ANTI-LOCK BRAKE SYSTEM

4825-00/4890-00/4890-01/4890-10/4892-01

GENERAL INFORMATION

OVERVIEW AND OPERATING PROCESS

CONFIGURATION

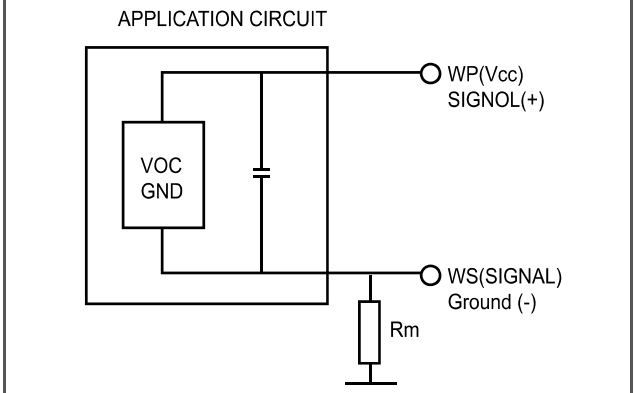
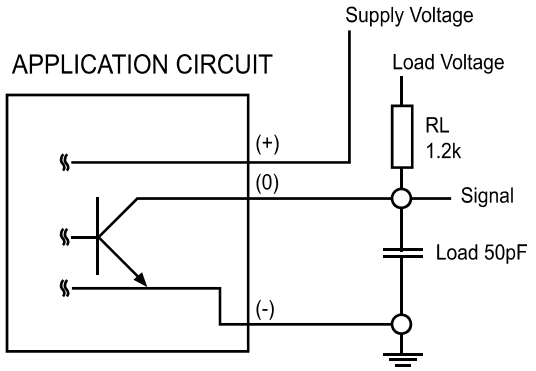
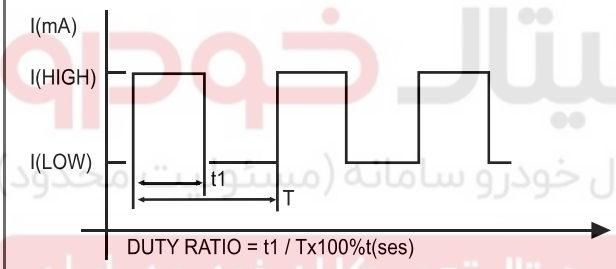
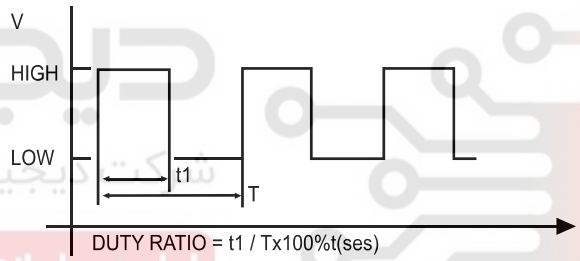
REMOVAL AND INSTALLATION

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	

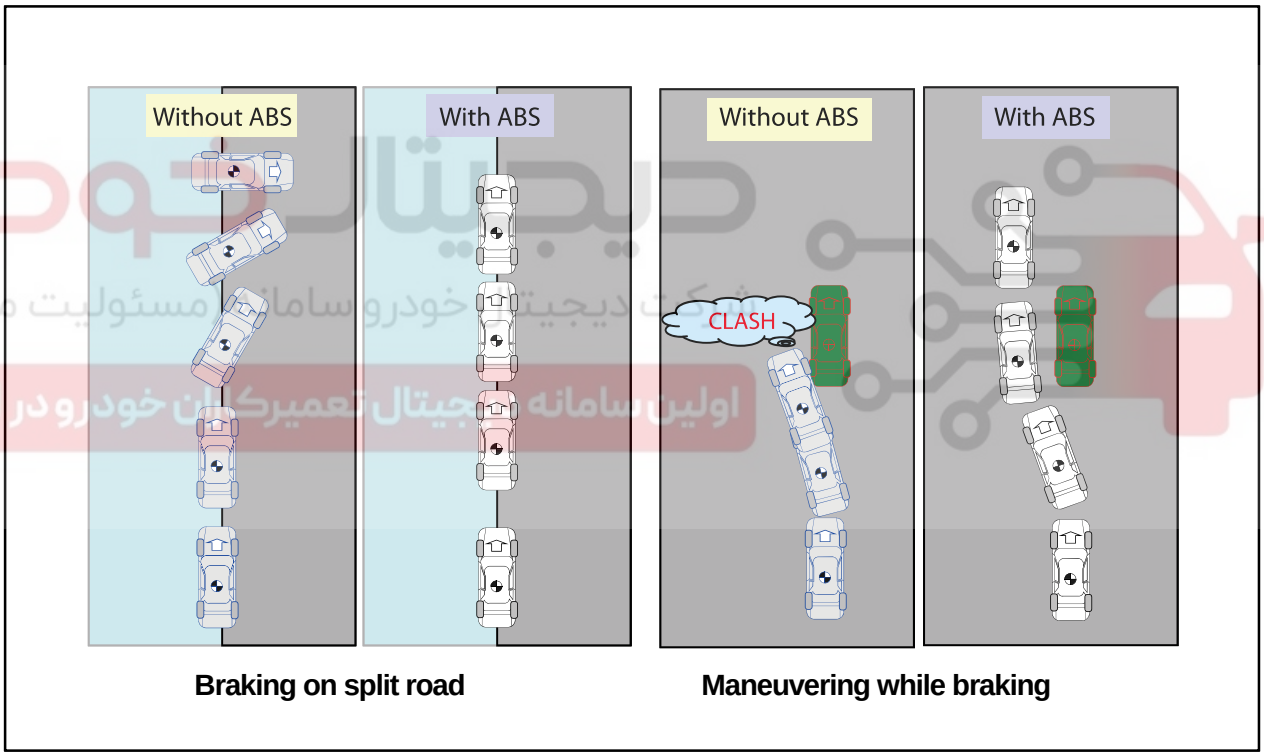
OVERVIEW AND OPERATING PROCESS

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**

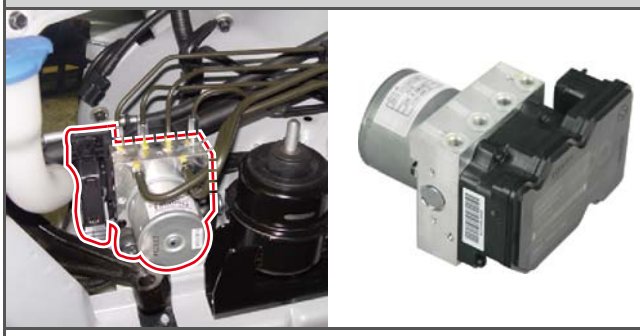
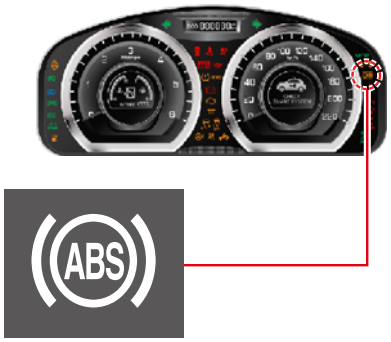


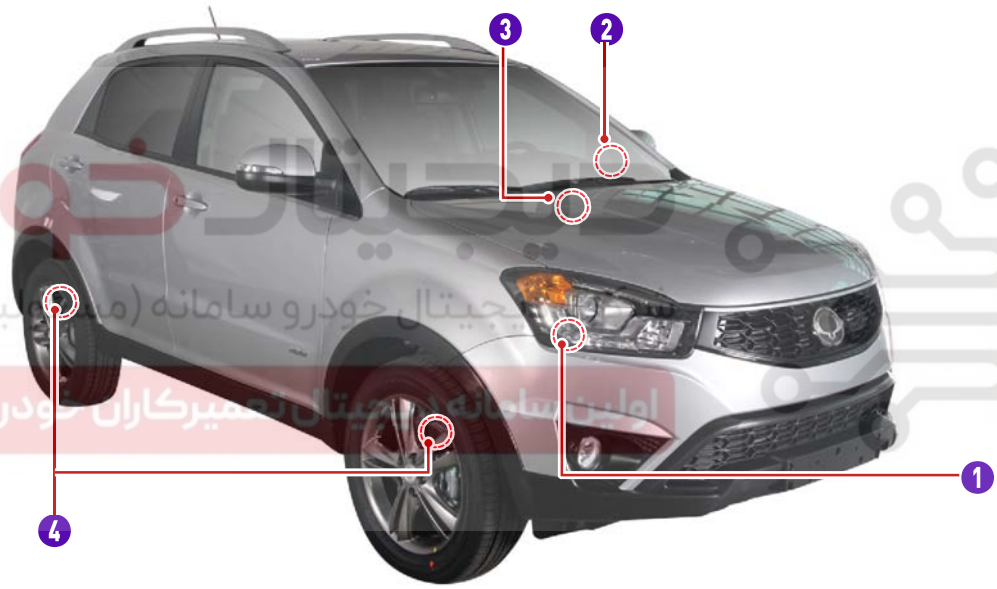
Braking on split road **Maneuvering while braking**

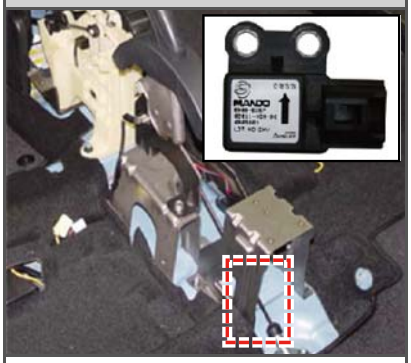
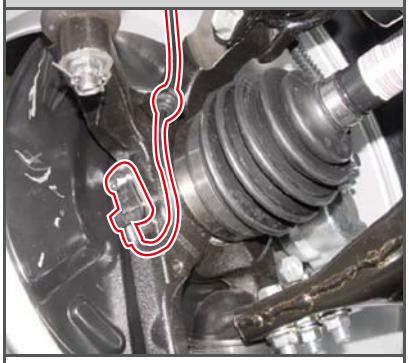
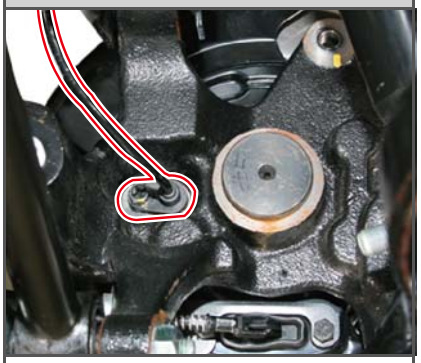
2) What is EBD (Electronic Brake-force Distribution)?

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.

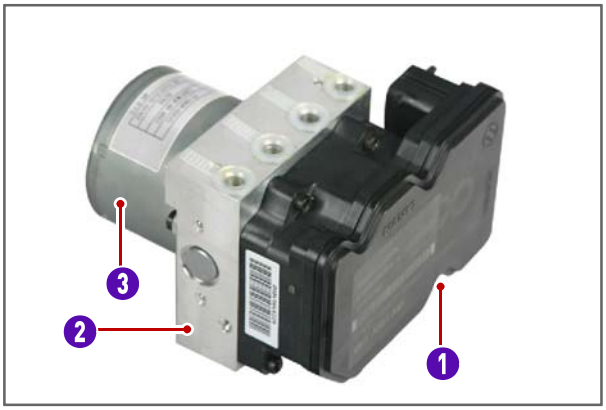
2. COMPONENT

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

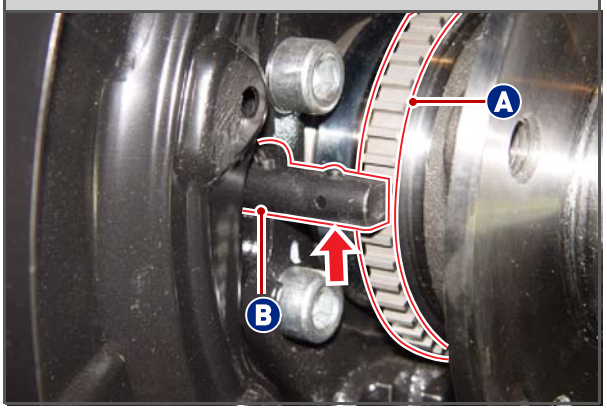
▶ **Wheel speed sensor**

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



Modification basis	
Application basis	
Affected VIN	

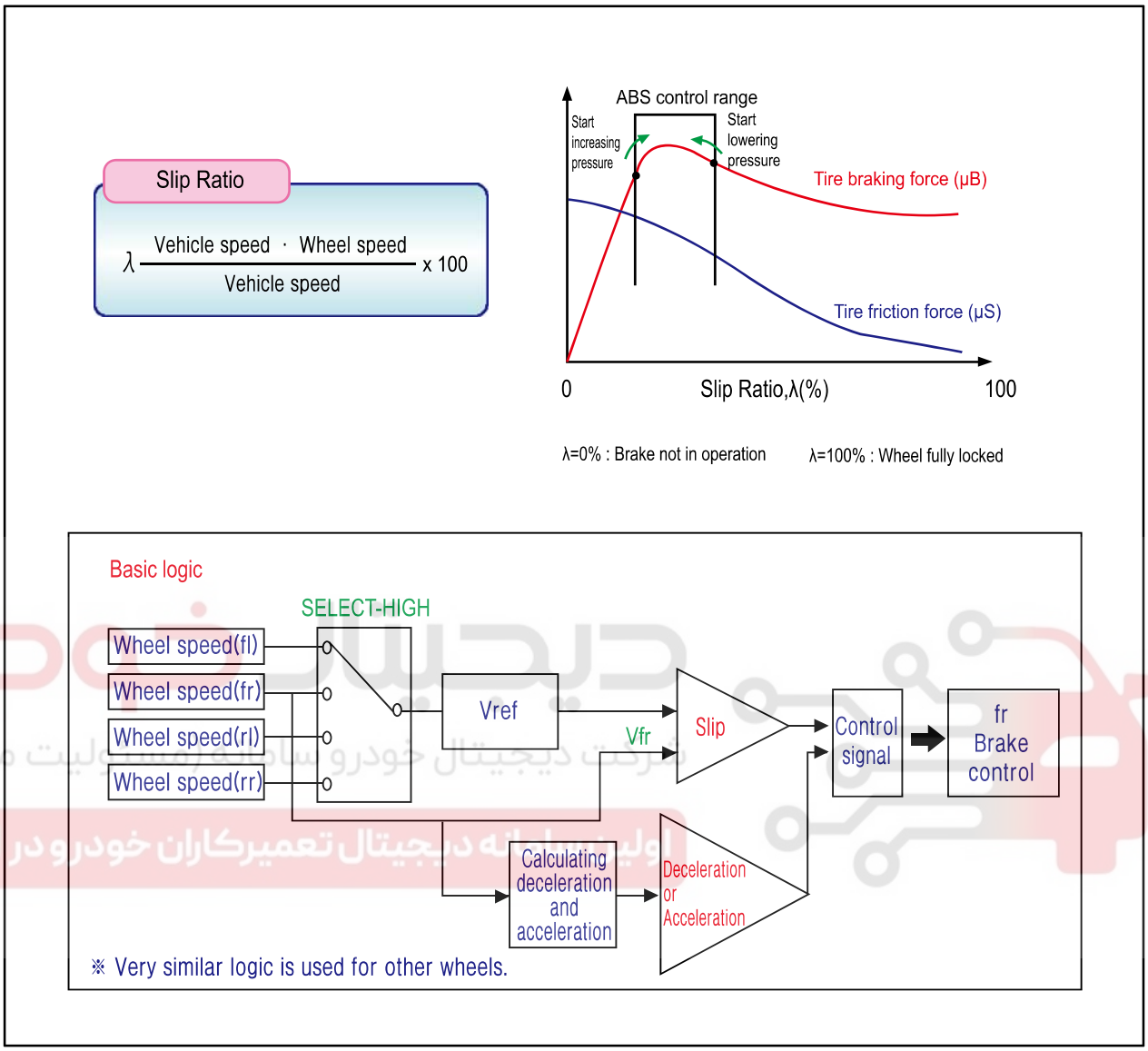
G-sensor


▶ 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.

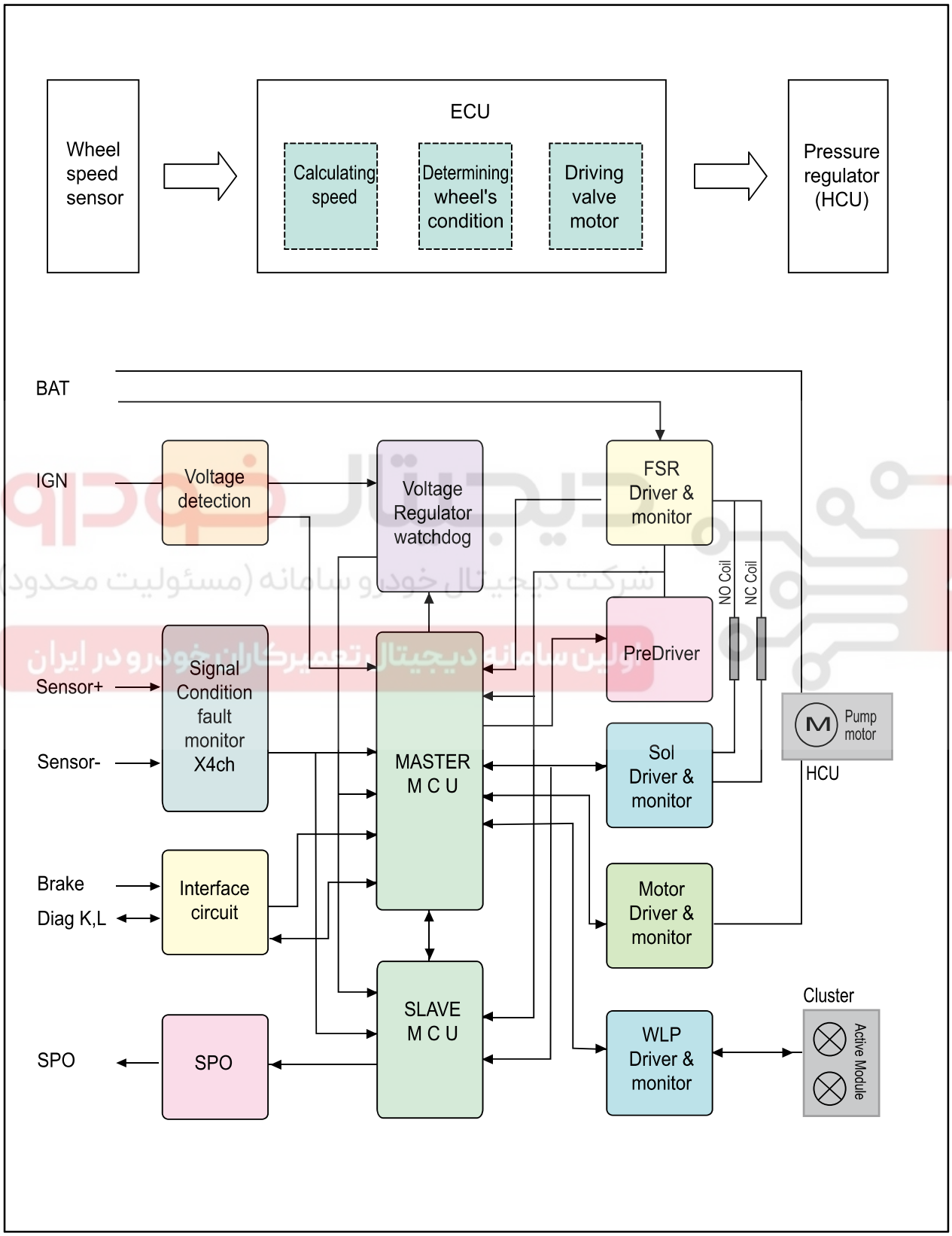
   a. When the solenoid valve is defective
   b. When one or more wheel sensors are defective
   c. When ABS HECU is defective
   d. When the voltage is abnormal
   e. When valve relay is defective

7. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

Modification basis	
Application basis	
Affected VIN	

5. SYSTEM OPERATION

1) Block Diagram of ABS HECU



Modification basis	
Application basis	
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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.

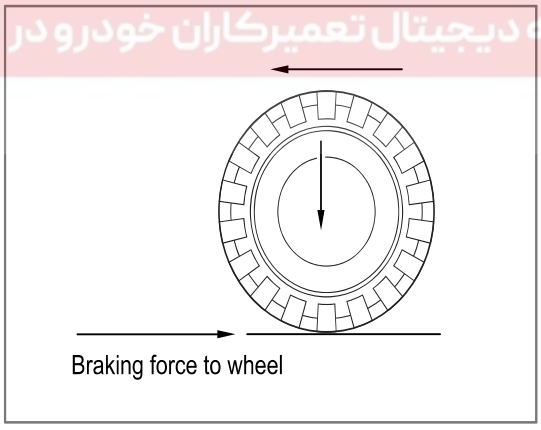
(1) Stopping distance

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

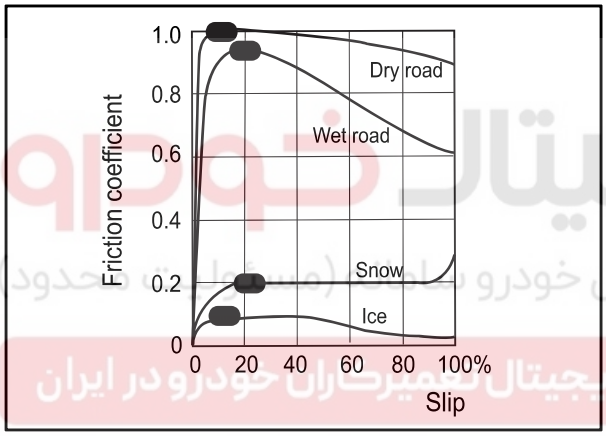
The brake slip is the difference between the vehicle speed and the wheel circumference speed. If the wheel locks, the slip is greatest, that is 100 %. If the wheel is running freely and un-braked, the slip is the lowest, equal to 0 %. Slip can be calculated from the vehicle speed Vveh and the wheel speed 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%

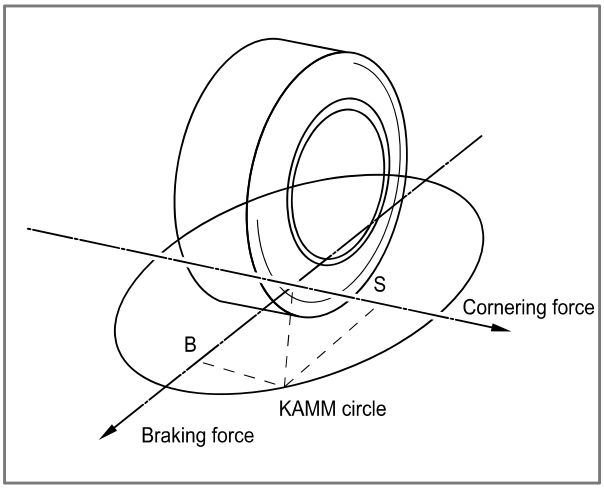
▶ Typical Slip Curves



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.

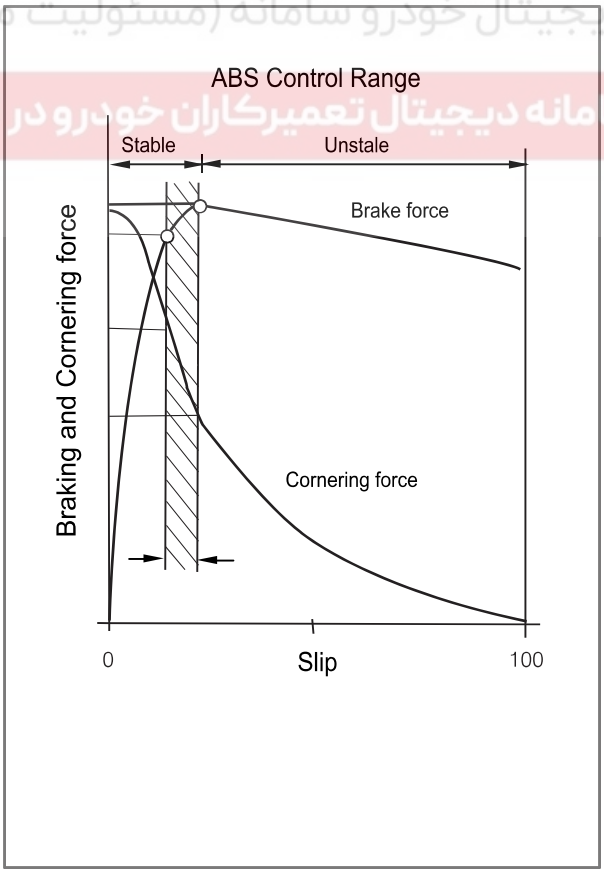
Modification basis	
Application basis	
Affected VIN	

▶ 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

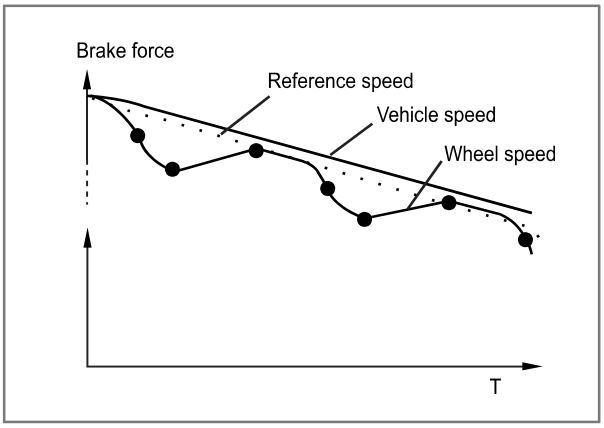


- Brake force
  When depressing the brake pedal the brake force increases to the maximum, then the brake force decreases until the wheel locks.
- Cornering force
  The cornering force is a maximum when the wheel is turning freely with zero slip. When braking the cornering force falls to zero if the wheel 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.

Modification basis	
Application basis	
Affected VIN	

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

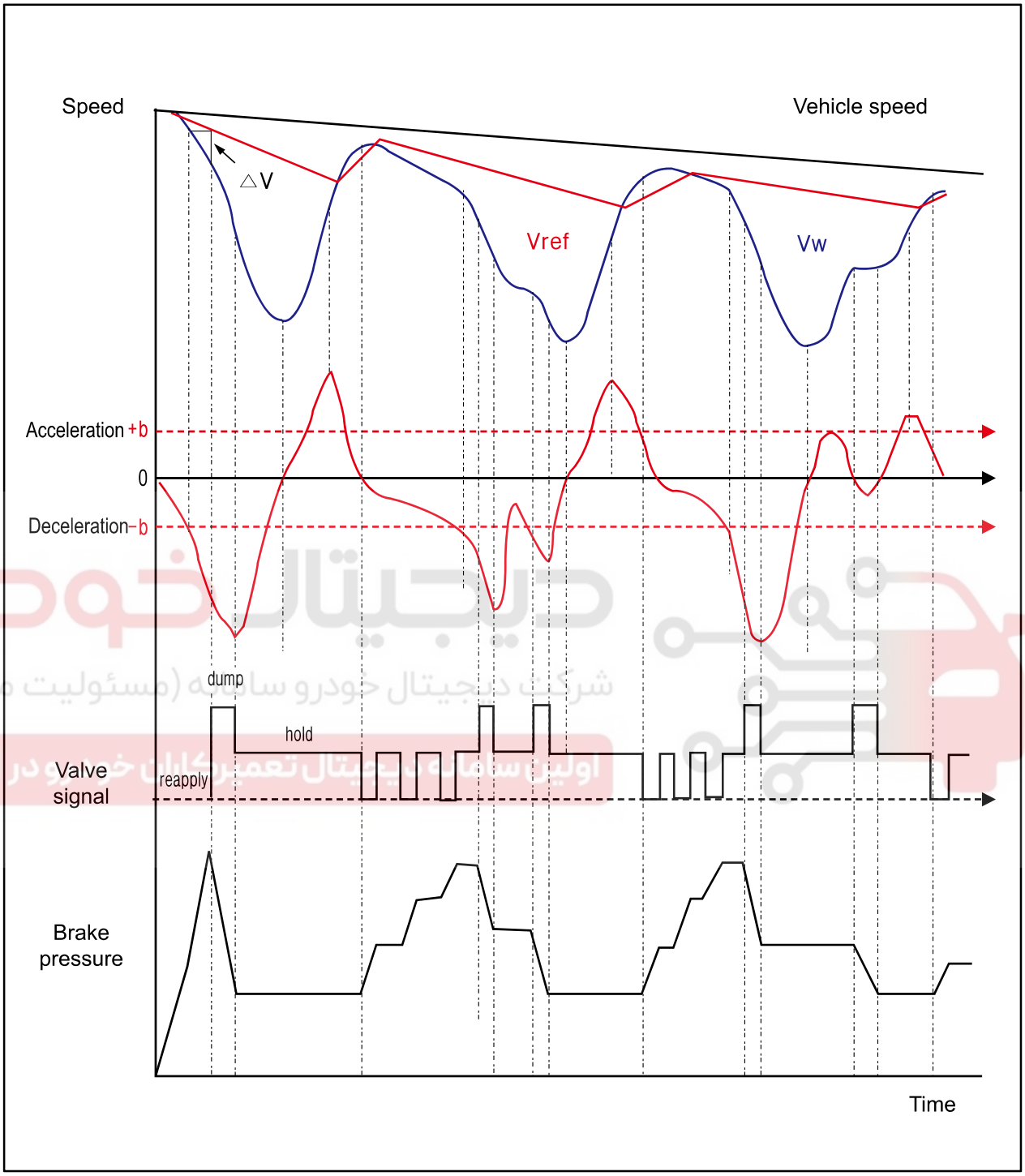
The reference speed is the mean, I.e. average speed of all wheel speeds determined by simple approximation.

▶ 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.

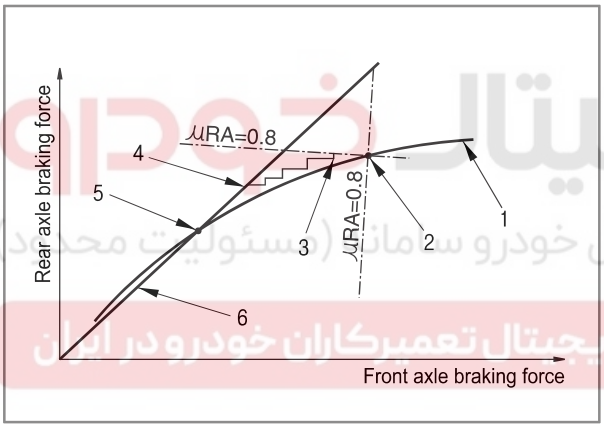
Modification basis	
Application basis	
Affected VIN	

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).

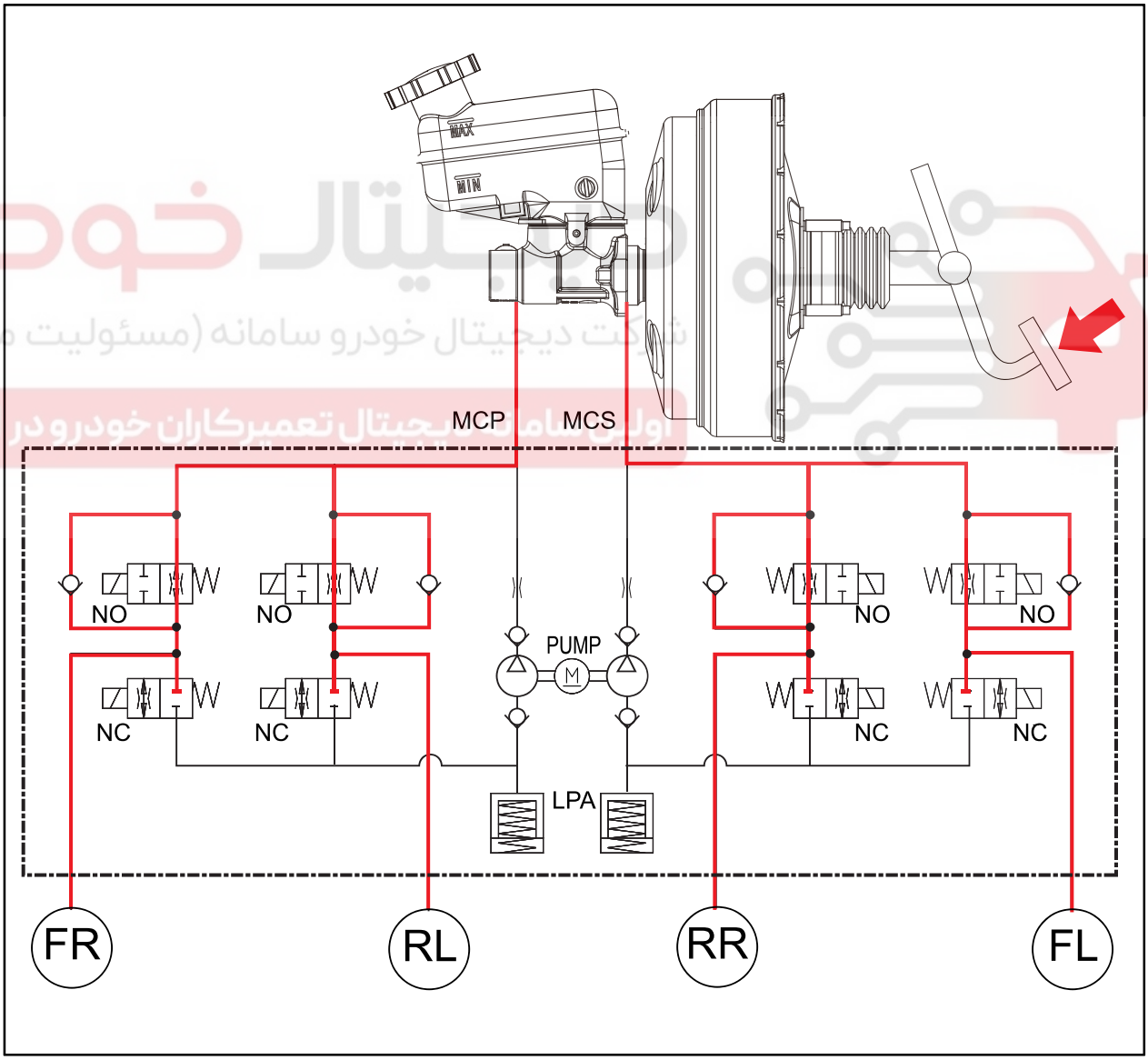
Modification basis	
Application basis	
Affected VIN	

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	

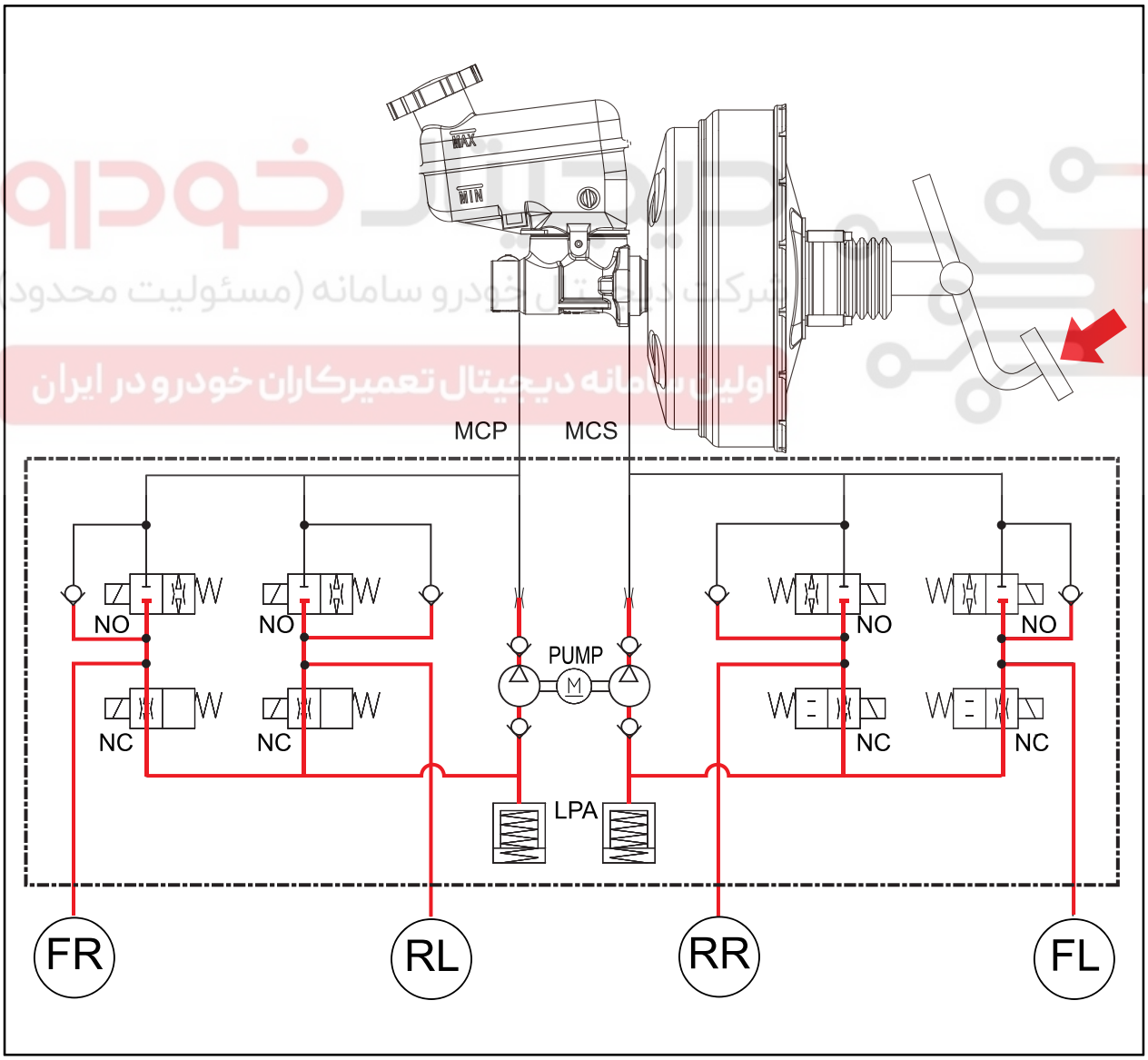


Modification basis	
Application basis	
Affected VIN	

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	
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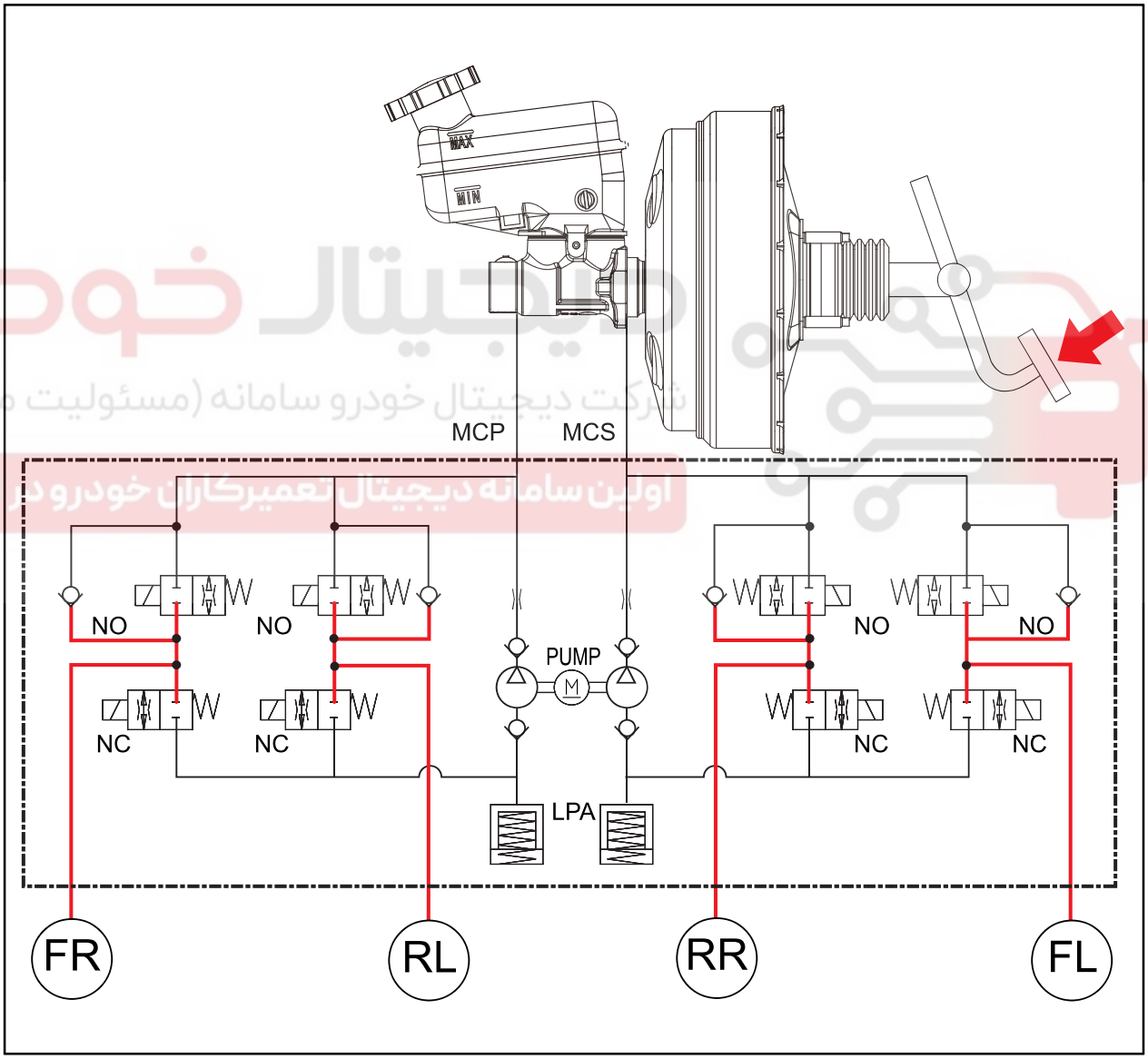
3) HOLD (ABS is working) Mode

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	



Modification basis	
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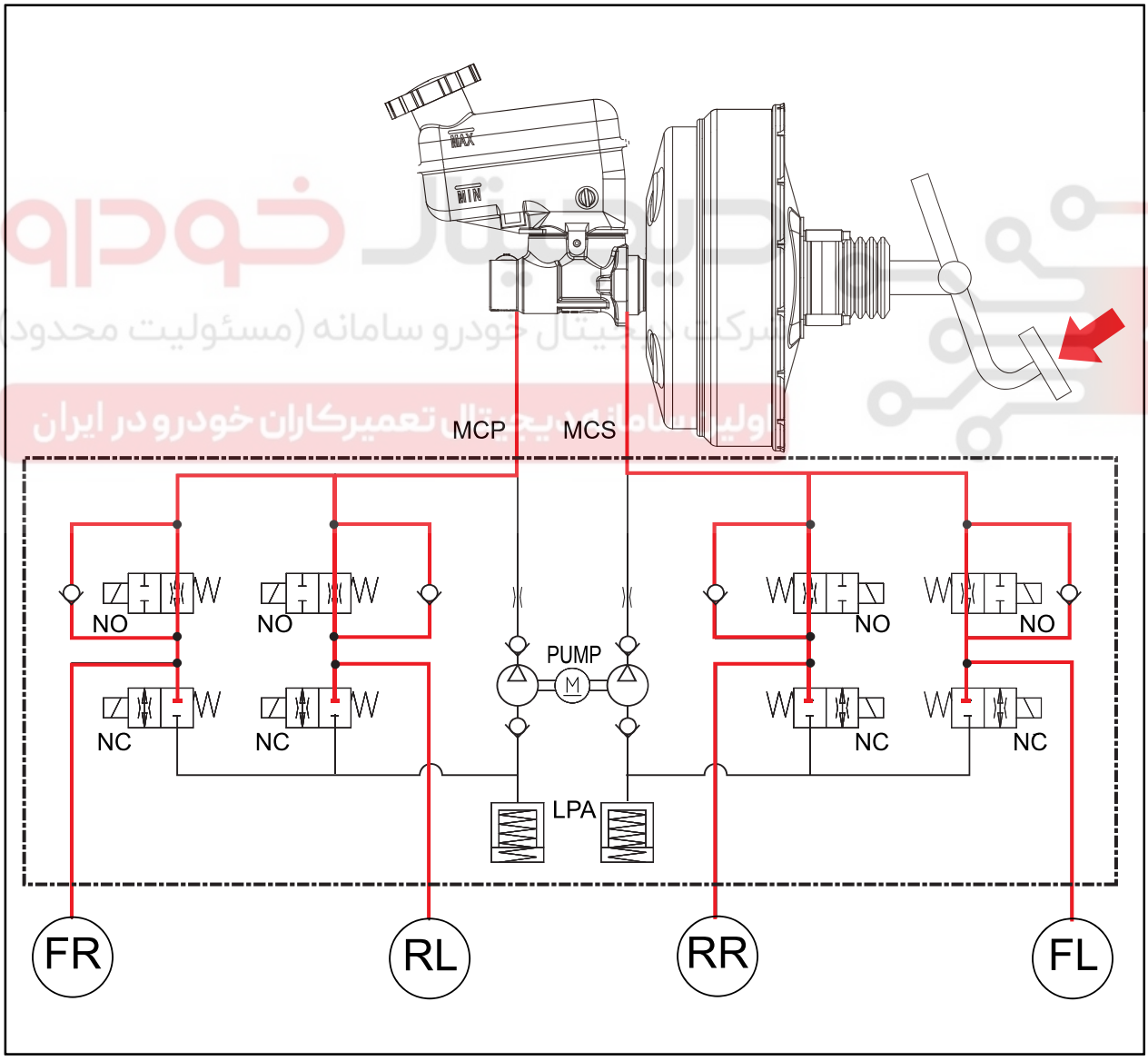
4) RISE (ABS is working) Mode

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	
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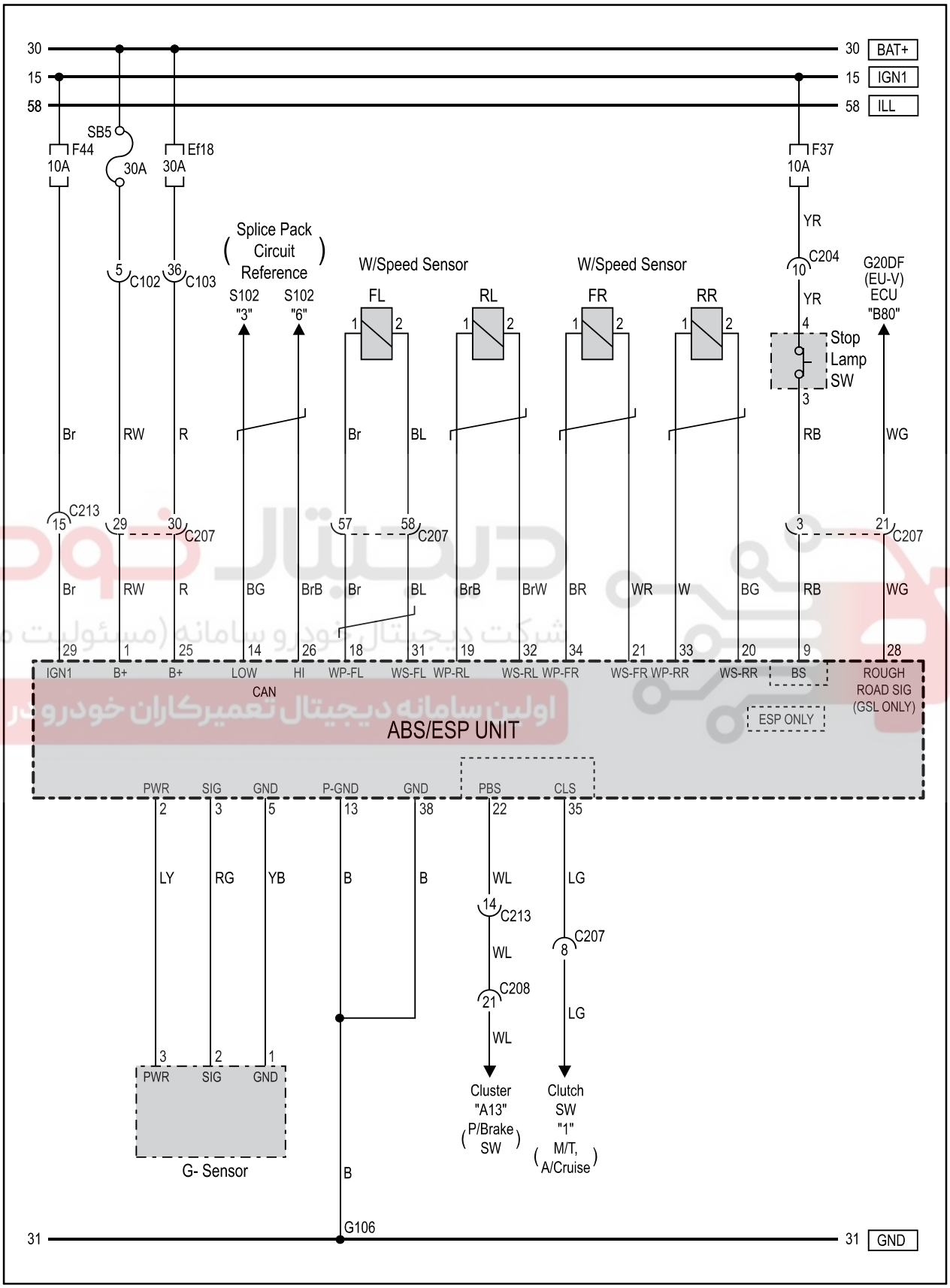
7. CIRCUIT DIAGRAM



Modification basis	
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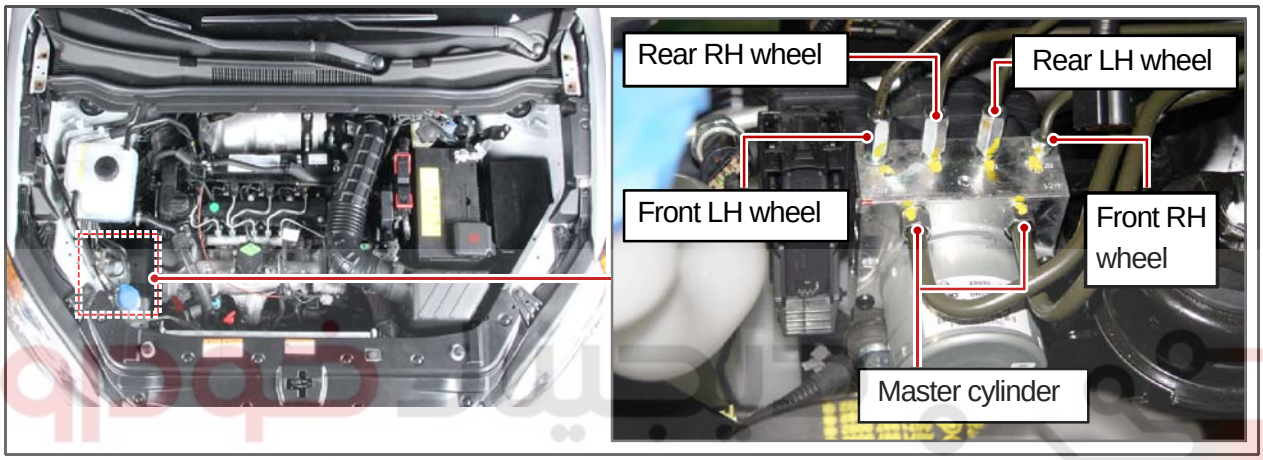
CONFIGURATION

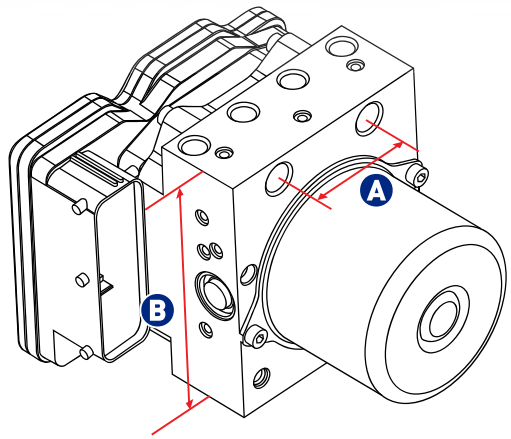
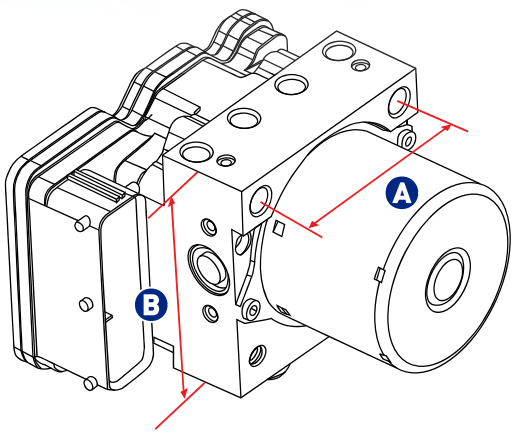
S.G.N. 4892-01

HECU (HYDRAULIC & ELECTRONIC CONTROL UNIT)

1) Mounting Location

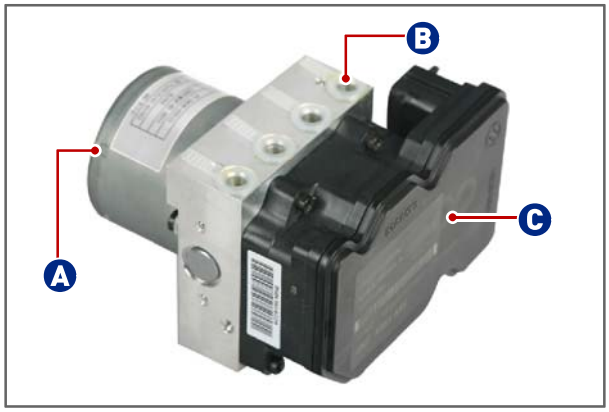
HECU (Hydraulic Electronic Control Unit) is located under power steering fluid reservoir.
HECU consists of motor pump, valve body and ECU with solenoid valves and pressure sensor, and ECU connector has 38 pins.



	Comparison between ESP HECU and ABS HECU	
	ESP HECU	ABS HECU
		
A	44.0mm	70.0mm
B	107.5mm	92.5mm

Modification basis	
Application basis	
Affected VIN	

2) Components Description of HECU



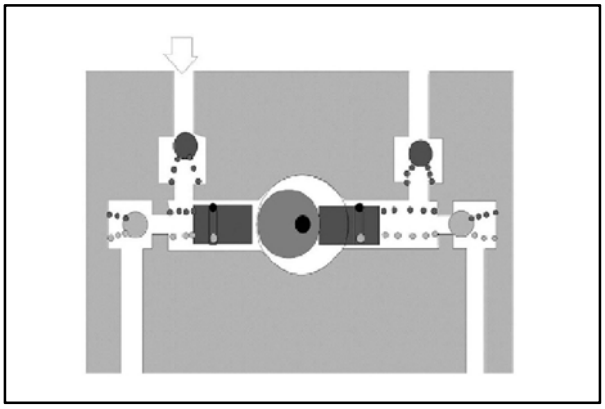
HECU consists of motor pump (A), solenoid valve (B), ECU (C) and pressure sensor.

1. **HCU (Hydraulic Control 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.

2. **Motor**

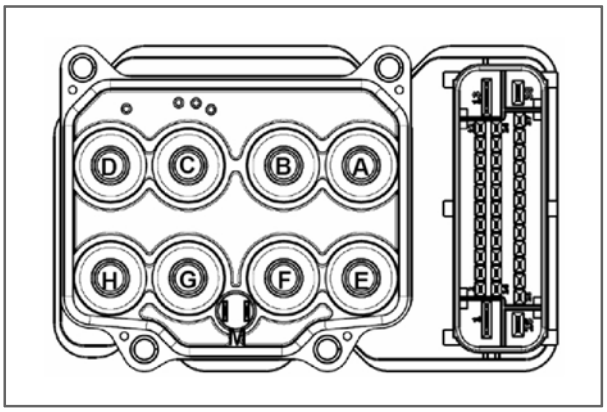
The motor is operated when ABS is activated. The cam-shaped output shaft of the motor enables the brake system to receive and supply the brake fluid during the motor operation.



▶ **Pumping**

When the cam pushes the left plunger during motor operation, the system pressure is generated in the left cylinder. At this time, the right plunger is expanded by spring force and the expanded volume of the right cylinder draws the brake fluid.

Modification basis	
Application basis	
Affected VIN	



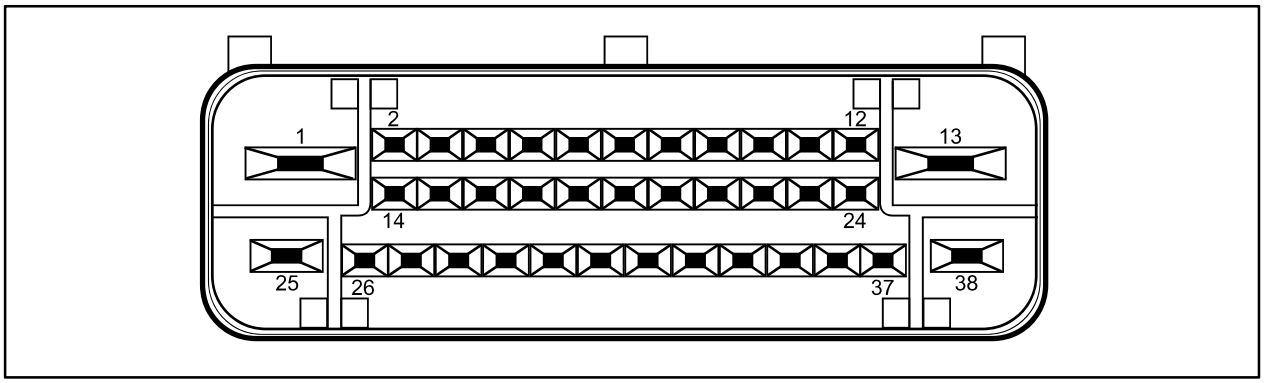
3. **ECU**

HECU controls the hydraulic valves by supplying or cutting off the voltage to solenoid valves depending on the wheel speed and other information from wheel speed sensors.
The ABS ECU has 8 solenoid valves.
It has four channels; 2 channels for front wheels and 2 channels for rear wheels.
Each channel has one inlet and one outlet valve, therefore, there are eight solenoid valves.

A: Outlet valve (FL)
B: Outlet valve (RR)
C: Outlet valve (RL)
D: Outlet valve (FR)
E: Inlet valve (FL)
F: Inlet valve (RR)
G: Inlet valve (RL)
H: Inlet valve (FR)

Modification basis	
Application basis	
Affected VIN	

3) ABS HECU Connector



Pin No.	Function	Remarks
1	BAT2	Motor
2	G sensor power	only for ABS 4WD
3	G sensor signal	only for ABS 4WD
4	-	
5	G sensor ground	
6	-	
7	-	
8	-	
9	-	
10	-	
11	-	
12	-	
13	Ground	
14	CAN Low	
15	-	
16	-	
17	Rear right sensor output (RR OUT)	
18	Power - wheel speed sensor (FL)	
19	Power - wheel speed sensor (RL)	
20	Signal - wheel speed sensor (RR)	
21	Signal - wheel speed sensor (FR)	
22	-	

Pin No.	Function	Remarks
23	Stop lamp switch	
24	-	
25	BAT1	Solenoid
26	CAN High	
27	-	
28	Front right sensor output (FR OUT)	
29	IGN1	CE
30	-	
31	Signal - wheel speed sensor (FL)	
32	Signal - wheel speed sensor (RL)	
33	Power - wheel speed sensor (RR)	
34	Power - wheel speed sensor (FR)	
35	-	
36	-	
37	-	
38	Ground	

Modification basis	
Application basis	
Affected VIN	

S.G.N. 4890-01

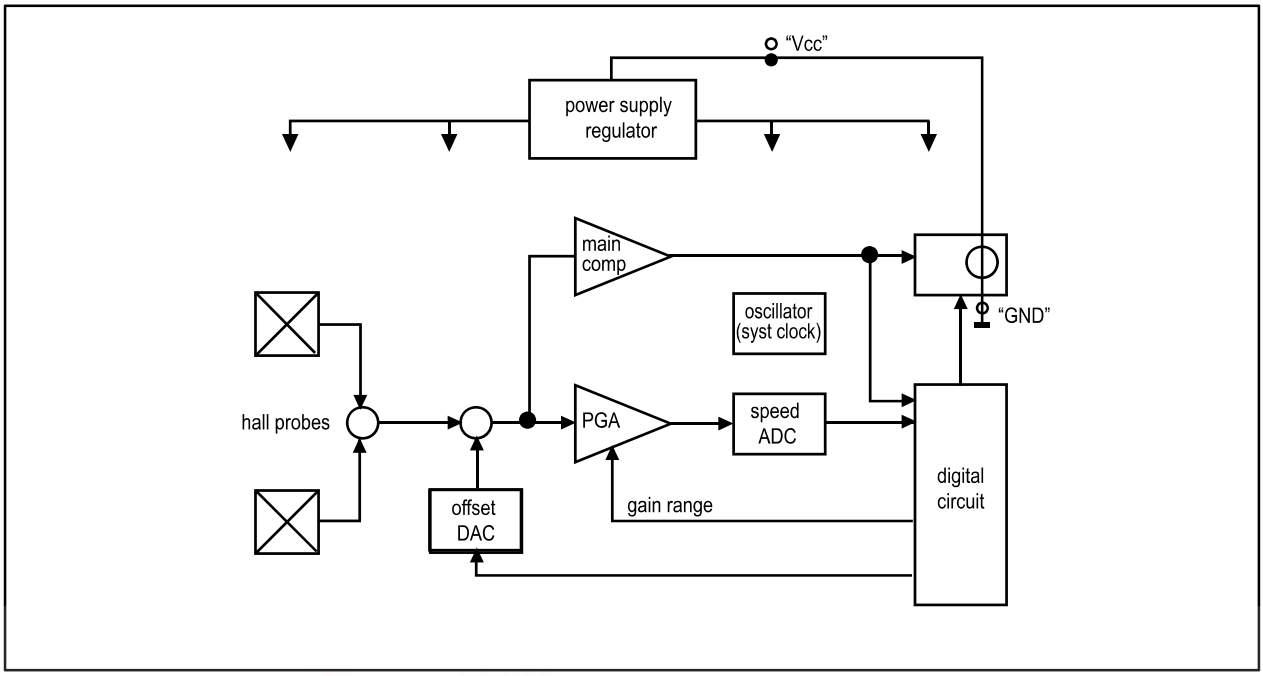
ACTIVE WHEEL SPEED SENSOR

1) Mounting Location

The wheel speed sensors are mounted to wheel knuckles and all of the sensors have the same appearance. But the rear wheel speed sensor for 2WD is little bit different.
For 4WD, the tone wheels are mounted to the drive shafts, while the tone wheels for 2WD are mounted to the rear side hub.

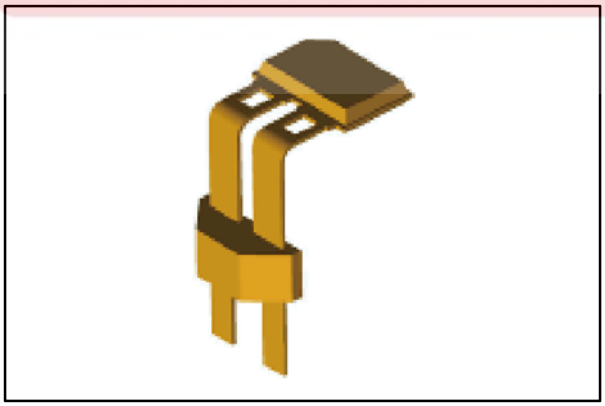
Modification basis	
Application basis	
Affected VIN	

2) Block Diagram



- Two hall elements with varying voltage according to magnetic field
- Power supply (12 V)
- Amplifier/Comparator
- Analog/digital converter

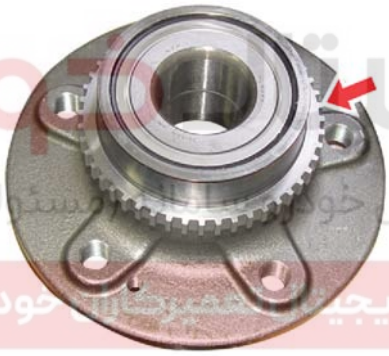
3) Hall Type Active Wheel Speed Sensor



The IC consists of 2 hall elements and a plastic housing with peripheral circuits integrated, and there is a capacitor for EMI performance improvement in the center of the lead frame. The 2 lead frames are for signal output and voltage supply.

Modification basis	
Application basis	
Affected VIN	

4) Function of Active Wheel Speed Sensor System

Tone Wheel
Tone wheel in drive shaft (4WD-front, rear/2WD-front) 
Tone wheel in hub (2WD-rear) 

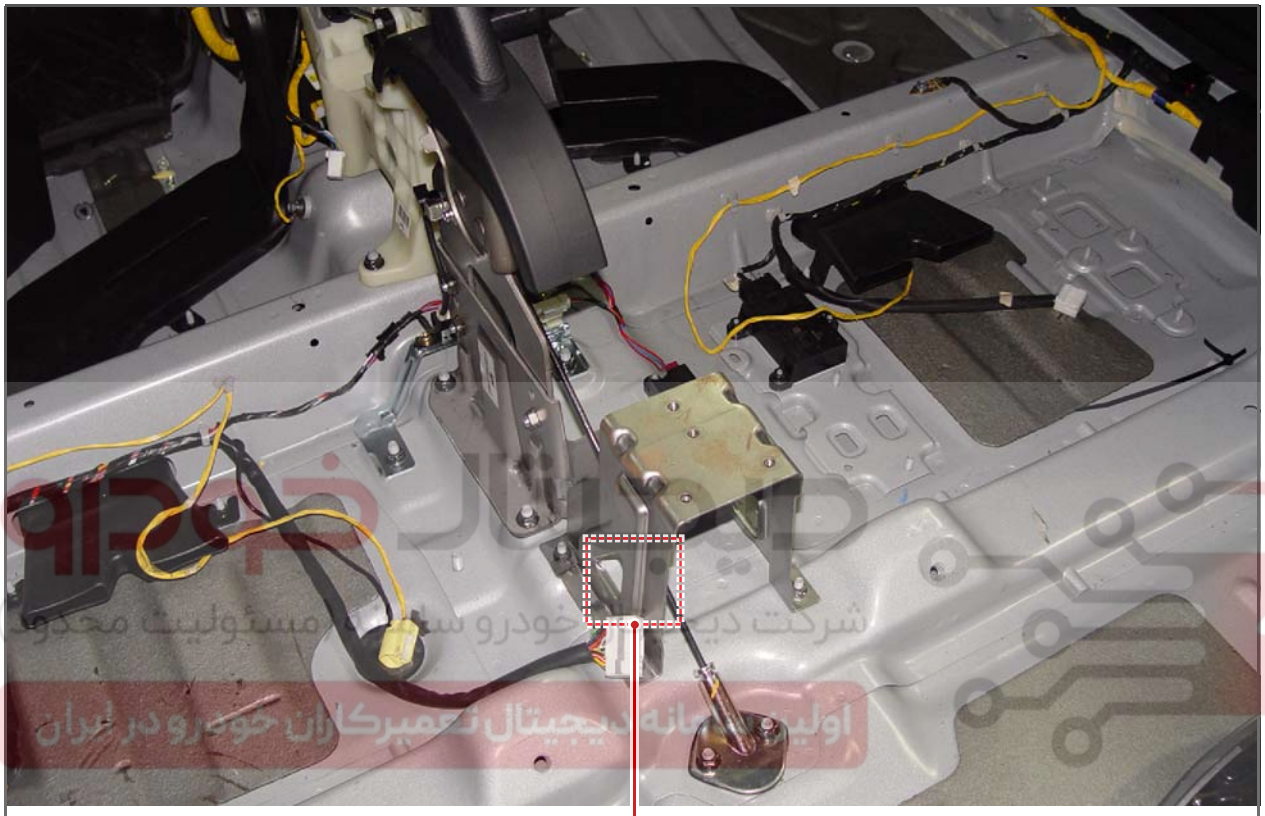
- Basically, the tone wheel or the magnetized encoder wheel is required to activate the sensor. When the wheel rotates, the magnetic flux is changed as a sine wave form and this change is converted to voltage value by the hall elements. The voltage of sine wave form is amplified by the amplifier and finally converted to rectangular wave form by the comparator. This signal is transmitted to the ABS control unit to measure the speed.
  When the vehicle wheel rotates, the tone
- wheel rotates, and this rotation of the wheels changes the magnetic flux of the sensor and generates the induced electromotive force. The frequency of this duty waveform changes relative to the number of the rotation counts, and this frequency is controlled to detect the wheel speed.

S.G.N. 4890-09

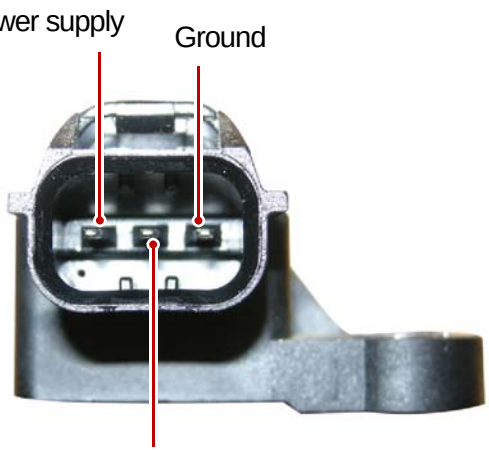
G-SENSOR (ONLY FOR 4WD)

1) Mounting Location

The G-sensor is fitted on the floor under the parking brake bracket in the center console. The ABS HECU is activated via the signal from the longitudinal acceleration sensor (G-sensor) module.



The arrow shown on top of the G-sensor should point straight forward when fitting.



Modification basis	
Application basis	
Affected VIN	

REMOVAL AND INSTALLATION

S.G.N. 4825-00

AIR BLEEDING

1) Air Bleeding Should be Done When

- After removal and installation of the brake master cylinder.
- After removal and installation of the ABS HECU.
- After removal and installation of the brake oil pipes and hoses.
- After replacing the brake fluid.

2) Precautions

- Wipe off any brake fluid on the paintwork immediately.
- The HECU for after sale service is filled with brake fluid, so below air bleeding processes should be carried out to bleed the internal circuit.
- The air bleeding should be repeated until bubbles come out and the break operating status should be checked at the final step.

3) Air Bleeding Procedure (With Diagnostic Tool)

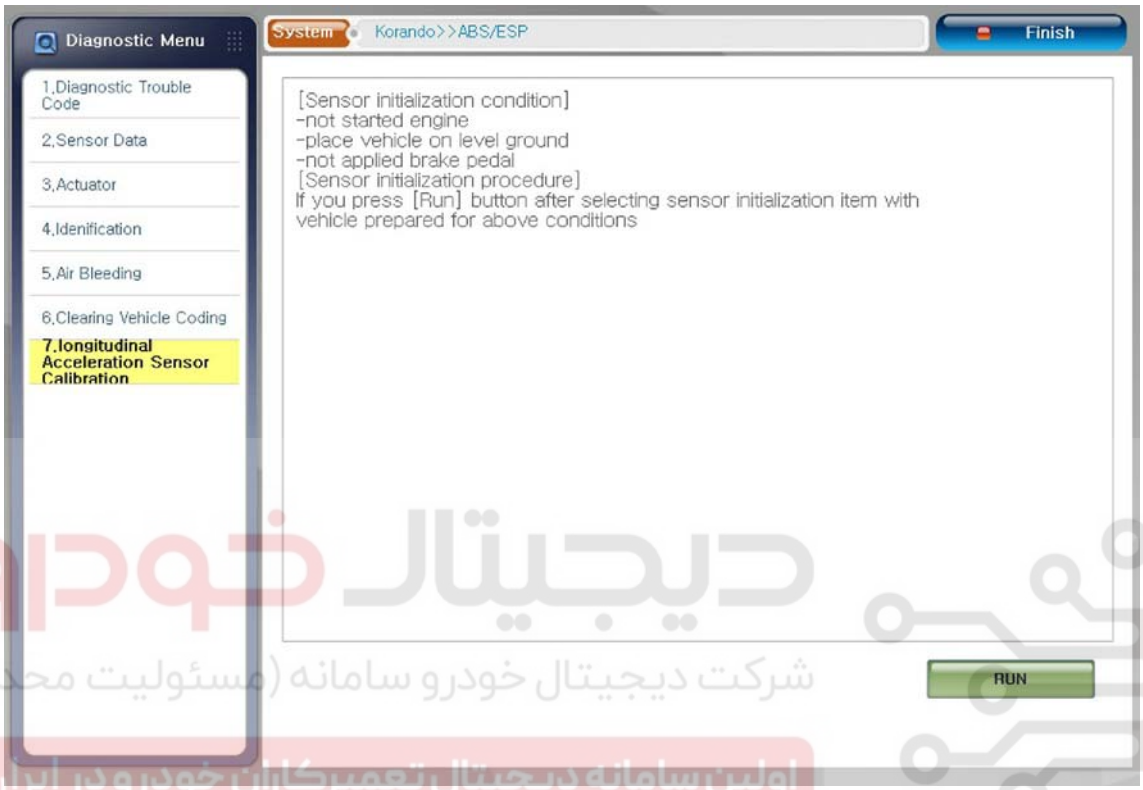
1. Apply the parking brake and start the engine when the shift lever is at “N(M/T)” or "P(A/T)" position.
2. Connect the oil supply device (air bleeding device) with air compressor to the brake fluid reservoir. The oil supply device should be filled with sufficient oil.
3. Loosen the air bleed screw in caliper and place an empty container under the screw.
4. Bleed the air in each wheel by using diagnostic device's air bleeding menu. At this time, the modulator motor runs for 180 seconds.
5. Simultaneously, run the oil supply device to supply oil and depress the brake pedal repeatedly. This procedure needs at least 3 persons for doing below jobs:
6. a. Collect the bleeding oil from the air bleed screw into the container.
   b. Depress the brake pedal repeatedly.
   c. Check the conditions of oil supply device.
   The air bleeding procedure should be started from the rear right wheel.
   Repeat the step 4 through 5 until clear brake fluid comes out of air bleed screw. Perform the same
7. procedures at each wheel.

Modification basis	
Application basis	
Affected VIN	

4) Air Bleeding by using Diagnostic Tool

(1) Sensor calibration (Initialization)

Performing a sensor initialization in the ESP diagnosis menu which enables the initialization of the sensor (only for ESP).



After confirming the vehicle conditions are met, click the "Run" button to start the initialization.

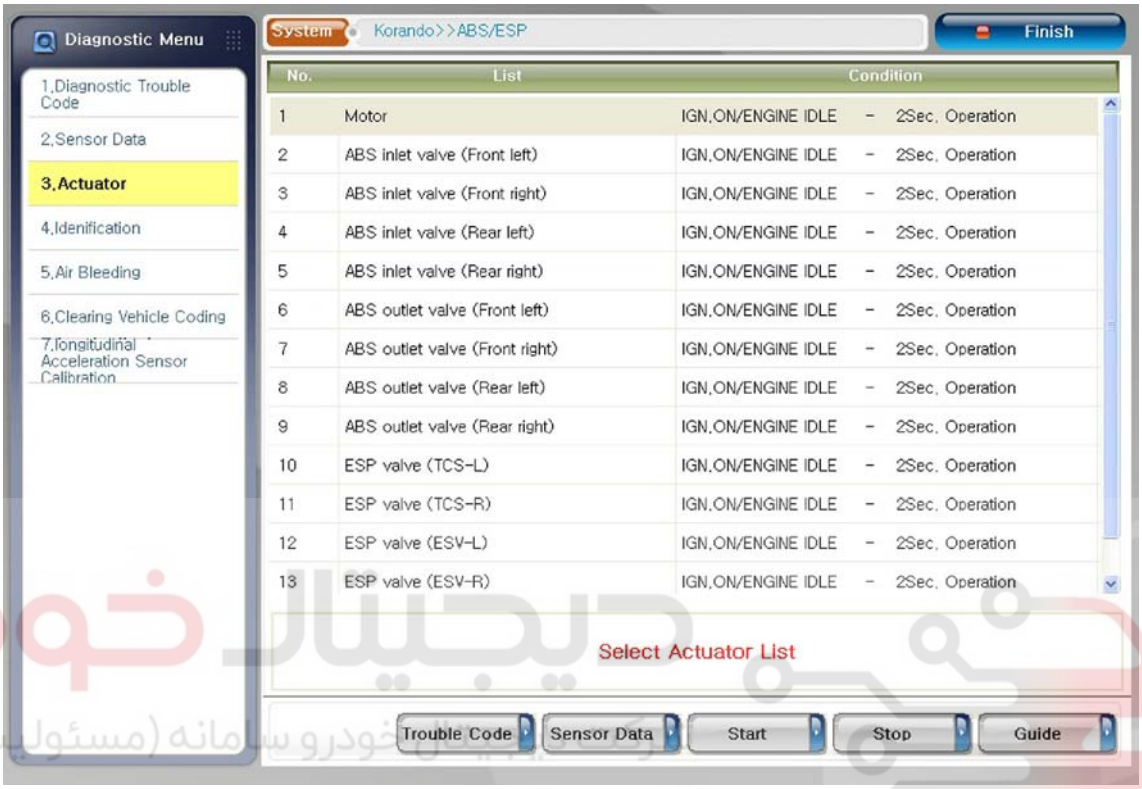
▶ **Steering wheel angle sensor**

- The steering wheel angle sensor automatically searches for a center position when the vehicle is driving straight forward with 20 km/h of driving speed (no additional diagnostic menu).

Modification basis	
Application basis	
Affected VIN	

(2) Operation Check

Select the "Actuator" in the diagnosis menu.



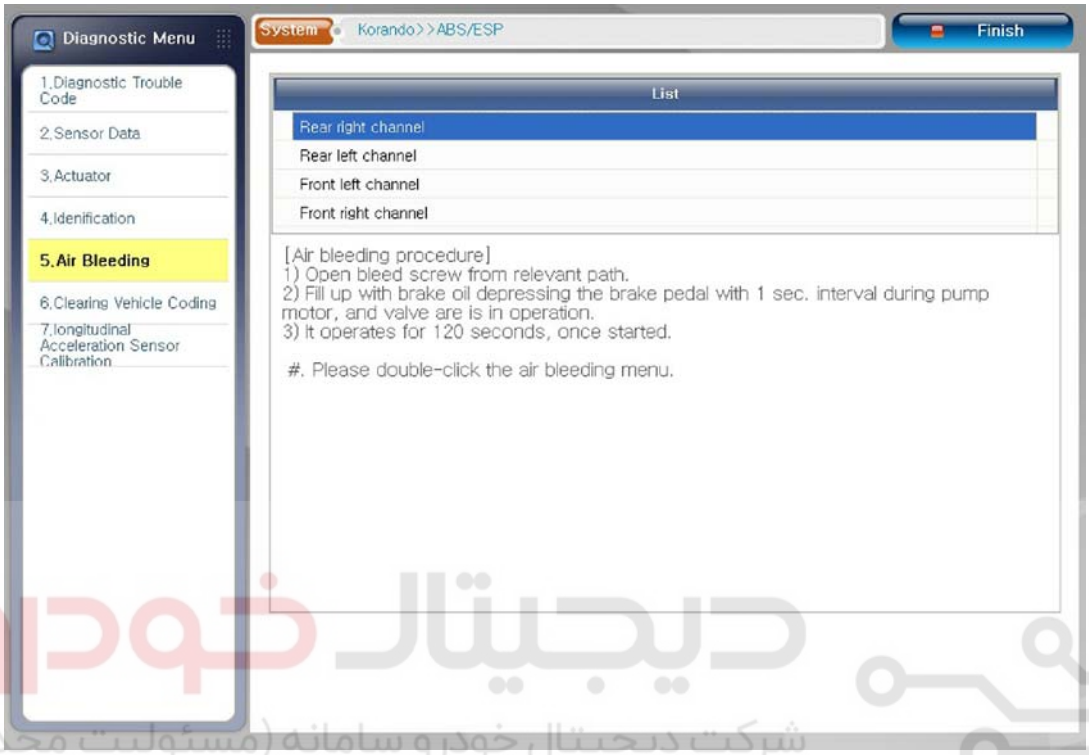
Pressing the "Start" button after selecting the desired device from the forced operation list enables the forced operation for 10 seconds.

NOTE

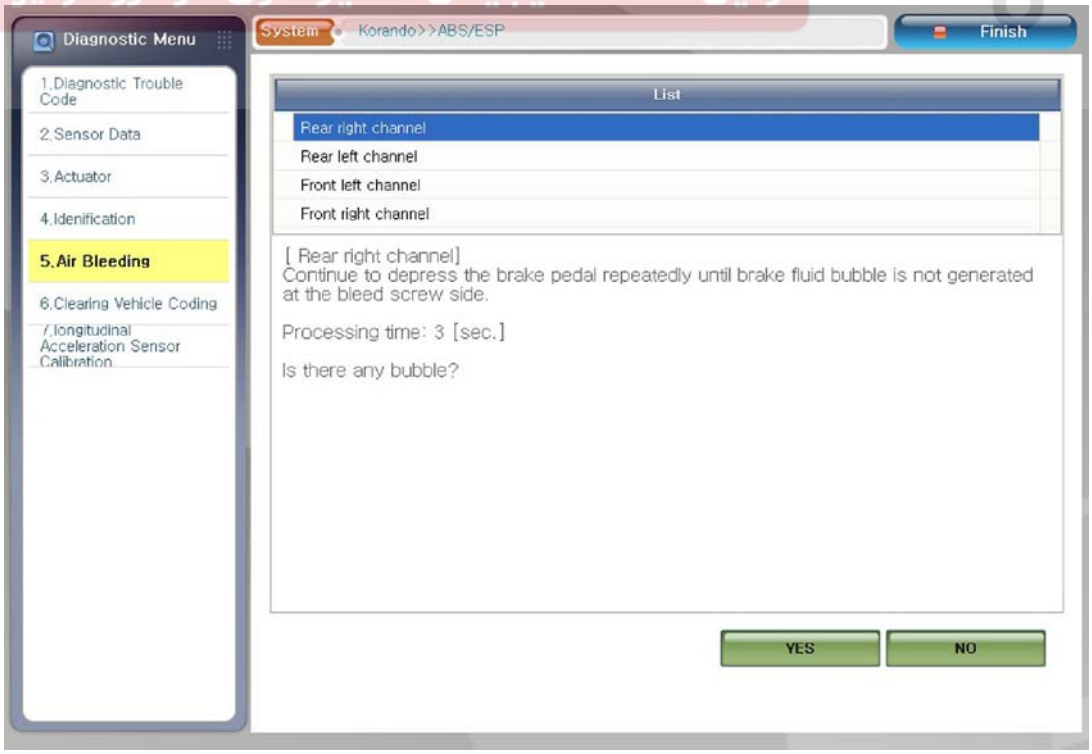
All components except the pump motor require brake pedal operation and can be checked by the forced operation.
Input/primary valve -> The brake pedal gets heavy and is not depressed completely.
Output/secondary valve -> The brake pedal is light and is depressed fully.

(3) Air bleeding

Select the "Air Bleeding" in the diagnosis menu. After confirming the vehicle conditions are met, click the "YES" button to start the initialization.

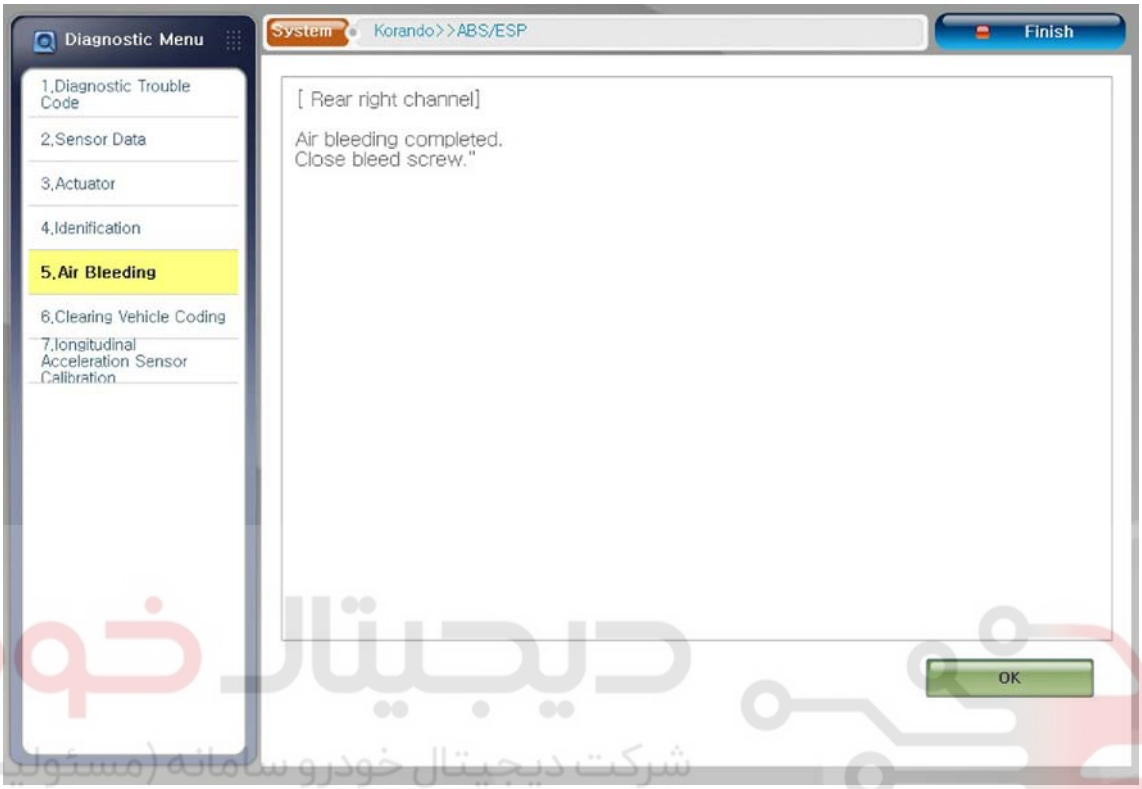


If no bubbles come out from the bleed screw, then click "YES".



Modification basis	
Application basis	
Affected VIN	

The pump motor stops operating with the message "Air Bleeding Completed".

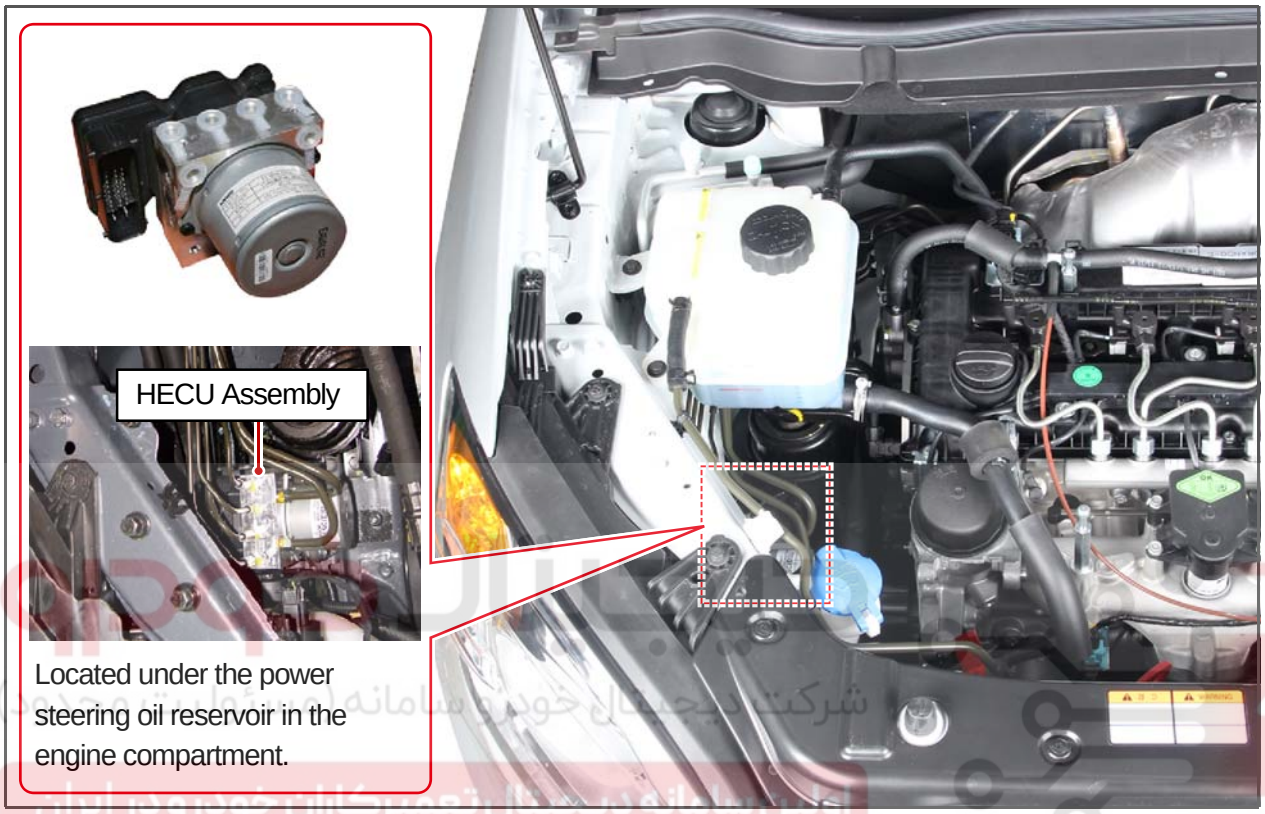


Perform the same procedures for the other brake lines.

S.G.N. 4892-01

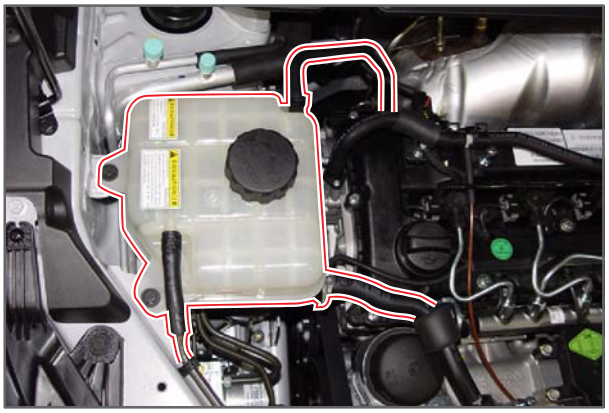
HECU (HYDRAULIC ELECTRONIC CONTROL UNIT) REMOVAL AND INSTALLATION

▶ **Mounting location**



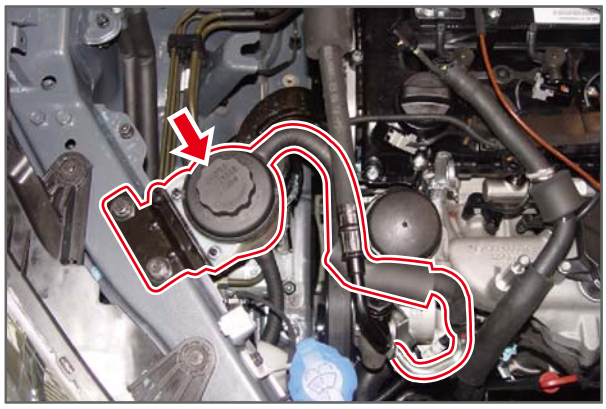
Preceding work

- Disconnect the negative cable from the battery.
- Collect the brake fluid from the brake fluid reservoir completely using an oil suction.
- Collect the coolant from the coolant reservoir completely using a suction device.

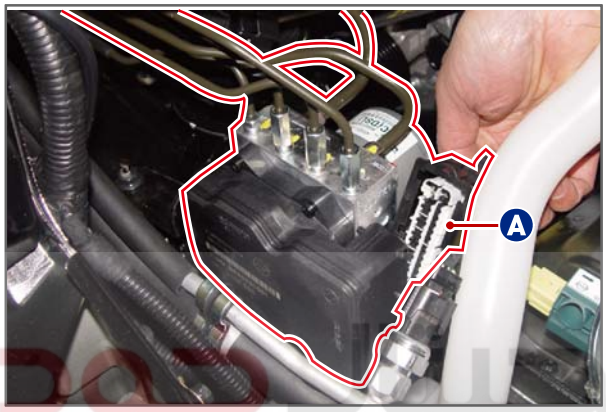


1. Remove the coolant reservoir. For further information, refer to the section "Cooling System" of Chapter "Engine".

Modification basis	
Application basis	
Affected VIN	



2. Remove the power steering oil reservoir. For further information, refer to the section "Steering".



3. Disconnect the ABS wiring harness connector (A) from the HECU socket and cover the openings of the connector and the socket with a piece of cloth to keep the brake oil entering.

CAUTION

Be careful not to allow any entry of air to the hydraulic modulator. If the air enters to the hydraulic system, perform bleeding using a diagnostic device which is programmed for ABS system.

4. Remove the hydraulic modulator assembly.

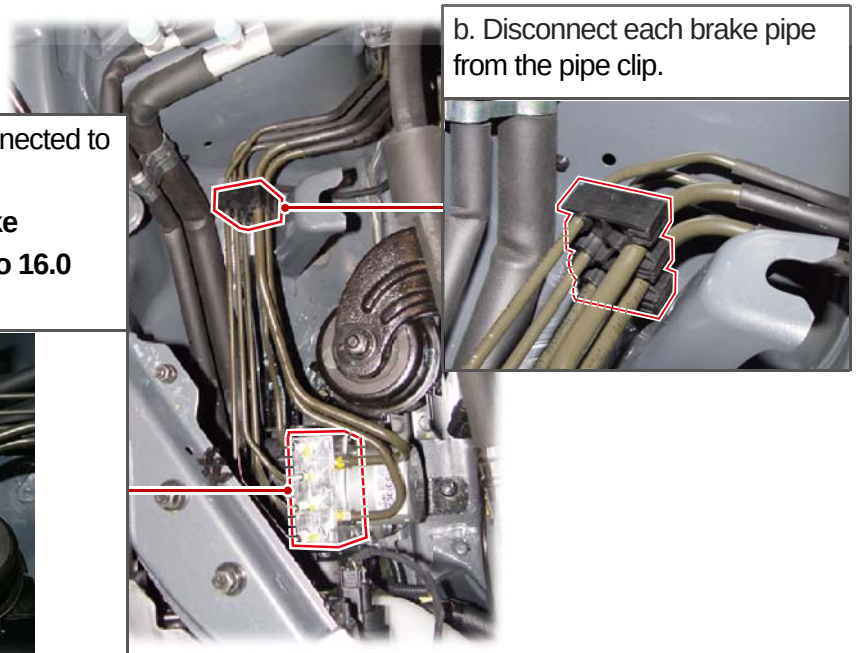
CAUTION

The openings of the pipes and the hydraulic modulator should be sealed with the sealing caps.

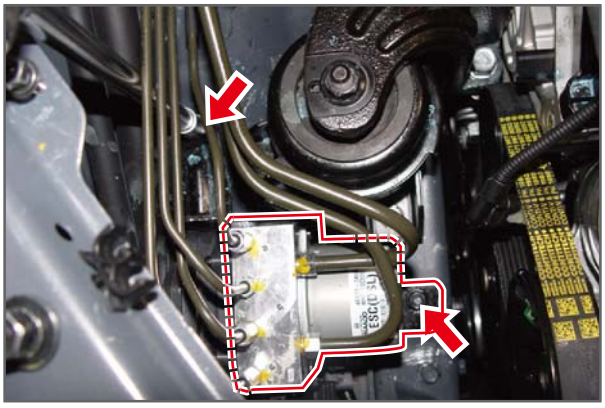
a. Disconnect all brake pipes connected to the hydraulic modulator.

- **Tightening torque for 6 brake caliper pipes (10 mm) 12.0 to 16.0 Nm**

b. Disconnect each brake pipe from the pipe clip.



Modification basis	
Application basis	
Affected VIN	



5. Unscrew the 2 bracket mounting nuts (12 mm) on the hydraulic modulator and remove the hydraulic modulator assembly.

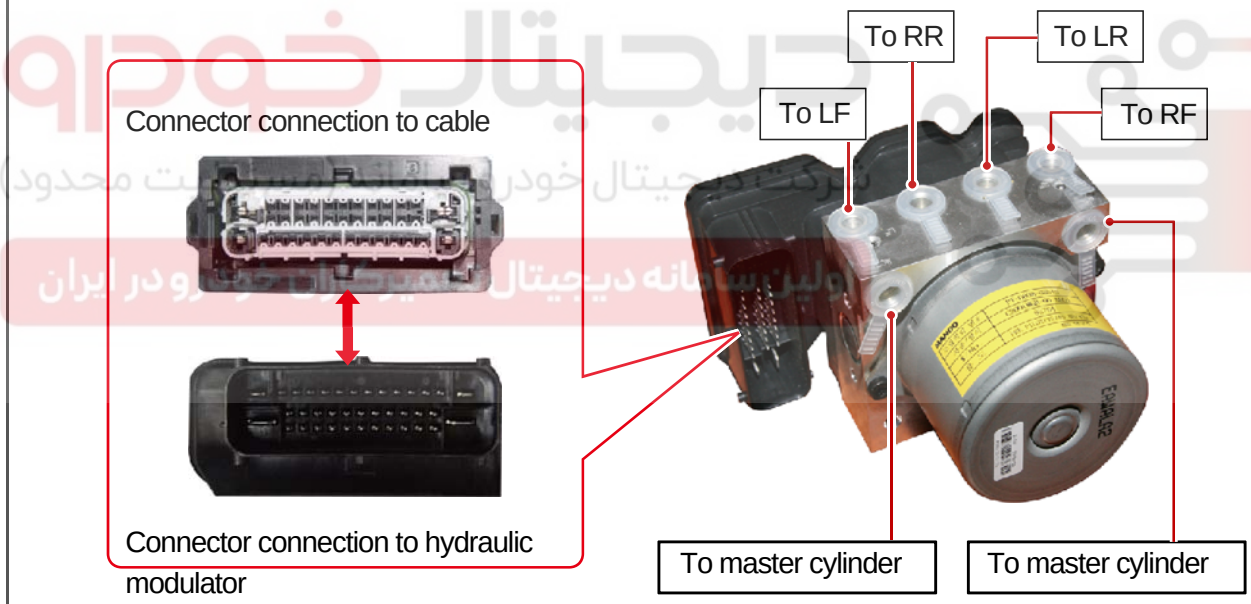
NOTE

Remove the hydraulic modulator by sliding aside the disconnected pipes. Do not apply excessive force to remove it. Otherwise, the pipes could be damaged.

Tightening torque 10.0 to 14.0 Nm

6. Install in the reverse order of removal.

Configuration of HECU



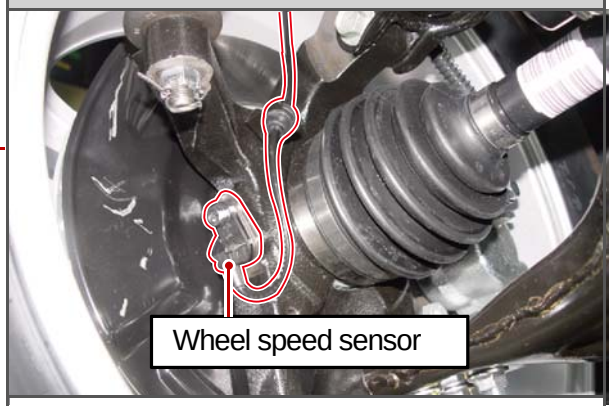
Modification basis	
Application basis	
Affected VIN	

S.G.N. 4890-01

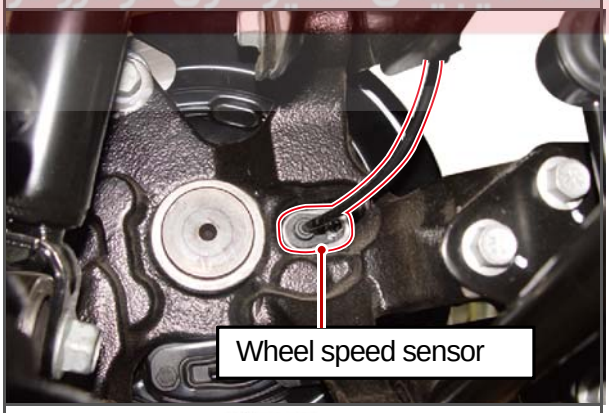
ACTIVE WHEEL SPEED SENSOR

▶ **Mounting location**

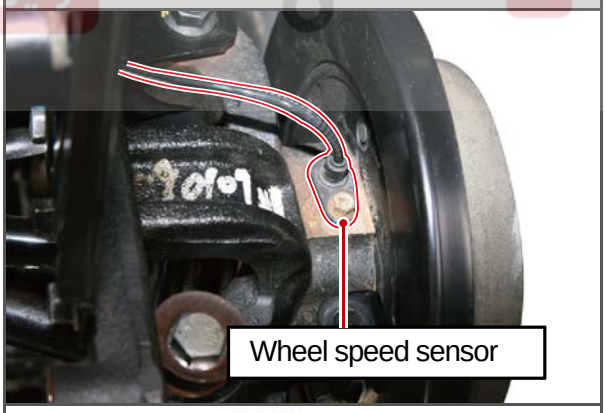
Front wheel speed sensor



Rear wheel speed sensor for 2WD



Rear wheel speed sensor for 4WD

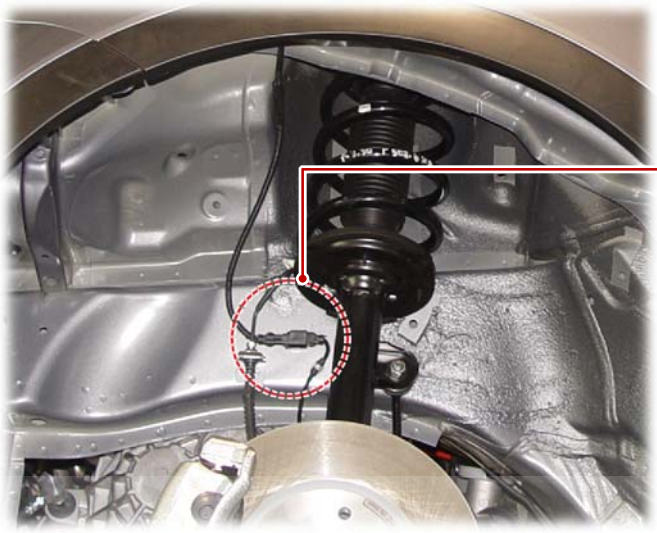


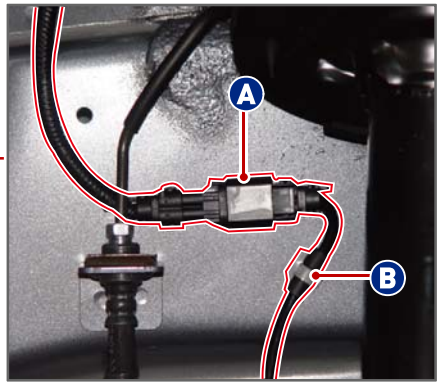
Modification basis	
Application basis	
Affected VIN	

▶ Front wheel speed sensor

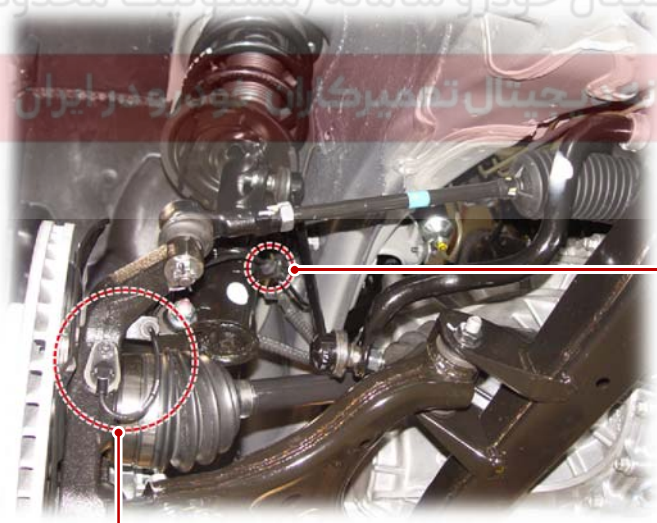
Preceding work Disconnect the negative cable from the battery.

1. Remove the connector (A) and cable mounting (B) for the front wheel speed sensor.

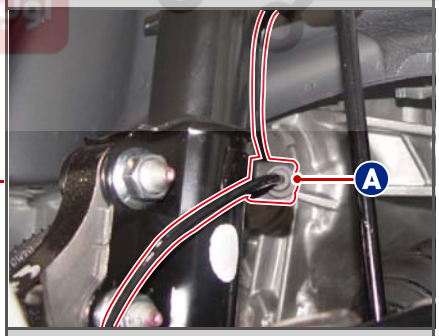




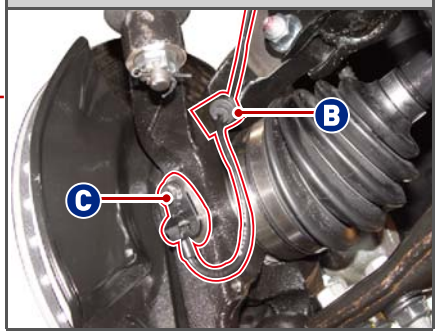
2. Disconnect the cable (A) connected to the shock absorber and the cable (B) connected to the knuckle, and unscrew the mounting bolt (10 mm) to remove the wheel speed sensor (C).



Mounting on shock absorber (A)



Mounting on knuckle (B) and sensor (C)



Tightening torque for wheel speed sensor mounting bolt (10 mm)	**7.8 to 11.8 Nm**

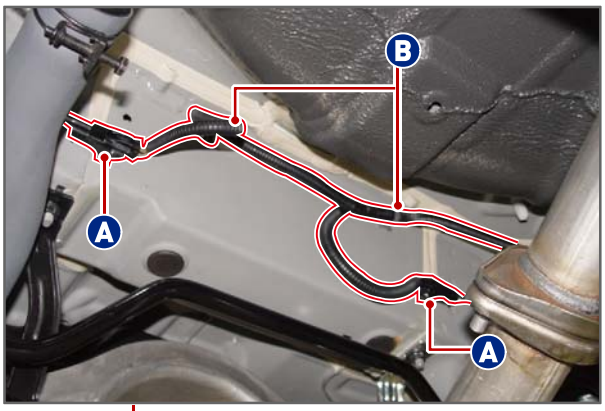
Modification basis	
Application basis	
Affected VIN	

3. Install in the reverse order of removal.

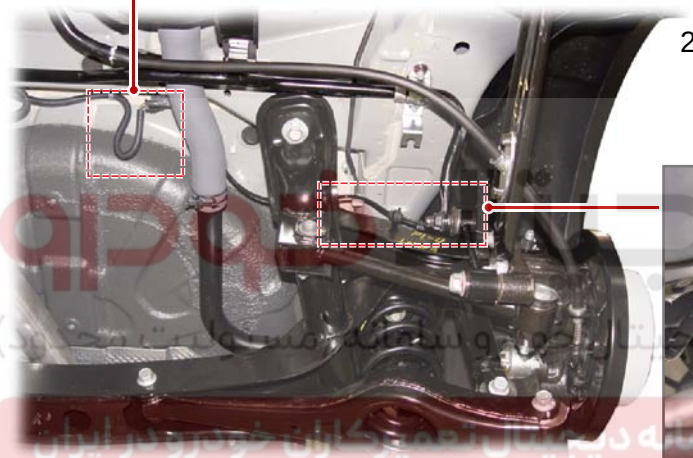
Modification basis	
Application basis	
Affected VIN	

▶ Rear wheel speed sensor

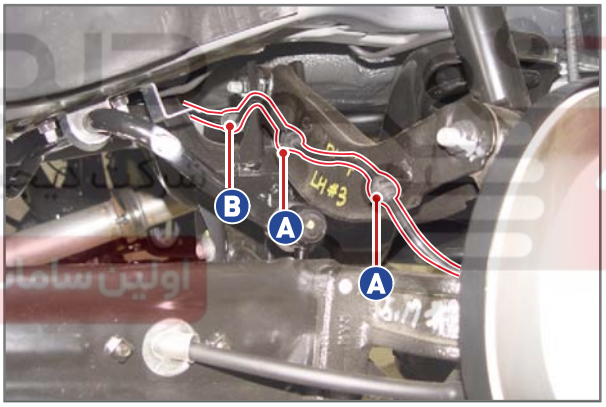
Preceding work Disconnect the negative cable from the battery.

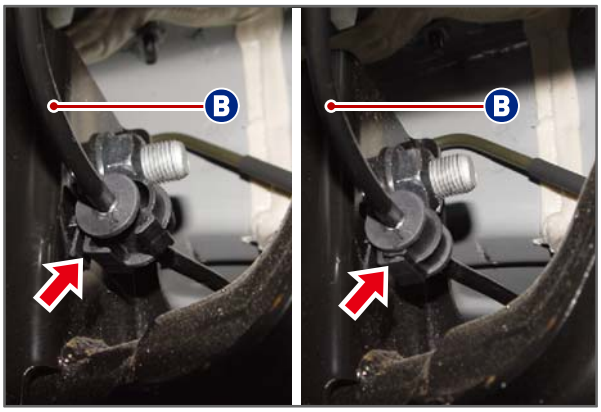


1. Remove the connector (A) and cable mounting (B) for the rear wheel speed sensor.



2. Disconnect the cable (A) connected to the upper arm and cable (B) connected to the sub frame.



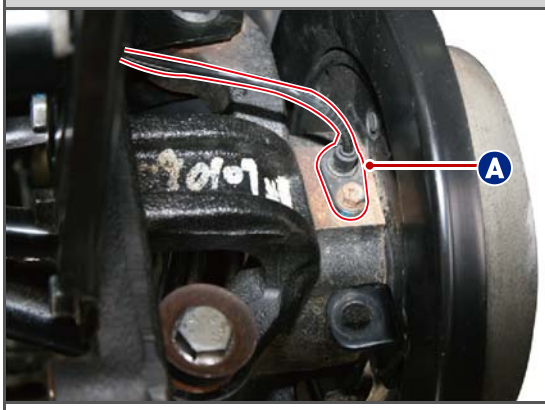


- Disengage the cable holder clip to disconnect the cable (B) installed to the frame as shown in the figure.

Modification basis	
Application basis	
Affected VIN	

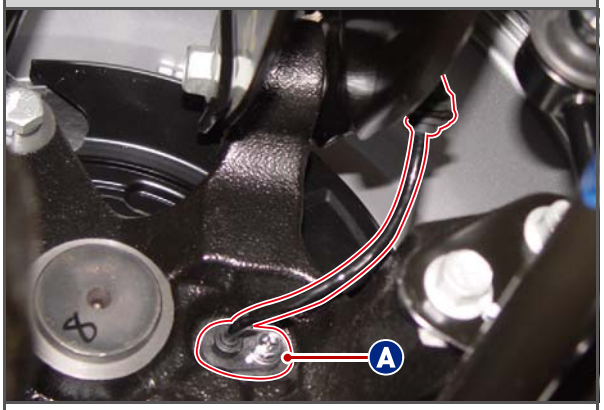
3. Unscrew the mounting bolt (10 mm) on the rear knuckle to remove the wheel speed sensor.

Rear wheel speed sensor for 4WD Mounting location



Tightening torque 7.8 to 11.8 Nm

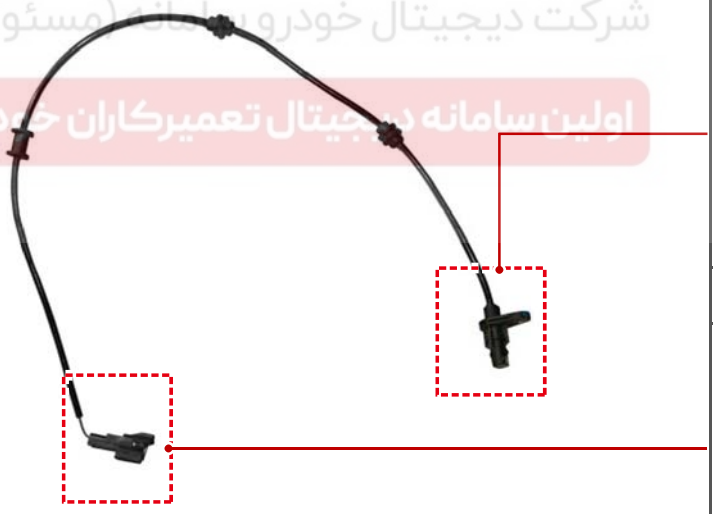
Rear wheel speed sensor for 2WD Mounting location



Tightening torque 7.8 to 11.8 Nm

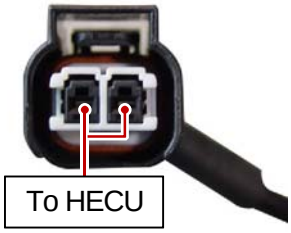
4. Install in the reverse order of removal.

Front wheel speed sensor for 4WD/2WD



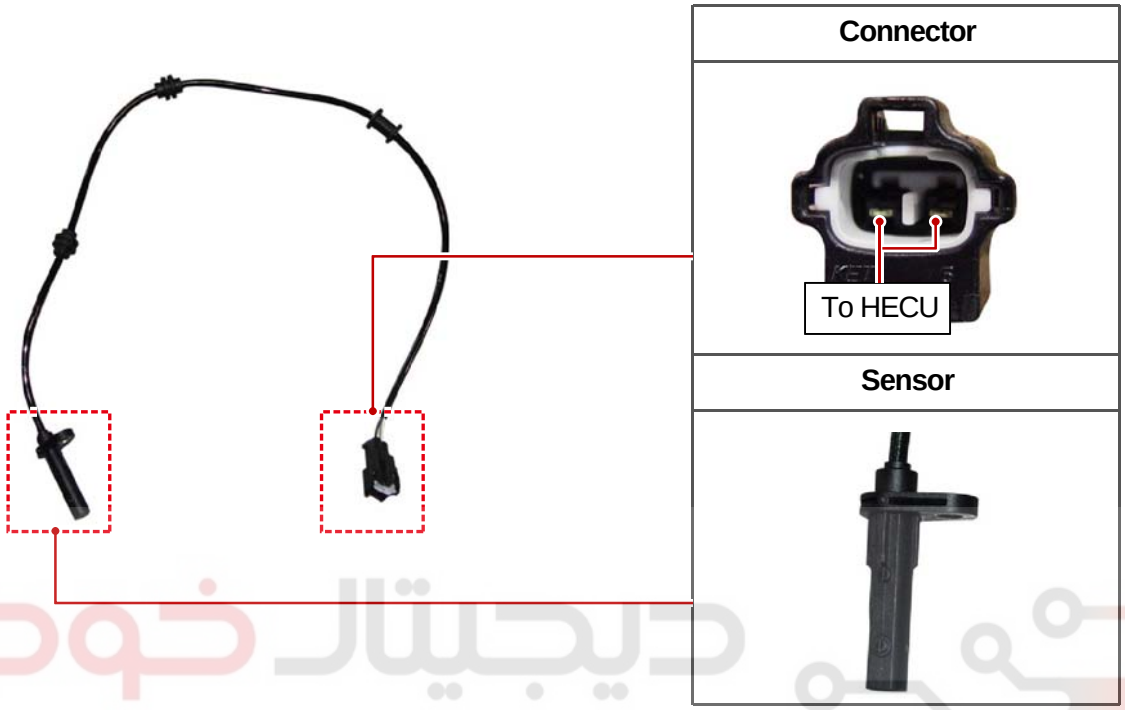
Sensor

Connector



Modification basis	
Application basis	
Affected VIN	

Wheel speed sensor for 2WD

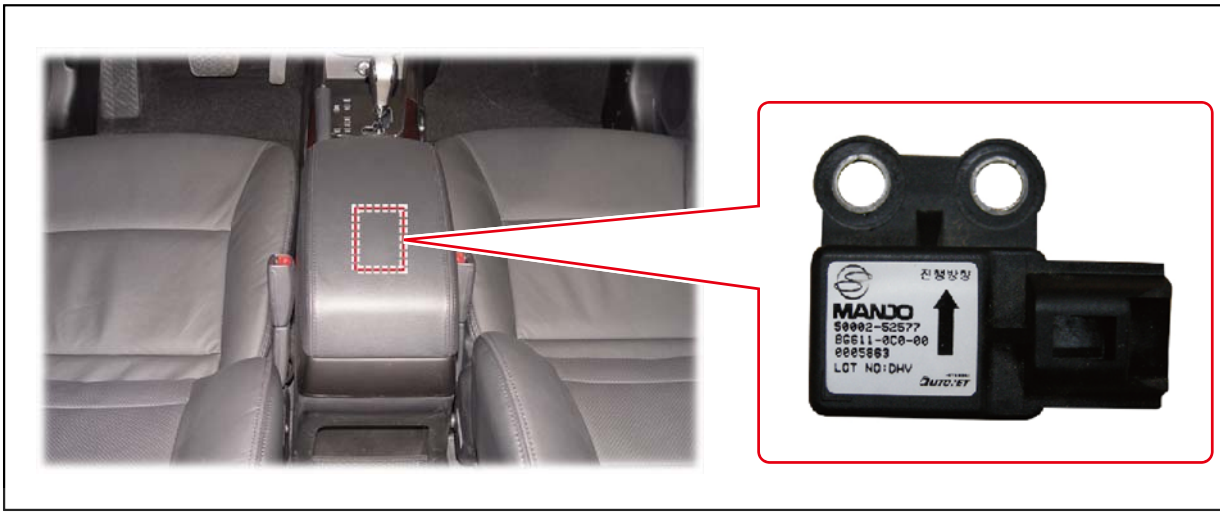


Modification basis	
Application basis	
Affected VIN	

S.G.N. 4890-10

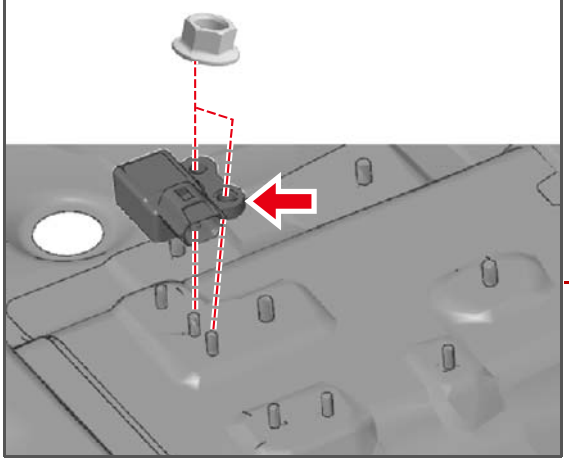
G-SENSOR (LONGITUDINAL ACCELERATION SENSOR)

▶ Mounting location



Preceding work
- Disconnect the negative cable from the battery.
- Remove the center console assembly.

G-sensor - 2666



1. Disconnect the G-sensor connector and unscrew the two mounting nuts (10 mm) to remove the G-sensor from the floor panel.

Tightening torque 3.9 to 7.8 Nm

2. Install in the reverse order of removal. The G-sensor must be fitted in the right direction.

Modification basis	
Application basis	
Affected VIN	

S.G.N. 4892-01 TROUBLE DIAGNOSIS CODE

1. DTC LIST

DTC	Description
C1101	Battery voltage high
C1102	Battery voltage low
C1112	Sensor power voltage error
C1200	WSS Front-LH open/short
C1201	WSS Front-LH range / performance / intermittent
C1202	WSS Front-LH invalid/no signal
C1203	WSS Front-RH open/short
C1204	WSS Front-RH range / performance / intermittent
C1205	WSS Front-RH invalid/no signal
C1206	WSS Rear-LH open/short
C1207	WSS Rear-LH range / performance / intermittent
C1208	WSS Rear-LH invalid/no signal
C1209	WSS Rear-RH open/short
C1210	WSS Rear-RH range / performance / intermittent
C1211	WSS Rear-RH invalid/no signal
C1274	G sensor open/short
C1275	G Sensor Range/Performance error installed system
C1285	G sensor calibration error
C1604	ECU hardware error
C2112	Valve relay error
C2380	ABS/ESP valve error
C2402	Motor electrical error
C1702	Variant coding error
C1520	Clutch switch open/short

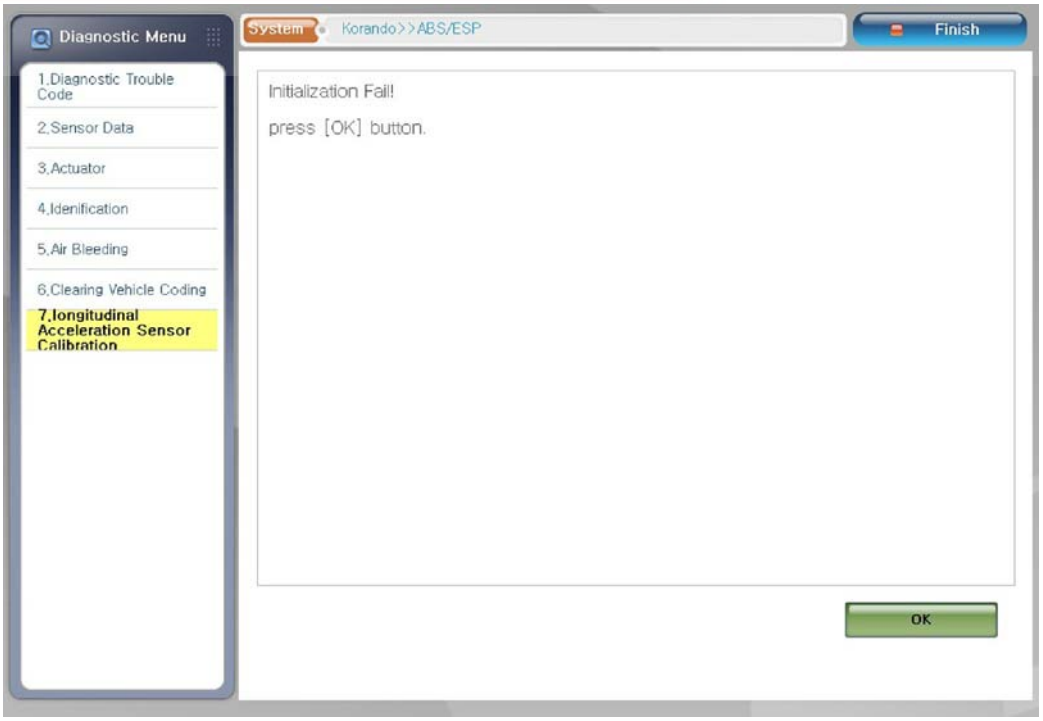
Modification basis	
Application basis	
Affected VIN	

2. HOW TO USE DIAGNOSTIC TOOL

1) Initialization

1. Performing a sensor initialization in the ABS/ESP diagnosis menu which enables the initialization of the sensor.

2. The screen below appears after completed the initialization process. Press “OK”.



Modification basis	
Application basis	
Affected VIN	

Memo