


2002 ACCESSORIES & EQUIPMENT

Anti Lock Brakes - Sedona

GENERAL

SPECIAL SERVICE TOOLS

Tool (Nunber and name)	Illustration	Use
OK2CA 089 HSP Hi-scan pro		Used to diagnose anti-lock brake system.

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Fig. 1: Illustrating Special Service Tools
Courtesy of KIA MOTORS AMERICA, INC.

SPECIFICATIONS

Items		Specifications
General	System	MGH-20
	Type	4-Sensors and 4-Channels
	Mode	ABS+EBD
HCU	Type	Diagonal Split
	Hydraulic control method	Hold/ Rise/ Dump (3Mode)
	Type of pump	Radial pistons (2 pistons)
	Type of motor	4-pole DC motor
ECU	Operation voltage	DC 10~ 16V
	Operation temperature	-40 ~ 110°C
ABS sensor	Type	Electromagnetic induction
	Resistance1275~1495	1275~1495Ω
	Air gap	Front 0.0079~0.048 in (0.2~1.2 mm)
		Rear 0.0039~0.048 in (0.1~1.2 mm)

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Fig. 2: Anti Lock Brake Specifications
Courtesy of KIA MOTORS AMERICA, INC.

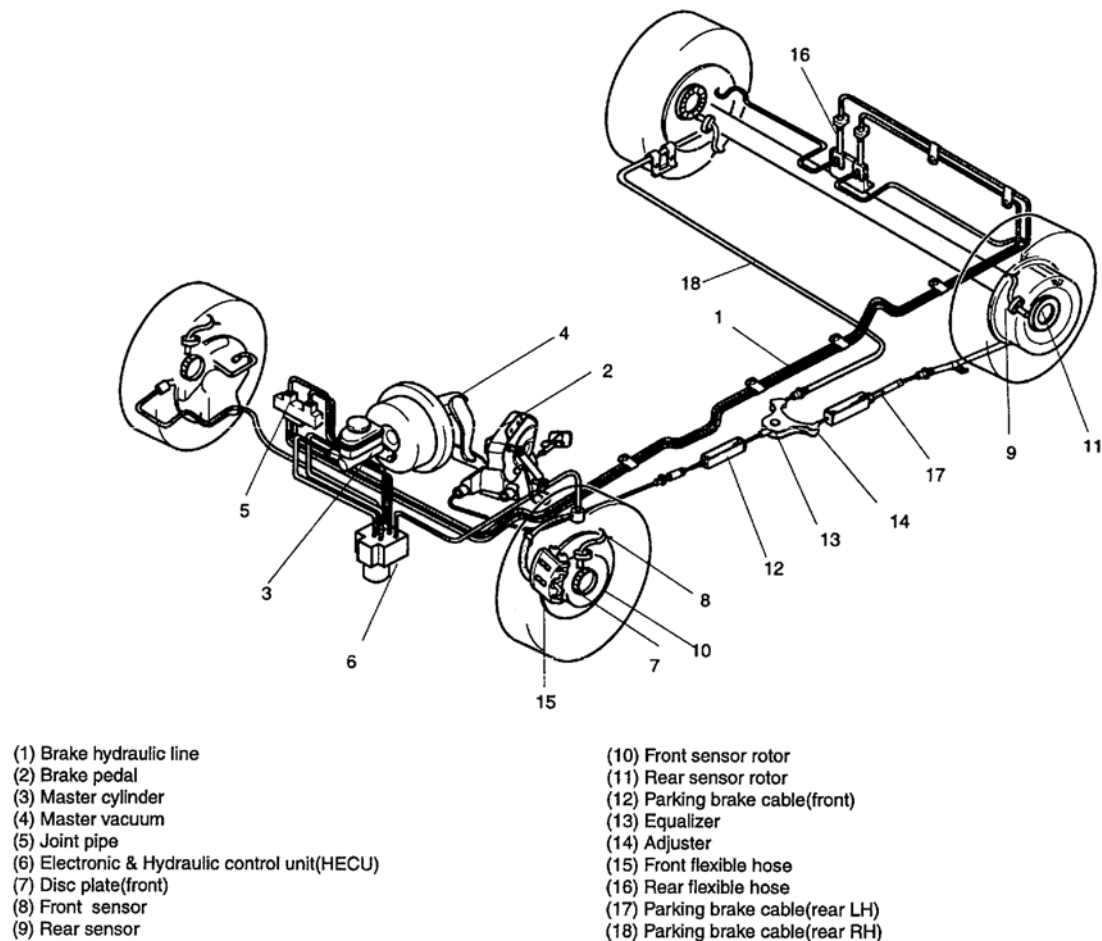
DESCRIPTION AND OPERATION

STRUCTURAL VIEW

Weather, road surface, and tire condition will affect vehicle performance. The MGH 20 system has been specifically calibrated for the vehicle to achieve the best possible balance between stopping distance, stability, and vehicle steering control.

4-wheel anti-lock brake systems are designed to provide the driver with:

- Enhanced steering control by enabling the vehicle to move in a driver controlled direction during braking.
- Enhanced braking stability by making the most of available traction (on most road surfaces).



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Fig. 3: Illustrating ABS Structural View
Courtesy of KIA MOTORS AMERICA, INC.

FUNCTIONAL DESCRIPTION

MGH 10 is a 4 channel system because it controls four separate hydraulic circuits: the left front wheel, the right

front wheel, the right rear wheel, and the left rear wheel. The system accomplishes this using information from 4 separate wheel speed sensors, one at each front wheel and one at each rear wheel.

4-wheel ABS limits wheel lockup by automatically modulating the brake pressure during hard braking. The MGH 10 can improve steering control during hard braking and reduce stopping distances under most conditions.

NOTE: Pumping the brake pedal is no longer necessary and should not be done.

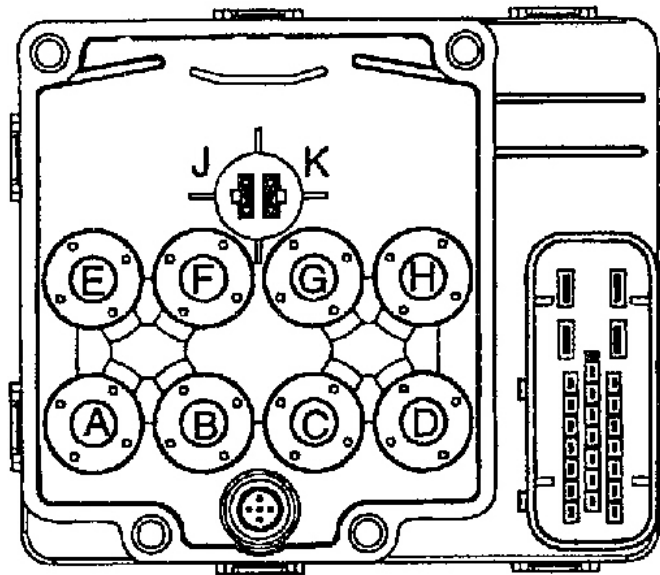
The ABS controls all 4 channels (both fronts and rears) independently. The brake force required to engage the ABS function may vary depending on road surface conditions and tire adhesion. A dry paved surface requires a higher brake force than a slippery surface to engage ABS.

The driver may feel a pedal pulsation (up and down movement of the brake pedal) during an ABS event. In addition, a noise from inside the engine compartment may be heard. This is considered a normal characteristic. The brake pedal effort and pedal feel during normal braking are similar to that of a conventional brake system.

ELECTRONIC CONTROL UNIT (ECU)

INTRODUCTION

The electronics and microprocessor are integrated with the solenoid coils inside a Coil Integrated Module. The ECU is mounted directly to the hydraulic control unit. The coils are used to operate the HCU valves during an ABS event. The ECU has circuits that monitor system status.



- A: INLET VALVE (FR)
- B: INLET VALVE (RL)
- C: INLET VALVE (RR)
- D: INLET VALVE (FL)
- E: OUTLET VALVE (FR)
- F: OUTLET VALVE (RL)
- G: OUTLET VALVE (RR)
- H: OUTLET VALVE (FL)
- J: MOTOR (GND)
- K: MOTOR(M+)

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Fig. 4: Illustrating ECU Hydraulic Control Valves
Courtesy of KIA MOTORS AMERICA, INC.

The ECU monitors the components of the system for faults. If a fault is detected, the ABS system will set a Diagnostic Trouble Code (DTC) and illuminate the amber ABS & EBD lamp, causing the ABS or EBD to be disabled. Although the ABS or EBD is inhibited, conventional brakes remain.

When the ignition switch is placed in the run position, the ECU will perform a preliminary self check on the anti-lock electrical system indicated by an illumination of the amber ABS or EBD warning lamp in the instrument cluster.

SOLENOID VALVE CONTROL

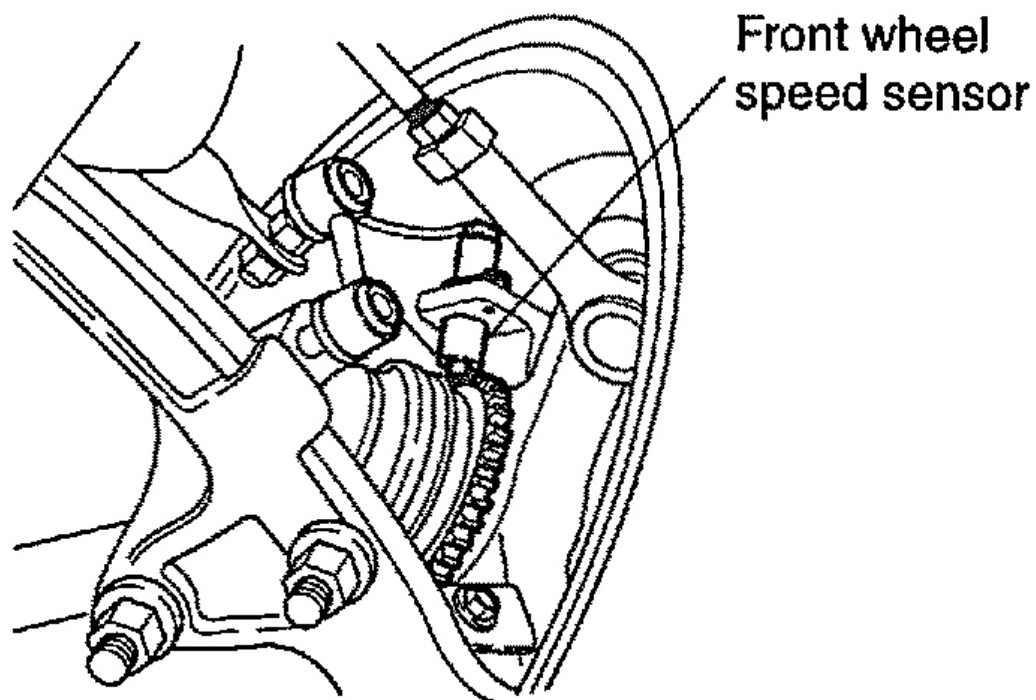
Solenoid valve operates when one side of valve coil applies positive voltage through valve relay and the other side connects to ground by MOSFET.

When valve relay turns ON and MOSFET turns ON by microprocessor signal, concerned solenoid valve operates.

ABS SPEED SENSORS

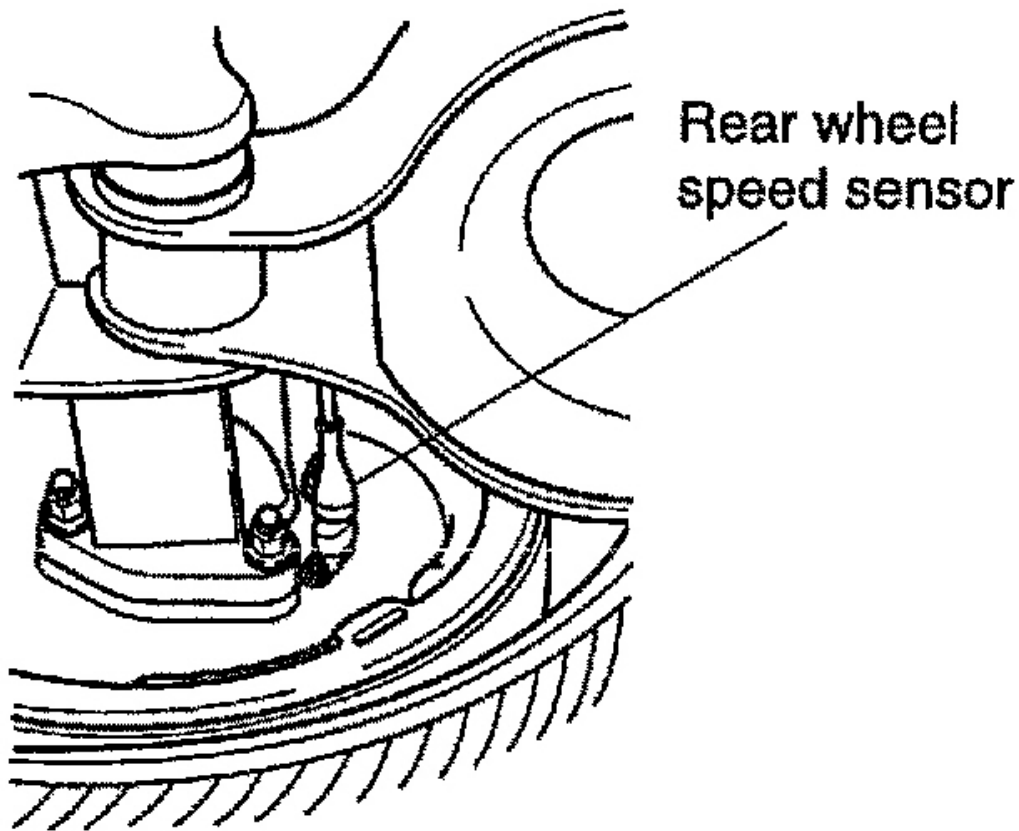
The speed sensors are a single pole, variable reluctance sensor, mounted to both rear hubs and both front half shafts. A toothed tone ring is press fit to the rear hub assemblies and provides the signal for the rear sensor.

The front tone rings are press fit to the half shaft assemblies. The signal generated is proportional to the speed of the wheels and is used by the ECU to monitor the wheel speeds.



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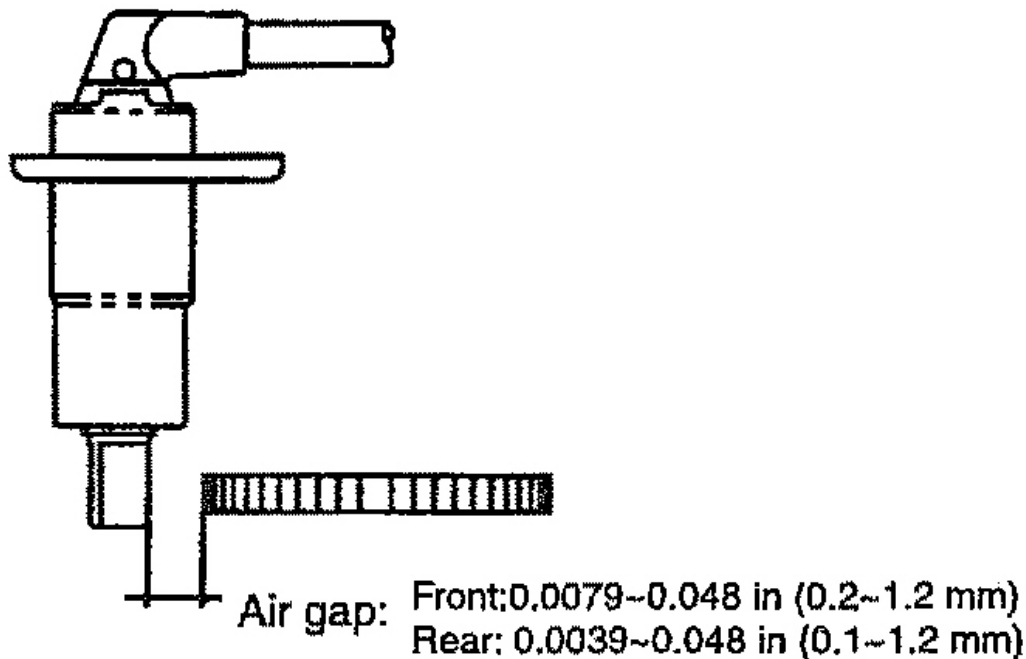
Fig. 5: Illustrating Front Wheel Sensor
Courtesy of KIA MOTORS AMERICA, INC.



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Fig. 6: Illustrating Rear Wheel Sensor
Courtesy of KIA MOTORS AMERICA, INC.

As the teeth of the tone ring move through the magnetic field of the sensor, an AC voltage is generated. This signal frequency increases or decreases proportionally to the speed of the wheel. The ECU monitors this signal to check for changes in wheel speeds. If the deceleration of one or more wheels is not within a predetermined amount, an ABS event is initiated.



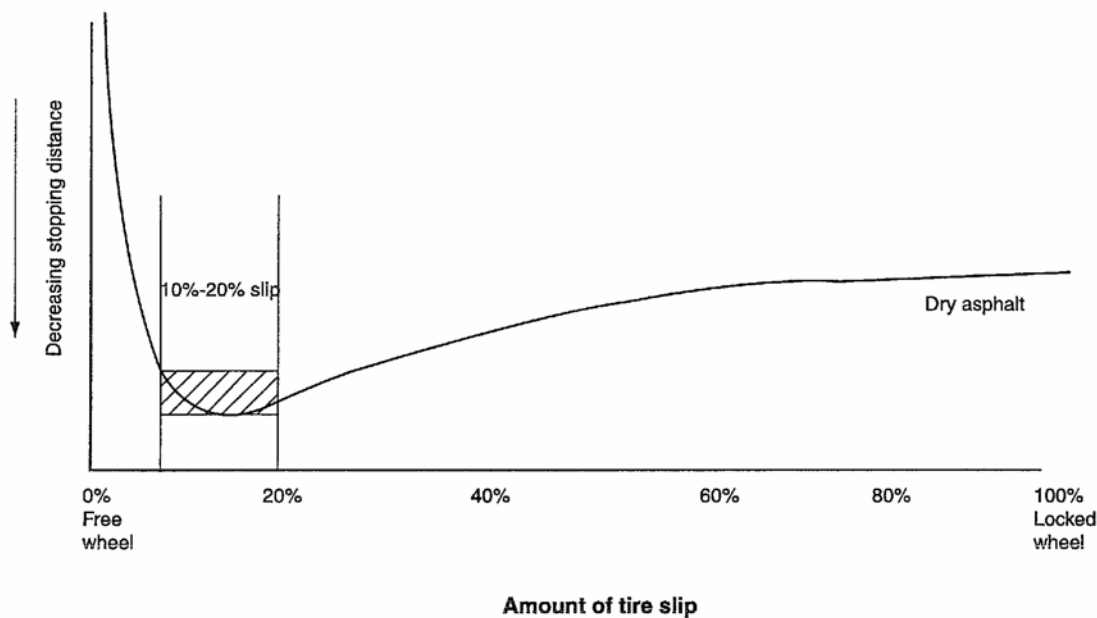
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Fig. 7: Illustrating Wheel Speed Sensor And Tone Ring
Courtesy of KIA MOTORS AMERICA, INC.

WHEEL SLIP

How well a vehicle can stop is related to how well the tire contact surface grips the road. At 0 % slip, the tire rotates freely. At 100 % slip, the tire and wheel are locked and the weight of the vehicle pushes the locked tires along the road surface. In this situation, vehicle stability may be lost, and steering control will be lost.

Normally, tires will grip to the road surface on average between 10 % and 20 % slip during hard braking. In this slip range, vehicle stopping distances and steering control will be at their best. Some slip is necessary to stop the wheel and achieve maximum braking performance.



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Fig. 8: Wheel Slip Range Chart

Courtesy of KIA MOTORS AMERICA, INC.

HYDRAULIC CONTROL UNIT (HCU)

ABS CONTROL STEPS

PHASE 0: Outside of ABS

PHASE 1: Pressure decreasing condition

PHASE 2: Pressure holding condition

PHASE 3: Pressure increasing condition

PHASE 4: Pressure decreasing condition

PHASE 5: Pressure decreasing condition

BASIC CONTROL

PHASE 0-PHASE 1: When ABS ECU detects the wheel locking, ABS ECU changes PHASE 0 to PHASE 1.

PHASE 1-PHASE 2: If wheel cylinder liquid pressure is decreased, ABS ECU changes PHASE 1 to PHASE 2.

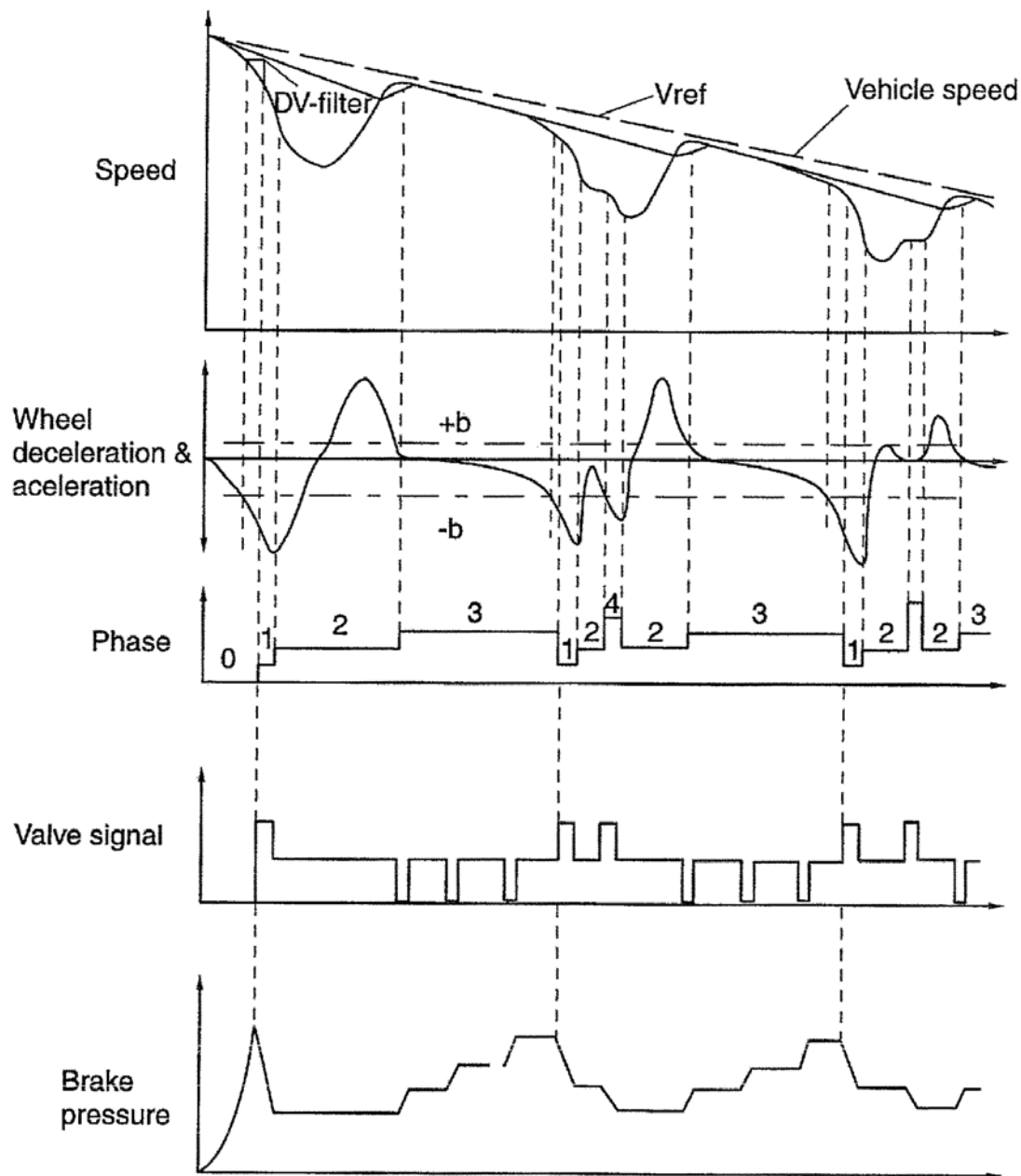
PHASE 2-PHASE 3: If it is judged that there is no lock phenomenon in wheel, ABS ECU changes PHASE 2 to

PHASE 3.

PHASE 2-PHASE 4: If wheel cylinder liquid pressure is cascading on the deceleration section, ABS ECU changes PHASE 2 to PHASE 4.

PHASE 2-PHASE 5: If wheel cylinder liquid pressure is cascading on the acceleration section, ABS ECU changes PHASE 2 to PHASE 5.

ABS CONTROL FLOW



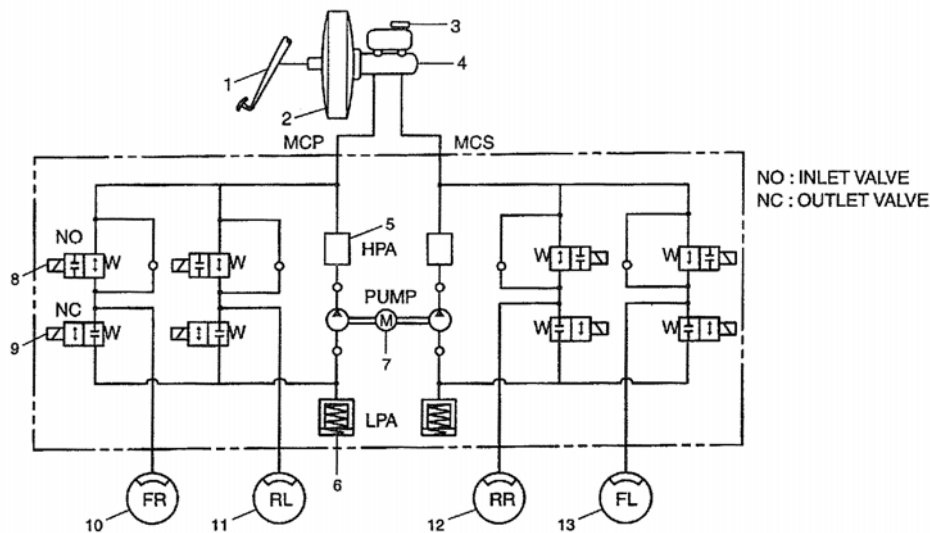
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Fig. 9: ABS Control Flow Chart
 Courtesy of KIA MOTORS AMERICA, INC.

ABS OPERATING MODES

WHEN ABS IS NOT OPERATED

OPERATING CONDITION



- | | |
|------------------------------|---------------------------------|
| 1. Brake pedal | 8. Normal open (Inlet valve) |
| 2. Master vacuum | 9. Normal close (Outlet valve) |
| 3. Brake reserve tank | 10. Front right wheel & caliper |
| 4. Master cylinder | 11. Rear left wheel & caliper |
| 5. High pressure accumulator | 12. Rear right wheel & caliper |
| 6. Low pressure accumulator | 13. Front left wheel & caliper |
| 7. Motor pump | |

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Fig. 10: Illustrating When ABS Is Not Operated Diagram
Courtesy of KIA MOTORS AMERICA, INC.

Solenoid valve	Electricity status	Valve open-close	Open-close channel
INLET	OFF	OPEN	Master cylinder ↔ Wheel cylinder
OUTLET	OFF	CLOSE	Wheel cylinder ↔ reservoir

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Fig. 11: Operating Condition Chart
Courtesy of KIA MOTORS AMERICA, INC.

In ordinary brakes, each solenoid valve is turned OFF when electricity is turned on from ABS ECU to the solenoid valve IN, OUT.

As for solenoid valve at this time, IN is opened and OUT is closed by spring action. If brake pedal is pushed down, master cylinder liquid pressure passes the solenoid valve and arrives at wheel cylinder, and the brake acts.

Afterwards if brake pedal is released, the liquid pressure passes IN and check valve to return to master cylinder, then brake is released.

OPERATING CONDITION



Fig. 12: Illustrating Dump Mode-Brake Pressure Decreasing Diagram
Courtesy of KIA MOTORS AMERICA, INC.

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Fig. 13: Operating Condition Chart
Courtesy of KIA MOTORS AMERICA, INC.

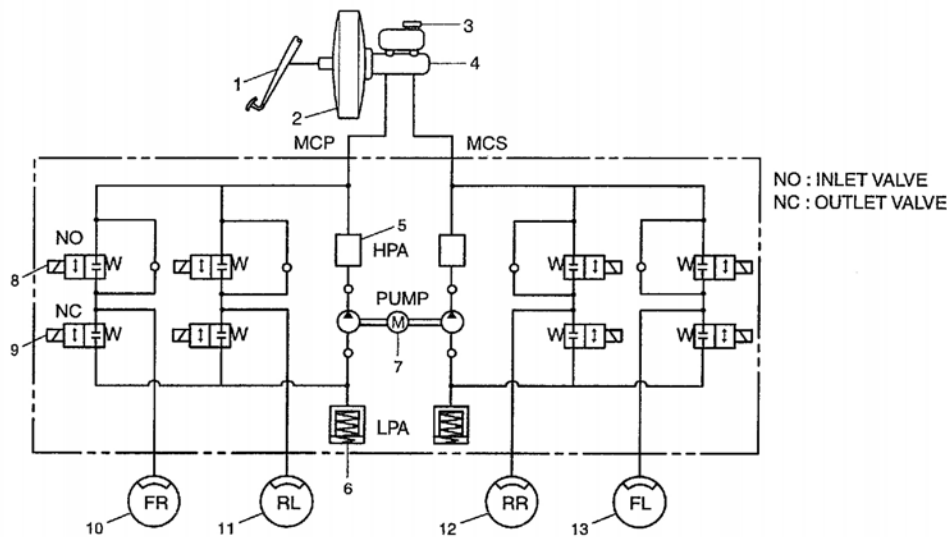
If wheels are about to be locked at sudden braking, ABS ECU outputs the signal decreasing the liquid pressure in solenoid valve, and each solenoid valve is turned ON.

At this time the solenoid valve IN is shut and interrupts the liquid channel from master cylinder. And solenoid valve OUT is opened and releases the liquid channel from wheel cylinder to the reservoir therefore the liquid pressure in wheel cylinder passes the solenoid valve OUT to arrive at reservoir solenoid valve OUT to arrive at

reservoir so that pressure is decreased.

HOLD MODE-BRAKE PRESSURE MAINTAINED

OPERATING CONDITION



- 1. Brake pedal
- 2. Master vacuum
- 3. Brake reserve tank
- 4. Master cylinder
- 5. High pressure accumulator
- 6. Low pressure accumulator
- 7. Motor pump
- 8. Normal open (Inlet valve)
- 9. Normal close (Outlet valve)
- 10. Front right wheel & caliper
- 11. Rear left wheel & caliper
- 12. Rear right wheel & caliper
- 13. Front left wheel & caliper

Fig. 14: Illustrating Hold Mode-Brake Pressure Maintained Diagram
Courtesy of KIA MOTORS AMERICA, INC.

Solenoid valve	Electricity status	Valve open-close	Open-close channel
INLET	ON	CLOSE	Master cylinder ↔ Wheel cylinder
OUTLET	OFF	CLOSE	Wheel cylinder ↔ reservoir

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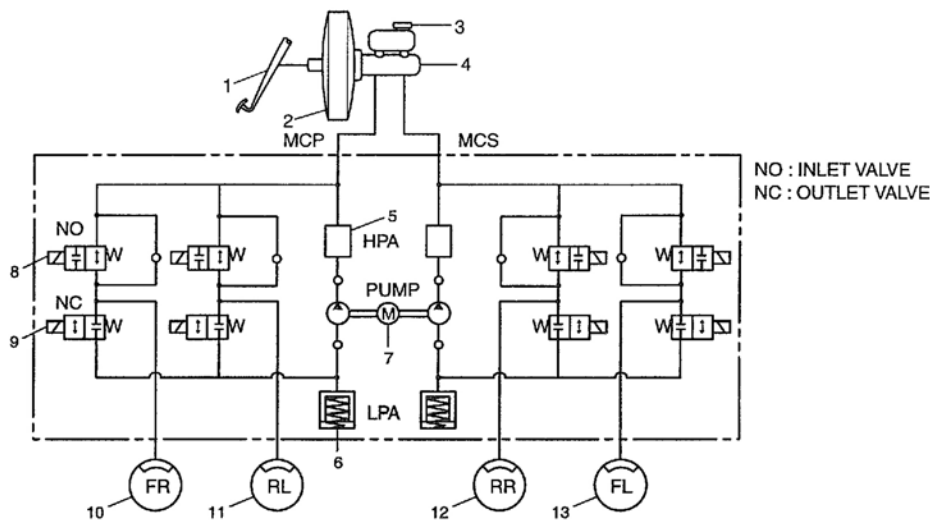
Fig. 15: Operating Condition Chart
Courtesy of KIA MOTORS AMERICA, INC.

If wheel cylinder liquid pressure is decreased to the ultimate state, ABS ECU outputs the signal maintaining the liquid pressure in solenoid valve, so that solenoid valve IN is turned ON and OUT is turned OFF.

Then wheel cylinder liquid because solenoid valve In and out are both shut so that liquid channel is interrupted.

RISE MODE-BRAKE PRESSURE INCREASING

OPERATING CONDITION



1. Brake pedal
2. Master vacuum
3. Brake reserve tank
4. Master cylinder
5. High pressure accumulator
6. Low pressure accumulator
7. Motor pump
8. Normal open (Inlet valve)
9. Normal close (Outlet valve)
10. Front right wheel & caliper
11. Rear left wheel & caliper
12. Rear right wheel & caliper
13. Front left wheel & caliper

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Fig. 16: Illustrating Rise Mode-Brake Pressure Increasing Diagram
Courtesy of KIA MOTORS AMERICA, INC.

Solenoid valve	Electricity status	Valve open-close	Open-close channel
INLET	OFF	OPEN	Master cylinder ↔ Wheel cylinder
OUTLET	OFF	CLOSE	Wheel cylinder ↔ reservoir

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Fig. 17: Operating Condition Chart
Courtesy of KIA MOTORS AMERICA, INC.

If it is judged that there is no lock phenomenon in wheels, then ABS ECU interrupts electricity in solenoid valve therefore each solenoid valve is turned OFF and the liquid pressure by motor pump passes the solenoid valve IN to arrive at wheel cylinder so that pressure is increased.

Fail-safe function

If failure occurred in ABS ECU system and the hydraulic, then the fail-safe circuit turns off the relay that supplies electricity to solenoid valve, stopping the control signal output, lighting the warning lamp at the same time to inform ABS failure to driver, in which case the ordinary brake function is secured under same condition as vehicles without ABS system.

TROUBLESHOOTING

SYSTEM OPERATION FLOW CHART

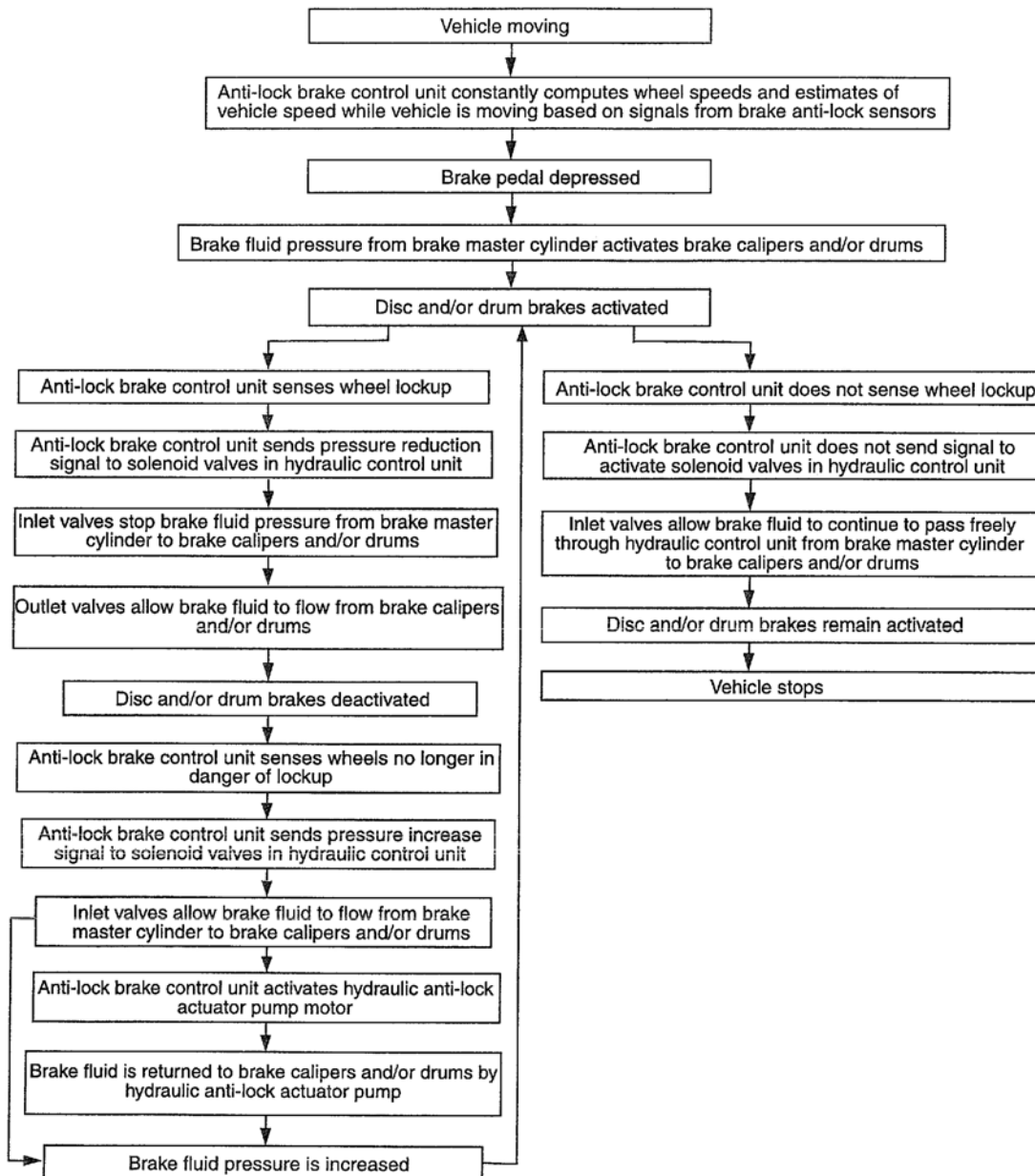


Fig. 18: System Operation Flow Chart
Courtesy of KIA MOTORS AMERICA, INC.

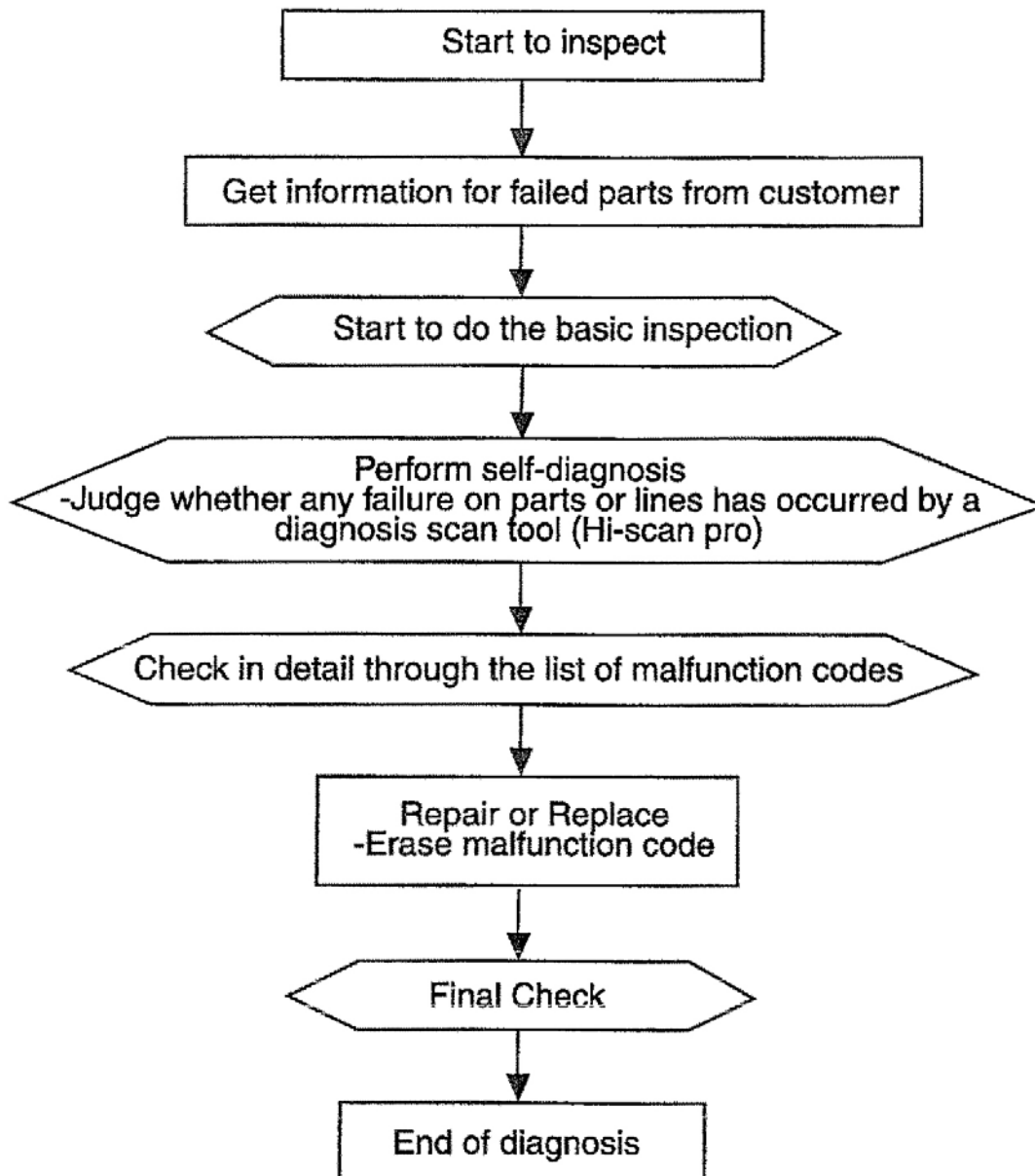
SYMPTOM RELATED DIAGNOSTIC PROCEDURES (ABS)

The wheel ABS is composed of electrical and mechanical components (hydraulic unit), and components of the standard brake system.

The system uses 4-sensors and 4-channels which control front wheels and rear wheels each independently. When the system detects a slip in one of the wheels, hydraulic pressure is applied to the brakes on the side where the slip is first detected.

Any malfunction of the ABS electrical or mechanical components is judged by the self-diagnosis function in the ABS control unit. All malfunctions are indicated by the warning lamp in the instrument panel. In normal condition, the ABS warning lamp is on for 2-3 seconds after engine starts and goes out. If it stays on continuously, you may have malfunction with ABS system. The location of a malfunction is indicated to the technician by a diagnosis scan tool (Hi-scan pro). The self-diagnosis and indication functions must be used when diagnosing malfunctions of the ABS.

HOW TO USE DIAGNOSIS AND TROUBLESHOOTING



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Fig. 19: Diagnosis And Troubleshooting Guide
Courtesy of KIA MOTORS AMERICA, INC.

SELF-DIAGNOSIS

The ABS control unit starts self-diagnostic functions after the ignition is switched ON. The ABS control unit detects failure for each circuit and component by comparing condition of the system with limited condition set inside the ABS control unit, ABS control unit stores the failure code and then outputs the four-digits of malfunction code to the diagnostic scan tool (Hi-scan pro) when the ABS terminal of the diagnostic connector is

connected.

SELF-DIAGNOSIS PROCEDURES (WITH THE DIAGNOSTIC SCAN TOOL)

1. With the ignition switch OFF, connect the diagnostic scan tool (Hi-scan pro) to the data link connector located under side of master vacuum in engine compartment.
2. Make sure the ignition switch is in the on position, and then choose correct vehicle and model, proceed to diagnostic data link menu item.
3. Choose the inspection item after initializing the unit.
4. Press malfunction code detection No. 1 and diagnostic scan tool will display any malfunction code found.

NOTE: **A malfunction code is a four-digits number which is continuously outputs until the failure code is erased by the diagnostic scan tool.**

5. From the list of failure codes, verify the failed part and repair it according to self-diagnosis procedures.
6. After repair, erase all malfunction codes stored in the ABS control unit by selecting inspection item (No. 4).

HOW TO ERASE MALFUNCTION CODE (WITH THE DIAGNOSTIC SCAN TOOL)

ABS control unit has an automatic malfunction code erasing function as below.

1. After the failures have been serviced, confirm the vehicle functions properly.
2. Press the enter key in malfunction code erase item (No. 4) among the inspection items of the diagnostic scan tool (Hi-scan pro).

CONNECTOR TERMINAL LIST

Connector Terminal			Specification	Note
No.	Mark	Terminal Name		
6	IGN+	Power source via Ignition Switch terminal	Over voltage range: $16.5 \pm 0.5V < V < 20V$ Operating voltage range: $9.5 \pm 0.5V < V < 16.5 \pm 0.5V$ Low voltage threshold: $9.5 \pm 0.5V$ Low voltage range: $7.2 \pm 0.5V < V < 9.5 \pm 0.5V$ System down range: $6.0 \pm 0.5V < V < 7.2 \pm 0.5V$ Controller off range: $V < 5.5 \pm 0.5V$ Max. current: $I < 300mA$	
2 18	GND1 GND2	Ground terminal	Max. current(total of 2 terminals): $I < 60A$	Inside control
24	BRAKE	Brake lamp Switch input terminal	Input voltage(low): $-1.00 < V(IL) < 2.75V$ Input voltage(high): $5.00 < V(IH) < 16.0V$	
9 23 5 19	FL+ FR+ RL+ RR+	Wheel sensor Input terminal	Min. sensor voltage: $V(s) > 150mVpp$ Resistance: $1100\Omega \pm 50\%$ Output range: 30~2000Hz Inductance: $0.7H \pm 50\%$ Permissible offset voltage range: $2.15V < V(offset) < 3.5V$	
8 22 4 20	FL- FR- RL- RR-			
10	ABS Warning lamp	ABS warning lamp output terminal	Max. current: $I < 200mA$ Saturation voltage, at $I=200mA$: $V_{sat} < 1.5V$	
15	EBD Warning lamp	EBD warning lamp output terminal	Max. current: $I < 200mA$ Saturation voltage, at $I=200mA$: $V_{sat} < 1.5V$	
3	Diagnosis	Diagnosis interface terminal	Input voltage: $V(IL) < 0.3VBV$ $V(IH) < 0.7VBV$ Output voltage: $V(IL) < 0.2VBV$ $V(IH) < 0.8VBV$	VB: Ignition voltage
2	Batt1	Battery power Source 1 terminal (valve power source)	Max. current (inside control): $I < 30A$ Max. current (outside control): $I < 20mA$ Dark current: $I < 0.3mA$	
17	Batt2	Battery power Source 2 terminal (Motor power source)	Inside control Max. rush current : $I < 100A(t < 100msec)$ Max. current : $I < 30A(t > 100msec)$ Dark current: $I < 0.3mA$	T: the running time of motor

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Fig. 20: Illustrating Connector Terminal List
Courtesy of KIA MOTORS AMERICA, INC.

THE MANAGEMENT OF FAILURE DETECTED

No.	Description
1	System down. Both the ABS and the EBD function are inhibited and the ABS and the EBD warning lamps is activated. In this failure, the valve relay and all solenoids are prevented from being switched on.
2	Only the ABS function is inhibited. The ABS warning lamp is activated and the EBD warning lamp not activated.
3	Sensor failure outside the ABS control cycle 1. Only one wheel failure: take the same action as management. 2. More than two wheels failure : take the same action as management.
4	Sensor failure inside the ABS control cycle 1. One front wheel failure: inhibit the ABS control of the Failed-wheel and maintain the ABS control of normal wheel. After the controller completes the ABS control, take the same action as the management. 2. Rear wheel failure: inhibit ABS control of both front wheels and the pressure of rear wheel is decreased. After the controller completes the ABS control, take the same action as the management. 3. More than two wheels failure: take the same action as the management.
5	Low operating voltage 1. Outside the ABS control cycle: inhibit the ABS control of front wheels and allow the ABS control of rear wheel, deactivating the motor. And the ABS warning lamp is directly switched on. When the voltage recover to the normal operating range, enable ABS function and ABS function and ABS warning lamp is switched off and erase the error code of low voltage. 2. Inside the ABS control cycle: inhibit the ABS control of front wheels and allow the ABS control of rear wheel, deactivating the motor. The ABS warning lamp is directly switched on and the state keeps continuously. The error code is always stored.
6	Motor failure inside the ABS control cycle. 1. Inhibit the ABS control of front wheels and allow the ABS control of rear wheel, deactivating the motor(in only motor failure). After the controller completes the ABS control, take the same action as the management 2.

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Fig. 21: The Management Of Failure Detected Chart
Courtesy of KIA MOTORS AMERICA, INC.

Detect mode:

- A. Initial check
- B. Outside the ABS control cycle
- C. Inside the ABS control cycle
- D. Diagnosis mode
- E. Failure mode

DIAGNOSTIC TROUBLE CODE DESCRIPTIONS

No.	Failure Location	Failure Cause	Condition for Detection	Error code	Management/ Detect mode				
					A	B	C	D	E
1.1	Sensor (wiring, harness, exciter, ECU)	Short to GND, Short to Batt, Open	The wheel velocity is below 7Km/h and the offset voltage of the sensor is outside the permitted range (2.15~3.5V). If this condition is continued for more than 140msec.	FL: C1200 FR: C1203 RL: C1206 RR: C1209	3	3	4	3	3
1.2		Speed Jump	The wheel deceleration of [-100(-25km/h) for 7ms] causes the controller to start monitoring this failure and to compare the wheel velocity with the vehicle velocity from next cycle. When its difference of -100g is continued for more than 140msec, controller recognize the failure.	FL: C1201 FR: C1204 RL: C1207 RR: C1210	-	3	4	3	3
1.3		Large Air gap	This monitoring is performed for the period that the minimum velocity rises from 2km/h to 10km/h. 1. When the minimum wheel velocity is 2km/h and the velocity of other wheels exceed 10km/h with the acceleration of < z0.4g, the controller start comparing the velocity of other wheels except the min. wheel. If their difference below 4km/h is continued for 154msec, otherwise, if their difference beyond 4km/h or > 0.4g is continued for 120 seconds. 2. 1n < z0.4g, when the velocity of more two wheels is 2km/h and the max. Wheel velocity exceeds 10km/h, the condition is continued for 5sec. Otherwise, 1 > 0.4g, the condition is 120 seconds.	FL: C1202 FR: C1205 RL: C1208 RR: C1211	-	3	-	3	3

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Fig. 22: Diagnostic Trouble Code Descriptions (1 Of 4)
Courtesy of KIA MOTORS AMERICA, INC.

No.	Failure Location	Failure Cause	Condition for Detection	Error code	Management/ Detect mode				
					A	B	C	D	E
1.4	Sensor (wiring, harness, exciter, ECU)	Wrong Exciter	1. Max. wheel velocity exceeds 20km/h and the wheel velocity is 40% of max. wheel velocity. If this condition is lasted for 120sec. 2. Max. wheel velocity exceeds 40km/h and the wheel velocity is 60% of max. wheel velocity. If this condition lasts for 120sec.	FL: C1201 FR: C1204 RL: C1207 RR: C1210	-	3	4	3	3
1.5		Long term ABS mode	1. During the ABS control cycle, if the wheel velocity of 2km/h lasts for more than 12sec. 2. If the ABS control cycle is continued for more than 36sec.	FL: C1202 FR: C1205 RL: C1208 RR: C1211	-	-	4	-	-
2.1	Valve relay (wiring harness, ECU)	Open	When the valve relay is switched on, the reference voltage of valve relay is outside the permitted range, which is continued for 56msec.	C2112	1	1	1	1	-
2.2		Short	When the valve relay is switched off, the reference voltage of valve relay is over the criterion, which is continued for 56msec.		1	-	-	-	1
3	Solenoid valve (ECU, wiring harness)	Open, Short, Leakage Current	1. When the valve relay is switched off, the drain voltage of the solenoid drive MOSFET is over the criterion, which is continued for 56msec. 2. When the valve relay is switched on and a solenoid off, the drain voltage of the solenoid drive MOSFET is under the criterion, which is continued for 56msec. 3. When the valve relay and a solenoid are switched on, the drain voltage of the solenoid drive MOSFET is over the criterion, which is continued for 56msec.	C1604	1	1	1	1	1

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Fig. 23: Diagnostic Trouble Code Descriptions (2 Of 4)
Courtesy of KIA MOTORS AMERICA, INC.

No.	Failure Location	Failure Cause	Condition for Detection	Error code	Management/ Detect mode				
					A	B	C	D	E
4.1	Motor relay, motor (wiring harness, ECU)	Motor relay or fuse open, motor short to GND	When the motor relay is switched on, the reference voltage of motor is under the criterion, which is continued for 49msec.	C2402		2	2	2	
4.2		Motor lock	The controller starts monitoring the motor voltage for 84msec from the time when the motor relay is switched off. If the motor voltage is under the criterion for 49msec, after 1.8sec from driving the motor off, the motor is reactivated for 1sec and the above check is performed again. In second check, when the motor voltage is under the criterion for 49msec, the controller recognizes the failure.			2	2	2	
4.3		Motor short to BATT	The controller starts monitoring the motor after 1.8sec from the time when the motor relay is switched off. If the motor voltage is over the criterion for 200msec.		2	2		2	2
4.4		Motor open	The controller starts monitoring the motor after 1.8sec from the time when the motor relay is switched off. If the motor voltage is outside the permitted range for 200msec.		2	2		2	2

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Fig. 24: Diagnostic Trouble Code Descriptions (3 Of 4)
Courtesy of KIA MOTORS AMERICA, INC.

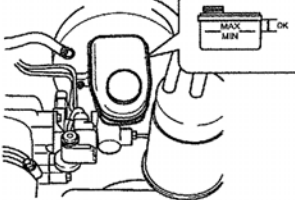
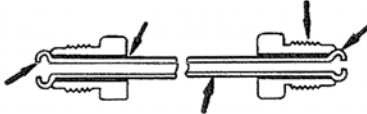
No.	Failure Location	Failure Cause	Condition for Detection	Error code	Management/ Detect mode				
					A	B	C	D	E
5.1	Power supply	Low voltage	1. When V(IGN) < 9.4V is continued for 500msec 2. If the voltage reaches to more than 9.6V, the controller recovers to normal state.	C1102	5	5	5	5	5
			1. When V(IGN) < 7.2V is detected during state 1) 2. If the voltage reaches to more than 7.5V, the controller recovers to state 1)		1	1	1	1	1
5.2		Over voltage	1. When V(IGN)>17V is continued for 500msec, or when V(IGN)>18V is continued for 49msec. 2. If the voltage recovers normal operating range, the controller is reset.	C1101	1	1	1	1	1
6.1	ECU	EEPROM failure	After the master processor writes the pre-defined data to EEPROM, read the data and compare each other. If they differ from each other.	C1604	1	1	1	1	1
6.2		MCU failure	If the master/slave processor detects abnormal operation in RAM, status register, interrupt, timer, A/D converter and cycle time.		2	2		2	2

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Fig. 25: Diagnostic Trouble Code Descriptions (4 Of 4)

BASIC INSPECTION

VISUAL OBSERVATION

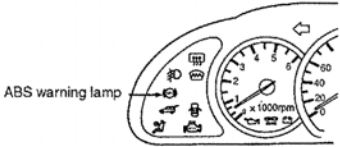
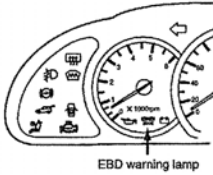
Step	Inspection	Actions	
1	Check if parking brake is working properly. - Stroke: 3.50-4.33 in (90-110 mm)	Yes	Go to next step.
		No	- Repair or replace lever/cable. - Inspect parking brake switch. - Check operation. - Turn adjusting nut.
2	Check if brake fluid level in the reservoir tank is between "Max" and "Min". 	Yes	Go to next step.
		No	Fill up brake fluids.
3	Check if brake fluids leak on all hydraulic lines. 	Yes	Replace corresponding part.
		No	Go to next step.
4	Check if ABS fuse is fully seated and intact. - Opened or shorted - Connection	Yes	Go to next step.
		No	Replace it.
5	Check if following component is fully seated and intact. - ABS sensor - Hydraulic control unit (Include ECU) - Brake fluids reserve tank - Stop lamp switch - ABS warning module - EBD Warning module (Parking brake switch)	Yes	Check functions.
		No	Connect it again. Repair or replace it.

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Fig. 26: Visual Observation Chart

Courtesy of KIA MOTORS AMERICA, INC.

CHECKING FUNCTIONALITY

Step	Inspection	Actions	
1	Verify if ABS warning lamp turns on for 2 to 3 seconds when ignition is switched ON. 	Yes	Go to next step.
		No	Check ABS warning lamp and wiring harness.
2	<ul style="list-style-type: none"> - Verify if brake warning lamp (EBD warning lamp) turns off when parking brake is released. - Verify if brake warning lamp turns on for 2 to 3 seconds when ignition is switched ON. After parking brake is released. 	Yes	Go to next step.
		No	<ul style="list-style-type: none"> - Check level of brake fluids. - Inspect brake pipes, hoses, wheel cylinder, seal and leak at master cylinder. - Brake warning lamp (EBD warning lamp) can turn on with ABS warning lamp at the same time when ABS is defective. - Although parking brake is released, brake warning lamp can turn on intermittently when ignition is switched on.
3	Retrieve malfunction codes using diagnostic tool (Hi-scan pro).	Yes	Go to corresponding detail inspection.
		No	Go to next step.
4	Go to step 3 again after driving vehicle, and retrieve malfunction codes.	Yes	Go to corresponding detail inspection.
		No	<ul style="list-style-type: none"> - Check each connector and connections. - System OK.

G01092266

Fig. 27: Checking Functionality Chart
 Courtesy of KIA MOTORS AMERICA, INC.

DIAGNOSTIC TROUBLE CODES

DTC INDEX

DTC	Description
<u>DTC C1200, C1203, C1206, C1209</u>	WHEEL SPEED SENSOR
<u>DTC C1201, C1204, C1207, C1210</u>	SPEED JUMP OR WRONG EXCITER
<u>DTC C1202, C1205, C1208, C1211</u>	AIR GAP ERROR
<u>DTC C1101, C1102</u>	VOLTAGE
<u>DTC C1604</u>	ECU HARDWARE
<u>DTC C2112</u>	VALVE RELAY
<u>DTC C2402</u>	PUMP MOTOR

DIAGNOSTIC TROUBLE CODE INSPECTION

DTC	Trouble location	Symptom
C1101	Battery voltage over volt	> 17V
C1102	Battery voltage low volt	< 9.4V
C1200	FL wheel sensor	Open or short to GND
C1201	- Range/ Performance	Speed jump or damaged exciter
C1202	- No signal	Air-gap error or wrong excite
C1203	FR wheel sensor	Open or short to GND
C1204	- Range/Performance	Speed jump or damaged exciter
C1205	- No signal	Air-gap error or wrong excite
C1206	RL wheel sensor	Open or short to GND
C1207	- Range/ Performance	Speed jump or damaged exciter
C1208	- No signal	Air-gap error or wrong excite
C1209	RR wheel sensor	Open or short to GND
C1210	- Range/Performance	Speed jump or damaged exciter
C1211	- No signal	Air-gap error or wrong excite
C1604	ECU hardware	ECU internal or valve failure
C2112	Valve relay, Fuse	Valve relay or fuse failure
C2402	Motor- Electrical or motor lock fail	Open or short to battery, motor relay, fuse

G01092267

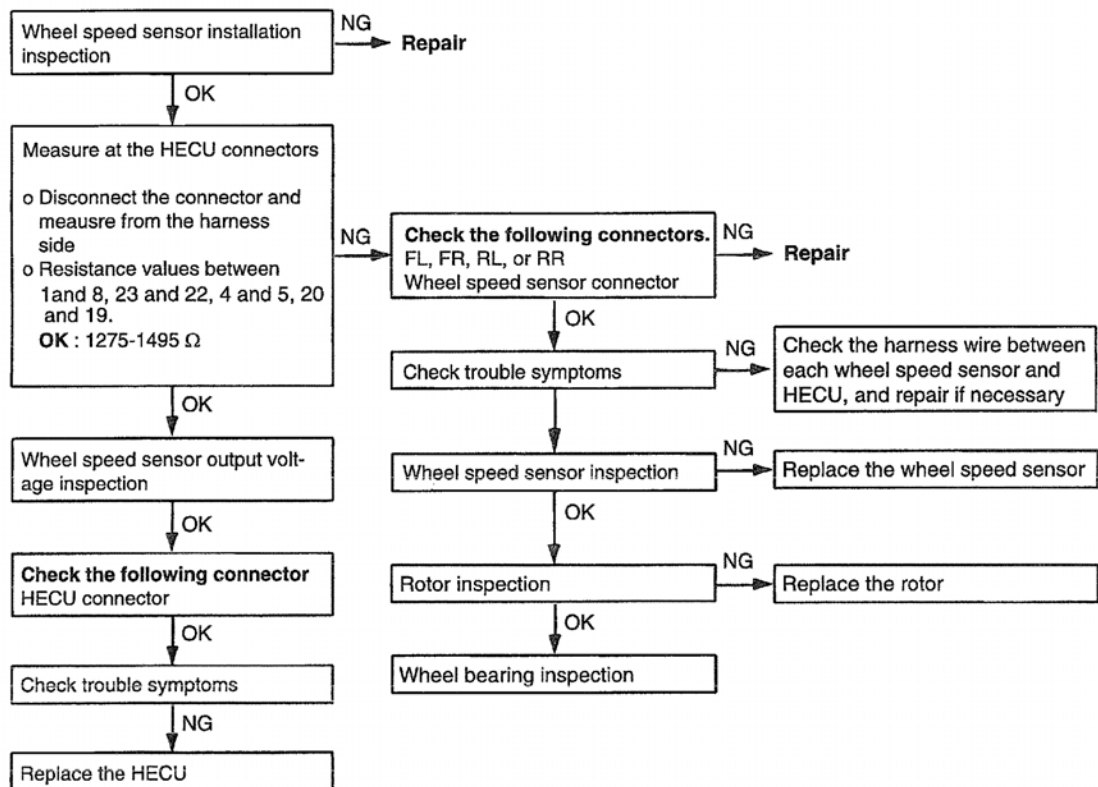
Fig. 28: Diagnostic Trouble Code Descriptions
Courtesy of KIA MOTORS AMERICA, INC.

DTC C1200, C1203, C1206, C1209: WHEEL SPEED SENSOR

DTC No. C1200, C1203, C1206, C1209 Wheel speed sensor open or short GND circuit	Probable cause
[Comment] The HECU determines that an open or short circuit occurs in more than one line of wheel speed sensors.	<ul style="list-style-type: none">• Malfunction of wheel speed sensor• Malfunction of wiring harness or connector• Malfunction of HECU

G01092268

Fig. 29: Wheel Speed Sensor Probable Cause Chart
Courtesy of KIA MOTORS AMERICA, INC.



G01092269

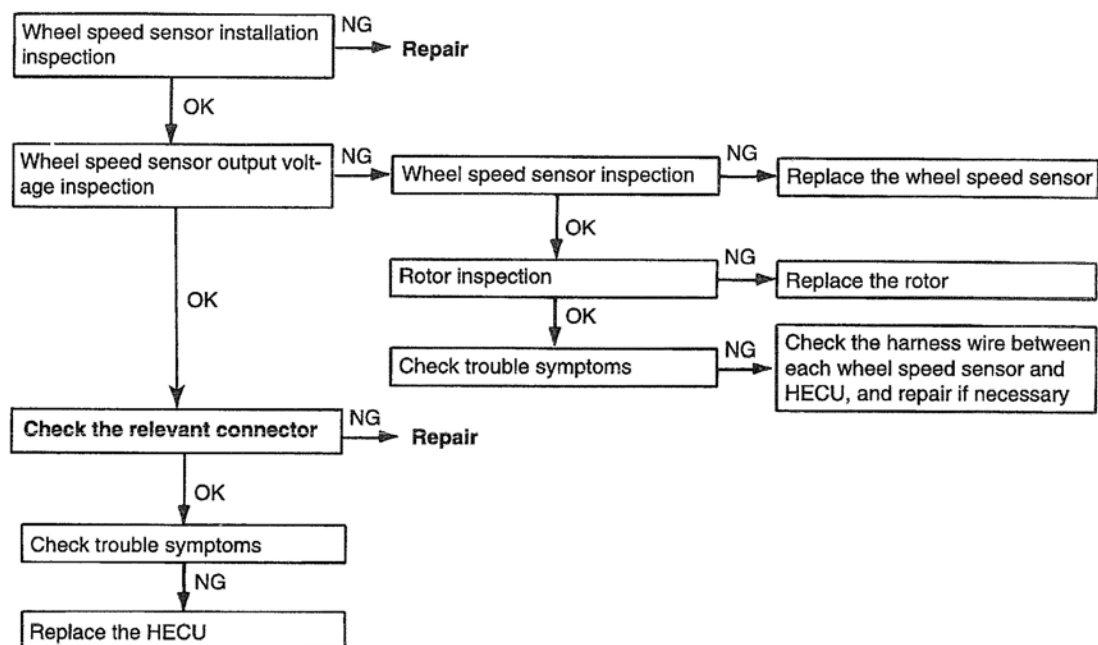
Fig. 30: Wheel Speed Sensor Diagnostic Chart
 Courtesy of KIA MOTORS AMERICA, INC.

DTC C1201, C1204, C1207, C1210: SPEED JUMP OR WRONG EXCITER

DTC No. C1201, C1204, C1207, C1210 (Speed jump or wrong exciter)	Probable cause
[Comment] A wheel speed sensor outputs an abnormal signal (other than an open short-circuit).	<ul style="list-style-type: none"> • Improper installation of wheel speed sensor • Malfunction of wheel speed sensor • Malfunction of rotor • Malfunction of wheel bearing • Malfunction of wiring harness or connector • Malfunction of HECU

G01092270

Fig. 31: Speed Jump Or Wrong Exciter Probable Cause Chart
 Courtesy of KIA MOTORS AMERICA, INC.



G01092271

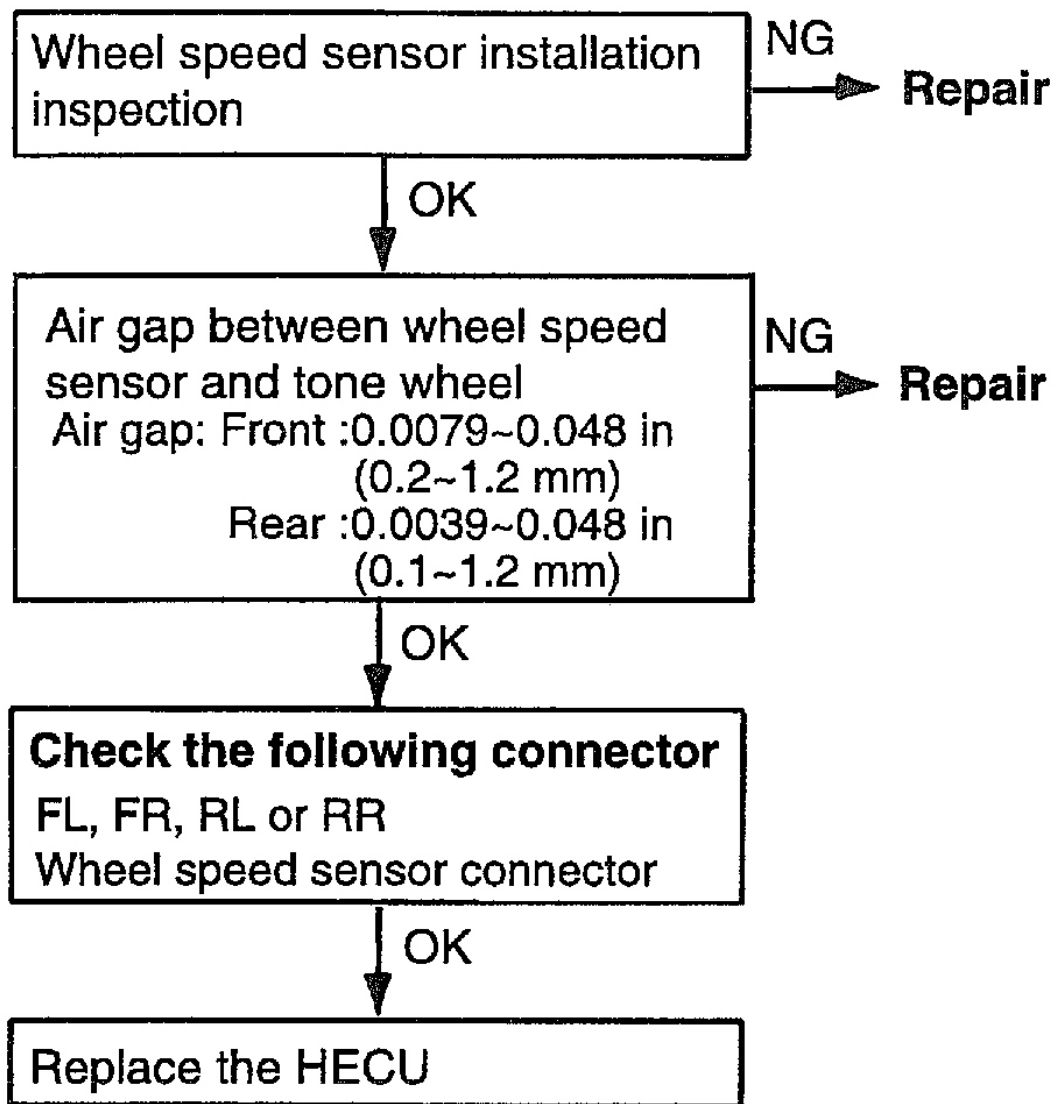
Fig. 32: Speed Jump Or Wrong Exciter Diagnostic Chart
Courtesy of KIA MOTORS AMERICA, INC.

DTC C1202, C1205, C1208, C1211: AIR GAP ERROR

DTC No. C1202, C1205, C1208, C1211 (Air gap error)	Probable cause
[Comment] A wheel speed sensor outputs an abnormal signal.	<ul style="list-style-type: none"> • Malfunction of wheel speed sensor • Improper installation of wheel speed sensor • Malfunction of rotor • Malfunction of wiring harness or connector • Malfunction of HECU

G01092272

Fig. 33: Air Gap Error Probable Cause Chart
Courtesy of KIA MOTORS AMERICA, INC.



G01092273

Fig. 34: Air Gap Error Diagnostic Chart
Courtesy of KIA MOTORS AMERICA, INC.

DTC C1101, C1102: VOLTAGE

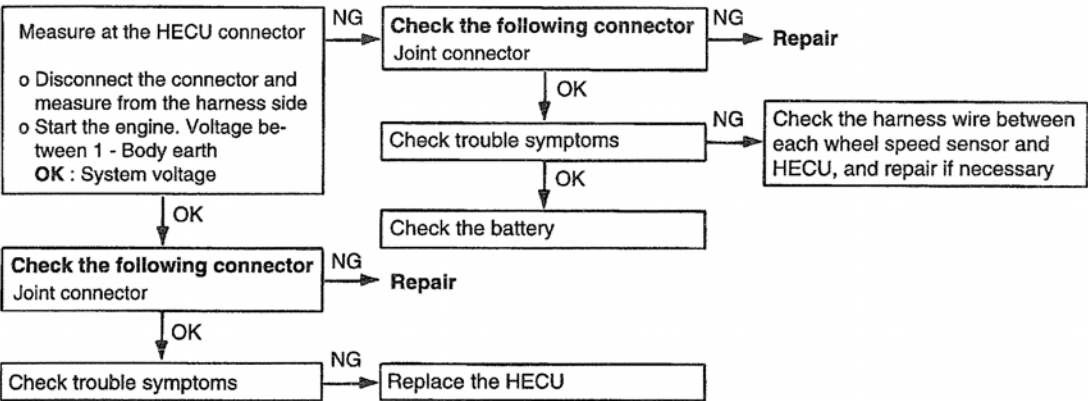
DTC No. C1101, C1102 Voltage out of range (Under and over voltage)	Probable cause
[Comment] The voltage of the HECU power supply drops lower or rises higher then specified value. If the voltage returns to the specified value, this code is no longer output.	<ul style="list-style-type: none"> • Malfunction of wiring harness or connector • Malfunction of HECU

G01092274

Fig. 35: Voltage Probable Cause Chart
 Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: If battery voltage drops or rises during inspection, this code will be output as well. If the voltage returns to standard value, this code is no longer output.

Before carrying out the following inspection, check the battery level, and refill it if necessary.



G01092275

Fig. 36: Voltage Diagnostic Chart
 Courtesy of KIA MOTORS AMERICA, INC.

DTC C1604: ECU HARDWARE

DTC No. C1604 ECU Hardware (Error valve failure)	Probable cause
[Comment] The HECU always monitors the solenoid valve drive circuit. It determines that there is an open or short-circuit in the solenoid coil or in a harness : When no current flows in the solenoid even though the HECU turns on it, and vice versa.	<ul style="list-style-type: none"> • Malfunction of wiring harness • Malfunction of hydraulic unit • Malfunction of HECU

G01092276

Fig. 37: ECU Hardware Probable Cause Chart

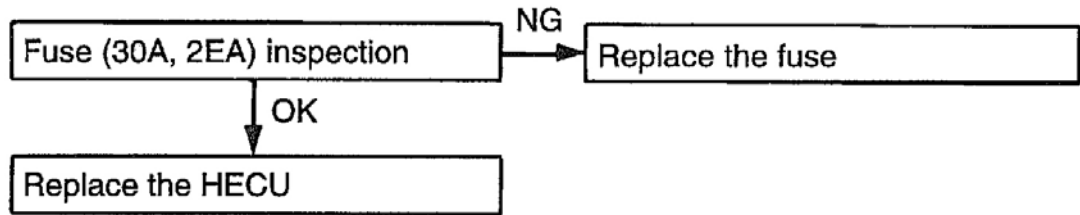
DTC C2112: VALVE RELAY

DTC No. C2112 Valve relay (Including fuse failure)	Probable cause
[Comment] When the ignition switch is turned to ON, the HECU switches the valve relay off and on during the initial check. In that way, the HECU compares the signals sent to the valve relay with the voltage in the valve power monitor line. That is how to check if the valve relay is operating normally. The HECU always checks if current flows in the valve power monitor line, too. It determines that there is an open circuit when no current flows. If no current flows in the valve power monitor line, this diagnosis code is output.	<ul style="list-style-type: none">• Malfunction of valve relay• Malfunction of wiring harness or connector• Malfunction of HECU• Malfunction of hydraulic unit

G01092277

Fig. 38: Valve Relay Probable Cause Chart
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: Whenever reading the diagnosis codes using the ABS warning lamp, this diagnosis code will be output.



G01092278

Fig. 39: Valve Relay Diagnostic Chart
Courtesy of KIA MOTORS AMERICA, INC.

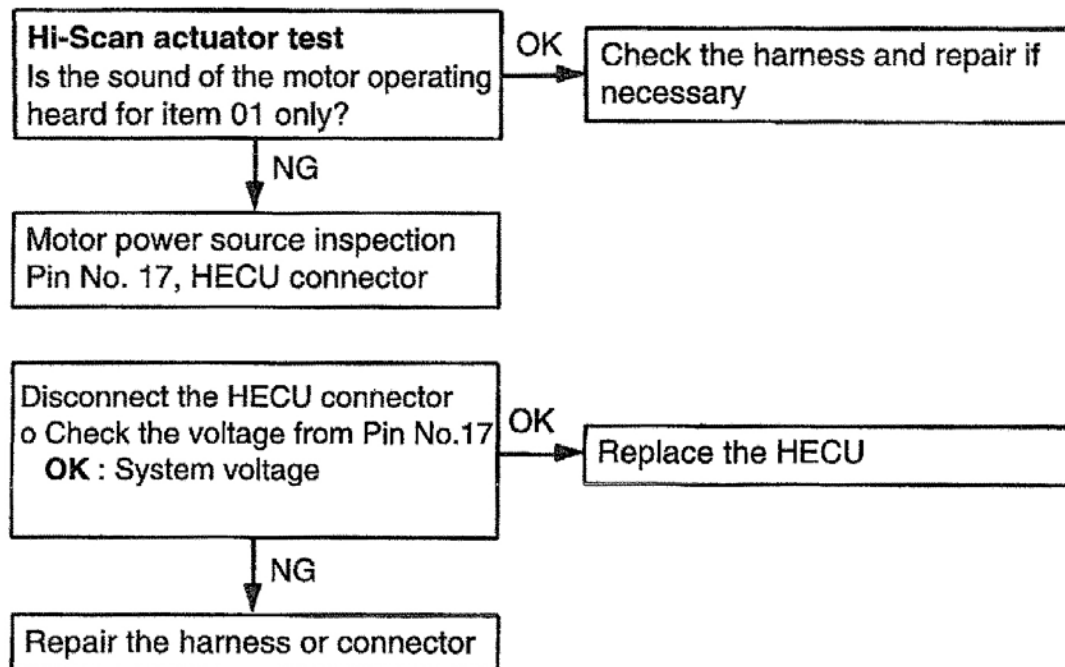
DTC C2402: PUMP MOTOR

DTC No. C2402 Electrical (Pump-motor)	Probable cause
[Comment] When the motor power line is normal but no signal is inputed to the motor monitor line when the motor power line is faulty.	<ul style="list-style-type: none">• Malfunction of wiring harness or connector• Malfunction of hydraulic unit• Malfunction of HECU

G01092279

Fig. 40: Pump Motor Probable Cause Chart
Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: Because force-driving of the motor by means of the actuator test will drain the battery, the engine should be started and left to run for a while after testing is completed.



G01092280

Fig. 41: Pump Motor Diagnostic Chart
Courtesy of KIA MOTORS AMERICA, INC.

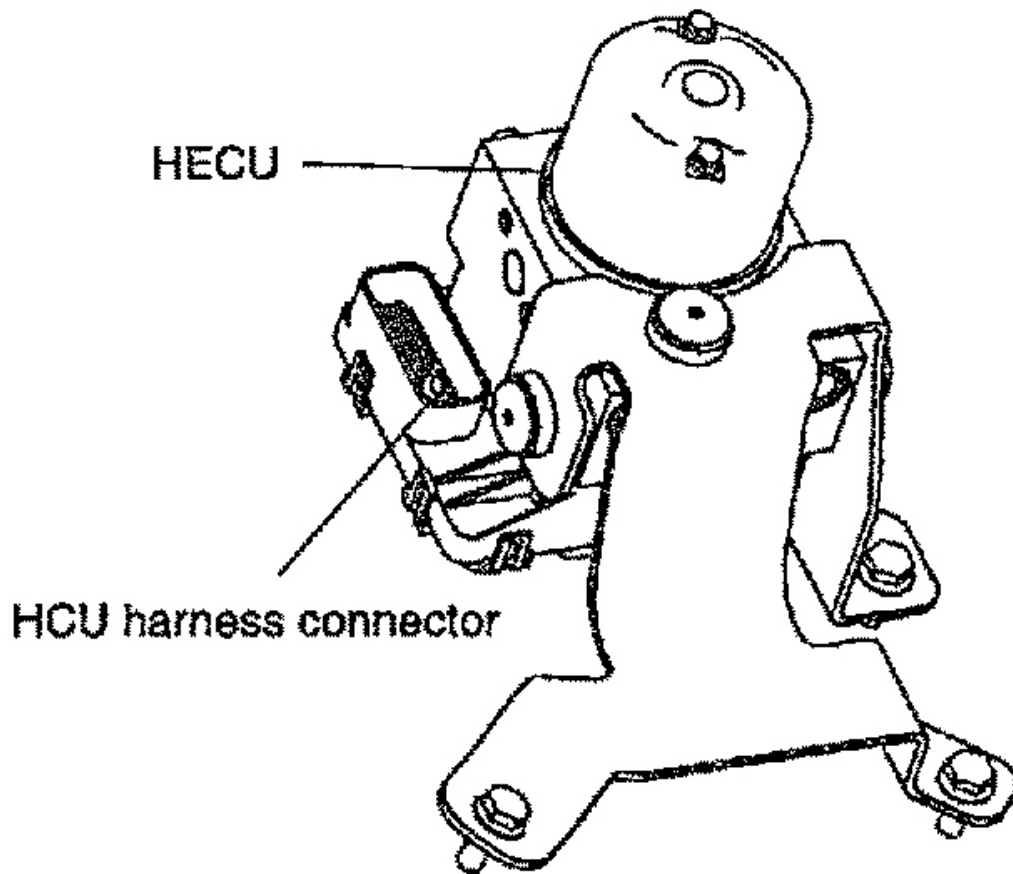
REMOVAL, INSPECTION & INSTALLATION

ANTI-LOCK BRAKING SYSTEM CONTROL MODULE

REMOVAL

1. Turn ignition "OFF".
2. Disconnect ECU harness connector from ECU assembly.

CAUTION: Do not apply a 12V power source to any terminal of the ECU connector when disconnected.



G01092281

Fig. 42: Illustrating HCU Harness Connector & HECU
Courtesy of KIA MOTORS AMERICA, INC.

3. Mark the brake pipes going into and out of the HCU with tags so reinstallation of the brake lines will be correct.

CAUTION: Before removing the brake pipes from HCU, the HCU must be thoroughly cleaned to prevent dirt particles from falling into the ports of HCU or entering the brake pipes.

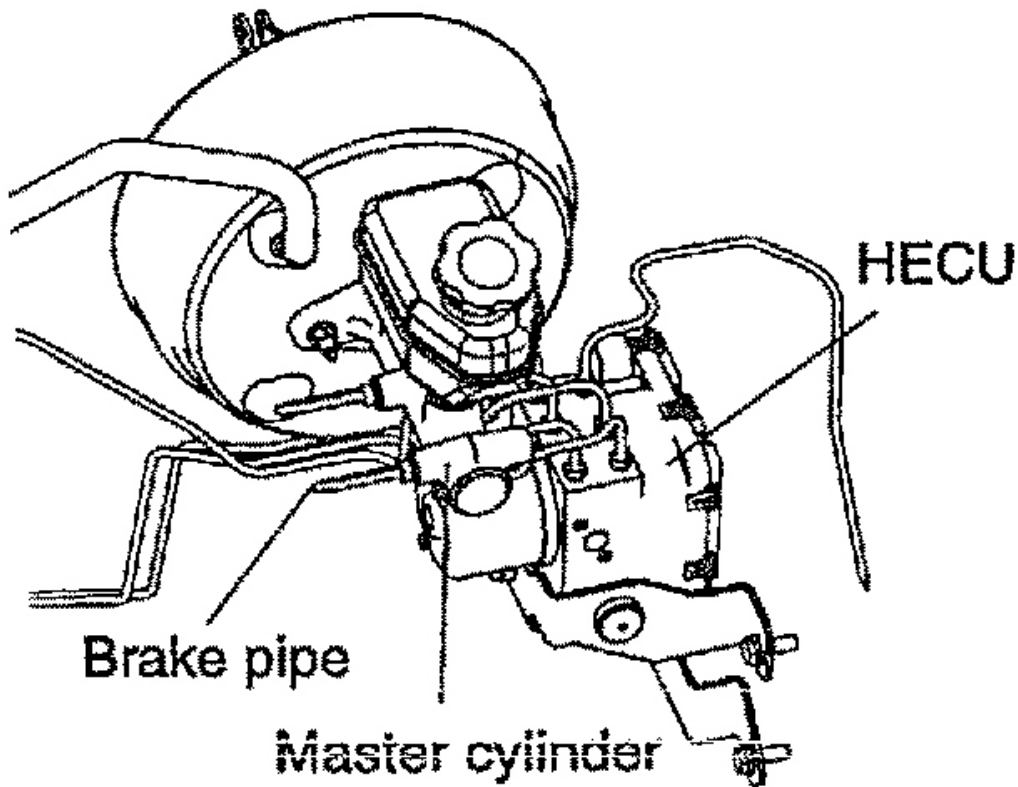
4. Remove the brake pipes from the HCU.
5. Loosen the mounting pin and grommet from HECU bracket and then remove HECU from HECU bracket.
6. Remove bolts attaching the ECU to the HCU.

7. Lift the ECU assembly straight from the HCU.
8. Clean the top of the HCU with a clean, dry cloth.

REPLACEMENT

1. Lower ECU onto the HCU and tighten its bolts to specification:
 - Tightening torque: 1.3-1.4 ft. lbs (1.7 - 1.9 N.m, 0.18 - 1.2 kgf. m)
2. Carefully place HECU to the HECU bracket.
3. Tighten the mounting pin and grommet to the HECU bracket:
 - Tightening torque: 5.8 - 7.2 ft. lbs (7.8 - 9.8 N.m, 0.8 - 1 kgf. m)
4. Reconnect six brake lines. Be certain that the four outlet lines have been connected to the correct ports. Tighten the nuts to specification:
 - Tightening torque: 9.4 - 15.9 ft. lbs (12.8 - 21.6 N.m, 1.3 - 2.2 kgf. m)

NOTE: **When installing the brake pipe lines on the HCU valve block, they must be located correctly in the valve block to ensure proper ABS operation.**



G01092282

Fig. 43: Illustrating Brake Pipes & HECU Locations
Courtesy of KIA MOTORS AMERICA, INC.

5. Connect the ECU harness connector to ECM assembly.
6. Bleed the base brakes.
7. Road test vehicle to ensure proper operation of the base and ABS systems.

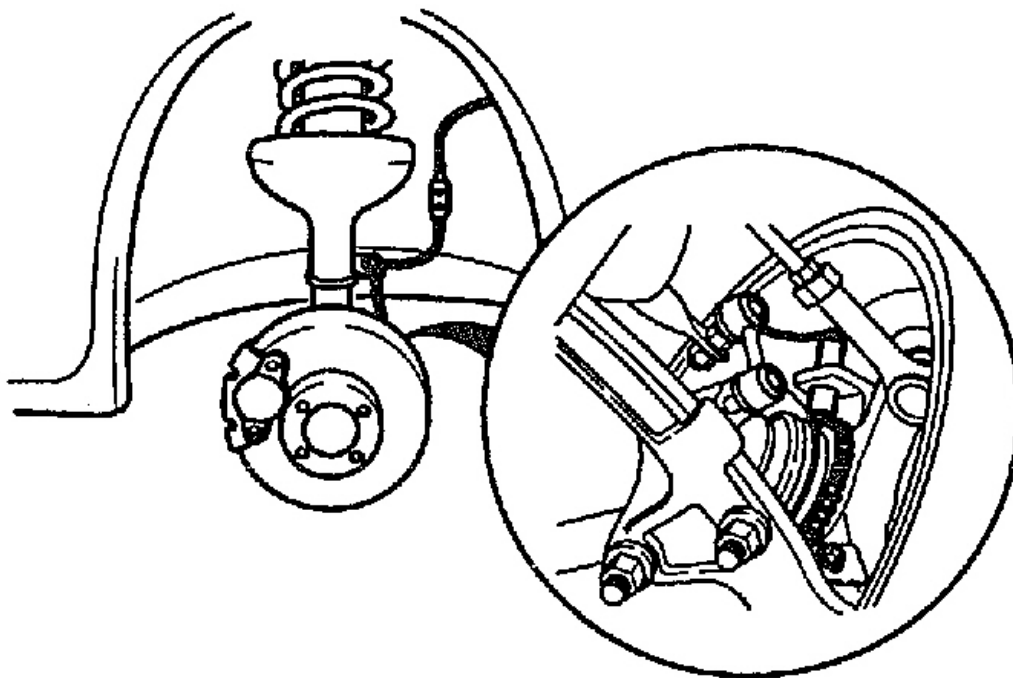
FRONT WHEEL SPEED SENSOR

REMOVAL

CAUTION: When disconnecting the wheel speed sensor from vehicle wiring harness, be careful not to damage pins on connector.

1. Remove harness connector.

2. Remove sensor bolt and remove the speed sensor.

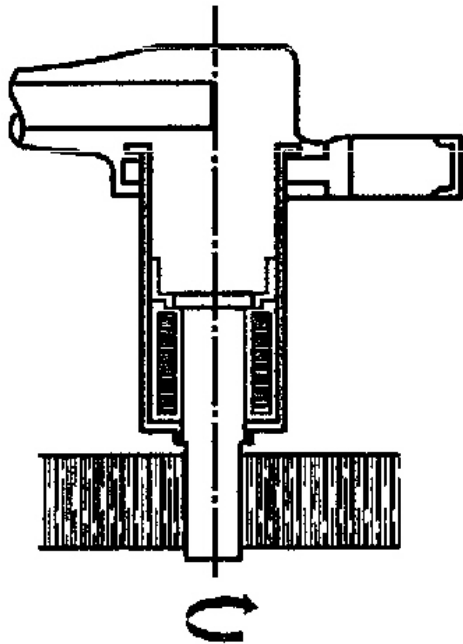


G01092283

Fig. 44: Removing Sensor Bolt And Remove The Speed Sensor
Courtesy of KIA MOTORS AMERICA, INC.

INSPECTION

1. Measure clearance:
 - Specified clearance: 0.0079 - 0.048" (0.2-1.2 mm)
2. Measure speed sensor resistance:
 - Resistance: 1275-1495ohm



G01092284



Fig. 45: Measuring Sensor Clearance
 Courtesy of KIA MOTORS AMERICA, INC.

REPLACEMENT

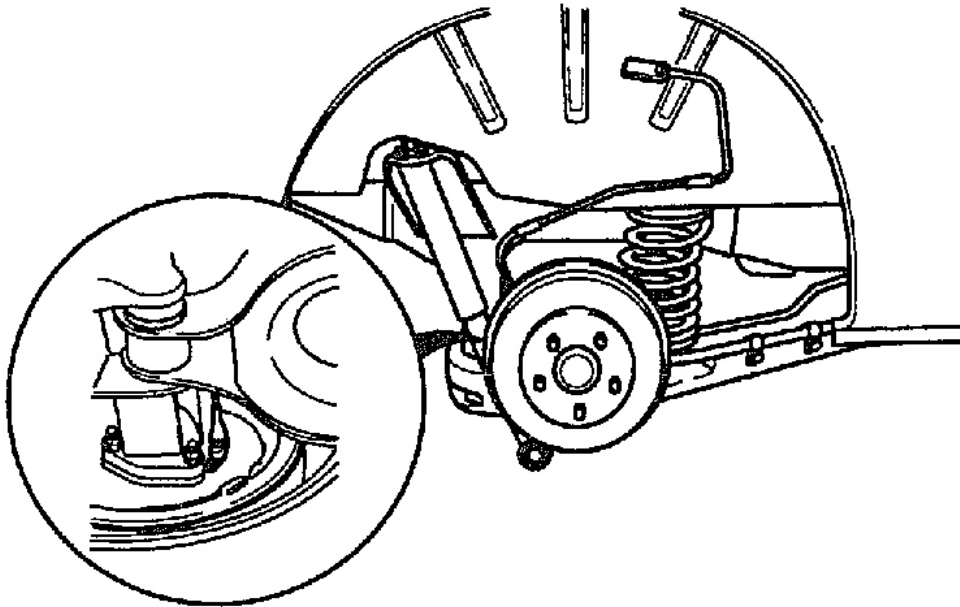
1. Clean speed sensor attaching surface.
2. Install speed sensor:
 - Tightening torque: 7 ft. lbs (9.5 N.m, 1 kgf. m)
3. Install the wiring harness connector with wheel speed sensor cable:
 - Be sure speed sensor cable connector is fully seated and locked into vehicle wiring harness connector.
4. Check the air gap between the face of the wheel speed sensor and the top surface of the tone-wheel:
 - Air gap: 0.0079-0.048" (0.2-1.2 mm)
5. Road test vehicle to ensure proper operation of the base and ABS brake system.

REAR WHEEL SPEED SENSOR

REMOVAL

CAUTION: When unplugging speed sensor cable from vehicle wiring harness be careful not to damage pins on the electrical connectors.

1. Remove the harness connector.
2. Remove the sensor bolt and remove the speed sensor.



G01092285

Fig. 46: Removing The Sensor Bolt And Remove The Speed Sensor
Courtesy of KIA MOTORS AMERICA, INC.

INSPECTION

1. Check clearance:
 - Measure the clearance: Specified clearance: 0.0039-0.048" (0.1-1.2 mm)
2. Measure speed sensor resistance:
 - Resistance: 1275-1495ohm

REPLACEMENT

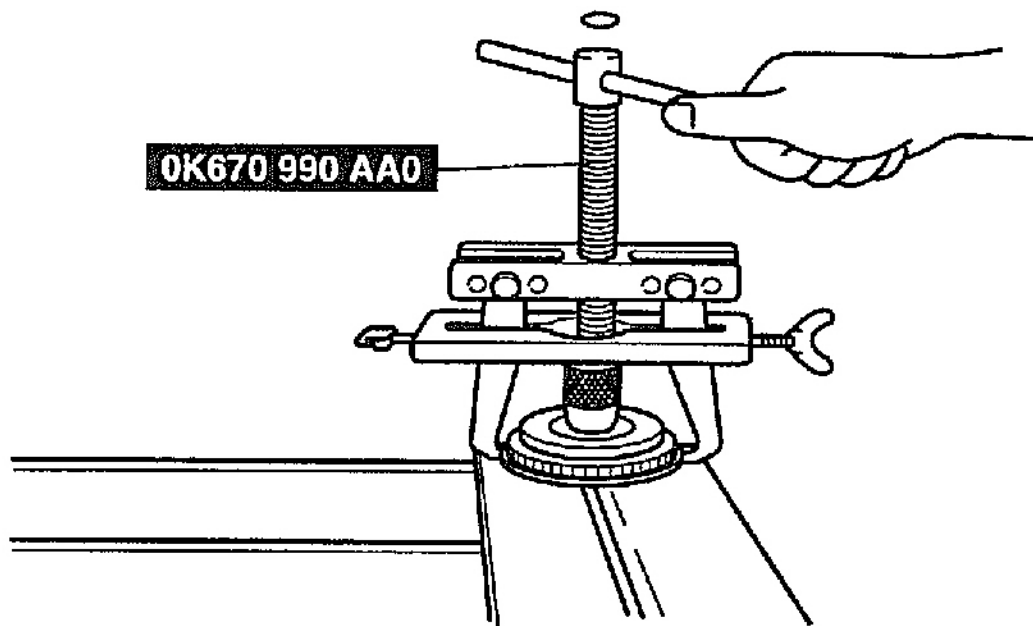
1. Clean the speed sensor attaching surface.
2. Install the speed sensor:
 - Tightening torque: 6-7 ft. lbs (8-9.5 N.m, 82-97 kg. cm)

3. Install the wiring harness connector with wheel speed sensor cable.
 - Be sure speed sensor cable connector is fully seated and locked into vehicle wiring harness connector.
4. Check the air gap between the face of the wheel speed sensor and the top surface of the tone-wheel.
 - Air gap: 0.0039-0.048" (0.1-1.2 mm)
5. Road test vehicle to ensure proper operation of the base and ABS brake system.

FRONT SENSOR ROTOR

REMOVAL

1. Remove wheel hub assembly from the vehicle.
2. Remove rotor with SST (0K670 990 AA0). Do not re-install a rotor which is removed.



G01092286

Fig. 47: Removing Front Sensor Rotor With Service Tool
Courtesy of KIA MOTORS AMERICA, INC.

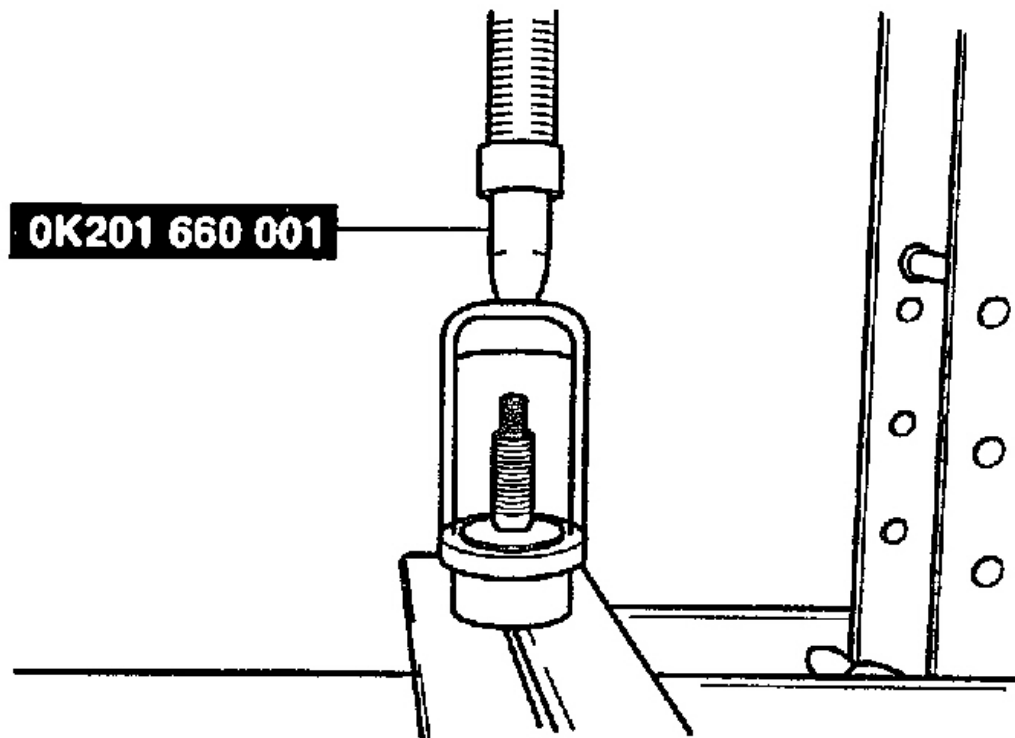
INSPECTION

1. Lift and properly support front of the vehicle.
2. From backside of wheel, closely inspect sensor rotor. Rotate wheel to examine all teeth.

3. Replace rotor if teeth are missing or damaged.

REPLACEMENT

1. Position a new sensor rotor on wheel hub as shown.
 - Number of sensor rotor teeth: 54
2. Press rotor onto wheel hub with SST (0K201 660 001).



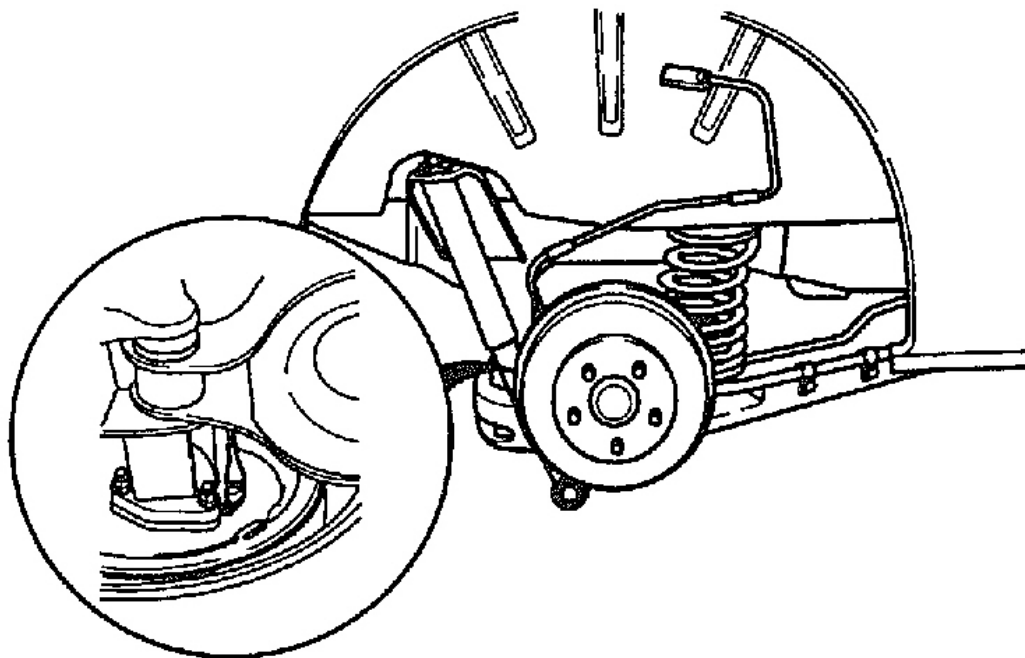
G01092288

Fig. 48: Pressing Rotor Onto Wheel Hub With Service Tool
Courtesy of KIA MOTORS AMERICA, INC.

3. Reinstall wheel hub assembly to vehicle.
4. Check the air gap between the face of the wheel speed sensor and the top surface of the tone-wheel.
 - Air gap: 0.0079-0.048 in (0.2-1.2 mm)
5. Road test vehicle to ensure proper operation of the base and ABS brake system.

REAR SENSOR ROTOR

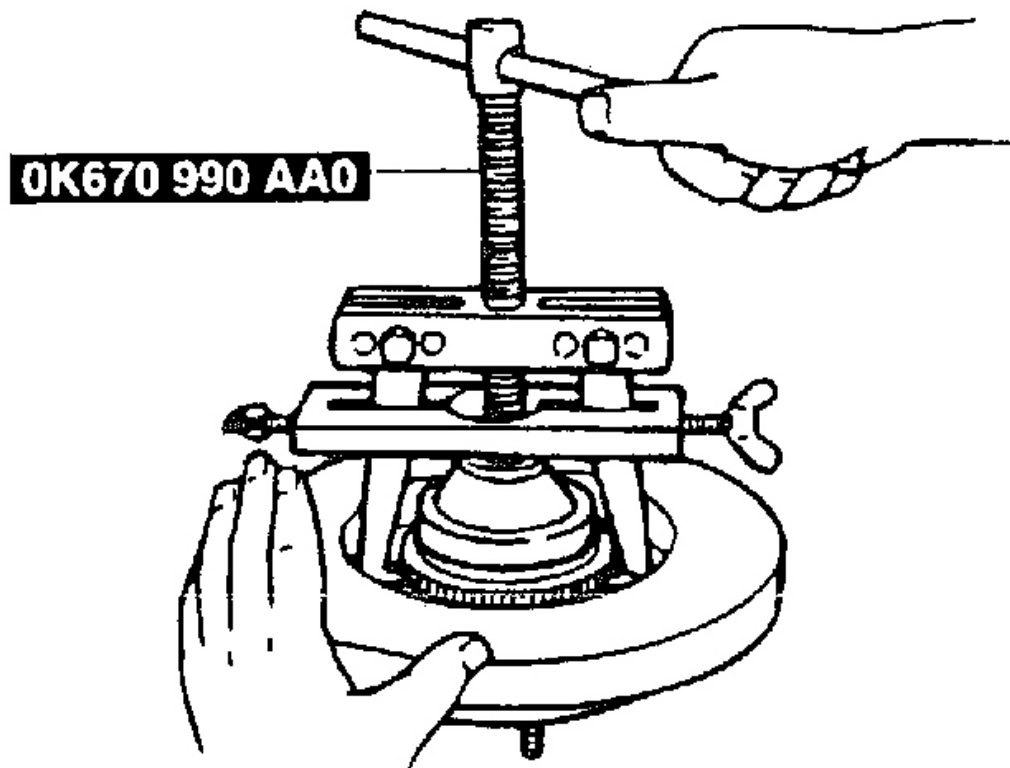
REMOVAL



G01092289

Fig. 49: Removing The Rear Wheel Hub Assembly From The Vehicle
Courtesy of KIA MOTORS AMERICA, INC.

1. Remove the rear wheel hub assembly from the vehicle.
2. Remove the sensor rotor with SST (0K670 990 AA0).

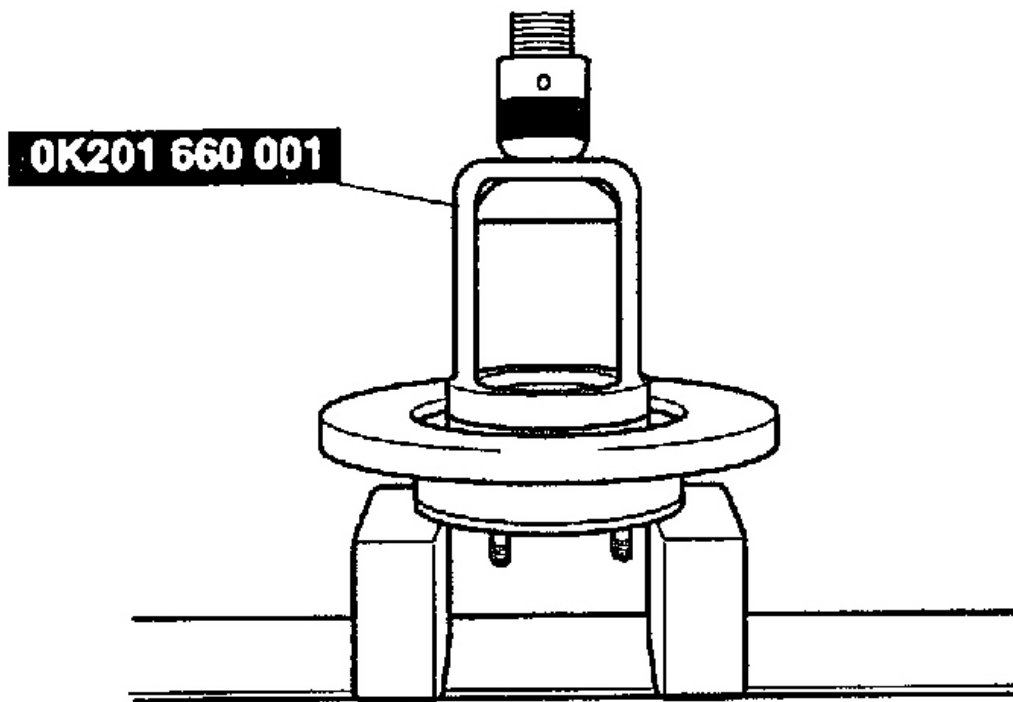


G01092290

Fig. 50: Removing The Sensor Rotor With Service Tool
Courtesy of KIA MOTORS AMERICA, INC.

REPLACEMENT

Number of sensor rotor teeth: 54



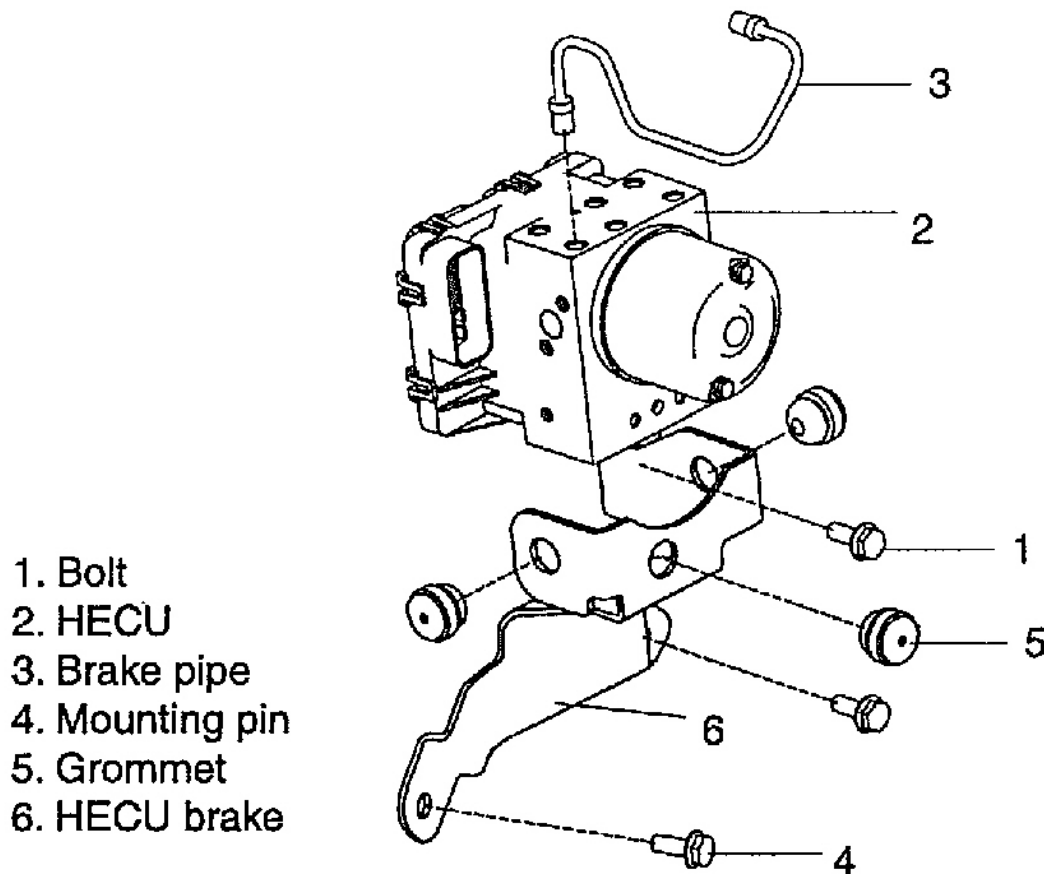
G01092291

Fig. 51: Installing A Sensor Rotor With Service Tool
Courtesy of KIA MOTORS AMERICA, INC.

1. Install a sensor rotor with SST (0K201 660 001).
2. Install the rear wheel hub assembly.
3. Check the air gap between the face of the wheel speed sensor and the top surface of the tone-wheel.
 - Air gap: 0.0039-0.048" (0.1-1.2 mm)
4. Road test vehicle to ensure proper operation of the base and ABS brake system.

ANTI-LOCK BRAKING SYSTEM MODULATOR

REMOVAL



G01092292

Fig. 52: Illustrating Anti-Lock Braking System Modulator Components
 Courtesy of KIA MOTORS AMERICA, INC.

1. Turn ignition "ON".
2. Disconnect ECU connectors from ECU assembly.

CAUTION: Do not apply a 12 volt power source to any terminal of the ECU connector when disconnected.

3. Mark the brake pipes going into and out of the HCU with tags so reinstallation of the brake lines will be correct

CAUTION: Before removing the brake pipes from HCU, the HCU must be thoroughly cleaned to prevent dirt particles from falling into the ports

of HCU or entering the brake pipes.

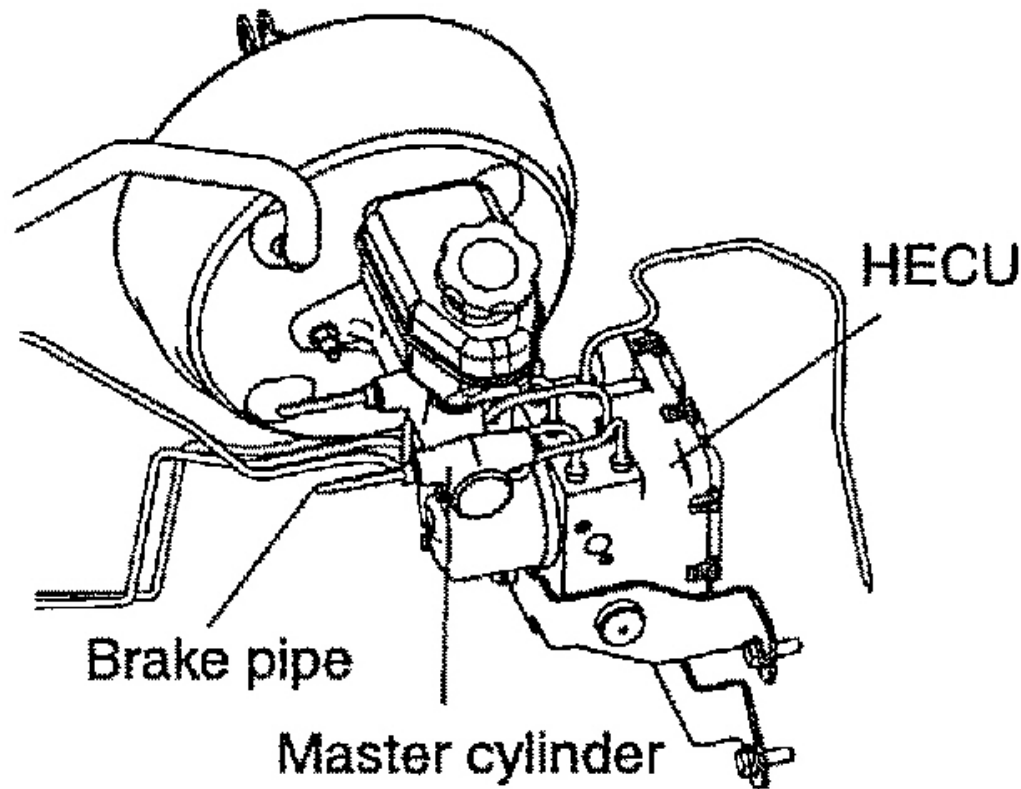
4. Remove the brake pipes from the HCU.
5. Remove the bolts attaching the HECU bracket to the fender.
6. Remove HECU and bracket from vehicle.
7. Remove the mounting pin and grommet attaching the HECU to the bracket and remove HECU from bracket.
8. Remove the bolts securing the ECU to the HCU and lift the ECU carefully off the HCU.
9. Verify that the seal on the ECU is free from nicks or cracking.

REPLACEMENT

1. Carefully replace ECU on the replacement HCU.
2. Torque the ECU bolts in the following two steps:
 - A. Start all bolts into the HCU and hand tighten.
 - B. Torque in the sequence shown until a final achieved for each bolt.
 - Tightening torque: 1.3-1.4 ft. lbs (1.7-7.9 N.m, 0.18-1.2 kgf. m)
3. Reattach bracket to the HECU mounting pin and grommet.
 - Tightening torque: 5.8-7.2 ft. lbs (7.8-9.8 N.m, 0.8-1.0 kgf. m)
4. Reinstall bolts and nuts attaching bracket to fender.
 - Tightening torque: 9.4-15.9 ft. lbs (12.8-21.6 N.m, 1.3-2.2 kgf. m)

NOTE: **When installing the brake pipe lines on the HCU valve block, they must be located correctly in the valve block to ensure proper ABS operation.**

5. Attach brake pipes to HECU, be careful to reattach the pipes in the same positions which they were in prior to removal.
 - Tightening torque: 9.4-15.9 ft. lbs (12.8-21.6 N.m, 1.3-2.2 kgf. m)



G01092293

Fig. 53: Illustrating HECU & Brake Pipe Positions
Courtesy of KIA MOTORS AMERICA, INC.

6. Reconnect ECU harness connectors.
7. Bleed the brakes.
8. Road test vehicle to ensure proper operation of the base and ABS systems.

EBD (ELECTRONIC BRAKE-FORCE DISTRIBUTION)

DESCRIPTION & OPERATION

1. Because accident can arise due to generation of spin in vehicle by preceding locking of rear wheel to front wheel owing to drift of vehicle weight at time of sudden braking during running, the preceding locking of rear wheel has been prevented by decreasing the braking pressure of rear wheel in comparison with front wheel, having furnished with P-valve (proportioning valve-passenger car) or LCRV, LSPV (load

conscious reducing valve, load sensing proportioning valve-small business car) as a countermeasure to that problem.

2. But these are all mechanical equipments and did not realize ideal rear brake force distribution.
3. Especially, though LCRV and LSPV applied in small business cars distributed rear brake force according to vehicle load to a certain degree, P-valve applied in passenger cars could not perform brake force distribution to weight increase, so inferiority in brake force has been viewed as problem.
4. And the required liquid pressure distribution curves for ideal braking differ by respective wheels according as the brake forces generated at respective wheels differ from one another depending on friction material dispersion in brake lining and pad; but ideal braking could not be achieved as only a certain constant liquid pressure distribution curve is maintained if only with mechanical P-valve, LCRV or LSPV.
5. Driver cannot know symptom at trouble time of P-valve, LCRV, LSPV etc; and vehicle body spin may arise at time of sudden braking during period of faulty trouble.
6. Wherefore ABS ECU controls so that rear wheel may be locked at same time of later than front wheel to solve the above problem matters, which is called EBD (electronic brake-force distribution) control.

PRINCIPLE

1. The principle is approximate control of brake force near the required liquid pressure distribution curve (ideal braking distribution curve) by way of adding a logic to ABS ECU instead of the existing P-valve.
2. Rear liquid pressure is controlled so that rear slip ratio will always be less than or same as that of front, having calculated the slip ratio from each wheel speed sensor at braking time.
3. Therefore rear wheel locking does not precede that of front wheel.
4. Consequently brake force improves as rear brake liquid pressure can be enlarged in amount of parts of as shown by deceleration liquid pressure in the figure below.
5. And eventually whole brake force improvement is realized as brake force can be controlled by liquid pressure distribution curves required of wheel according to friction material dispersion.

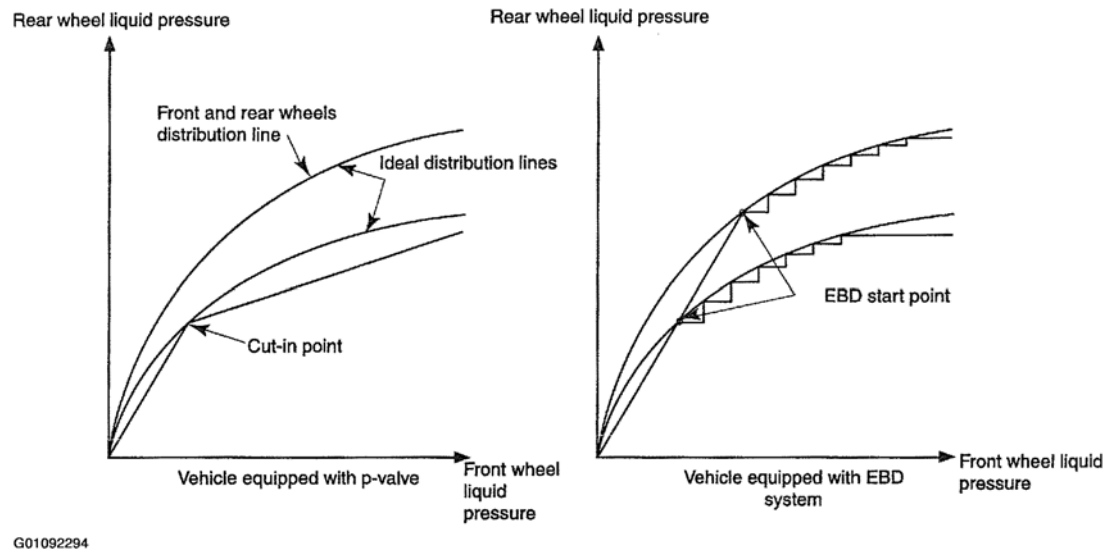


Fig. 54: Illustrating Liquid Pressure Distribution Curve
 Courtesy of KIA MOTORS AMERICA, INC.

EBD OPERATION

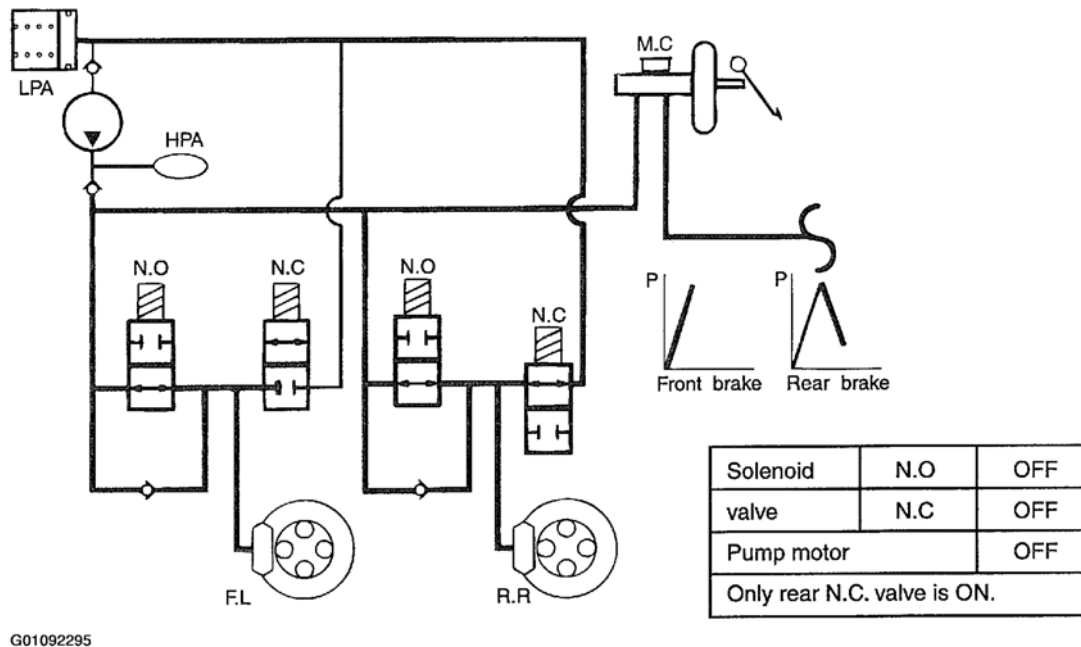


Fig. 55: EBD Operation Diagram
 Courtesy of KIA MOTORS AMERICA, INC.

1. Just before rear wheel is locked preceding to front wheel, ABS ECU lets NC valve of wheel side about to

be locked be ON (OPEN) so that the brake oil pressure of wheel about to be locked be decreased and the locking be prevented.

- 2. If the wheel rotates as brake force is decreased, ABS ECU again lets NC valve be OFF (CLOSE) so that the brake pressure applied at MC be transmitted to clipper.
- 3. Motor pump does not act at this time.

EFFECT

- 1. Brake distance is decreased as rear brake force is enhanced in comparison with existing P-valve.
- 2. Stability is secured at time of rotating braking because as right and left rear wheel liquid pressures may be controlled independently from each other.
- 3. Brake pedal force decreases.
- 4. Stable braking effect can be achieved because front brake pad abrasion and temperature rise and are decreased as braking effect of rear brake is increased at braking time.
- 5. P-valve can be eliminated.

EBD TYPE

Category	Vehicle equipped with EBD system
General performance Comparison	Ideal rear brake force distribution is feasible because control of pressure much greater than 30 bars at sudden braking time is feasible under condition of heavyvehicle (five persons boarded) and high speed.
At time of failure	When it is transferred to ordinary brake but please drive slowly becausegeneration of spin is worried because there is no P-valve. Abstain from behavior of taking a sudden brake; go to maintenance center at once to take measures.

G01092296

Fig. 56: General Performance Comparison Chart
Courtesy of KIA MOTORS AMERICA, INC.

SAFETY

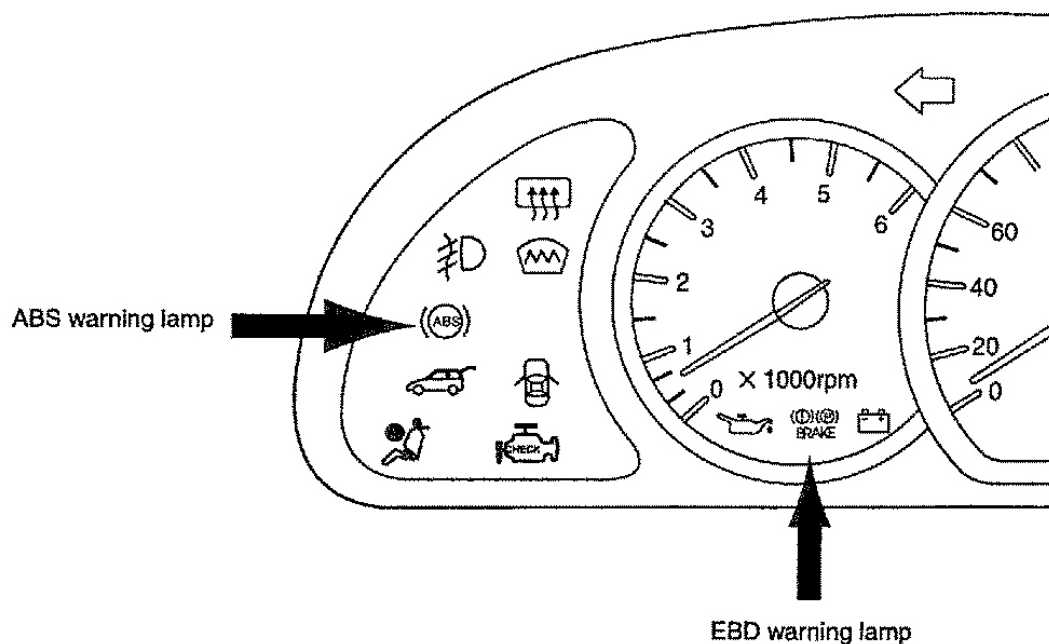
- 1. Failure trouble ratio decreases than with ABS because EBD continues to control even in the following cases among ABS failure causes.
 - 1. One wheel speed sensor failure.
 - 2. Motor pump failure.
 - 3. Failure by low voltage of battery.
- 2. Though there is no alarm instrument for P-valve by which driver may always be informed so that drive cannot know whether or not of failure trouble, in which case body spin may be generated if taken a sudden braking under condition of failure situation; in case of EBD failure trouble, the existing parking brake lamp is lighted to alarm EBD failure situation to driver so that driver can repair.
- 3. EBD fail-safe.

Cause of system failure	System		Warning lamp	
	ABS	EBD	ABS	EBD
None	operate	operate	OFF	OFF
1 Sensor failure	does not operate	operate	ON	OFF
Pump failure	does not operate	operate	ON	OFF
Low voltage of battery	does not operate	operate	ON	OFF
Failure of Plural sensors Valve failure ECU failure Other failures	does not operate	does not operate	ON	ON

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Fig. 57: EBD Fail-Safe Chart
Courtesy of KIA MOTORS AMERICA, INC.

WARNING LAMP



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Fig. 58: Locating ABS & EBD Warning Lamp
Courtesy of KIA MOTORS AMERICA, INC.

1. ABS warning lamp.
 1. It is turned on for three seconds at time of ON of ignition Key and turns off afterwards.
 2. It is extinguished at start of operation.

3. It is lighted if system abnormality arise.
 4. It is lighted during self-diagnosis.
 5. During its lighting, ABS control is interrupted and only ordinary brake operates in same way as ABS-noninstalled vehicle.
 6. It is lighted when ECU connector is removed.
2. EBD (electronic brake-force distribution) warning lamp.
1. It is lighted at time of ON of ignition Key.
 2. It is extinguished at start of operation.
 3. It is lighted when parking brake switch is ON.
 4. It is lighted when brake oil is deficient.
 5. It is lighted when EBD control is infeasible.
 - When there is trouble at solenoid valve.
 - When there is trouble in more than one sensor.
 - When there is trouble in ECU.
 - In case of high voltage.