD) / 63 kgf (4WD)			
Gear ratio	1st	3.538	3.385	3.616	
	2nd	1.909	1.708	1.957	
	3rd	1.179	1.033	1.207	
	4th	0.814	0.786	0.905	
	5th	0.734	0.730	0.842	
	6th	0.628	0.595	0.714	
	Reverse	3.910	3.747	3.747	
Synchronizer ring type	1st	T: Triple-cone			
	2nd	T: Triple-cone			
	3rd	T: Triple-cone			
	4th	D: Double-cone			
	5th	D: Double-cone			
	6th	S: Single-cone			
	Reverse	T: Triple-cone			
Shifting	Type	Remote (Cable type)			
	Gear selector lever position				Reversing: Reverse ring pull type

Item				Specification	Remark
Transmission fluid	Transmission fluid			SAE 75W / 85, API GL-4	
	Capacity			1.65 L	
	Replacement interval	DSL	EU	Inspect and replenish every 60000 km (or 3 years) Normal driving condition: Fill for Life (Severe driving condition: Change every 120000 km)	
			GEN	Inspect and replenish every 60000 km (or 4 years) Normal driving condition: Fill for Life (Severe driving condition: Change every 120000 km)	
		GSL		Inspect and replenish every 60000 km (or 4 years) Normal driving condition: Fill for Life (Severe driving condition: Change every 120000 km)	

Modification basis	
Application basis	
Affected VIN	

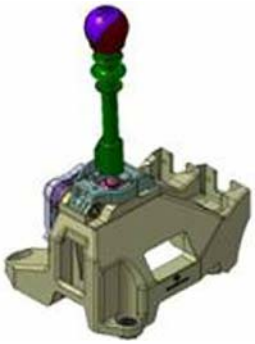
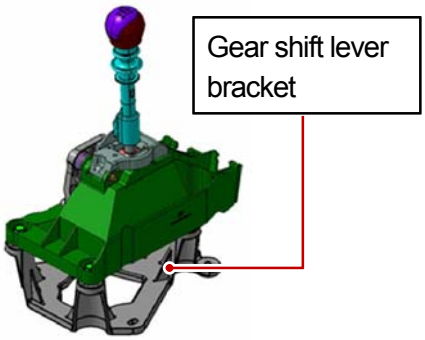
2. TIGHTENING TORQUE



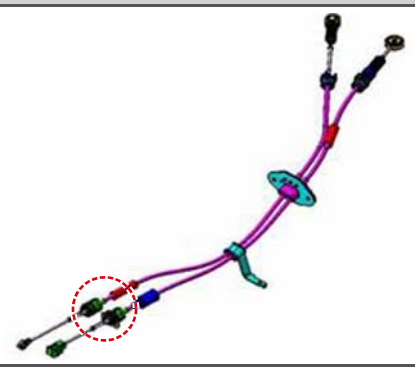
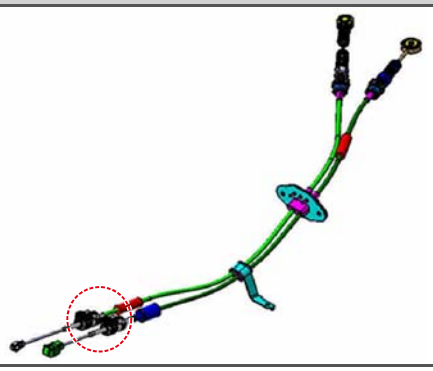
Part name	Tightening torque	Remark
1. Drive gear mounting bolt of differential carrier	166.6 to 176.4 Nm	10 EA
2. Reverse shaft mounting bolt	74.5 to 89.2 Nm	
3. Transmission case mounting bolt	19.6 to 26.5 Nm	22 EA
4. Concentric slave cylinder mounting bolt	11.8 to 14.7 Nm	3 EA
5. Backup lamp switch	29.4 to 34.3 Nm	
6. Neutral switch	29.4 to 34.3 Nm	
7. Oil filler plug	58.8 to 78.4 Nm	
8. Oil drain plug	58.8 to 78.4 Nm	
9. Oil plug	58.8 to 78.4 Nm	
10. Shift lever mounting nut	42.2 to 53.9 Nm	
11. Selector lever mounting nut	42.2 to 53.9 Nm	
12. Control shaft assembly mounting bolt	9.8 to 11.8 Nm	7 EA
13. Guide bolt	42.2 to 53.9 Nm	

3. MAJOR CHANGES IN MANUAL TRANSAXLE

1) Gear Shift Lever and Cable

Gear shift lever assembly	
Old	**New**
	
The gear shift lever bracket has been changed to adopt the premium console.	



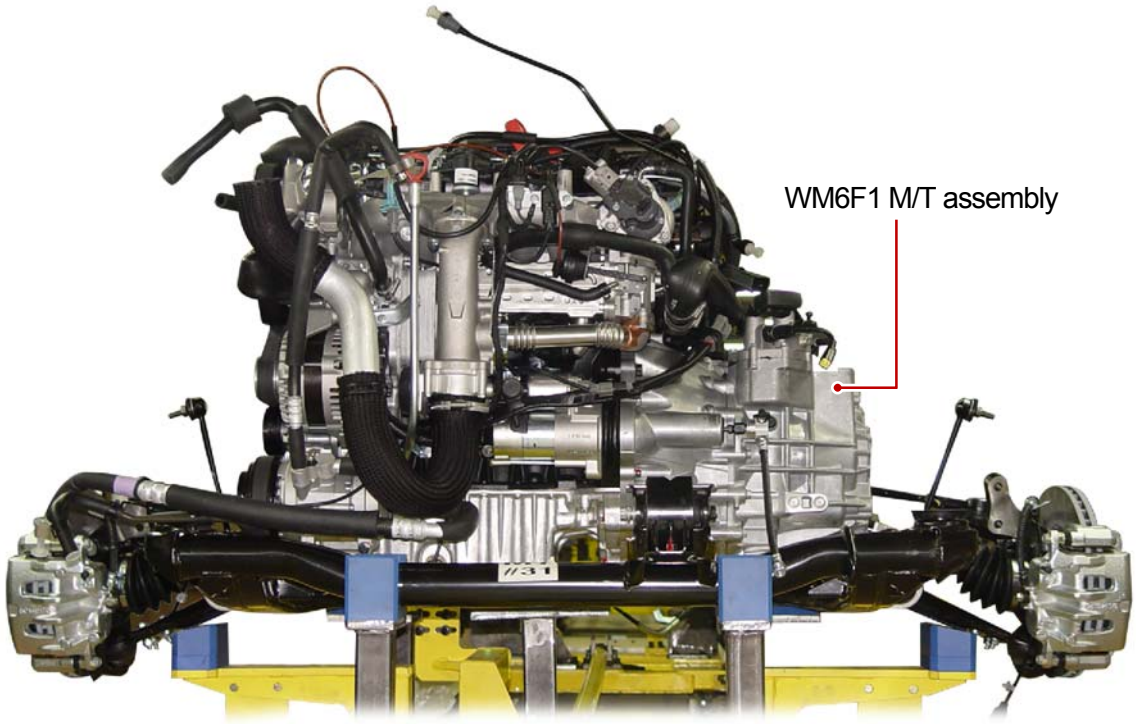
Gear shift cable assembly	
Old	**New**
	
The connection and socket to lever has been changed.	

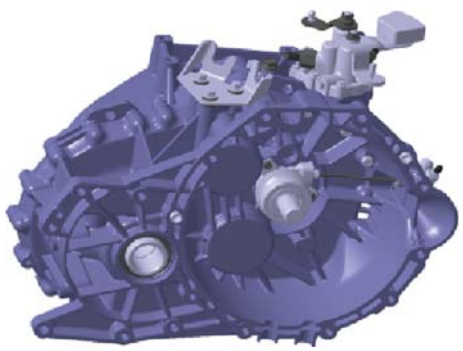
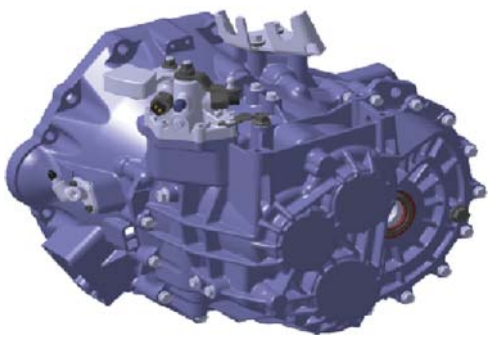
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

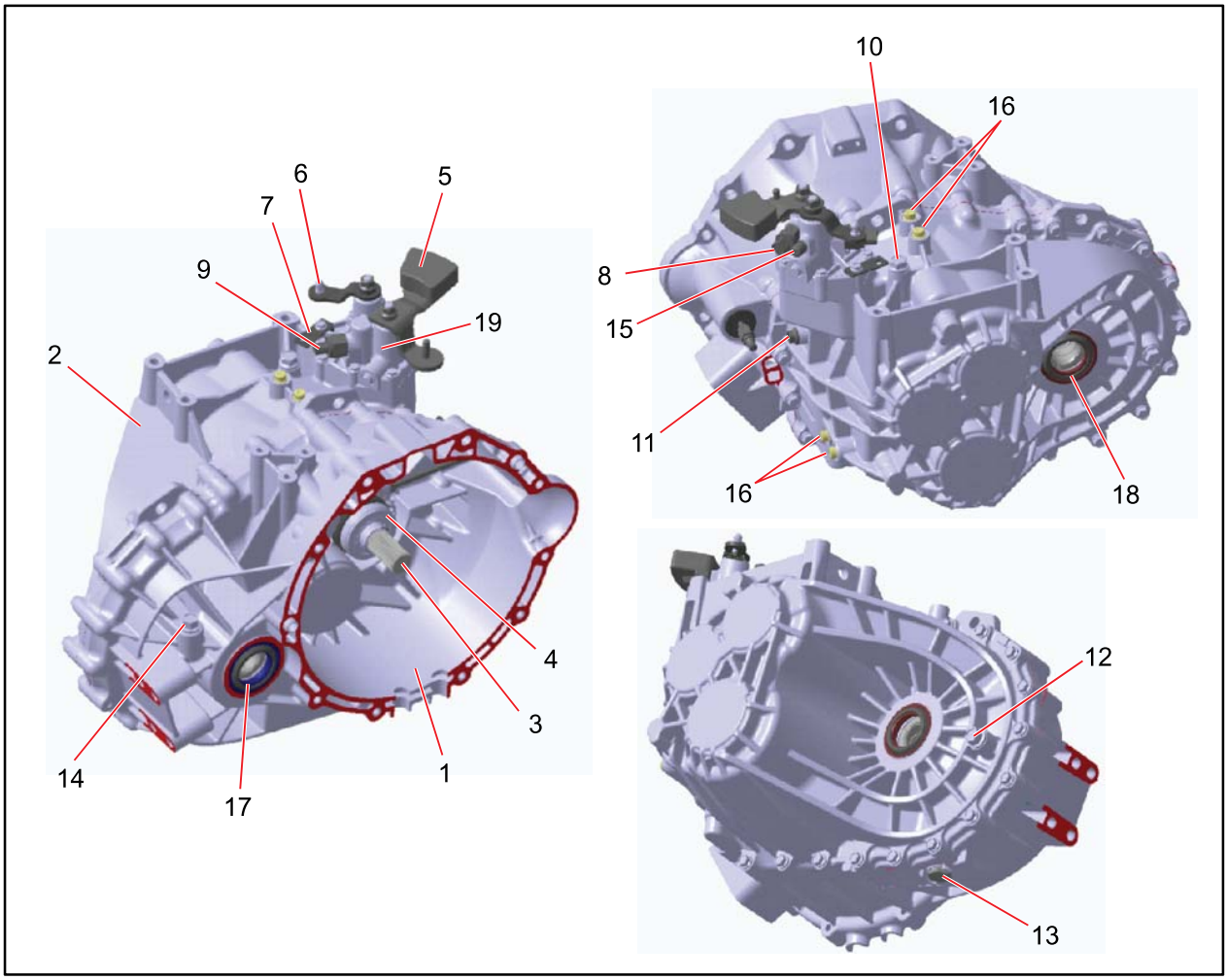
This vehicle is equipped with WM6F1 M/T (Manual Transmission). This transmission is integrated with an axle and designed to maximize the driving performance by optimizing the gear ratio according to the engine torque.



Front view	Rear view
	

1) Characteristics of WM6F1 M/T

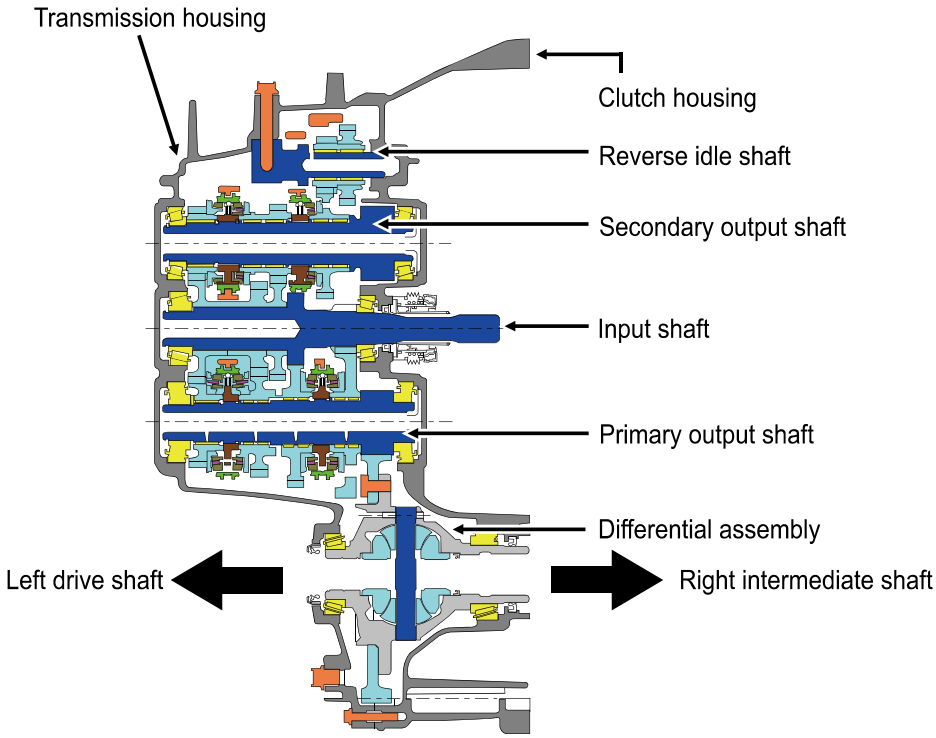
- Both Forward and Reverse gears use the helical gear and are made of high-strength material.
- Drives the clutch with a concentric slave cylinder mounting bolt.
- Shifting the transmission gears is performed through the remote control cable.
- A pull type clutch is used for Reverse gear shifting.
- Features triple/double/single synchronization.

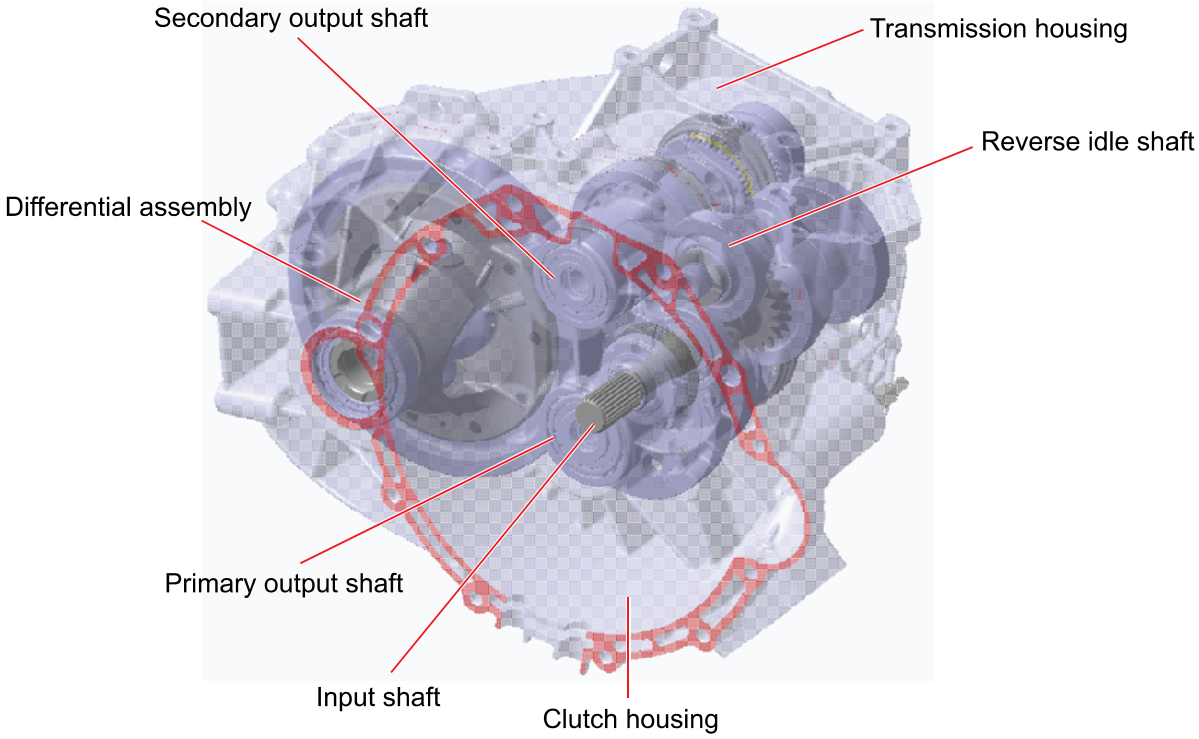


1. Clutch housing
2. Transmission case
3. Input shaft
4. Concentric slave cylinder
5. Shift lever
6. Selector lever
7. Wiring bracket
8. Neutral switch
9. Backup lamp switch
10. Reverse idle shaft mounting bolt
11. Control guide bolt
12. Oil filler plug (for servicing)
13. Oil drain plug
14. Oil filler plug (for manufacturing)
15. Air breather
16. Detent pin (for securing shift fork)
17. Oil seal (RH)
18. Oil seal (LH)
19. Control housing

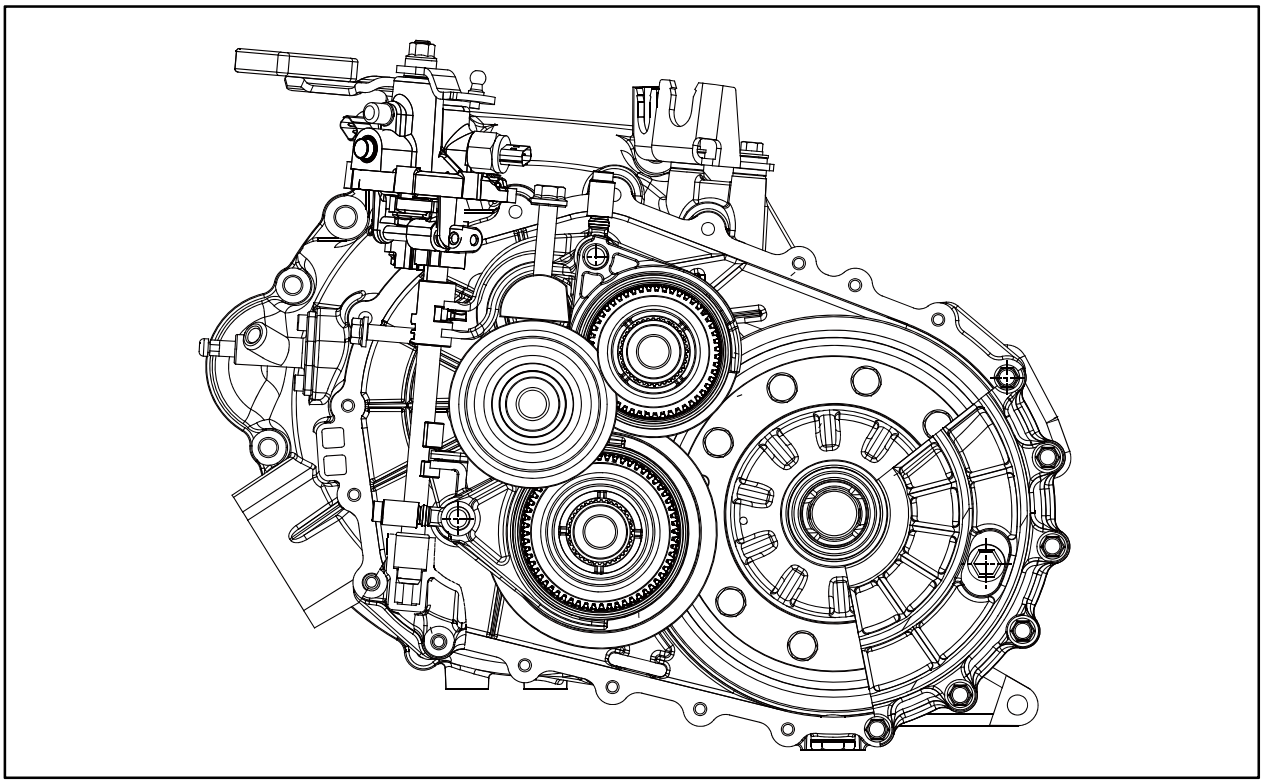
Modification basis	
Application basis	
Affected VIN	

2) Internal Configuration





3) Schematic Diagram



4) Gear Ratio

Item	Speed gear			Final gear			Total gear ratio
	Number of teeth		Gear ratio	Number of teeth		Gear ratio	
	Input	Output		Input	Output		
1st	13	46	3.538	13	59	4.538	16.059
2nd	22	42	1.909				8.664
3rd	28	33	1.179				5.349
4th	43	35	0.814				3.694
5th	38	28	0.737	15	59	3.933	2.898
6th	43	27	0.628				2.47
Reverse	13	17	3.91				15.377
	24	36					

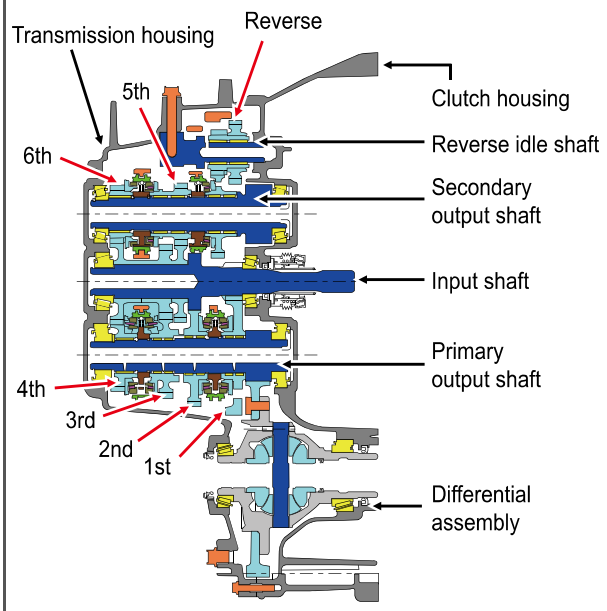
NOTE

- One input gear is used for 1st forward driving and back-up driving.
- One input gear is used for 4th and 6th forward driving.

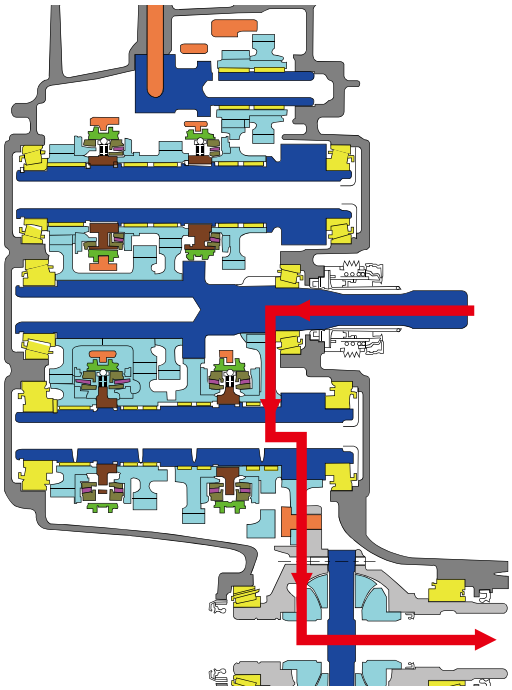
Modification basis	
Application basis	
Affected VIN	

2. POWER FLOWS

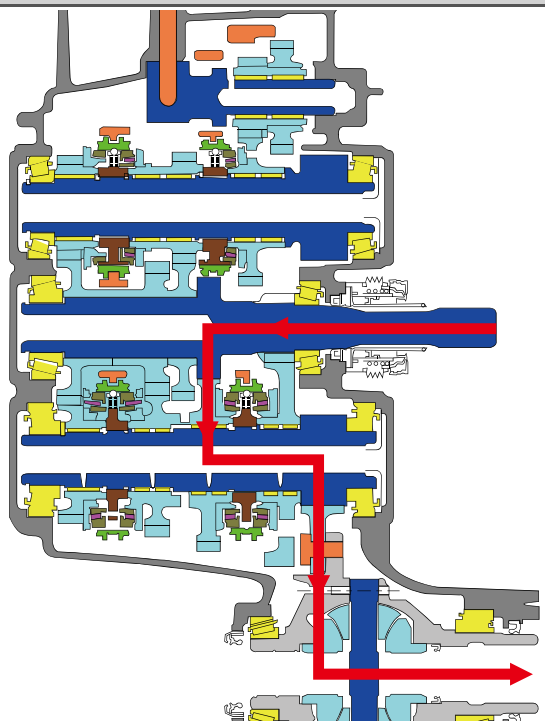
Sectional view of WM6F1 M/T



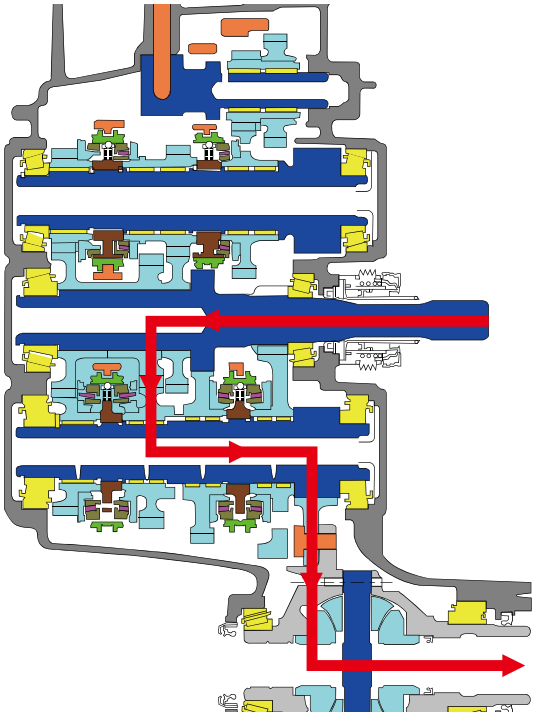
1st speed gear



2nd speed gear

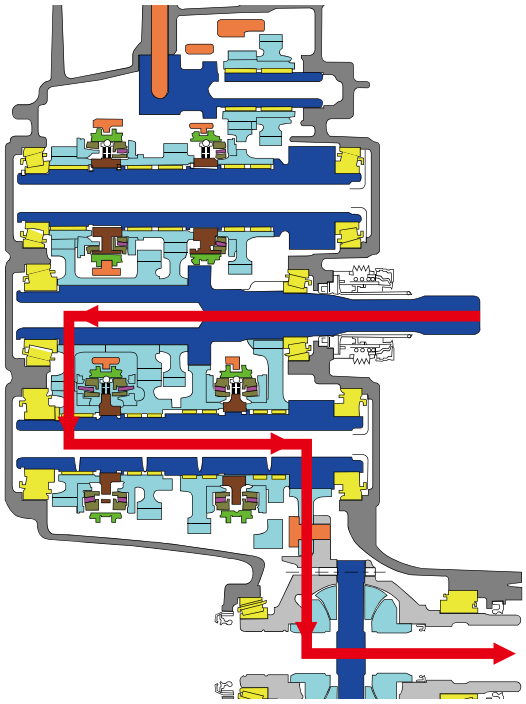


3rd speed gear

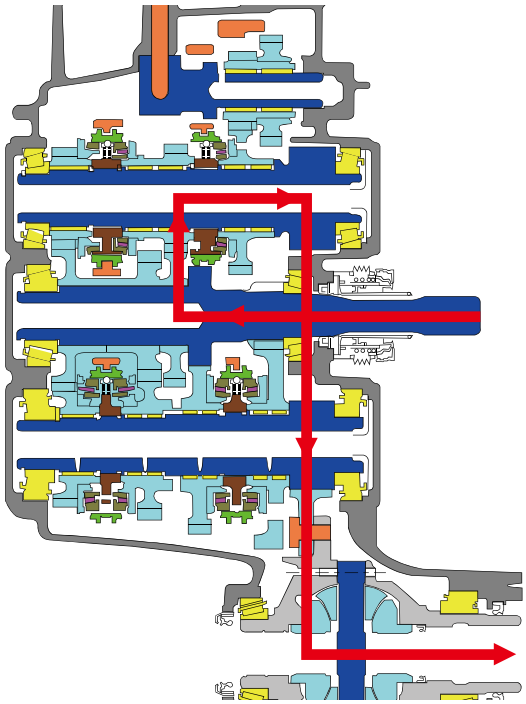


Modification basis	
Application basis	
Affected VIN	

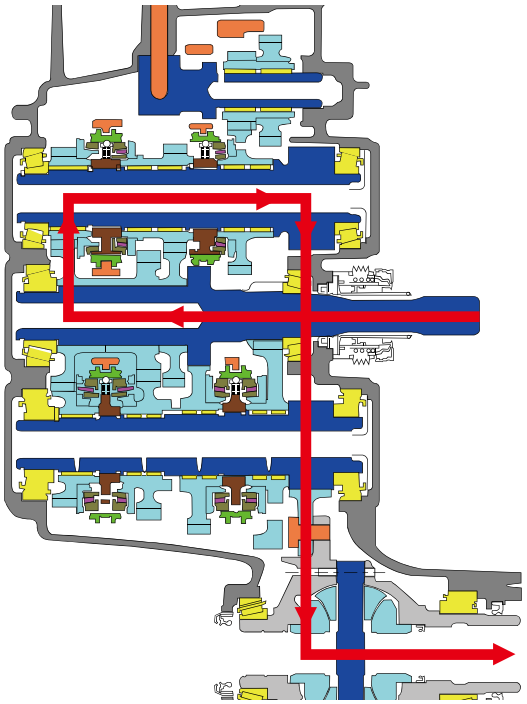
4th speed gear



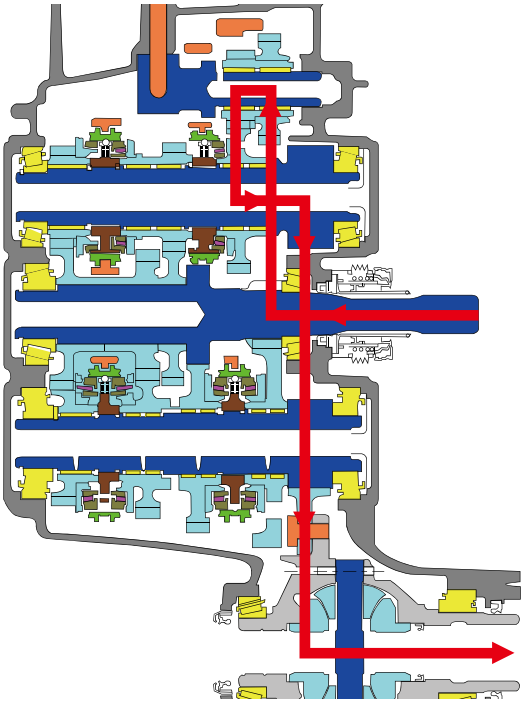
5th speed gear



6th speed gear

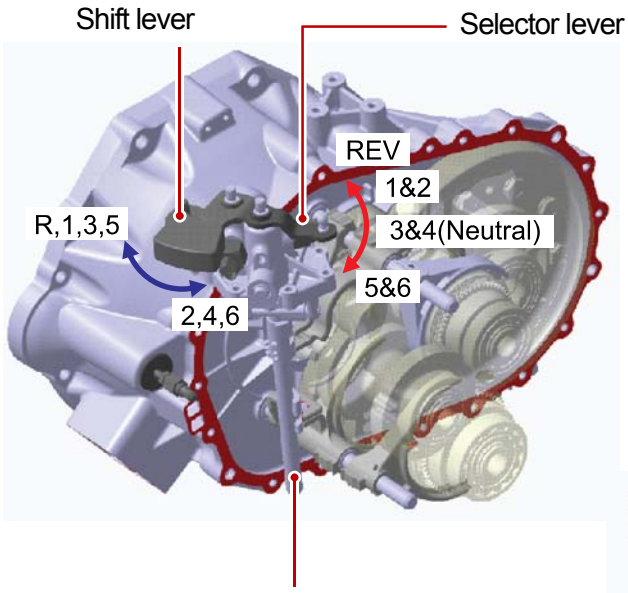


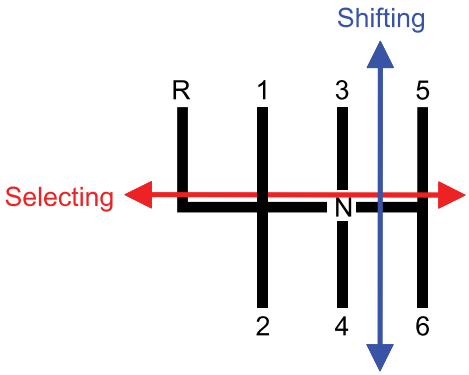
Reverse gear

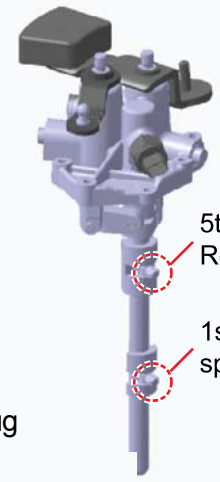


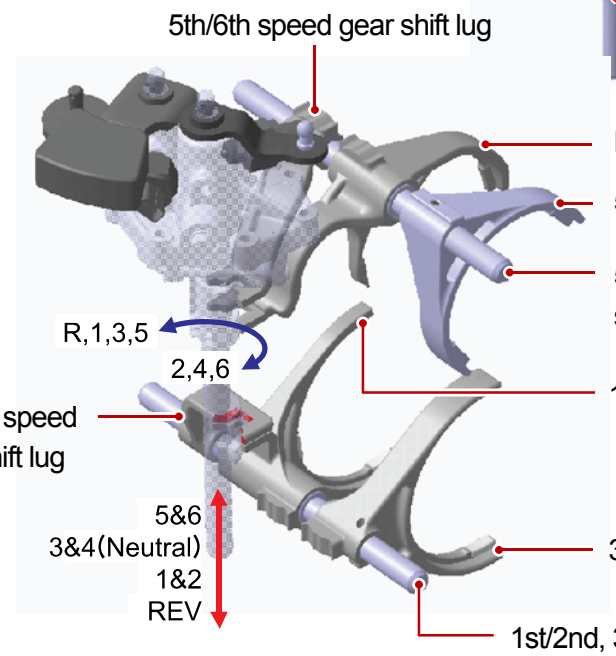
Modification basis	
Application basis	
Affected VIN	

3. SHIFTING MECHANISM









Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Operating type		Hydraulic type
Clutch cover	Type	Diaphragm spring strap
	Adjusting type	SATIC (Self Adjusting Technology with Integrated Cassette) type
Clutch pedal	Type	Suspended type
	Max. operating travel	135 ± 3 mm
	Pedal free play (Longitudinal)	7.1 ± 3 mm
	Pedal free play (Transverse)	3 mm
Clutch disc	Type	Dry type single diaphragm (Rigid type)
	Diameter of facing	Outer: 250 ± 1 mm Inner:160 ± 0.8 mm
	Thickness of disc	Free: 8.7 ± 0.3 mm
		When loaded: 8.0 ± 0.2 (at 7,800 N)
	Numbers of disc	2
	Weight	1.18 kg
	Flywheel type	DMF (Dual Mass Flywheel)
Setting load of clutch cover assembly		At least 7,800 N
Clutch master cylinder	Operating travel	30 mm
	Inner diameter	17.46 mm
Concentric slave cylinder	Maximum operating travel	12.55 mm
	Operating pressure	Maximum 50 bar
Clutch oil	Standard	DOT 3 or DOT 4
	Capacity	As required

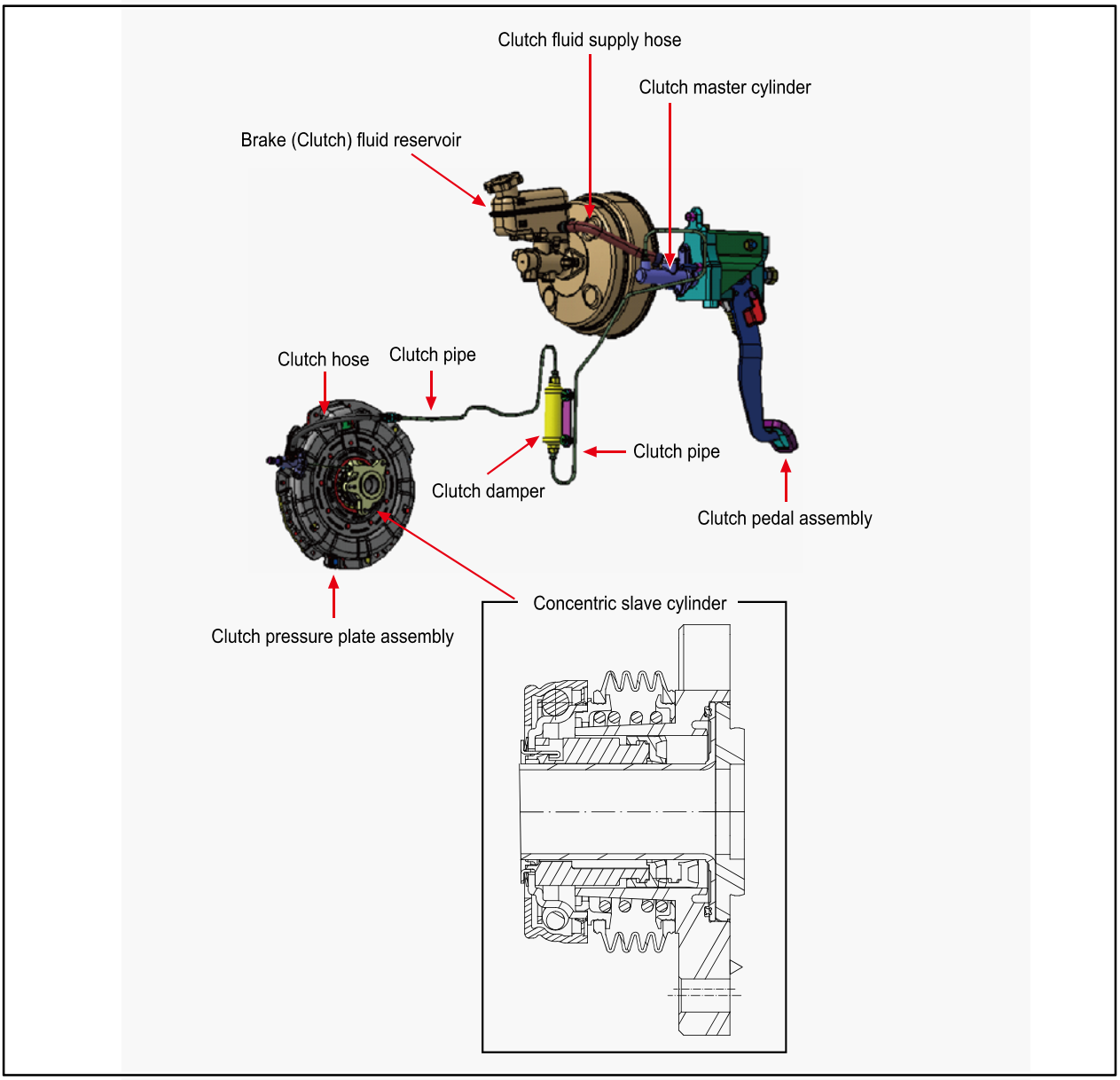
2. TIGHTENING TORQUE

Description		Tightening torque	Amount
Clutch housing bolt	Upper (17 mm)	85.0 to 100 Nm	2
	Front (14 mm)	54.0 Nm + 20°	1
	Rear (14 mm)	51.3 to 56.7 Nm	2
	Lower (14 mm)	56.0 to 62.0 Nm	4
Pressure plate assembly bolt (Hexagon 6 mm)		21.0 to 27.0 Nm	6
Concentric slave cylinder bolt (Hexagon 5 mm)		10 to 16 Nm	3
Concentric slave cylinder oil pipe nut		24.5 to 28.4 Nm	Remove the nut if it is necessary. (Once removed, apply the Loctite on the thread before installation.)
Master cylinder nut (12 mm)		7.8 to 17.6 Nm	
Master cylinder oil pipe nut (10 mm)		14.7 to 17.6 Nm	
Master cylinder push rod lock nut		8.8 to 13.7 Nm	
Clutch oil chamber screw and bolt (10 mm)		3.9 to 7.8 Nm	
Oil pipe nut (10 mm)		14.7 to 17.6 Nm	
Clutch pedal mounting nut (12 mm)		7.8 to 17.6 Nm	
Stopper bolt		16 to 22 Nm	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

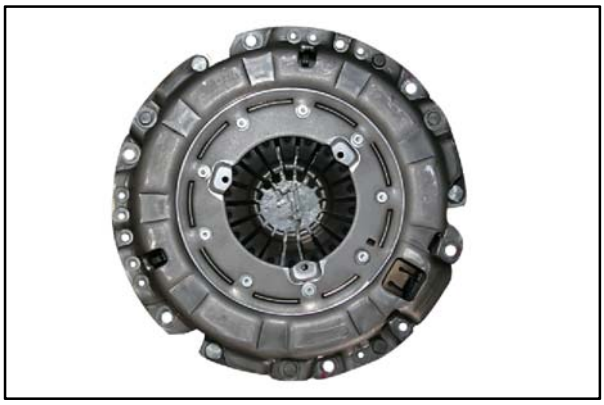
The hydraulic clutch transmits the force required to operate the clutch pedal to the concentric slave cylinder fitted to the clutch housing as a hydraulic pressure.
(The hydraulic pressure is transmitted in the following order: Clutch pedal - Clutch master cylinder - Clutch pipe - Clutch damper - Clutch pipe and hose - Concentric slave cylinder - Pressure plate - Flywheel.)
If a driver depress the clutch pedal, the hydraulic pressure is generated in the master cylinder. It is transmitted to the concentric slave cylinder through the pipe, resulting in the cylinder being forced out. At this time, the clutch disc is forced against the cylinder by pushing the cover. This, in turn, remove the flywheel from the pressure plate. As a consequence, the power from the engine will be cut off and the gear change can be carried out.



2. SATIC (SELF ADJUSTING TECHNOLOGY WITH INTEGRATED CASSETTE)

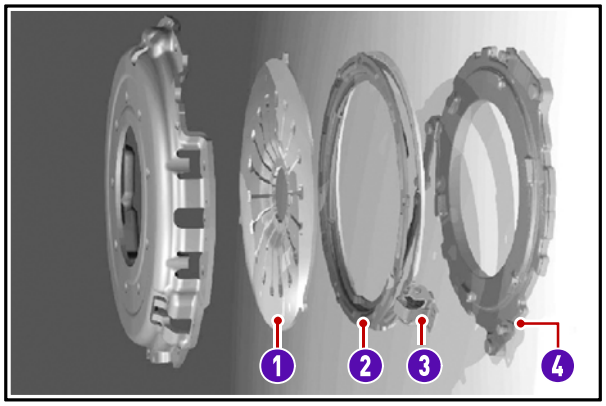
1) System Description

▶ Function

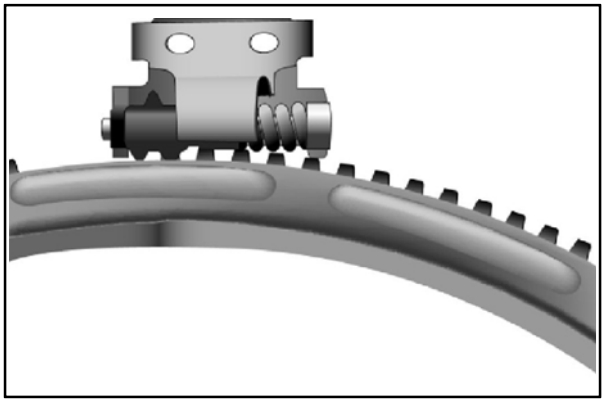


On the conventional clutch, the pedal force tends to increase in proportion to the degree of disc run-out. However, the SATIC clutch has the adjusting function which activates the cassette system inserted to the clutch cover to maintain a constant pedal force and clearance when the disc runs out. (Unlike SAT type, SATIC type does not need SST for clutch cover removal.)

▶ Operation



Diaphragm spring rotates the adjusting equipment as clutch disc is wearing and so, pressure plate is pushed to clutch disc side at the amount of wear.
Disc wear (Free play) → Diaphragm spring (1) → Adjusting equipment (2, 3) → Pressure plate (4)



Modification basis	
Application basis	
Affected VIN	

2) Overview

▶ Driving elements

The driving elements consist of two flat surfaces machined to a smooth finish.
One of these is the rear face of the engine flywheel and the other is the clutch pressure plate. The clutch pressure plate is fitted into a clutch steel cover, which is bolted to the flywheel.

▶ Driven elements

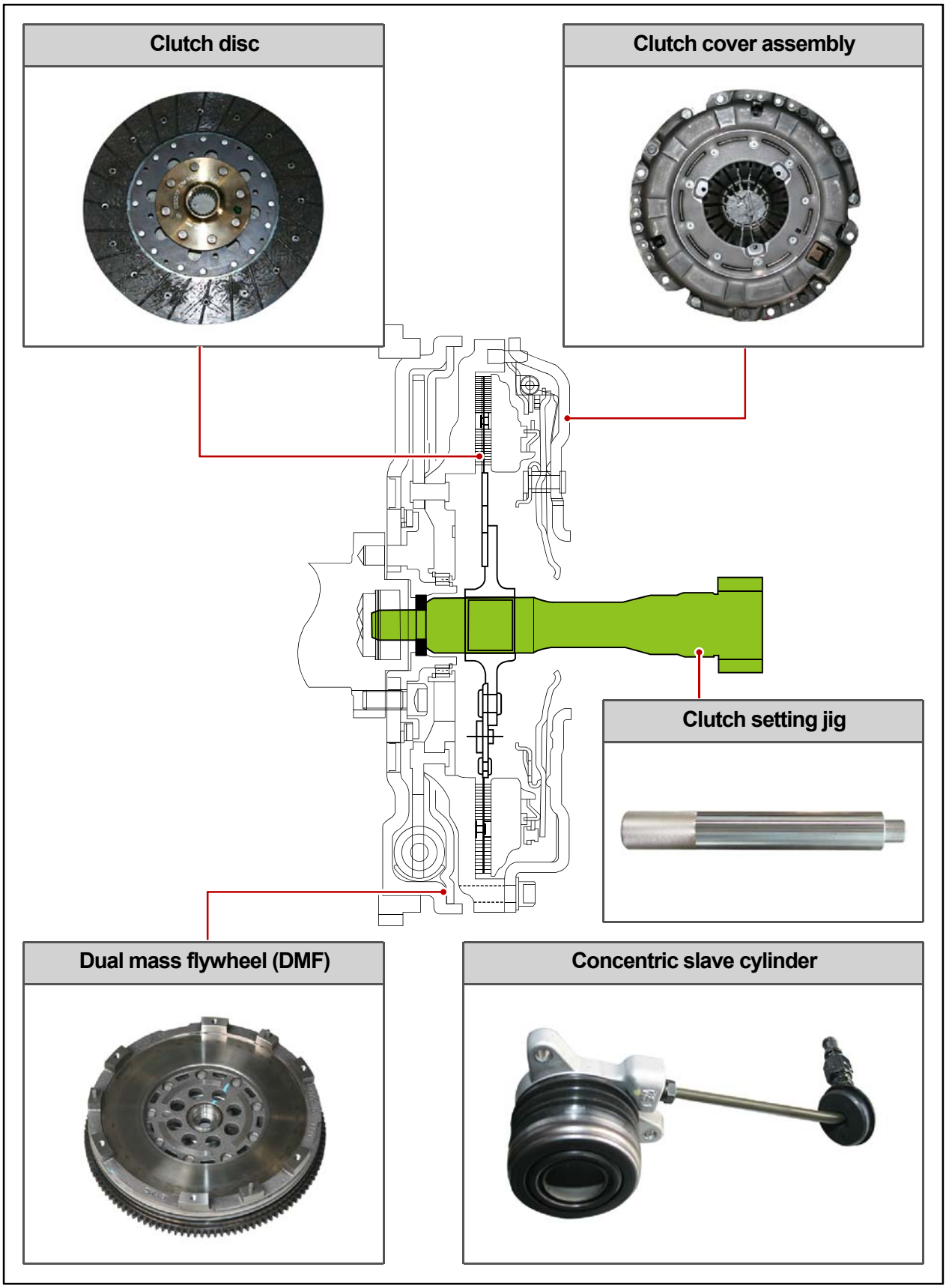
The driven element is the clutch disc with a splined hub which is free to slide lengthwise along the splines of the input shaft.
The driving and driven elements are held in contact by spring pressure. This pressure is exerted by a diaphragm spring in the clutch cover pressure plate assembly.

▶ Operating Elements

The clutch "release" system consists of the clutch pedal and clutch release cylinder.
This system directly releases the clutch by using hydraulic pressure while the conventional clutch system releases the clutch by using release lever and release fork. This system provides higher efficiency than conventional clutch system, and its durability is superior.

- Clutch master cylinder (mounted on clutch pedal)
- Concentric slave cylinder pipe (mounted inside of transmission)

3) Layout



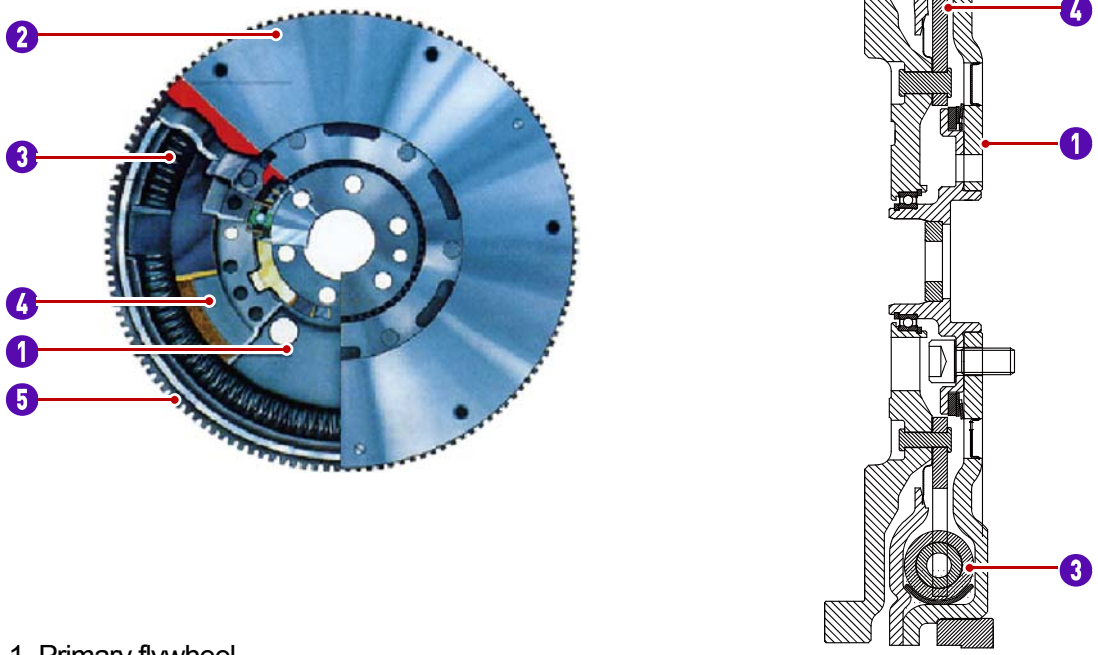
Modification basis	
Application basis	
Affected VIN	

3. DUAL MASS FLYWHEEL (DMF)

The dual mass flywheel (DMF) is of having a mass divided into two halves.
While one mass is connected to the engine crankshaft, which is affected by the mass moment of inertia of the engine, the other mass is affected by one of the transmission.
The divided dual masses are connected to the coil spring and damping system internally.

▶ **The DMF has the following benefits:**

- Reducing fuel consumption by lowering engine speed
- Reducing rattling noise and vehicle vibration in all driving ranges
- Reducing synchronization wear
- Facilitating gear change
- Protecting power train parts by preventing excessive load from being delivered



1. Primary flywheel
2. Secondary flywheel
3. Arc damper spring
4. Torque limiter
5. Ring gear

PROPELLER SHAFT (4WD ONLY) 3310-01

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Structure		2-piece type with CV joint, spider, and rubber coupling
Weight		below 12.0 kg
Joint type		CV joint, spider, rubber coupling
Spider	Numbers	one (installed on center bearing side)
	External diameter	Ø24 mm
	Overall size	Ø62.5 mm
Dimension (Length x Dia.)	No.1 shaft (TM to spider)	1,069 x Ø60 mm
	No. 2 shaft (spider to axle)	847.5 x Ø60 mm
Runout of tube (after installation)		0.3 mm
Unbalance		80g.mm @ 3,000rpm (second measurement: 120 g.mm)
U-joint	Starting torque	0.3 to 0.7 Nm
	Minimum starting angle	18°
Amount of grease in CV joint		210+-10g

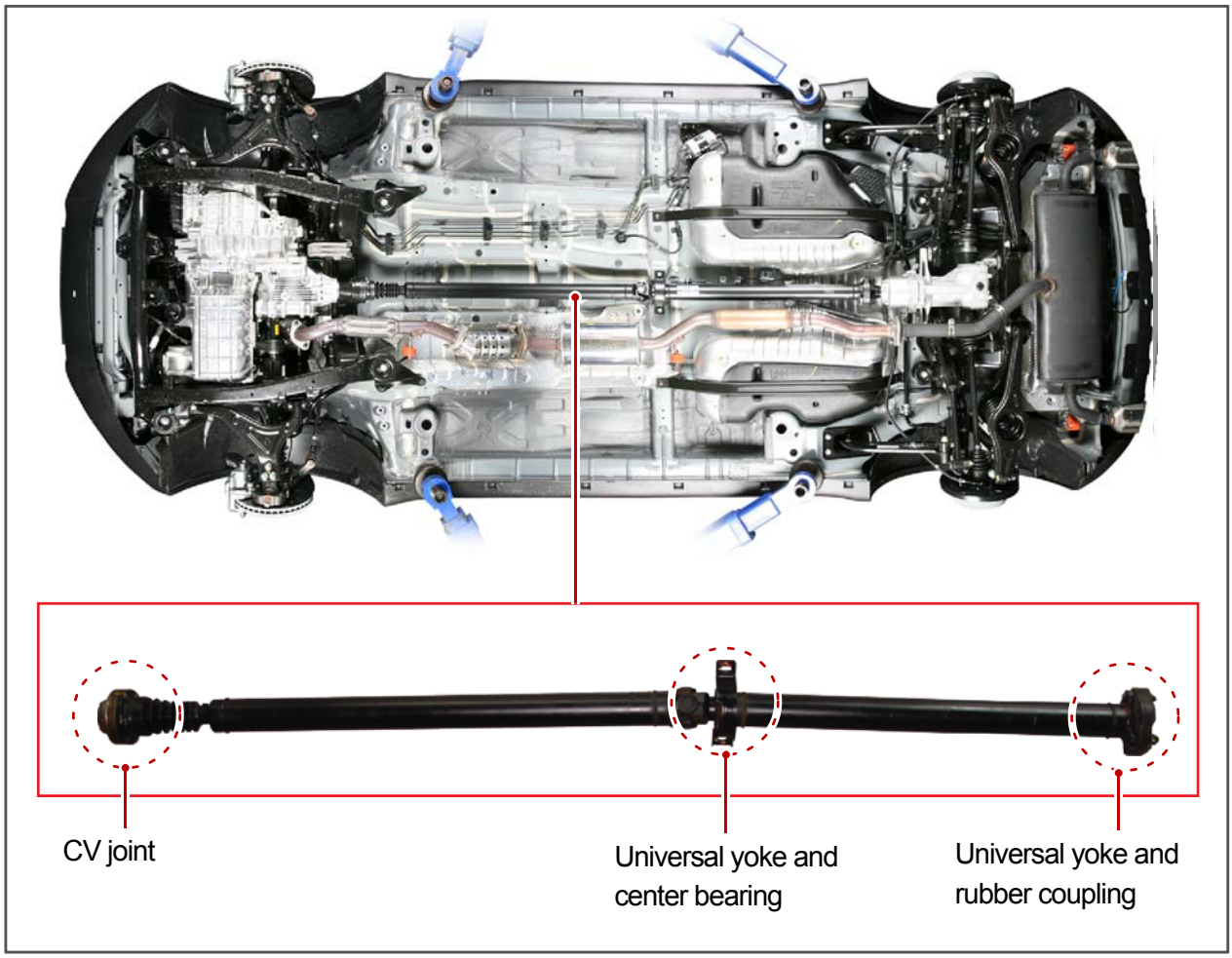
2. TIGHTENING TORQUE

Fastener	Tightening torque
Bolt/nut for rubber coupling (rear axle side)	39.2 to 49.0 Nm
Bolt/nut for CV joint (transaxle side)	29.4 to 39.2 Nm
Mounting bolt for center bearing	58.8 to 68.6 Nm

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The propeller shaft is a thin steel pipe which transfers the power from the transmission to the E-coupling, and has high resistance to torsion and bending.
The propeller shaft has the universal joint (cross axle) mounted on the center of the shaft and splines for the slip joint on the E-coupling side to accommodate the height and length changes which occur as the shaft rotates at high speed.
And the rubber bushing for center bearing in the center of the propeller shaft keeps the balance of the shaft and absorbs its vibration.

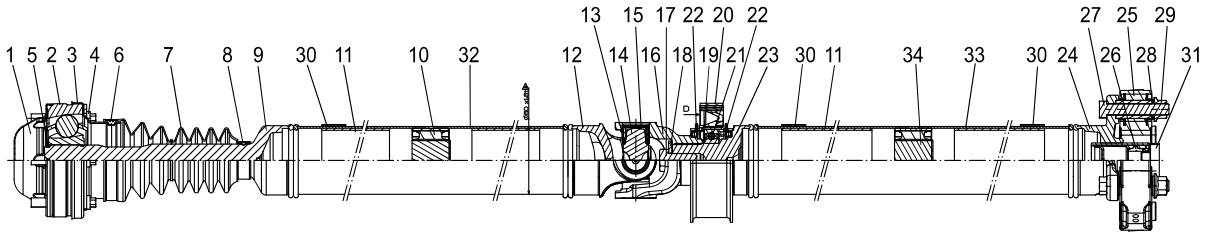


▶ **Function of propeller shaft**

- Transmits driving torque.
- Accommodates the angle change (universal joint / CV joint).
- Accommodates the axial length change (splines for the slip joint).

Modification basis	
Application basis	
Affected VIN	

2. COMPONENT



1	End cap	18	Plain washer
2	VL joint assembly	19	AL washer
3	Washer	20	Center bearing assembly
4	Bolt	21	Ball bearing
5	Circlip	22	Dust shield
6	Clamp (big)	23	Intermediate shaft
7	Boot	24	Fork yoke
8	Clamp (small)	25	Rubber coupling
9	Stub shaft	26	Alignment support
10	Bending absorber	27	Bolt
11	Paper damper	28	Washer
12	Tube yoke	29	Lock nut
13	Oil seal	30	Balance weight
14	Spider	31	Protecter
15	Bearing cap	32	Tube
16	Intermediate yoke	33	Tube
17	Bolt	34	Bending absorber

CAUTION

Do not remove the rubber coupling since the vibration balance could be improper once removed it.

DRIVE SHAFT AND AXLE

4110-01

GENERAL INFORMATION

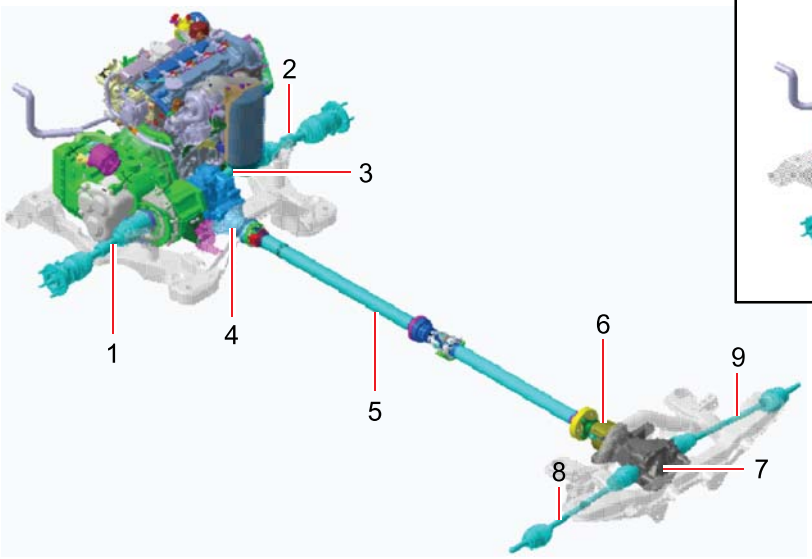
1. SPECIFICATION

Component		Item	Specifications
2WD, 4WD	Front drive shaft	Joint type	Inside: Tripod joint Outside: Ball joint
		Max. allowed angle	Inside: 23° Outside: 46°
		To compensate the bending angle	Installation of equivalent length shaft
4WD only	Rear drive shaft	Joint type	Inside: Cross groove joint Outside: Ball joint
		Max. allowed angle	Inside: 23° Outside: 23°
	Rear differential carrier	Type	Independent Rear Drive Axle (IRDA)
		Reduction gear type	Hypoid gear
		Gear reduction ratio	2.93
		Diameter of gear	Ø152 mm
		Oil type	Hypoid gear oil (SAE 75W/90)
		Final drive gear backlash	0.10 to 0.15 mm
		Differential gear backlash	0 to 0.076 mm
	Propeller shaft	Joint type	PTU side: CV joint Rear axle side: Rubber coupling
		Sliding distance	±25 mm or more
		Unbalance	80 g.mm or less at 3,000 rpm
		Total runout	0.3 mm or less

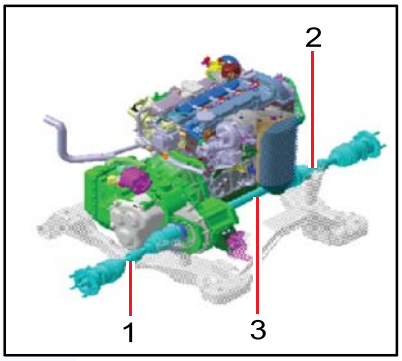
OVERVIEW AND OPERATING PROCESS

1. COMPONENT

For AWD vehicle



For 2WD vehicle

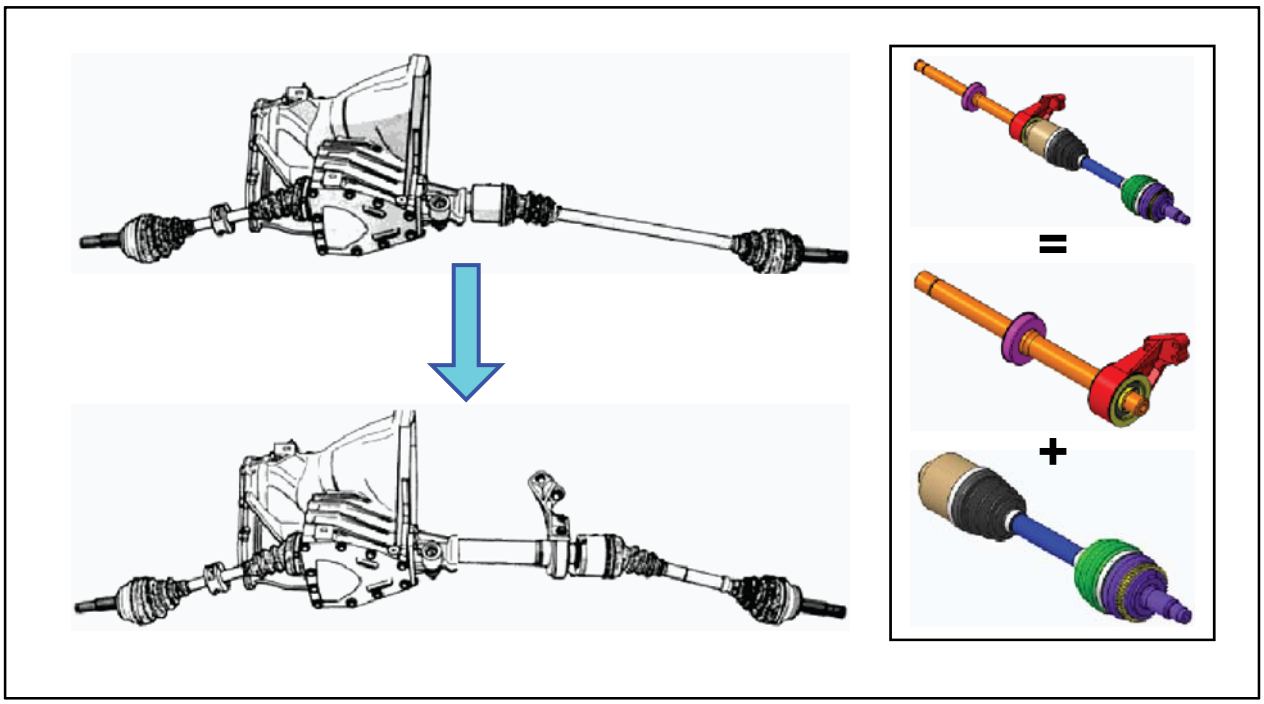


1. Front drive shaft (LH)
2. Front drive shaft (RH)
3. Intermediate shaft
4. Power transfer unit(PTU) - 4WD
5. Propeller shaft - 4WD
6. E-coupling - 4WD
7. Rear differential carrier - 4WD
8. Rear drive shaft (LH) - 4WD
9. Rear drive shaft (RH) - 4WD

Modification basis	
Application basis	
Affected VIN	

2. TORQUE STEER

Torque steer is a condition in which a vehicle pulls to either side because of an inequality of traction between the left and right driving wheels when a large torque is applied to the front wheel of a FWD or 4WD.
Especially for a FWD vehicle, this mechanical condition can cause the steering effect because of the output torque (rotational force) produced by the gyroscope.
This rotational force is due to the difference in distance between the left/right front wheels and the transaxle which leads to the change of the shaft bending angle.
To prevent this, the intermediate shaft, called Intermediate shaft, is employed on each side so that the bending angle and the length are kept constant.

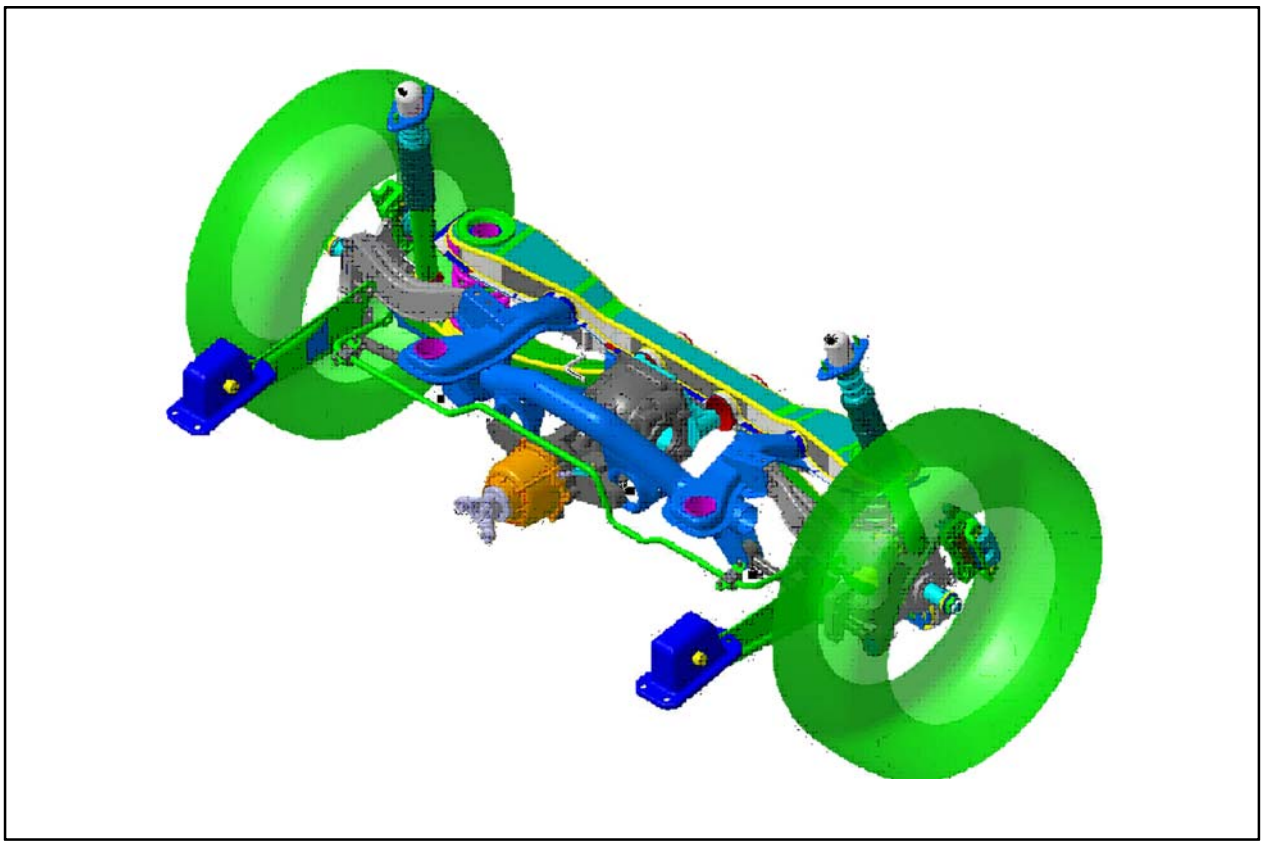


CAUTION

A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. In essence, a mechanical gyroscope is a spinning wheel or disk whose axle is free to take any orientation. Although this orientation does not remain fixed, it changes in response to an external torque much less and in a different direction than it would without the large angular momentum associated with the disk's high rate of spin and moment of inertia. Since external torque is minimized by mounting the device in gimbals, its orientation remains nearly fixed, regardless of any motion of the platform on which it is mounted.

3. REAR AXLE

The rear axle installed in this car is a removable axle, called IRDA (Independent Rear Differential Axle).
The rear differential carrier is installed directly on the sub frame,
and there is an independent suspension that allows each wheel on the same axle to move vertically and independently of each other with the universal joint and the slip joint.



Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
PTU (Power Transfer Unit)	Gear ratio	2.929
	Numbers of helical gear	22/39
	Numbers of hypoid gear	23/38
	Oil	IDEMITSU LW 80W/90
	Oil capacity	≒ 0.58 L
	Operating temperature	−40 to 150°C
E-coupling	Maximum torque	1,000 Nm
	Operating temperature	−40 to 120°C
	Numbers of main clutch	Outer: 11, Inner: 11
	Numbers of pilot clutch	Outer: 4, Inner: 3
	Coil windings	240 turns
	Weight	8 kg
	Oil	ECF107 (ATF based EMCD special oil)
	Oil capacity	0.145 L (145 ml)

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The AWD system in this vehicle is the electronic 4WD system and controls the traction to rear wheels according to the driving conditions.

1) Driving Mode

(1) AUTO mode (Normal driving mode)

Normally the vehicle is in 2WD mode.
Automatically change to this mode when the vehicle needs higher traction.

(2) LOCK mode (when pressing 4WD LOCK switch)

- This mode provides the highest traction. Use this mode when driving on unpaved, rugged, steep, sandy, wet or slippery roads.
- In 4WD LOCK mode, if the rear wheel speed exceeds 40 km/h, 4WD LOCK mode is canceled and 4WD AUTO mode is activated (Indicator OFF). If the speed is decreased below 35 km/h, 4WD LOCK mode is resumed (Indicator ON again).

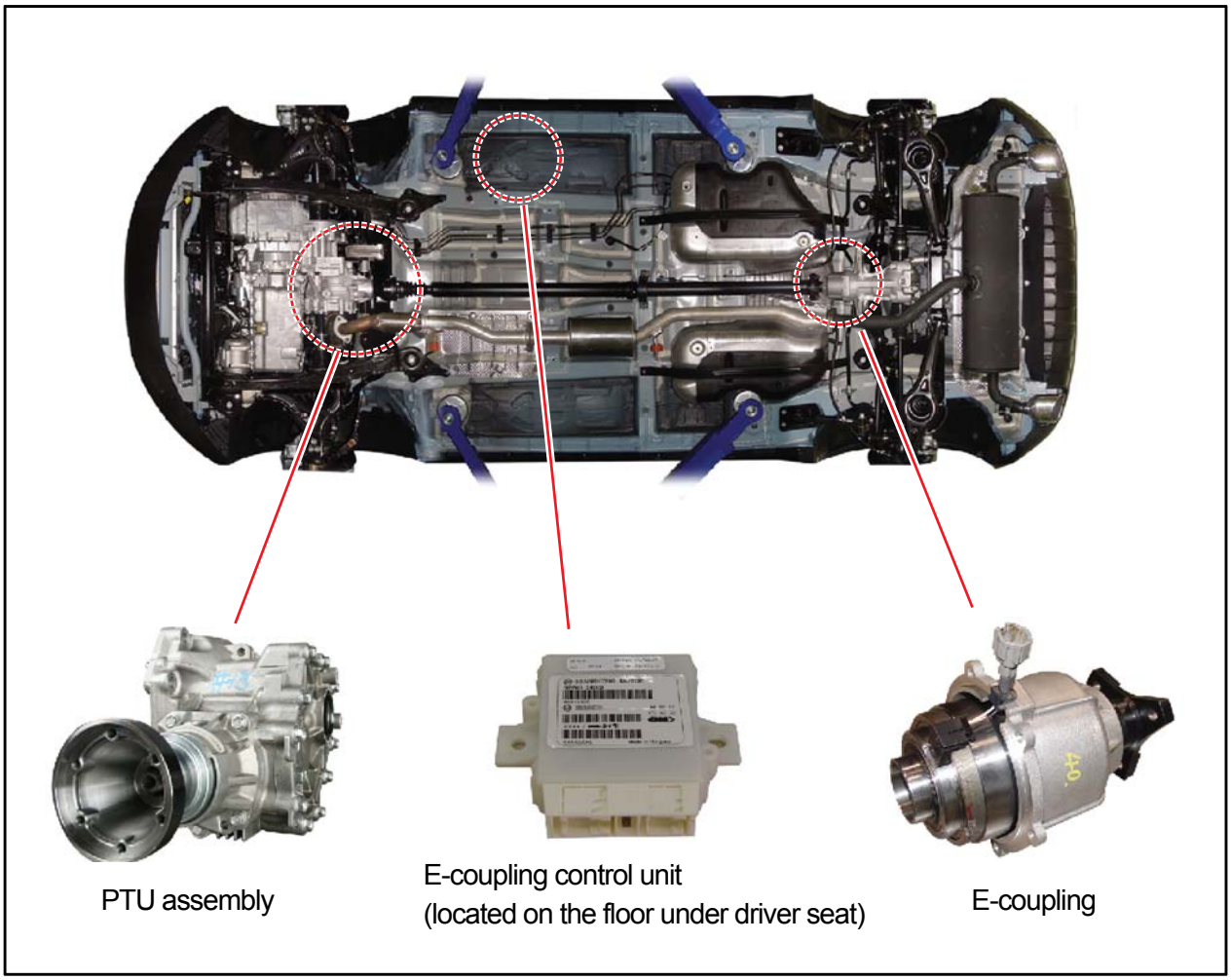


▶ **Mode table**

4WD LOCK switch	Vehicle speed	Driving mode
Not pressed (4WD AUTO)	No conditions	4WD AUTO
Pressed (4WD LOCK)	over 40 km/h	4WD AUTO
Pressed (4WD LOCK)	below 35 km/h	4WD LOCK

Modification basis	
Application basis	
Affected VIN	

2. SYSTEM LAYOUT



1) Components

(1) PTU (Power Transfer Unit)

The power transfer unit in the front wheel drive model changes the angle of engine torque to 90° and transfer it to E-coupling to distribute the torque to rear wheels.

(2) E-Coupling (Electronic Coupling)

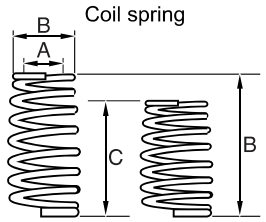
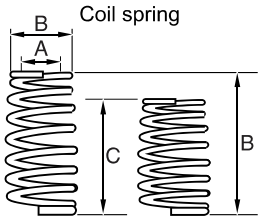
E-Coupling transfer the engine torque from PTU to rear axle and controls to distribute it between front wheels and rear wheels.

(3) E-Coupling Control Unit (ECU)

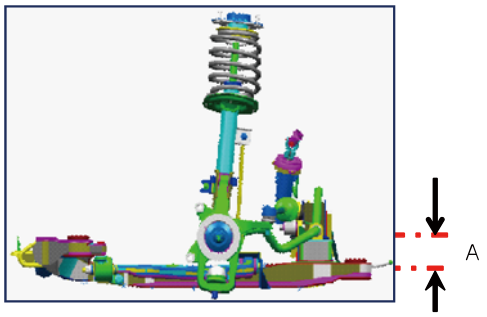
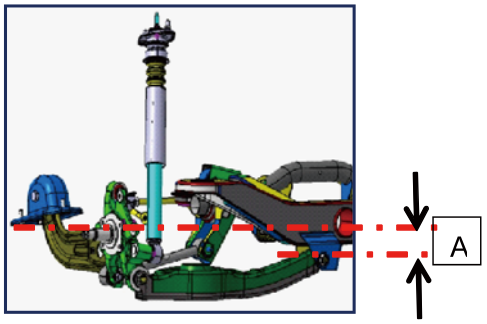
E-Coupling controls the current (clutch engagement force) of EMCD in E-Coupling according to CAN signals (wheel speed, engine torque, pedal position, ABS/ESP signals).
* EMCD: Electro-Magnetic Control Device

GENERAL INFORMATION

1. SPECIFICATION

System	Description		Specification	
Front suspension	Suspension type		Macperson strut type	
	Spring type		Coil spring	
	Stabilizer type		Torsion bar type	
	Shock absorber 	Type	Cylindrical reciprocation type	
		Max. length (extended)	554 mm	
		Min. length (compressed)	372 mm	
	Min. length (compressed) 	Inner diameter (A)	Upper: 84.0 mm Lower: 100.0 mm	
		Outer diameter (B)	163.1 mm	
		Free length (C)	356.1 mm	
		Installed length (D)	276.0 mm	
		Coil windings	5.32 turns	
		Winding direction	Right direction	
Rear suspension	Driving type		AWD	2WD
	Suspension type (trailing, upper, lower & track rod)		Multi-link type	←
	Spring type		Coil spring	←
	Stabilizer type		Torsion bar type	←
	Shock absorber	Type	Cylindrical reciprocation type	←
		Max. length (extended)	551 mm	←
		Min. length (compressed)	361 mm	←
	Coil spring	Diameter (A)	12.8 mm	12.6 mm
		Free length (B)	287.1 mm	291.7 mm
		Coil windings	6.64 turns	6.32
		Winding direction	Right direction	←

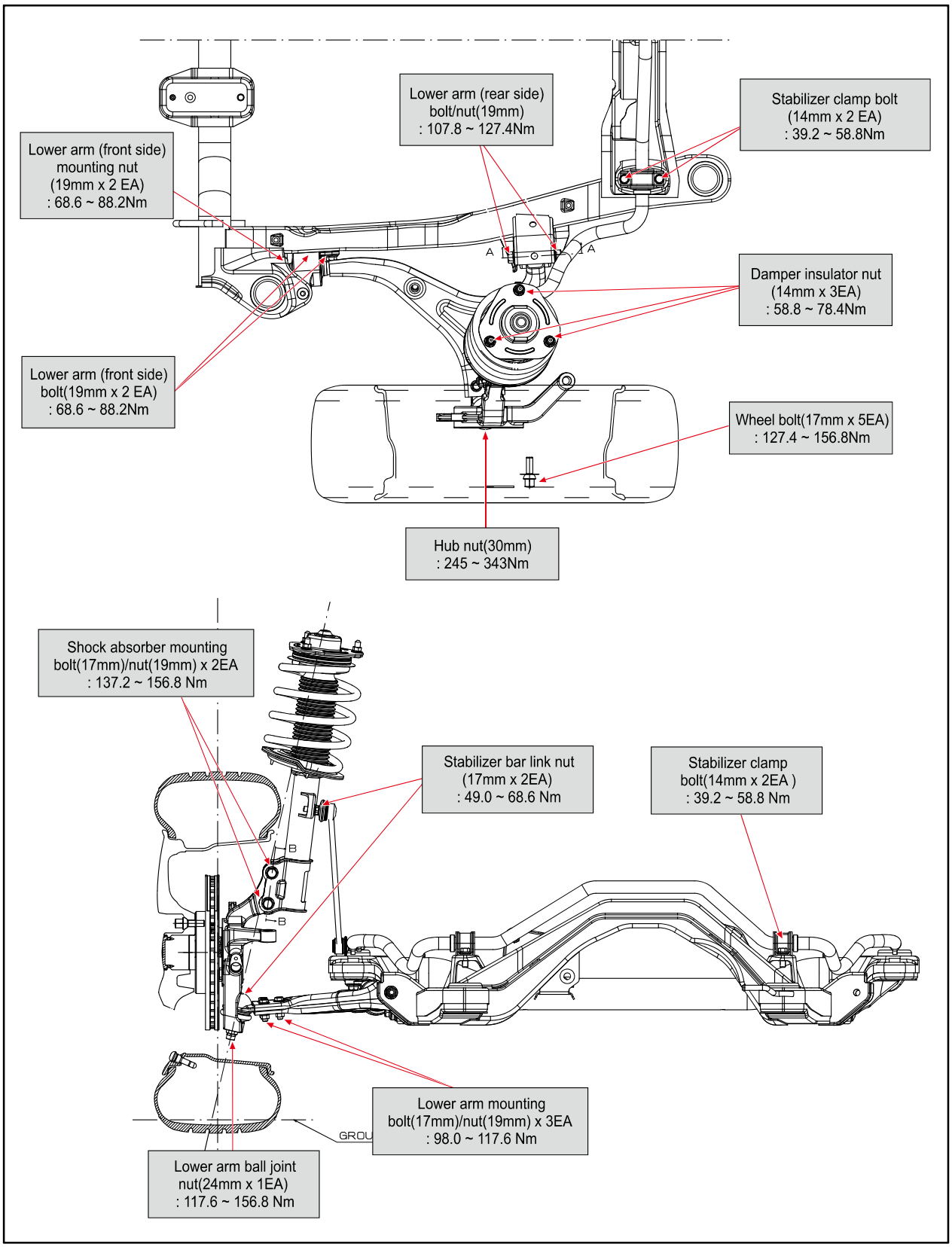
1) Wheel Alignment

System	Description	Specification	
Front	Ground clearance (A)	76.8 ± 5 mm	
	Trim height : wheel center ↔ Wheel house	433 mm	
	Camber (maintenance free)	−0.15 ± 0.5˚	
	Caster (maintenance free)	4.8 ± 0.5˚	
	Total toe-in	0.0 ± 0.1˚ (adjust by tie rod)	
	King pin angle	12.85˚	
Rear	Ground clearance (A)	63.3 ± 5 mm	
	Trim height : wheel center ↔ Wheel house	437 mm	
	Camber (maintenance free)	−0.5 ± 0.5˚ [adjust by cam bolt on upper arm]	
	Total toe-in	0.0 ± 0.1˚ [adjust by cam bolt on track rod]	

Modification basis	
Application basis	
Affected VIN	

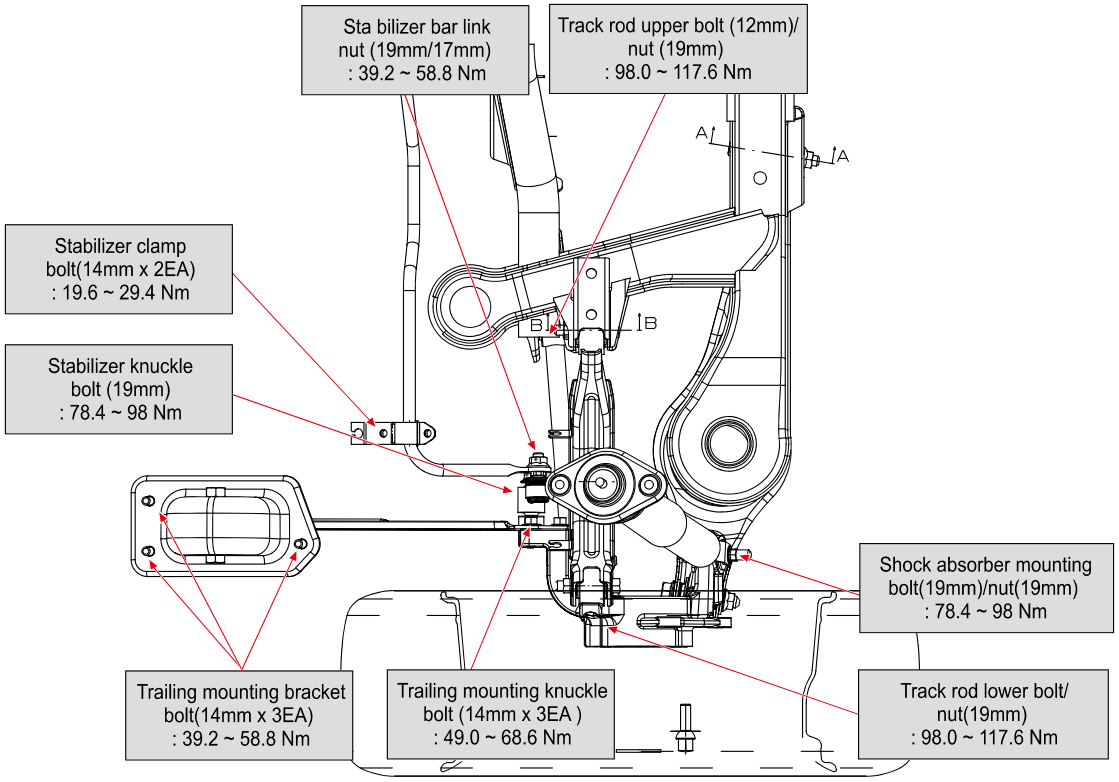
2. TIGHTENING TORQUE

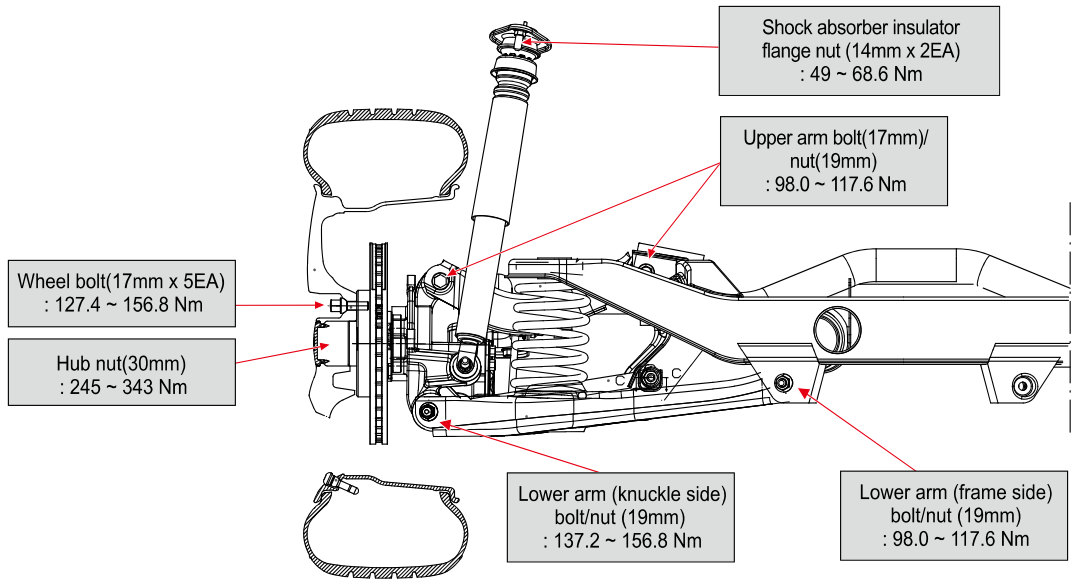
▶ Front suspension assembly



Modification basis	
Application basis	
Affected VIN	

▶ Rear suspension assembly



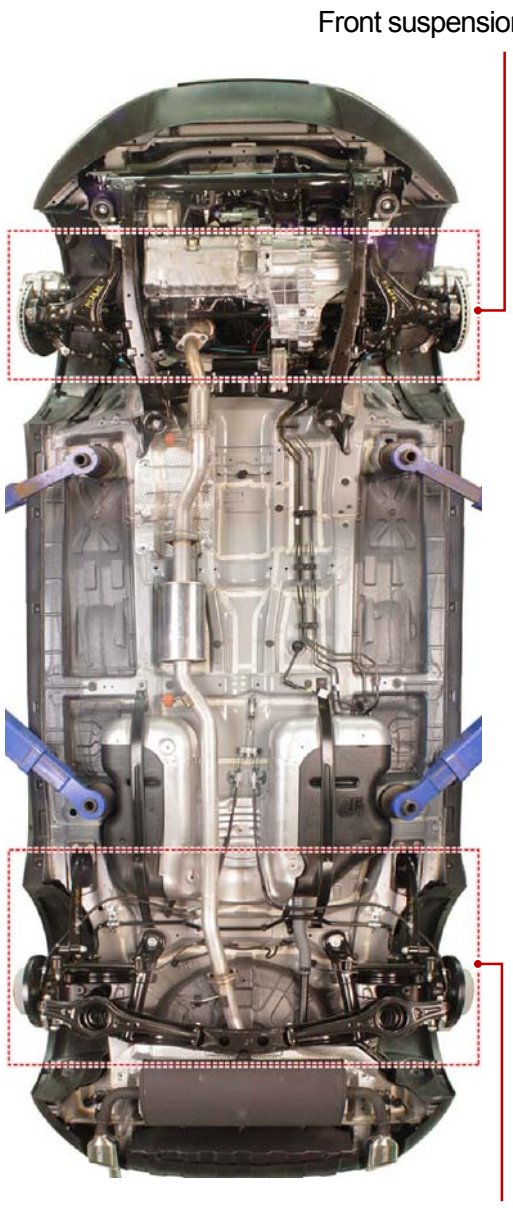
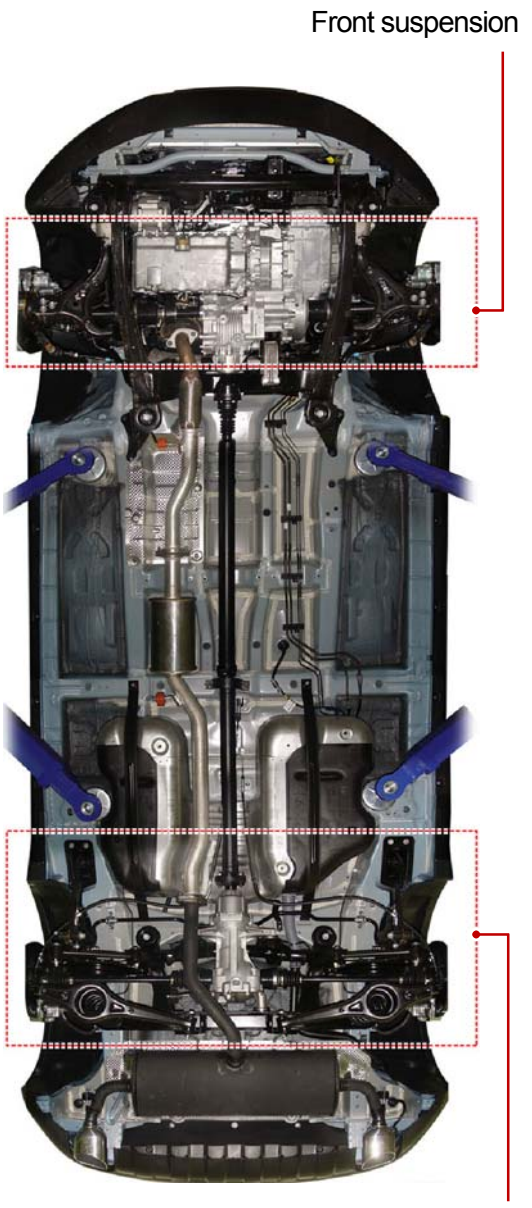


Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

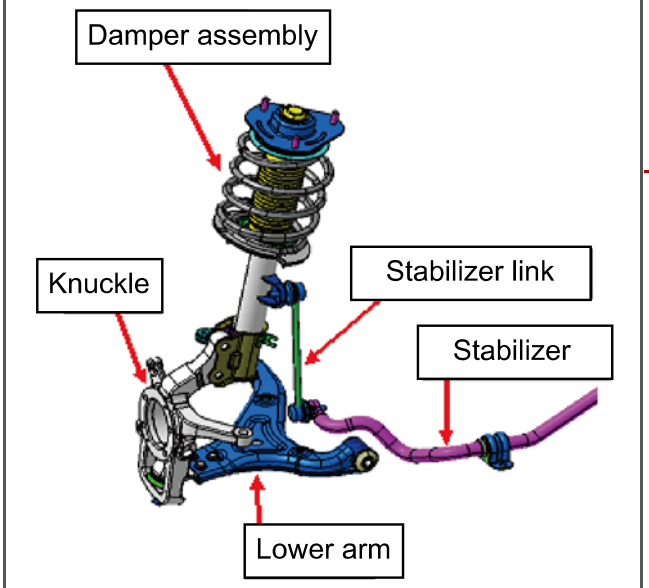
The suspension is the device to connect the axle and vehicle. It absorbs the vibrations and impacts from road surface, which enhances the comforts, driving force, braking force and drivability.

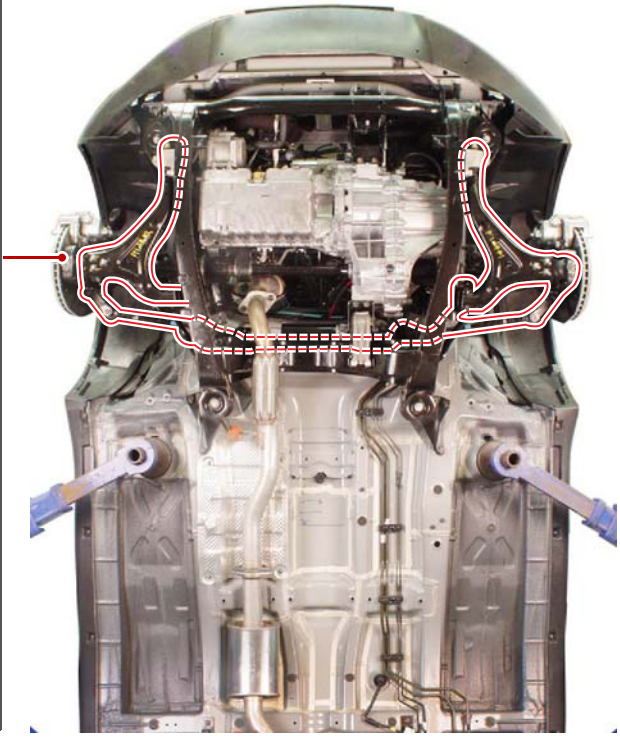
Underview of vehicle with 2WD, 6M/T	Underview of vehicle with 4WD, 6A/T
	

1) Front Suspension (Macperson Strut Type)

Front suspension supports the vehicle weight and absorber the vibration from tires. And, in this type of suspension, the steering linkage tie rod is mounted on the knuckle.

Macperson strut type suspension





Macperson strut type suspension is the independent suspension which has the spring on the strut integrated with shock absorber. The lower arm is installed on sub frame and large strut damper is installed on the knuckle to support the tire. This type of suspension is normally applied to the vehicle with monocoque body, especially on the front wheel drive type. The upper part with spring is mounted at body mount and the strut with shock absorber is linked on the steering knuckle.

▶ Advantages

1. Compact and simple design
2. Stable wheel alignment
3. Good load distribution and easy installation
4. Less effect from tire up/down movement

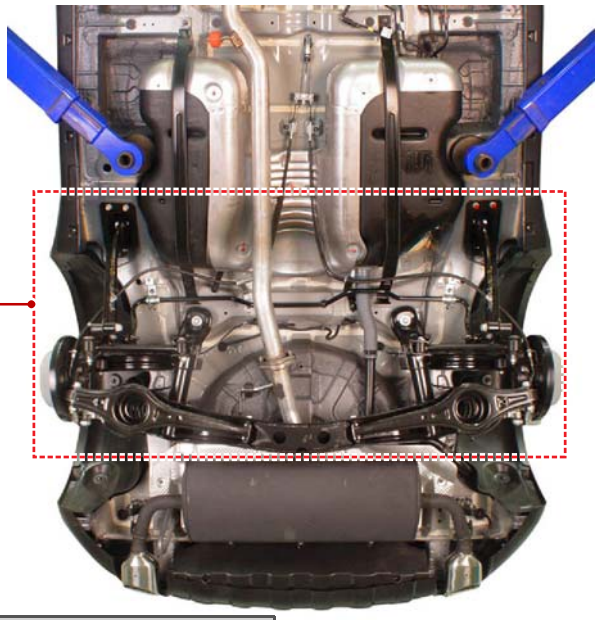
▶ Disadvantages

1. Comparatively weak to the impact from road surface and lateral shock due to long strut and single swing arm

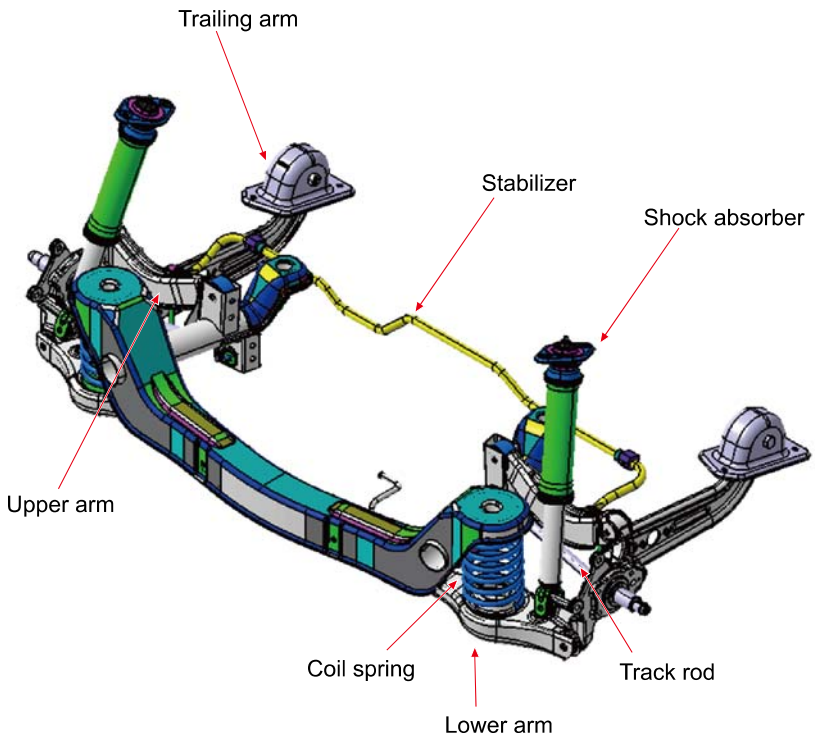
Modification basis	
Application basis	
Affected VIN	

2) Rear Suspension (Multi-link Type)

Multi-link type suspension is the independent suspension. It provides good ride comfort and drivability by reducing the coil spring weight. Also, it increases the space for passenger compartment by lowering the floor.
This type of suspension consists of multiple links such as trailing arm, upper arm, lower arm and track rod.



Layout



GENERAL INFORMATION

1. SYSTEM OVERVIEW

1) Terms and Definition

- CBS: Conventional Brake System
- ABS: Anti-Lock Brake System
- EBD: Electronic brake-Force Distribution
- ESP: Electronic Stability Program
- ABD: Automatic Braking Differential
- ASR: Acceleration Slip Regulation
- AYC: Active Yaw Control (Understeer and Oversteer Control)
- HBA: Hydraulic Brake Assistant
- ARP: Active Rollover Protection
- HSA: Hill Start Assistant

2) Functions

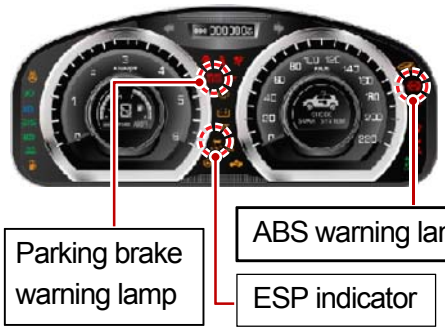
<table>
<tr><th>Function</th><th>Vehicle with CBS</th><th>Vehicle with ABS/EBD</th><th>Vehicle with ESP</th></tr>
<tr><td>ABS</td><td rowspan="8">Not applied</td><td>Applied</td><td rowspan="8">Applied</td></tr>
<tr><td>EBD</td><td>Applied</td></tr>
<tr><td>ABD</td><td rowspan="7">Not applied</td></tr>
<tr><td>ASR</td></tr>
<tr><td>AYC</td></tr>
<tr><td>HBA</td></tr>
<tr><td>ARP</td></tr>
<tr><td>HSA</td></tr>
</table>

3) Parts Arrangement

<table>
<tr><th>Part name</th><th>Vehicle with CBS</th><th>Vehicle with ABS/EBD</th><th>Vehicle with ESP</th></tr>
<tr><td>HECU</td><td rowspan="10">Not applied</td><td rowspan="5">Applied</td><td rowspan="5">Applied</td></tr>
<tr><td>Front wheel speed sensor</td></tr>
<tr><td>Rear wheel speed sensor</td></tr>
<tr><td>ABS warning lamp</td></tr>
<tr><td>EBD indicator</td></tr>
<tr><td>Longitudinal G sensor</td><td>2WD: N/A, 4WD: Applied</td><td>Not applied</td></tr>
<tr><td>Sensor cluster
(Yaw rate sensor, lateral/longitudinal G sensor)</td><td rowspan="4">Not applied</td><td rowspan="4">Applied</td></tr>
<tr><td>ESP indicator</td></tr>
<tr><td>ESP OFF switch and warning lamp</td></tr>
<tr><td>Steering wheel angle sensor</td></tr>
</table>

4) Component

A. Meter cluster-ABS, EBD, ESP indicator/warning lamp

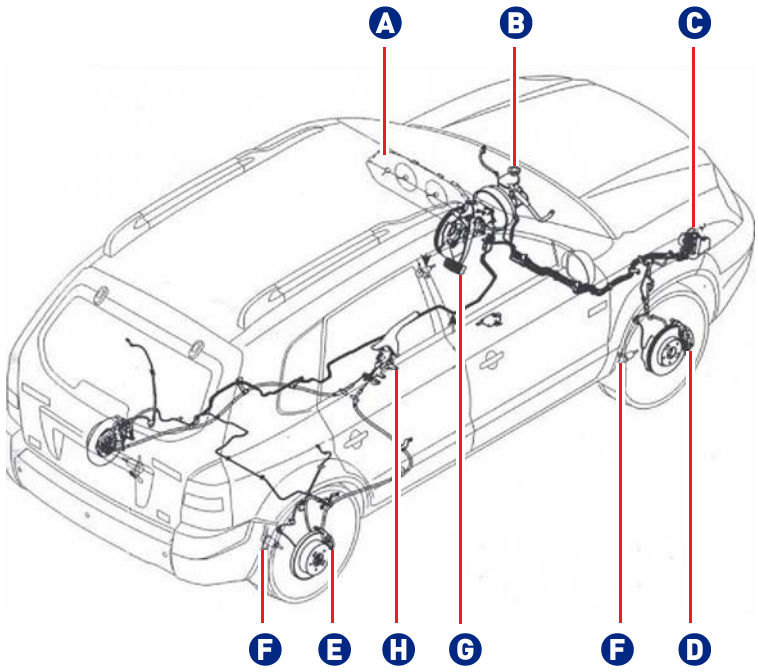


B. Master cylinder and booster

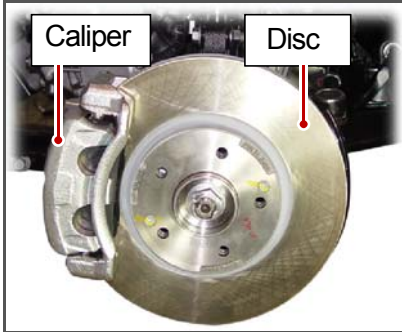


C. HECU

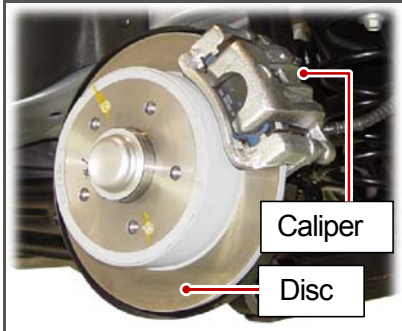




D. Front brake assembly



E. Rear brake assembly



F. Front/rear wheel speed sensor

Front/rear-4WD



Rear-2WD



G. Brake pedal



H. Parking brake



Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATION (DSL ONLY)

Unit	Description	Specification
Front brake	Type	Ventilated disc
	Outer diameter of disc	Ø298 mm
	Inner diameter of caliper cylinder	Ø43.0 x 2 mm
	Thickness of disc	26 mm (wear limit: 24 mm)
	Thickness of brake pad	10.5 mm (wear limit: 2 mm)
	Pad wear indicator	Mechanical type
Rear brake	Type	Solid disc
	Outer diameter of disc	2WD: Ø262 mm, 4WD: Ø284 mm
	Thickness of disc	10 mm (wear limit: 8.4 mm)
	Thickness of brake pad	10 mm (wear limit: 2 mm)
	Pad wear indicator	Mechanical type
Brake booster	Type	Vacuum assist type
	Size	8” + 9” (Tandem)
Master cylinder	Type	Tandem (level sensor installed)
	Inner diameter of cylinder	Ø25.4 mm
Brake pedal	Maximum operating stroke	140 ± 3 mm
	Pedal ratio	3.8 : 1
	Free play	3 to 10 mm
Parking brake	Type	Mechanically expanded rear lining
	Operating type	Hand operated type
	Inner diameter of drum	2WD: Ø168 mm, 4WD: Ø190 mm
Brake oil	Specification	DOT 4
	Capacity	0.7 to 0.8 liters

NOTE

Service interval for brake fluid: Change every other year.

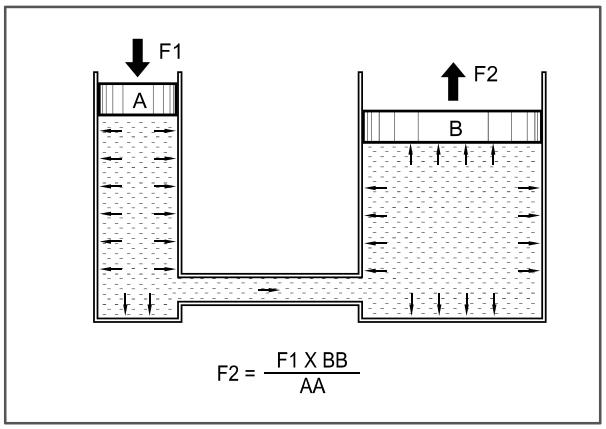
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

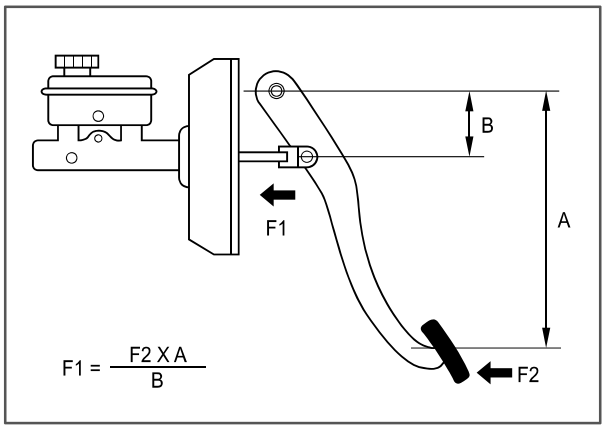
Even though a driver cuts off the power, while driving, the vehicle continues to move due to the law of inertia. Therefore, a braking device is needed to stop the vehicle. The brake system normally uses the frictional discs that converts the kinetic energy to the thermal energy by frictional operation. The brake system consists of the brake disc (front wheel), brake disc or drum (rear wheel), parking brake (mechanical type), master cylinder, booster, pedal and supply lines (pipes and hoses).

▶ Hydraulic brake



This system uses the leverage effect and Pascal's principle. When depressing the brake pedal, the pedal pressure is increased by booster and is delivered to master cylinder to generate hydraulic pressure. The hydraulic pressure generated by the master cylinder is delivered to the brake caliper through the brake pipes or hoses. This hydraulic pressure pushes the brake calipers, accordingly the caliper pads are contacted to brake disc to generate the braking force.

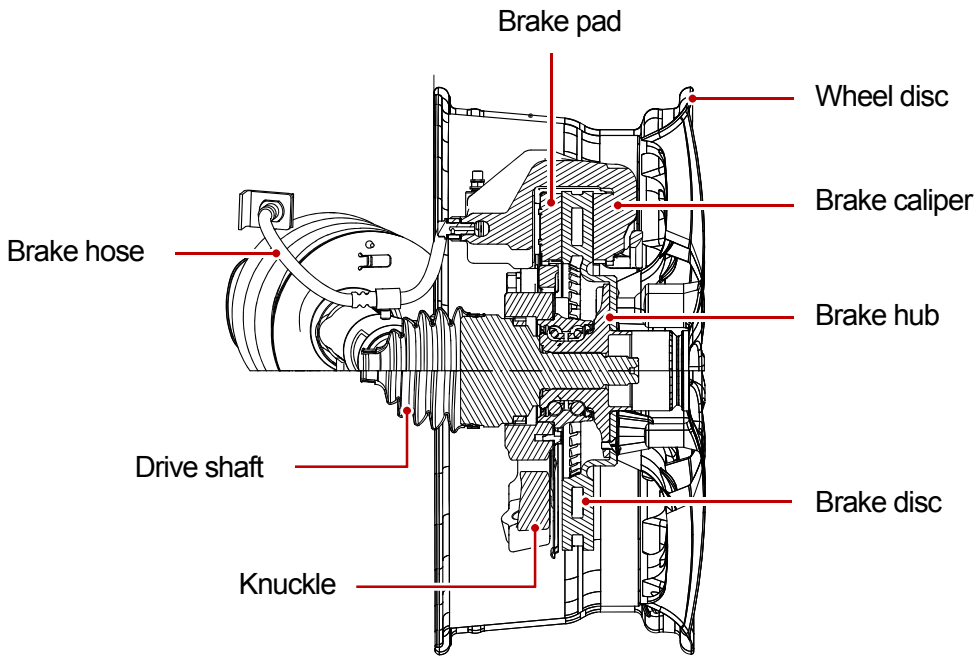
▶ Brake pedal

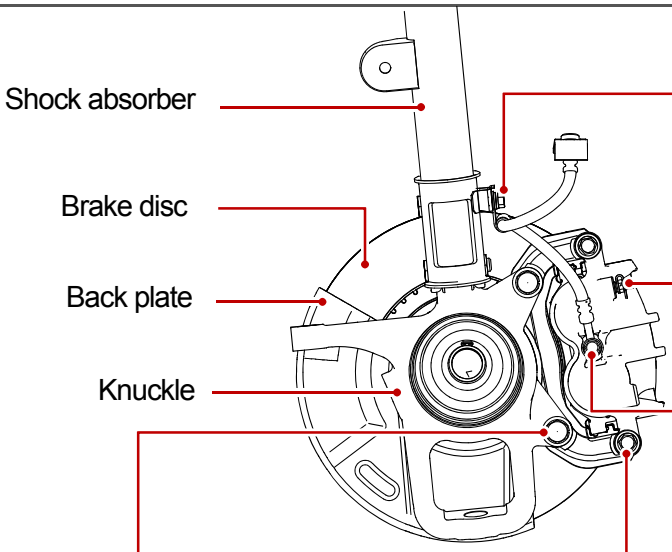


Brake pedal uses the leverage effect to apply bigger force to the brake master cylinder.

2. SECTIONAL DIAGRAM

▶ **Front disc brake**





Brake hose bracket mounting bolt (12 mm): **9.8 ~ 12.8Nm**

Air breather screw: **8.8 ~ 10.8Nm**

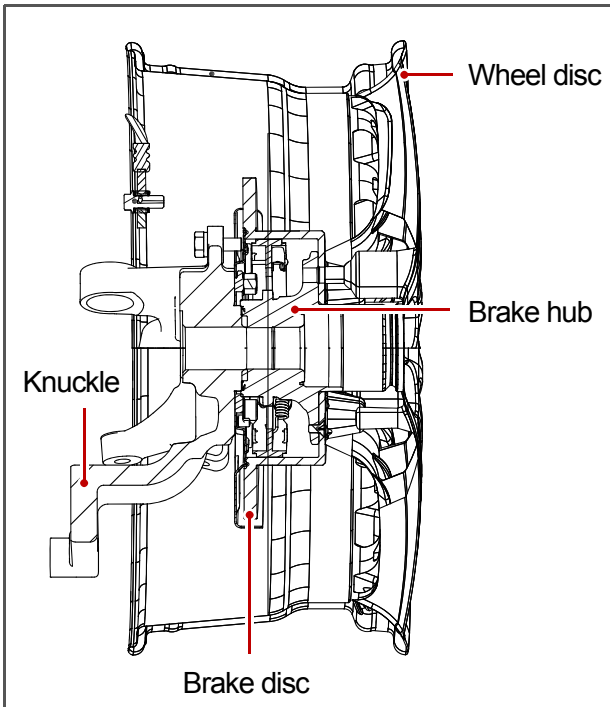
Brake hose bolt (12 mm): **19.6 ~ 29.4Nm**

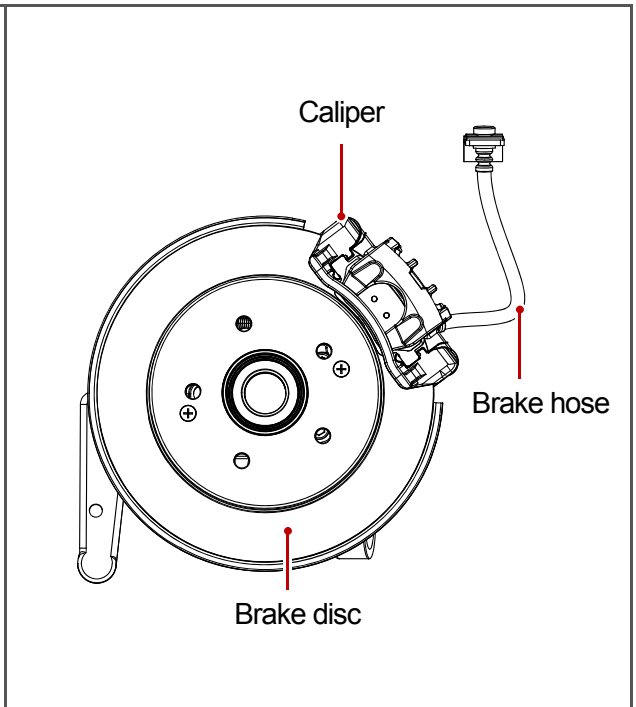
Pad guide bolt: **25.5~30.4Nm**

Caliper mounting bolt (19mm x 2EA): **83.3 ~ 102.9Nm**

Modification basis	
Application basis	
Affected VIN	

▶ **Rear disc brake**



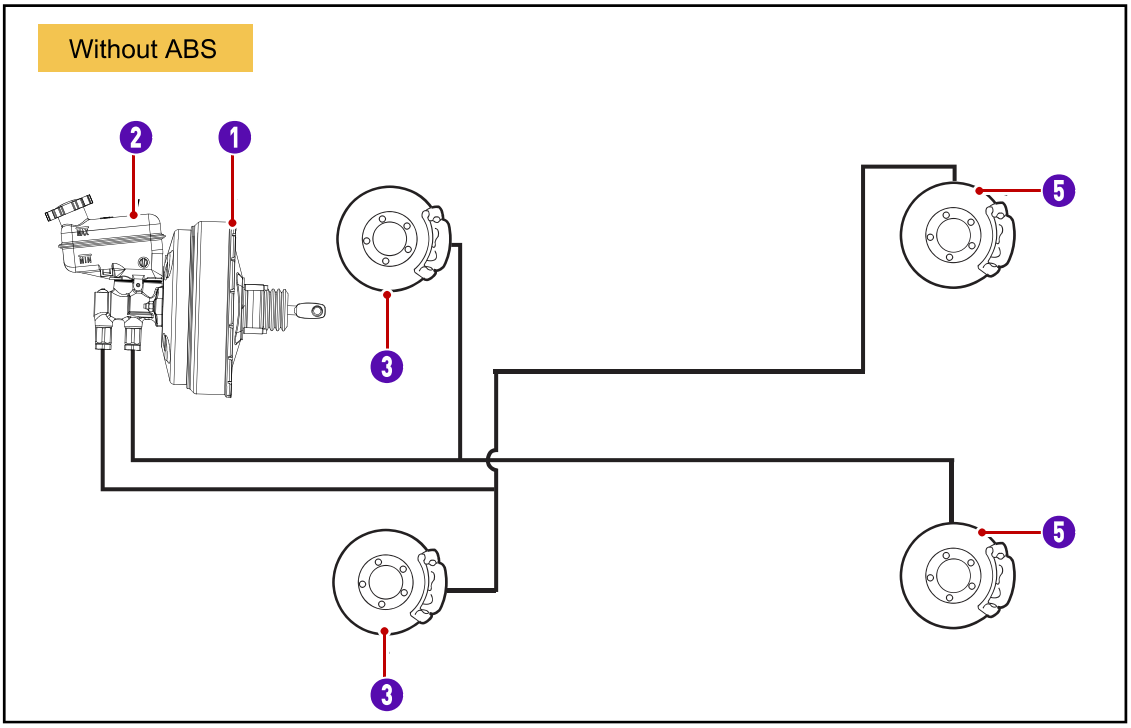


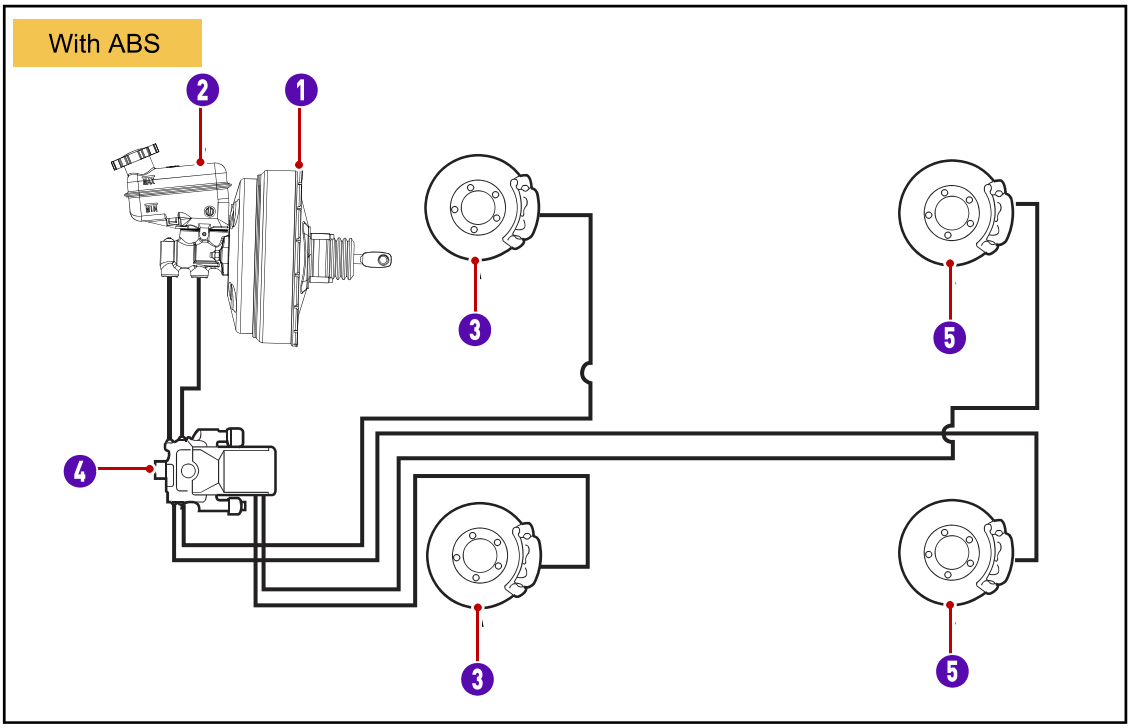
1) Tightening torque

Fastener	Tightening torque	Remark
Brake pad guide bolt	25.5 ~ 30.4Nm	14 mm x 2EA
Brake caliper mounting bolt	52.9 ~ 63.7Nm	17 mm x 2EA
Brake hose bolt	19.6 ~ 29.4Nm	12mm
Brake hose bracket mounting bolt	9.8 ~ 12.8Nm	12mm
Air breather screw	8.8 ~ 10.8Nm	-

3. SYSTEM LAYOUT

▶ **Hydraulic line**



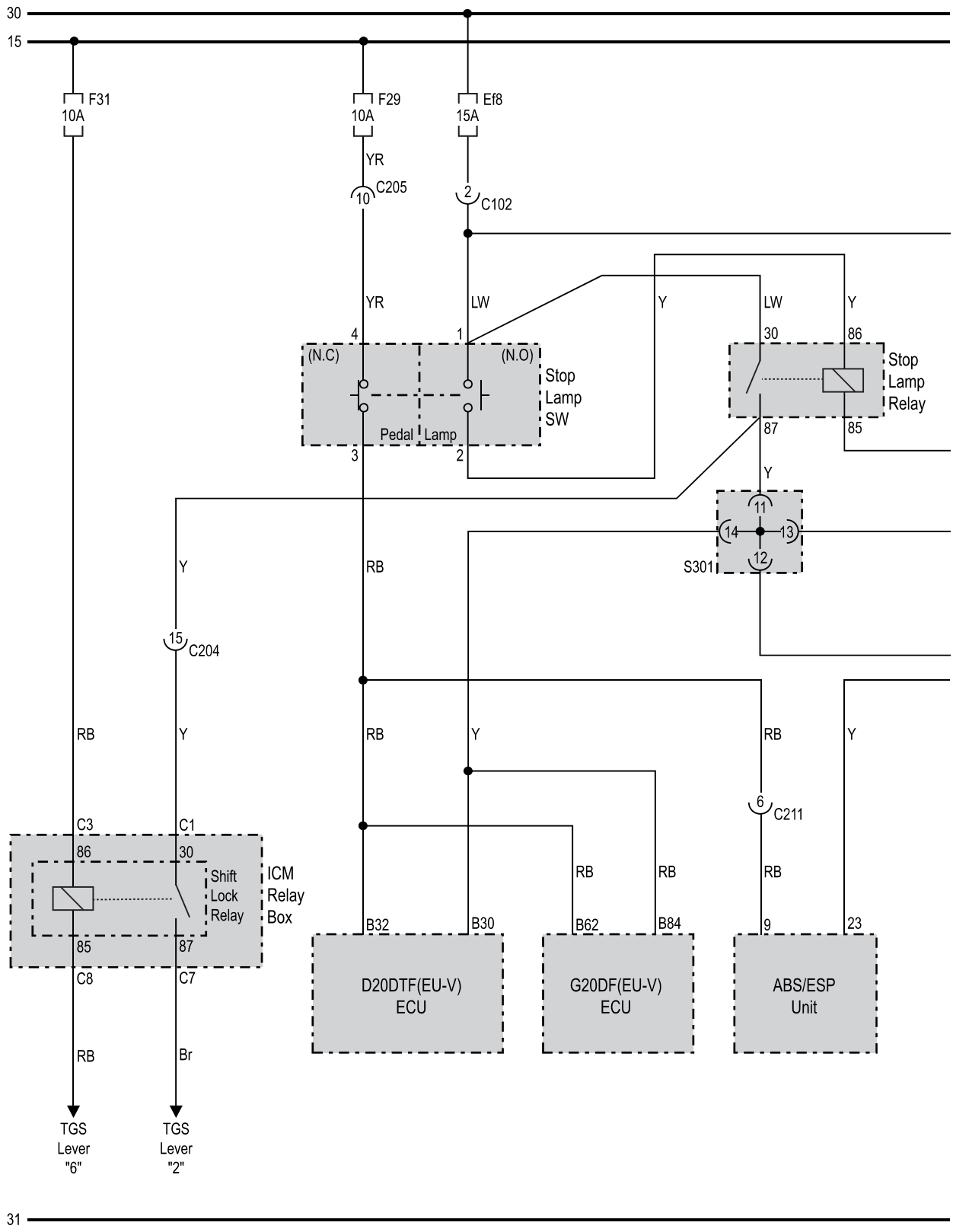


1. Brake booster
2. Brake reservoir and master cylinder
3. Front disc brake and caliper
4. HECU (Hydraulic & Electric Control Unit)
5. Rear disc brake and caliper

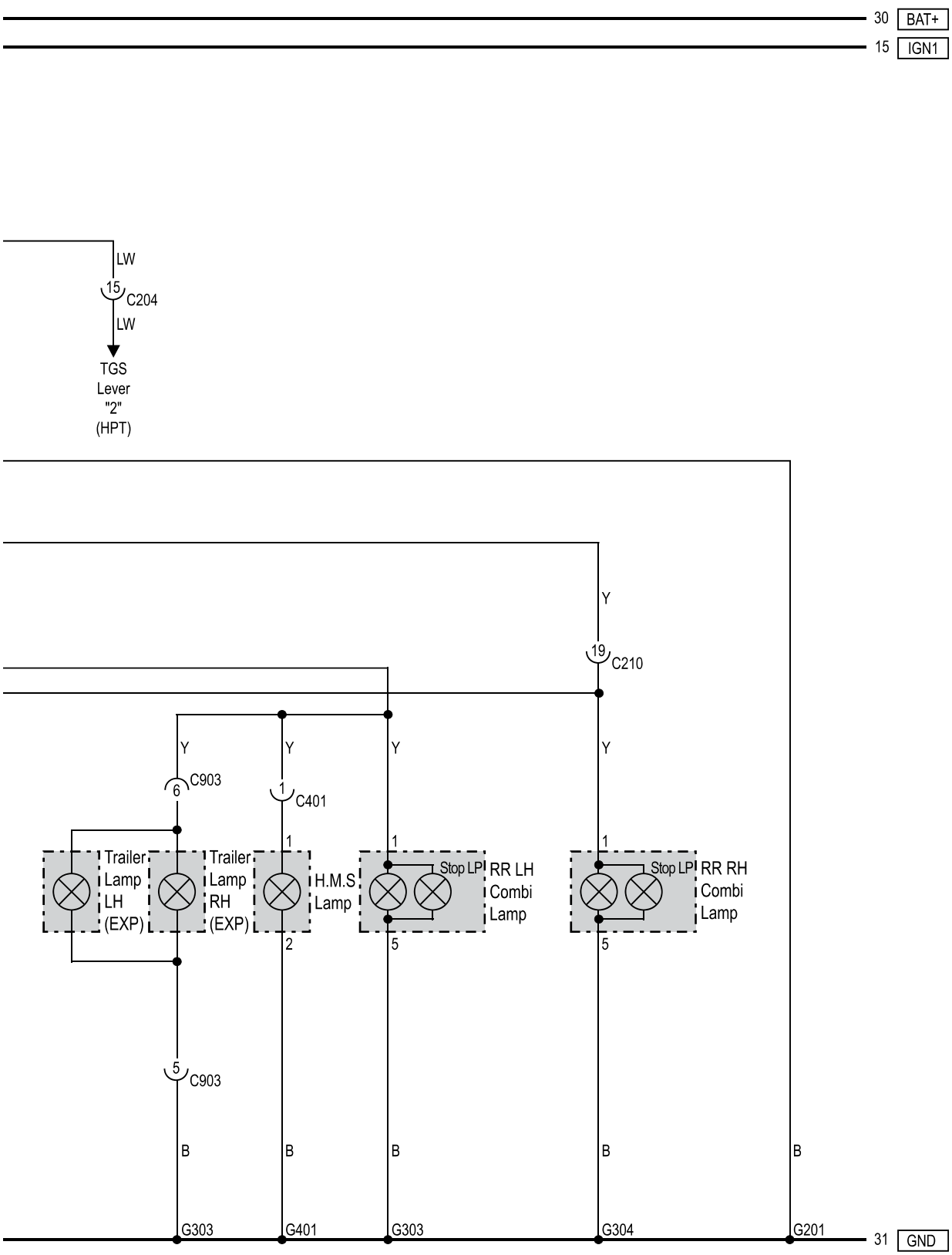
Modification basis	
Application basis	
Affected VIN	

Memo

4. CIRCUIT DIAGRAM OF STOP LAMP



Modification basis	
Application basis	
Affected VIN	



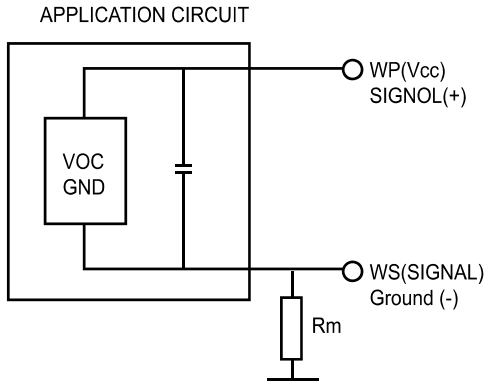
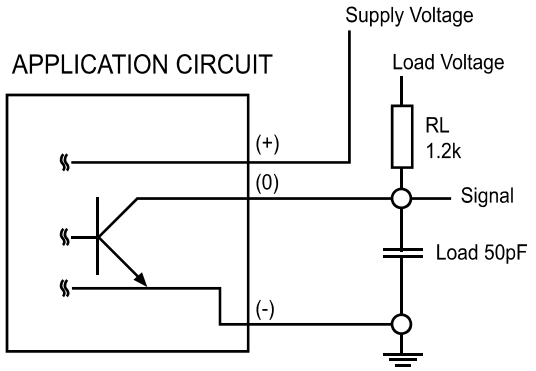
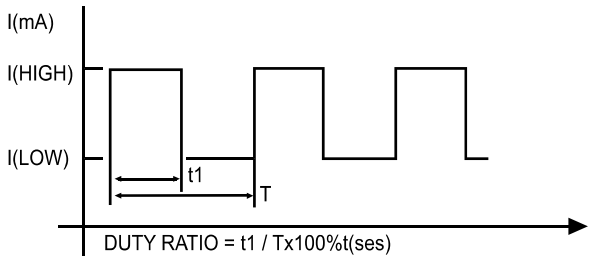
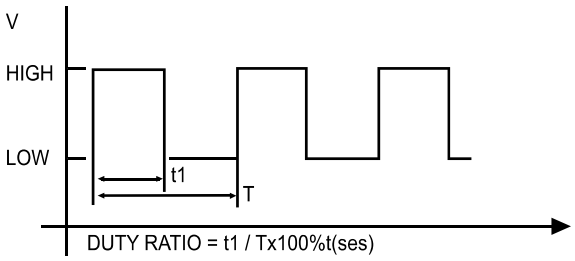
Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification	
		ABS	**ESP**
HECU	Clock frequency	32 MHz	50 MHz
	Memory	128 KB	512 KB
	Switch	Orifice	Orifice
Wheel speed sensor		**ABS / ESP**	**CBS**
	Operating temperature	− 40°C to 150°C	− 40°C to 150°C
		− 40°C to 115°C	− 40°C to 115°C
	Operating frequency	1 to 2,500 Hz	1 to 8,000 Hz
	Operating voltage	4.5 to 16 V	3.3 to 18 V
G-sensor		**ABS**	**CBS / ESP**
	Operating voltage	4.75 to 5.25 V	N/A
	Operating temperature	− 30°C to 85°C	
	Operating range	-1.5 to 1.5 g	
	Output voltage	0.5 to 4.5 V	

▶ Circuit diagram of wheel speed sensor

ABS / ESP	CBS
	
	

Modification basis	
Application basis	
Affected VIN	

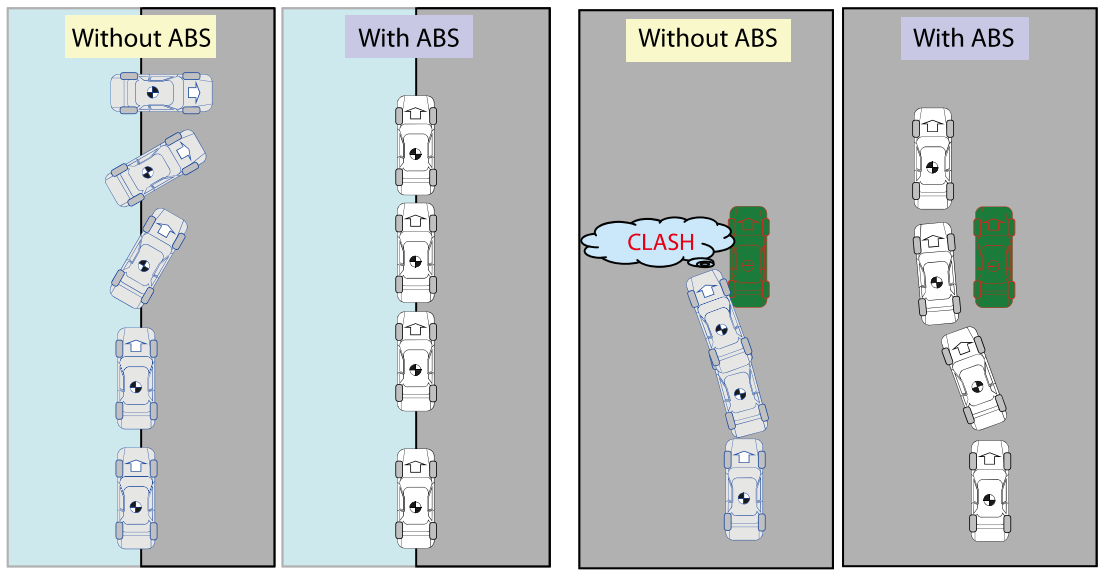
OVERVIEW AND OPERATING PROCESS

1. SYSTEM OVERVIEW

1) What is ABS?

When braking suddenly or braking on slippery roads, the vehicle keeps moving forward but the wheels are locking and not rotating. If these happen, the vehicle may lose stability or rotate resulting in an accident. ABS helps to maintain directional stability and control of the vehicle. ABS is designed to secure more safety and increase the control of steering wheel during emergency braking situation. But, ABS does not guarantee perfect safety beyond its physical limit. ABS in this vehicle contains EBD function. In normal driving conditions, the brake system operates without ABS function.

▶ **ABS effect according to braking conditions**

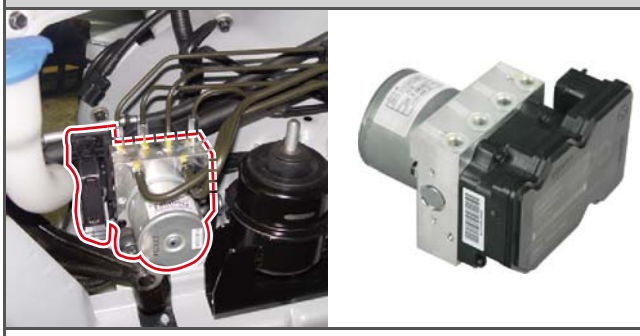
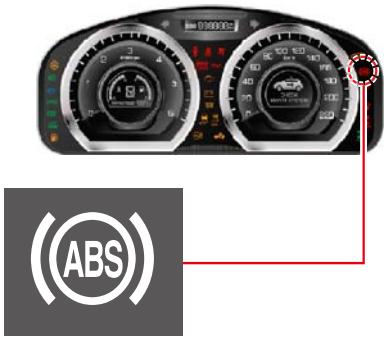


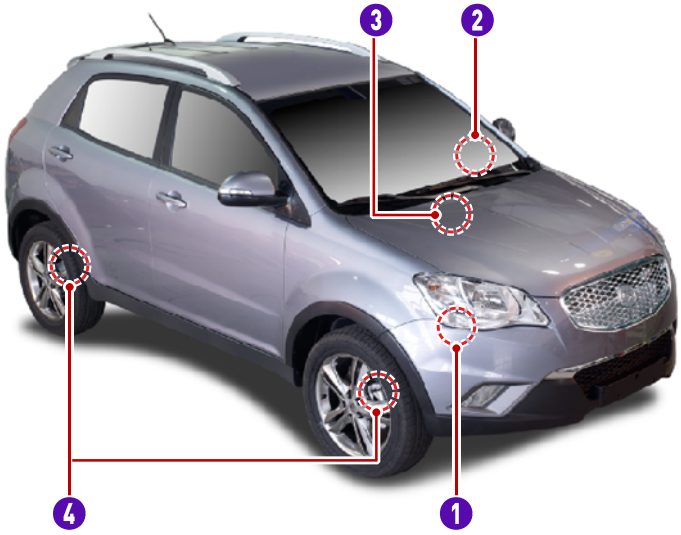
Braking on split road **Maneuvering while braking**

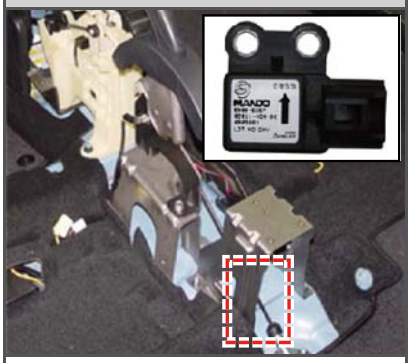
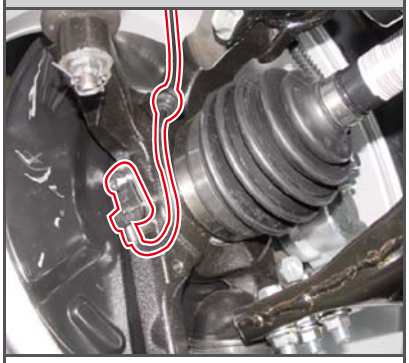
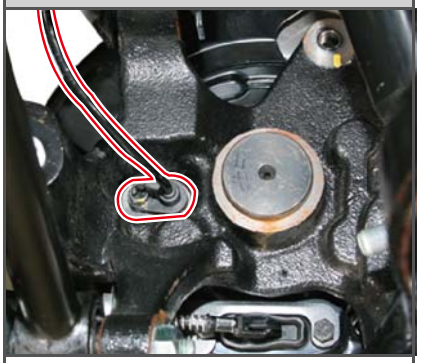
2) What is EBD (Electronic Brake-force Distribution)?

EBD is an automobile brake technology that automatically varies the amount of force applied to each of a vehicle's brakes, based on road conditions, speed, loading, etc. Always coupled with anti-lock braking systems, EBD can apply more or less braking pressure to each wheel in order to maximize stopping power whilst maintaining vehicular control. EBD does not operate when ABS is working.

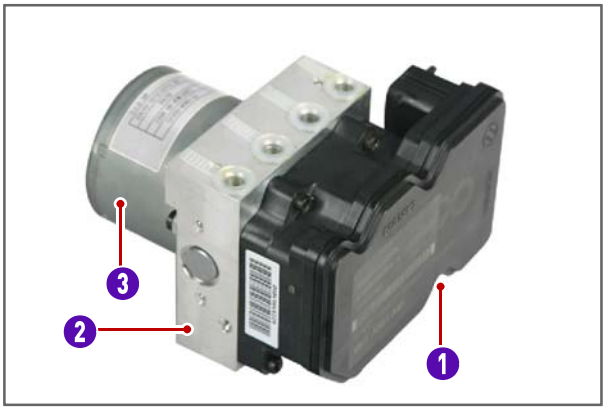
2. COMPONENT

1. ABS hydraulic device and control unit	2. ABS warning lamp
 Located under the power steering fluid reservoir and contains the pressure sensor.	 EBD warning lamp (ABS warning lamp + Brake warning lamp)



3. G-sensor (for 4WD)	4. Wheel speed sensor (for 4WD)	4. Rear wheel speed sensor (for 2WD)
 Located on the floor under parking brake bracket in center console.	 Located on knuckle. The appearance of front sensor is same with rear sensor.	 Located on knuckle. The appearance is different from that for 4WD.

Modification basis	
Application basis	
Affected VIN	



▶ HECU

1. ECU (Electronic Control Unit)

ECU calculates the wheel speed, acceleration and deceleration with the information from wheel speed sensor, and determines the wheel slip to control the valve and motor.

2. HU (Hydraulic Unit)

The hydraulic circuit contains the primary circuit and secondary circuit for ABS operation. This unit controls the hydraulic pressure to each wheel. If the system needs ABS operation, the valves in the unit operate to control HOLD, RISE and DUMP according to ECU control logic.

3. Motor

The motor is operated when ABS is activated. The cam-shaped output shaft of the motor enables the brake system to receive and supply the brake fluid during the motor operation.

4WD - Front/Rear wheel speed sensor
2WD - Front wheel speed sensor



2WD - Rear wheel speed sensor



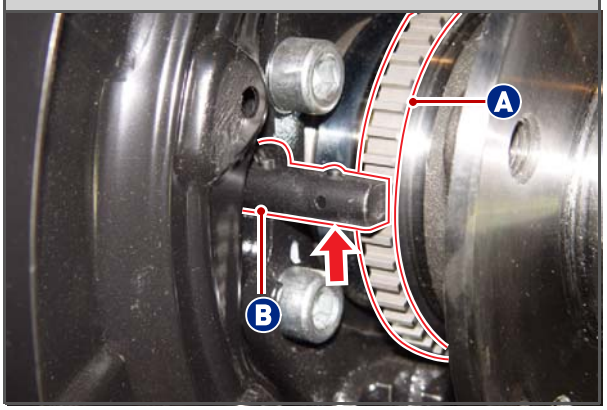
▶ Wheel speed sensor

Wheel speed sensor sends the data detected by tone wheel to HECU.

NOTE

Rear wheel speed sensor in 2WD vehicle is different from that in 4WD vehicle.

Location of rear tone wheel (A) and wheel sensor (B) in 2WD vehicle



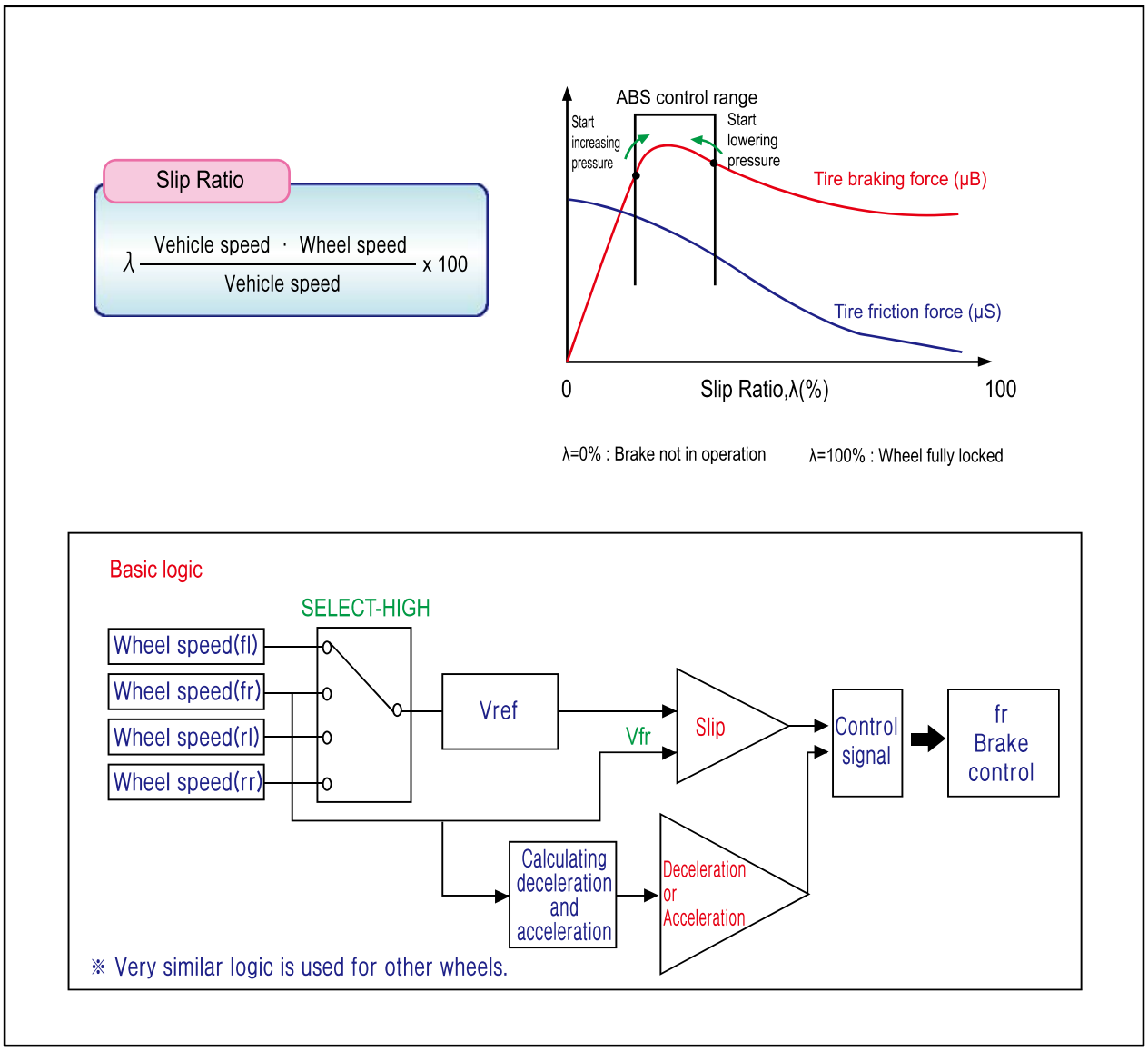
G-sensor


▶ G-sensor (only for 4WD)

For the vehicle with the ABS, a speed difference between the wheels is not noticeable as all the wheels are slipping during abrupt braking. Therefore, the vehicle needs the speed information from other sensors other than the wheel speed sensor. On the 2WD vehicle, there is not large difference between the vehicle speed reduction and actual wheel speed reduction in the event of braking since the driving wheels are in the front. So, the ABS HECU can control the vehicle, based on a calculation value. But, on the 4WD vehicle, if a speed reduction occurs in the front or rear of the vehicle, it affects the other side wheel. In other words, braking the rear wheels induces also a large speed reduction in the front wheels. The longitudinal acceleration sensor is used for this case. It controls the ABS by using the signals from the sensor during abrupt braking and acceleration.

Modification basis	
Application basis	
Affected VIN	

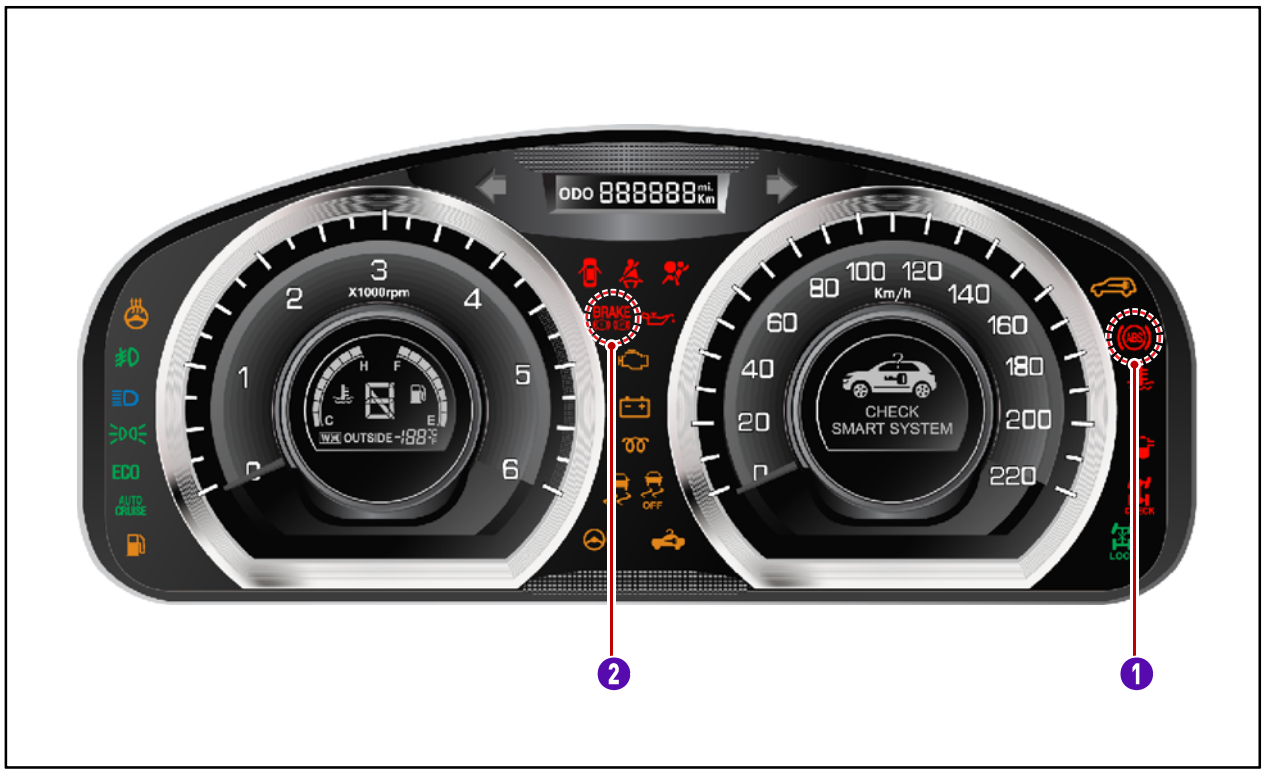
3. ABS CONTROL LOGIC



The principal ABS control logic is the determination of the reference speed by choosing one wheel meeting a certain condition, while sensing the speed information from 4 wheel speed sensors when the vehicle is being driven.

For example, when the comparison of the reference speed with front right wheel speed shows a slip, the control signal is determined according to whether it's deceleration or acceleration. If the control conditions are met, the brake for the front right wheel will be got under control.

4. WARNING LAMPS



1. ABS warning lamp
2. Brake warning lamp
   (EBD warning lamp: ABS warning lamp + Brake warning lamp)

1) ABS Warning Lamp

ABS warning lamp module indicates the self diagnosis and malfunction.
ABS warning lamp ON:

1. When turning the ignition switch to ON position, ABS warning lamp comes on for 3 seconds for self-diagnosis and goes off if the system is OK (initialization mode).
2. When the system is defective, the warning lamp comes on.
3. When the self-diagnosis is performing, the warning lamp comes on.
4. When the HECU connector is disconnected, the warning lamp comes on.
5. ABS is not available during lamp ON. In this condition, Only normal brake system without ABS function is available.
6. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

Modification basis	
Application basis	
Affected VIN	

2) EBD (Electronic Brake-force Distribution) Warning Lamp (Brake Warning Lamp)

EBD warning lamp when the system performs the self diagnosis and when it detects the malfunction of EBD system. However, the brake warning lamp comes on regardless of EBD when the parking brake is applied.

EBD warning lamp ON:

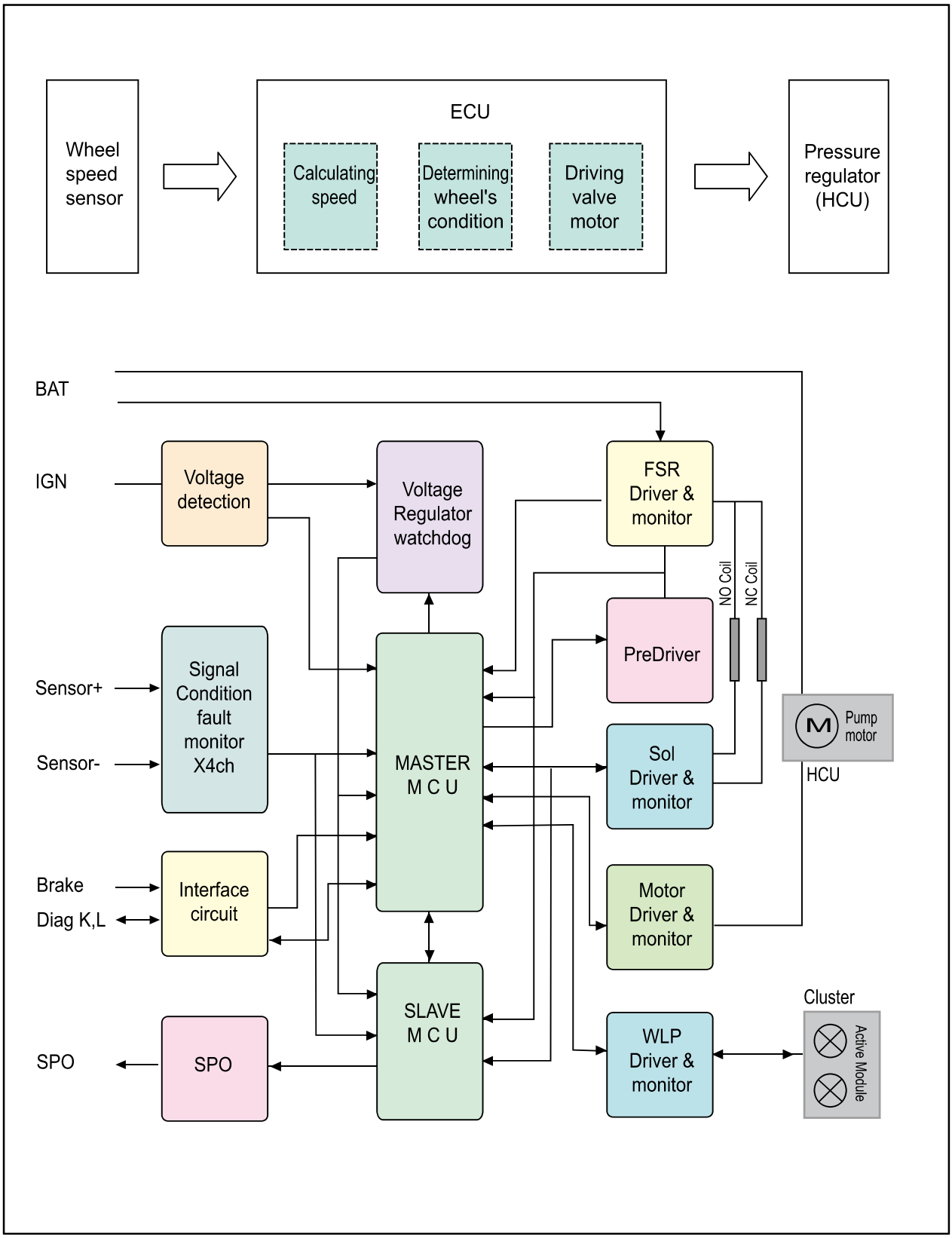
1. When turning the ignition switch to ON position, ABS warning lamp and the brake warning lamp comes on for 3 seconds for self diagnosis and goes off if the system is OK (initialization mode). When applying the parking brake, the brake warning lamp comes on.
2. When the brake fluid is not sufficient, the brake warning lamp comes on.
3. When the self-diagnosis is performing, the warning lamp comes on.
4. When the HECU connector is disconnected, the warning lamp comes on.
5. When the system is defective, ABS warning lamp and the brake warning lamp come on
6. simultaneously.

    a. When the solenoid valve is defective
    b. When one or more wheel sensors are defective
    c. When ABS HECU is defective
    d. When the voltage is abnormal
    e. When valve relay is defective

7. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

5. SYSTEM OPERATION

1) Block Diagram of ABS HECU



Modification basis	
Application basis	
Affected VIN	

2) Basic Theory of ABS Function

To give you a better understanding of the tasks and functions of ABS, we will first look at the physics principles.

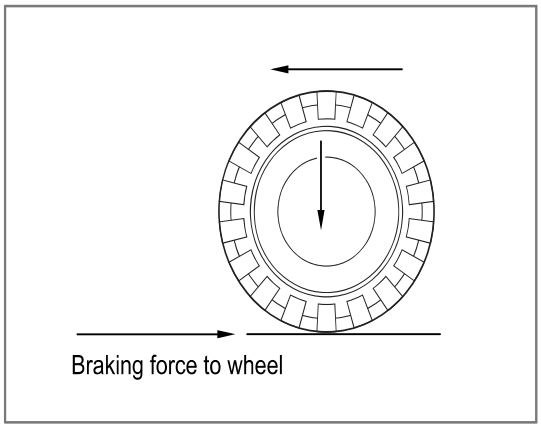
(1) Stopping distance

The stopping distance depends on the vehicle weight and initial speed when braking starts. This also applies for vehicle with ABS, where ABS always tries to set an optimum brake force on each wheel. As great forces are exerted between the tires and the carriageway when braking, even with ABS the wheels may scream and rubber is left on the road. With an ABS skid mark one may be able to clearly recognize the tire profile. The skid mark of an ABS vehicle does not however leave any hint of the speed of the vehicle in the case of an accident, as it can only be clearly drawn at the start of braking.

(2) Brake force on a wheel

The maximum possible brake force on a wheel depends on the wheel load and the adhesion coefficient between tire and carriageway. With a low adhesion coefficient the brake force, which can be obtained is very low. You are bound to know the result already from driving on winter roads. With a high adhesion coefficient on a dry road, the brake force, which can be obtained, is considerably higher. The brake force, which can be obtained, can be calculated from below formula:

▶ **Maximum brake force**



FBmax = wheel load FR x coefficient of frictionMh

The braking process cannot be described sufficiently accurately with the brake forces calculated. The values calculated only apply if the wheel is not locked. In the case of a locking wheel, the static friction turns into lower sliding friction, with the result that the stopping distance is increased. This loss of friction is termed "slip" in specialist literature.

▶ Slip

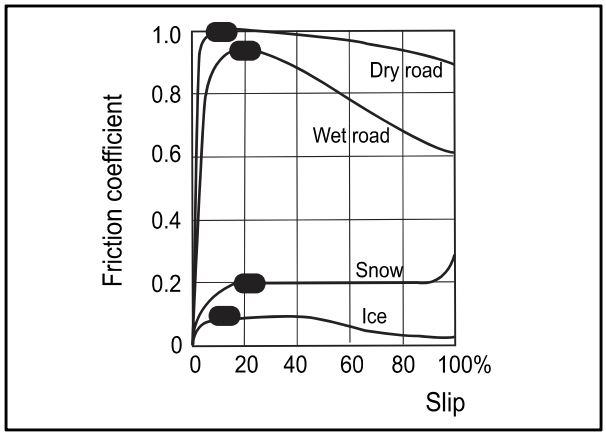
The brake slip is the difference between the vehicle speed and the wheel circumference speed. If the wheel locks, the slip is greatest, that is 100 %. If the wheel is running freely and un-braked, the slip is the lowest, equal to 0 %. Slip can be calculated from the vehicle speed Vveh and the wheel speed Vw. The equation for this is:

Vveh = 100 km/h, Vw = 70 km/h

$$\text{Slip ratio (S)} = \frac{\text{Vveh - Vw}}{\text{Vveh}} \text{ X } 100\%$$

S = 30%

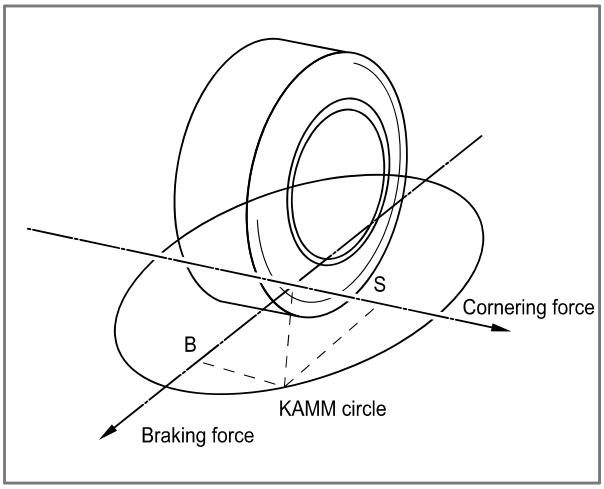
▶ Typical Slip Curves



For the various road conditions, the friction coefficients were plotted. The typical course of the curves is always the same. The only special feature is shown by the curve for freshly fallen snow, for this curve increases at 100 % slip. In a vehicle without ABS, the wheel locks on braking and therefore pushes a wedge before it. This wedge of loose surface or freshly fallen snow means and increased resistance and as a result the stopping distance is shorter. This reduction in stopping distance is not possible with a vehicle with ABS, as the wheel does not lock. On these surfaces the stopping distance with ABS is longer than without ABS. The reason for this is based in physics and not in the Anti-Lock System.
However, as mentioned before, ABS is not about the stopping distance, but maneuverability and driving stability, for the vehicle with locking wheels without ABS cannot be steered.

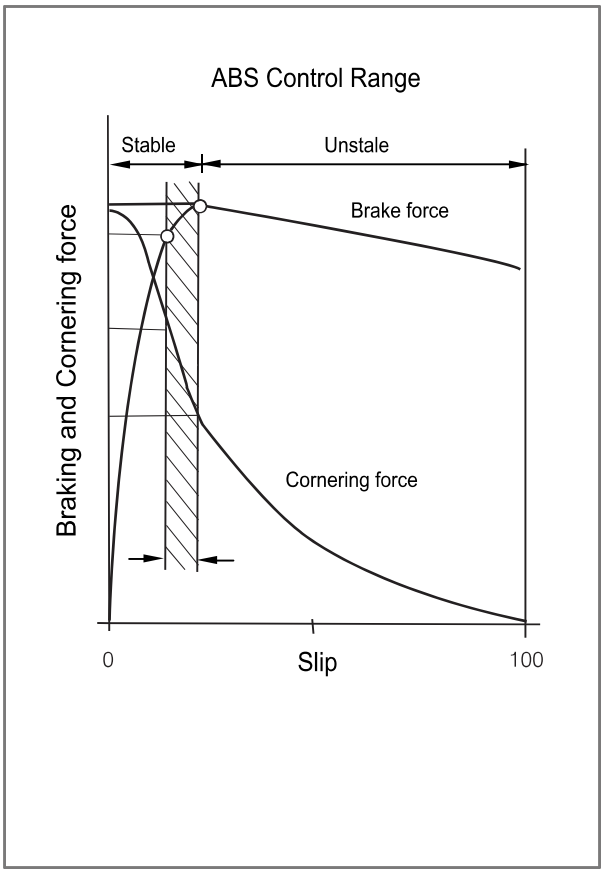
Modification basis	
Application basis	
Affected VIN	

▶ KAMM circle



Before we go into the Kamm circle, you should know that a tire offers a maximum of 100 % transmissibility. It is all the same for the tire whether we require 100 % in the direction of braking or in the direction of the acting lateral force, e.g. when driving round curves. If we drive into a curve too fast and the tire requires 100 % transmissibility as cornering force, the tire cannot transmit any additional brake force. In spite of the ABS the car is carried out of the curve. The relationship between brake force B and cornering force S is shown very clearly in the Kamm circle. If we put a vehicle wheel in this circle, the relationship becomes even clearer. In this relationship: as long as the acting forces and the resulting force remain within the circle, the vehicle is stable to drive. If a force exceeds the circle, the vehicle leaves the road.

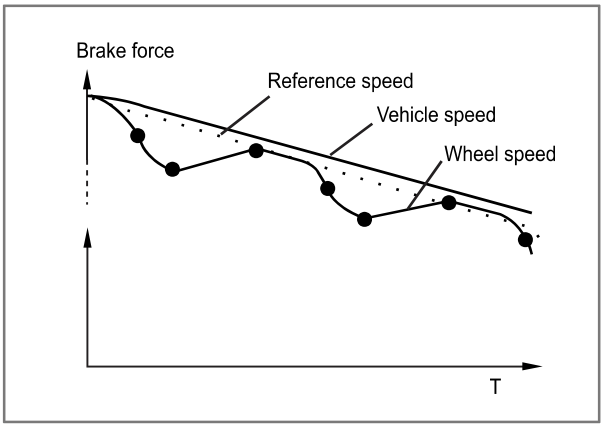
▶ Brake and cornering force



- Brake force
  When depressing the brake pedal the brake force increases to the maximum, then the brake force decreases until the wheel locks.
- Cornering force
  The cornering force is a maximum when the wheel is turning freely with zero slip. When braking the cornering force falls to zero if the wheel locks (slip 100 %).
- ABS operating range
  The operating range starts just before the maximum brake force and ends in maximum, for the unstable range then begins, in which no further modulation is possible. The ABS controls the regulation of the brake pressure so that the brake force only becomes great enough for a sufficient proportion of cornering force to remain. With ABS we remain in the Kamm circle as long as the car is driving sensibly. We will leave driving physics with these statements and turn to the braking systems with and without ABS.

3) Basic ABS Control

▶ Operation of ABS control unit



Applications of the ABS control unit The signals produced by the wheel sensors are evaluated in the electronic control unit. From the information received, the control unit must first compute the following variables:

- Wheel speed
- Reference speed
- Deceleration
- Slip

▶ Reference speed

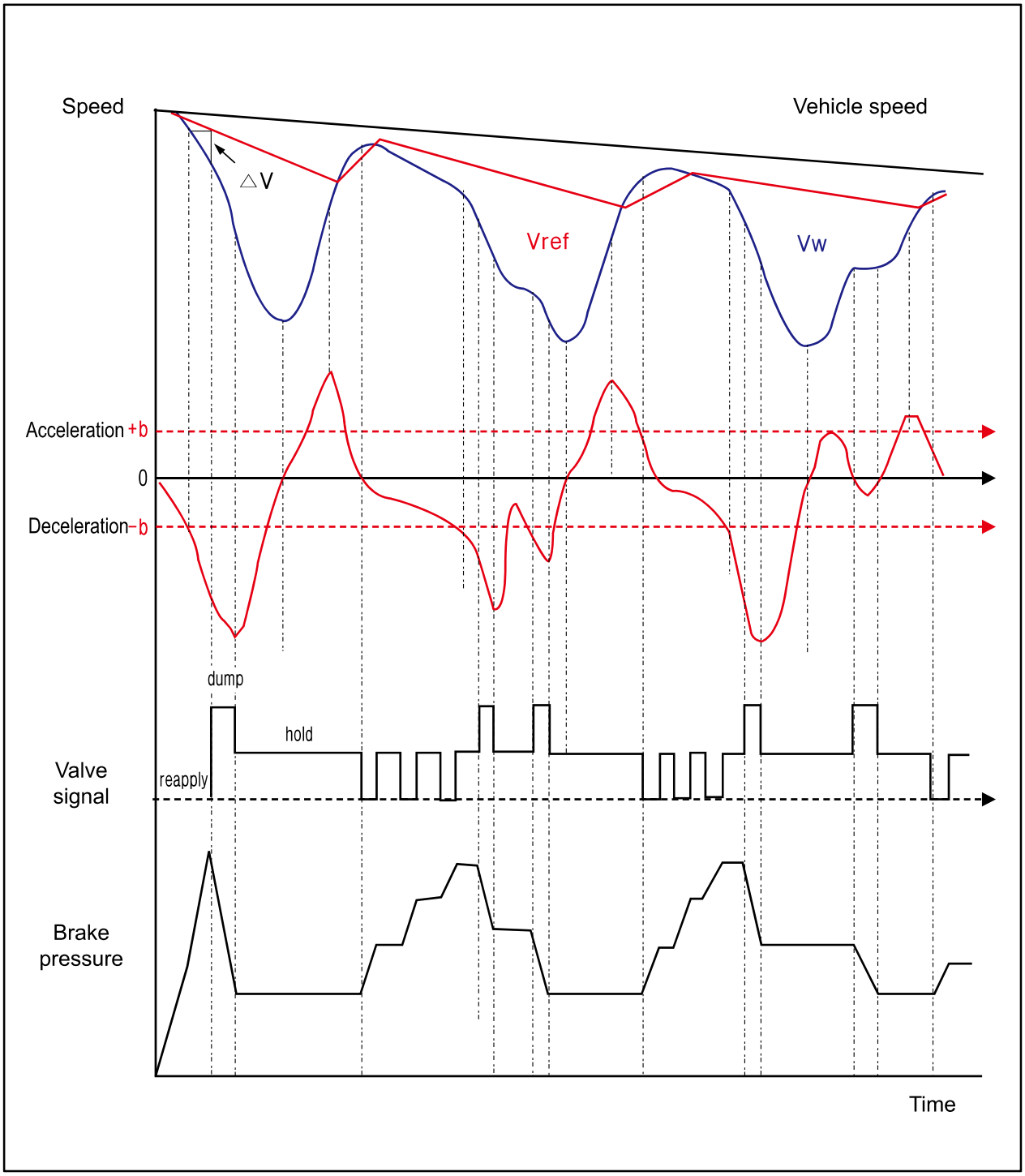
The reference speed is the mean, I.e. average speed of all wheel speeds determined by simple approximation.

▶ Simplified ABS control

If, during braking, one wheel speed deviates from the reference speed, the ABS control unit attempts to correct that wheel speed by modulating the brake pressure until it again matches the reference speed. When all four wheels tend to lock, all four wheels speeds suddenly deviate from the previously determined reference speed. In that case, the control cycle is initiated again in order to again correct the wheel speed by modulating the brake pressure.

Modification basis	
Application basis	
Affected VIN	

4) ABS Control Pattern



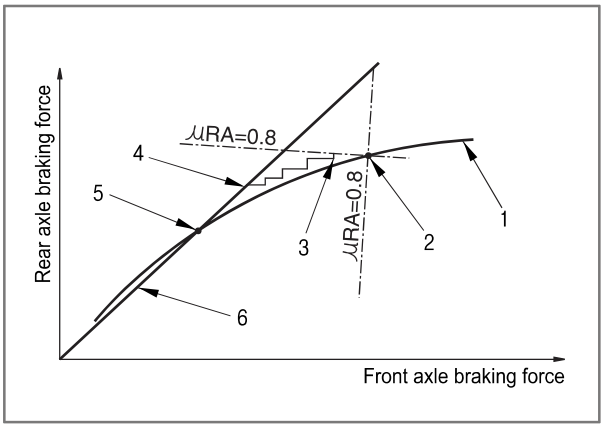
The ABS control is performed by comparing the reference speed with each wheel speed. Firstly, it is determined whether the vehicle is in the deceleration or acceleration state using the wheel speed change ratio. Then, a signal is transmitted to the valve.
Finally, the brake pressure is adjusted via the signal.

5) EBD (Electronic Brake Force Distribution) System

▶ System description

As an add-on logic to the ABS base algorithm, EBD works in a range in which the intervention thresholds for ABS control are not reached yet.
EBD ensures that the rear wheels are sensitively monitored for slip with respect to the front axle. If slip is detected, the inlet valves for the rear wheels are switched to pressure hold to prevent a further increase in pressure at the rear-wheel breaks, thus electronically reproducing
a pressure-reduction function at the rear-wheel brakes.
ABS features an enhanced algorithm which includes control of the brake force distribution between the front and rear axles. This is called Electronic Brake Distribution. In an unloading car condition the brake efficiency is comparable to the conventional system but for a fully loaded vehicle the efficiency of the EBD system is higher due to the better use of rear axle braking capability.

▶ Advantages



- Elimination of conventional proportioning valve
  EBD utilizes the existing rear axle wheel speed sensor to monitor rear wheel slip.
  Based on many variables in algorithm a
- pressure hold, increase and/or decrease pulsetrain may be triggered at the rear wheels insuring vehicle stability.
  Vehicle approaches the ideal brake force
- distribution (front to rear).
  Constant brake force distribution during vehicle
- lifetime.
  EBD function is monitored via ABS safety logic
- (conventional proportioning valves are not monitorable).

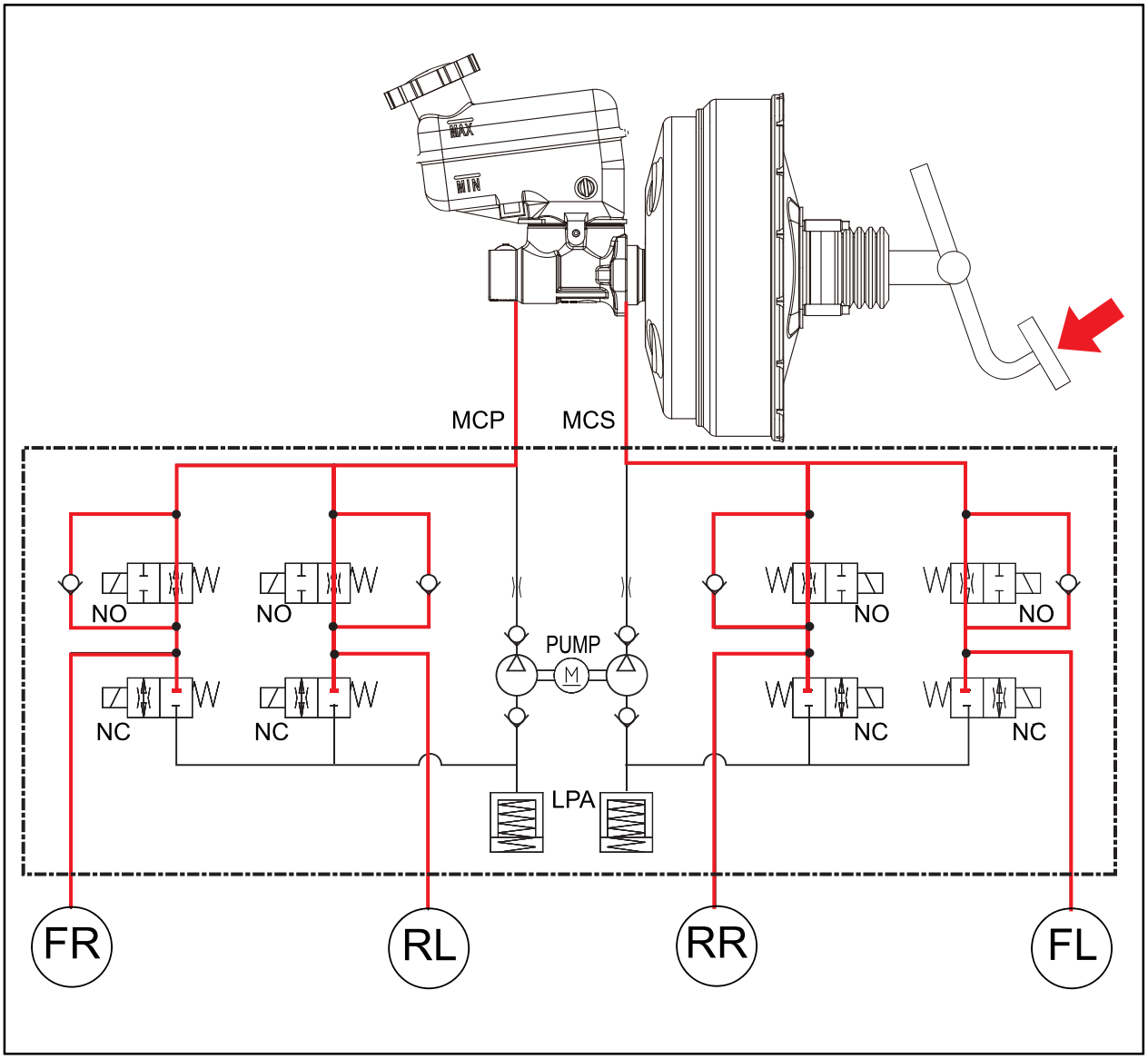
Modification basis	
Application basis	
Affected VIN	

6. HYDRAULIC CIRCUIT OF ABS

1) Normal Brake Operation (ABS is not working) Mode

If the driver depress the brake pedal so that the ABS does not operate, the hydraulic pressure in the master cylinder increases through the vacuum booster and it is delivered to the wheel via the normal open inlet valve. At this moment, the normally-closed outlet valve is closed The speed of the wheel that hydraulic pressure is delivered reduces gradually.

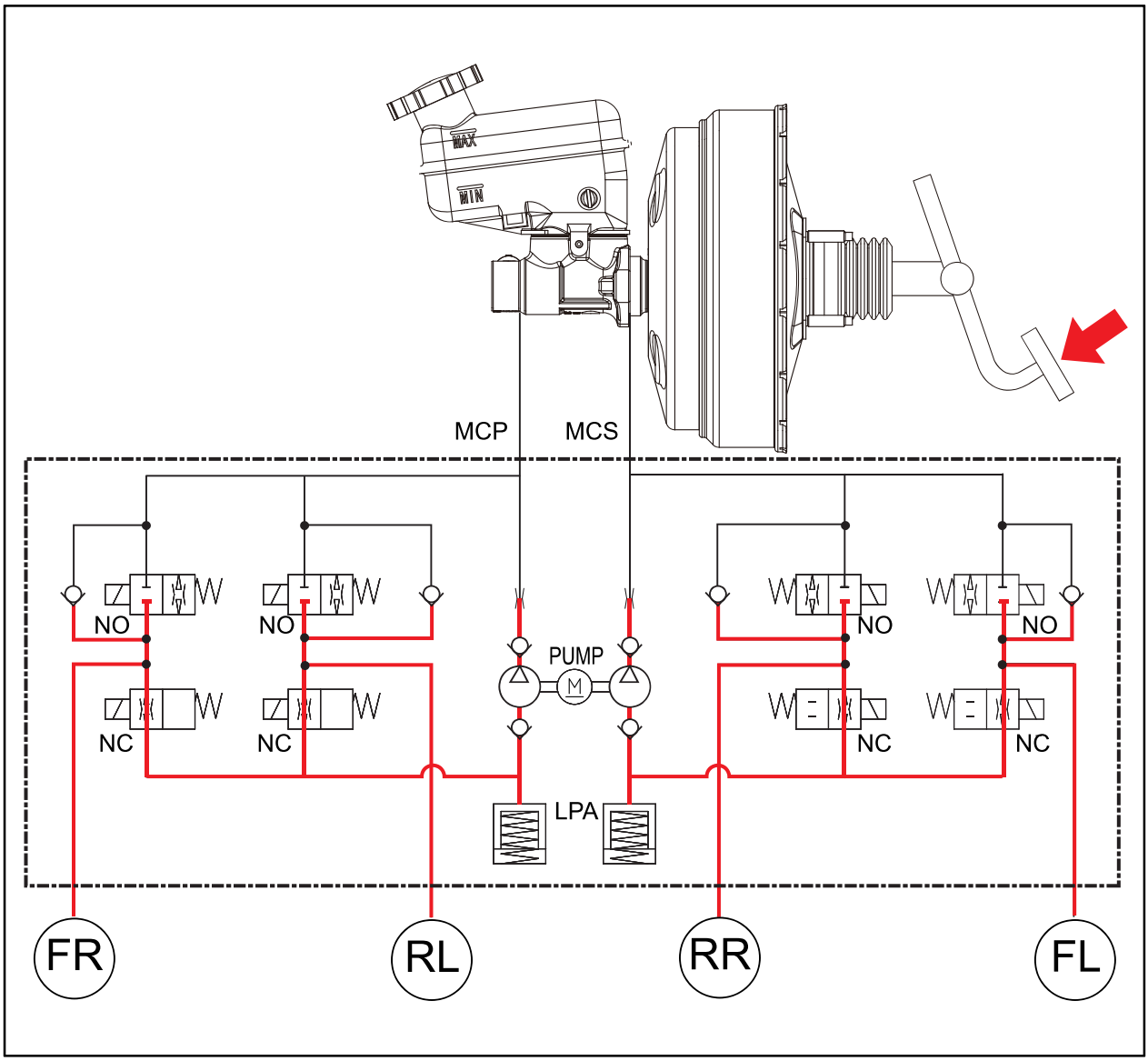
Solenoid valve	Valve Open/Close	Pump motor
Inlet valve - Normal open (NO) valve	Open	OFF
Outlet valve - Normal close (NC) valve	Close	



2) DUMP (ABS is working) Mode

Even when the hydraulic pressure on each circuit is constant, the wheel can be locked as the wheel speed decreases. This is when the ABS HECU detects the wheel speed and the vehicle speed and gives the optimized braking without locking the wheels. In order to prevent the hydraulic pressure from increasing, the inlet valve will be closed, the outlet valve will be opened and the oil will flow into the low pressure chamber. In addition, the ABS HECU operates the pump to circulate the oil in the low pressure chamber to the master cylinder. This may make the driver to feel the brake pedal vibration and some noises.

Solenoid valve	Valve Open/Close	Pump motor
Inlet valve - Normal open (NO) valve	Close	ON
Outlet valve - Normal close (NC) valve	Open	

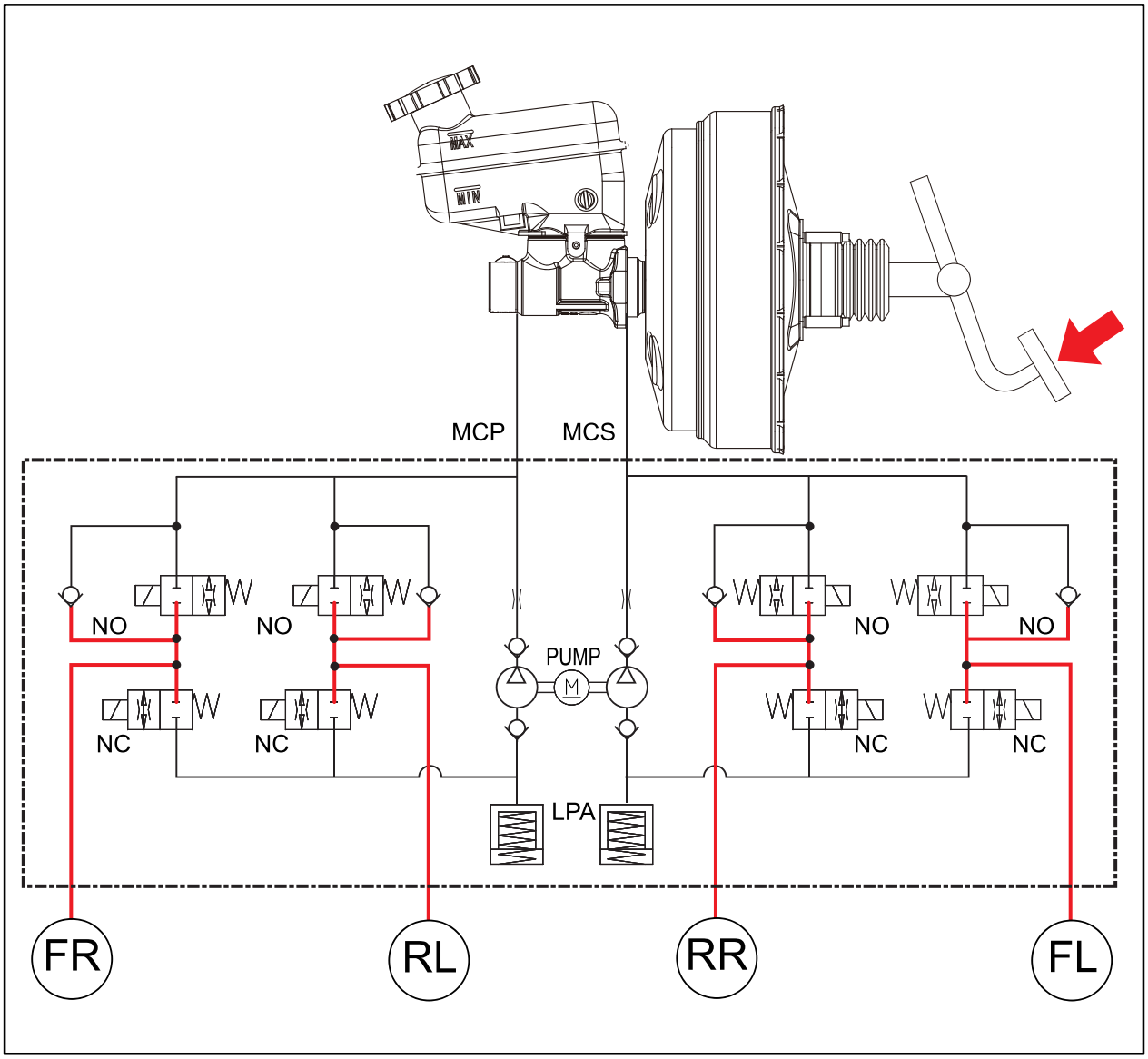


Modification basis	
Application basis	
Affected VIN	

3) HOLD (ABS is working) Mode

As hydraulic pressure on each wheel increases, the wheel tends to lock. In order to prevent the wheel from locking, the hydraulic valve modulator operates the inlet valve control solenoid to stop increasing the hydraulic pressure by closing the inlet valve. At this moment, the outlet valve is closed. This procedure helps the wheel to maintain a constant hydraulic pressure.

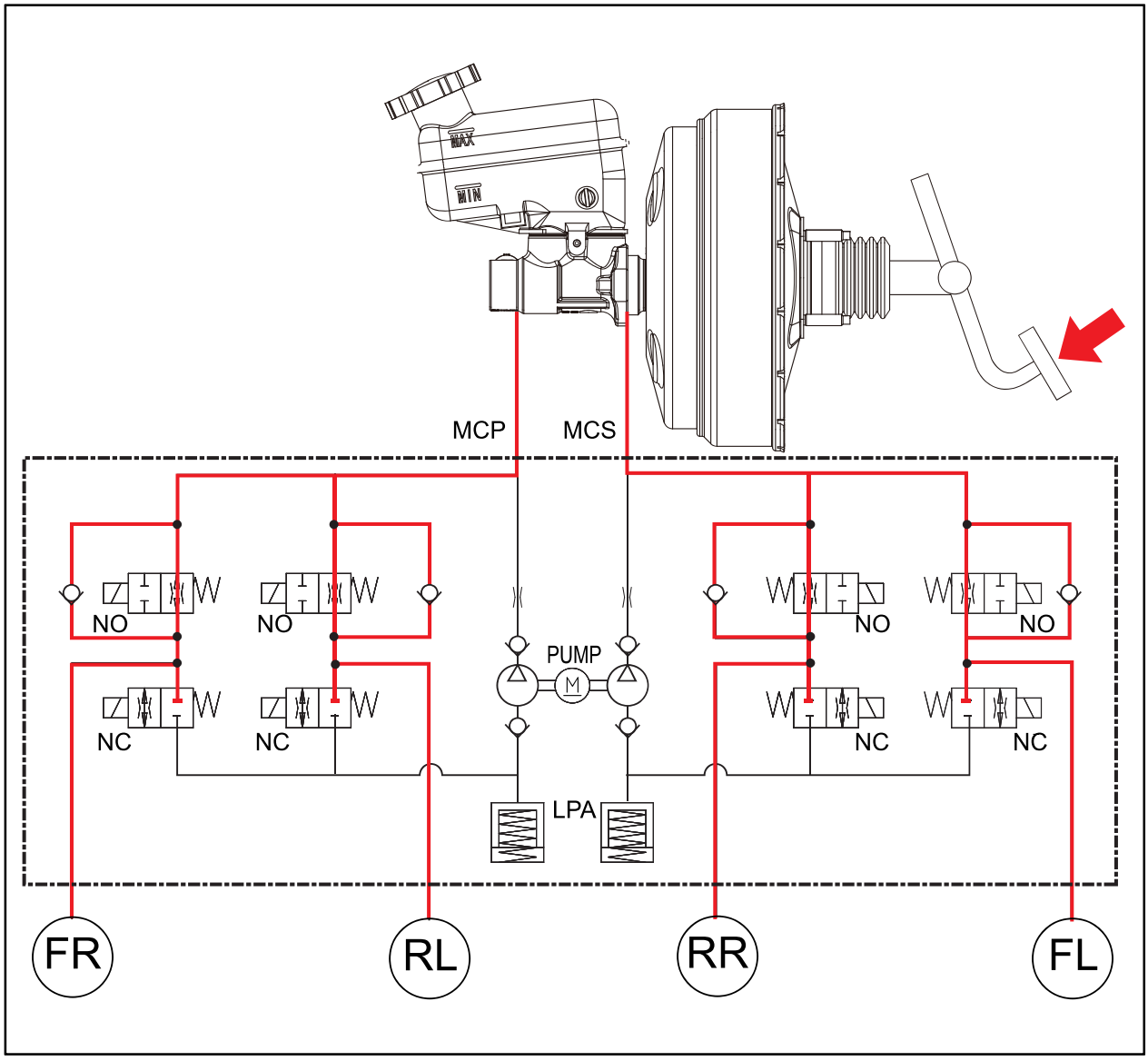
Solenoid valve	Valve Open/Close	Pump motor
Inlet valve - Normal open (NO) valve	Close	OFF
Outlet valve - Normal close (NC) valve	Close	



4) RISE (ABS is working) Mode

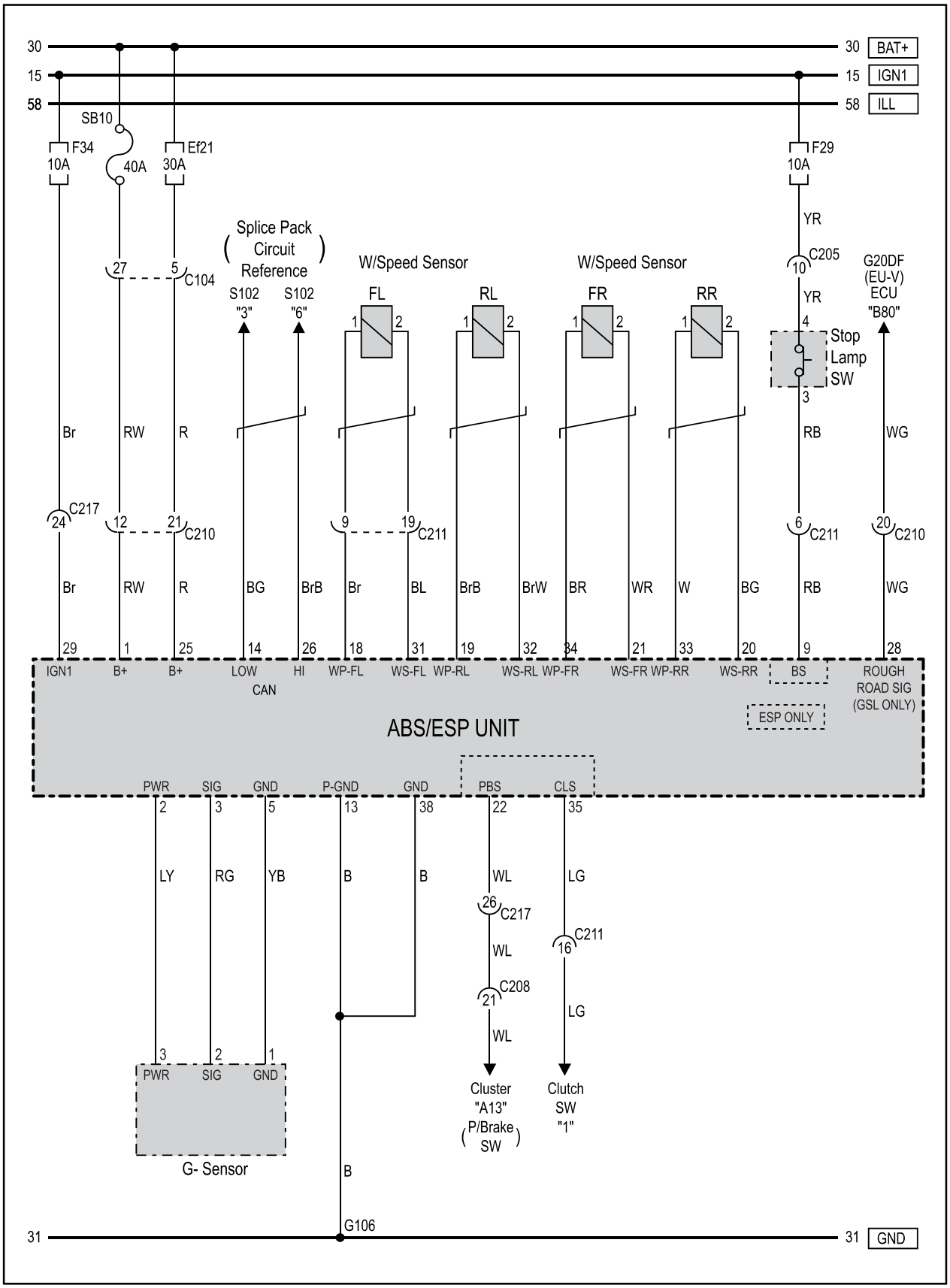
As the wheel speed increases, the inlet valve opens and the wheel's pressure increases due to the master cylinder pressure. In addition, the pump circulates the oil in the low pressure chamber to the wheel. As the hydraulic pressure to the wheel increases, the wheel speed will reduce. This operation continues repetitively until there are no signs that the ABS HECU tends to lock the wheels. Since the ABS hydraulic pressure control process takes place repeatedly for a short time, there may be some vibration and noises at the brake pedal.

Solenoid valve	Valve Open/Close	Pump motor
Inlet valve - Normal open (NO) valve	Open	ON
Outlet valve - Normal close (NC) valve	Close	



Modification basis	
Application basis	
Affected VIN	

7. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	
	ABS	ESP
HECU	Clock frequency: 32 MHz	Clock frequency: 50 MHz
	Memory: 128 KB	Memory: 512 KB
	Switch orifice	Switch orifice
Wheel speed sensor	Active type	Active type
Steering wheel angle sensor	None	Max. detection angle speed: 1500 °/Sec
		Operating voltage: 9 to 12 V
Sensor cluster	None	Yaw rate sensor + lateral G sensor + longitudinal G sensor (4WD)
Longitudinal G sensor	4WD only	None
Pressure sensor	None	HECU integrated

1) Specification of Active Wheel Sensor

Description	Specification
Supplying voltage	DC 12 V
Output current (at 2.75 km/h of vehicle speed)	7 mA (Lo) ~ 14 mA (Hi) +20%/-16%
Tightening torque	Front: 7.8 to 11.8 Nm
	Rear: 7.8 to 11.8 Nm
Operating temperature	−40 ~ 150 ℃
Operating frequency	1 ~ 2,500 Hz

2) Specification of Steering Wheel Angle Sensor

Description	Specification
Operating voltage	9 to 16 V
Maximum output current	10 mA
Maximum detection angle speed	±100°/Sec
Operating temperature	−30 to 75 ℃
Supplying voltage	9 to 16 V (battery voltage)
Output voltage (HI)	approx. 3.50 V (3.0 to 4.1 V)
Output voltage (LO)	approx. 1.50 V (1.3 to 2.0 V)
Pulses/rev	45 pulses/rev

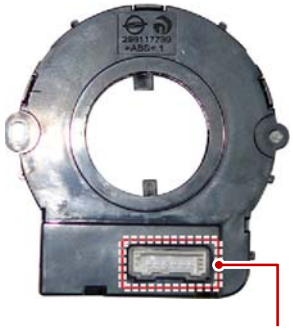
3) Specification of Sensor Cluster

Description	Specification	
Supplying voltage	approx. 12 V (8 to 16 V)	
Current consumption	below 250 mA	-
Operating range	Yaw rate sensor	± 75 °/Sec
	Lateral/longitudinal sensor	± 14.7m/Sec²

2. MAJOR CHANGES

1) Steering Wheel Angle Sensor

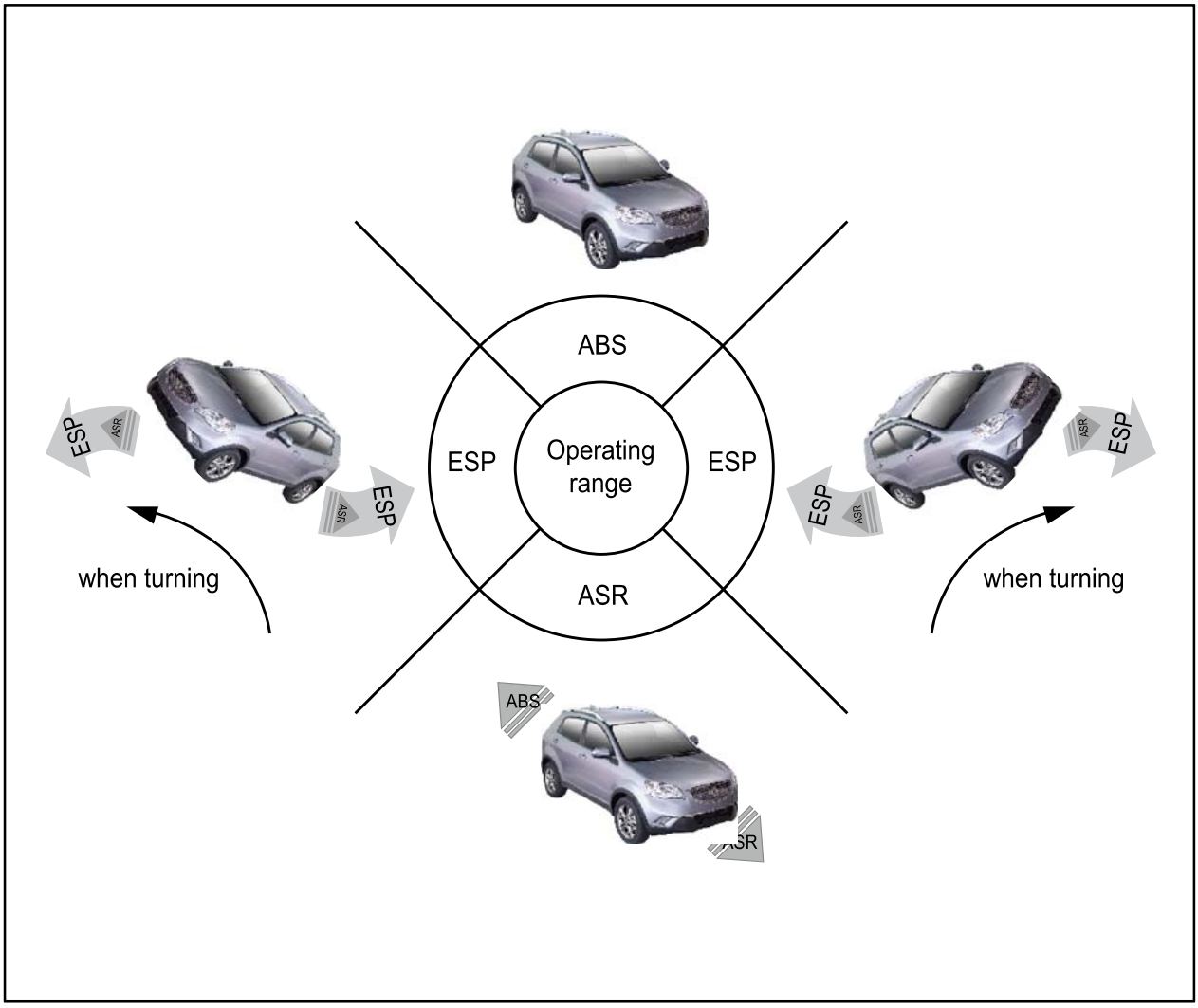


SWAS (Steering Wheel Angle Sensor)	
Old	**New**
 Sensor connector	 Sensor connector
1. The sensor has been changed due to newly adopted steering wheel heating system. 2. The location of sensor connector and the pin arrangement of connector have been changed.	

OVERVIEW AND OPERATING PROCESS

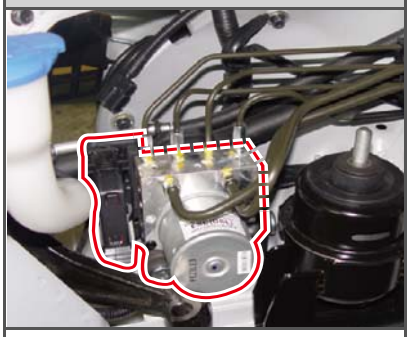
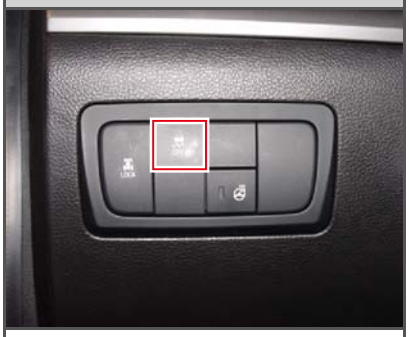
1. OVERVIEW

The ESP (Electronic Stability Program) has been developed to help a driver avoid danger of losing control of the vehicle stability due to understeer or oversteer during cornering. The yaw rate sensor, lateral sensor and longitudinal sensor in the sensor cluster and the steering wheel angle sensor under the steering column detect the vehicle conditions when the inner or outer wheels are spinning during oversteer, understeer or cornering. The ESP ECU controls against oversteer or understeer during cornering by controlling the vehicle stability using input values from these sensors and applying the braking force to the corresponding wheels independently. The system also controls the engine power right before the wheel spin synchronized to decelerate the vehicle automatically in order to maintain the vehicle stable during cornering.

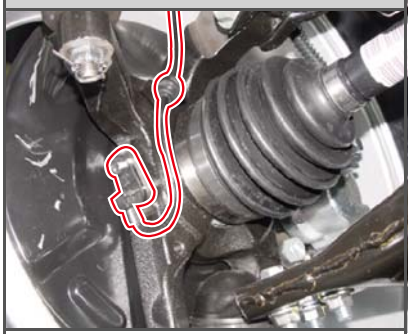
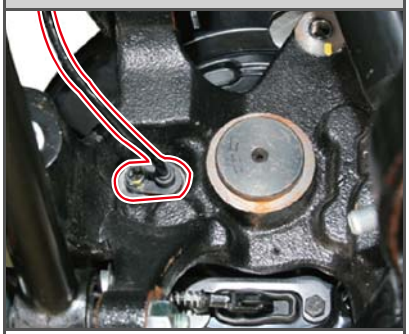


Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS

1. HECU assembly	2. Steering wheel angle sensor	3. ESP OFF switch
		
Located under the power steering fluid reservoir and contains the pressure sensor.	Located on column shaft with contact coil.	Located on the left side of instrument panel.



4. Sensor cluster	5. Wheel speed sensor (4WD/2WD-front)	6. Rear wheel speed sensor (2WD)
		
Located on the floor under front passenger seat.	Located on knuckle. the appearance of front sensor is same with rear sensor.	Located on knuckle. The appearance is different from that for 4WD.

3. PRECAUTIONS

CAUTION

The warning lamp flashes and warning beep sounds when the ESP is operating

When the ESP operates during vehicle movement, the ESP warning lamp on the instrument panel flashes and beep comes on every 0.1 second. The ESP system is only a supplementary device for comfortable driving. When the vehicle exceeds its physical limits, it cannot be controlled.
Do not rely on the system. Keep on the safe driving.

Feeling when ESP is working

When the ESP system activates, the feeling can be different depending on vehicle driving conditions. For example, you will feel differently when the ESP system is activated during the ABS is operating with the brakes applied and when the brakes are not applied on a curve.
If the ESP system operates when the brake is applied, the brake pressure will be increased on the corresponding wheel which already has braking pressure for the ESP controls.

ARP Operation

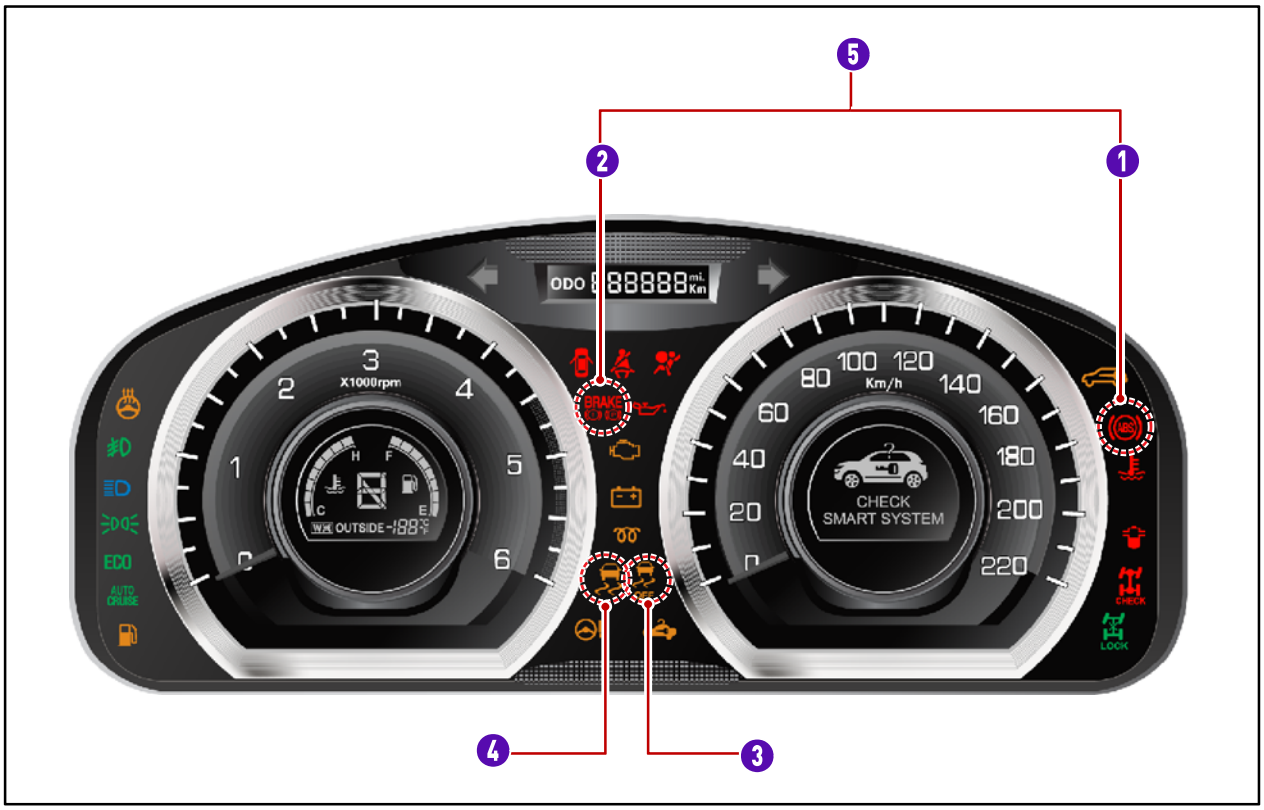
During the ARP operation, vehicle safety (rollover prevention) takes the first priority and thus, stronger engine control is in effect. Consequently, the vehicle speed decreases rapidly, so the driver must take caution for the vehicle may drift away from the lane.

Noise and vibration that driver feels when ESP system is operating

The ESP system may transfer noise and vibration to the driver due to the pressure changes caused by the motor and valve operations in a very short period of time. And, keep in mind that the output and vehicle speed could be decreased without rpm increase due to the ASR function that controls the engine power.

Modification basis	
Application basis	
Affected VIN	

4. WARNING LAMPS



1. ABS warning lamp
2. Brake warning lamp
3. ESP OFF indicator
4. ESP warning lamp/indicator
5. EBD warning lamp

1) ABS

ABS warning lamp module indicates the self-diagnosis and malfunction.
ABS warning lamp ON: Warning Lamp

1. When turning the ignition switch to ON position, ABS warning lamp comes on for 3 seconds for self-diagnosis and goes off if the system is OK (initialization mode).
2. When the system is defective, the warning lamp comes on.
3. When the self-diagnosis is performing, the warning lamp comes on.
4. When the HECU connector is disconnected, the warning lamp comes on.
5. ABS is not available during lamp ON. In this condition, Only normal brake system without ABS function is available.
6. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

2) EBD (Electronic Brake-force Distribution) Warning Lamp (Brake Warning Lamp)

EBD warning lamp when the system perform the self diagnosis and when it detects the malfunction of EBD system. However, the brake warning lamp comes on regardless of EBD when the parking brake is applied.

EBD warning lamp ON:

1. When turning the ignition switch to ON position, ABS warning lamp and the brake warning lamp comes on for 3 seconds for self diagnosis and goes off if the system is OK (initialization mode). When applying the parking brake, the brake warning lamp comes on.
2. When the brake fluid is not sufficient, the brake warning lamp comes on.
3. When the self-diagnosis is performing, the warning lamp comes on.
4. When the HECU connector is disconnected, the warning lamp comes on.
5. When the system is defective, ABS warning lamp and the brake warning lamp come on
6. simultaneously.

   a. When the solenoid valve is defective
   b. When one or more wheel sensors are defective
   c. When ABS HECU is defective
   d. When the voltage is abnormal
   e. When valve relay is defective

7. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

3) ESP OFF Indicator

ESP OFF indicator ON:

1. When turning the ignition switch to ON position, ESP warning lamp comes on for 3 seconds for self diagnosis and goes off if the system is OK (initialization mode).
2. When the ESP OFF switch is pressed to turn off ESP function, ESP OFF indicator comes on.

4) ESP Warning Lamp

1. ESP warning lamp ON:
2. When turning the ignition switch to ON position, ESP warning lamp comes on for 3 seconds for self diagnosis and goes off if the system is OK (initialization mode).
3. When the system is defective, the warning lamp comes on.
4. When the ESP function is activated, ESP warning lamp blinks with the interval of 2 Hz.
5. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

5) ESP OFF Switch

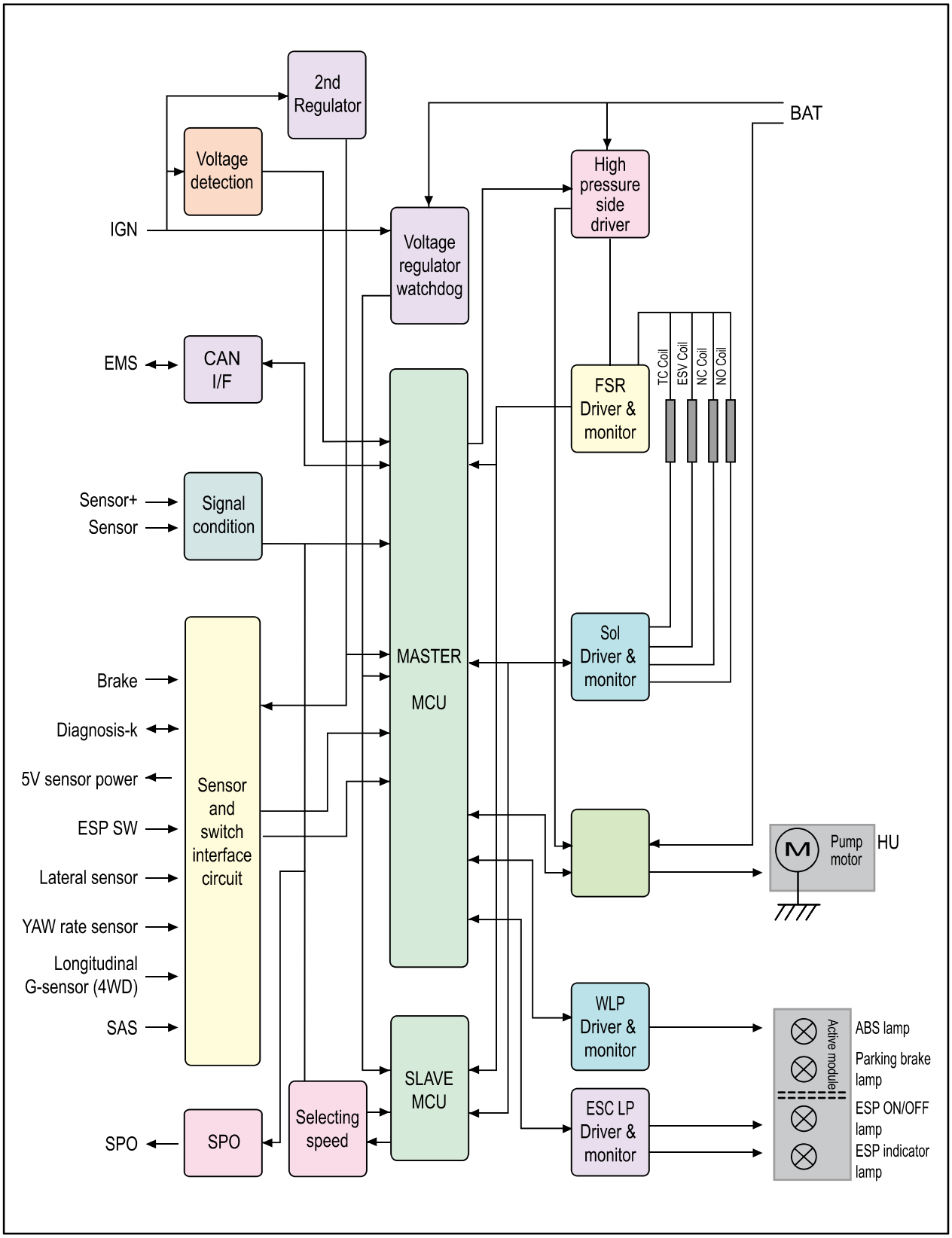
If ESP OFF switch is pressed, ESP function is deactivated and the ESP OFF indicator in the instrument cluster comes on.

To resume the ESP function, press the switch again. At this time, ESP OFF indicator goes out.

Modification basis	
Application basis	
Affected VIN	

5. SYSTEM DESCRIPTION

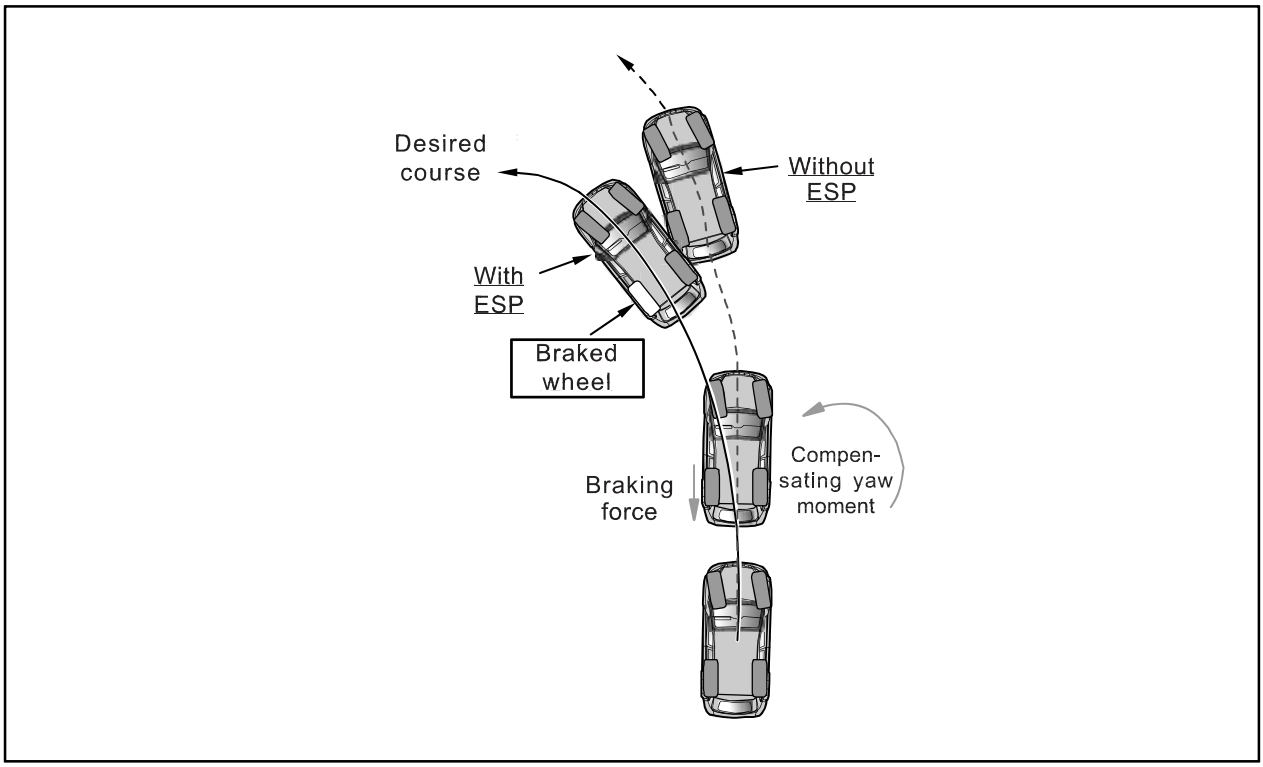
1) Block Diagram of ESP HECU



2) Operation of ESP System

The ESP (Electronic Stability Program) has been developed to help a driver avoid danger of losing control of the vehicle stability due to understeer or oversteer during cornering. The yaw rate sensor, lateral sensor and longitudinal sensor in the sensor cluster and the steering wheel angle sensor under the steering column detect the vehicle conditions when the inner or outer wheels are spinning during oversteer, understeer or cornering. The ESP ECU controls against oversteer or understeer during cornering by controlling the vehicle stability using input values from these sensors and applying the braking force to the corresponding wheels independently. The system also controls the engine power right before the wheel spin synchronized with the ASR function to decelerate the vehicle automatically in order to maintain the vehicle stable during cornering.

(1) Under steering



▶ What is understeering?

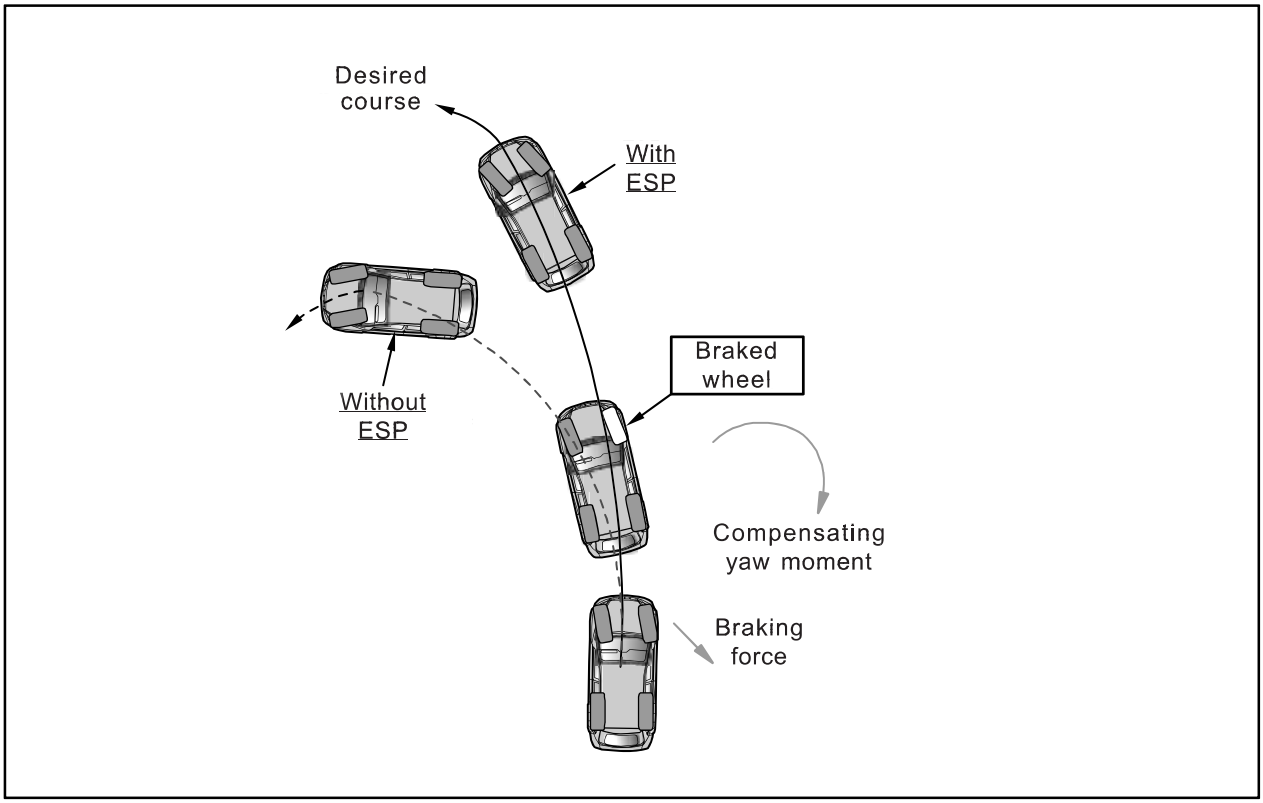
Understeer is a term for a condition in which the steering wheel is steered to a certain angle during driving and the front tires slip toward the reverse direction of the desired direction. Generally, vehicles are designed to have understeer. It is because that the vehicle can return back to inside of cornering line when the steering wheel is steered toward the inside even when the front wheels are slipped outward. As the centrifugal force increases, the tires can easily lose the traction and the vehicle tends to slip outward when the curve angle gets bigger and the speed increases.

Modification basis	
Application basis	
Affected VIN	

▶ ESP controls during understeer

The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs reversely against the vehicle cornering direction during understeer with the yaw rate sensor and lateral sensor. Then, the ESP system applies the braking force to the rear inner wheel to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as intended.

(2) Over steering



▶ What is oversteering?

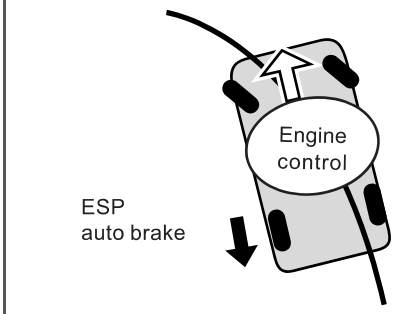
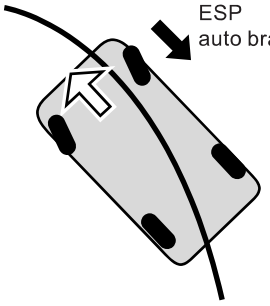
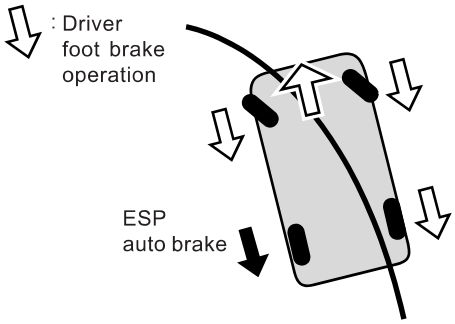
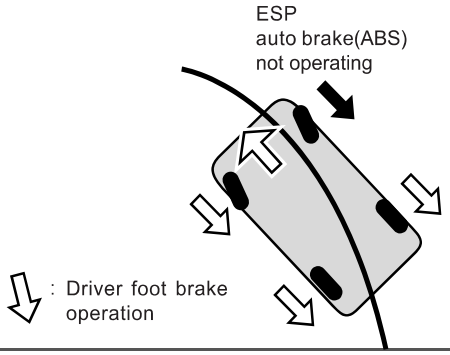
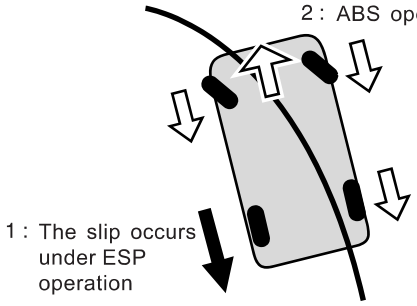
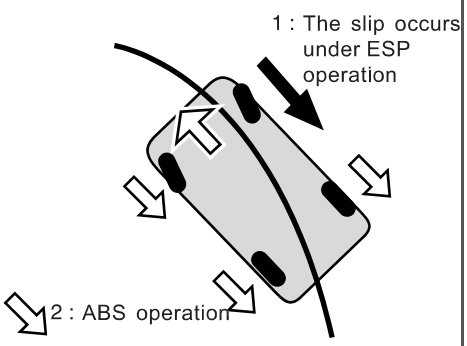
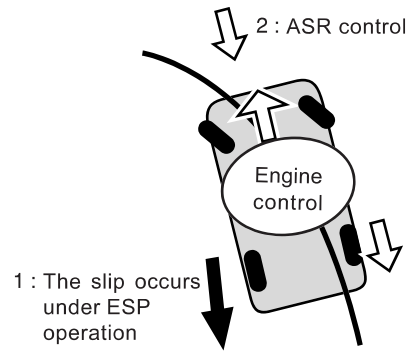
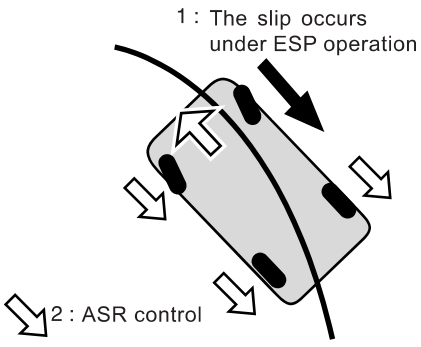
Oversteer is a term of a condition in which the steering wheel is steered to a certain angle during driving and the rear tires slip outward losing traction.
Compared to understeering vehicles, it is hard to control the vehicle during cornering and the vehicle can spin due to rear wheel moment when the rear tires lose traction and the vehicle speed increases.

▶ ESP controls during oversteer

The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs towards the vehicle cornering direction during oversteer with the yaw rate sensor and lateral sensor. Then the ESP system applies the braking force to the front outer wheel to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as intended.

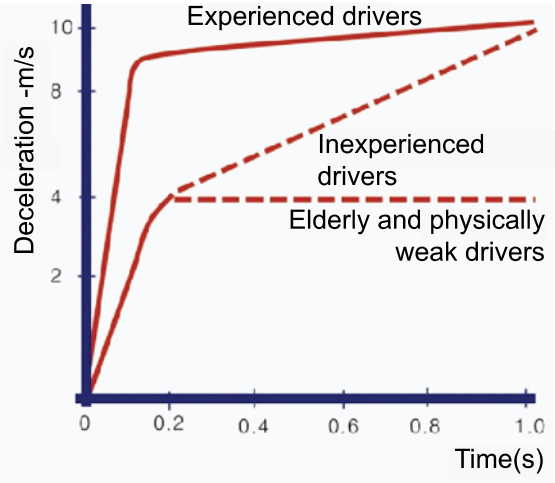
3) Vehicle Control During Cornering

The figure below shows the vehicle controls by the ESP system under various situations such as when the brake pedal is depressed or not depressed during cornering, when the ABS is operating and when braking without the ABS. It also includes the vehicle conditions when the TCS, a part of the ESP system, is operating.

Condition	Understeer control	Oversteer control
Only ESP in operation No braking by driver		
ESP + Normal braking (no ABS operation)		
ESP + ABS brake		
ESP + ASR		

Modification basis	
Application basis	
Affected VIN	

4) HBA (Hydraulic Brake Assist System)



(1) Purpose

HBA (Hydraulic Brake Assist) system helps in an emergency braking situation when the driver applies the brake fast, but not with sufficient pressure, which leads to dangerously long braking distance. ECU recognizes the attempt at full braking and transmits the signal calling for full brake pressure from the hydraulic booster. An inexperienced, elderly or physically weak driver may suffer from the accident by not fully pressing the brake pedal when hard braking is required under emergency. The HBA System increases the braking force under urgent situations to enhance the inputted braking force from the driver. Based on the fact that some drivers depress the brake pedal too soft even under when hard braking is necessary, the HECU system is a safety supplementary system that builds high braking force during initial braking according to pressure value of the brake pressure sensor and the pressure changes of the pressure sensor intervals. When the system is designed to apply high braking force when brake pedal is depressed softly by an elderly or physically weak driver, the vehicle will make abrupt stopping under normal braking situation due to high braking pressure at each wheels.

(2) Operation

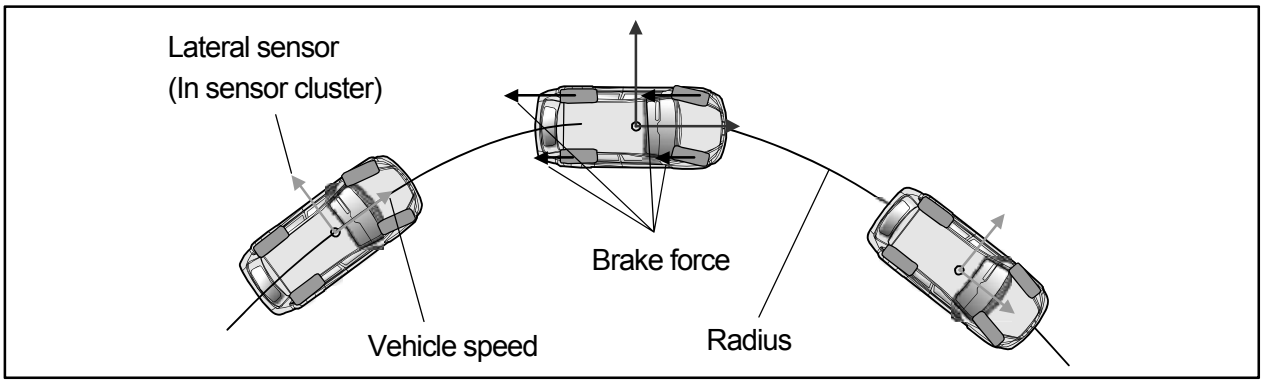
The brake pressure value and the changed value of the pressure sensor are the conditions in which the HBA System operates. There are 2 pressure sensors under the master cylinder. When the ESP ECU system determines that emergency braking is present, the pump operates, the brake fluid in the master cylinder is sent to the pump and the braking pressure is delivered to the wheels via the inlet valves . If the drive depress the brake pedal slowly, the pressure change is not high. In this case, only the conventional brake system with booster is activated.

(3) Operating conditions

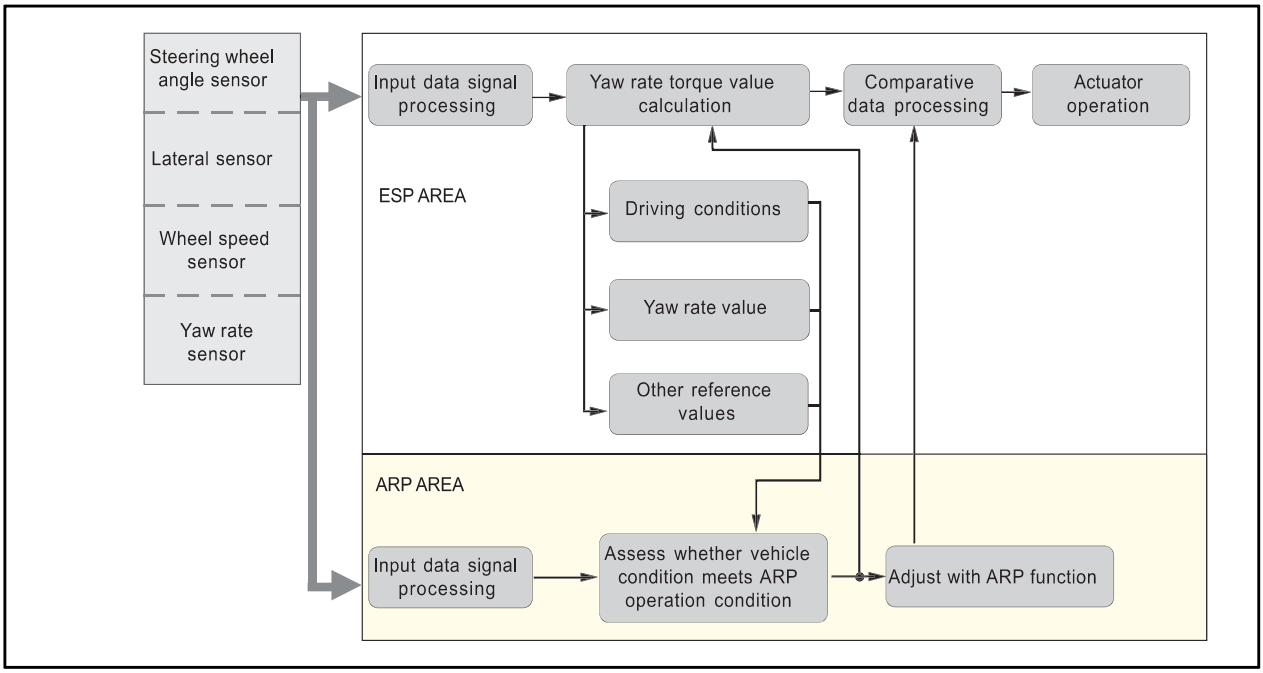
- Sensor pressure: over 40 bar
- Pressure changes: over 850 bar/sec
- Vehicle speed: over 30 km/h

5) ARP (Active Roll-Over Protection)

The ARP (Active Roll-over Protection) system is a safety assistant device that minimizes, by controlling brakes and the engine, the physical tendency of the vehicle rollover during sharp lane changes or U-turns. For the system, software is added to the existing ESP system and no additional device or switch is needed. One must note that the ARP system, just as general assistant devices including the ABS, is only a safety assistant device using the ESP system and its function is useless when the situation overcomes the physical power. Following picture shows how the ARP compensates the vehicle position by varying each wheel's braking power to overcome the physical tendency of the vehicle rollover during sharp turns.



The vehicle driving condition is controlled by the internally programmed logic according to the input signals from wheel speed sensor, steering angle sensor and lateral sensor.



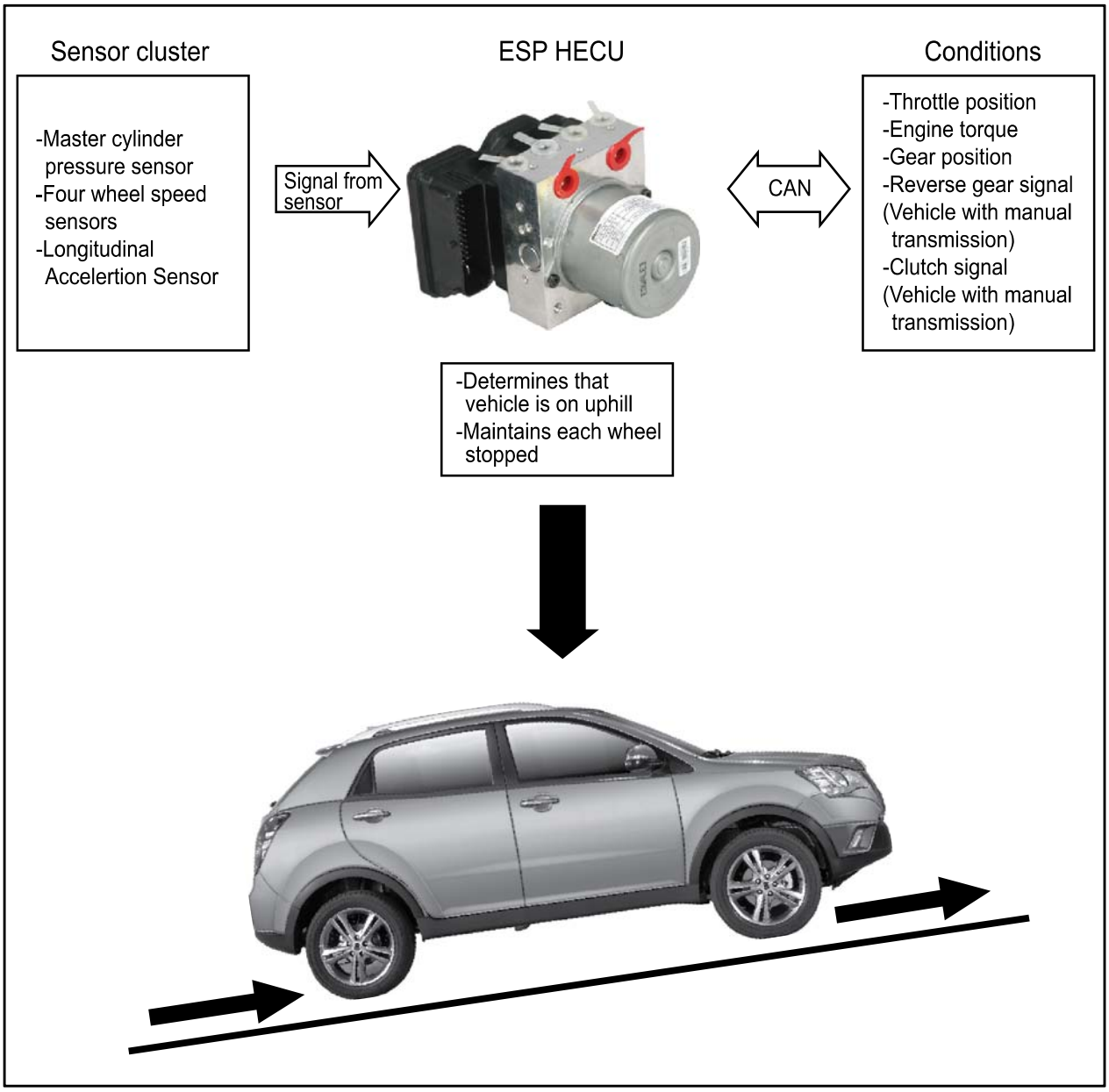
CAUTION

During the ARP operation, vehicle safety (rollover prevention) takes the first priority and thus, stronger engine control is in effect. Consequently, the vehicle speed decreases rapidly, so the driver must take caution for the vehicle may drift away from the lane.

Modification basis	
Application basis	
Affected VIN	

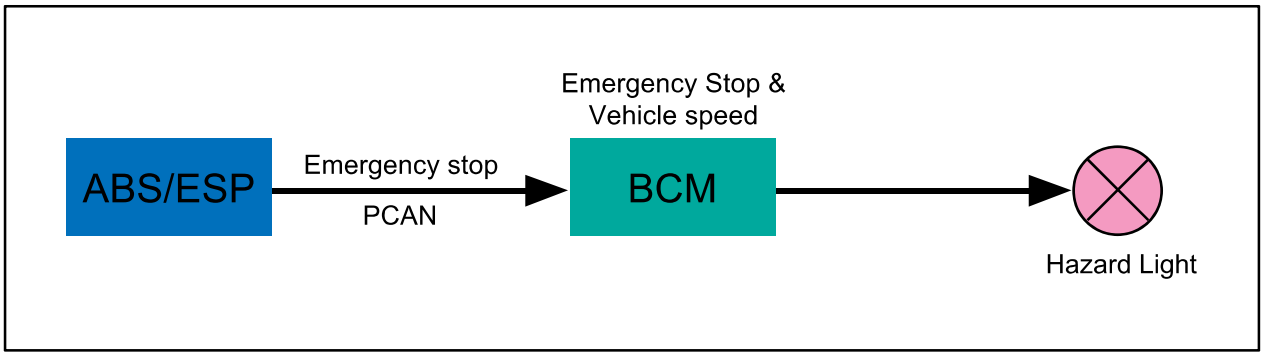
6) HSA (Hill Start Assist)

The HSA (Hill Start Assist) prevents the vehicle from rolling backward by supplying the hydraulic pressure to the wheels by the HECU after the brake pedal is released when starting off on uphill.



7) Emergency Hazard Flasher Control (Coupled with ABS)

(1) System layout



(2) Emergency stop signal function

When ABS system is operating (or sudden braking), the hazard warning flashers will blink for 10 seconds to inform the emergency situation to the vehicles behind.

(3) Operating process

When receiving the emergency stop signal through PCAN communication it blinks with the interval of 4 Hz and when receiving the emergency stop OFF signal through PCAN communication it blinks with the interval of 1.25 Hz, normal operating speed.
However, the manual operation of the switch has a priority over this function.

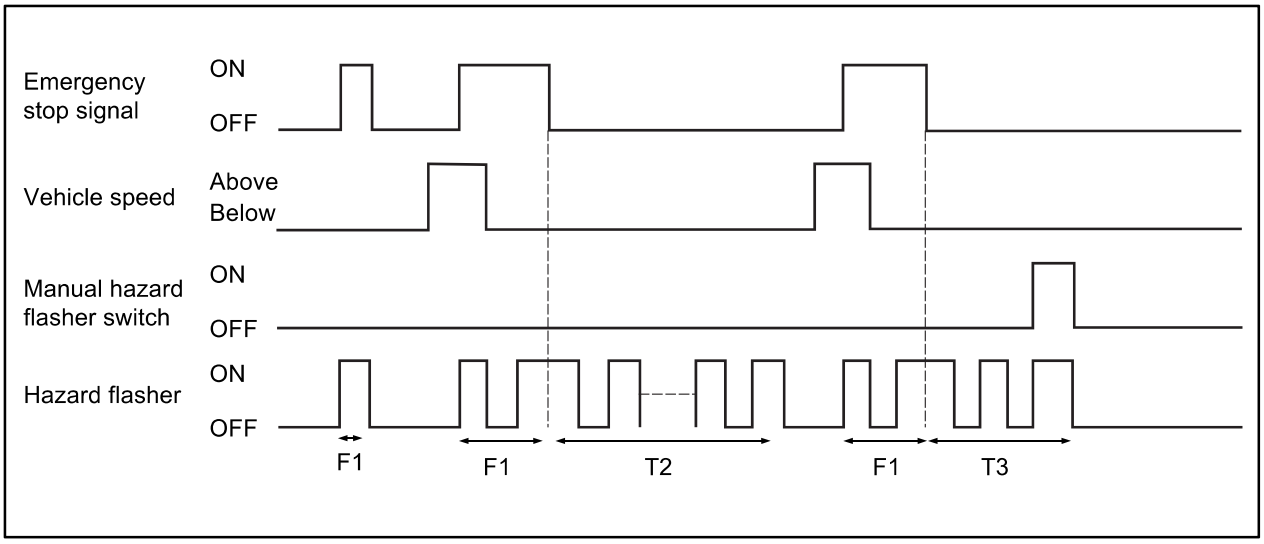
NOTE

Priority: Manual operation > Emergency stop signal > Emergency hazard flasher > Auto hazard flasher

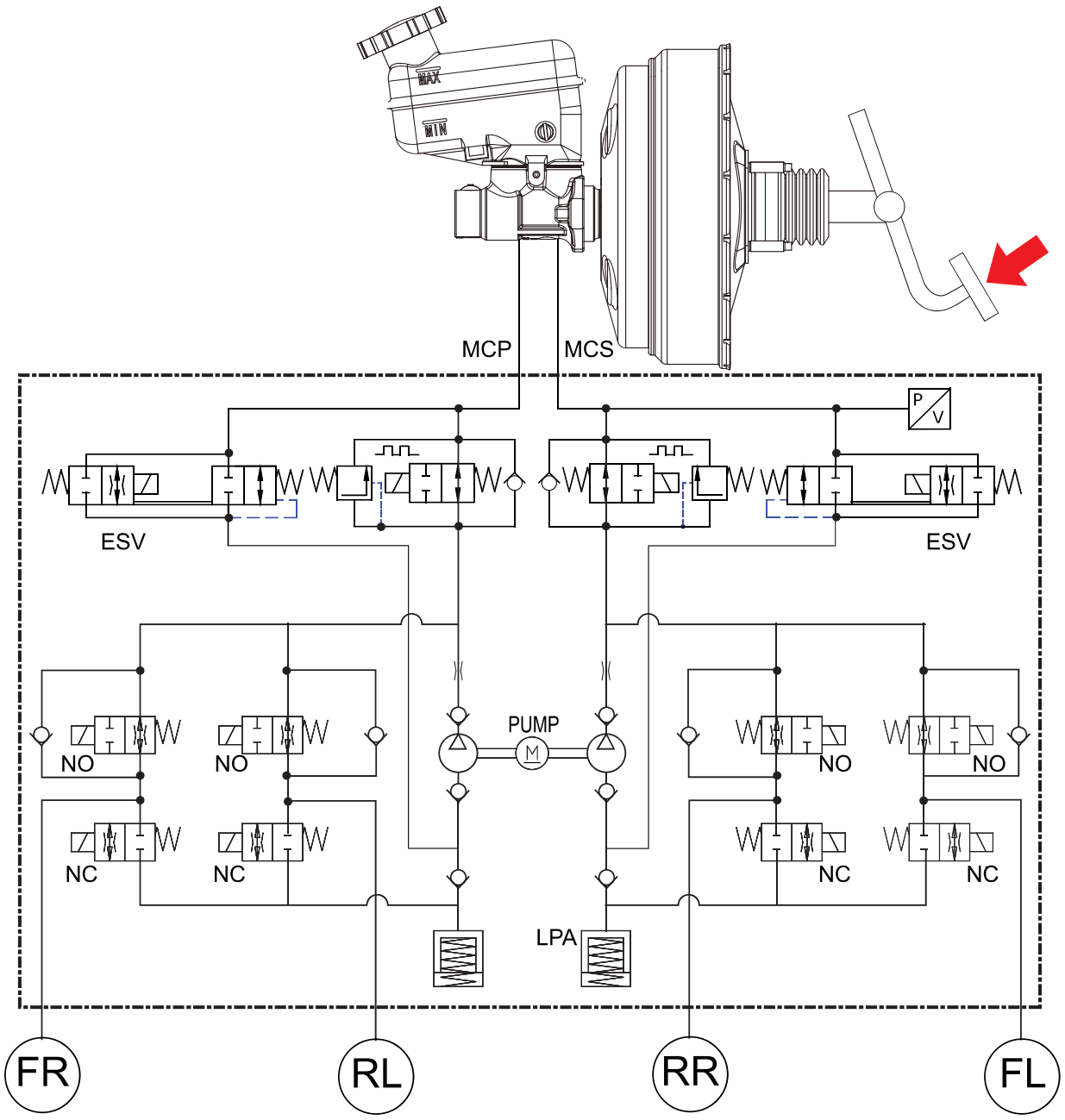
Modification basis	
Application basis	
Affected VIN	

The BCM flashes the emergency auto hazard flasher with interval of 1.25 times/sec.:

- The emergency hazard flasher does not operate if the vehicle speed is over 50 km/h when the emergency stop signal is received.
- The emergency hazard flasher operates if the vehicle speed is 50 km/h or lower when the emergency stop signal is received.
- When vehicle speed increases more than 10 km/h above the speed when the signal is received during operation by emergency braking signal, the emergency hazard flasher stops operation. When turning emergency hazard flasher switch OFF during operation by emergency braking signal,
- it stops operation.
  It is deactivated automatically 10 seconds after if items 2) and 3) above are not met during operation
- by emergency braking signal.
  If multi-function automatic hazard flasher signal is received during operation by emergency braking
- signal, it will be overridden.



6. HYDRAULIC CIRCUIT OF ESP



MCP: Master Cylinder Primary
MSP: Master Cylinder Secondary
ESV: Electric Shuttle Valve
NO: Normal Open
NC: Normal Close
LPA: Low Pressure Accumulator

Modification basis	
Application basis	
Affected VIN	

▶ Circuit description

When compared to the vehicle equipped with ABS/EBD only, the internal hydraulic circuit has a normally-open separation valve and a shuttle valve in primary circuit and in secondary circuit.
When the vehicle brakes are not applied during engine running or when applying the non-ABS operating brakes, the normally-open separation valve and the inlet valve are open, whereas the normally-closed shuttle valve and the outlet valve are closed.
When the ESP system is operating, the normally-open separation valve will be closed by the solenoid valve operation and the hydraulic circuit will be established by the shuttle valve. Then, the inlet and outlet valves will be closed or open depending on the braking pressure RISE, HOLD or DUMP conditions.

▶ Flashing warning lamp and warning sound during ESP operation

When the ESP operates while the vehicle is moving, the ESP warning lamp on the instrument panel flickers and the buzzer sounds at every 0.1 second. The ESP lamp operation is to inform a driver that the vehicle is extremely unstable.
The ESP system is just a supplementary system for the vehicle and it cannot control the vehicle over the physical limit. Do not solely rely on the system but be advised to drive the vehicle safely.

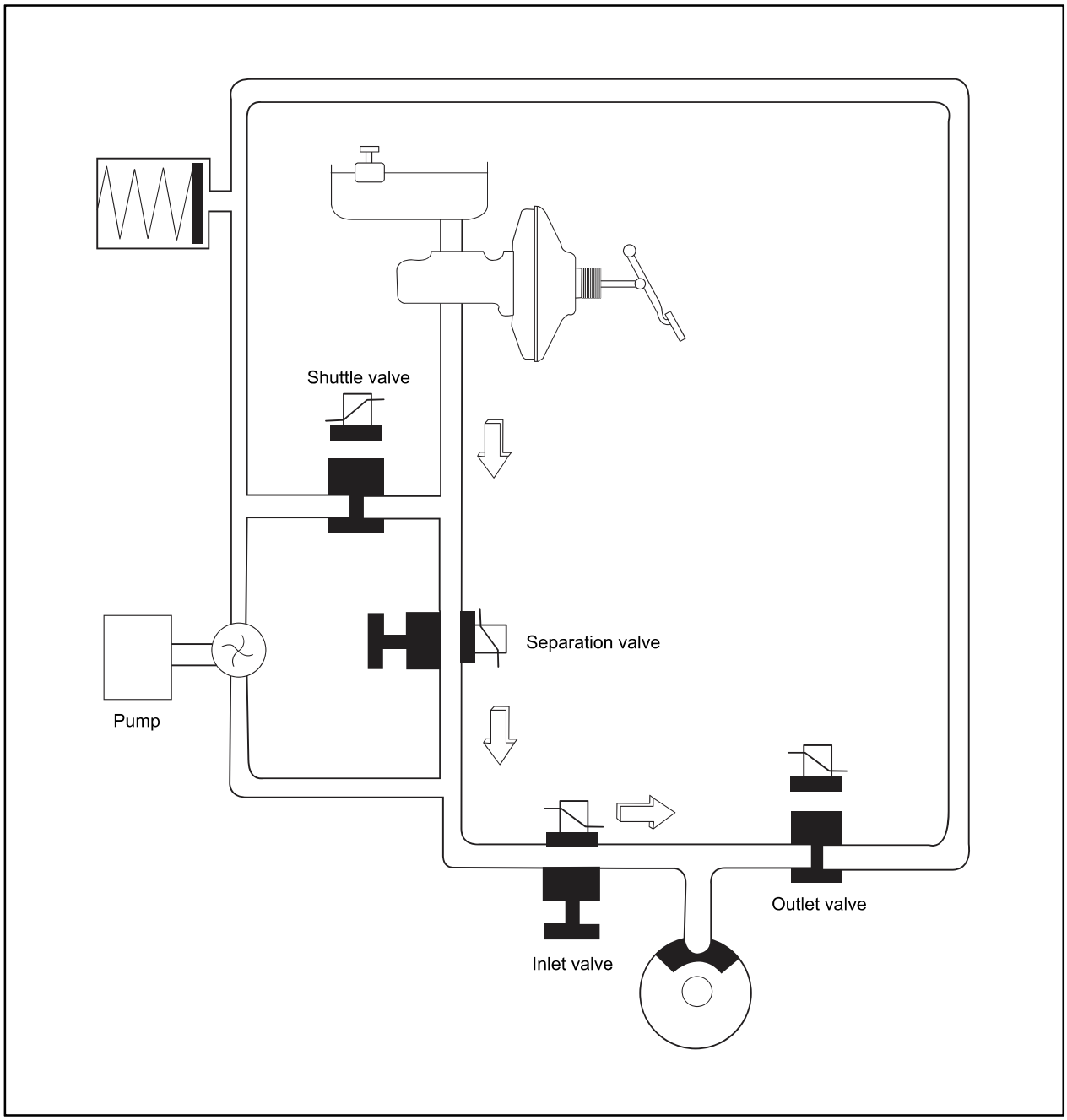
▶ Drive feeling during ESP operation

When the ESP system activates, the driving feeling can be different depending on vehicle driving conditions. For example, it will feel different when the ESP system is activated while the ABS is operated by depressing the brake pedal and when the ESP system is in control without the brake pedal depressed on the same curve.
If the ESP system operates with the brake applied, the brake pressure will be increased on the corresponding wheel which already has braking pressure for the ESP controls. In other words, the ESP system would make the driver feel more abruptly braked compared to the situation that the braking pressure is applied to wheel which had no braking force.

▶ Noise and vibration that driver senses during ESP operation

The ESP system may transfer noise and vibration to a driver due to the pressure changes caused by the motor and valve operations in a very short period of time.
Extreme cornering will trigger the ESP operation and this will make the driver sense noise and vibration due to sudden brake application.
Also, the ESP system controls the engine power. Therefore, the driver may notice the engine power decreases even when the accelerator pedal is depressed.

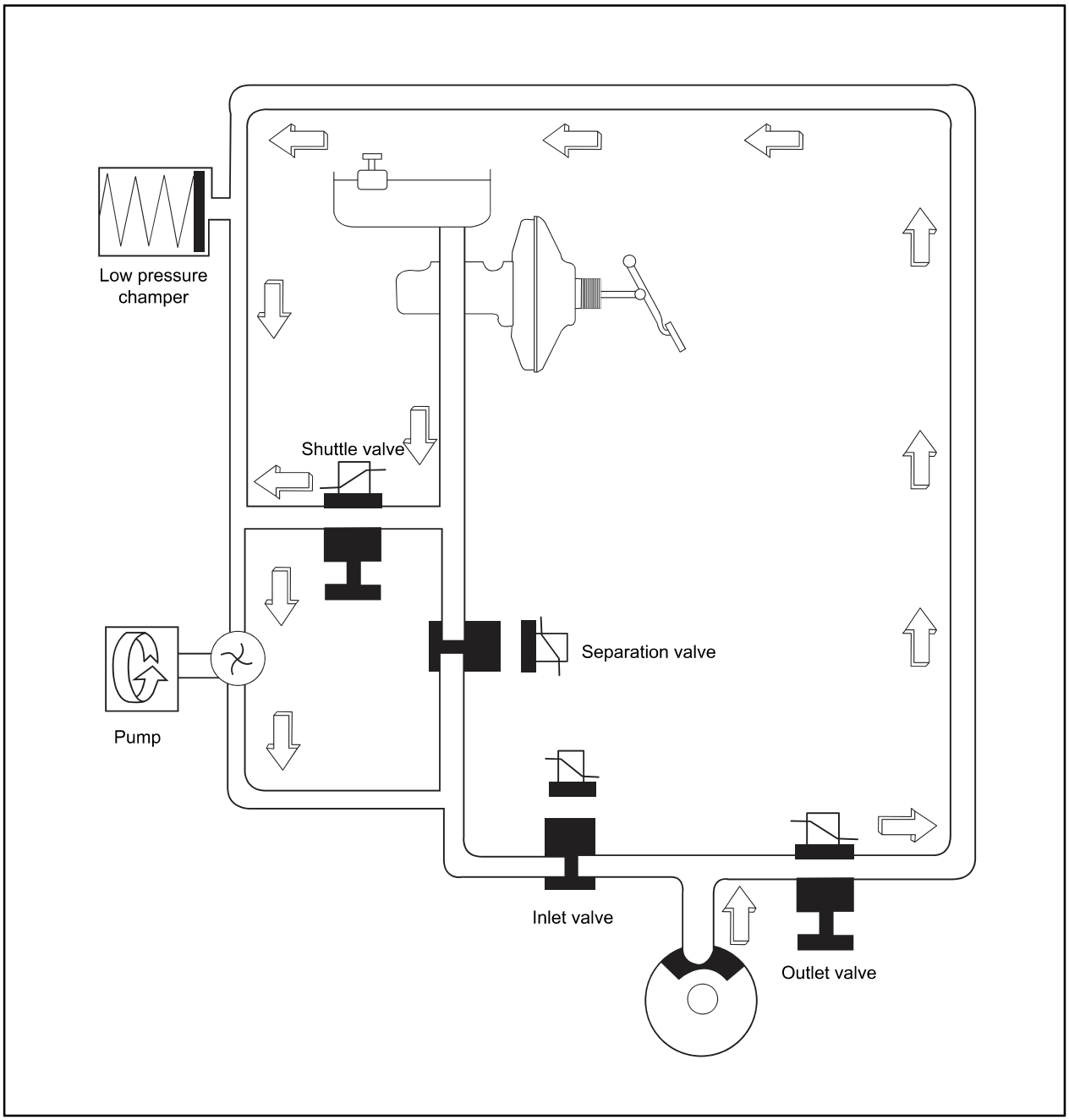
1) Idling and Normal Braking Condition



In this position, the separation valve and the inlet valve are open (normal open), the electrically operated shuttle valve and the outlet valve are closed.
When the brake is applied under these conditions, the brake fluid will be sent to each wheel via the separation valve and inlet valve.

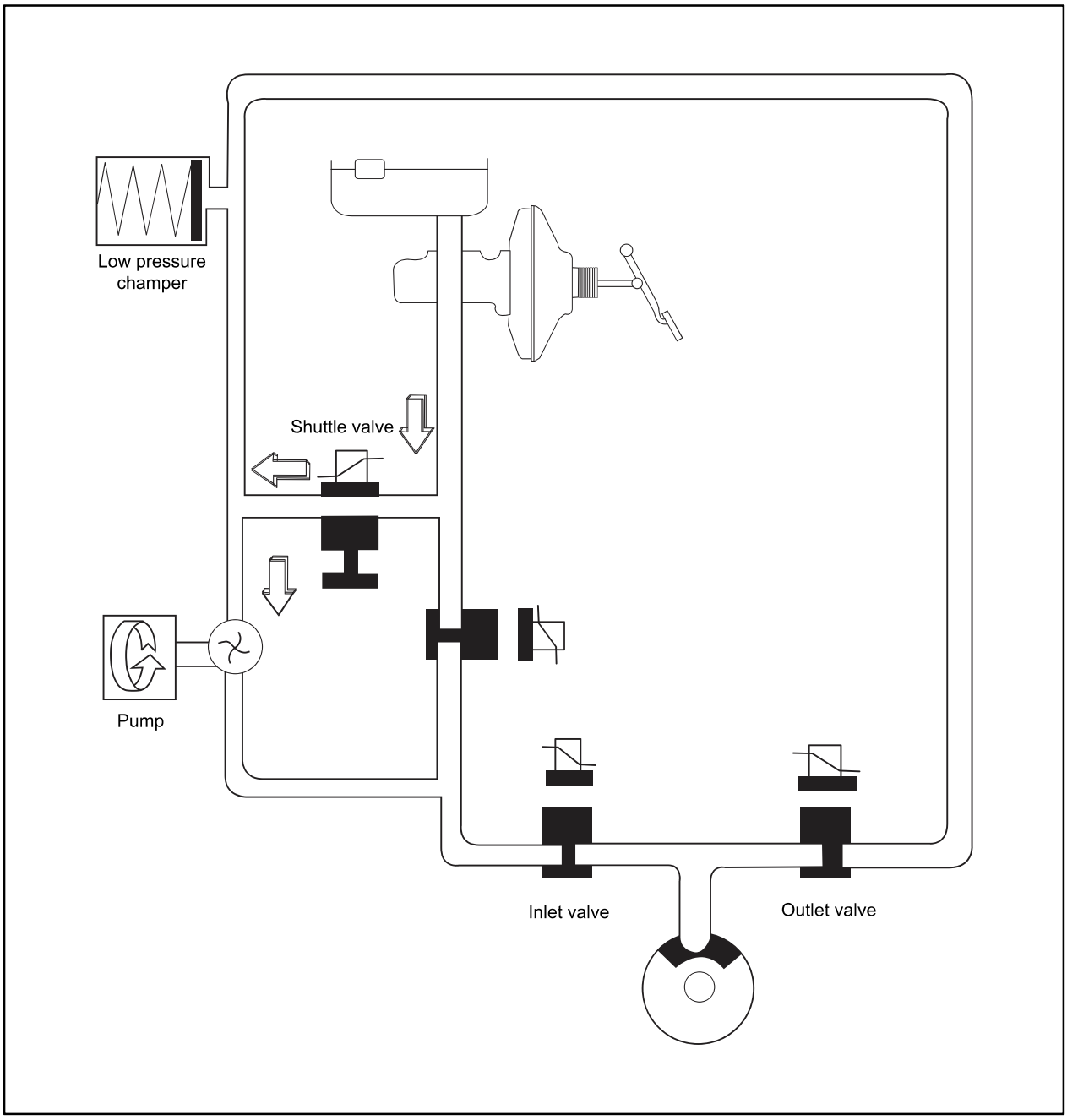
Modification basis	
Application basis	
Affected VIN	

2) DUMP (ESP is working) Mode



The pressure decreases just before the wheel speed drops and the wheels are locked.
The inlet valve closes and the outlet valve opens as in the ABS HECU and the oil is gathered at the low pressure chamber while no additional oil is being supplied. Then the pump operates to allow fast oil drainage. The shuttle valve and the separation valve do not operate while decompression.

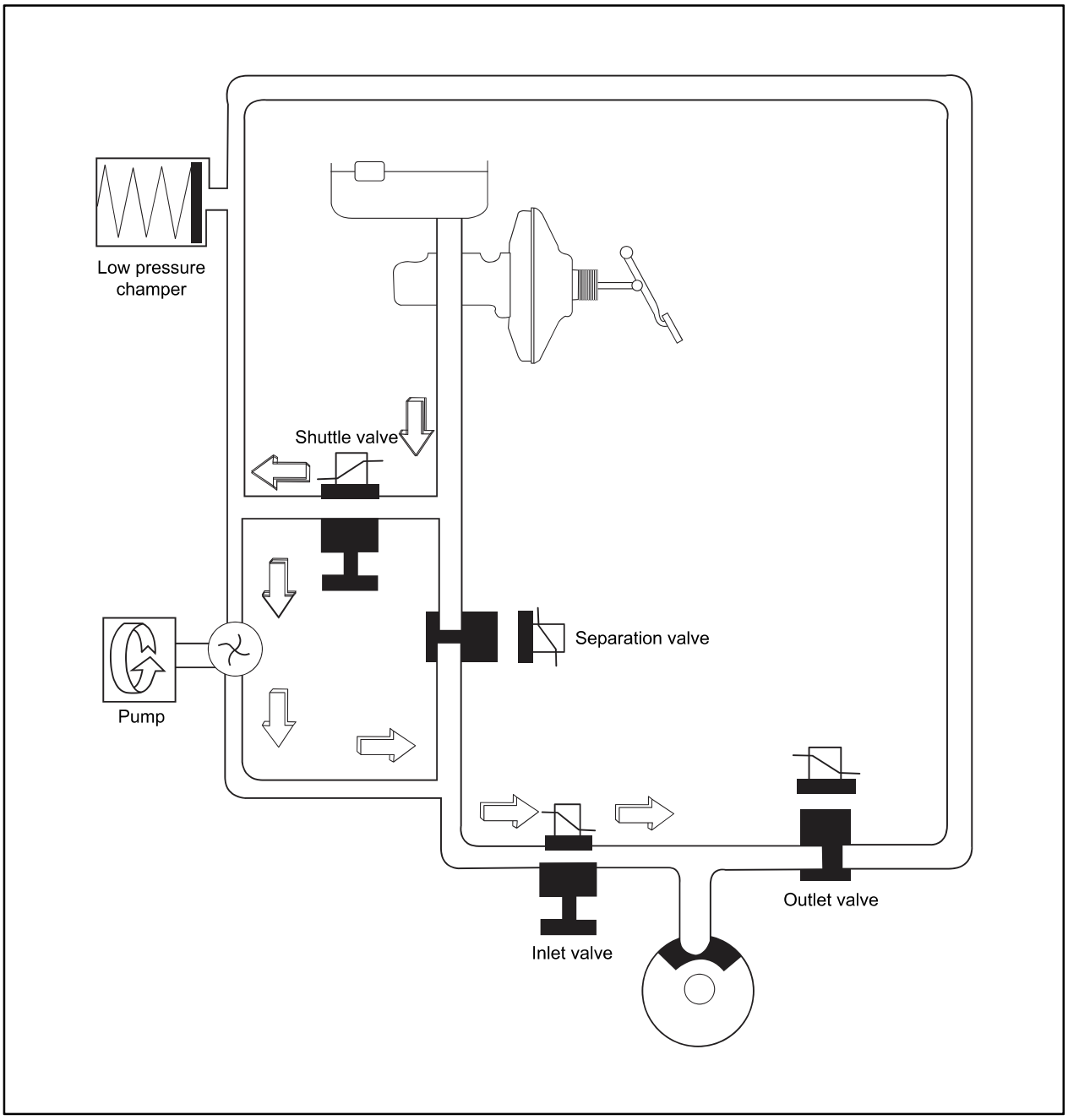
3) HOLD (ESP is working) Mode



The Inlet valve and outlet valve will be closed to maintain the pressure in the hydraulic circuit applied at the wheels. By closing the valves, the hydraulic pressure at the wheels will not be lost or supplied any more. During ESP operation, the separation valve closes and only the shuttle valve at the pump opens.

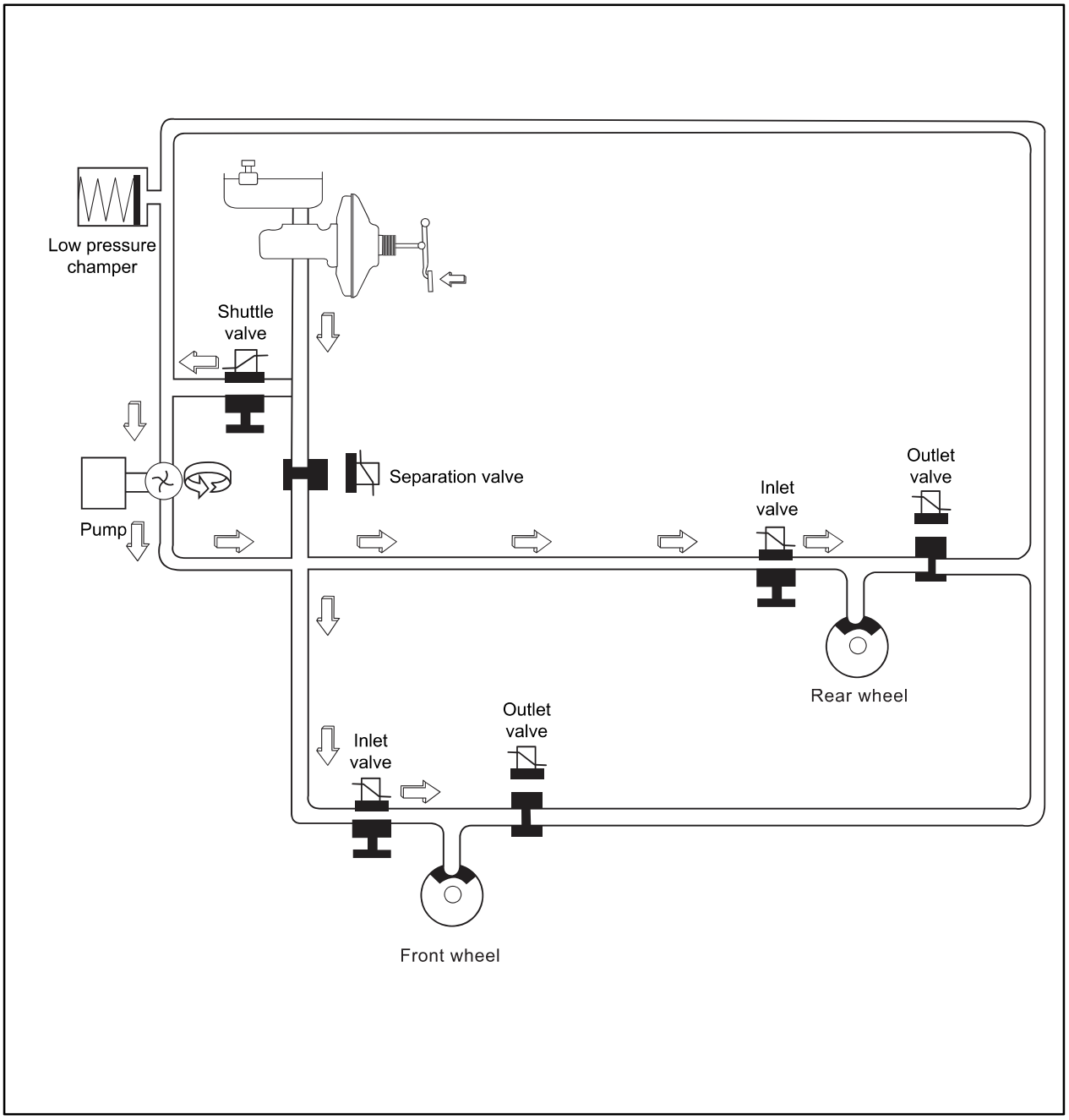
Modification basis	
Application basis	
Affected VIN	

4) RISE (ESP is working) Mode



The shuttle valve and inlet valve will be open and the separation valve and outlet valve will be closed. Then, the pump is operated. When ESP operates while the ABS is operating, the pressure will be increased continuously until just before the corresponding wheel gets locked.

5) Hydraulic Circuit of HBA

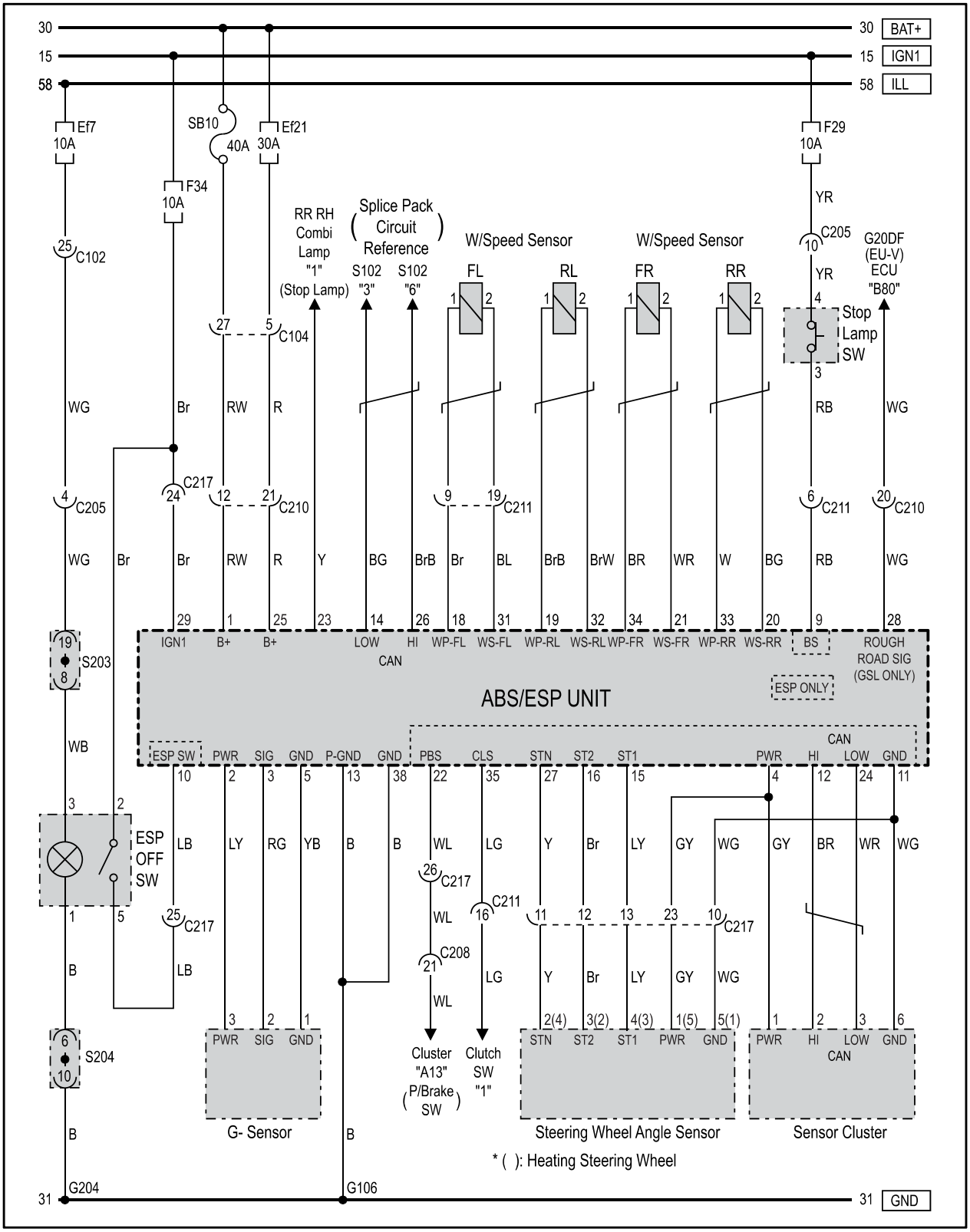


The above figure shows one front and one rear wheel and the same hydraulic circuit forms as in the ESP operation. When HECU recognizes that it is an emergency and it is required for hard braking, depending on the pressure value of the brake pressure sensor and pressure changes caused by the pressure sensor timing, it operates the pump immediately to apply the brake pressure at the wheels. Then, the pressure in the pump increases until just before the corresponding wheel gets locked. The motor still keeps rotating and the outlet valve and the separation valve will stay closed. When the wheel starts to lock, the HBA function cancels and switches to ABS operation.

Modification basis	
Application basis	
Affected VIN	

7. CIRCUIT DIAGRAM

▶ **Wheel speed sensor, Stop lamp switch, Self diagnostic connector, Warning lamp (ABS/ESP)**



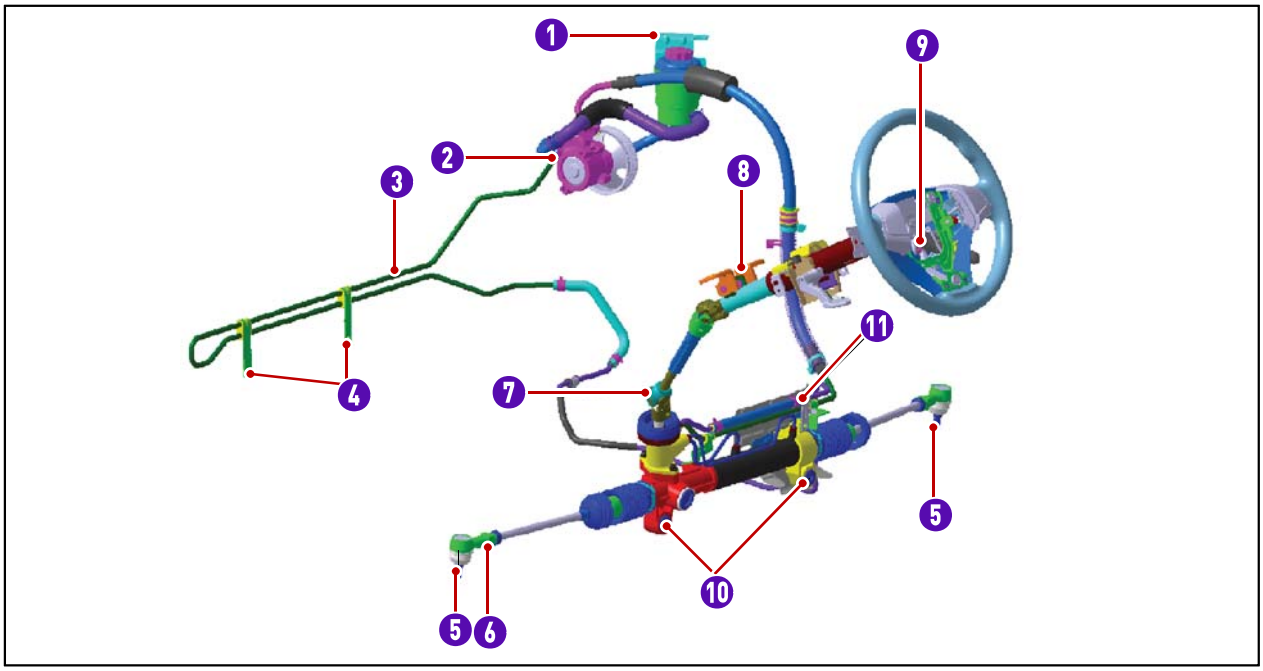
Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

1. SPECIFICATION (HPS)

Component	Item		Specification
Steering wheel	Type		3-spoke
	Outside diameter		Φ 380 mm
	Number of revolutions		3.11 rotations
	Heated wire		Simple ON/OFF
Gear box	Type		Rack and pinion
	Gear ratio		46.94
	Rack stroke		± 73 mm
Steering angle	Inner		39°
	Outer		31.24°
Wheel alignment	Toe-in		2 ± 2 mm
Oil pump	Type		Vane (removable pump and reservoir)
	Maximum pressure		100 ± 3 bar
	Displacement		6.0 to 9.75 ℓ/min
	Pulley diameter		Φ 115 mm
Steering column	Tilting angle	Up	+ 2.0
		Down	- 30
Lower shaft	Type		Ball slip
Steering oil	Oil type		ATF Dexron II or III
	Oil reservoir capacity		1 ℓ
	Change interval		EU (Diesel): Check and add at every 20,000 km GEN (Diesel, Gasoline): Check and add at every 15,000 km
Turning capability	Min. turning radius		5.4 m

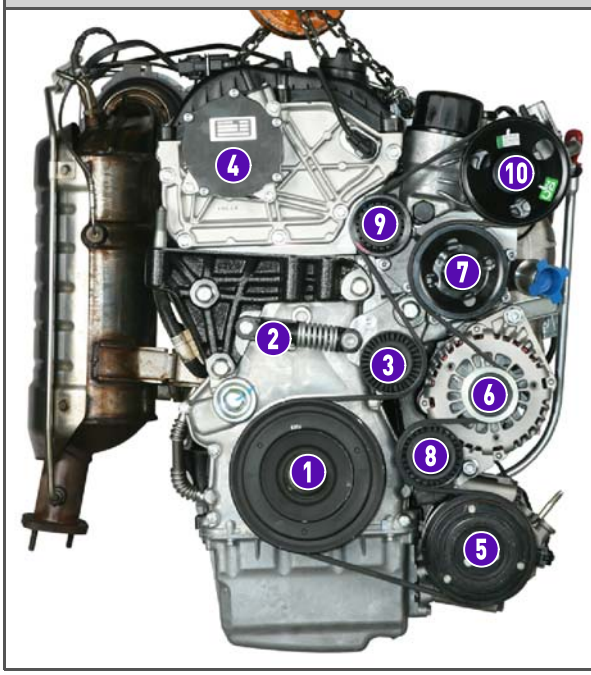
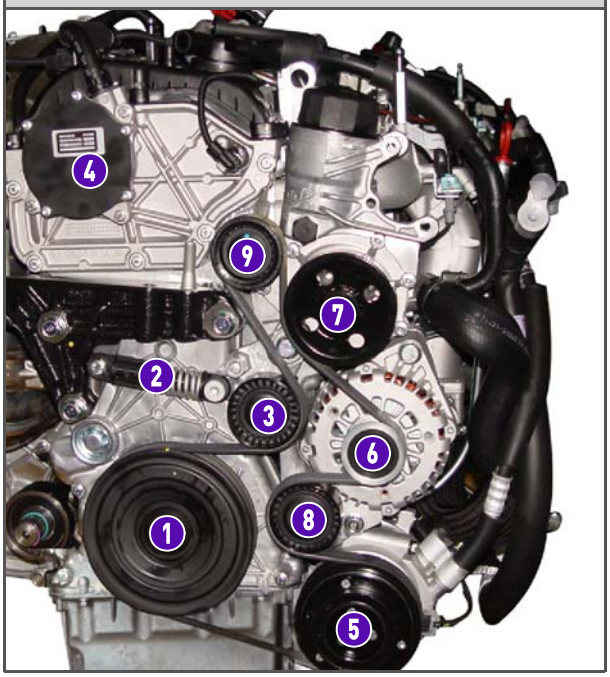
2. TIGHTENING TORQUE



Item		Tightening torque	Remark
1. Power steering reservoir mounting bolt		8.8 to 13.7 Nm	12 mm x 2 EA
2. Power steering pump	Upper mounting bolt/nut	25 ± 2.5 Nm	13 mm x 1 EA
	Lower mounting bolt	25 ± 2.5 Nm	12 mm x 2 EA
3. Oil pipe	Eye bolt (pump side)	53.9 to 63.7 Nm	22 mm
	Steering gear box side nut	31.4 to 37.2 Nm	17 mm
4. Oil pipe bracket mounting nut		6.8 to 10.8 Nm	10 mm
5. Tie rod end lock nut		44.1 to 53.9 Nm	17 mm
6. Tie rod nut		63.7 to 78.4 Nm	22 mm
7. Lower shaft	Lower mounting bolt (gear box side)	17.6 to 24.5 Nm	12 mm
	Upper mounting bolt (column side)	17.6 to 24.5 Nm	12 mm
8. Column shaft	Lower mounting bolt	19.6 to 24.5 Nm	12 mm
	Upper mounting nut	19.6 to 24.5 Nm	12 mm
9. Steering wheel nut		39.2 to 58.8 Nm	22 mm
10. Loosened gear box mounting bolt/nut		Left: 98.0 to 127.4 Nm	17 mm
		Right: 88.3 to 107.9 Nm	17 mm
11. Heat shield mounting bolt		8.8 to 13.7 Nm	12 mm x 2 EA

Modification basis	
Application basis	
Affected VIN	

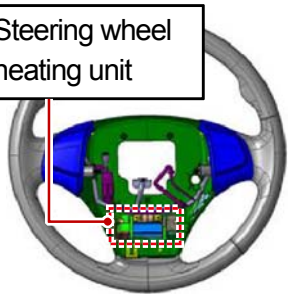
3. DIFFERENCES BETWEEN HPS AND EPS

HPS (Hydraulic Power Steering)	EPS (Electric Power Steering)
	

	HPS	EPS
1	Crankshaft pulley (DDU)	←
2	Auto tensioner	←
3	Tensioner pulley	←
4	Vacuum pump	←
5	A/C compressor pulley	←
6	Alternator pulley	←
7	Water pump pulley	←
8	No.1 idle pulley	←
9	No.2 idle pulley	←
10	Power steering pump	-

4. MAJOR CHANGES

1) Steering Heating System

Steering wheel heating unit	
Old	**New**
	
The steering wheel heated wire and the heating unit are installed in the steering wheel assembly.	

Lower switch cluster	
Old	
	
New	
	
The steering wheel heating switch has been added on the lower switch cluster.	



▶ **Specifications**

Description	Specification
Power consumption	Below 95W
Rated voltage	12V
Operating voltage	9V~16V
Rated current	6±2.0A

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

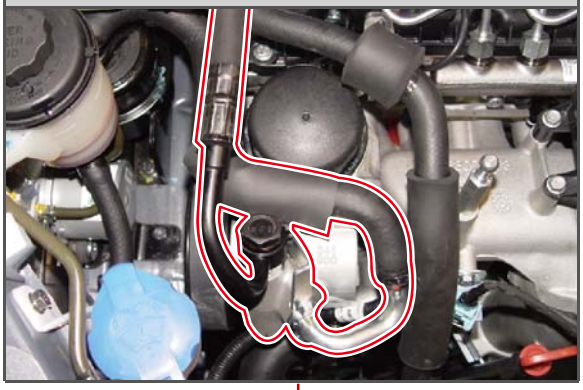
1. SYSTEM DESCRIPTION

The power steering has been designed to make the wheel move more easily than in a manual steering system. The hydraulic power assists the process utilizing hydraulic fluid. The fluid increases pressure in the power steering pump and aids the movement of the steering mechanism.
The power steering system consists of pump, oil reservoir, rack and gear box.
The power steering pump is a vane type and delivers hydraulic pressure to operate the power steering system.
The pressure relief valve in the pump controls the discharging pressure.
The rotary valve in the rack and the pinion gear directs the oil from the power steering pump to one side of the rack piston. The integrated rack piston converts the hydraulic pressure to linear movement. The operating force of the rack moves the wheels through the tie rod, the tie rod end and the steering knuckle.
Even though the hydraulic pressure cannot be generated, a driver can steer the vehicle without power assist but it needs very high steering force.
In this case, the operating force of the steering wheel is conveyed to the pinion, and the movement of the pinion moves the rack through the pinion gear combined to the rack gear.

2. SYSTEM LAYOUT

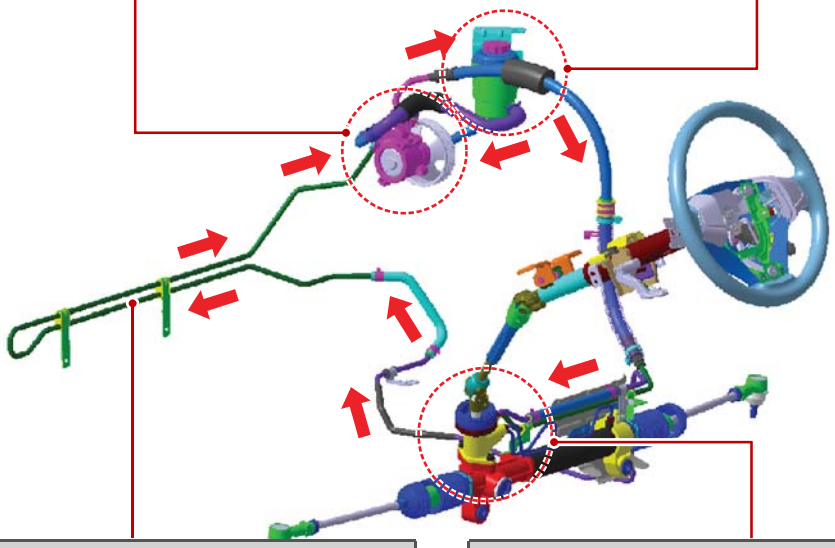
The steering pump is driven by the engine power through a belt. This pump circulates the power steering oil from the reservoir -> steering pump -> oil supply pipe -> steering gear box -> oil return pipe -> reservoir to perform steering operations.

Installation of power steering pump and pipe

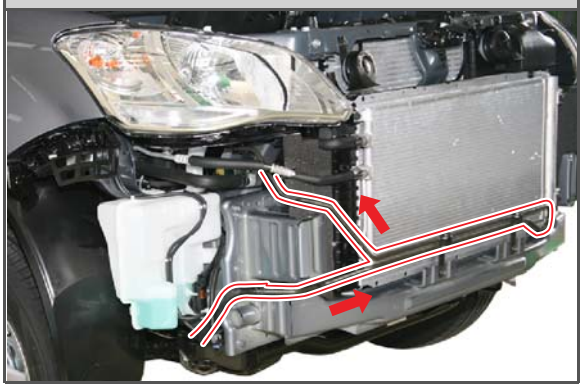


Installation of reservoir and hose

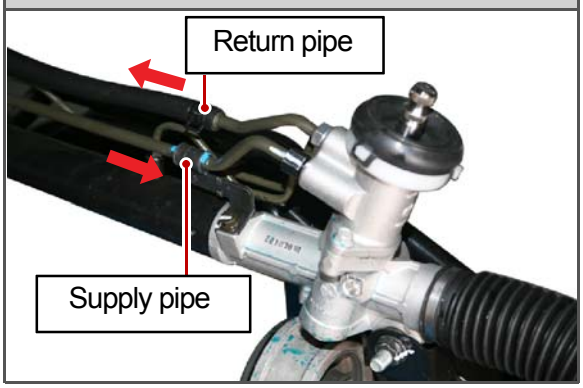




Installation of pipe



Installation of steering gear box and pipe



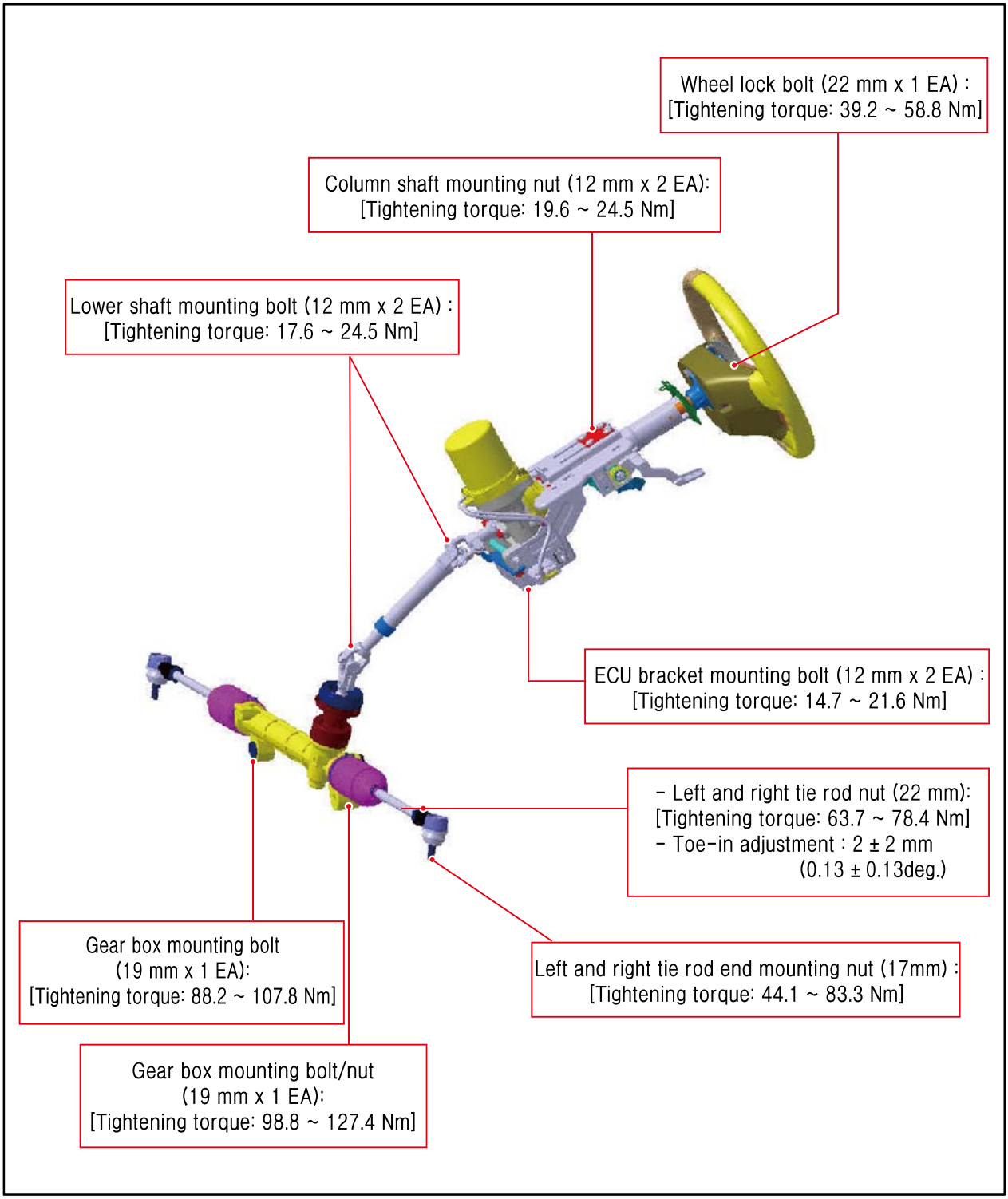
Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

1. SPECIFICATION

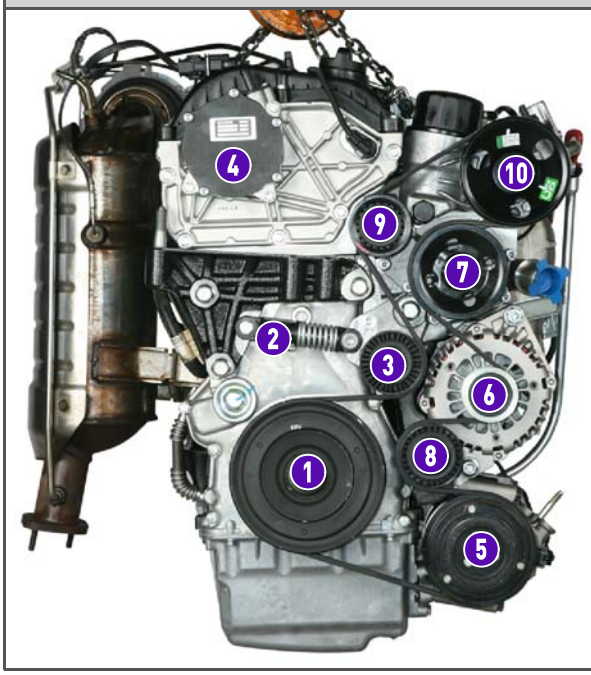
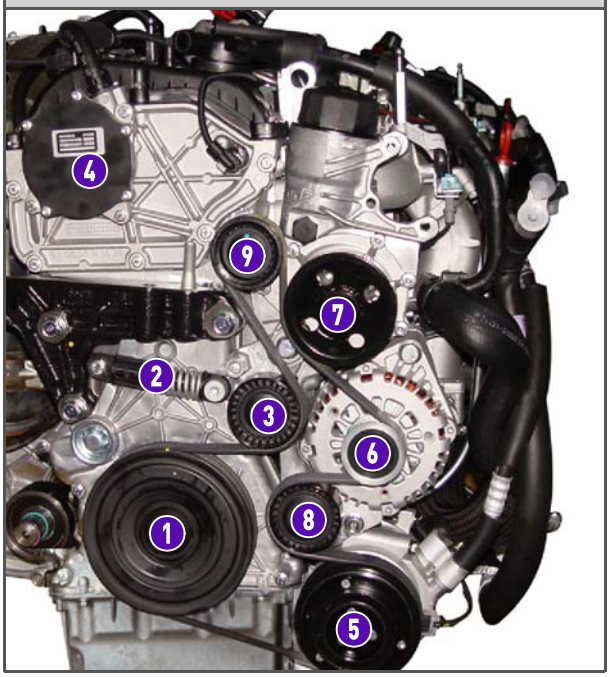
Unit	Description	Specification
System operation	Operating type	Motor driven power steering system
	Operating temperature	− 40°C to 80°C
	Rated voltage	12 V
	Rated current	85 A
Operating voltage	Network	8 to 16 V
	C-EPS ECU	8 to 16 V
	Full Performance	10 to 16 V
Motor	Type	3-Phase BLAC (Brushless AC)
	Rated current/voltage	85 A / 12 V (at idle 0.5 A)
	Position sensor type	Hall sensor type
Torque & angle sensor	Type	Non-contact type
Steering column	Operating type	Manual tilting & telescoping
Lower shaft	Type	Sliding (Ball slip) type
Steering gear	Gear ratio	46.94 mm/rev
	Rack stroke	146 mm
Maximum steering angle	Inner wheel	39°
	Outer wheel	31.24°

2. TIGHTENING TORQUE



Modification basis	
Application basis	
Affected VIN	

3. DIFFERENCES BETWEEN HPS AND EPS

HPS (Hydraulic Power Steering)	EPS (Electric Power Steering)
	

	HPS	EPS
1	Crankshaft pulley (DDU)	←
2	Auto tensioner	←
3	Tensioner pulley	←
4	Vacuum pump	←
5	A/C compressor pulley	←
6	Alternator pulley	←
7	Water pump pulley	←
8	No.1 idle pulley	←
9	No.2 idle pulley	←
10	Power steering pump	-

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

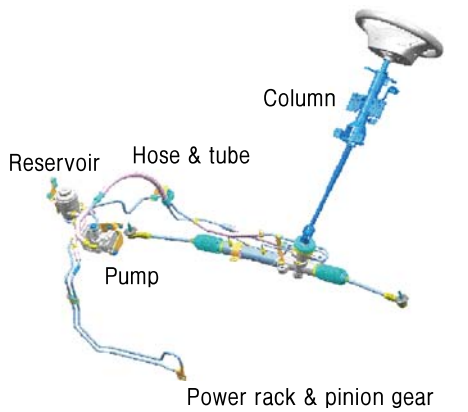
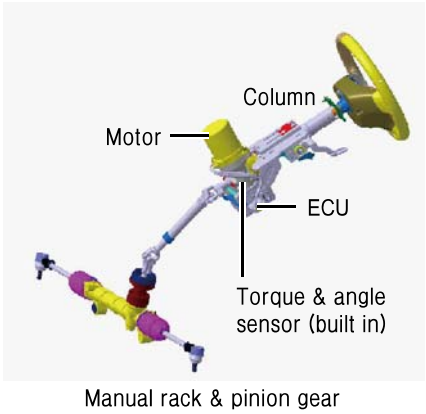
The electric power steering, EPS, does not have any belt-driven steering pump constantly running, so it is lightweight and the motor consumes energy only when the steering wheel is turned by the driver, and this leads to improvement in fuel efficiency. Also, the elimination of a belt-driven pump and its accessories greatly simplifies manufacturing and maintenance. While offering these benefits, as it does not contain any steering oil, the environment is not polluted both when the steering system is produced and discarded.
In other words, the electric power steering (EPS) system uses the electric motor to assist the steering force. It functions independently regardless of whether the engine is running or not, unlike the existing hydraulic power steering.
The EPS system generates an assist steering force variably depending on the driving conditions by controlling the motor's operation, based on the input signals from the sensors such as torque sensor and angle sensor. In turn, the EPS receives the torque signal by the driver's movements of the steering wheel, as well as the vehicle speed, and uses the motor to determine the assist torque. The EPS controls the motor for this. Another features of EPS are fail-safe function, diagnosis function, communication function between units and interface function for external diagnostic device.
The EPS system components such as the torque sensor, steering angle sensor, fail-safe relay, etc. are located in the steering column and EPS unit assembly.

▶ **Advantages:**

(1) Assurance of improved steering
- Provides optimal steering force according to the vehicle speed
- Enhanced steering stability while driving at high speed

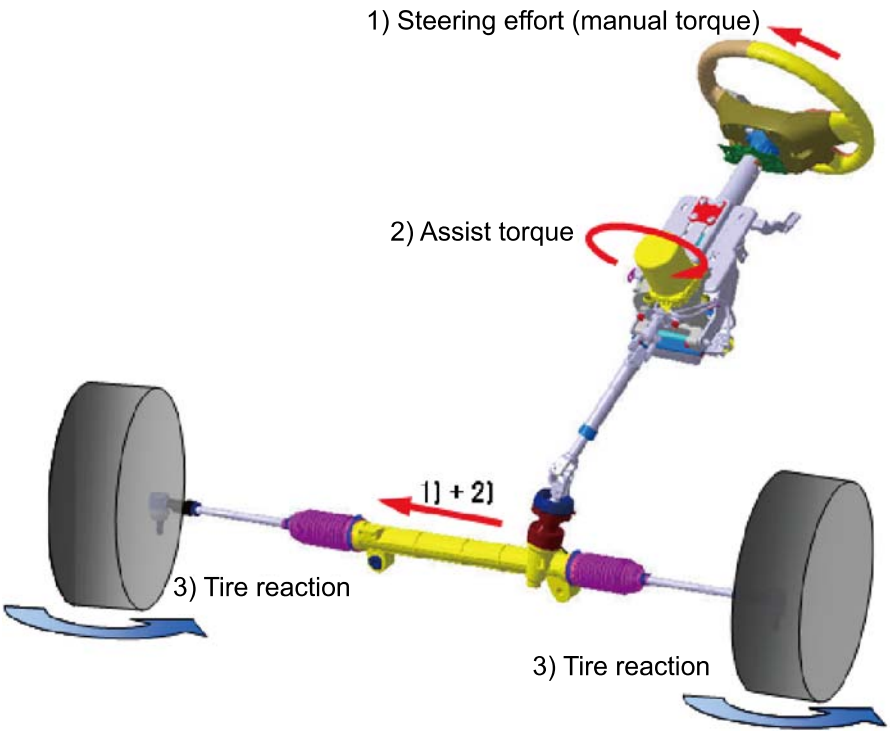
(2) Reduced fuel consumption
- Consumes energy only when steering wheel is turned (improved by 3 to 5%)
- Energy saving (reduced by 85% compared with hydraulic power steering)
- Reduced number of parts: Elimination of steering pump, hydraulic hose, pump pulley, oil reservoir, belt, bracket, etc.

▶ **Comparison between hydraulic power steering and electric power steering (EPS)**

Hydraulic power steering	Electric power steering
	

Modification basis	
Application basis	
Affected VIN	

2. OPERATION



Output torque = 1) Steering force (manual torque) + 2) Assist torque

When the driver turns the steering wheel, a torque is generated and the torque sensor and the steering angle sensor in the EPS system detect the rotation of the steering column to run the electric motor. At this time, the worm gear connected to the motor drives the helical gear mounted to the steering column to generate the assist torque for the steering column. This allows the driver to operate the steering wheel easier.

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification	Remark
Tire	16 inch	215 / 65R 16	Standard
	17 inch	225 / 60R 17	Optional
	18 inch	225 / 55R 18	Optional
Tire inflation pressure		32psi	-
Wheel	16 inch	6.5 J X 16	Standard
	17 inch	6.5 J X 17	Optional
	18 inch	6.5 J X 18	Optional
Balance weight		Inner: Clip-on type Outer: Adhesive type	- -
Tightening torquse of wheel bolt		127.4 ~ 156.8 Nm	17mm X 5 (Length:56.5 mm)

1) Appearance of Wheels

16 inch: 215/65R 16	17 inch: 225/60R 17	18 inch: 225/55R 18
		

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

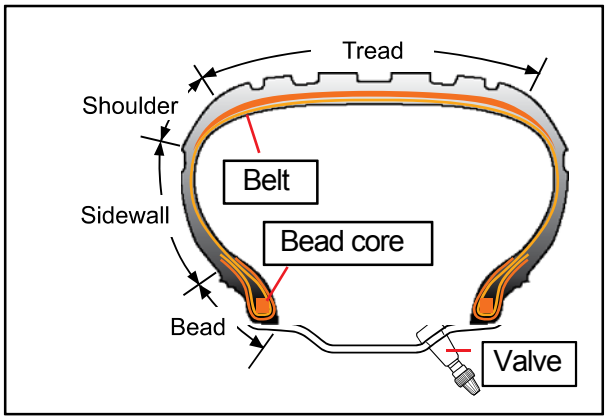
A radial tire uses a cord angle of 90 degrees. That is, the cord material runs in a radial or direct line from one bead to the other across the tread. In addition, a radial tire has a belt overwrap under the tread surface to provide greater structural stability. The belt overwrap of a radial tire distortion while the radial structure enables high speed driving.
Tire supports the weight of the vehicle, reduces the impact from the road and at the same time, transmits the power to propel, brake and steer on the road. It also functions to maintain a vehicle's movement. In order to complete such tasks, a tire must be structured to be a resilient vessel of air.
There is wear limit mark on the tire, which protrudes as a strip shape located approximately 1.6 mm from the groove bottom. This wear limit mark is not seen from the outside so there is additional "▲" mark on the shoulder to let the driver find the wear mark easily. To measure the tire groove depth, measure at any point other than the point which has a wear limit mark.
The tire is worn unevenly according to the driver's driving habit, improper servicing, low tire inflation pressure, changed tire location, etc.

1) Structure of Tire

Tread
This thick layer of rubber provides the interface between the tire and the road. Wear-resistant rubber is used to protect the carcass and belt against fractures and impacts and to deliver a long driving life.

Shoulder
Located between the tread and sidewall, the shoulder rubber is the thickest so that the design must allow for the easy diffusion of heat generated within the tire while driving.

Sidewall
The part between the shoulder and bead, the flexible sidewall protects the carcass and enhances the ride. A tire's type, size, structure, pattern, manufacturing company, product name and various characters are indicated here.

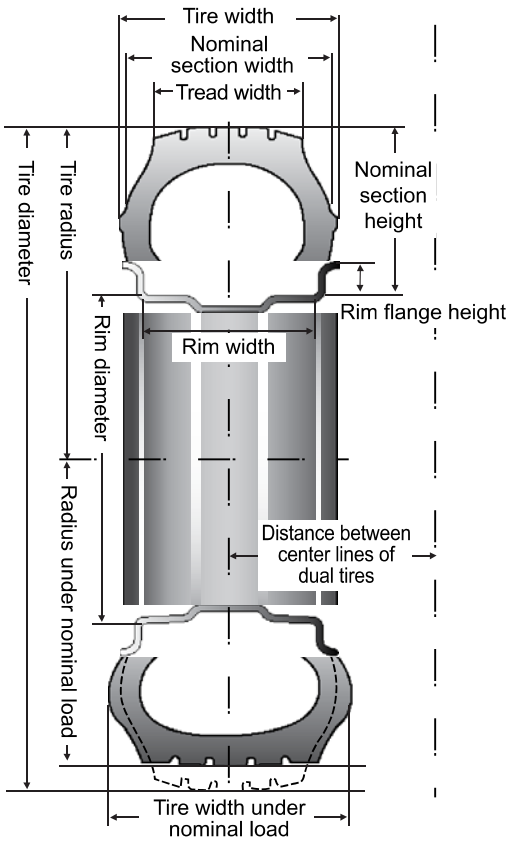


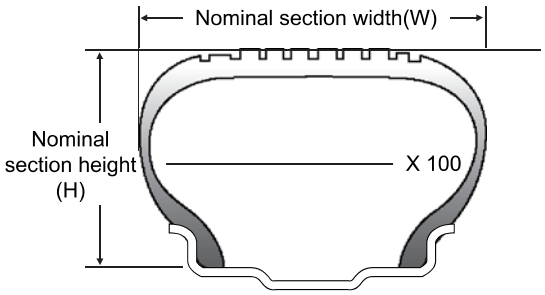
Bead
The bead attaches the tire to the rim and wraps the end of the cord fabric. Comprised of the bead wire, core, flipper and other parts, the bead is generally designed to be slightly tight around the rim so that in the case of a sudden drop in inflation pressure, the tire will not fall off the rim.

Carcass
As the most important framework of a tire, the entire inner layer of cord fabric is called the carcass. The carcass acts to support air pressure, vertical load and absorb shocks.

Modification basis	
Application basis	
Affected VIN	

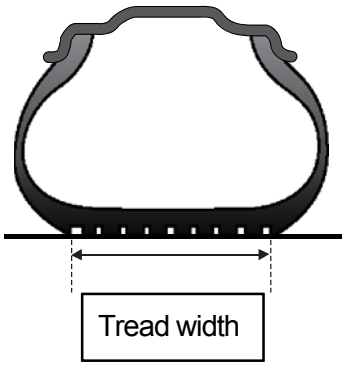
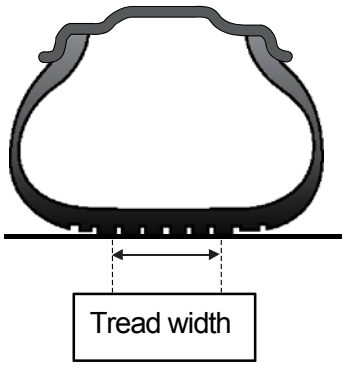
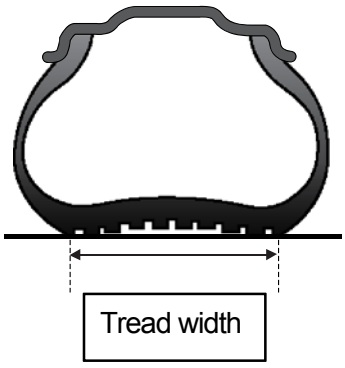
2) Tire Unit Indication





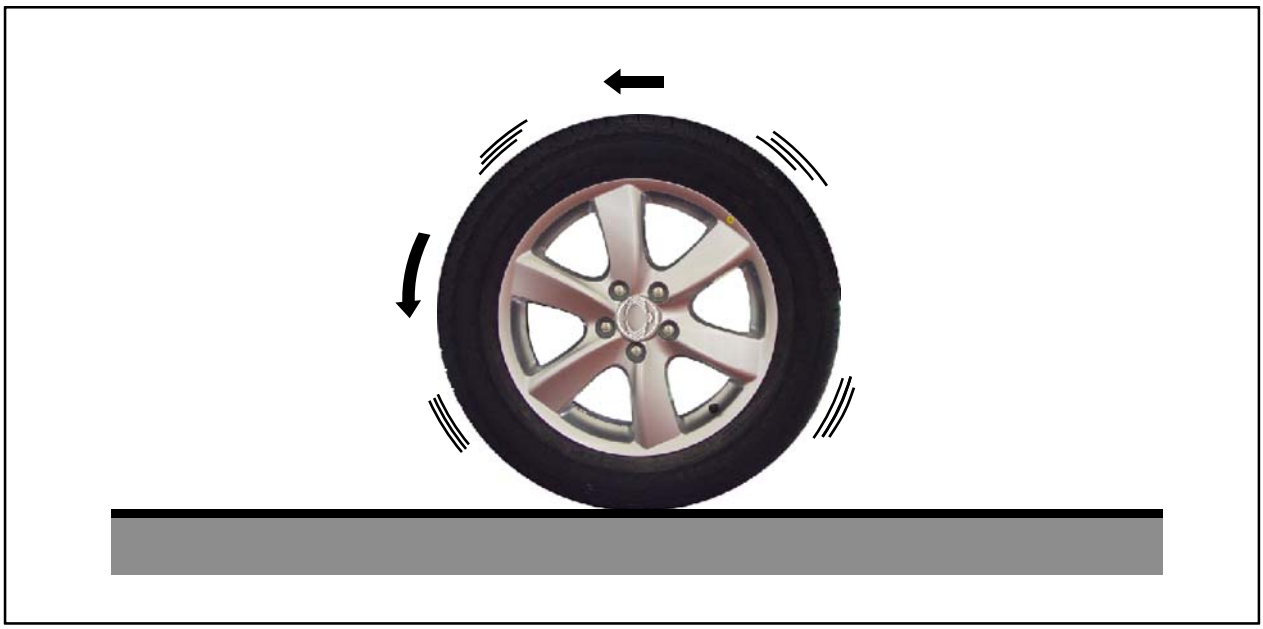
Aspect ratio (%)
= Nominal section height (H) / Nominal section width (W)
X 100

3) Tire Inflation Pressure (32 psi)

Proper inflation pressure	Excessive inflation pressure	Low inflation pressure
		
The contact area between the ground and tire faces the tread layer completely. Thus the driving force and the braking force are optimized, and the tire is worn out evenly resulting in increased life.	The contact area between the ground and tire is not enough, so the tire is worn out unevenly and the tire is vulnerability to outside influence.	The contact area between the ground and tire is excessive, so a lot of heat is generated and the tire is worn out unevenly and abnormally.

2. ABNORMAL TIRE SYMPTOM

1) Standing Wave

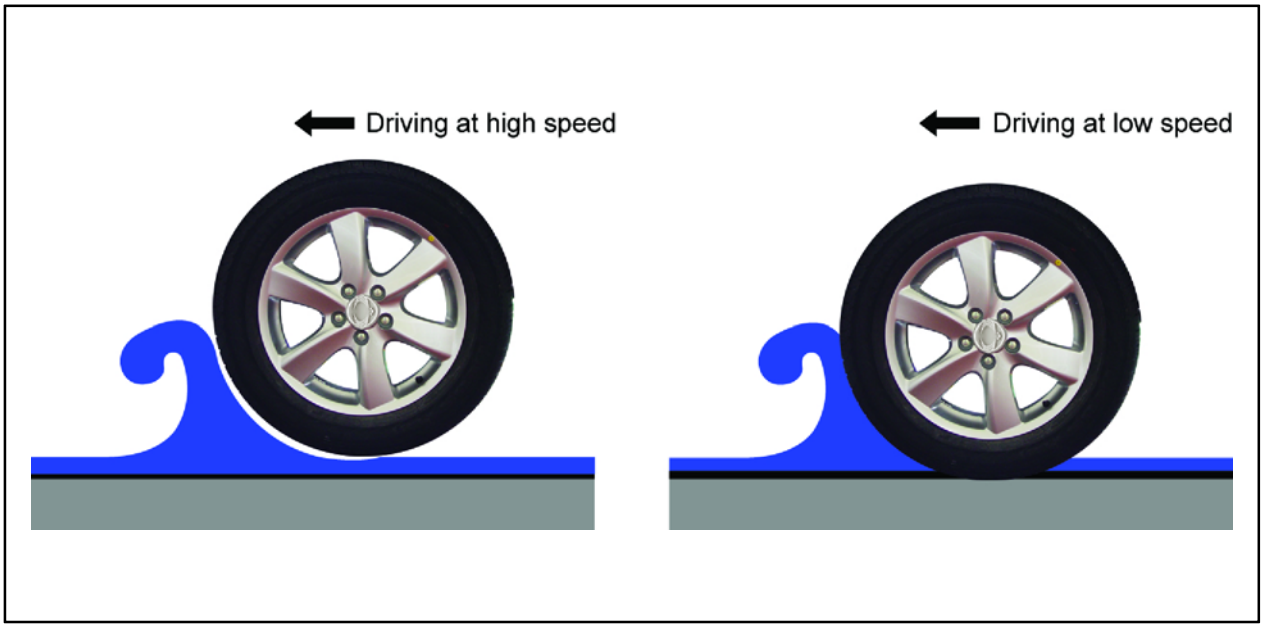


Specified tire inflation pressure	32psi

During driving, the rotating tire repeats deformation and restoring movement in is tread. This happens when the tire pressure is low in high speed driving.
However, when the wheel rotating speed is fast, the tire is deformed even before it is restored to its original shape and the trembling wave appears on the tread portion. If this symptom lasts for an extended period of time, the tire can be blown out in a short period of time.
If the standing wave symptom occurs on the tire, rubber on the tread comes off and eventually the tire can be blown out which is very dangerous. When driving at high speed, the inflation pressure should be increased to decrease heat generation due to extension and contraction motion, to decrease hydroplaning and to prevent standing wave.
To prevent this symptom, it is recommended to increase the tire pressure 10 ~ 30 % higher than the specified pressure value in high speed driving.

Modification basis	
Application basis	
Affected VIN	

2) Hydro Planing

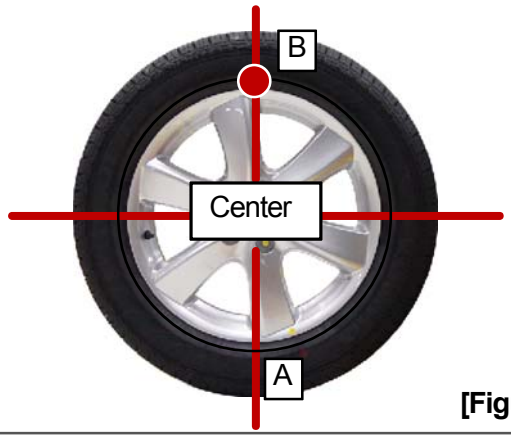


When the vehicle is driven on a road surface covered with water at high speed, tires do not contact with the road surface but rotate floating on a thin film of water.
It causes brake failure, lower traction force and losing the steering performance.
To prevent this, increase the tire inflation pressure, use tires with leaf shape tread which is not worn. However, it is a best measure to drive slowly.

3. WHEEL BALANCE

If weight is not equally distributed around the wheel, unbalance centrifugal force by the wheel rotation produces vibration. As the centrifugal force is produced proportional to the square of the rotating speed, the wheel weight should be balanced even at high speed. There are two types of the tire and wheel balancing: static and dynamic. Abnormal vibration may also occur due to unbalanced rigidity or size of tires.

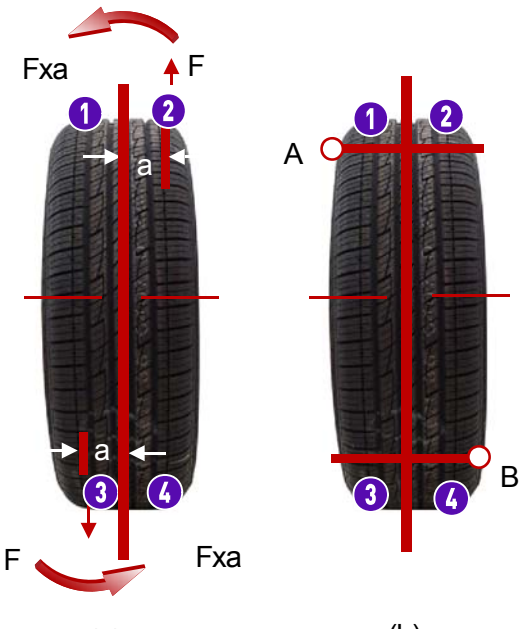
1) Static Balance



[Figure 1]

When the free rotation of the wheel is allowed, the heavier part is stopped on the bottom if the wheel weight is unbalanced and this is called "Static Unbalance". Also, the state at which tire's stop position is not same is called "Static Balance" when the wheel is rotated again. If the part A is heavier as shown in the figure 1, add the balance weight of a weight corresponding to unbalanced weight from B to A to maintain the static balance. If the static balance is not maintained, tramping, up and down vibration of the wheels, occurs.

2) Dynamic Balance



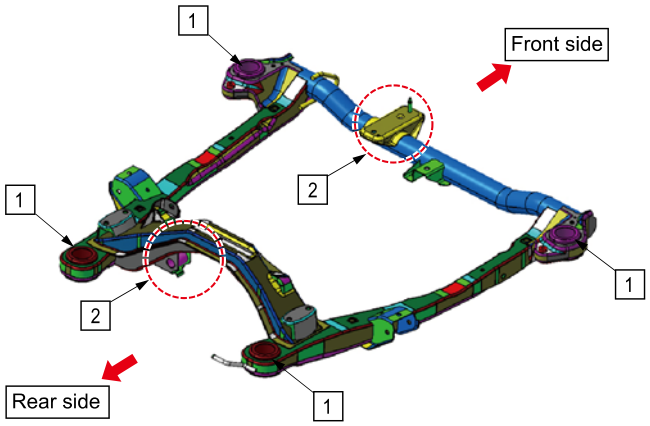
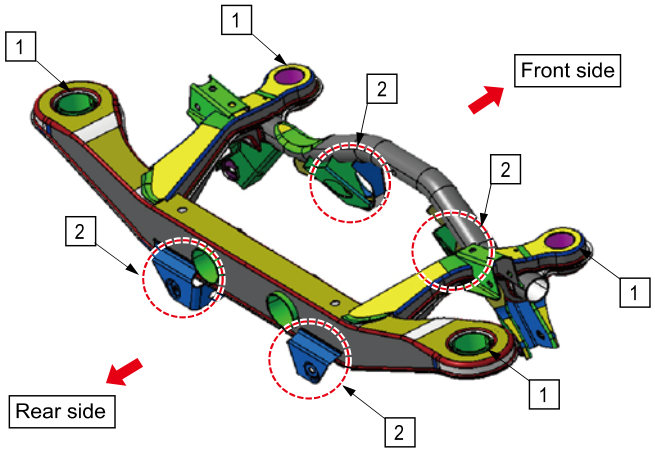
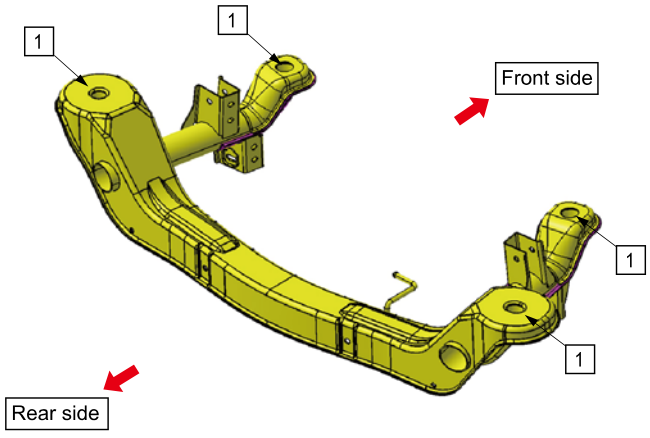
[Figure 2]

The static unbalance of the wheel creates the vibration in the vertical direction, but the dynamic unbalance creates the vibration in the lateral direction. As shown in the figure 2 (a), if two parts, (2) and (3), are heavier when the wheels are under the static balance condition, dynamic unbalance is created, resulting in shimmy, left and right vibration of the wheels, and the torque Fxa is applied in the axial direction. To correct the dynamic unbalance, add the balance weight of a same weight for two points of the circumference of the rim, A and B, as shown in the figure 2 (b), and apply the torque in the opposite direction to the torque Fxa to offset in order to ensure smooth rotation of the wheel.

Modification basis	
Application basis	
Affected VIN	

GENERAL INFORMATION

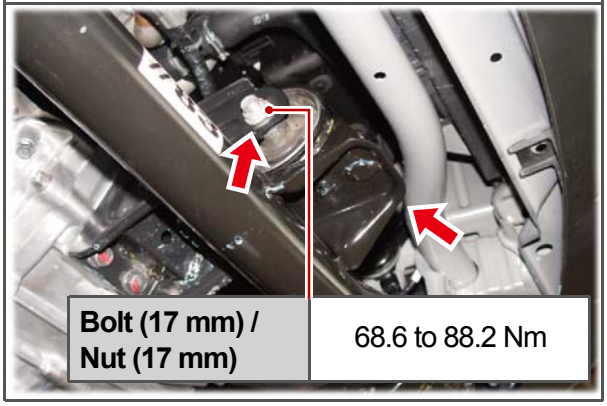
1. SPECIFICATION

Unit	Construction	
Front sub frame	1. Body mounting: 4-points bush 2. Transaxle mounting: 2-points bush 3. Weight: 22.37 kg	
Rear sub frame (4WD)	1. Body mounting: 4-points bush 2. Axle mounting: 4-points bush 3. Weight: 16.61 kg	
Rear sub frame (2WD)	1. Body mounting: 40 points direct mounting Spring link: 2. Direct mounting without bracket on rear cross member Weight: 12.74 kg 3.	

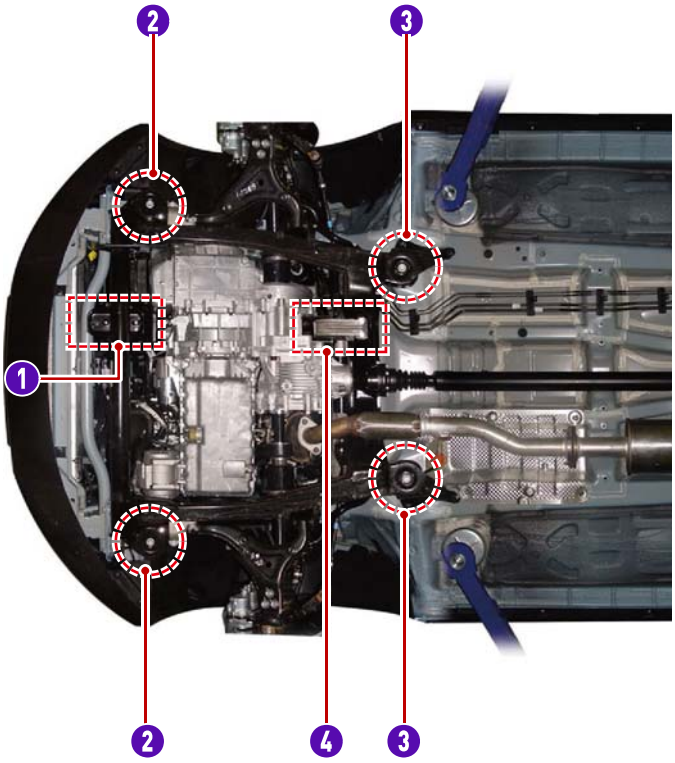
2. TIGHTENING TORQUE

▶ **Front sub frame - based on 4WD**

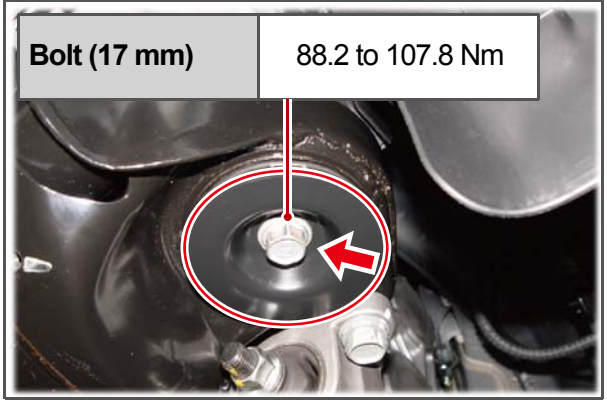
1. Transaxle mounting (Front)



Bolt (17 mm) / Nut (17 mm)	68.6 to 88.2 Nm



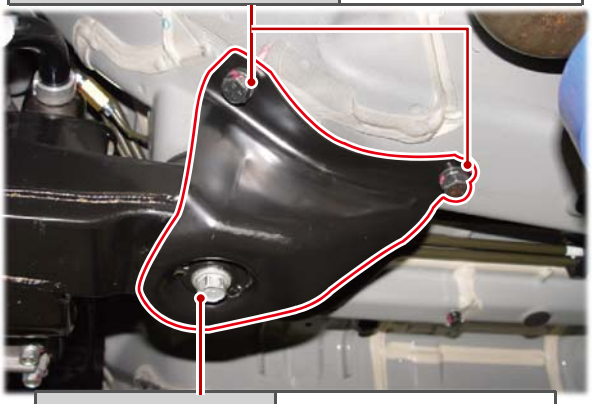
2. Front mounting (LH & RH)



Bolt (17 mm)	88.2 to 107.8 Nm

3. Rear mounting (LH & RH)

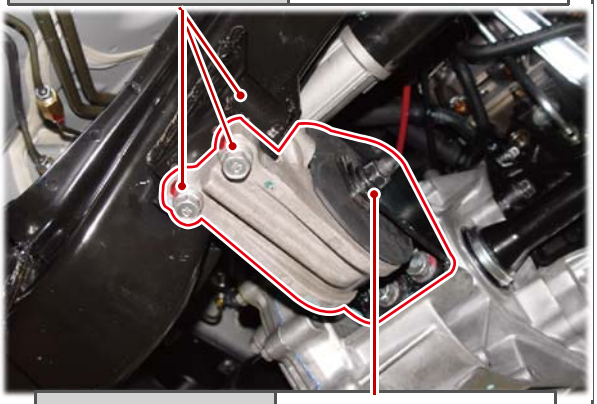
2 Bracket mounting bolts (17 mm)	88.2 to 107.8 Nm



Bolt (17 mm)	88.2 to 107.8 Nm

4. Transaxle mounting (Rear)

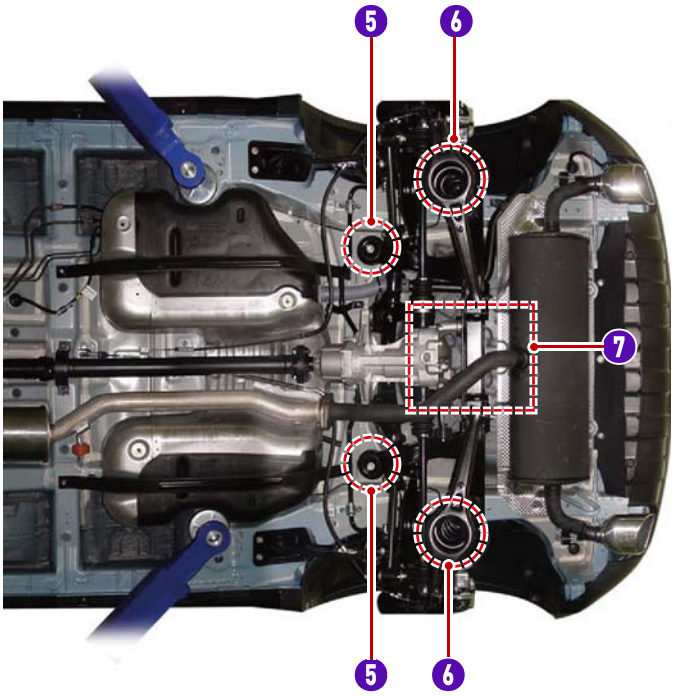
3 Bolts (14 mm)	29.4 to 49.0 Nm



Bolt (14 mm) / Nut (14 mm)	68.6 to 88.2 Nm

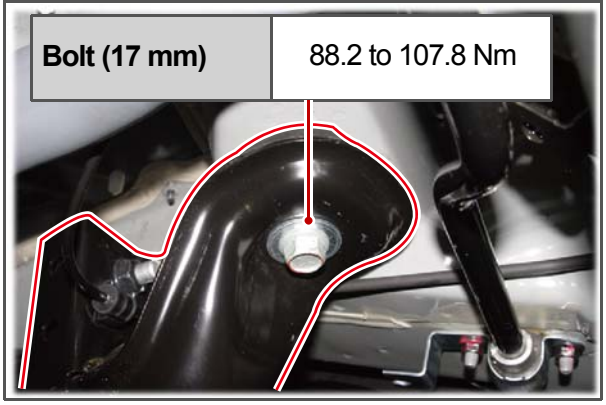
Modification basis	
Application basis	
Affected VIN	

▶ Rear sub frame - based on 4WD



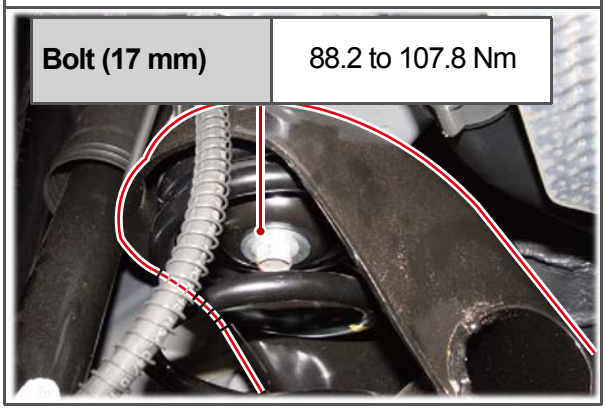
5. Front mounting (LH & RH)

Bolt (17 mm)	88.2 to 107.8 Nm



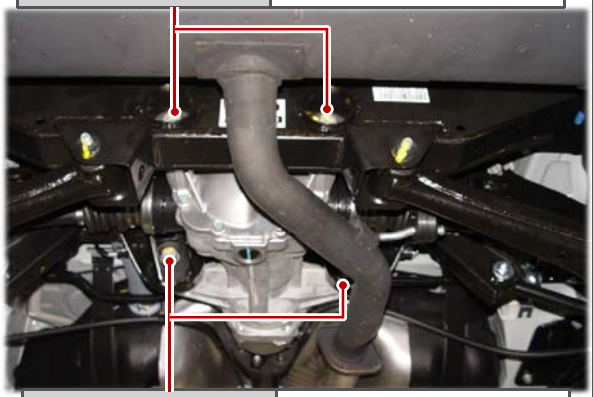
6. Rear mounting (LH & RH)

Bolt (17 mm)	88.2 to 107.8 Nm



7. Rear axle mounting

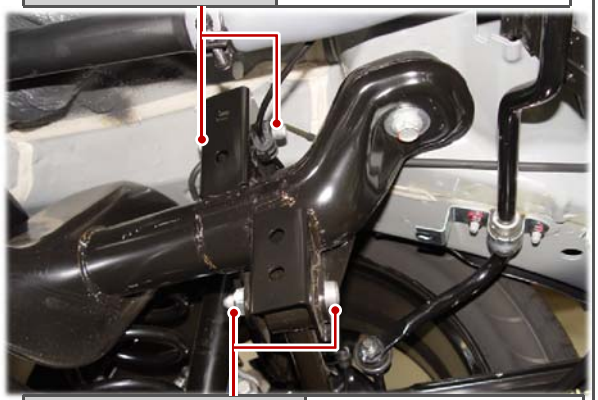
Rear mounting bolt (17 mm)	107.8 to 127.4 Nm



Rear mounting bolt (14 mm)	68.6 to 88.2 Nm

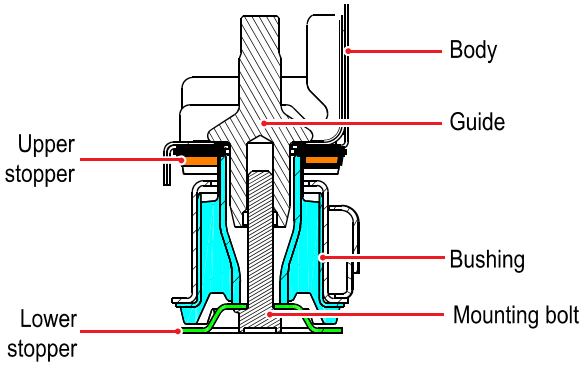
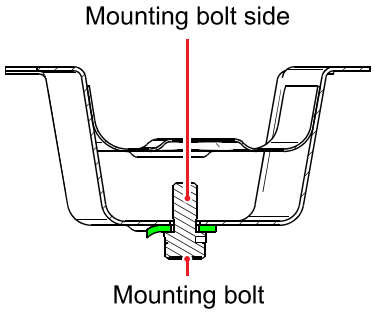
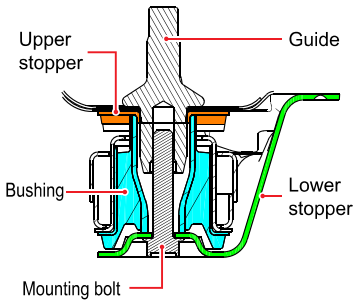
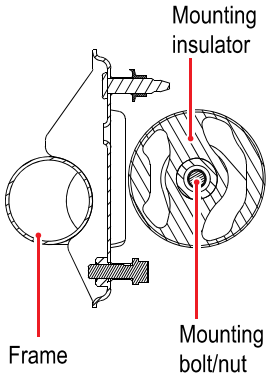
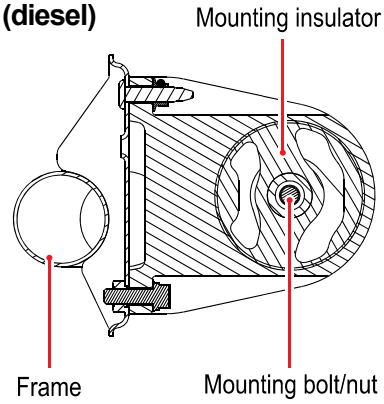
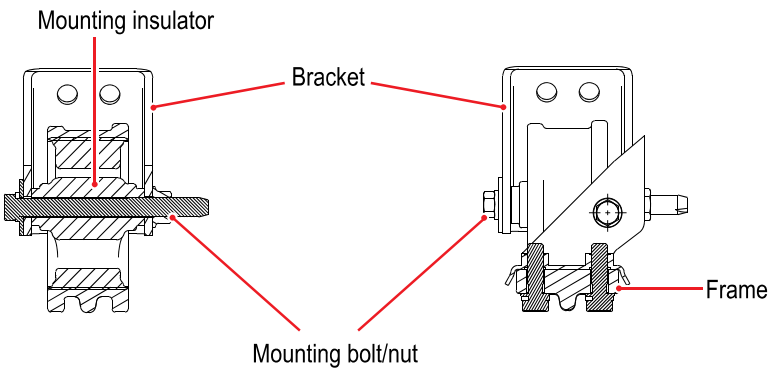
8. Other connections for rear sub frame (LH & RH)

Upper arm bolt (17 mm) / Nut (19 mm)	98.0 to 117.6 Nm



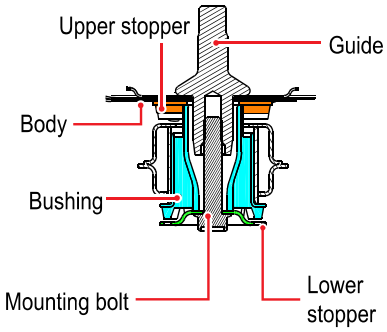
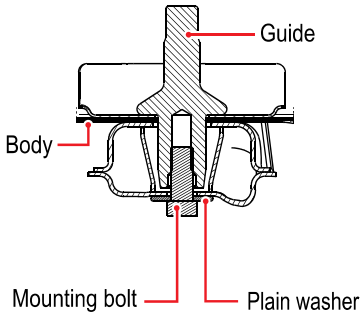
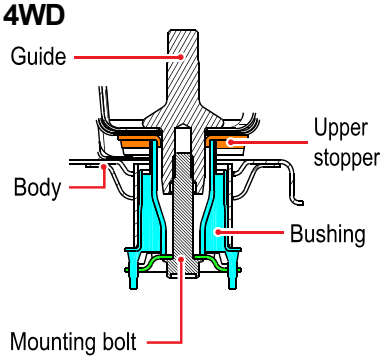
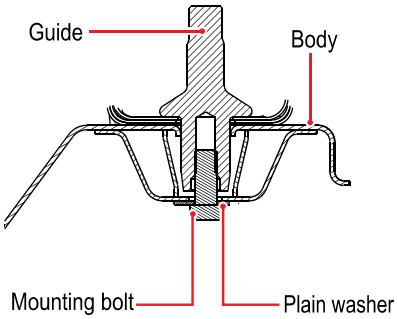
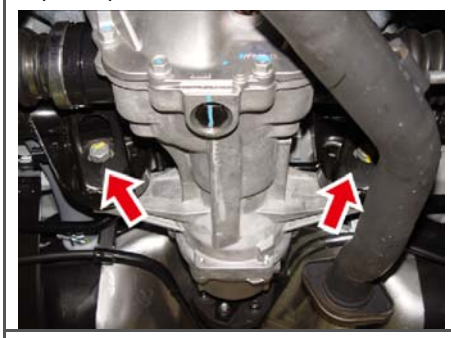
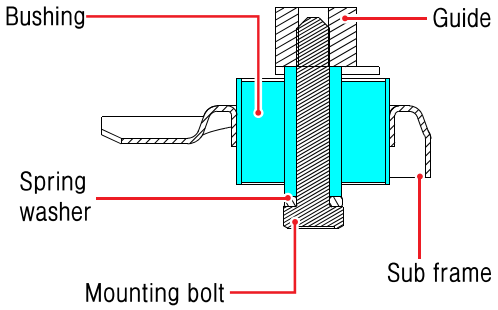
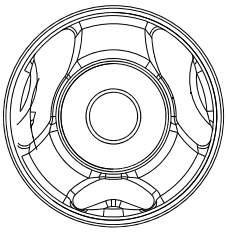
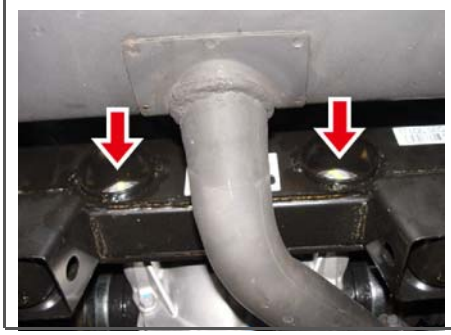
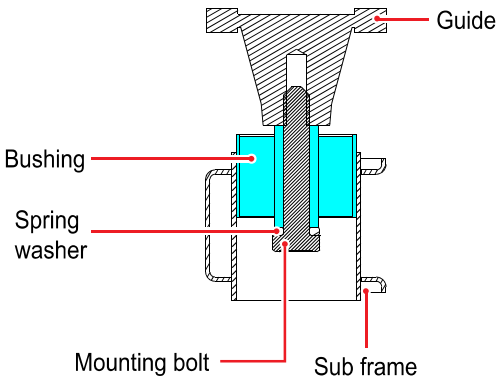
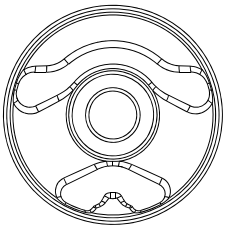
Lower arm nut/Bolt (19 mm)	98.0 to 117.6 Nm

1) Sectional Diagram and Bolts for Front Sub Frame

<table>
<tr><th>Installation</th><th>Sectional diagram</th></tr>
<tr><td>1. Front
  </td><td> 
</td></tr>
<tr><td rowspan="2">2. Rear
  </td><td>Mounting bracket
 
</td><td>Mounting bolt
 
</td></tr>
<tr><td colspan="2">3. Transaxle mounting (Front)
 
Mounting nut 29.4 to 39.2 Nm</td></tr>
<tr><td>For manual transaxle
 
</td><td>For automatic transaxle (diesel)
 
</td></tr>
<tr><td>4. Transaxle mounting (Rear)
 
Bolt 9.4 to 39.2 Nm</td><td colspan="2"> 
</td></tr>
</table>

Modification basis	
Application basis	
Affected VIN	

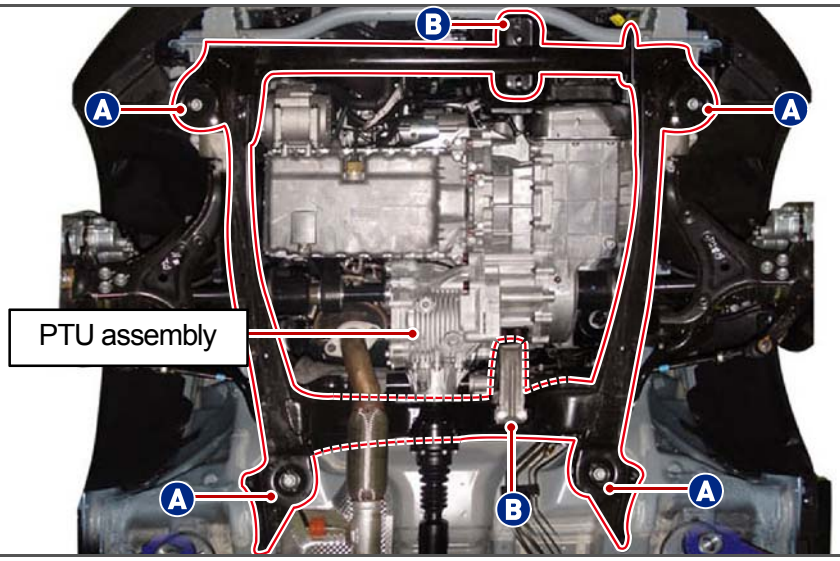
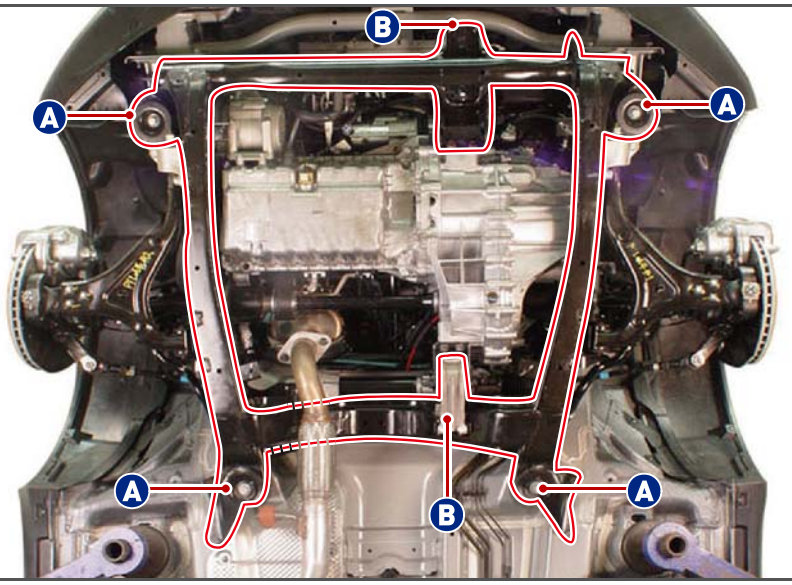
2) Sectional Diagram and Bolts for Rear Sub Frame

Installation	Sectional structure	
1. Front 	**4WD** 	**2WD** 
2. Rear 	**4WD** 	**2WD** 
3. Rear axle - Front (4WD) 		
4. Rear axle - rear (4WD) 		

OVERVIEW AND OPERATING PROCESS

S.G.N. 4012-01 OVERVIEW OF FRONT SUB FRAME

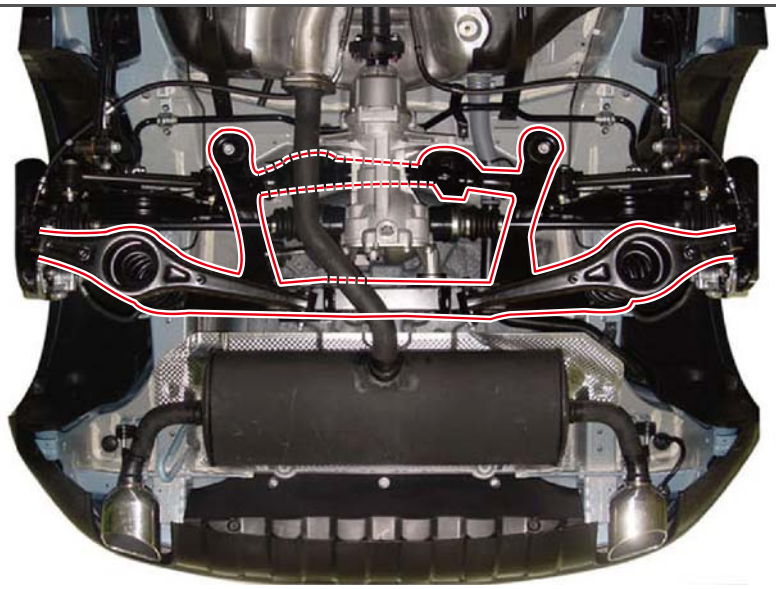
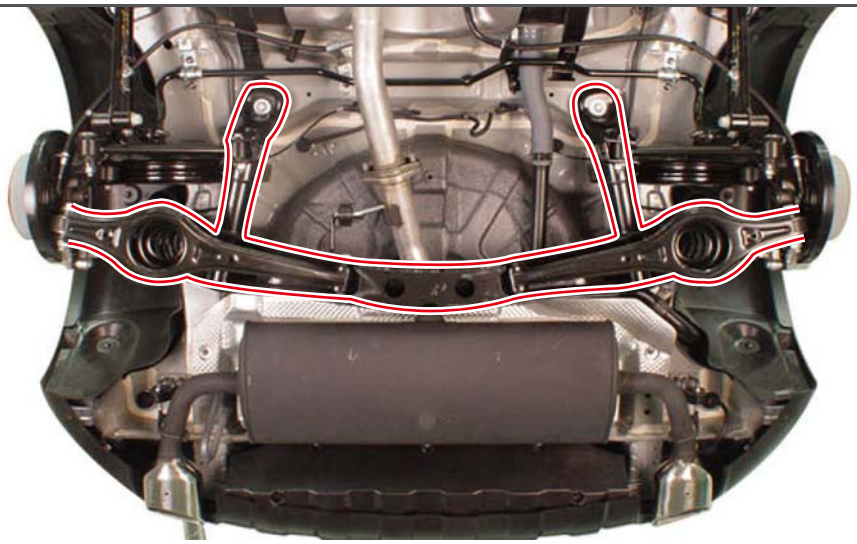
The front sub frame consists of 4 body bush mountings(A) and 2 engine bush mountings(B) which reduce the vibration from the powertrain and road, and also control the torque. And the two engine bush mountings consist of an engine mounting which supports the engine powertrain and a transmission mounting.
The engine side and transmission side mountings are rubber mountings with brackets and insulators while the body mounting is a rubber bush mounting which is fitted to the frame.

Installation of front sub frame (4WD)	The installation of the front sub frame is the same for both automatic transmission and manual transmission. For 4WD, the PTU and the propeller shaft are installed.
	
Installation of front sub frame (2WD)	The installation of the front sub frame is the same for both automatic transmission and manual transmission.
	

Modification basis	
Application basis	
Affected VIN	

S.G.N.
4015-01 OVERVIEW OF REAR SUB FRAME

The rear sub frame system consists of body bush mountings and direct mountings which reduce the vibration transmitted from the powertrain and road to the vehicle body.
For 4WD, it consists of 4 body mountings (bush mountings) and 2 axle mountings (bush mountings) and for 2WD, it consists of 4 body mountings (direct mountings).

Installation of rear sub frame (4WD)	The installation of the rear sub frame is the same for both automatic transmission and manual transmission. For 4WD, the E-coupling, propeller shaft and rear axle are installed.
	
Installation of rear sub frame (2WD)	The installation of the rear sub frame is the same for both automatic transmission and manual transmission.
	

AIR CONDITIONER SYSTEM

6810-00

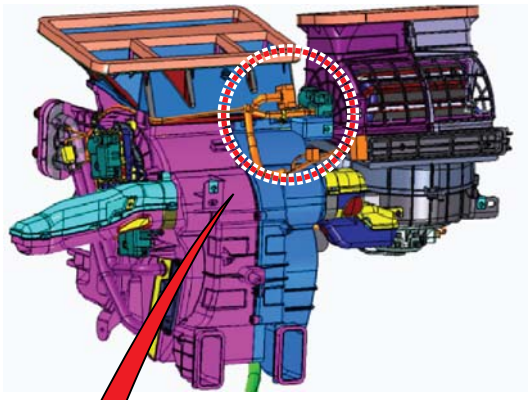
GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Heater	Core size (㎜)	200 x 165.5 x 25
	Capacity (kcal/h)	4,800
Evaporator	Core size (㎜)	254.8 x 196.75 x 60
	Capacity (kcal/h)	4,700
Blower	Supply power (W)	240 + 10% Max (at 12 V)
	Fan speed (rpm)	2900±200 Max (Rec.Mode: 420㎥/h)
PTC	Supply power	1 kW
Condenser	Core size (㎜)	588 x 455 x 16 (2,625)
	Capacity (kcal/h)	12,000
	Capacity of receiver drier	250 cc
compressor	Capacity	170 cc/rev
	Diameter of pulley	Ø120
	Max. continuous speed	8,000 rpm
	voltage	DC 12 V
	Power consumption	2.2 A

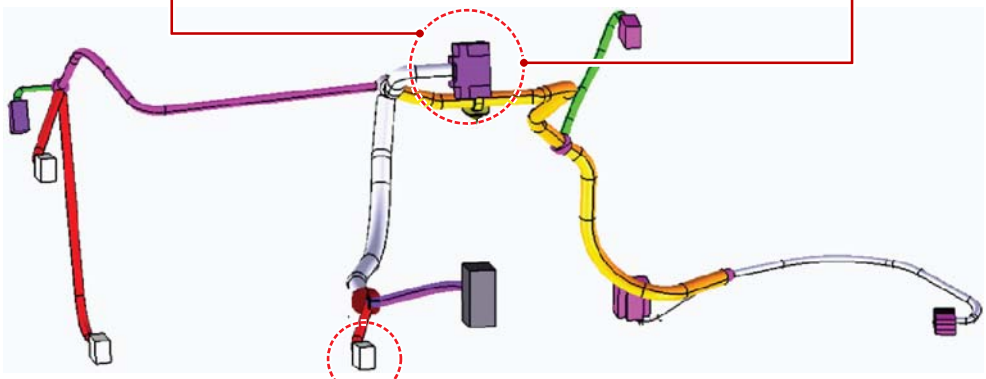
2. MAJOR CHANGES

1) Heater & Evaporator Module (Wiring Specification)



Ambient temperature sensor signal wiring added to vehicle wiring connecting connector (2 circuits)
: manual A/C

Blower max signal wiring added to vehicle wiring connecting connector (1 circuit)
: manual A/C & FATC

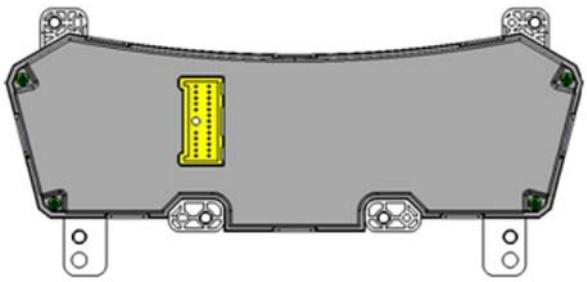
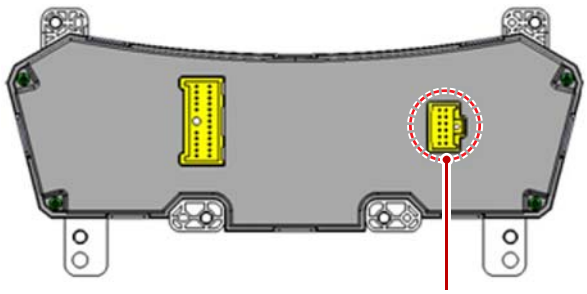


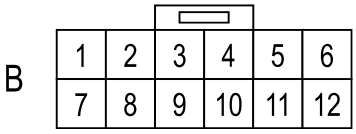
Manual A/C: Wiring pin added to controller assembly connector
FATC: Wiring pin added to existing connector of controller assembly

The driving circuit for the manual A/C ambient temperature sensor is added, giving the change to the heater and evaporator module.

Modification basis	
Application basis	
Affected VIN	

2) Manual A/C Controller

Manual air conditioner controller	
Previous	**Current**
	
The driving circuit for the ambient temperature sensor is added to the manual air conditioner controller for ambient temperature display on the instrument cluster.	

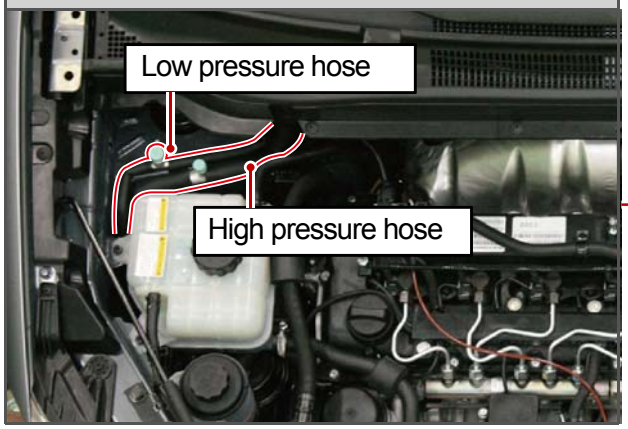


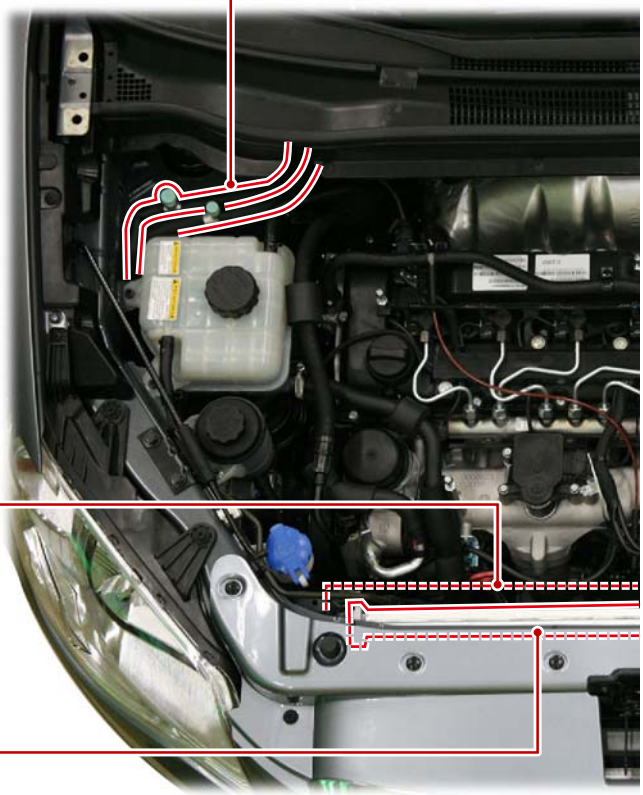
Pin No.	Function
B1	-
B2	-
B3	-
B4	Water temp. signal
B5	-
B6	-
B7	-
B8	-
B9	-
B10	Sun-load sensor signal
B11	Ambient temp. sensor signal
B12	-

OVERVIEW AND OPERATING PROCESS

1. SYSTEM LAYOUT

Line & port

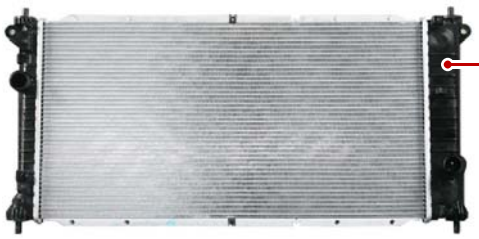




Electric fan



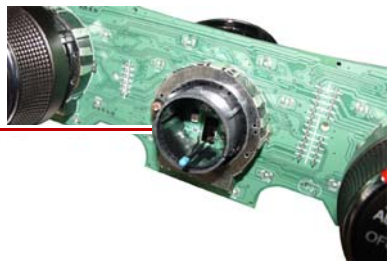
A/C condenser & receiver drier

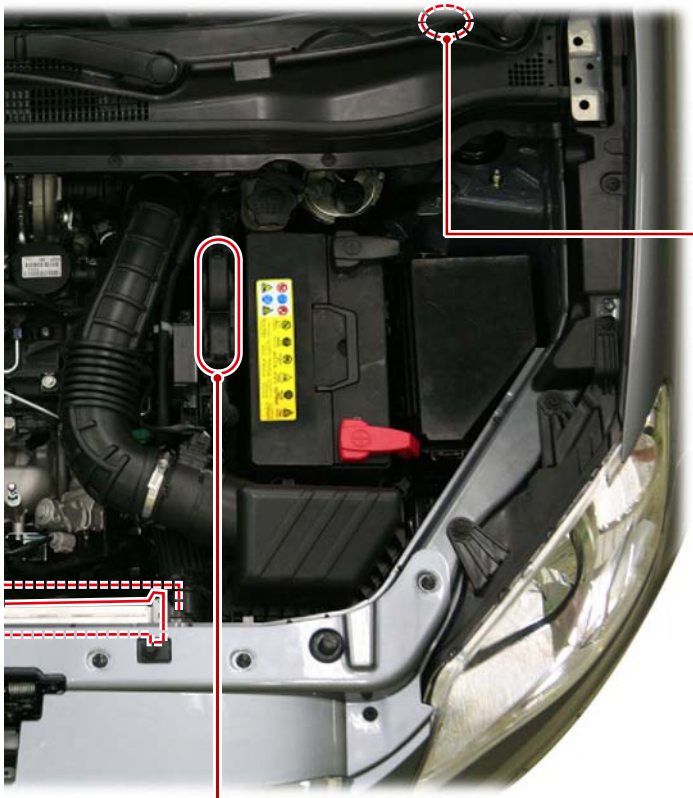


A/C compressor



Modification basis	
Application basis	
Affected VIN	

FATC	Incar sensor
	



Sun-load sensor



Refrigerant pressure sensor



Engine ECU

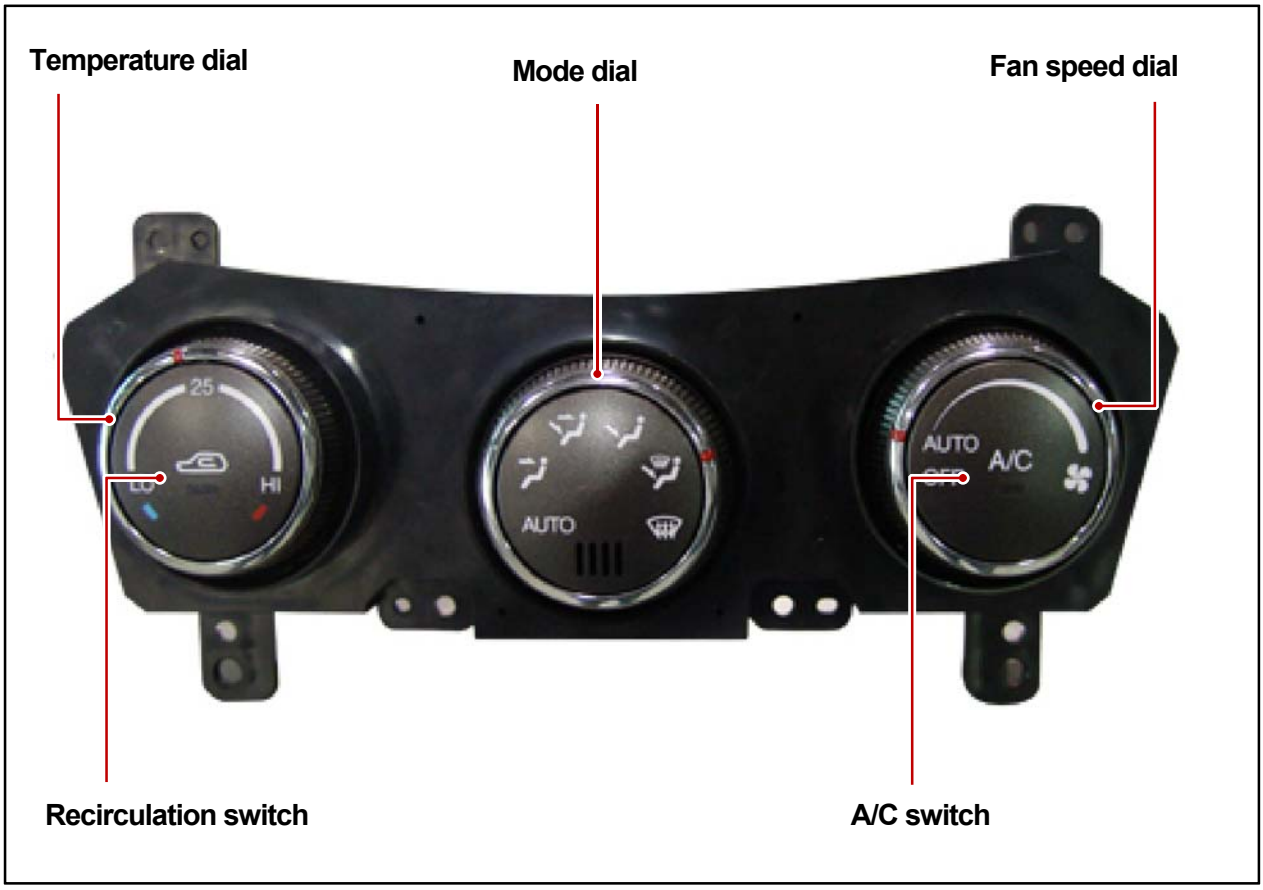


Ambient temperature sensor



2. HEATER AND A/C CONTROL

1) Full Automatic A/C Control



▶ Temperature dial

Temperature dial

- To adjust the temperature, turn this dial as required. Turning the dial to HI increases the temperature and LO decreases the temperature.



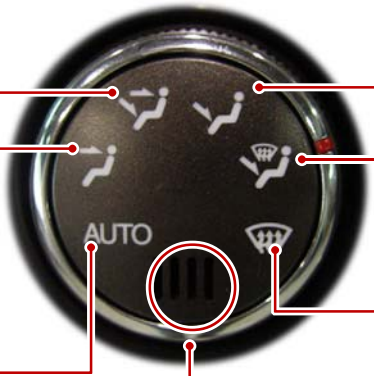
Recirculation switch

- When you press this switch, recirculation indicator comes on and the system is changed into the recirculation mode. (However, under defroster mode or defroster/floor mode, it stays in the fresh air mode.)

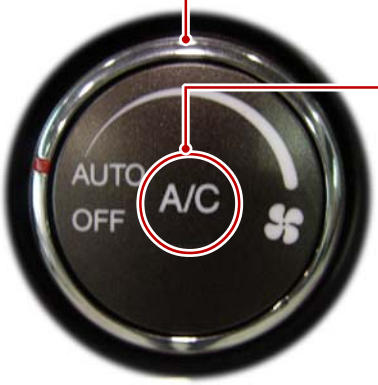
Modification basis	
Application basis	
Affected VIN	

▶ Mode dial

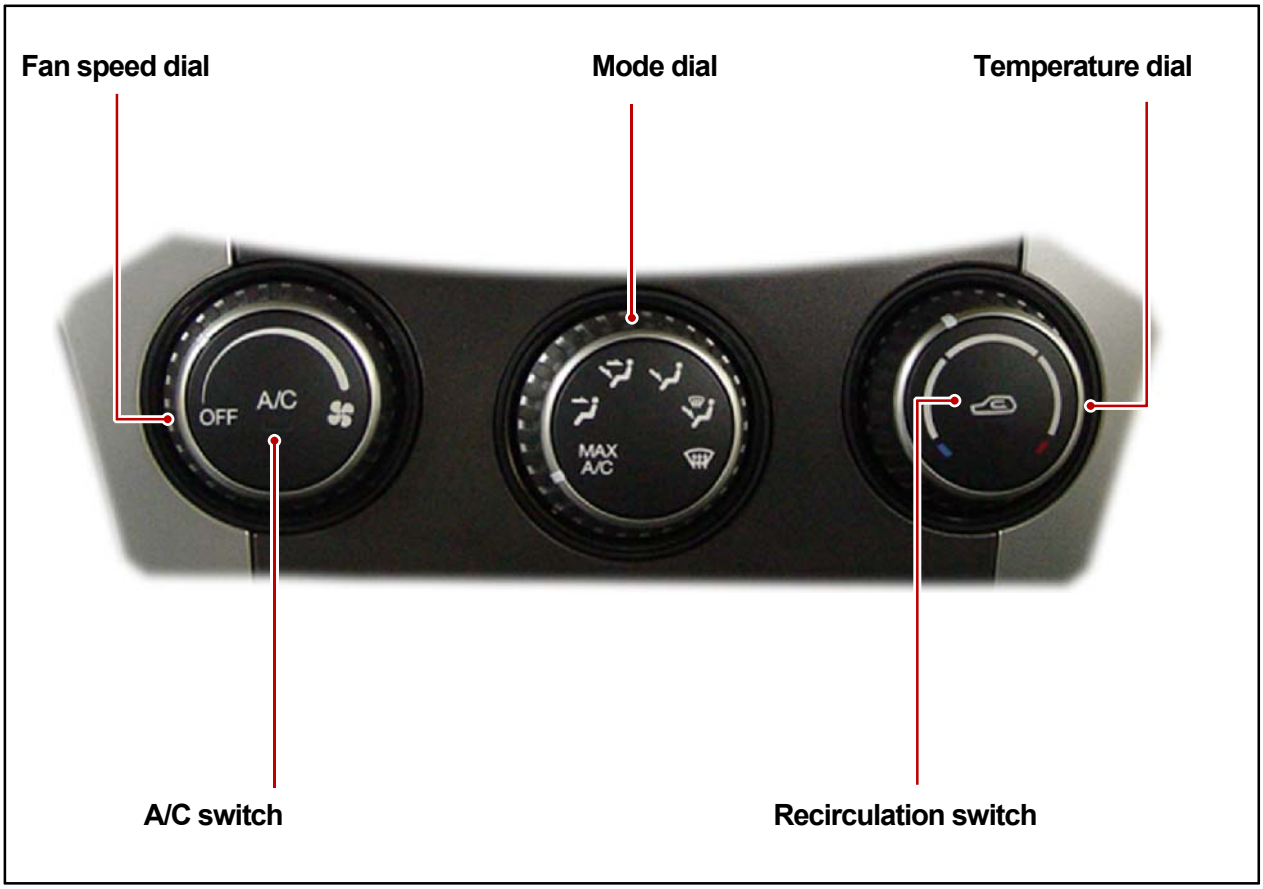
- The air flow direction can be controlled by turning the dial.



▶ Fan speed dial



2) Manual A/C Control



▶ **Fan speed dial**



Fan speed dial

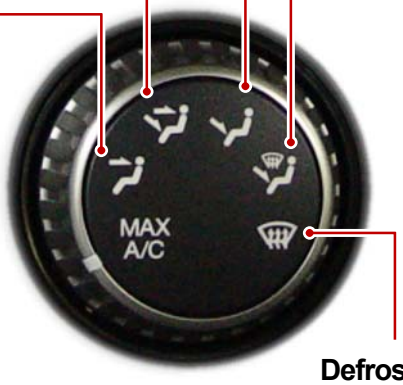
The fan speed can be adjusted by rotating the switch. To stop the operation, turn the dial to the "OFF" position.
The level is adjustable in 7 steps.

A/C switch

When pressing the switch with the engine running, the A/C compressor operates and the indicator comes on. Pressing the switch again deactivates the compressor and turns off the indicator.

Modification basis	
Application basis	
Affected VIN	

▶ Mode dial



Defrost mode

Use this switch to remove fog or ice from the windshield.
When pressing this switch, the airflow direction will be changed to windshield and door glasses, the A/C is operated automatically and the air source mode is set to fresh air mode.

▶ Temperature dial



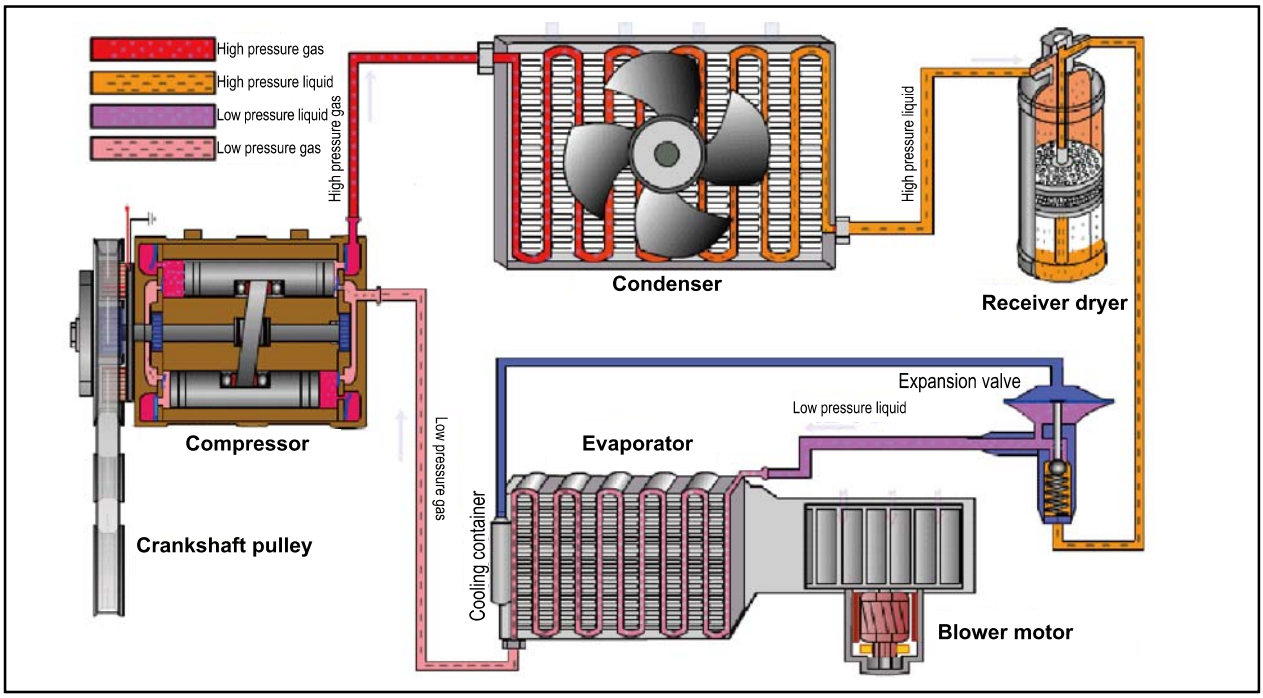
Temperature dial

Rotate this dial to adjust the temperature.
Turning this switch clockwise (red side) increases the temperature and counterclockwise (blue side) decreases the temperature.

Recirculation switch

When pressing this switch, the air is recirculated in the vehicle and the indicator on the switch comes on. When pressing it again, the indicator goes off and the fresh air comes in. When it's rainy or humid, set this switch to fresh air mode with the defroster mode selected to clear the fogged windshield.

3. A/C COOLING CYCLE



1) System flow

- "Compression -> Condensation -> Expansion -> Evaporation"

2) Functions

(1) Compressor

- Condition: Gas
- Function: Circulates the refrigerant and increases the pressure and temperature for easier evaporation.

(2) Condenser

- Condition: Gas/Liquid
- Function: Cools and condenses the refrigerant by using ambient air to liquefy it under high pressure.

(3) Receiver drier

- Condition: Gas/Liquid
- Function: Keeps the refrigerant free from moisture by separating/collecting the moisture from it.

(4) Expansion valve

- Condition: Liquid/Liquefied gas
- Function: Performs adiabatic expansion and flow control for easier evaporation.

(5) Evaporator

- Condition: Liquefied gas/Gas
- Function: Cools the air by absorbing the heat from the air around the evaporator.

Modification basis	
Application basis	
Affected VIN	

3) Description for Each Cycle

(1) Compression

- The evaporated refrigerant in the evaporator enters to the compressor. And the refrigerant gas is compressed until it can be liquefied at ambient temperature.
- Thus, the low refrigerant pressure is maintained so that the liquid refrigerant can be evaporated actively at low temperature (around 0℃).

(2) Condensation

- The high pressure and high temperature gas (refrigerant) from the compressor is cooled down by the fresh air entered into the condenser. Then, this gas is converted to liquid and collected in the receiver drier.
- The heat generated from the high pressure refrigerant is dissipated to the ambient air, and it is called "heat of condensation".
  The heat of condensation is the summation of the heat of vaporization (heat that the refrigerant absorbs from the inside of the vehicle) and the calorific value converted from the amount of work which is needed to compress.

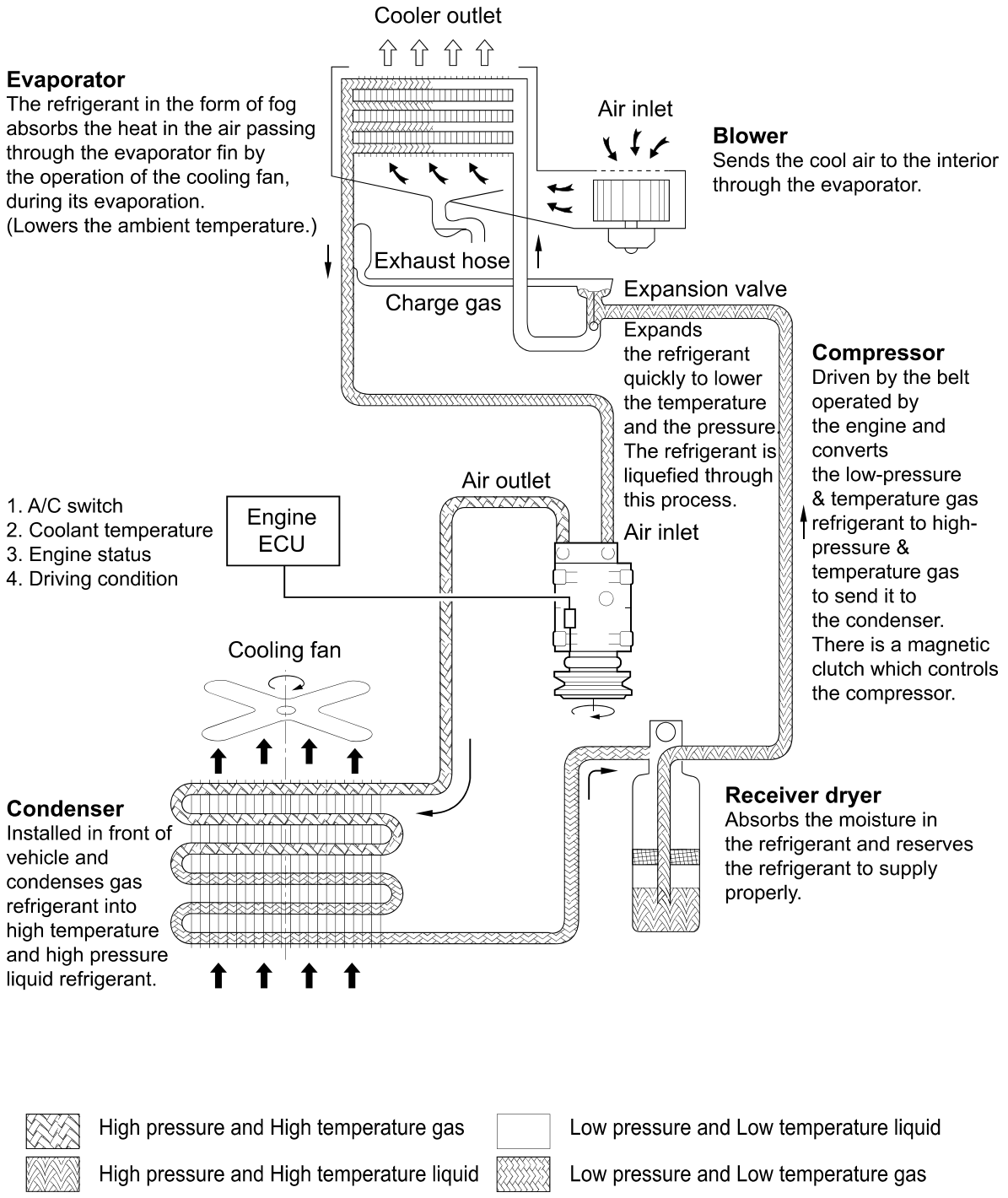
(3) Expansion

- The liquid refrigerant lowers the pressure making its evaporation easily accomplished.
- This process (lowering the pressure to the level at which evaporation easily takes place before the liquid refrigerant is sent to the evaporator) is called
  "Adiabatic Expansion".
- During adiabatic expansion, the expansion valve lowers the pressure of the refrigerant and determines the correct amount of refrigerant going into the air conditioning evaporator.
- That is, the amount of heat, which is needed to stop the evaporation, is determined according to the cooling load.
- The expansion valve detects this and regulates the amount of the refrigerant exactly.

(4) Evaporator

- The refrigerant is converted from liquid to gas in the evaporator.
  (The refrigerant in the form of fog in the evaporator is vaporized actively)
- At this time the refrigerant, in the form of liquid, absorbs the heat in the air which is need for evaporation (latent heat) and is cooled down. Then the blower blows the cooled air inside the vehicle to lower the temperature.
- There are liquid refrigerant from the expansion valve and evaporated refrigerant in the evaporator.
  The evaporation temperature can be predicted from the evaporation pressure (i.e. relationship
- between saturation pressure and saturation temperature).
  It is important to keep the pressure inside the evaporator low, so that the refrigerant is evaporated at
- low temperature to make sure the completely evaporated refrigerant is entered into the compressor.

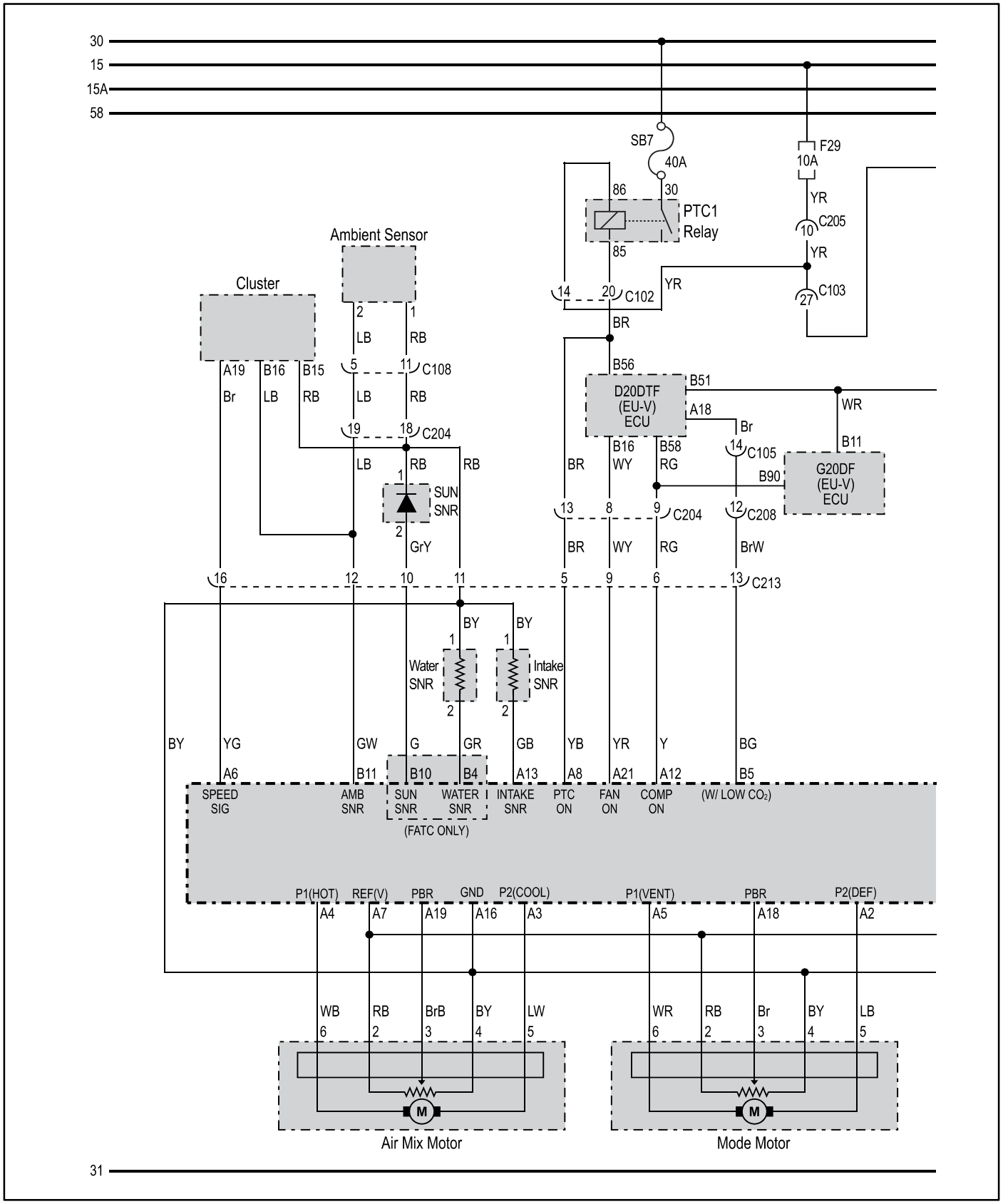
4. A/C COOLING CIRCUIT



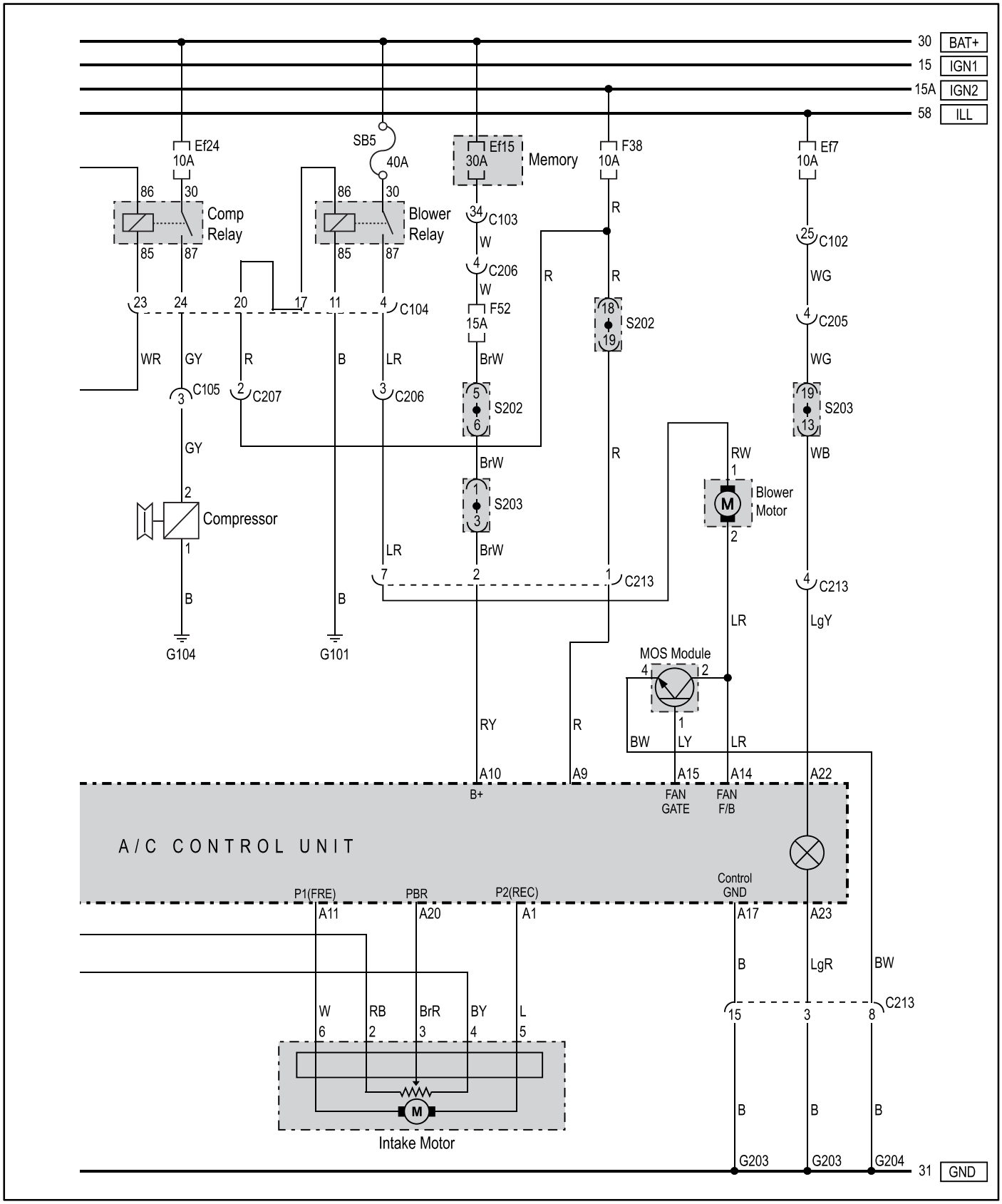
Modification basis	
Application basis	
Affected VIN	

Memo

5. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

Air bag

8810-00

GENERAL INFORMATION

1. SPECIFICATIONS

Operating voltage	9 to 16 V
System diagnosis and SDM self diagnosis voltage	9 to 16 V
Ignition voltage for side air bag and pretensioner	9 to 16 V
Communication voltage for front impact sensor	9 to 16 V
Communication voltage for side impact sensor	9 to 16 V
Operating temperature	−40℃ ~ 85℃
Storage temperature	−40℃ ~ 90℃
Ignition temperature	−30℃ ~ 85℃
Overvoltage protection	24 V

2. MAJOR REPLACEMENT PARTS AFTER AIR BAG DEPLOYMENT

A. In Case Of Front Air Bag Deployment

Air bag unit and its wirings (including connectors), seat belt pretensioner and its wirings (including connectors), all front air bags, instrument panel, front impact sensor and other damaged components

B. In Case Of Curtain Air Bag Deployment

Deployed curtain air bag, air bag unit and its wiring (including connector), impact G sensor assembly for curtain air bag, damaged trim, seat and roof headlining

3. OPERATING CONDITIONS

A. Front Air Bag System



▶ **The air bag deploys when:**

- A front collision occurs, which occupants cannot be protected by seat belt.

▶ **The air bag can deploy when:**

- Underbody impact from the road surface, impact against the curb at a very high speed, or dropping impact onto the road surface with a large angle occurs.

▶ **The air bag does not deploy when:**

- The vehicle rolls over or tips over sideward, or a side/rear collision occurs.
- the impact of the collision is low enough for the seat belt to protect the occupant properly.

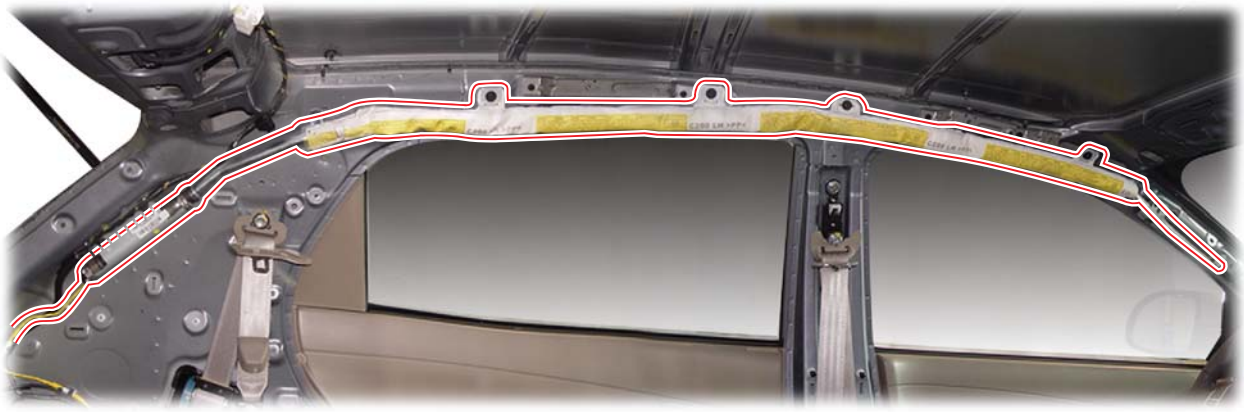
▶ **Seldom oeprate**

- A collision to diagonal direction (not a front collision) occurs or the vehicle tips over.
- A weak collision, which the sensor cannot detect, occurs (under the activation requirements). A collision against narrow objects such as a telegraph pole or a tree occurs.
- The vehicle falls into a drainage or a puddle.
- The front of the vehicle crashes into high impact point vehicle such as a truck.
- The hood is hit by falling stones.
- The air bag warning lamp is on.
-

Modification basis	
Application basis	
Affected VIN	

2) Side Air Bag System

▶ Curtain air bag



The curtain air bags are installed to the upper end of both doors. The air bags provide head protection for the front and rear outboard occupants in a side collision.

▶ Side air bag

Driver's	Passenger's
	

The curtain air bags are installed on the left side (driver side) and the right side (passenger side) of the front seat.

CAUTION

The front air bag system and the side air bags system function independently of each other according to the impact area and the severity of the impact.

▶ **The air bag deploys when:**

- a severe oblique collision occurs with a specific severity, angle, speed, and position.

▶ **The air bag can deploy when:**

- the vehicle rolls over or tips over sideward with a severe impact.
- The vehicle is stationary or a front collision occurs with low speed.
- A rear collision occurs.
- The impact of the collision is low enough for the seat belt to protect the occupant properly.

▶ **The air bag does not deploy when:**

- The vehicle is stationary or a front collision occurs with low speed.
- A rear collision occurs.
- The impact of the collision is low enough for the seat belt to protect the occupant properly.

▶ **Seldom oeprate**

- A collision with oblique impact to the front seat direction or a front collision to the diagonal direction occurs.
- a frontal or rear collision occurs.
- The vehicle rolls over or tips over sideward with minor impact.
- The air bag warning lamp is on.

C. General Warnings for Air Bag

- Do not check the circuits with a circuit tester. Do not attempt to modify any air bag component including the steering wheel, air bag mountings and related wirings.
- Do not subject any air bag component, such as the steering wheel, air bag mountings, wirings, to impacts. You might get severely injured by sudden deployment of the air bag.
- As the air bag/seat belt pretensioner parts are very hot after being deployed. Allow them to cool down sufficiently before touching them.
- The deployed air bag/seat belt pretensioner cannot deploy again. It will work when an additional impact is applied. The components of the deployed air bag/seat belt pretensioner are non-reusable parts. Therefore, remove or replace them as a unit.
- The air bag and seat belt pretensioner systems contain explosive charges, so handle carefully when disposing or replacing them.
- Incorrect inspection can result in serious injuries or malfunctions in the air bag and seat belt pretensioner system.
- The air bag warning lamp is illuminated for 3 to 7 sec. after the engine is started to check the system. Drive the vehicle after this warning lamp is turned off. If this warning lamp stays ON, the system may be defective. Have the air bag system checked immediately by Ssangyong Dealer or Ssangyong Authorized Service Center.

Modification basis	
Application basis	
Affected VIN	

- As the air bag system is very hot after being deployed, allow at least 30 minutes for the system to cool down sufficiently before touching it. It can cause serious burns.
- When an occupant fastens the seat belt in an unstable or inclined posture, the air bag system cannot protect the occupant properly. Moreover, the occupant can be injured by the air bag.
- Children and infants should ride in a rear seat. Seating in the passenger's seat with carrying a child or infant is strictly prohibited. An infant or a child could be severely injured by air bag deployed.
  A child restraint system must be placed in a rear seat.
- A child restraint system must not be placed in the passenger's seat. An infant or a child could be
- severely injured by the air bag deployment.
  Do not cover, place any object or affix any stickers on the air bag inflation location.
- Do not cover the front seat. The side air bag will not work properly.
- Never put your arms around the front seat from behind, lean on the front seatback, or put your arms
- out of the window. You can severely injured when the side air bag deploys.
  Never lean on the door since it becomes very dangerous when the side air bag deploys.
- Do not put any object such as an umbrella or bags between the door and side air bag mounting.
- The side air bag deploys when there is a severe side collision.
  Do not put any object such as an umbrella or bags between the door and side air bag mounting.
- Do not slam the front door to close it. The side air bag may deploy unexpectedly.
- Do not move your seat too close to the steering wheel or dashboard. Being too close to the steering wheel or instrument panel during the air bag deployment could cause serious injury, including death
- Move back as far as practical to allow the air bag room to inflate when driving.
- Do not incline toward the steering wheel or hold the steering wheel with your hands crossed. Never allow the front passenger to put hands or feet on the dash board. It can cause severe injures when the air bag inflates.
- Never put your feet on the dash board. You can severely injured when the air bag inflates.
- It is normal that a loud noise, dust and smoke occur when the air bag and seat belt pretensioner
- operate.
  A large quantity of non-toxic gas is generated when the air bag or seat belt pretensioner deploys. If
- these airborne particles irritate your skin, eyes, nose, or throat, rinse the area with cool water. If the irritation continues, see your doctor.
  The windshield glass may be broken when the passenger air bag deploys.
- The air bag is a unit to save an occupant's life from sudden accident and it inflates at a very fast speed by gas with high temperature, which might cause injury, such as an abrasion, bruise and burn depending on the accident conditions.
  A loud noise and non-toxic smoke-like particles are generated when air bags deploy.
-

4. CAUTIONS FOR AIR BAG OPERATION

When turning on the ignition switch, the air bag warning lamp is illuminated for about 6 sec. and then goes off.
If the air bag warning lamp comes on or does not go off while the vehicle is driven, the air bag system is faulty.

CAUTION

1. When there is any deployed air bag (including curtain air bag and seat belt pretensioner), the air bag unit should be replaced. Any DTC (Diagnostic Trouble Code) for the air bag unit should not be cleared since it has status data when the air bag deployed.
2. Note that the used components related to the air bag system, especially the air bag unit, should be packed in an air tight container to prevent any damage.
3. Do not connect a tester probe to the air bag connector or air bag body to measure the supply voltage or resistance. The detonator may explode due to a sudden extra power supplied by the tester.
4. Before removing or installing any air bag related components, disconnect the negative battery cable.

Modification basis	
Application basis	
Affected VIN	

Memo

OVERVIEW AND OPERATING PROCESS

1. SYSTEM CONFIGURATION

A Driver air bag module



B Passenger air bag module



C BCM





D SDM unit assembly



E Seat Belt Pretensioner



Modification basis	
Application basis	
Affected VIN	

F Height adjuster





G Front impact sensor assembly



Air bag warning lamp (IP)



I Inflatable curtain air bag module



J Side air bag sensor assembly



Modification basis	
Application basis	
Affected VIN	

2. OPERATING CONDITIONS

Once the ignition starts, the SDM starts to diagnose the air bag system during the ignition process.
If the system is OK, the SDM is armed for a specific impact on the vehicle. The ignition time takes about 6 sec.

1) Front Air Bag Operating Conditions When A Frontal Impact Occurs

Impact to	Front side
Driver air bag	IGN
Passenger air bag	IGN
Seat belt pretensioner - Driver side	IGN
Seat belt pretensioner - Passenger side	IGN

2) Side Air Bag Operating Conditions When A Side Impact Occurs

Impact to	Left direction	Right direction
Seat belt pretensioner - Driver side	IGN	IGN
Seat belt pretensioner - Passenger side	IGN	IGN
Side air bag module - Passenger side	IGN	Not ignite
Side air bag module - Passenger side	Not ignite	IGN
Inflatable curtain air bag module - Driver side	IGN	Not ignite
Inflatable curtain air bag module - Passenger side	Not ignite	IGN

3. DEPLOYMENT

1) Air Bag System Deployment (Firing Loop)

According to the collision deceleration rate that each collision G sensor reads, the air bag unit sends out about 2~4 or higher Amp current. This current generates some heat, which fires the detonator in the inflator.
The table shows the basic inner resistance of the air bag related module and the basic instant current necessary for firing.

Air bag module	Driver/passenger Air bag	Side air bag	Curtain air bag	Seat belt Pretensioner
Resistance at -30 to +85°C	2.0 ±0.3 Ω	2.0 ±0.3 Ω	2.0 ±0.3 Ω	2.15 ±0.35 Ω
Non-ignition current at +85°C	For 10 sec. 0.4 A	For 10 sec. 0.4 A	For 10 sec. 0.4 A	For 10 sec. 0.2 A
All-ignition current at -35°C	For 2 msec. 1.2 A	For 2 msec. 1.2 A	For 2 msec. 1.2 A	For 2 msec. 0.8 A
Periodic test current	Continuous 50 mA	Continuous 50 mA	Continuous 50 mA	Continuous 50 mA
Insulating resistance	For 2 sec. at DC 500 V 1 MΩ	For 2 sec. at DC 500 V 1 MΩ	For 2 sec. at DC 500 V 1 MΩ	At DC 500 V, 100 KΩ

CAUTION

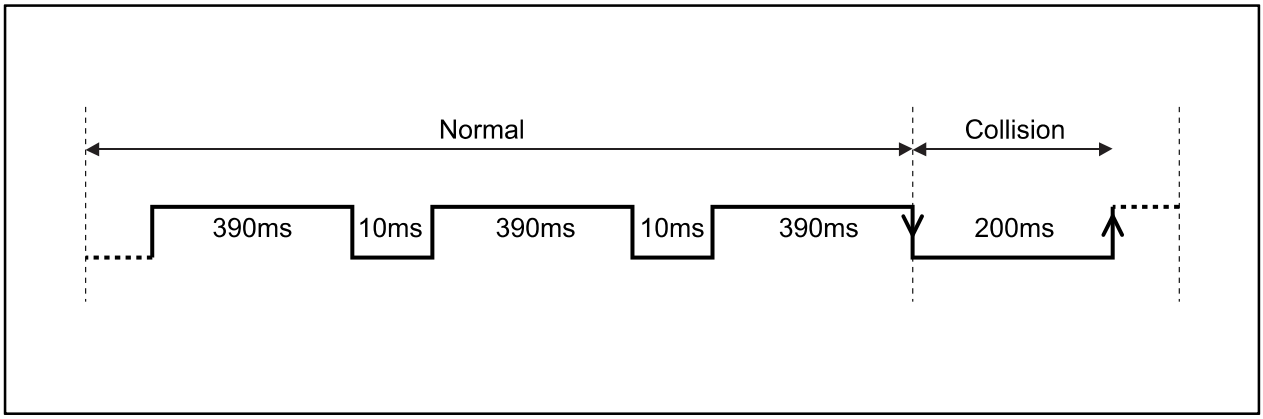
- Do not connect a tester probe to the air bag connector or air bag body to measure the supply voltage or resistance. The detonator may explode due to a sudden extra power supplied by the tester.
- Before removing or installing any air bag related components, disconnect the negative battery cable.

▶ **Resistance of air bag wiring**

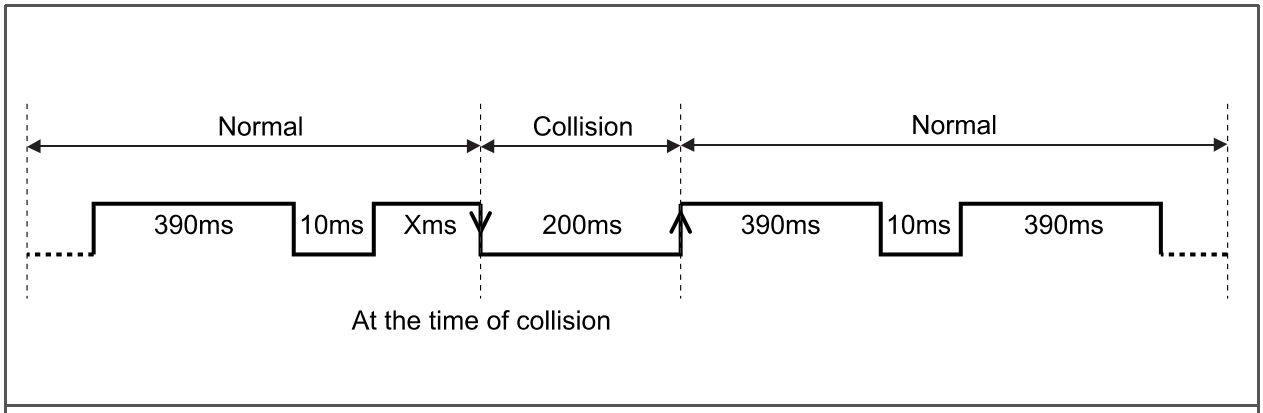
Pin No.	Driver side (or LH)	Passenger side (or RH)
Front air bag	0.0366 Ω	0.0530 Ω
Belt pretensioner	0.1477 Ω	0.1563 Ω
Side air bag	0.1074 Ω	0.1149 Ω
Curtain air bag	0.2210 Ω	0.2327 Ω

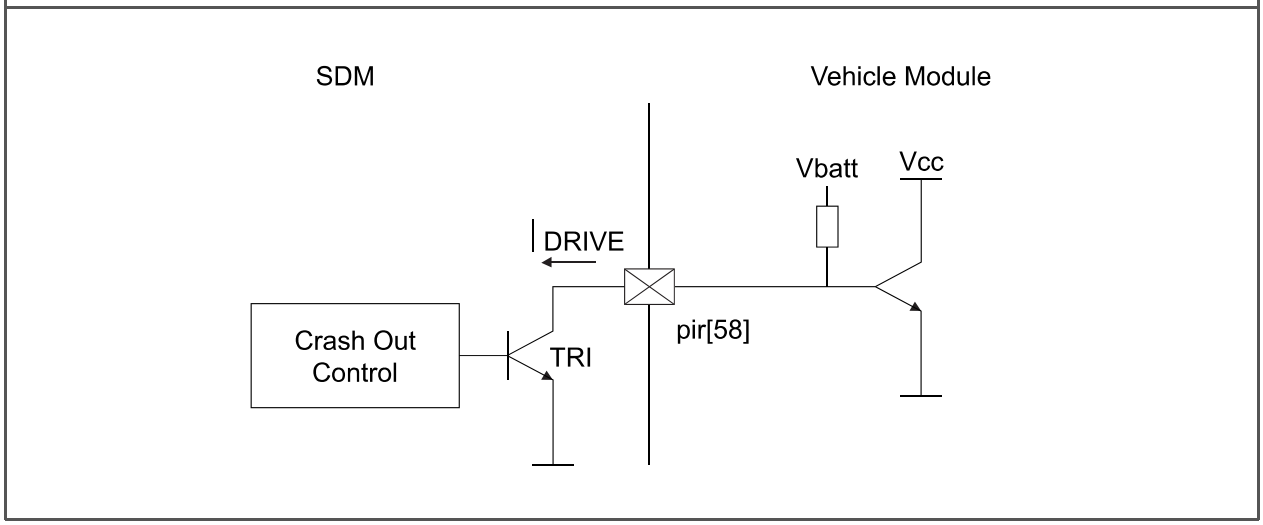
2) Air Bag Deployment Signal Output (Crash Out)

When a situation which requires air bag deployment occurs, they system outputs the air bag deployment signal (crash out). If another air bag-required situation occurs while the deployment signal is sent, the second crash out will be delayed until the current 200 ms crash out is completed. (The tolerance at the time of signaling is ±5%)



The signal repeats increasing for 390 msec. and decreasing for 10 msec. before crash. At the time of crash, the switch is closed and the signal is kept low condition for 200 msec.
At the time of crash, the crash out signal is changed to the low condition for 200 ms immediately to indicate the crash moment.





Modification basis	
Application basis	
Affected VIN	

▶ Collision signal interface

The open collector driver raises or lowers the voltage of the pin no. 58 by switching on and off the drive transistor. The vehicle module can be operated normally only by the logic of open collector interface and can be maintained in a pull-up state. The followings are the specifications of the electrical interface.

Pin No.	Minimum	Average	Maximum	Remark
Driving current (current value when the transistor is turned on)	12.31 mA	19.6 mA	30 mA	Depending on the battery voltage
Leakage current (current value when the transistor is turned off)	147.6 μA		376 μA	No crash signal
Load resistance	590 ohms			Above than this value

NOTE

The load resistance of the SDM is 590 ohms or higher. It may not be possible to operate the collision occurrence circuit normally if the resistance value is not as specified.

3) CAN Communication Interface (FIS and SIS)

The CAN communication interface uses the PWM for the supply current and the current loop and communicates with the SDM to transmit the information. The serial communication and power for the satellite are supplied through the communication line.

Stage	FIS	SIS
Initial stage	Tracking/Check (Self test)	Same as FIS
Normal operation	Checks the FIS condition and sends the result as "OK" or "NOK", and also sends the "severity" of the crash.	Same as FIS
Voltage	The FIS hardware reset was performed under 5 V, communication voltage low	Same as FIS
Fault	The fault is found in the current ignition cycle but the fault is deactivated in the next ignition cycle.	Multiple faults can be found and deactivated in the same ignition cycle.

The FIS moves to the initial stage if 'leakage to GND' is occurred in normal operating stage to shut down the power and prevent abnormal operation.

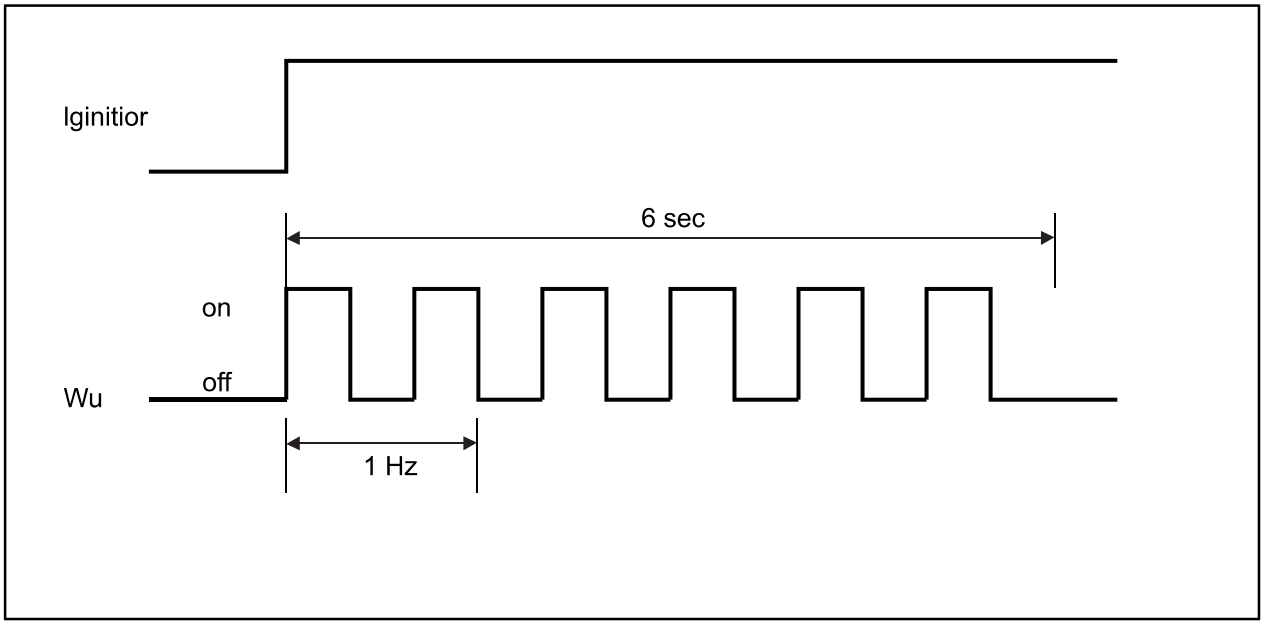
※ FIS: Front Impact Sensor
SIS: Side Air bag Sensor

Modification basis	
Application basis	
Affected VIN	

4. AIR BAG WARNING LAMP OPERATIONAL CONDITIONS

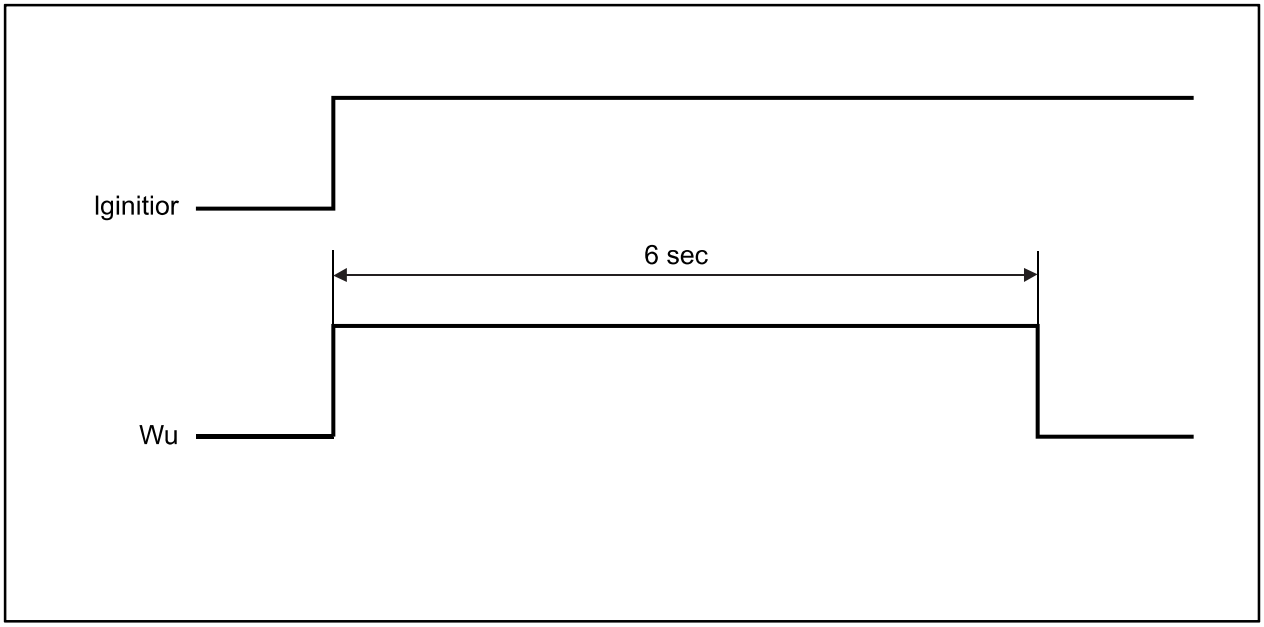
▶ When there are no active and past faults

The air bag warning lamp is operated as shown below if there is no fault occurred in the previous ignition cycle and the SDM is running without any active fault right after starting the ignition cycle.



▶ When there is no active fault and past faults occurred less than 10 times

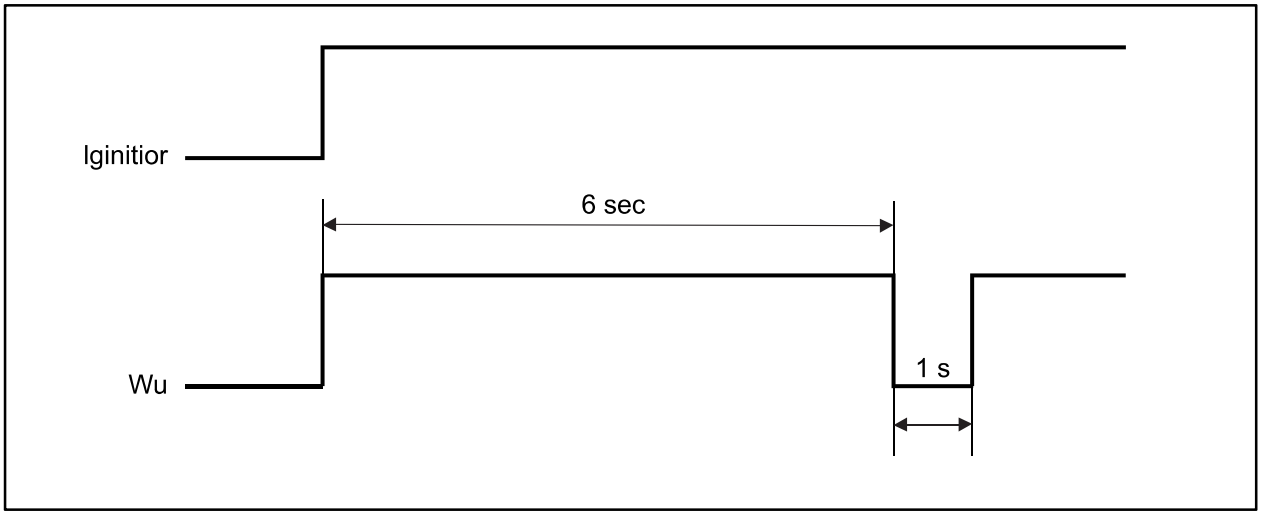
The warning lamp is operated as shown below every time the vehicle is started if the SDM is running without any active fault in the entire time and past faults in the previous ignition cycle occurred within 10 times.
"Battery voltage too low" is not included in the past faults.



▶ When there is any active fault or past faults occurred 10 times or more

If there is any active fault or past faults occurred 10 times or more in the last ignition cycle, the SDM operates the warning lamp as shown below. If below conditions are met, the SDM is operated in the same way.

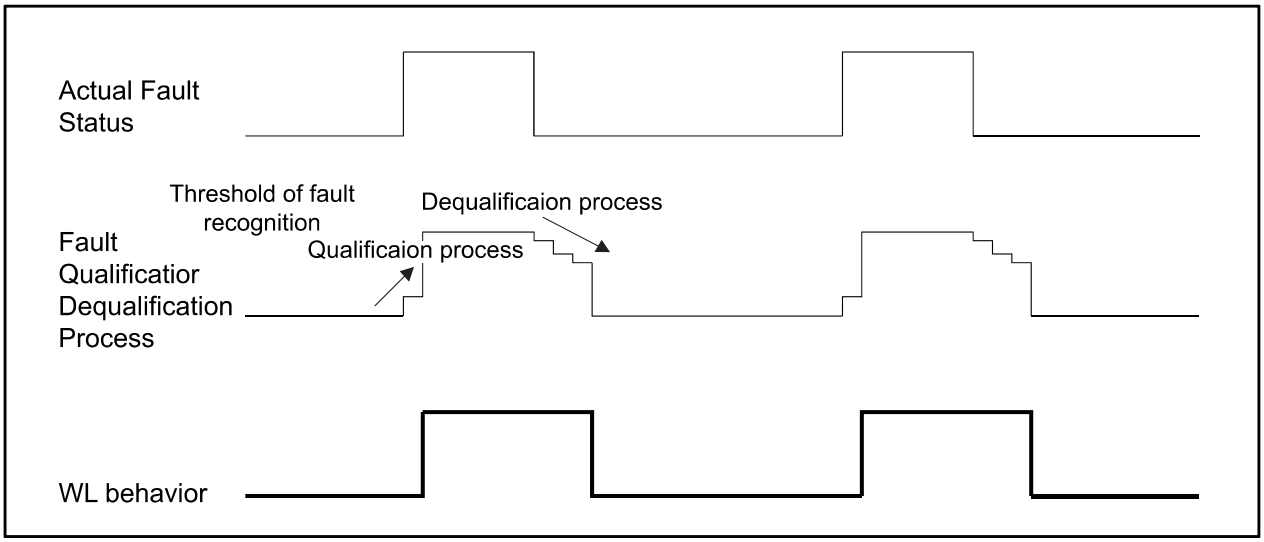
- Active fault
- When the past faults occurred 10 times or more (except 'battery voltage too low')
- Internal fault
- Impact record
- Pretensioner deployed only



If the connector is not connected properly or SDM battery voltage is out of the specified range internally (battery voltage for warning lamp), the warning lamp is kept ON.

▶ Warning lamp condition change during operation

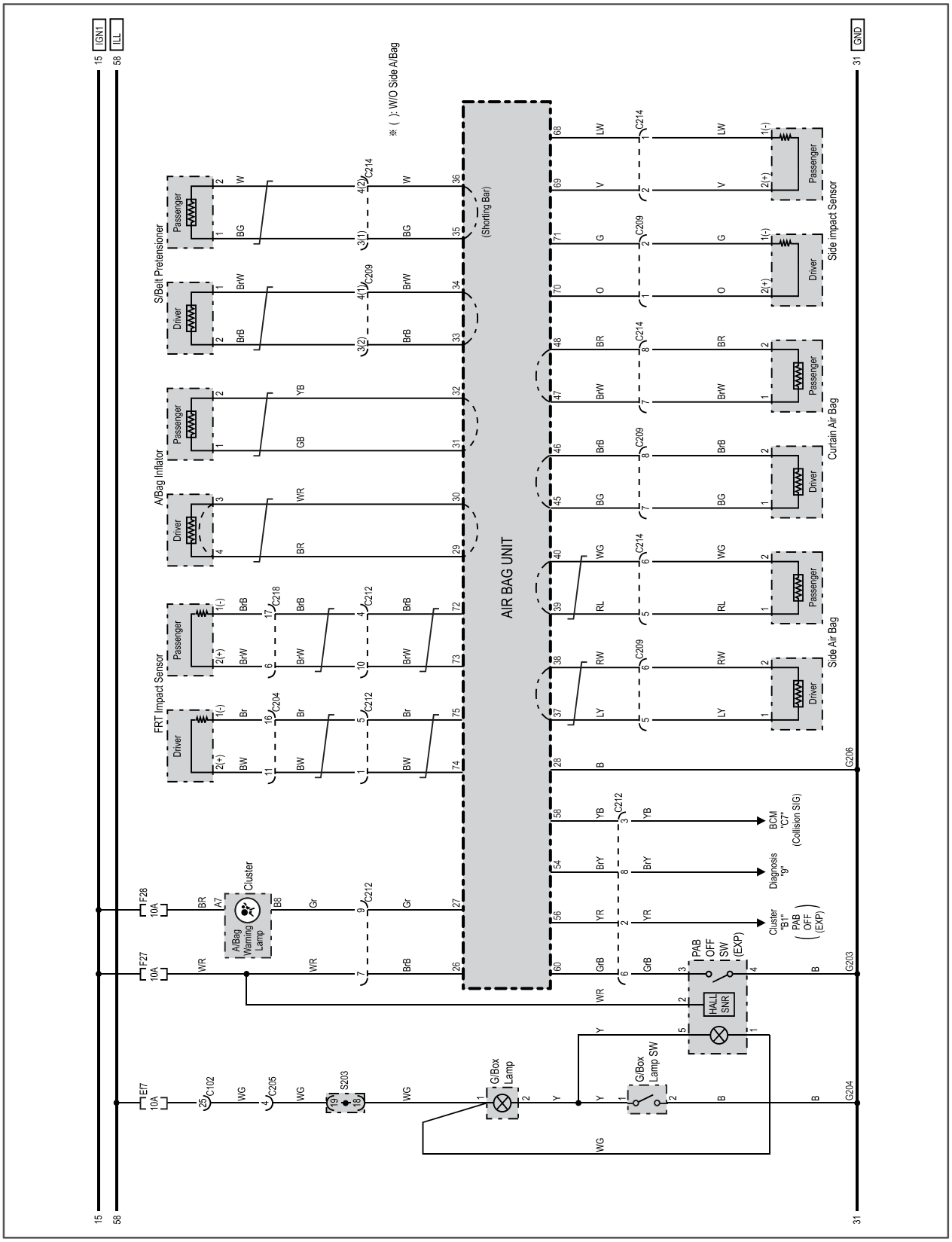
The warning lamp comes on or off according to the actual fault condition during SDM operation. If there is any active fault or active fault becomes past fault, the warning lamp is illuminated and if the fault is deactivated, the warning lamp goes off.



Modification basis	
Application basis	
Affected VIN	

5. CIRCUIT DIAGRAM

▶ 8810-01 Air bag (Curtain air bag/Side air bag)



SEAT 7410-00

GENERAL INFORMATION

1. SPECIFICATIONS

Pin No.			Front heated (driver seat)	Front heated (passenger seat)	Rear seats
Type		Manual	Manual 6 steps	Manual 4 steps	4:6 split
		Automatic	Power (Electric) 6 steps	-	-
Height adjuster		Manual	±25 mm (pumping type)	-	-
		Automatic	± 25 mm	-	-
Sliding			240 mm (190+50 mm)	240 mm (190+50 mm)	-
Reclining			66° (20+46°)	66° (20+46°)	17.5° (7+10.5°)
Lumbar support			2 steps (standard)	-	-
Seat warmer (cushion & seatback)			ON (high, low) OFF	ON (high, low) OFF	ON/OFF
Head restraint	Conventional	Up/Down	90 mm (15 mm x 6)	90 mm (15 mm x 6)	45 mm (15 mm x 3)
		Sliding	24 mm (8 mm x 3)	24 mm (8 mm x 3)	-
	Electronic active type		Optional (tilting, 15°)	Optional (tilting, 15°)	-
Seat belt			3-point type, ELR, PT, L/L	3-point type, ELR, PT, L/L	LH/RH & Center: 3-point type, ELR
Seatback pocket			Net type/Leather	Net type/Leather	-

- Fabric seat: Net type seatback pocket
- Leather seat: Leather band type seatback pocket

2. WARNINGS FOR POWER SEAT

▷ Adjust the driver's seat before driving.
▷ Make sure that the seat is firmly secured after adjusting.
▷ Never drive the vehicle with the head restraint removed or lowered excessively. Otherwise, your neck, spine or other parts of the body can be severely injured in the event of an accident.
If you recline the seatback excessively, you could slide under the seat belt and be injured severely
▷ in a collision.
Do not put any object that could damage the seat on the seat.
▷ The front and rear seats are equipped with the heated wire (seat warmer) system. Using the seat
▷ warmer system excessively may cause minor burns. The following occupants should exercise special care when using the heated wire seat.

- Infant, child, old or handicapped person
- Person with sensitive skin
- Exhausted person
- Persons who is drunk or took medicine which causes drowsiness such as sleeping pills, cold tablets, etc.

▷ Do not place anything on the seat that insulates against the heat, such as a blanket or cushion.
Make sure that the head restraints are in place and secured properly. Never drive the vehicle with
▷ the head restraint removed.
To minimize the injuries in a collision or an abrupt stop, make sure the seatback is in the upright
▷ position before driving. If the seatback is reclined too much, the occupant could slide under the seat belt in a collision or an abrupt stop and cannot be protected properly by the airbag system.

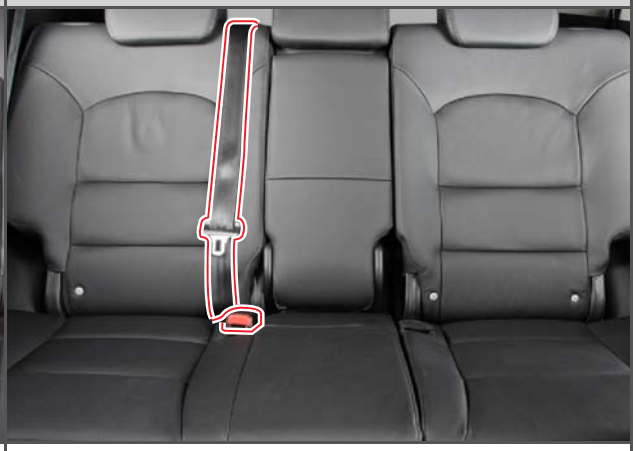
3. CAUTIONS FOR POWER SEAT

▷ You can operate the power seat with the ignition switch OFF. However, frequent operation of the seat switch with the engine stopped can result in battery becoming discharged.
▷ Operating more than one seat adjustment switch at the same time can cause damage to the seat motor. Therefore, operate the seat switch only one at a time.
▷ Do not use organic solvents such as benzene, thinner, alcohol or gasoline to prevent the seat cover from being damaged while cleaning.
▷ Do not operate the seat position adjustment switch forcefully when the seat does not move or it contacts an object.
▷ If the power seat is not operated, check and correct the problem before driving off.

Modification basis	
Application basis	
Affected VIN	

4. MAJOR CHANGES

1) Rear Center Seat Belt

Rear center seat belt	
Previous	**Current**
	
2-point type	3-point type

2) Front Seat Back Board

Front seat back board	
Previous	**Current**
	 
Hook: Installed Pocket: Net type	Hook: Not installed Pocket: Fabric seat - Net type Leather seat - Band type

3) Front Buckle

Driver's



Front buckle	
Previous	**Current**
	
Pad is attached to buckle	No pad is attached to buckle

Modification basis	
Application basis	
Affected VIN	

SUNROOF SYSTEM

7340-00

GENERAL INFORMATION

1. SPECIFICATIONS

Operating voltage	9 to 16 V
Operating current (open & close)	Max. 6 A
At no load	Approx. 3 A
Leakage current	Max. 1 mA or less
Roof motor operating speed (at opening and closing)	1.4 ± 0.5 sec./100 mm
Motor overload stop conditions	Current for 25 A or higher and torque (load) for 7.5 Nm or higher
2-step opening amount	1st step sliding open: 370 ± 5 mm
	2nd step sliding open: 450 ± 5 mm
Vertical/horizontal tolerance for sunroof glass panel	± 2 mm

2. CAUTIONS WHEN WORKING

1. Wear clean work clothes and gloves.
2. Replace and wash the gloves frequently.
3. Any unauthorized modification or operational test is not allowed since the sunroof motor and control unit are preset at the factory.
4. You can use basic tools, e.g. a 25T/10T star screwdriver, flat-bladed and cross-tip screwdrivers. Do not use any similar tool.
5. Take care not to drop the sunroof assembly when removing it and do not keep it right up.

OVERVIEW AND OPERATING PROCESS

1. SYSTEM LAYOUT

OPEN



TILT





Sunroof switch

1



Sunroof assembly

2



Sunroof motor & control unit

3



Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

1) Sunroof Switch

▶ Sunroof switch

The sunroof switches are included in the overhead console switches and consists of the TILT, CLOSE and OPEN switches.



▷ **TILT**

Opens only rear section of the sunroof.

▷ **CLOSE**

Closes the sunroof.

▷ **OPEN**

Opens the sunroof.



▶ Sunroof glass

The sunroof glass can be open in two steps and can be tilted by the switch operation.

▶ Sun shade panel

This can be closed or open manually to block sunlight when the sunroof function is not in use.

2) Sunroof Sliding Opening/Closing

Open: 2-step open





- Push up the switch

- **Push up the switch briefly: 2-step auto sliding open**
  When pushing up the switch briefly, the sunroof is automatically opened. Opening is carried out in 2 steps. In first step, the area 5 cm behind the sunroof is not opened. Push up the switch once again in order to open the sunroof completely. The sunroof operation stops if you operate the switch during its operation.
- **Push up and hold the switch: manual sliding open**
  The sunroof is opened as long as pushing up the switch.

Closing sunroof (Sliding close)





- Pull down the switch

- **Pull down the switch briefly: auto sliding close**
  When pulling down the switch briefly, the sunroof is automatically closed. To stop the closing sunroof, operate the switch to either direction.
- **Pull down and hold the switch: manual sliding close**
  The sunroof is closed as long as pulling down the switch.

Modification basis	
Application basis	
Affected VIN	

3) Sunroof Tilt Up/Down

This function is to raise or lower the rear section of the sunroof.

Tilt Up





- Pull down the switch

- The rear side of the sunroof is tilted up when pulling down the sunroof switch with the sunroof closed.

Tilt Down





- Push up the switch

- The rear side of the sunroof is tilted down when pushing up the sunroof switch with the sunroof tilted up.

CAUTION

When leaving the vehicle, make sure the sunroof is completely closed. The sunroof may look closed but it might be tilted up.

4) Sunroof Safety Function

To prevent any body parts from being trapped by the sliding sunroof, an Anti-Pinch Function automatically opens the sunroof when an object is trapped.

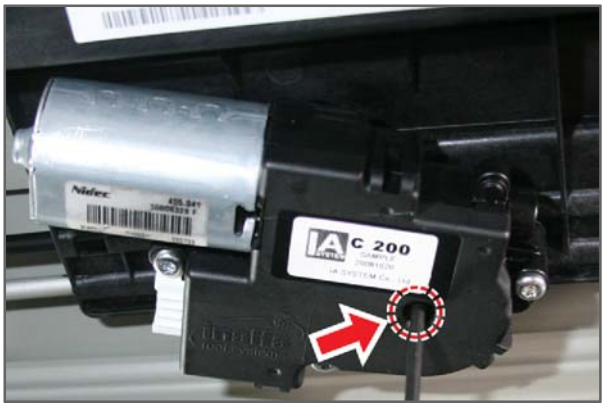
CAUTION

The anti-pinch function is deactivated just before the sunroof closes.
The sunroof safety function is just a safety supplementary system which cannot replace driver's care and caution. Moreover, it may not be able to operate due to electric part or other conditions.

▶ **Wind buffeting**

- When you drive this vehicle with the window or sunroof open at a certain position, you may feel some pressure upon your ears or hear some noises similar to those from a helicopter. This happens because of an influx in air through the window or sunroof and its resonance effect. If this happens, adjust by opening the window or sunroof.

5) Emergency Operation



If the sunroof becomes out of order while it is open or tilted, the sunroof can be operated through the motor operating hole of the sunroof motor.

Modification basis	
Application basis	
Affected VIN	

3. SUNROOF OPEN WARNING

1) Warning Sound

When removing the key and then opening the door with the sunroof open, the warning sound is heard. Closing the door stops the warning sound.

2) Message on Instrument Cluster

The following message is displayed on the screen in the instrument cluster.

Supervision type



CAUTION

General precaution for sunroof

- Even though the sunroof can be operated when the engine is not running, operating the sunroof repeatedly with the engine turned off will run down the battery. Operate the sunroof while the engine is running.
- When the sunroof operation is completed, release the switch. Keeping pressing the switch can result in malfunction.
  Especially in winter, never operate the sunroof if operation areas are iced. Wait until melted.
  Make sure that the sunroof is completely closed when leaving the vehicle. Leaving the vehicle with
- the sunroof open result in a theft. In addition, rain or snow can get into the vehicle through the open sunroof.
  When the sunroof is fully open, wind buffeting symptom can be worse. In this case, try to adjust
- the sunroof position manually or open the sunroof into 1st first step until the wind buffeting is disappeared.
  Parts of the body can be trapped in the sunroof and can be struck by passing objects. Do not stick
- hands, head or anything else out of the openings.
  Remove any dirt and foreign material stuck on the edge of the sunroof glass periodically.
- Noise can occur due to friction when operating the sunroof.

4. ZERO POINT SETTING

If the sunroof is stopped midway due to a discharged battery or power failure, you need to re-calibrate the starting point of the sunroof. In addition, the following cases need reset of the starting point for the sunroof. (See page 20 in Reset of Sunroof Zero Point (Initialization))

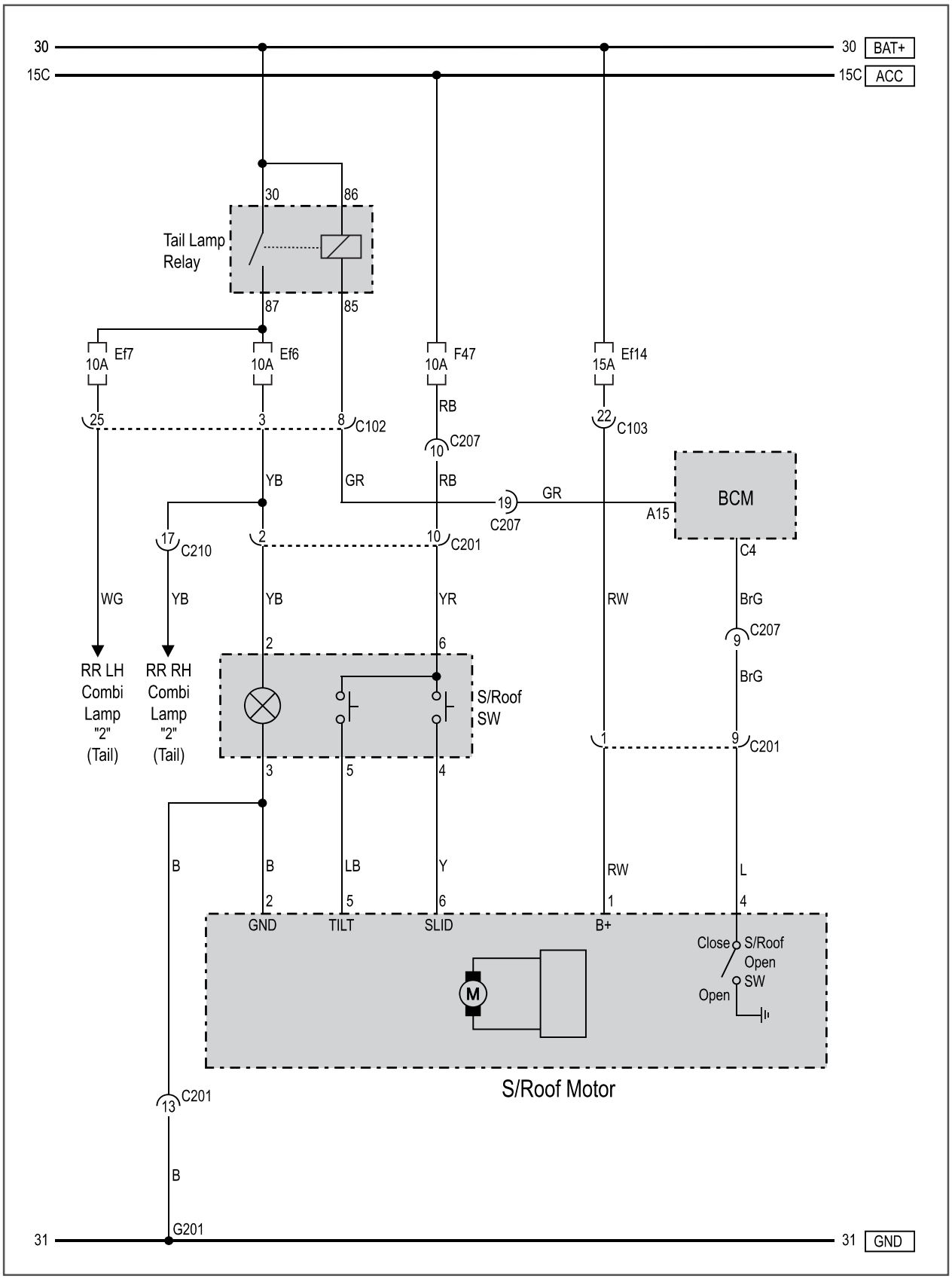




- The sunroof does not completely close or open by operating the switch once.
- The sunroof slides back to close. But the operation does not stop even after a complete close and tilts up the sunroof.
- The opening gap remarkably decreases for the sliding open or tilt up.
- Operation of the sunroof switch does not do anything or work properly.
- The operating process is not same as before due to discharged or disconnected battery.

Modification basis	
Application basis	
Affected VIN	

5. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

BODY INTERIOR

5110-01

GENERAL INFORMATION

1. MAJOR CHANGES

1) Luggage Lid

Front view	
Previous	**Current**
	
Latch type	Band type

Rear view	
Previous	**Current**
	
No anchor system for keeping lid open	Retaining hook

NO DATA

BODY REPAIR

5110-01

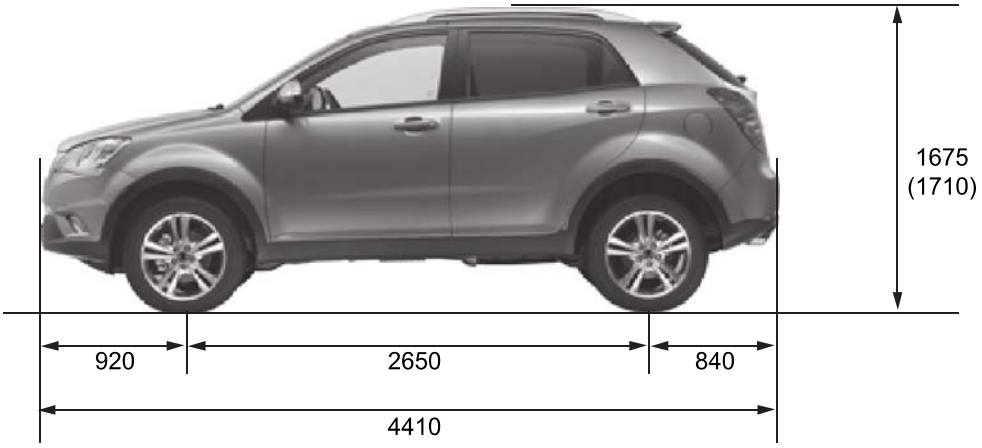
GENERAL INFORMATION

1. MAJOR DIMENSION

Top view



Side view



Front side



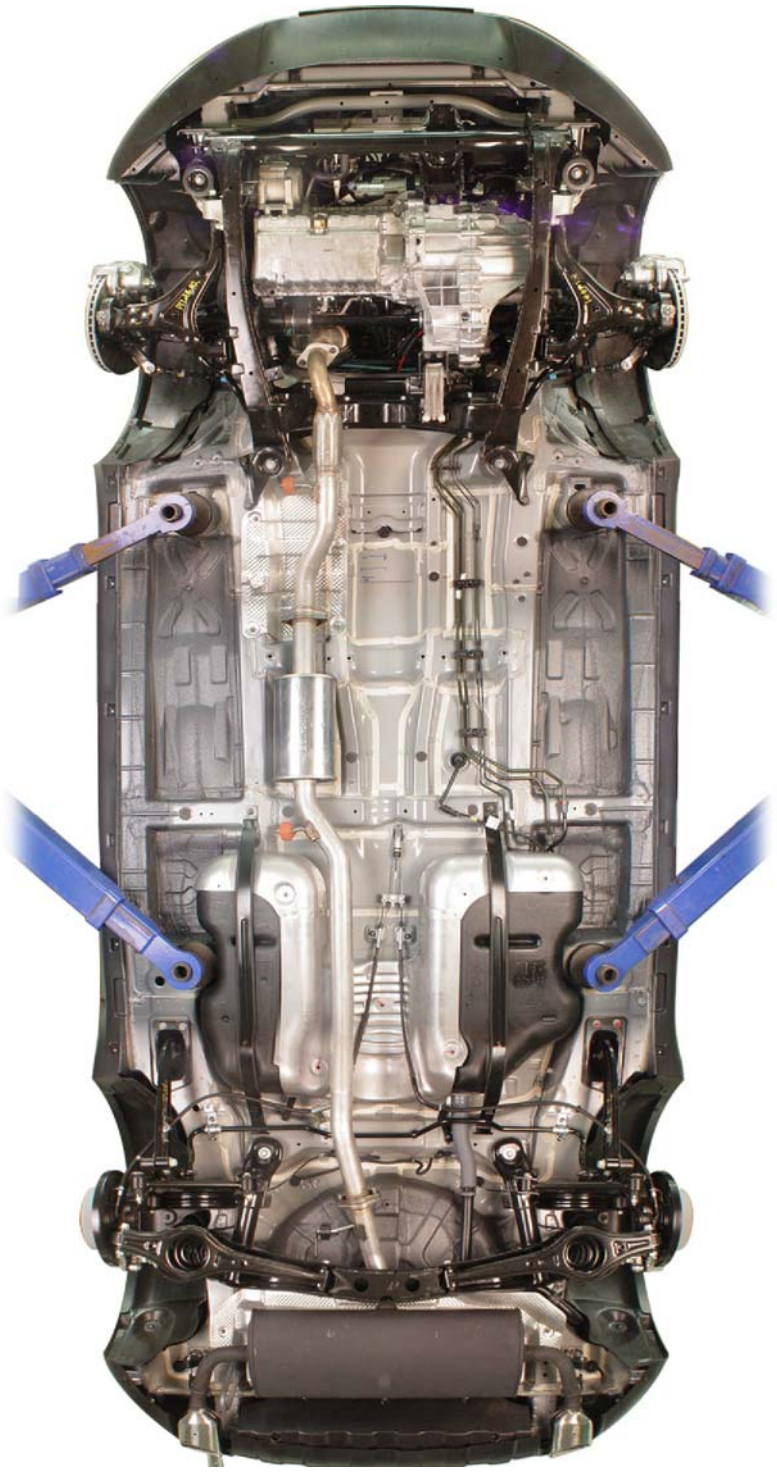
Rear view



Modification basis	
Application basis	
Affected VIN	

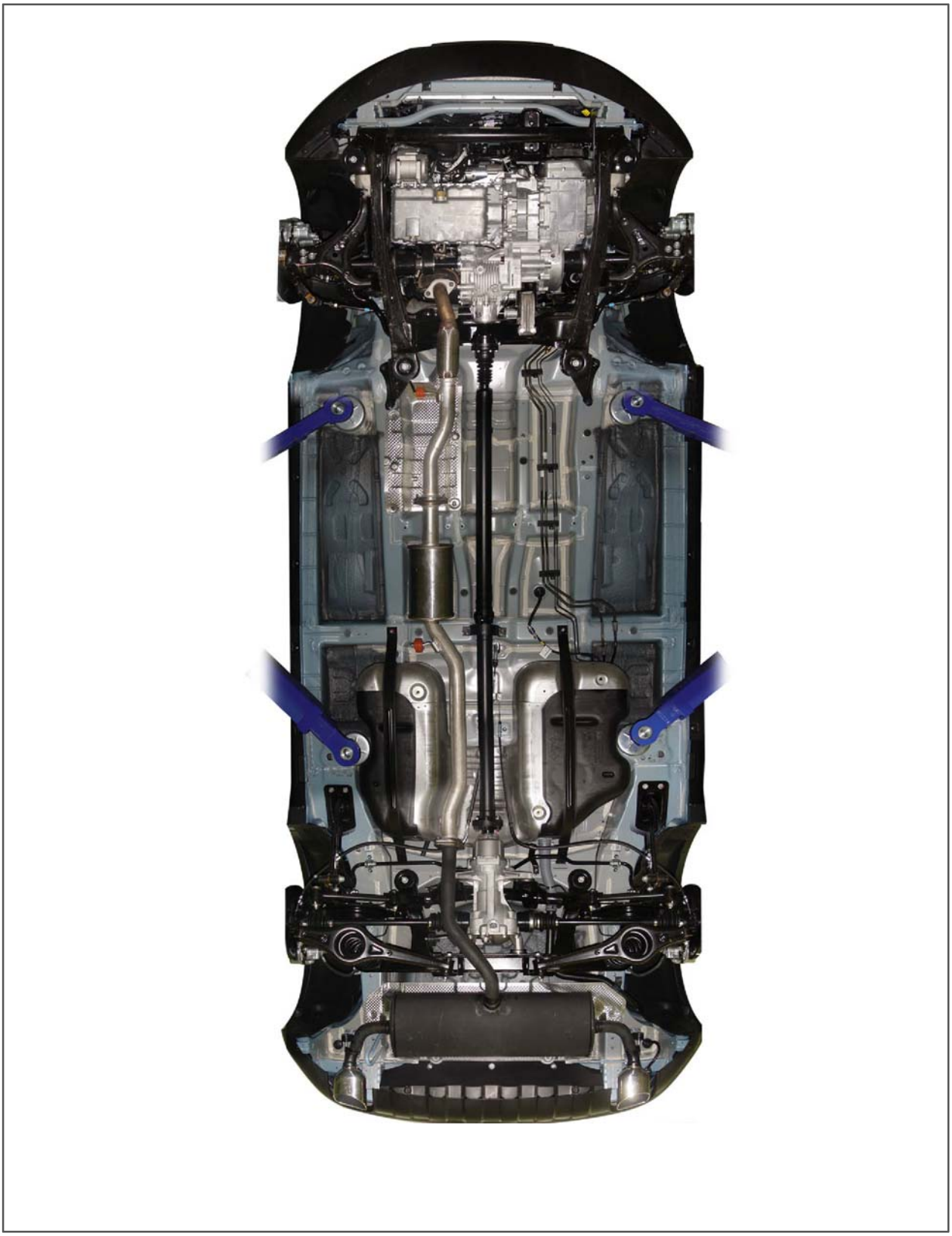
2. JACK POINTS

1) 2WD



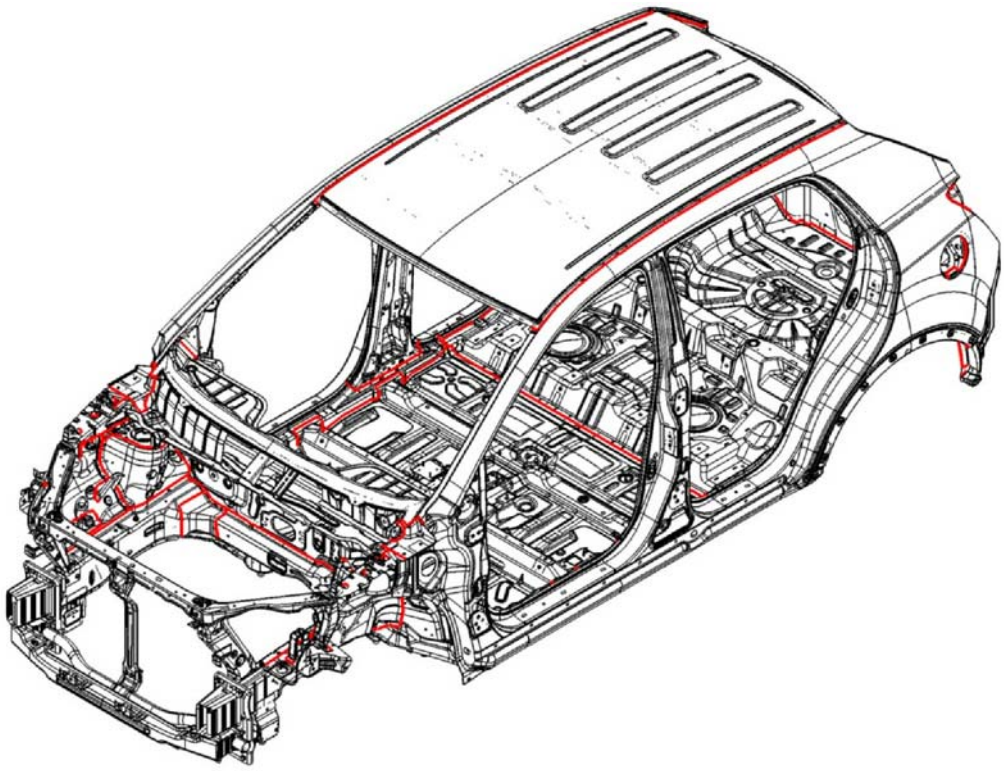
Modification basis	
Application basis	
Affected VIN	

2) 4WD



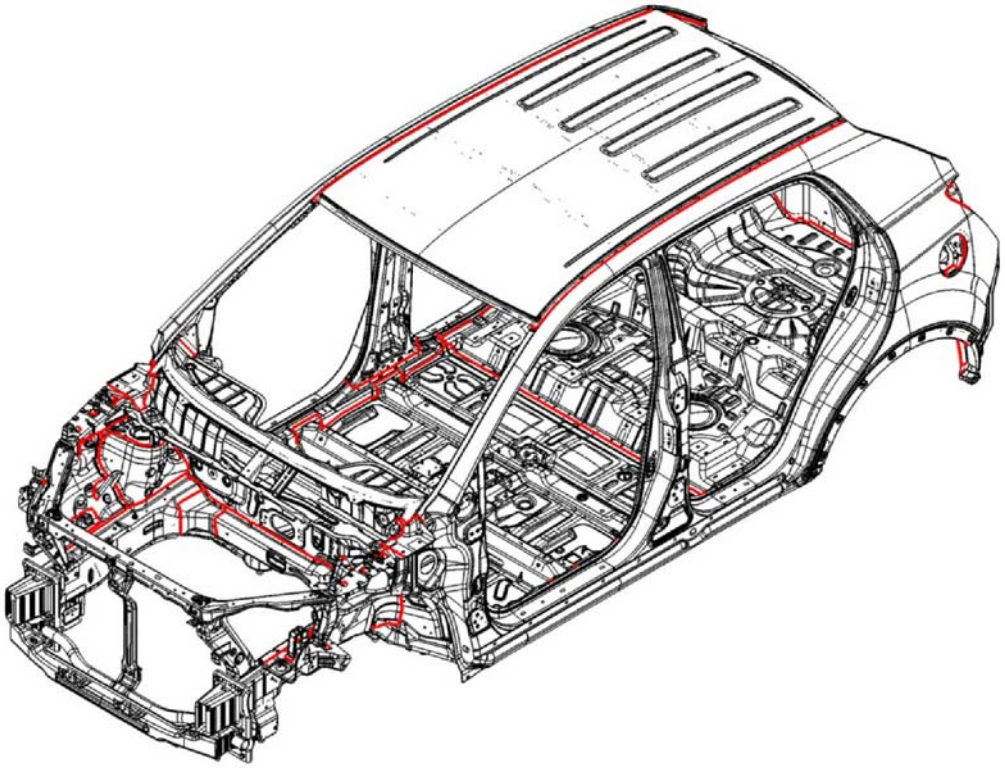
3. SEALING APPLICATION POINTS

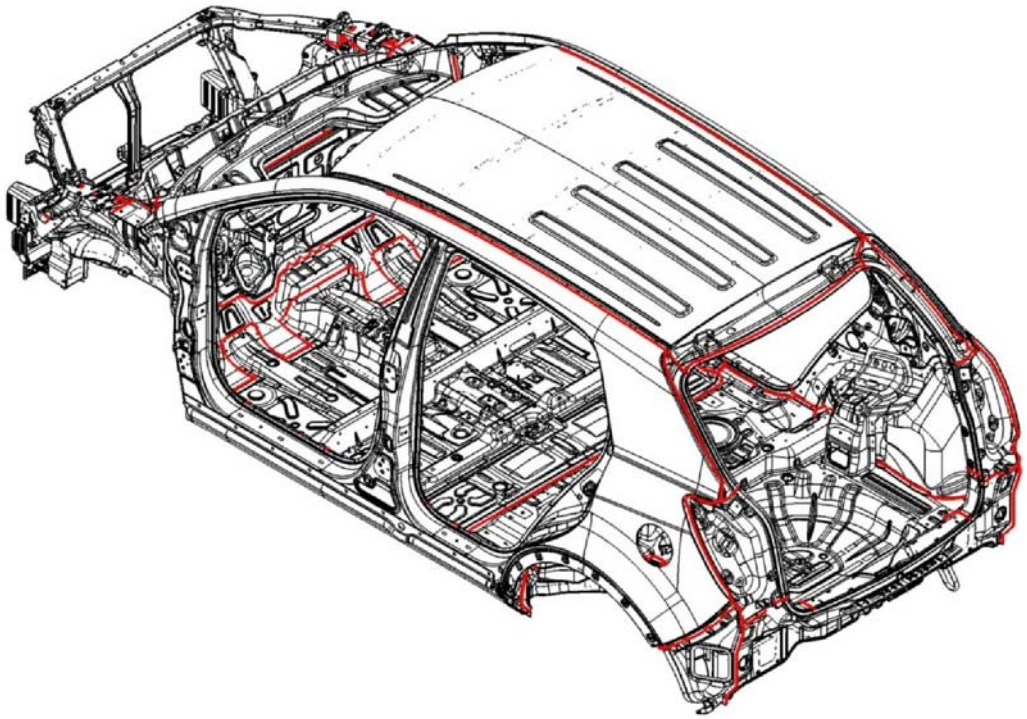
1) Dash Panel, Engine Tunnel, Floor, Etc.



Modification basis	
Application basis	
Affected VIN	

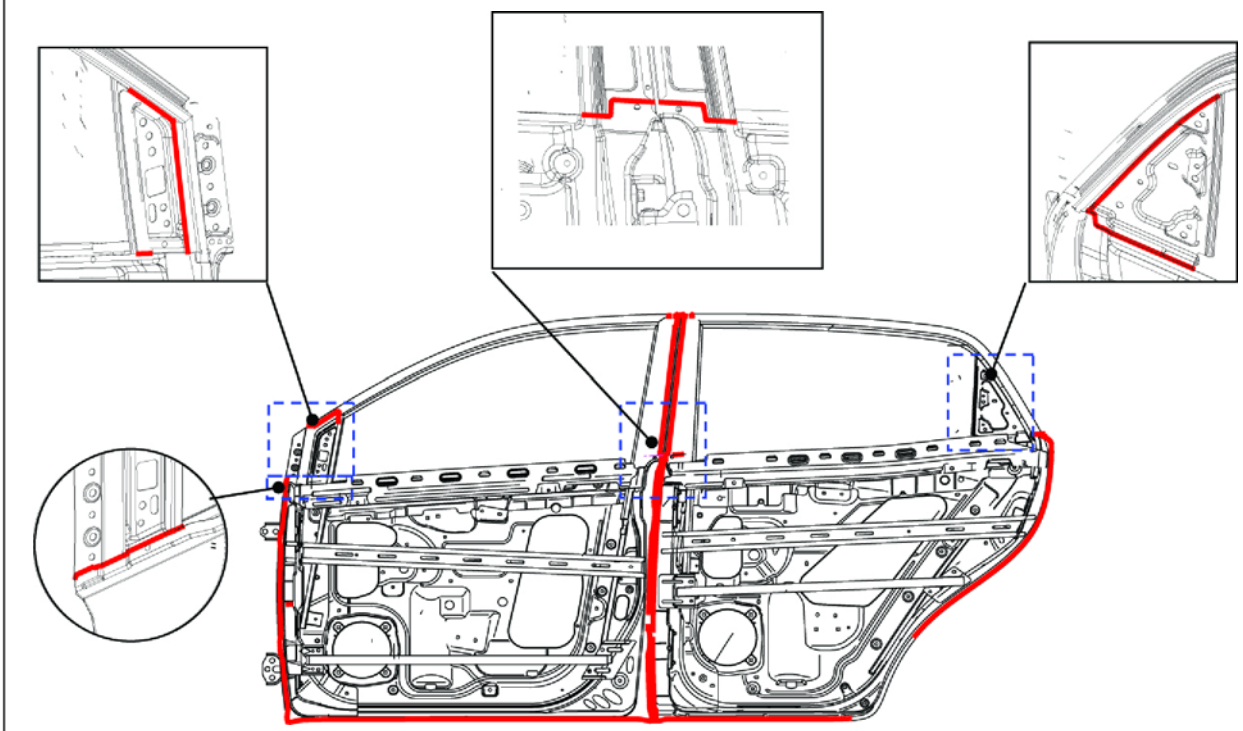
2) White Body



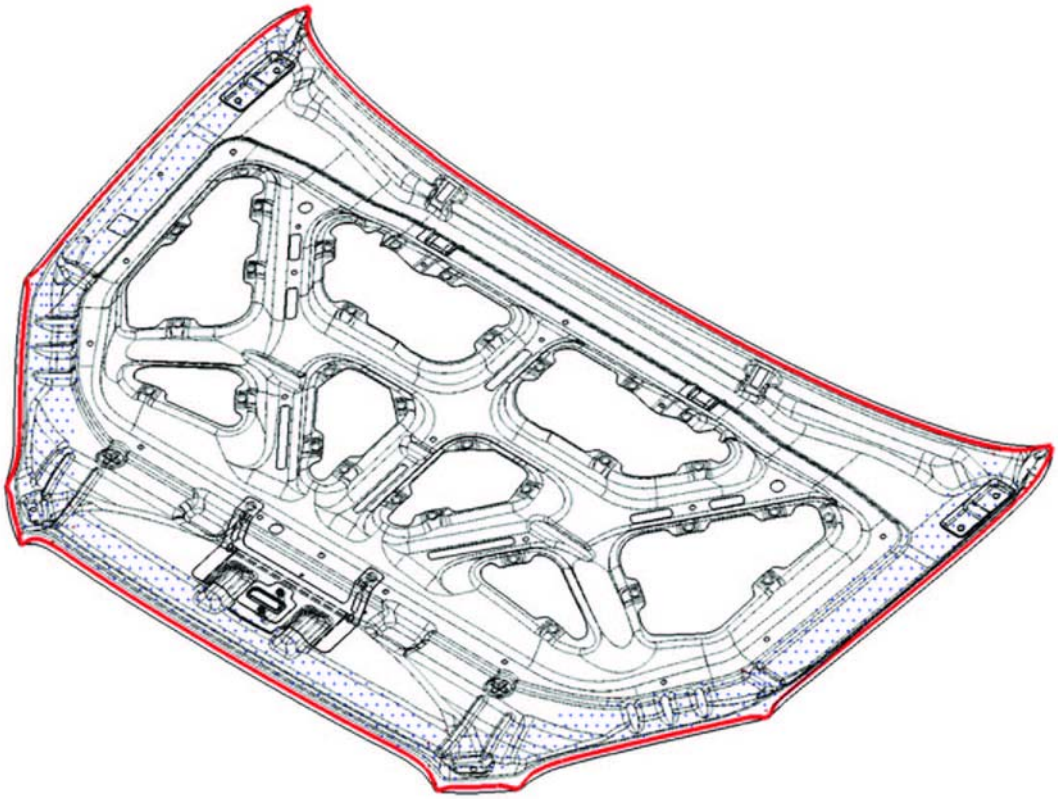


Modification basis	
Application basis	
Affected VIN	

3) Front & Rear Door Panel

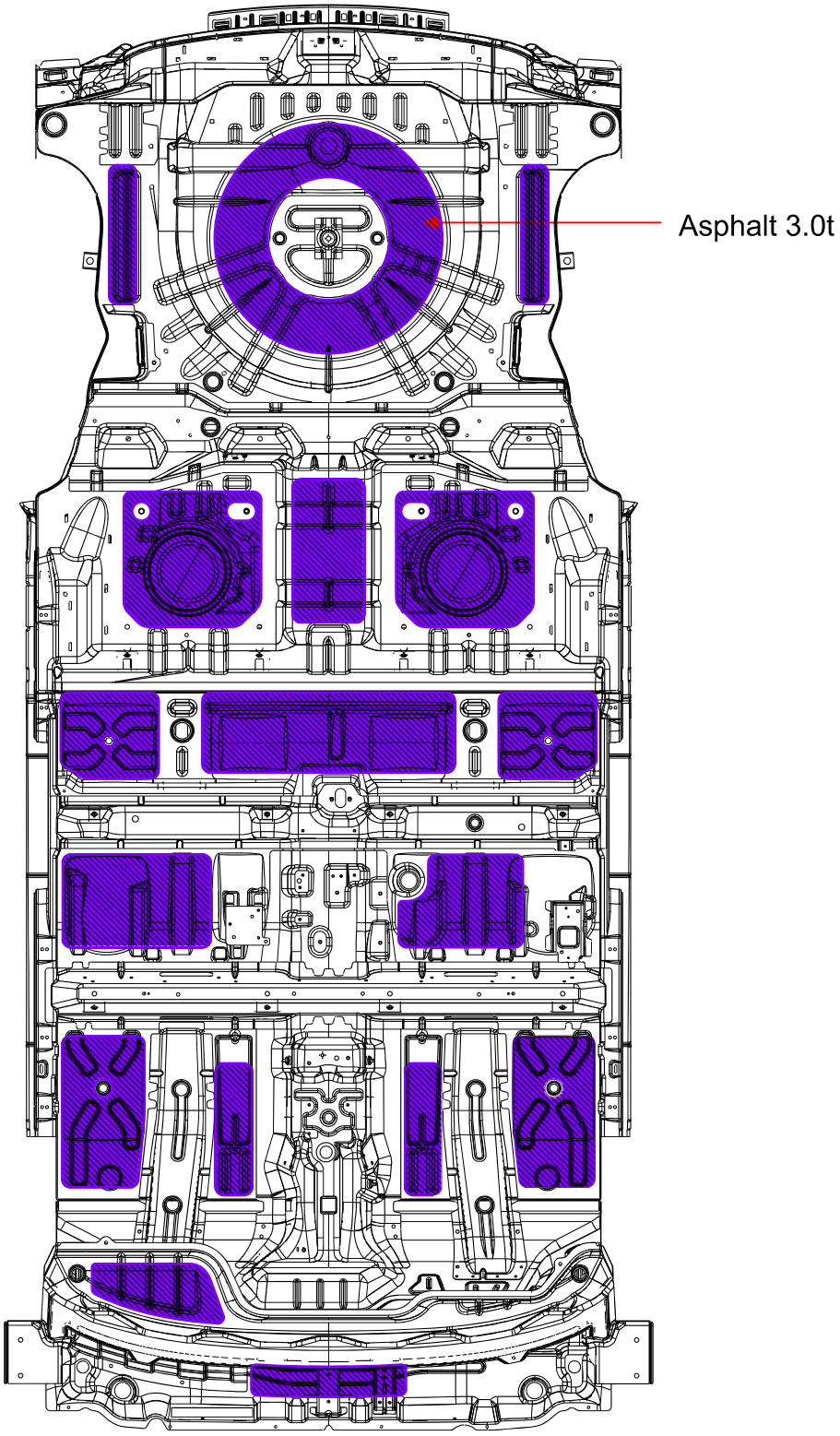


4) Engine Hood Panel



Modification basis	
Application basis	
Affected VIN	

4. DEADENER APPLICATION POINTS

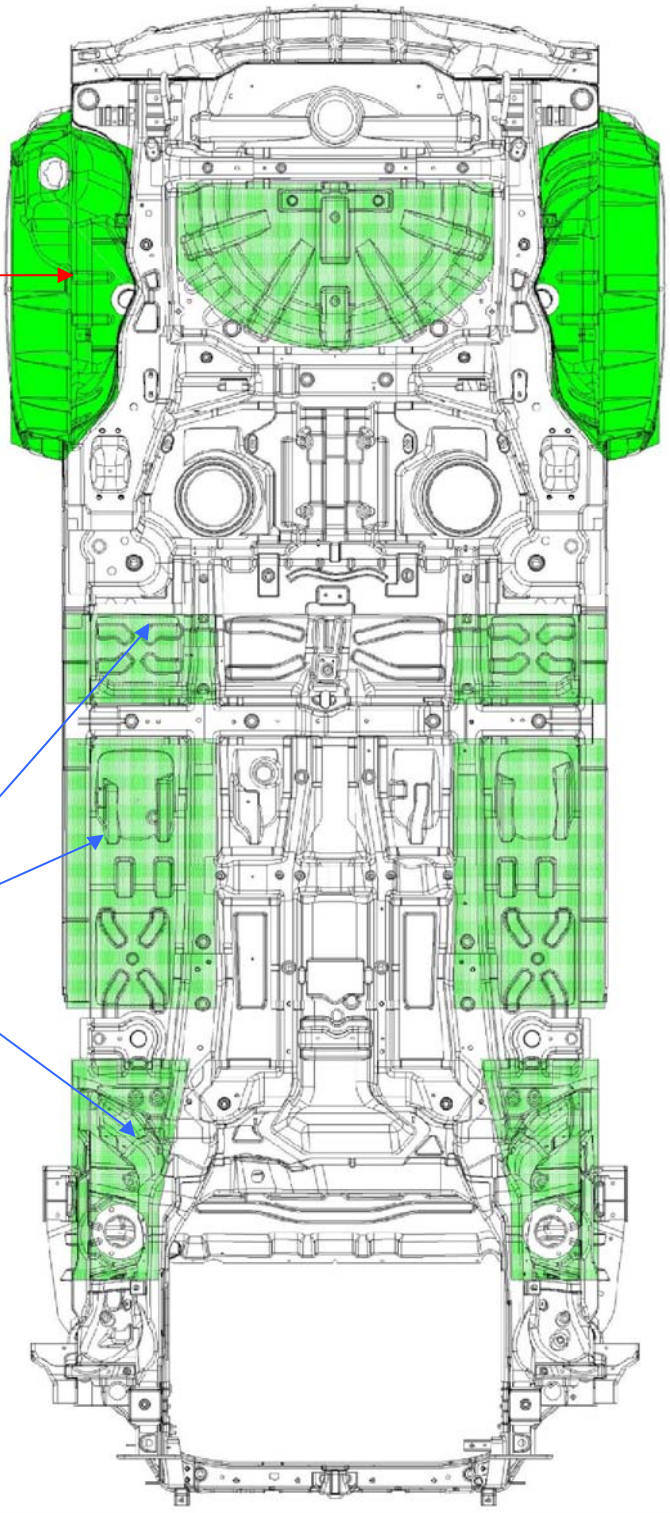


Modification basis	
Application basis	
Affected VIN	

5. UNDER COATING

Thickness
: 500 $^{+100}_{-50}$ ㎛

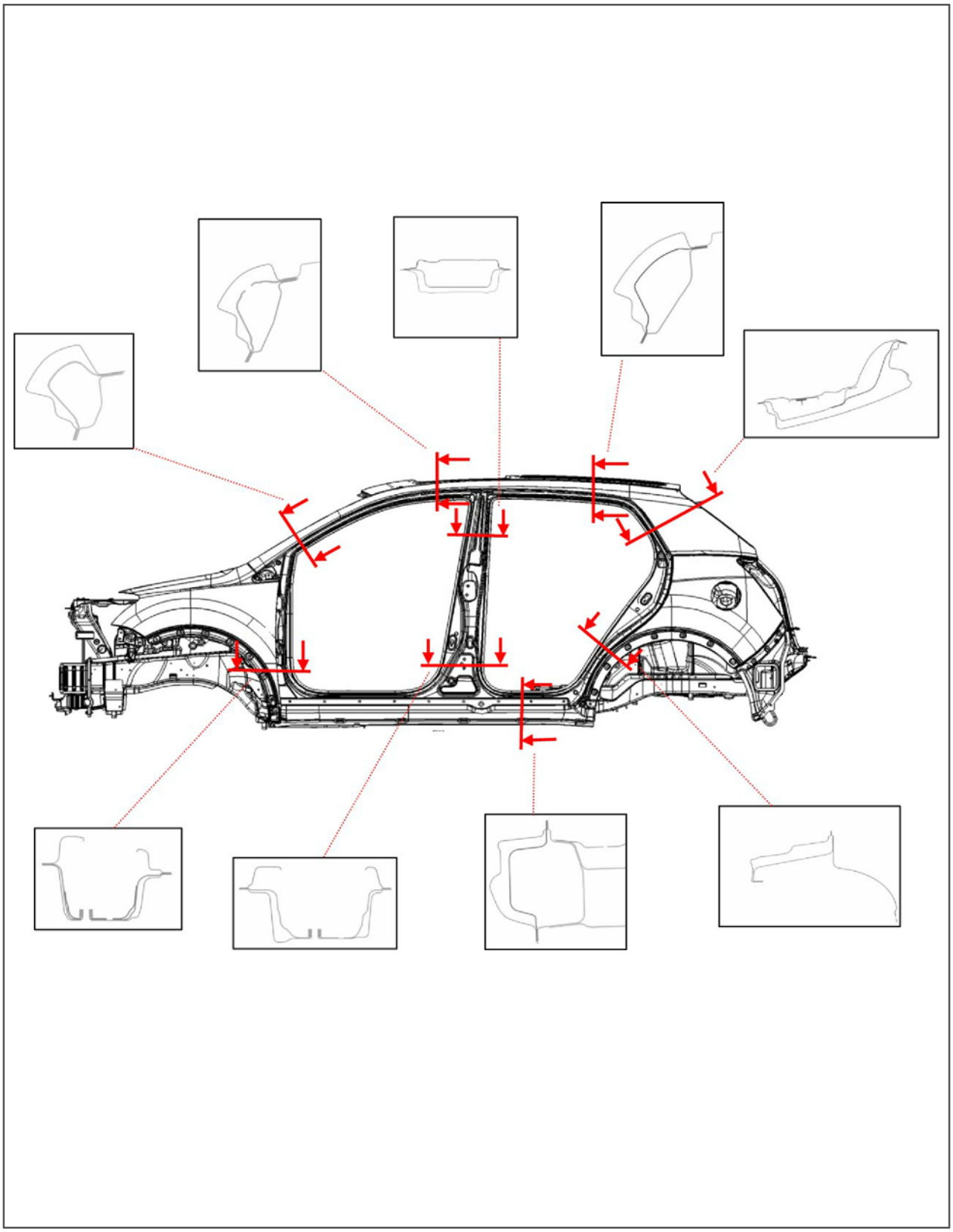
Thickness
: 200 $^{+100}_{-50}$ ㎛



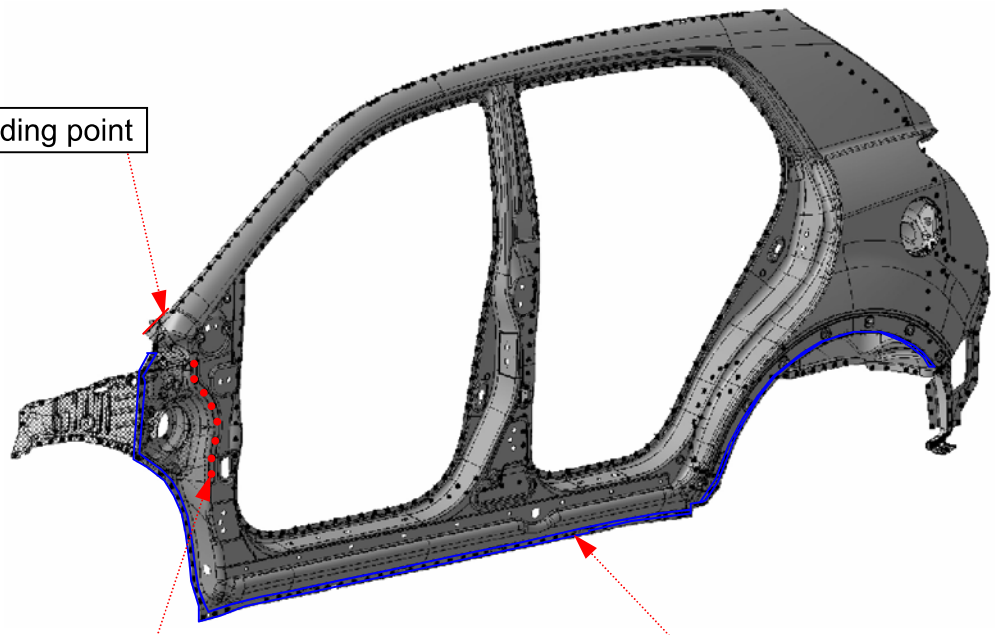
Modification basis	
Application basis	
Affected VIN	

6. MAJOR WELDING POINTS

1) Cross Sectional View of Major Panels

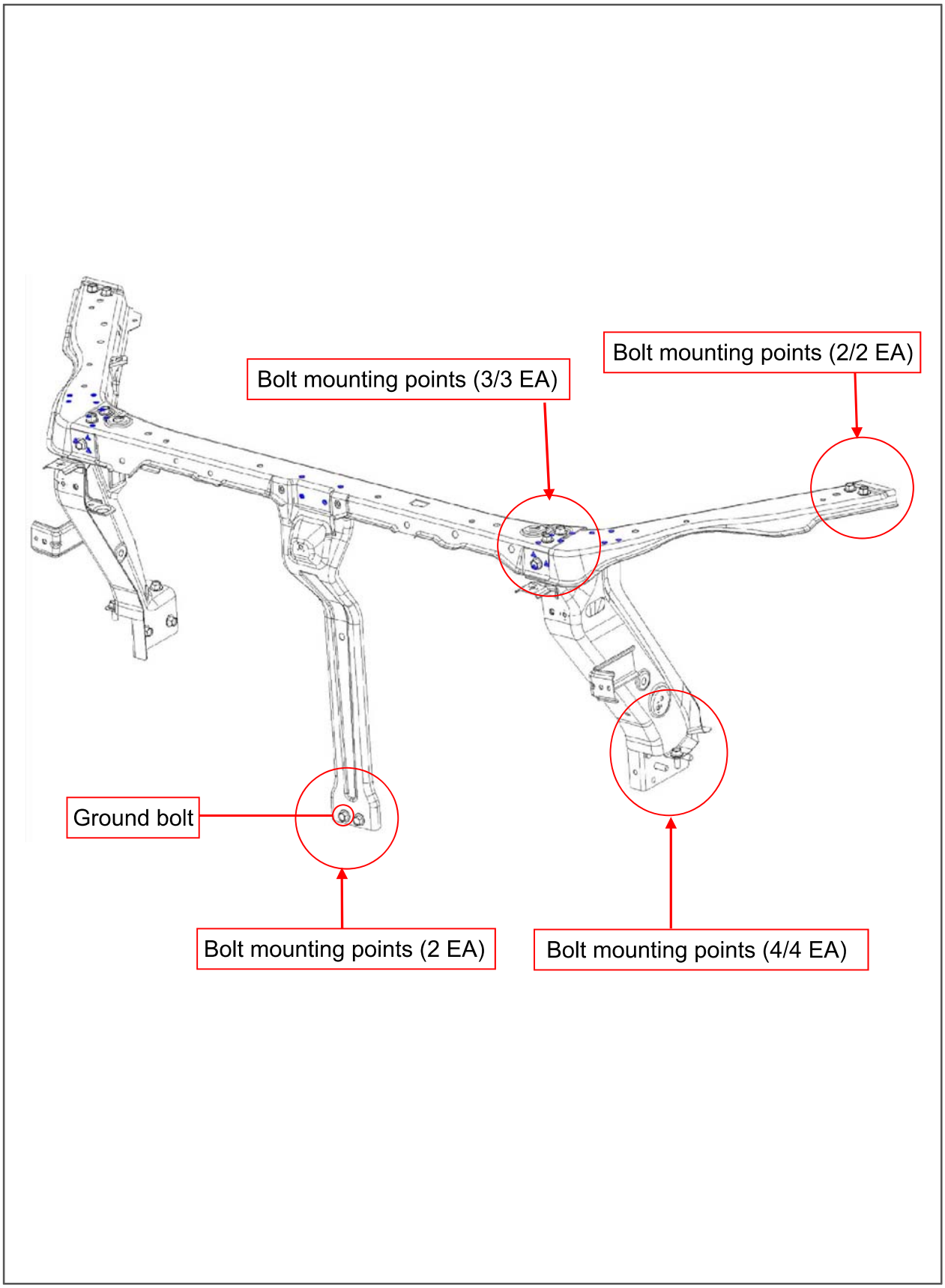


2) Side Panel

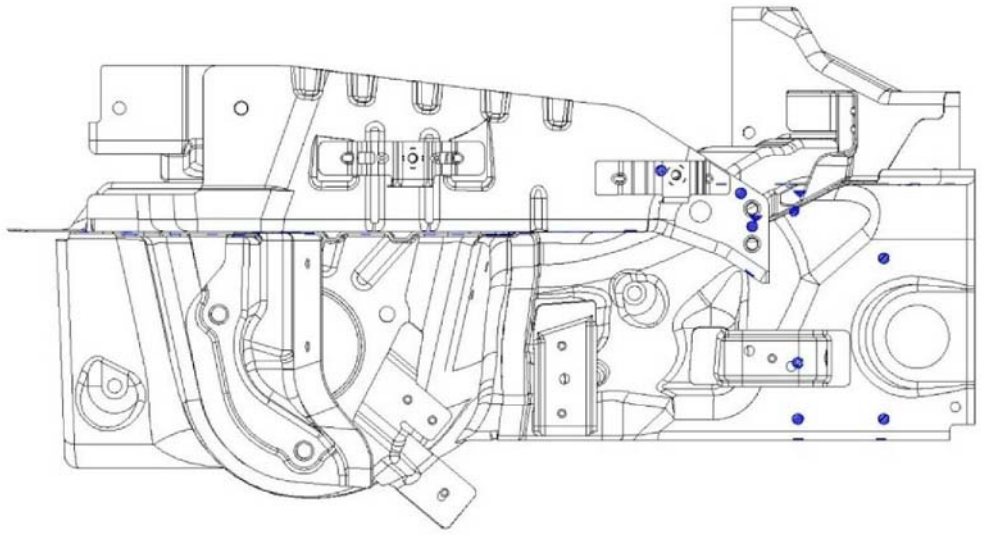


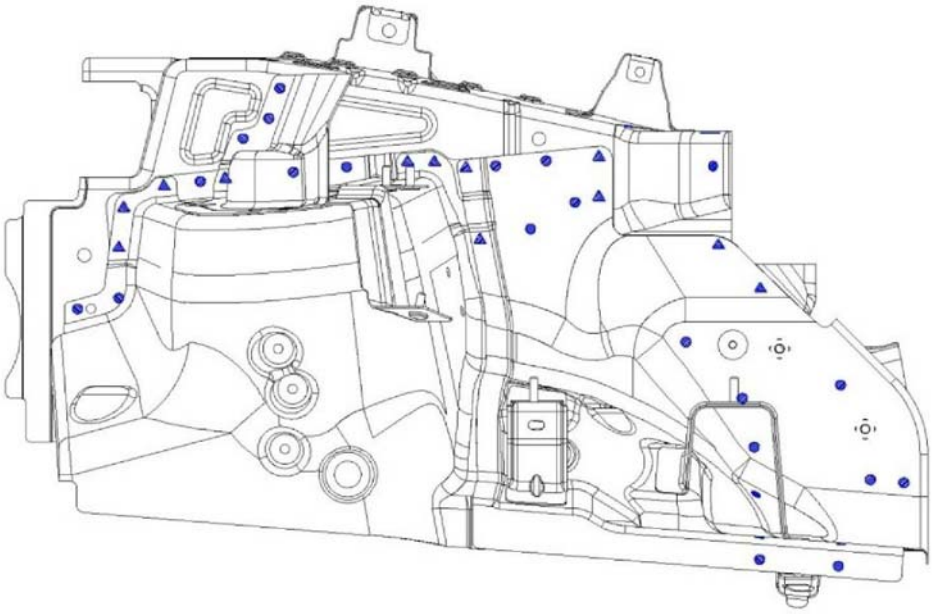
Modification basis	
Application basis	
Affected VIN	

3) Front Panel



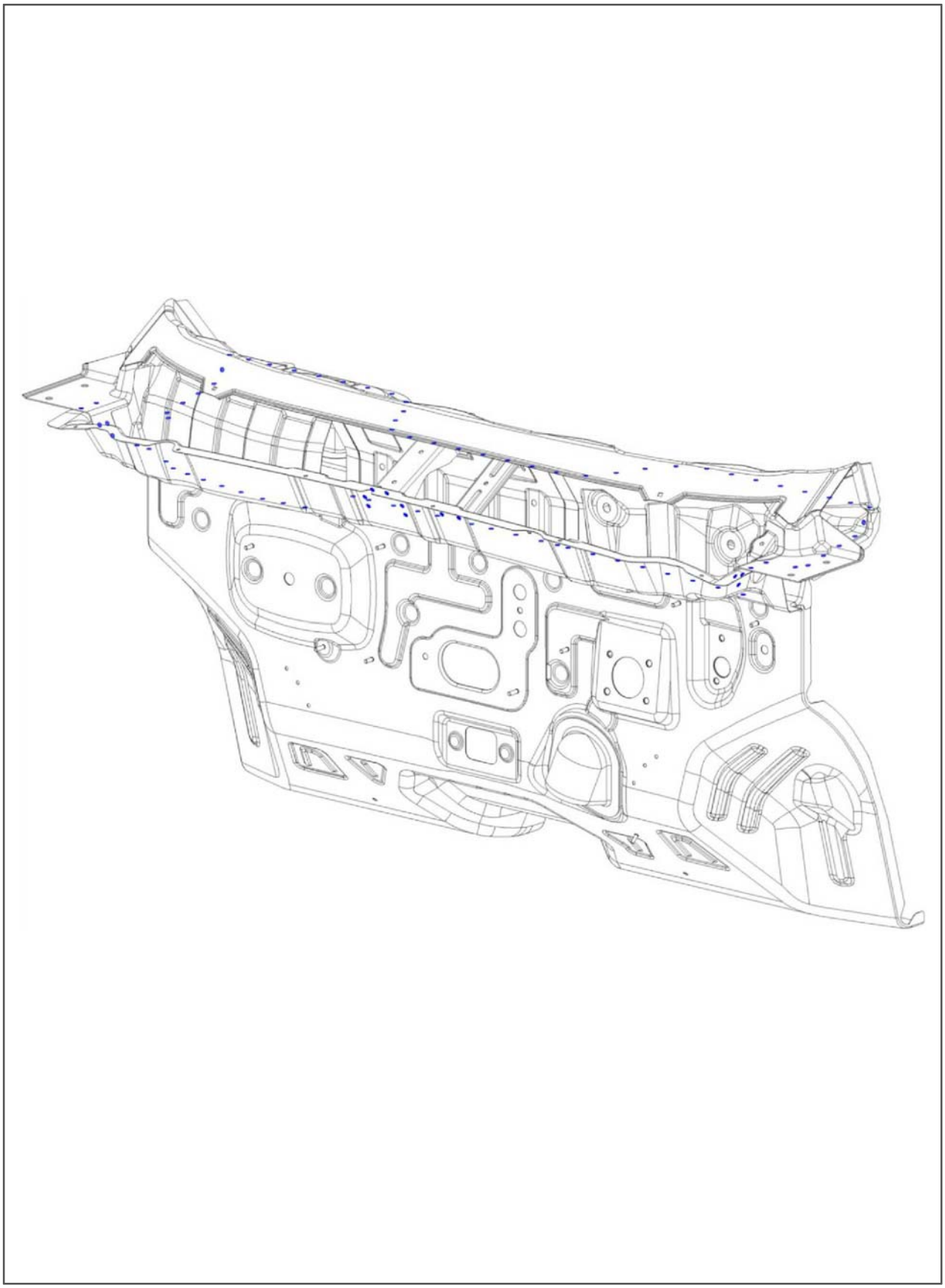
4) Apron Panel



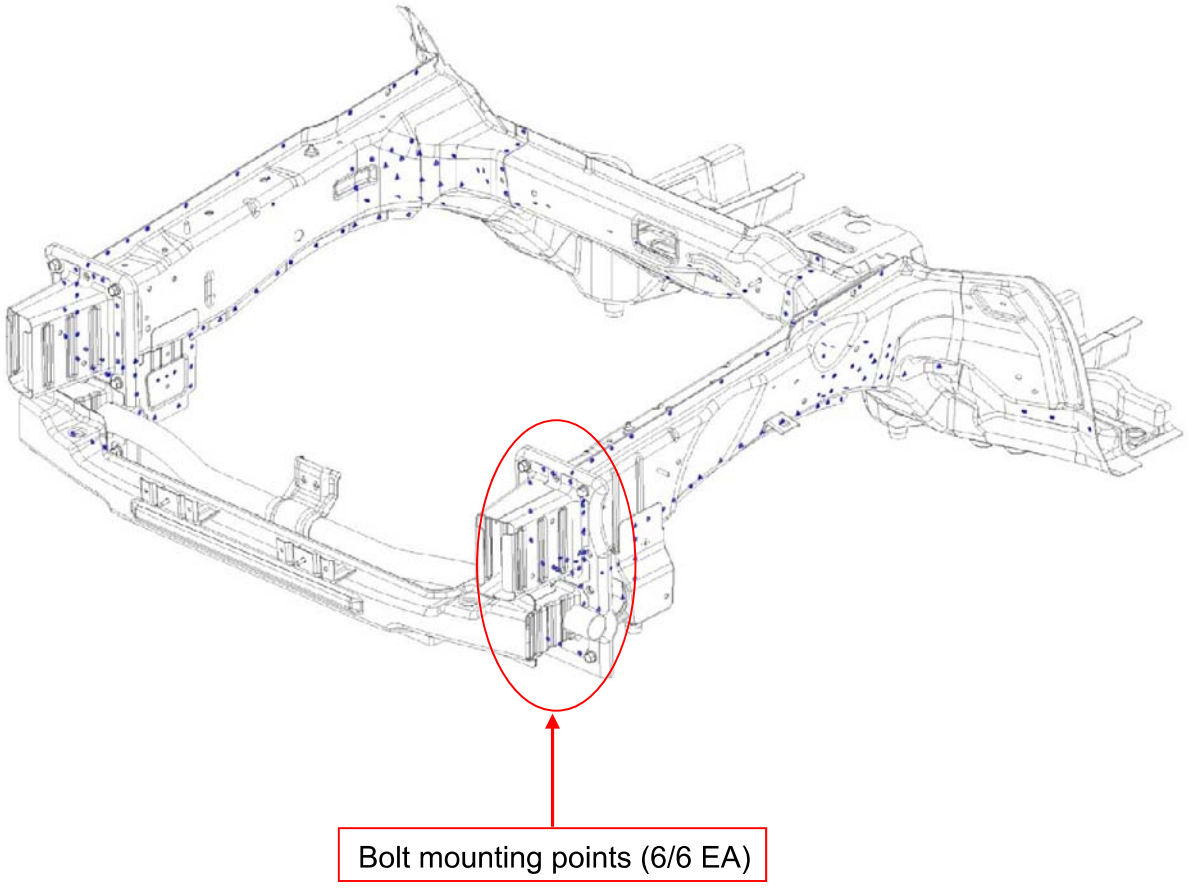


Modification basis	
Application basis	
Affected VIN	

5) Dash & Cowl Panels

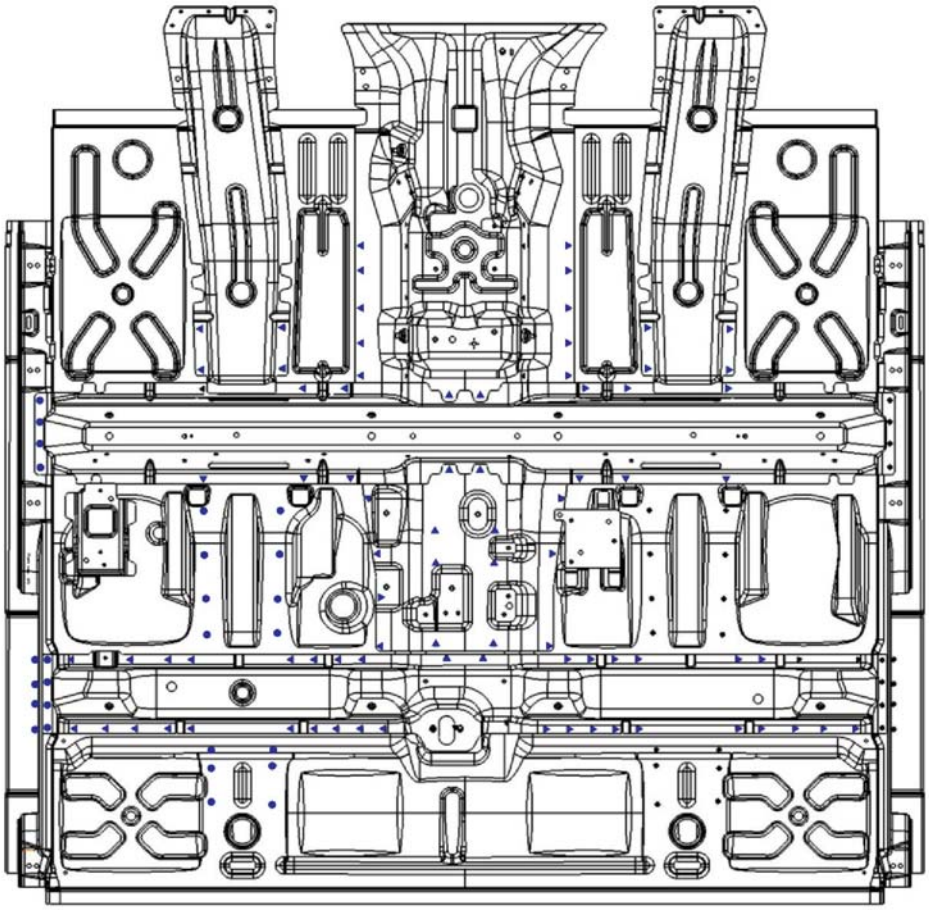


6) Front H-Frame Panel

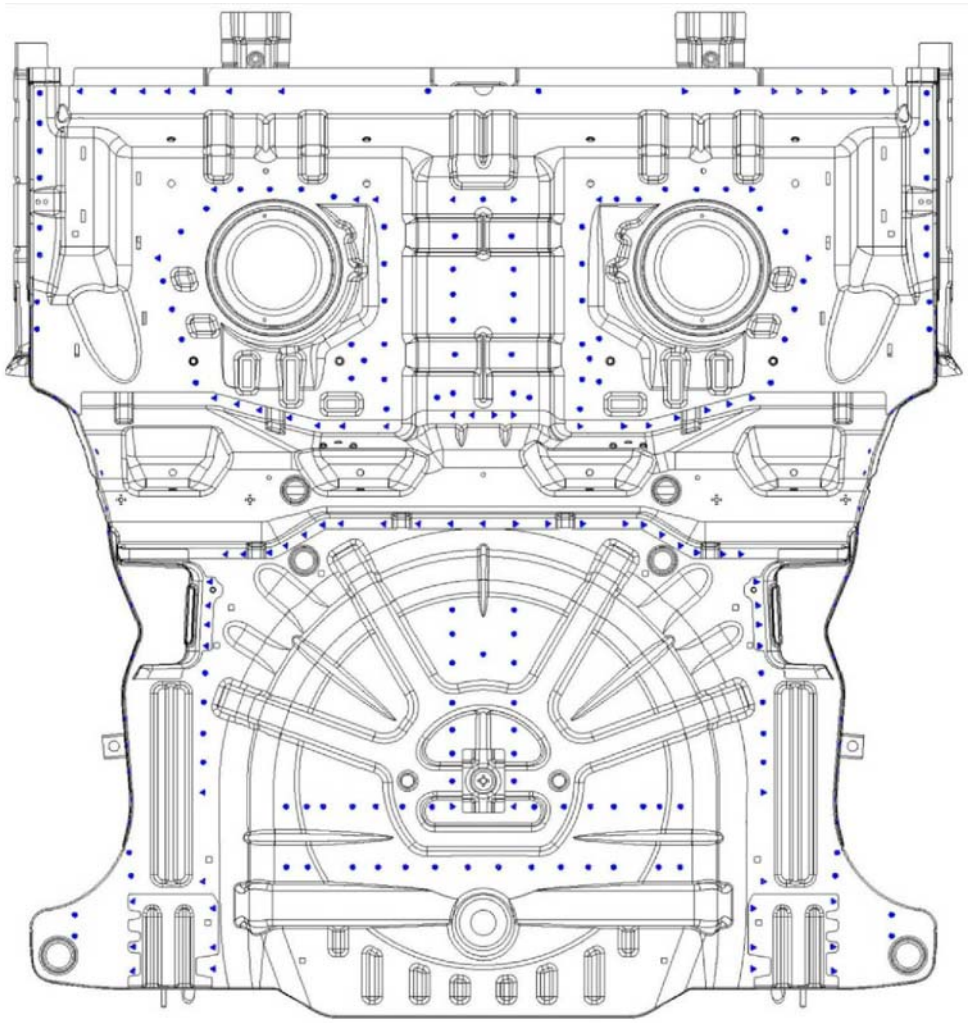


Modification basis	
Application basis	
Affected VIN	

7) Front Floor Panel

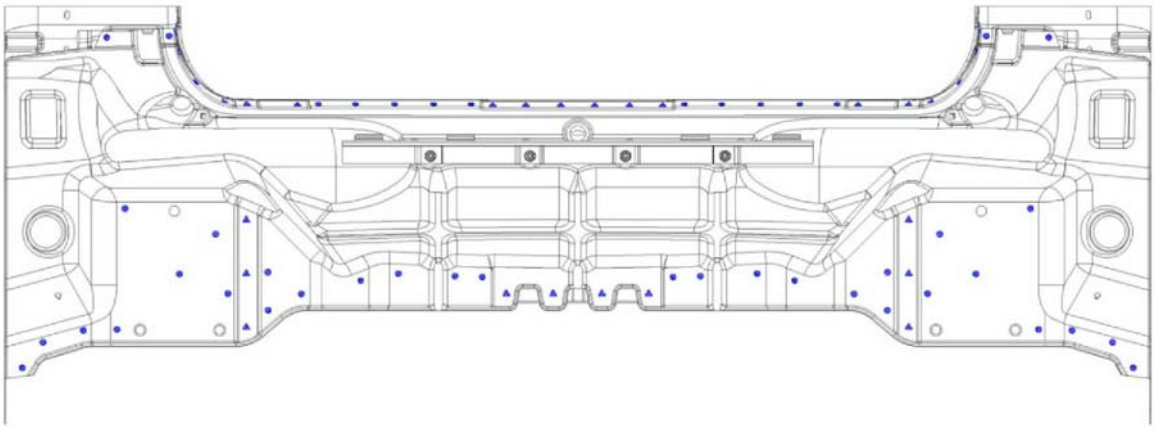


8) Rear Floor Panel



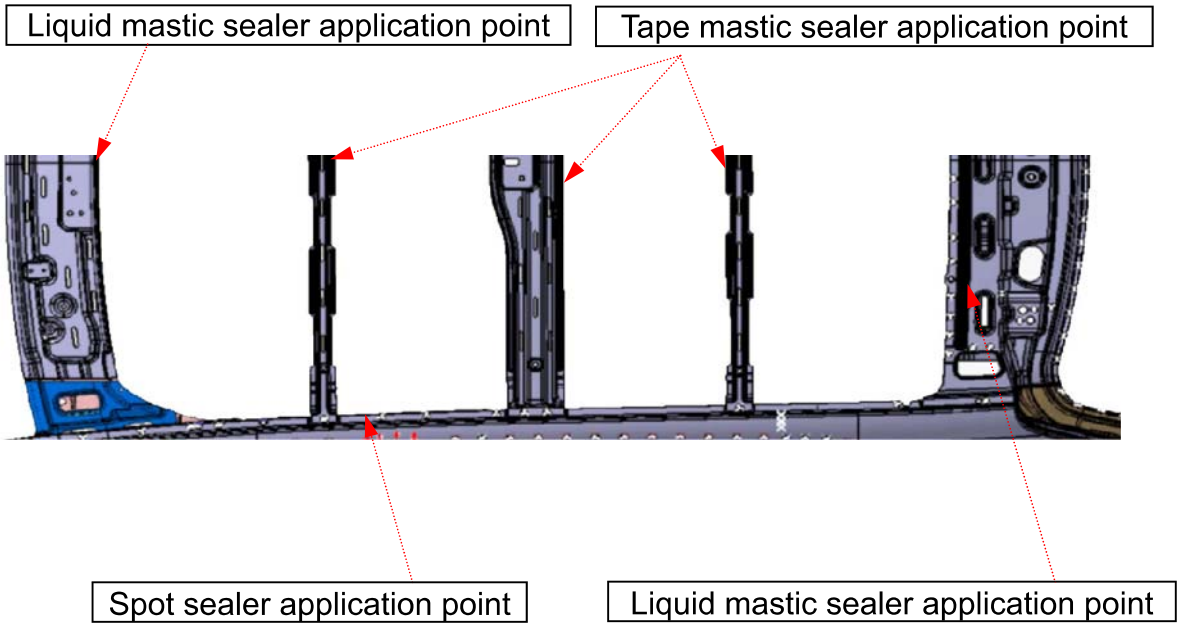
Modification basis	
Application basis	
Affected VIN	

9) Rear End Panel



Modification basis	
Application basis	
Affected VIN	

10) Roof Panel

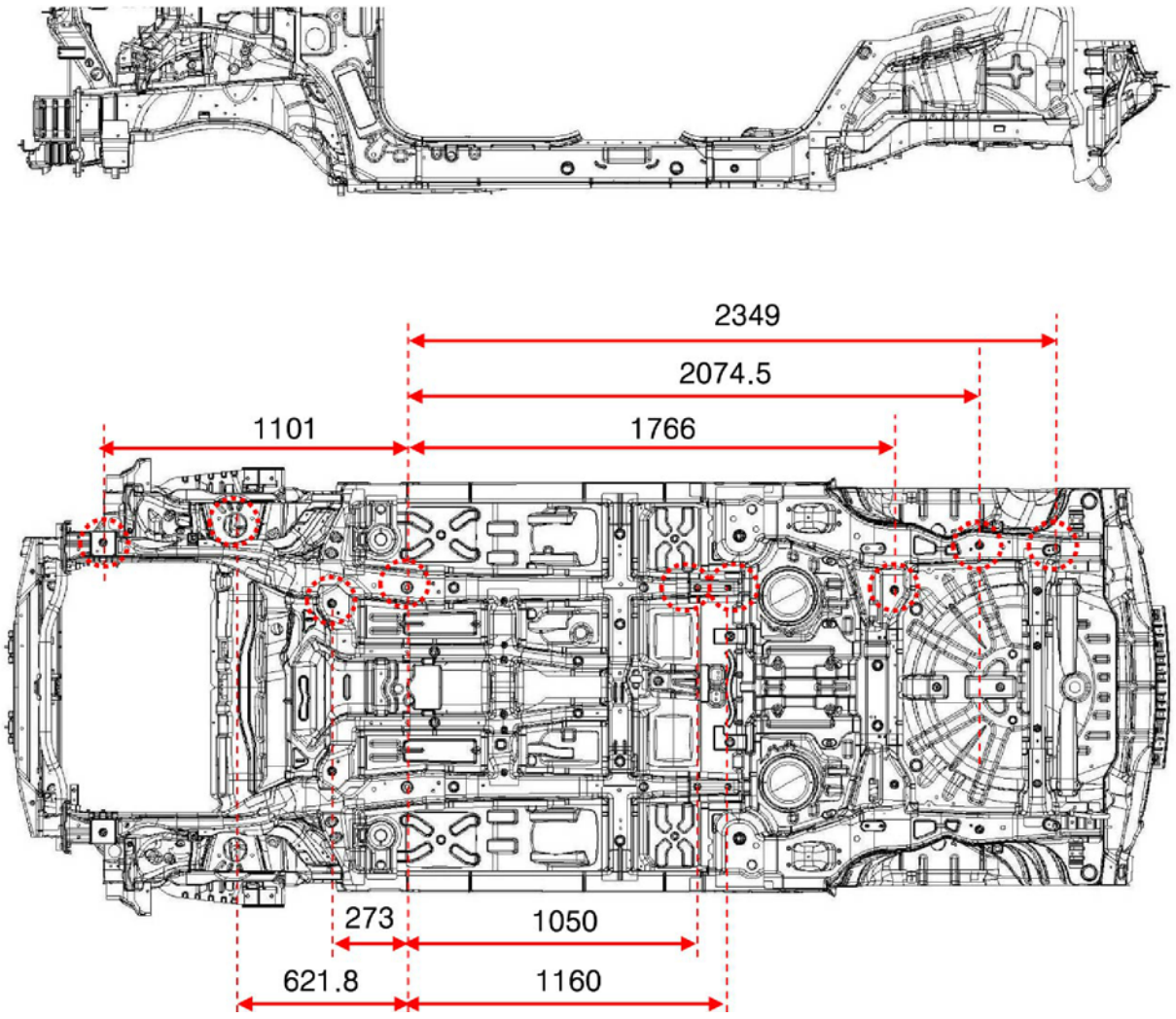


Modification basis	
Application basis	
Affected VIN	

7. MAJOR BODY DIMENSIONS

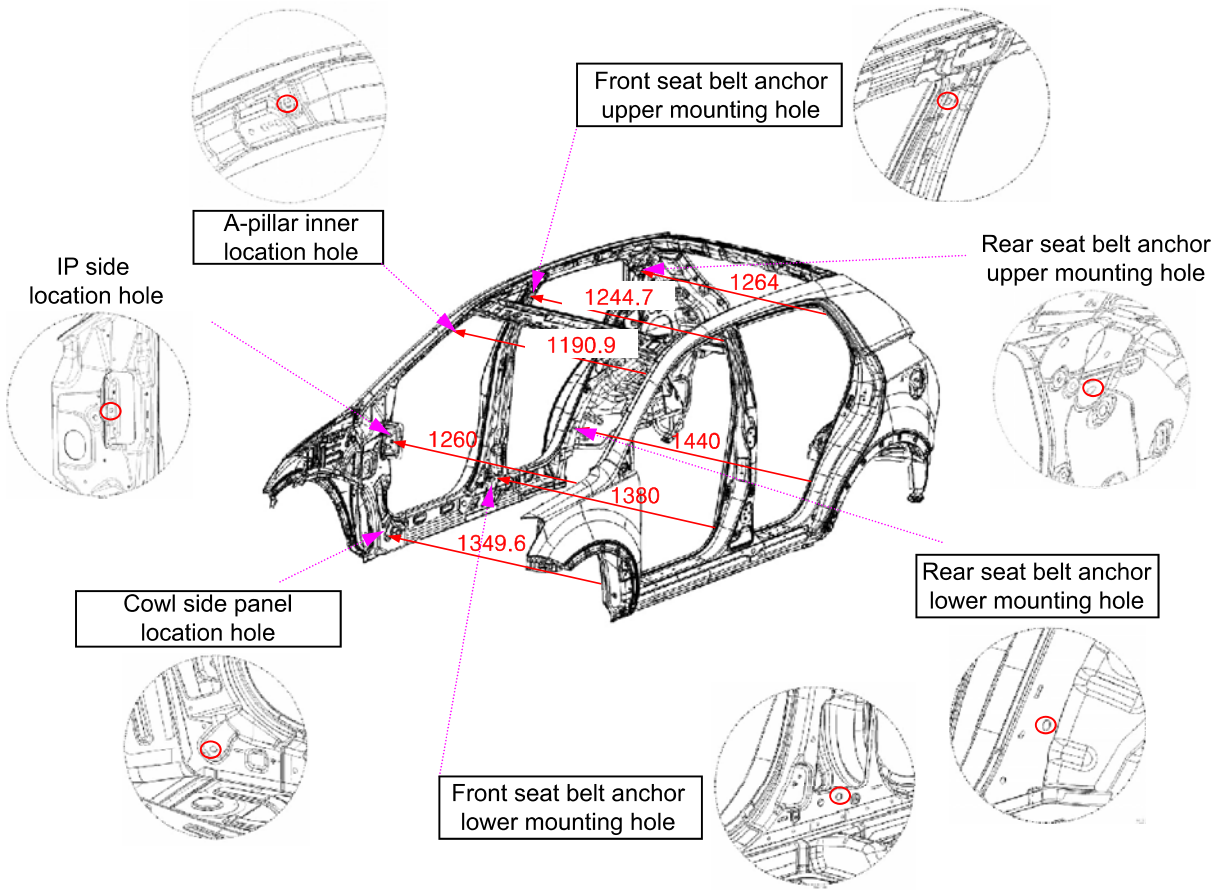
1) Under Body

Unit: mm



2) Vehicle Structure

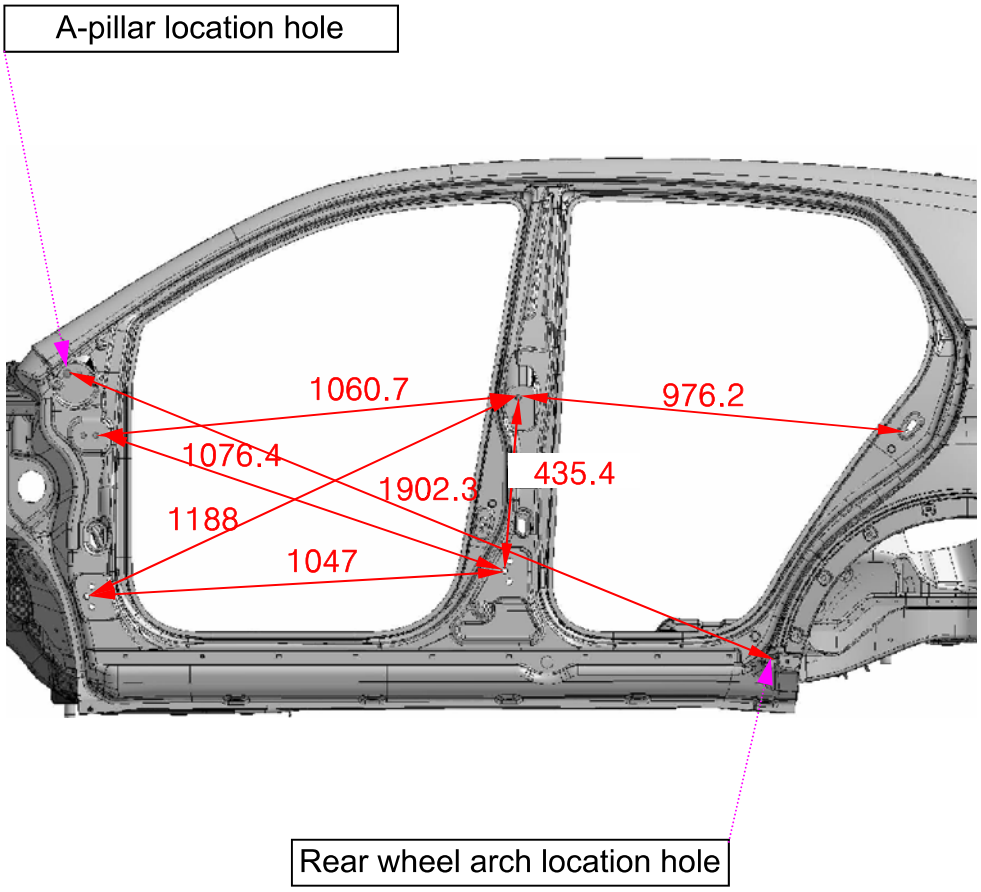
Unit: mm



Modification basis	
Application basis	
Affected VIN	

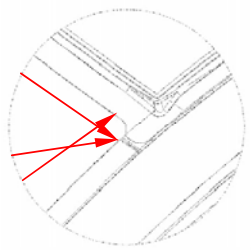
3) Side Structure

Unit: mm

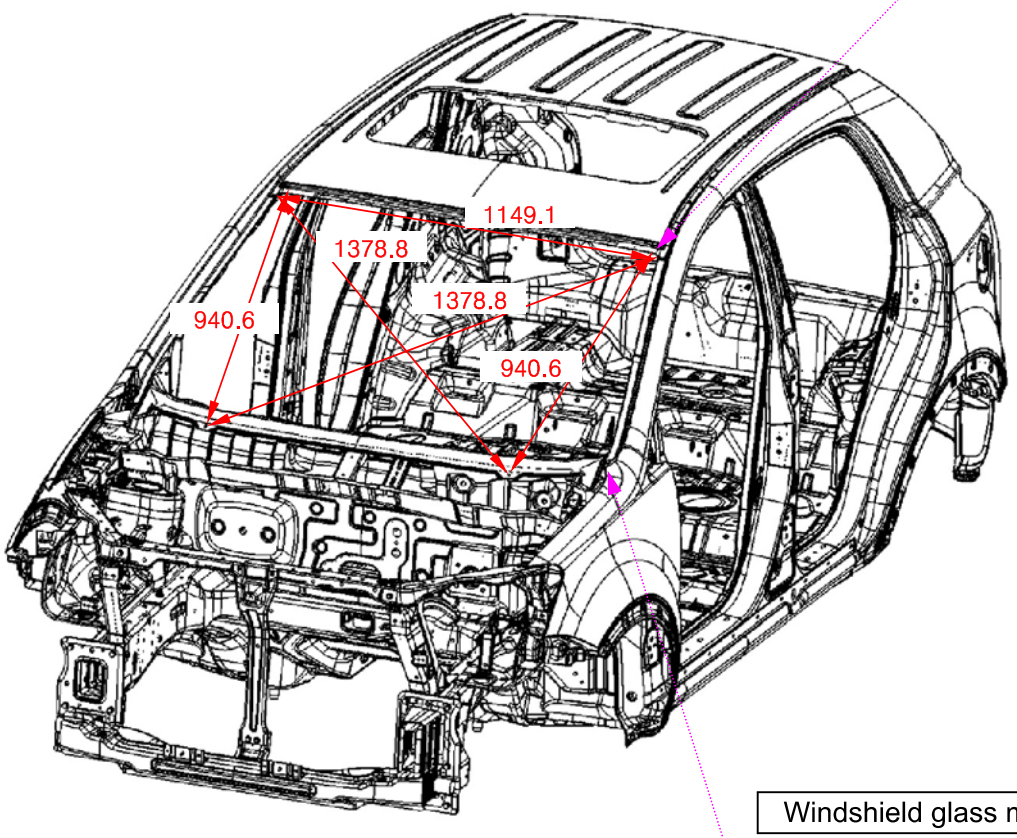


4) Windshield Glass Area

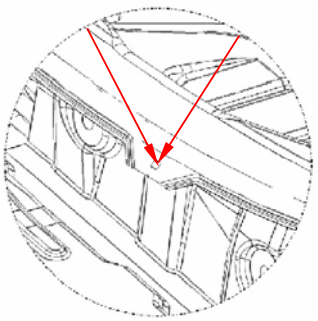
Unit: mm



Roof panel, side outer panel edge



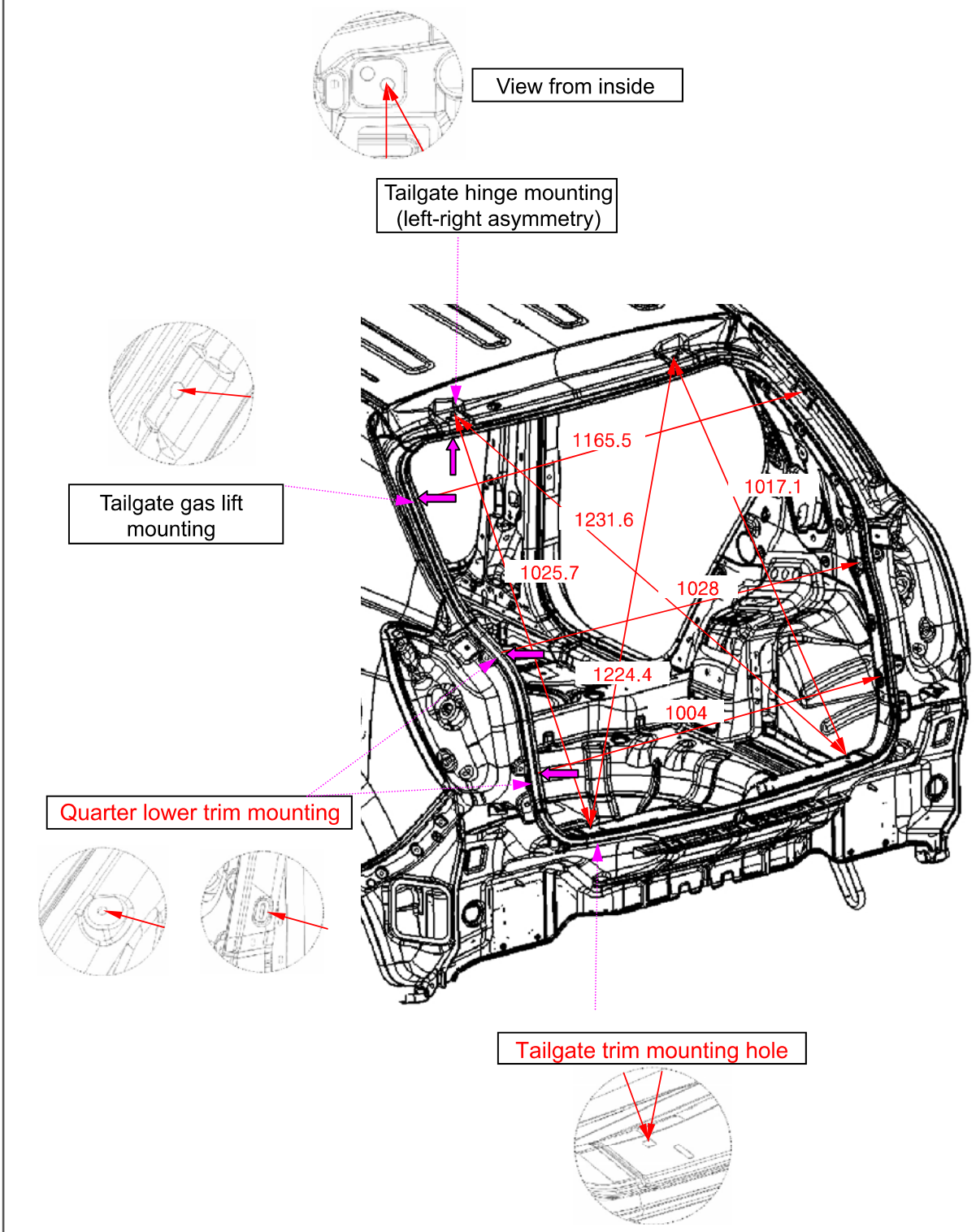
Windshield glass mounting



Modification basis	
Application basis	
Affected VIN	

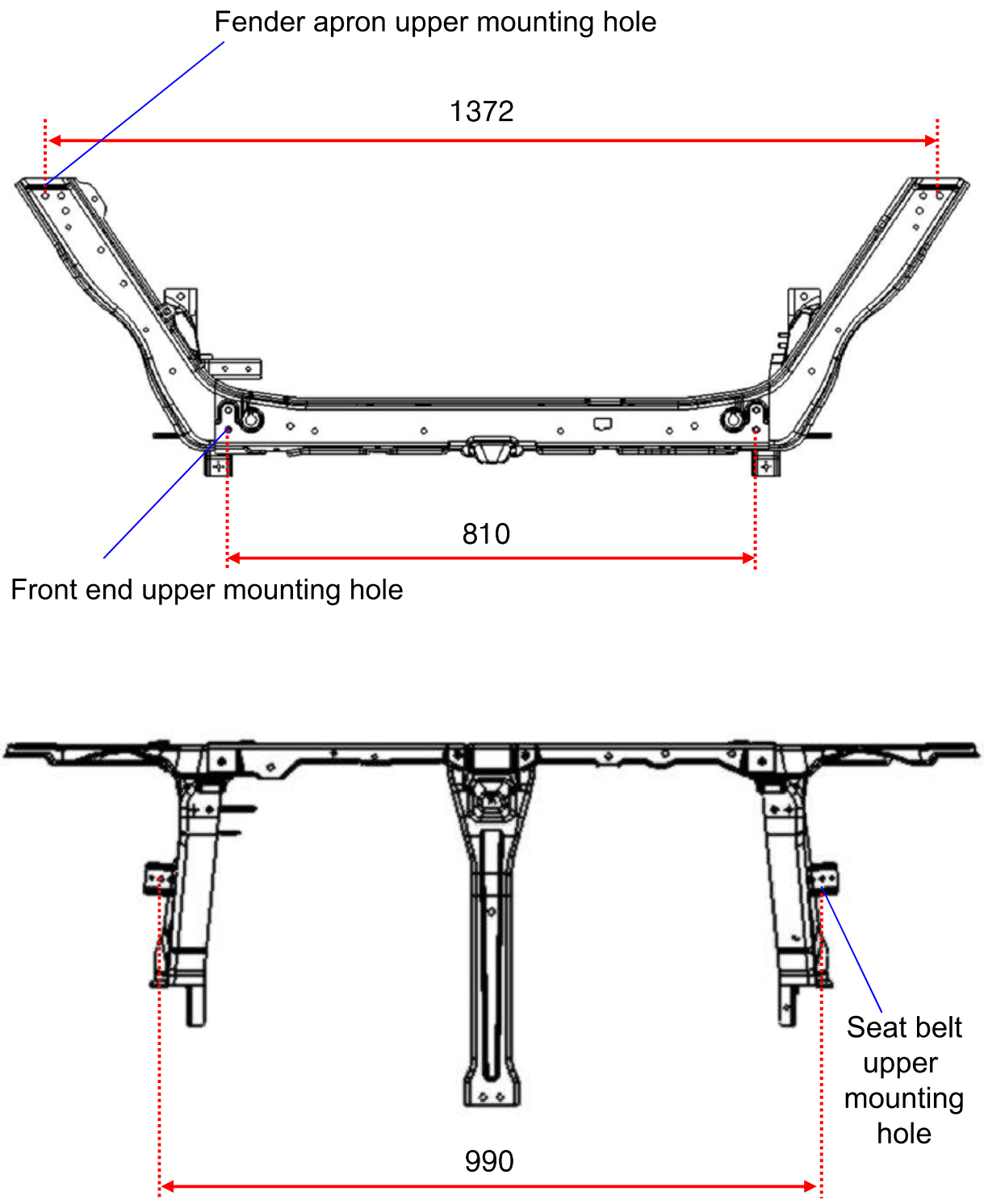
5) Tail Gate Area

Unit: mm



6) Front End

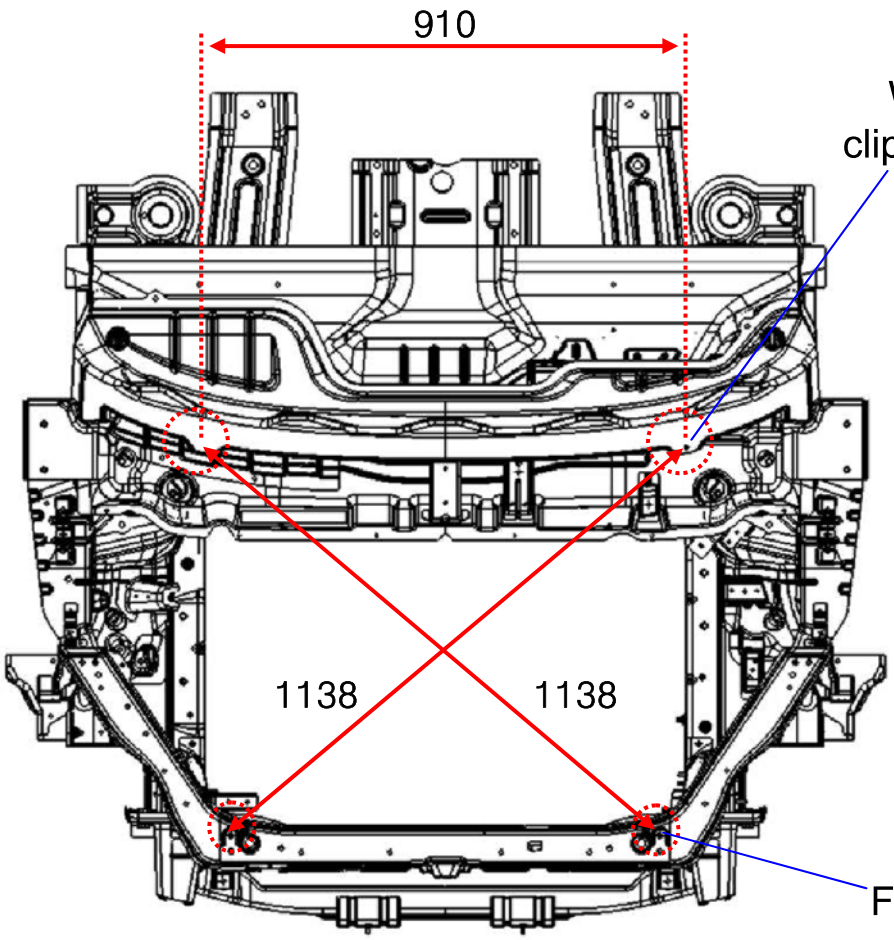
Unit: mm



Modification basis	
Application basis	
Affected VIN	

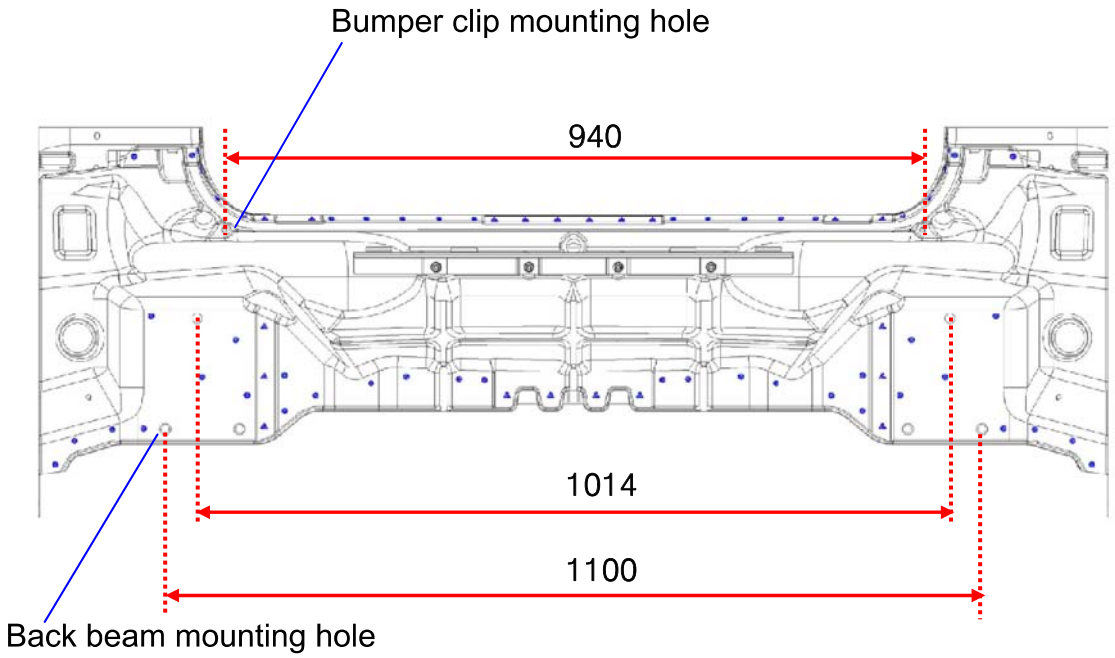
7) Engine Compartment

Unit: mm



8) Back Panel

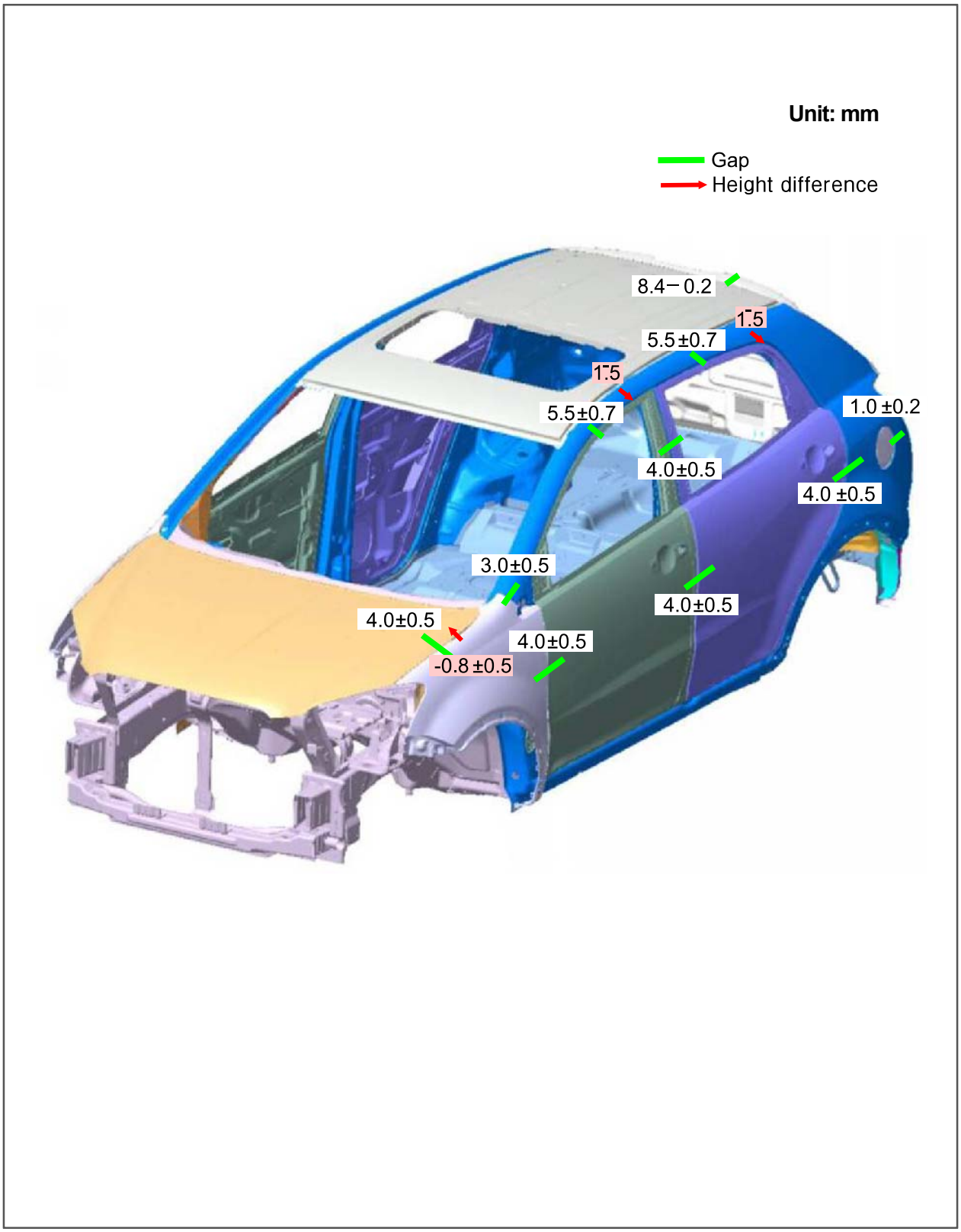
Unit: mm



Modification basis	
Application basis	
Affected VIN	

8. GAP CHART

1) Side Body



2) Front

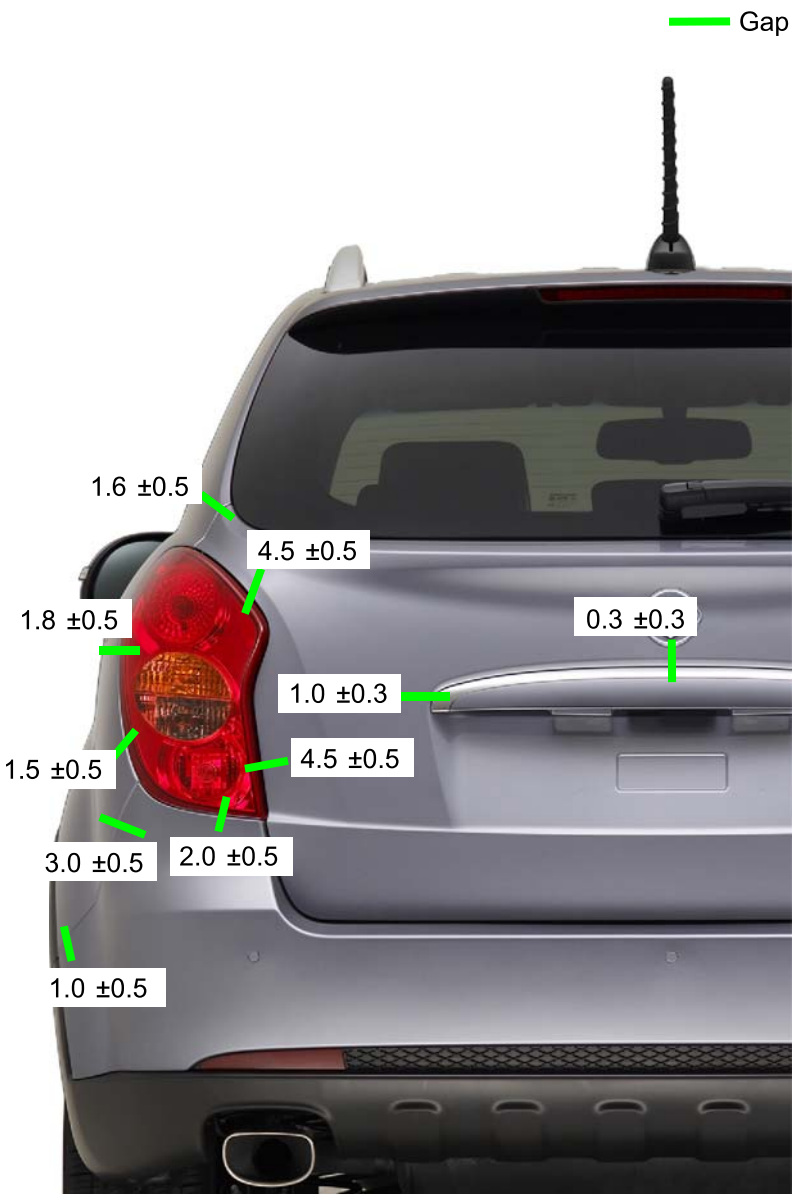
Unit: mm



Modification basis	
Application basis	
Affected VIN	

3) Rear

Unit: mm



Memo