Brake System

GENERAL

SPECIFICATIONS E3F3EAB7

Item	Specification
Master cylinder · Type · I.D. mm(in) · Piston stroke mm(in) · Fluid level warning sensor	 Tandem type 25.4(1.0) 30 ~ 32(1.18 ~ 1.26) Provided
Brake booster · Type · Boosting ratio	 Vacuum 9 : 1
Front brake(Disc) · Type · Disc O.D. · Disc thickness · Pad thickness · Cylinder type · Cylinder I.D.	 Floating type with ventilated disc 303mm (11.8in) 28mm (1.10in) 11mm (0.43in) Single piston Ø60mm (Ø2.36in)
Rear brake(Disc) · Type · Disc O.D. · Disc thickness · Pad thickness · Cylinder type · Cylinder I.D	 Floating type with solid disc 284mm (10.31in) 10mm (0.39in) 10mm (0.39in) Single piston Ø34mm (Ø1.34in)
Parking brake · Type · Actuation · D.I.H	 Mechanical brake acting on rear wheels Foot Type Ø190mm (Ø7.48in)

O.D=Outer Diameter
I.D=Inner Diameter

NOTE

ABS : Anti-lock Brake System
ESP : Electronic Stability Program

SPECIFICATIONS(ABS)

Part		Item		Standard value	Remark
HECU (Hydraulic and Electronic Control Unit)		Operating voltage Operating temperature		10V ~ 16V -40°C ~ 110°C (-40°F ~ 230°F)	ABS, TCS, EBD integrated control unit Communicate ECM with CAN
		Weight Motor Motor power Pump capacity Accumulator amount		2.7kg (ABS) 3.1kg (TCS) 12V, 35A 190W 5.5 cc/sec 3.0 cc	NO : Normal Open NC : Normal Close TC : Traction Control HS : Hydraulic Shuttle
		Valve	NO	Operating voltage : 12V Consumption current : Max. 25A	
			NC		
			TC		
			HS		
Warn-ing Lamp	ABS	Operating voltage Consumption current		12V Max. 20mA (ABS/EBD) Max. 100mA (TCS/TCS OFF)	Brake warning lamp - Parking brake - Brake oil warning - EBD fail
	TCS				
	TCS OFF				
	BRAKE (EBD)				
Active Wheel Speed Sensor		Operating voltage Tone wheel		7.5 ~ 20V 47T	-40°C ~ +60°C (-40°F ~ 140°F)
		Current con-sumption	I (Low)	7mA+20%/-16%	When measuring sensor current, be sure to install resistance (R=115Ω) at active sensor connector to prevent active sensor damaging.
			I (High)	14mA+20%/-16%	

ESP (ELECTRONIC STABILITY PROGRAM)

SPECIFICATION

Part		Item		Standard value	Remark
HECU (Hydraulic and Electronic Control Unit)		Operating Voltage Operating temperature		10V ~ 16V -40°C ~ 110°C (-40°F ~ 230°F)	ABS, TCS, ESP, EBD integrated control unit. Communicate ECU & TCU with CAN
		Weight Motor Motor power Pump Capacity Accumulator amount		3.1kg 12V, 35A 265 W 5.5 cc/sec 3.0 cc	NO : Normal Open NC : Normal Close TC : Traction Control HS : Hydraulic Shuttle
		Valve	NO	Operating Voltage : 12V Consumption current : Max. 25A	
			NC		
			TC		
			HS		
Warn-ing Lamp	F/L ESP/TCS	Operating Voltage Consumption current		12V Max. 100mA	F/L : Function Lamp W/L : Warning Lamp
	W/L ESP/TCS				
Active wheel speed sensor		Con-sump-tion current	I (Low)	7mA +20%/ -16%	When measuring sensor current or operating voltage value, be sure to install resistance (R=115Ω) at active sensor to prevent active sensor damaging. Operating Temp. range : -40°C ~ +60°C
			I (High)	14mA +20%/ -16%	
		Operating Voltage Tone wheel		7.5V ~ 20V 47T	
Steering Wheel Angle Sensor		Operating Voltage Consumption current Operating Angular velocity High output voltage Low output voltage		9.0V ~ 16V Max.120mA 1500°/s 3.0V ~ 4.1V 1.3V ~ 2.0V	Operating Temp. range : -30°C ~ 75°C (-22°F ~ 167°F)
Yaw-rate & lateral G sensor		Operating voltage Operating current Operating Yaw-rate Angular velocity Operating range (for G sensor)		8V ~ 16 V below 250mA -75°/s ~ +75°/s -1.7gN ~ +1.7gN	Operating Temp. range : -40°C ~ 85°C (-40°F ~ 185°F)

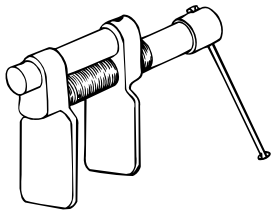
SERVICE STANDARD

Items	Standard value
Brake pedal height	193.5mm(7.62in)
Brake pedal full stroke	126.7 ± 3mm (4.99 ± 0.12in)
Adjust Brake pedal full stroke	63.6 ± 2mm (2.50 ± 0.08in)
Brake pedal free play	3 ~ 8mm(0.11 ~ 0.31in)
Stop lamp switch outer case to pedal stopper clearance	1.2 ~ 1.8mm (0.05 ~ 0.07in)
Booster push rod to master cylinder piston clearance	0 (at 500mmHg)
Parking brake pedal stroke when stroke assembly is pushed with 196N (20kgf, 44lb force)	88 ~ 98mm (3.46 ~ 3.86in)
Front disc brake pad thickness	11mm (0.43in)
Front disc thickness	28mm (1.1in)
Rear disc brake pad thickness	10mm (0.39in)
Rear disc brake disc thickness	10mm (0.39in)
Rear parking brake lining thickness	4.3mm (0.17in)

TIGHTENING TORQUE

Items	Nm	kgf.m	lb-ft
Master cylinder to booster mounting nut	8 ~ 12	0.8 ~ 1.2	5.89 ~ 8.68
Brake booster mounting nut	13 ~ 16	1.3 ~ 1.6	9.4 ~ 11.6
Bleeder screw	7 ~ 13	0.7 ~ 1.3	5.06 ~ 9.4
Brake tube nut, brake hose	13 ~ 17	1.3 ~ 1.7	9.4 ~ 12.3
Caliper assembly to knuckle	80 ~ 100	8 ~ 10	57.9 ~ 72.3
Brake hose to front caliper	25 ~ 30	2.5 ~ 3.0	18.1 ~ 21.7
Caliper guide rod bolt	22 ~ 32	2.2 ~ 3.2	15.9 ~ 23.1
Stop lamp switch mounting nut	8 ~ 10	0.8 ~ 1.0	5.89 ~ 7.23
Brake pedal assembly bracket mounting nut	13 ~ 16	1.3 ~ 1.6	9.4 ~ 11.6
Brake pedal mounting nut	25 ~ 35	2.5 ~ 3.5	18.1 ~ 25.3
Active wheel speed sensor mounting bolt on the brake plate	8 ~ 10	0.8 ~ 1.0	5.89 ~ 7.2
HECU mounting bolt	8 ~ 10	0.8 ~ 1.0	5.89 ~ 7.2
HECU mounting bracket bolt	17 ~ 26	1.7 ~ 2.6	12.3 ~ 18.8
HECU port	12.2 ~ 16.3	1.22 ~ 1.63	8.82 ~ 11.79
Yaw rate & lateral acceleration sensor bolt	8 ~ 10	0.8 ~ 1.0	5.89 ~ 7.2
Master cylinder pressure sensor	26 ~ 30	2.6 ~ 3.0	18.8 ~ 21.7

SPECIAL TOOL E48278DB

Tool(Number and Name)	Illustration	Use
09581-11000 Piston expander	 EJDA043A	Spreading the front disc brake piston

TROUBLESHOOTING E8174126

PROBLEM SYMPTOMS TABLE

Use the table below to help you find the cause of the problem. The numbers indicate the priority of the likely cause of the problem. Check each part in order. If necessary, replace these parts

Symptom	Suspect Area	Reference
Lower pedal or spongy pedal	1. Brake system (Fluid leaks) 2. Brake system (Air in) 3. Piston seals (Worn or damaged) 4. Rear brake shoe clearance(Out of adjustment) 5. Master cylinder (Faulty)	repair air·bleed replace adjust replace
Brake drag	1. Brake pedal freeplay (Minimum) 2. Parking brake lever travel (Out of adjustment) 3. Parking brake wire (Sticking) 4. Rear brake shoe clearance(Out of adjustment) 5. Pad or lining (Cracked or distorted) 6. Piston (Stuck) 7. Piston (Frozen) 8. Anchor or Return spring (Faulty) 9. Booster system (Vacuum leaks) 10. Master cylinder (Faulty)	adjust adjust repair adjust replace replace replace replace replace replace
Brake pull	1. Piston (Sticking) 2. Pad or lining (Oily) 3. Piston (Frozen) 4. Disc (Scored) 5. Pad or lining (Cracked or distorted)	replace replace replace replace replace
Hard pedal but brake inefficient	1. Brake system (Fluid leaks) 2. Brake system (Air in) 3. Pad or lining (Worn) 4. Pad or lining (Cracked or distorted) 5. Rear brake shoe clearance(Out of adjustment) 6. Pad or lining (Oily) 7. Pad or lining (Glazed) 8. Disc (Scored) 9. Booster system (Vacuum leaks)	repair air·bleed replace replace adjust adjust replace replace replace

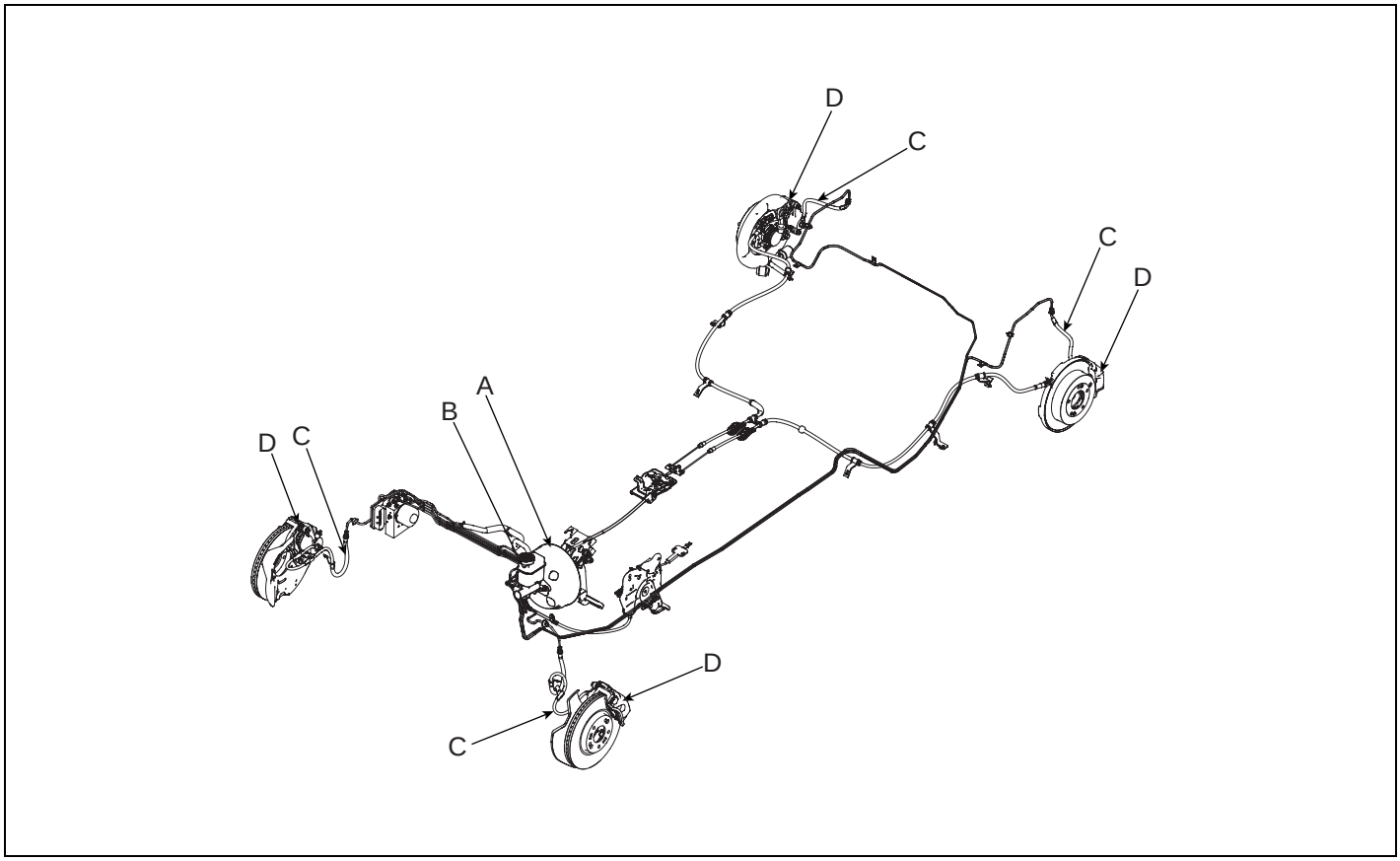
Symptom	Suspect Area	Reference
Noise from brake	1. Pad or lining (Cracked or distorted) 2. Installation bolt (Loosen) 3. Disc (Scored) 4. Sliding pin (Worn) 5. Pad or lining (Dirty) 6. Pad or lining (Glazed) 7. Anchor or Return spring (Faulty) 8. Brake pad shim (Damage) 9. Shoe hold-down spring (Damage)	replace adjust replace replace clean replace replace replace replace
Brake fades	1. master cylinder 2. Pad or lnning	replace replace
Brake vibration, pulsation	1. Disc (Excessive thickness variation) 2. Disc (Faulty run-out) 3. Disc (Uneven worn or crack) 4. Pad or lining (Uneven worn and contact) 5. Caliper (Faulty pad sliding)	replace replace replace replace replace
Brake Chatter	Brake chatter is usually caused by loose or worn components, or glazed or burnt linings. Rotors with hard spots can also contribute to brake chatter. Additional causes of chatter are out-of-tolerance rotors, brake lining not securely attached to the shoes, loose wheel bearings and contaminated brake lining.	

BRAKE SYSTEM

OPERATION AND LEAKAGE CHECK E2129510

CHECK ALL OF THE FOLLOWING ITEMS:

Component	Procedure
Brake Booster (A)	Check brake operation by applying the brakes during a test drive. If the brakes do not work properly, check the brake booster. Replace the brake booster as an assembly if it does not work properly or if there are signs of leakage.
Piston cup and pressure cup inspection (B)	• Check brake operation by applying the brakes. Look for damage or signs of fluid leakage. Replace the master cylinder as an assembly if the pedal does not work properly or if there is damage or signs of fluid leakage. • Check for a difference in brake pedal stroke between quick and slow brake applications. Replace the master cylinder if there is a difference in pedal stroke.
Brake hoses (C)	Look for damage or signs of fluid leakage. Replace the brake hose with a new one if it is damaged or leaking.
Caliper piston seal and piston boots (D)	Check brake operation by applying the brakes. Look for damage or signs of fluid leakage. If the pedal does not work properly, the brakes drag, or there is damage or signs of fluid leakage, disassemble and inspect the brake caliper. Replace the boots and seals with new ones whenever the brake caliper is disassembled.



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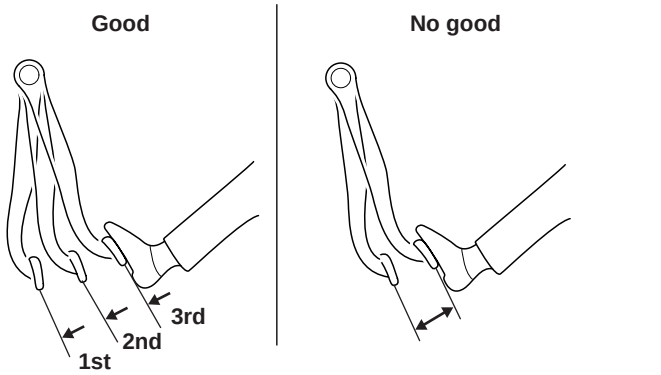
BRAKE BOOSTER OPERATING TEST

For simple checking of the brake booster operation, carry out the following tests

1. Run the engine for one or two minutes, and then stop it. If the pedal depresses fully the first time but gradually becomes higher when depressed succeeding times, the booster is operating properly, if the pedal height remains unchanged, the booster is defective.



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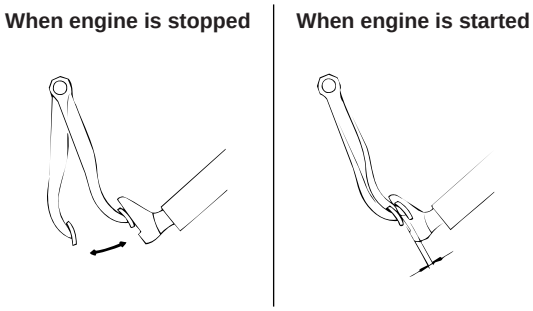
2. With the engine stopped, step on the brake pedal several times.
   Then step on the brake pedal and start the engine. If the pedal moves downward slightly, the booster is in good condition. If there is no change, the booster is defective.



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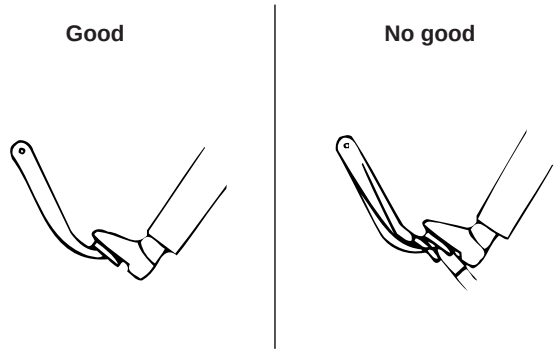
3. With the engine running, step on the brake pedal and then stop the engine.
   Hold the pedal depressed for 30 seconds. If the pedal height does not change, the booster is in good condition, if the pedal rises, the booster is defective.
   If the above three tests are okay, the booster performance can be determined as good.
   Even if one of the above three tests is not okay, check the check valve, vacuum hose and booster for defect.



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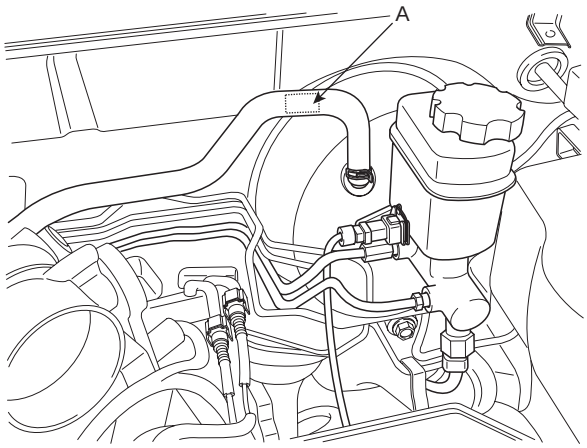
VACUUM HOSE (CHECK VALVE)

INSPECTION

1. Disconnect the brake booster vacuum hose (check valve built in) (A) at the booster (B).

2. Start the engine and let it idle. There should be vacuum available. If no vacuum is available, the check valve is not working properly. Replace the brake booster vacuum hose and check valve and retest.



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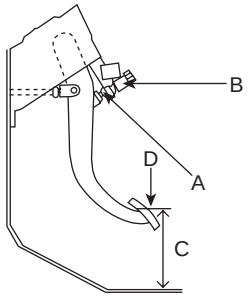
BRAKE PEDAL BRAKE SWITCH ADJUSTMENT

PEDAL HEIGHT

1. Disconnect the brake switch connector, loosen the brake switch locknut (A), and brake off the back switch (B) until it is no longer touching the brake pedal.

2. Lift up the carpet. At the insulator cutout, measure the pedal height (C) from the middle of the left-side center of the pedal pad (D).

Standard pedal height(with carpet removed):
193.5mm (7.62in.)



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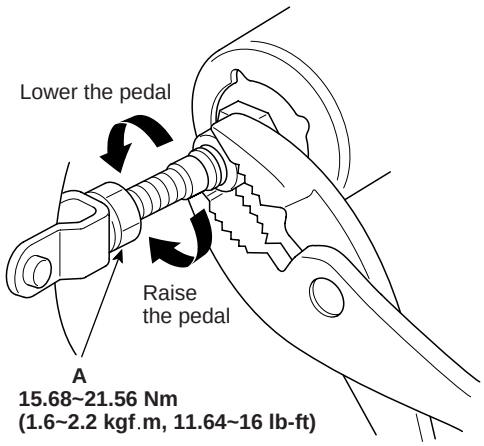
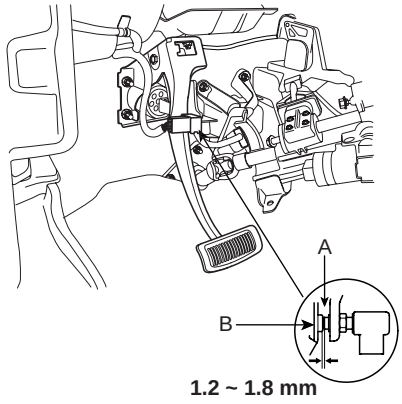
3. Loosen the pushrod locknut (A), and screw the pushrod in or out with pliers until the standard pedal height from the floor is reached. After adjustment, tighten the locknut firmly. Do not adjust the pedal height with the pushrod depressed.



EJRF700A

BRAKE SWITCH CLEARANCE

Screw in the brake switch until its plunger is fully depressed (threaded end (A) touching the pad (B) on the pedal arm) then back off the switch 3/4 turn to make 1.2 ~ 1.8mm(0.05 ~ 0.07in.) of clearance between the brake switch connector. Make sure that the brake lights go off when the pedal is released.



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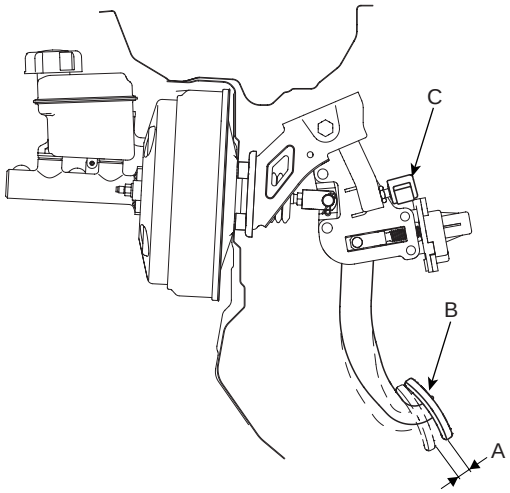
PEDAL FREE PLAY

1. With the engine off, inspect the pedal free play (A) on the pedal pad (B) by pushing the pedal by hand.

Free play : 3 ~ 8mm (0.12 ~ 0.31in.)



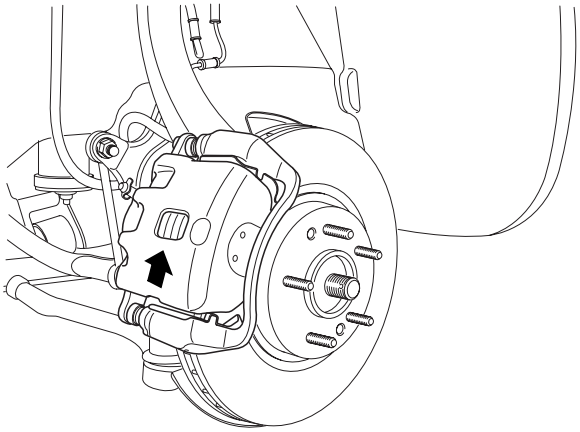
KJBF500C

2. If the pedal free play is out of specification, adjust the brake switch (C). If the pedal free play is insufficient, it may result in brake drag.

INSPECTION OF FRONT DISC BRAKE PAD

1. Check the brake pad thickness through the caliper body inspection hole.

Pad thickness
Standard value : 11.0mm (0.43in)
Service limit : 2mm (0.0787in)



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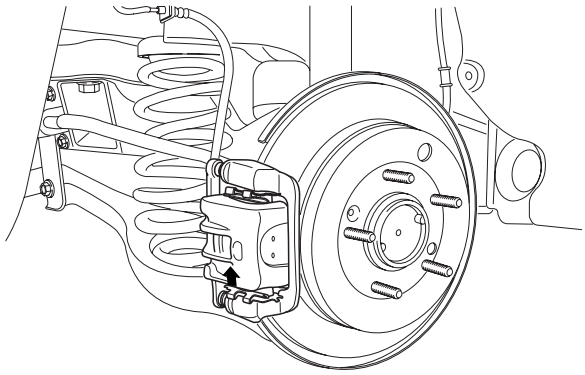
CAUTION

- ***If the pad lining thickness is out of specification, left and right pads must be replaced as a complete set.***
- ***When the thickness difference between the left pad and right pad is large, check the sliding condition of the piston and the guide rod.***

INSPECTION OF REAR DISC BRAKE PAD

1. Check the rear disk brake pad thickness through the caliper body inspection hole.

Pad thickness
Standard value : 10.0mm (0.39in)
Service limit : 2.0mm (0.0787in)



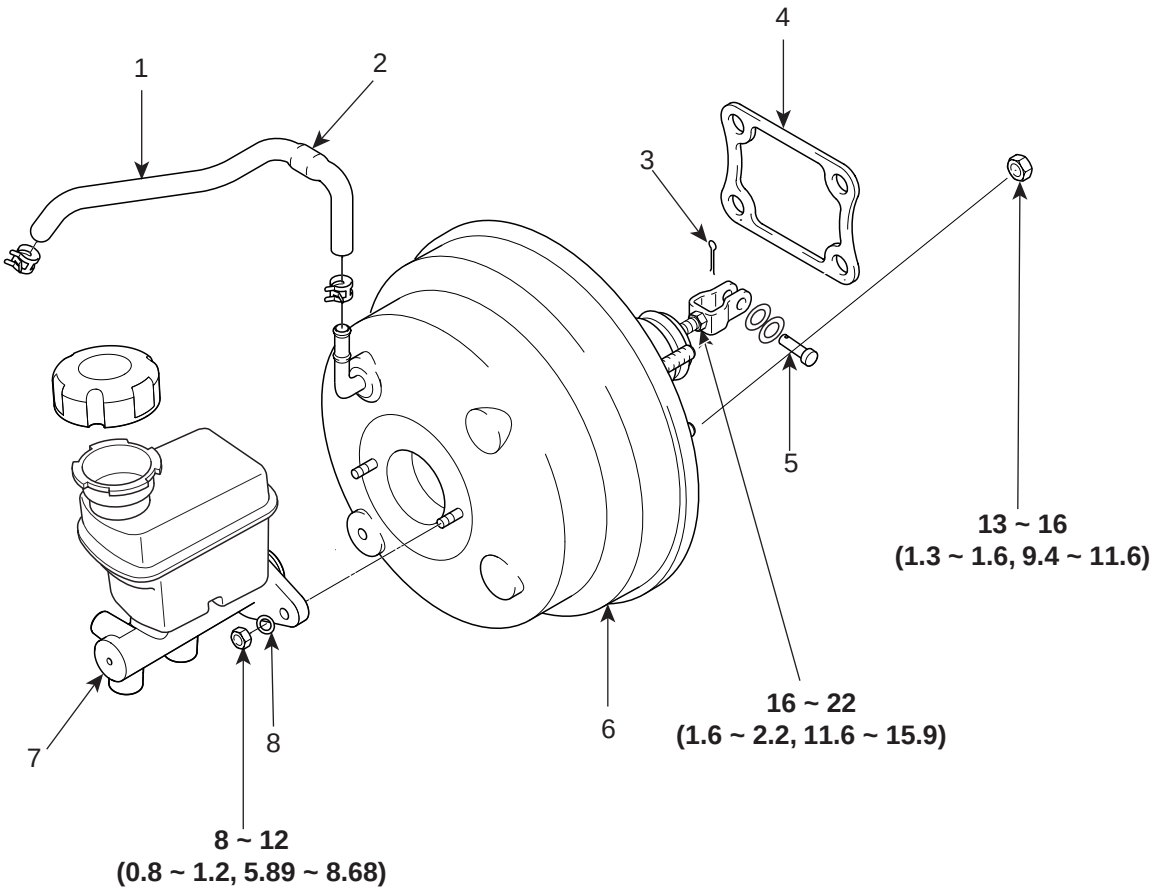
KJBF502A

CAUTION

- ***If the pad thickness is out of specification, left and right pads must be replaced as a complete set.***
- ***When the thickness difference between the left pad and right pad is large, check the sliding condition of the piston and the guide rod.***

BRAKE BOOSTER

COMPONENTS E48432F4



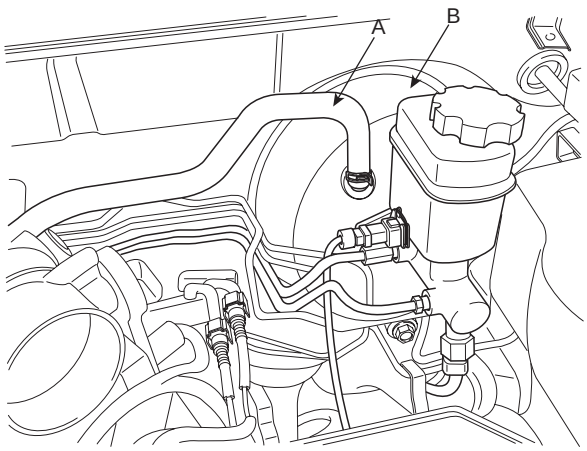
TORQUE : Nm (kgf.m, lb-ft)

1. Vacuum hose
2. Check valve
3. Snap pin
4. Seal
5. Clevis pin
6. Brake booster
7. Master cylinder
8. Washer

SGHBR6500N

REMOVAL E2C2F79E

1. Remove the master cylinder (Refer to 'Master cylinder removal').
2. Disconnect the vacuum hose (A) from the brake booster (B).



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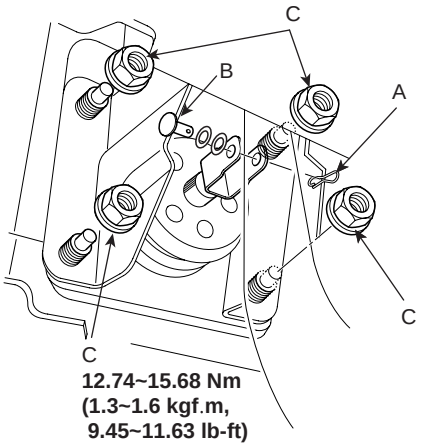
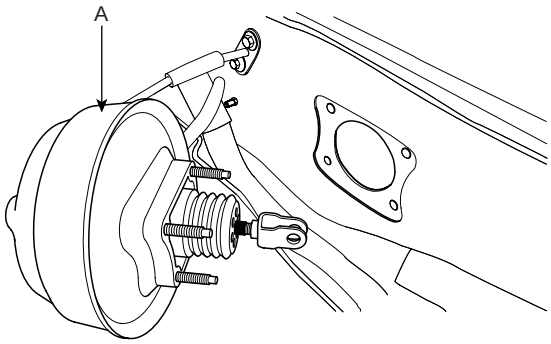
3. Remove the snap pin (A) and clevis pin (B).



EJRF700C

4. Remove the four booster mounting nuts (C).
5. Remove the brake booster (A).

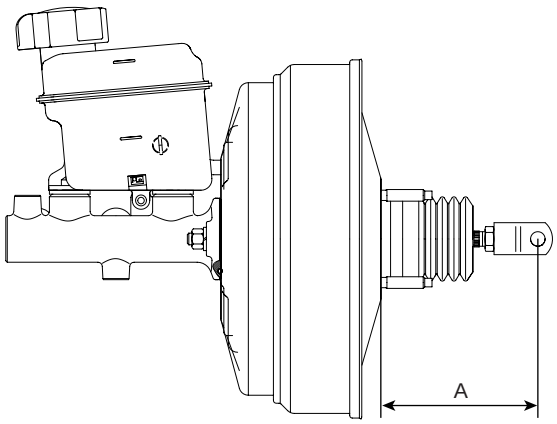


EJKE305D

INSTALLATION E93B6E16

1. Adjust push rod length of the booster, and then install the seal on the booster assembly.

Standard length (A): 103.5± 0.5 mm (4.07 ± 0.019 in.)



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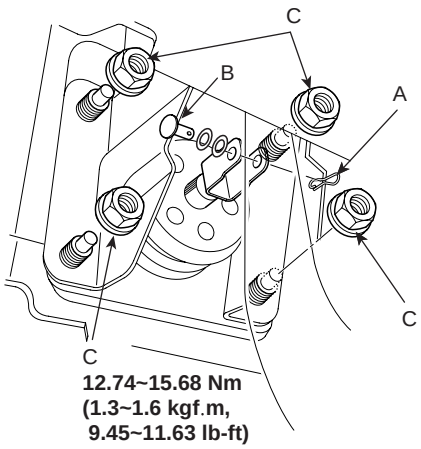
2. Insert the booster and tighten the nuts (C).



EJRF700D

3. Connect the booster push rod and brake pedal with a pin (B) and install a snap clevis pin (A) to the clevis pin (B).

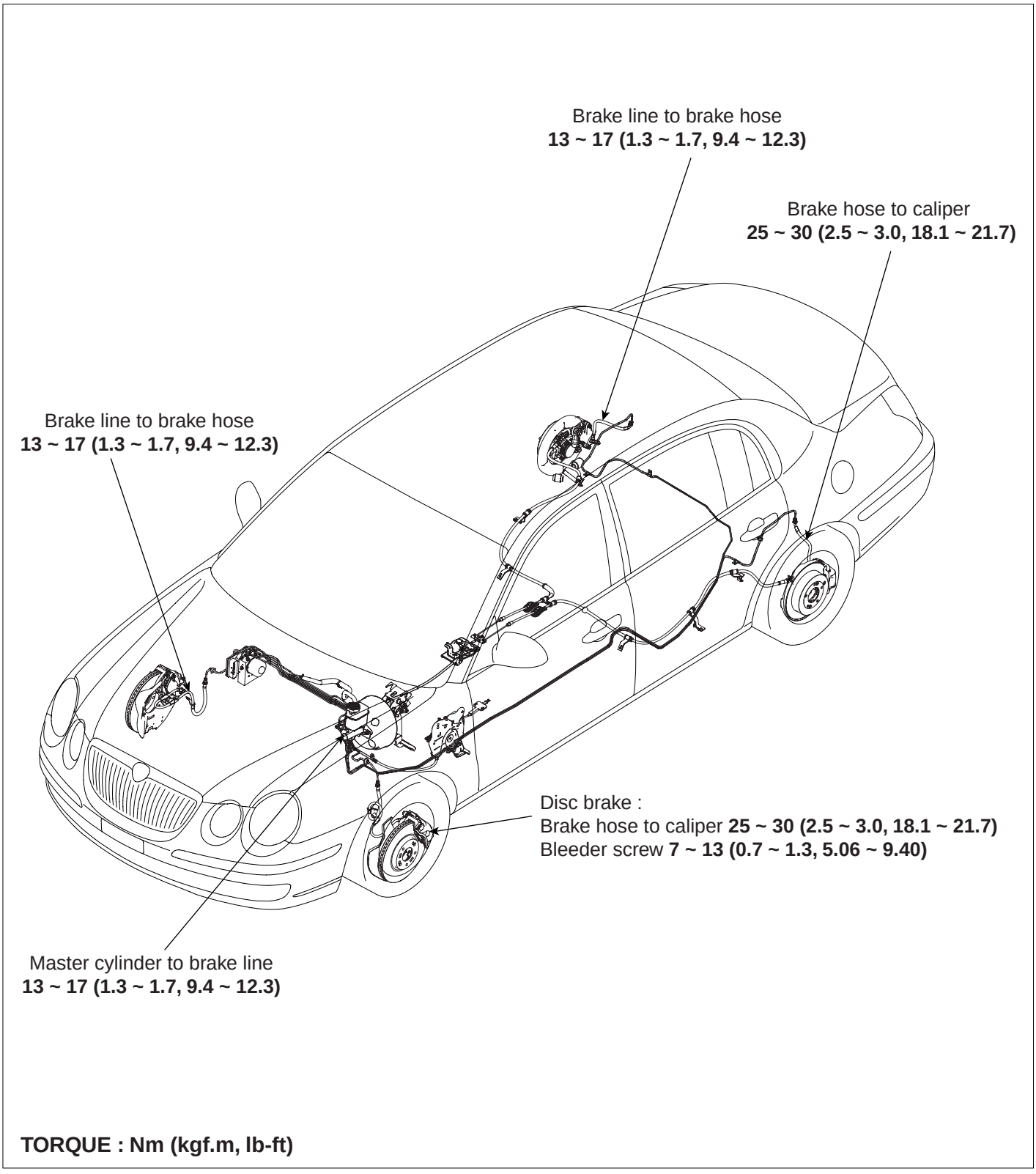
CAUTION

Grease the pin before installing the snap pin. Always use a new snap pin.

4. Install the master cylinder.
5. Connect the vacuum hose to the brake booster.
6. After filling the brake reservoir with brake fluid, bleed the system (Refer to 'Bleeding of brake system').
7. Check for fluid leakage.
8. Check and adjust the brake pedal for proper operation.

BRAKE LINE

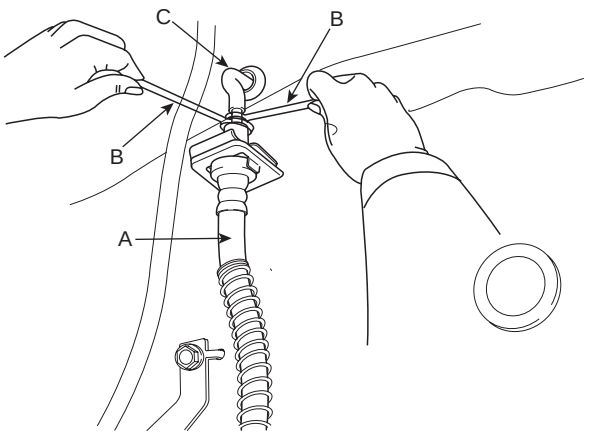
COMPONENT EBD61AD2



SGHBR6501N

REMOVAL E28EB83D

1. Disconnect the brake hose (A) from the brake line (C) using a flare-nut wrench (B).



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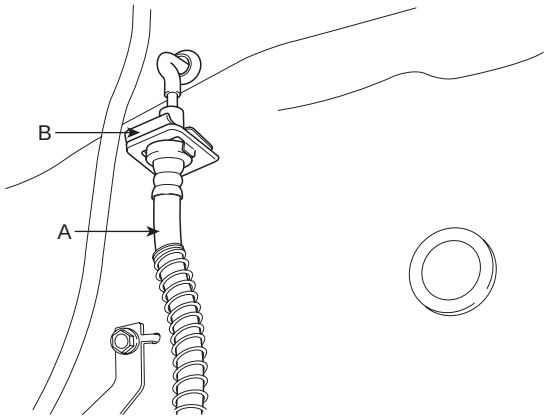
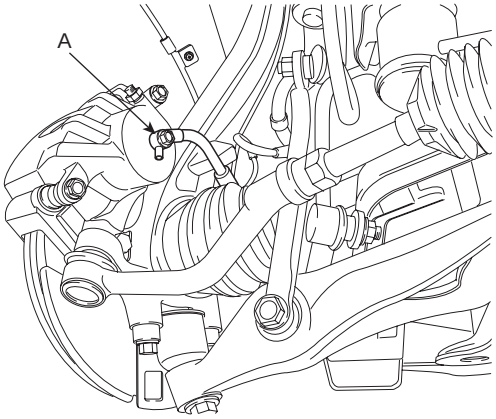
2. Remove the brake hose clip (B), and then remove the brake hose (A).



SGHBR6585D

3. Remove the connector bolt (A) from the caliper, and disconnect the brake hose from the caliper.



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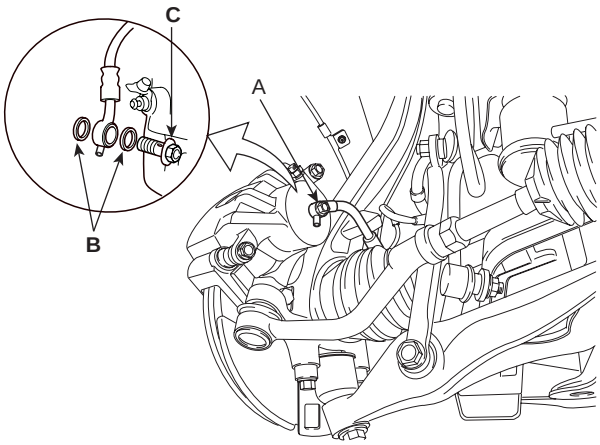
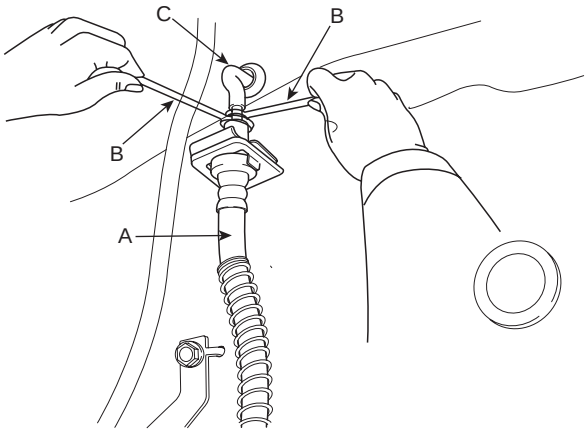
INSTALLATION EB3F1DBD

1. Install a brake hose(A) on the caliper with tightening brake hose bolt(C) and washer(B).



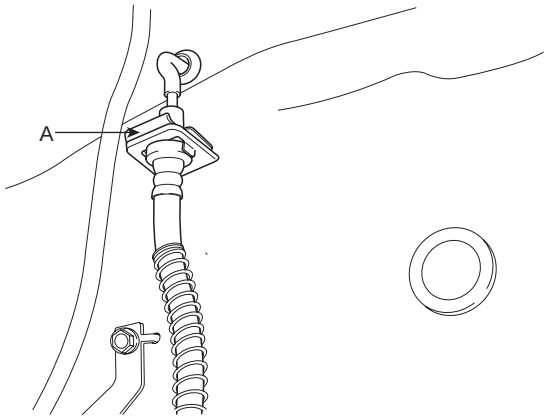
KJBF500I

2. Connect the brake hose (A) to the brake line (C) using a flare-nut wrench (B).



SGHBR6584D

3. Install the brake hose clip (A) to the brake hose bracket.



SGHBR6586D

4. After installing the brake hose, bleed the brake system.

INSPECTION EDE0E463

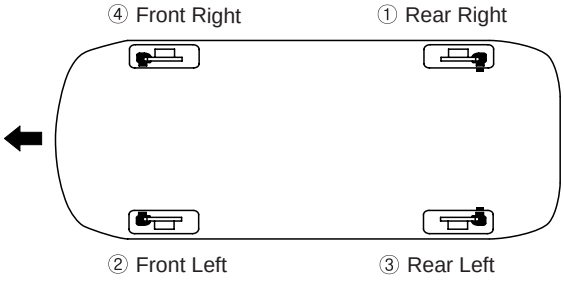
- Check the brake tubes for cracks, crimps and corrosion.
- Check the brake hoses for cracks, damaged and oil leakage.
- Check the brake tube flare nuts for damage and oil leakage.

BRAKE SYSTEM BLEEDING E81563AD

NOTE

- *Do not reuse the drained fluid.*
- *Always use Genuine DOT3 or DOT 4 Brake Fluid. Using a non-Genuine DOT3 or 4 brake fluid can cause corrosion and decrease the life of the system.*
- *Make sure no dirt of other foreign matter is allowed to contaminate the brake fluid.*
- *Do not spill brake fluid on the vehicle, it may damage the paint; if brake fluid does contact the paint, wash it off immediately with water.*
- *The reservoir on the master cylinder must be at the MAX (upper) level mark at the start of bleeding procedure and checked after bleeding each brake caliper. Add fluid as required.*

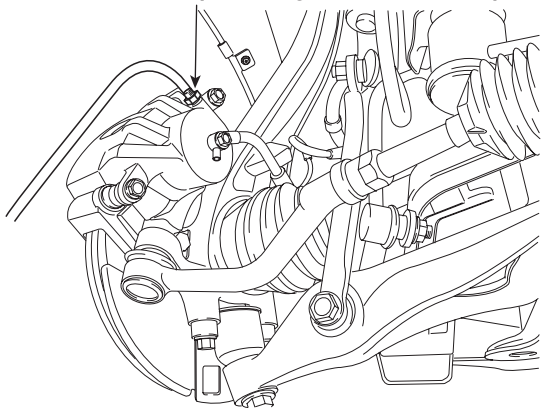
1. Make sure the brake fluid in the reservoir is at the MAX (upper) level line (A).
2. Have someone slowly pump the brake pedal several times, then apply pressure.
3. Lossen the right-rear brake bleed screw to allow air to escape from the system. Then tighten the bleed screw securely.
4. Repeat the procedure for wheel in the sequence shown below until air bubbles no longer appear in the fluid.
5. Refill the master cylinder reservoir to MAX(upper) level line.



EJKE003B

FRONT DISC BRAKE

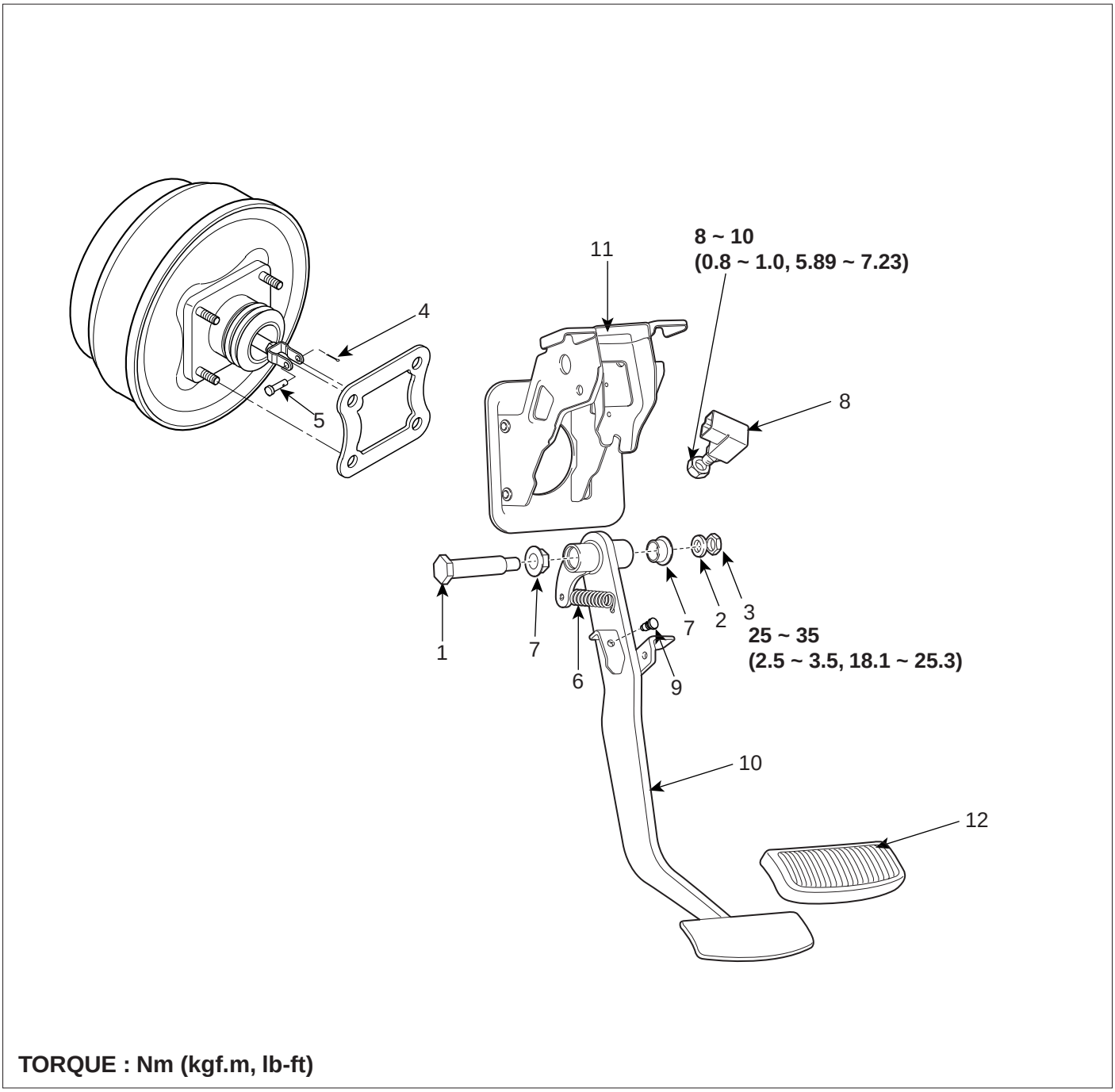
6.86~12.74 Nm (0.7~1.3 kgf.m, 5.09~9.45 lb-ft)



EJBF500C

BRAKE PEDAL

COMPONENTS E1B6E6AC

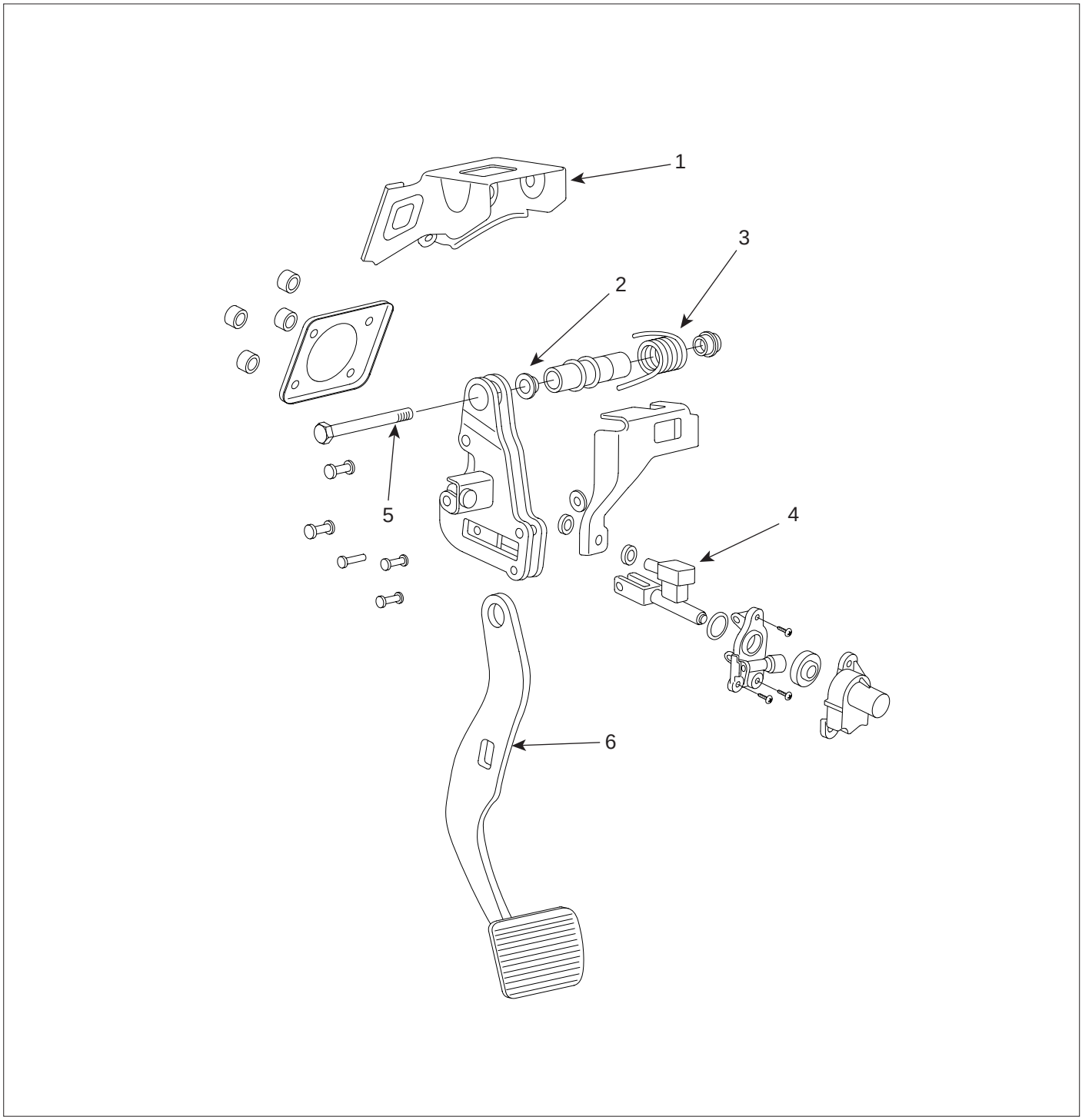


TORQUE : Nm (kgf.m, lb-ft)

1. Bolt
2. Spring washer
3. Nut
4. Snap pin
5. Pin assembly
6. Return spring
7. Bushing
8. Stop lamp switch
9. Stopper rubber
10. Brake pedal arm
11. Member assembly
12. Pedal pad

SGHBR6502N

COMPONENTS (ADJUSTABLE PEDAL)

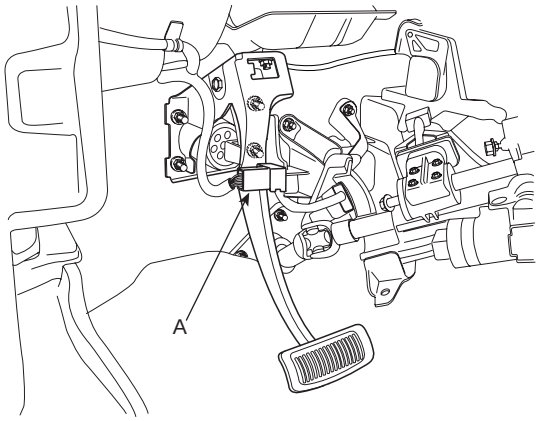


1. Member assembly bracket
2. Bushing
3. Return spring
4. Stop lamp switch
5. Shaft bolt
6. Brake pedal

EJRF500N

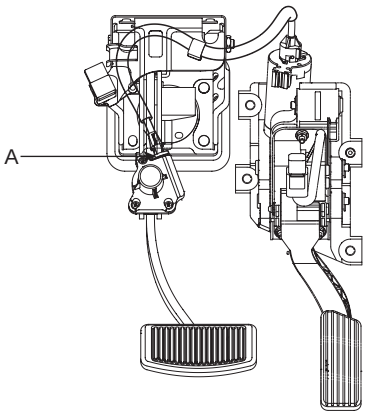
REMOVAL E4341076

1. Remove the lower crash pad.(Refer to BD-"crash pad")
2. Pull down steering column shaft after removing 4 bolts.
3. Remove the stop lamp switch connector (A).



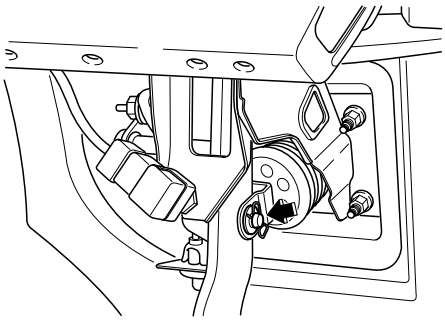
KJBF503A

4. Remove the adjustable cable (A) in caseof the adjustable brake pedal.



SGHBR6636D

5. Remove the pin and snap pin.



AJCD008E

6. Loosen the brake pedal member assembly mounting nuts and then remove the brake pedal assembly.

INSTALLATION EC921BB0

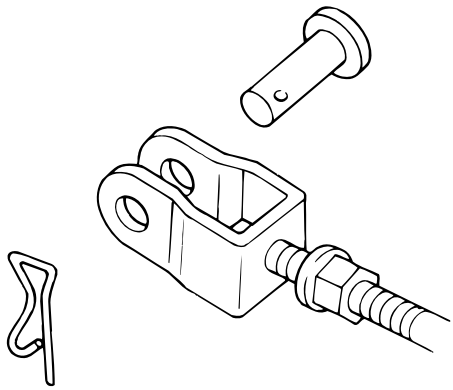
1. Installation is the reverse of removal.

CAUTION

Coat the inner surface of the bushings with the specified grease.

Specified grease : LiG-2

2. Before inserting the pin, apply the specified grease to the joint pin.



EJQE008R

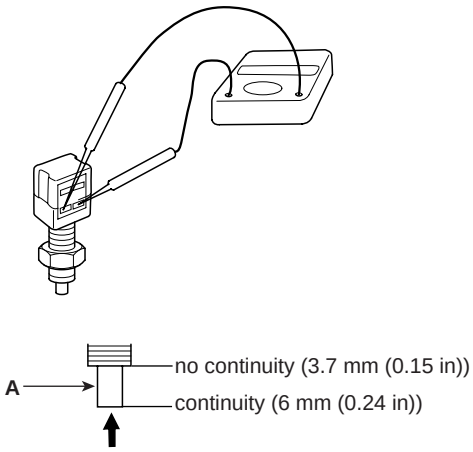
3. Install the snap pin.
4. Install the nuts with specified torque, when installing the brake pedal.

Torque : Nm(kgf.m,lb-ft) : 12.74 ~ 15.68(1.3 ~ 1.6, 9.45 ~ 11.63)

5. Adjust the brake pedal height and free play.
6. Install the stop lamp switch.

INSPECTION E25C9BCB

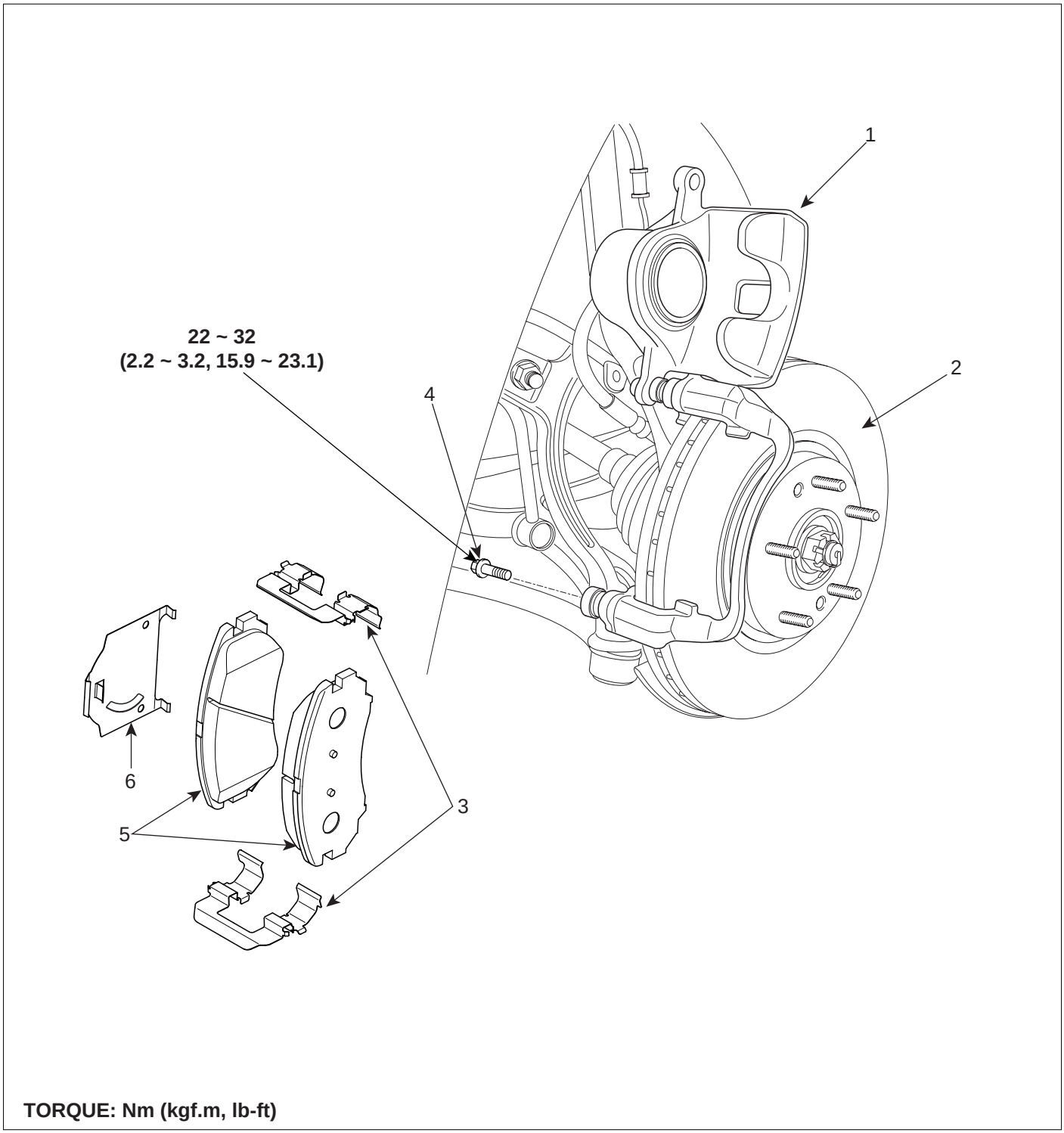
1. Check the bushing for wear.
2. Check the brake pedal for bending or twisting.
3. Check the brake pedal return spring for damage.
4. Check the stop lamp switch.
   1) Connect a circuit tester to the connector of stop lamp switch, and check whether or not there is continuity when the plunger of the stop lamp switch is pushed in and when it is released.
   2) The stop lamp switch is in good condition if there is no continuity when plunger(A) is pushed.



UJBG501B

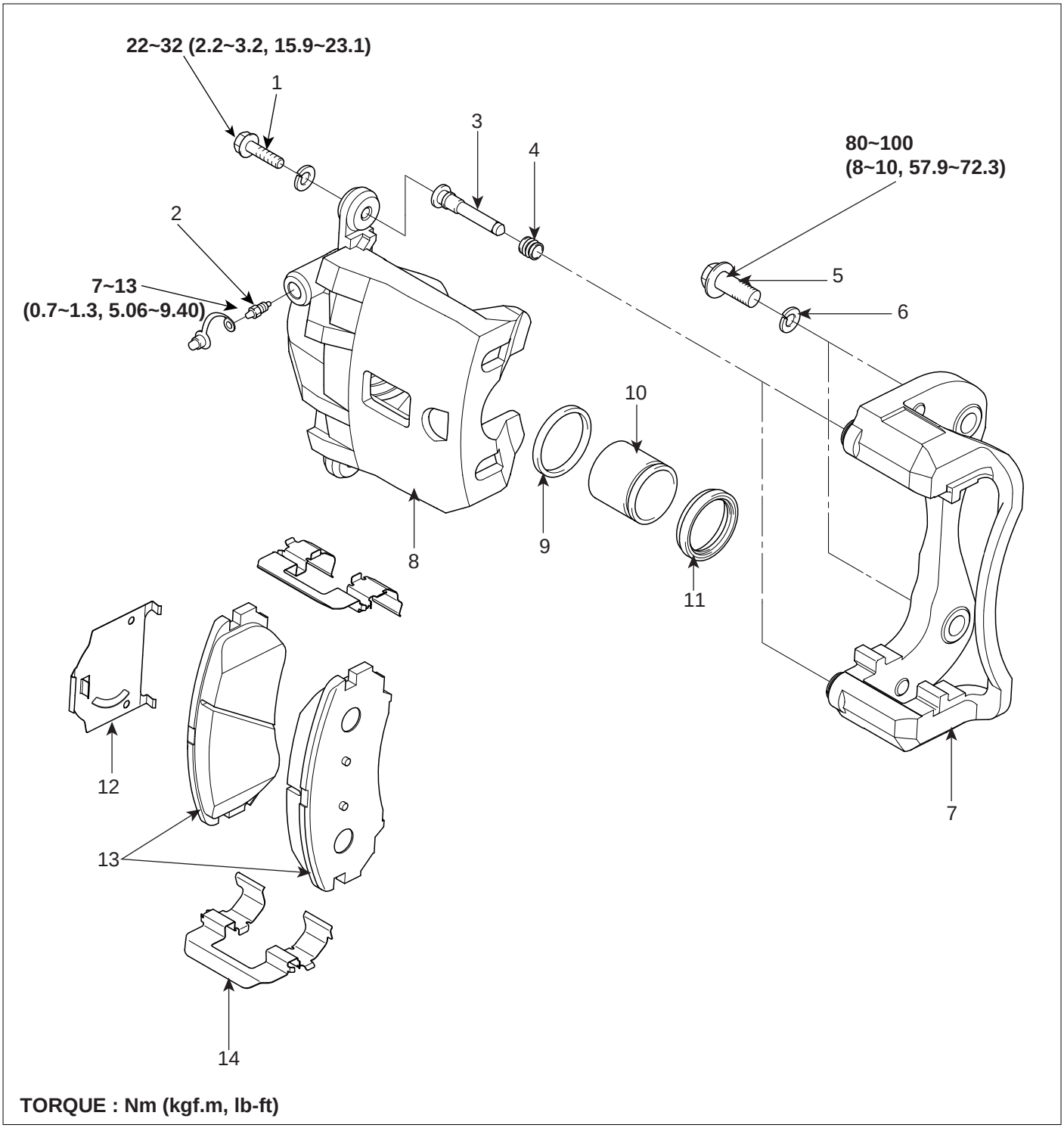
FRONT DISC BRAKE

COMPONENTS EF05F2BB



1. Brake caliper
2. Brake disc
3. Pad retainers
4. Guide rod bolt
5. Brake pads
6. Brake pad shims

SGHBR6503N



1. Guide rod bolt
2. Bleeder screw
3. Guide rod
4. Boot
5. Caliper mounting bolt
6. Washer
7. Caliper bracket
8. Caliper body
9. Piston seal
10. Piston
11. Piston boot
12. Inner shim
13. Brake pad
14. Pad retainer

SGHBR6504N

REMOVAL E81BD77A

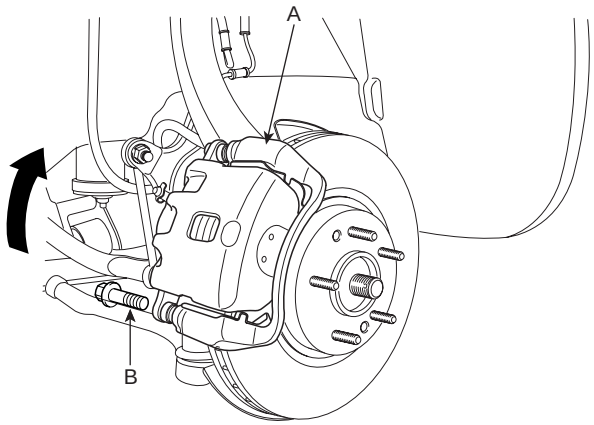
CAUTION

Frequent inhalation of brake pad dust, regardless of material composition, could be hazardous to your health.

- ***Avoid breathing dust particles.***
- ***Never use on air hose or brush to clean brake assemblies.***

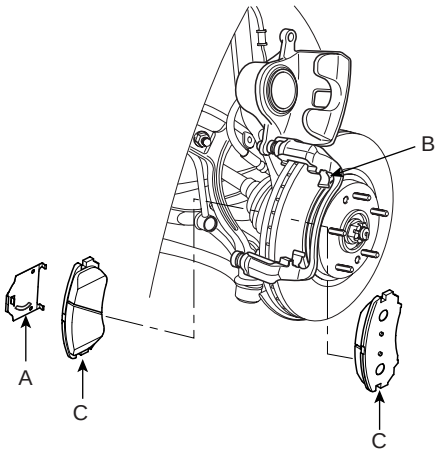
1. Lossen the front wheel nuts slightly. Raise the front of the vehicle, and make sure it is securely supported. Remove the front wheels.

2. Remove the guide rod bolt(B), After raise the caliper assembly(A), support it with a wire.



KJBF500N

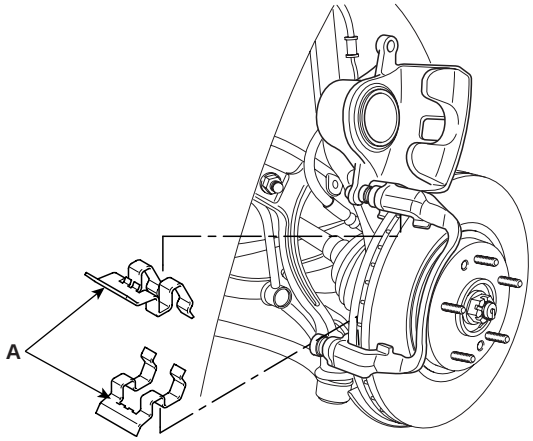
3. Remove pad shim(A), pad retainer(B) and pad assembly(C) in the caliper bracket.



SGHBR6505N

INSTALLATION EFDBEFBC

1. Install the pad retainers (A) on the caliper bracket.

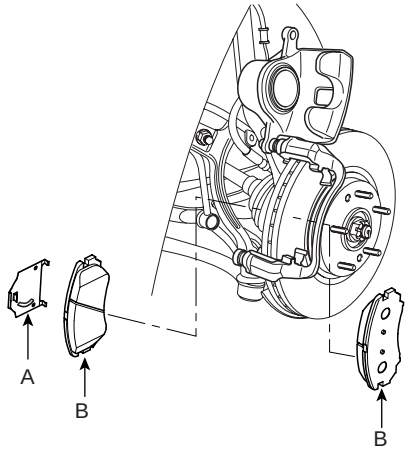


KJBF500S

2. Install pad shims(A) and the brake pads(B) with the wear indicator on the inside.

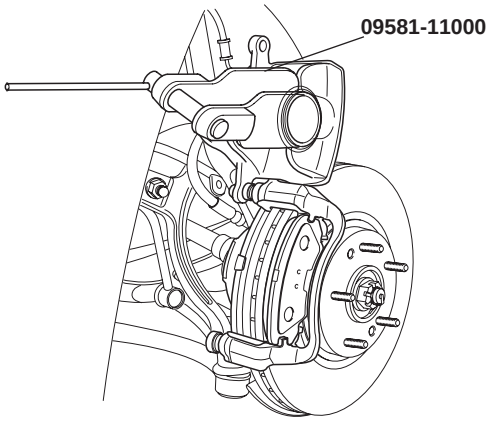
CAUTION

If you are reusing the pads, always reinstall the brake pads in their original positions to prevent a momentary loss of braking efficiency.



SGHBR6506N

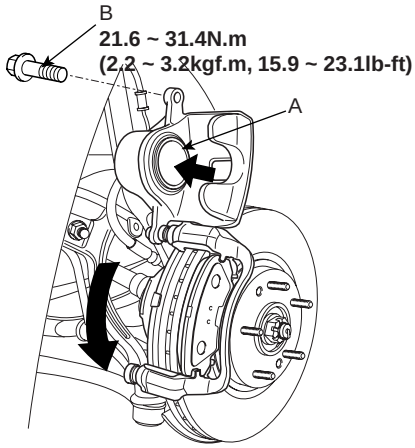
3. Insert the piston in the cylinder using the special tool (09581-11000).



KJBF500U

4. Push in the piston(A) so that the caliper will fit over the pads. Make sure that the piston boot is in position to prevent damaging it when pivoting the caliper down.

5. Being careful not to damage the pin boot, install the guide rod bolt (B) with the specified torque.



SGHBR7597N

6. If caliper assembly was removed, install the brake hose to the caliper.

7. Refill the master cylinder reservoir to the MAX line.

8. Bleed the brake system.(Refer to 'Bleeding of ABS system')

9. Depress the brake pedal several times to make sure the brakes work, then test-drive.

NOTE

Engagement of the brake may require a greater pedal stroke immediately after the brake pads have been replaced as a set. Several applications of the brake will restore the normal pedal stroke.

10. After installation, check for leaks at hose and line joints or connections, and retighten if necessary.

INSPECTION E396E730

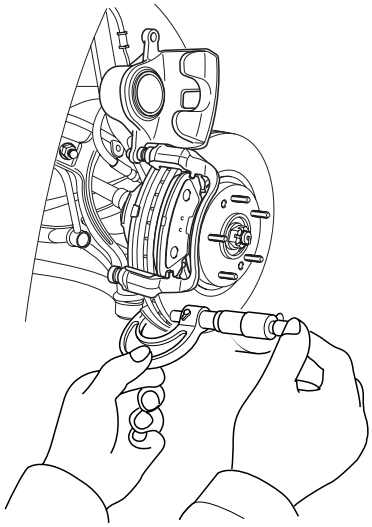
FRONT BRAKE DISC THICKNESS CHECK

1. Remove all rust and contramination from the surface, and measure the disc thickness at 8 points, at least, of same distance (5mm) from the brake disc outer circle.

Front brake disc thickness Standard value : 28.0mm(1.10in) Limit : 26.4mm(1.04in)

2. Thickness variation should not exceed 0.005mm (0.0002in) (circumference) and 0.01mm (0.0004in)(radius) at any directions.

3. If wear exceeds the limit, replace the discs and pad assembly left and right of the vehicle.

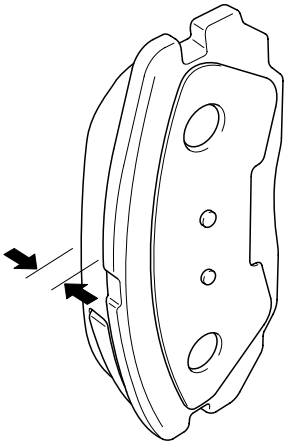


KJBF500P

FRONT BRAKE PAD CHECK

1. Check the pad wear. Measure the pad thickness and replace it, if it is less than the specified value.

Pad thickness
Standard value : 11mm (0.43in)
Service limit : 2mm (0.0787in)



EJRF702K

2. Check that grease is applied, to sliding contact points and the pad and backing metal for damage.

FRONT BRAKE DISC RUN OUT CHECK

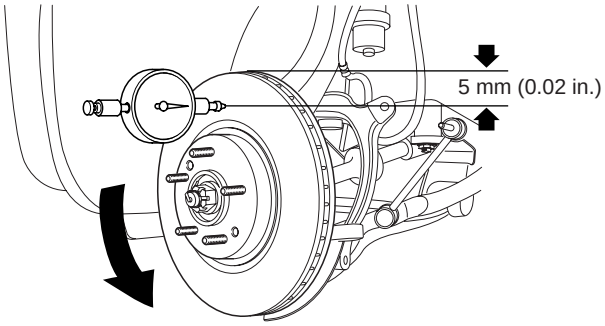
1. Place a dial gauge about 5mm (0.2in.) from the outer circumference of the brake disc, and measure the run out of the disc.

Brake disc run out
Limit : 0.04mm (0.0016in.) or less (new one)

2. If the run out of the brake disc exceeds the limit specification, replace the disc, and then measure the run out again.

3. If the run out does not exceed the limit specification, install the brake disc after turning it 180° and then check the run out of the brake disc again.

4. If the run out cannot be corrected by changing the position of the brake disc, replace the brake disc.



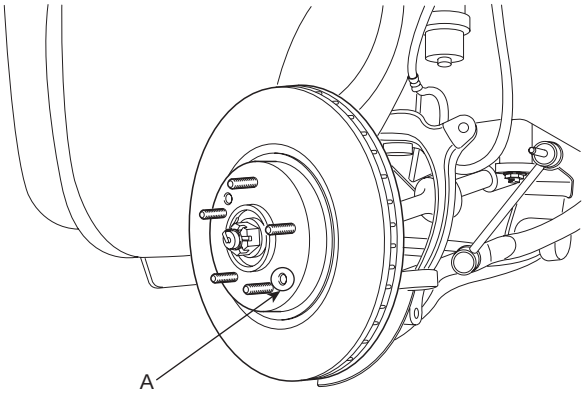
EJBF500G

SEIZING OF FRONT BRAKE DISC

1. Remove the brake disc from hub using an M8 screw (A) if the brake disc has been seized with the hub due to corrosion or overheating.

   NOTE

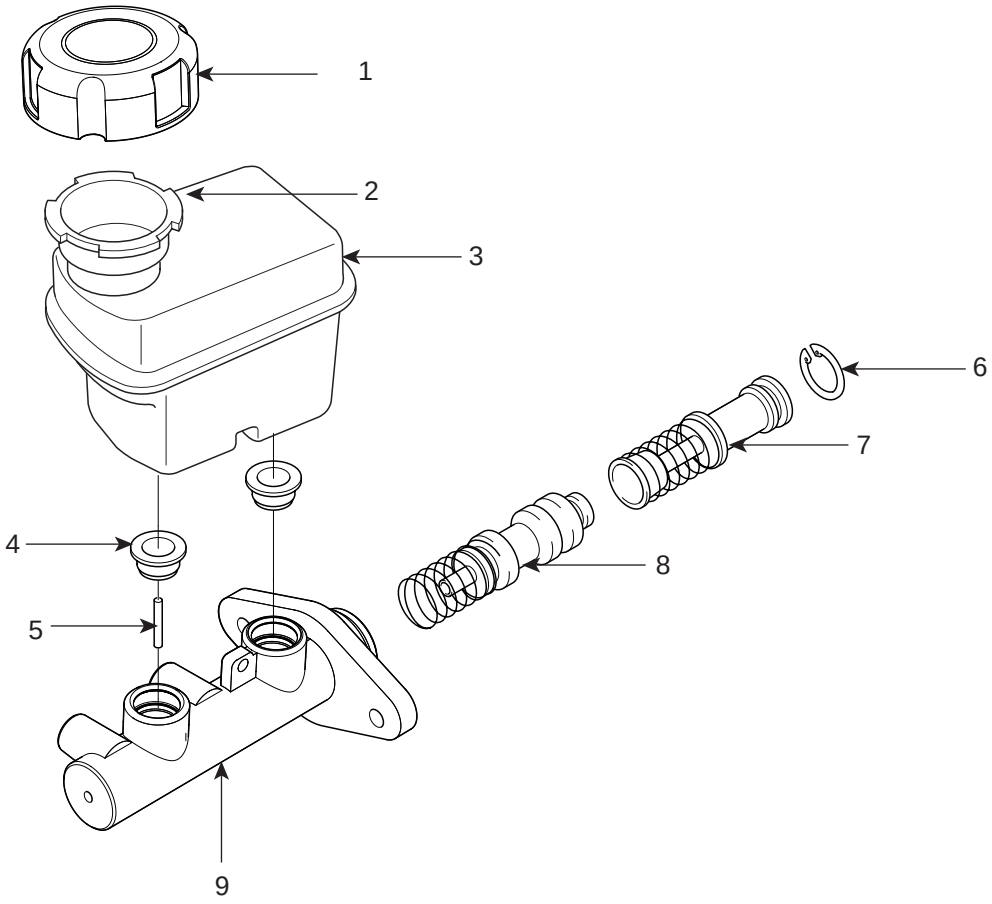
   Be careful not to use a hammer. The disc can be damaged if you remove the disc from the hub by hammering.



KJBF500R

MASTER CYLINDER

COMPONENTS EBDC2AFB



1. Reservoir cap
2. Brake fluid filter
3. Reservoir
4. Grommet
5. Cylinder pin
6. Retainer
7. Primary piston assembly
8. Secondary piston assembly
9. Master cylinder body

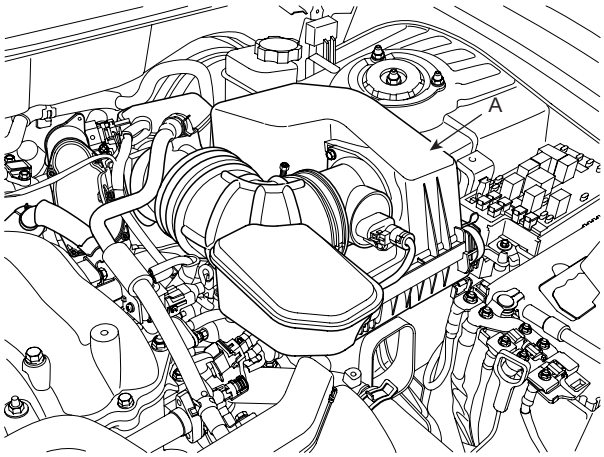
UJBG500B

REMOVAL EDEEF5AF

NOTE

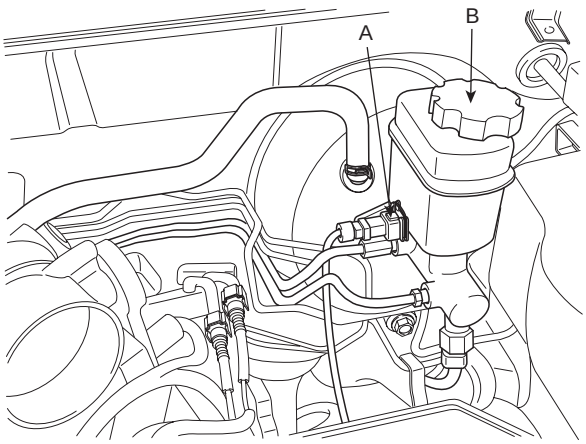
Do not spill brake fluid on the vehicle; it may damage the paint; if brake fluid does contact the paint, wash it off immediately with water.

1. Remove the intake hose and air cleaner assembly (A).



SGHBR6593D

2. Disconnect the brake fluid level switch connector (A), and remove the reservoir cap (B).

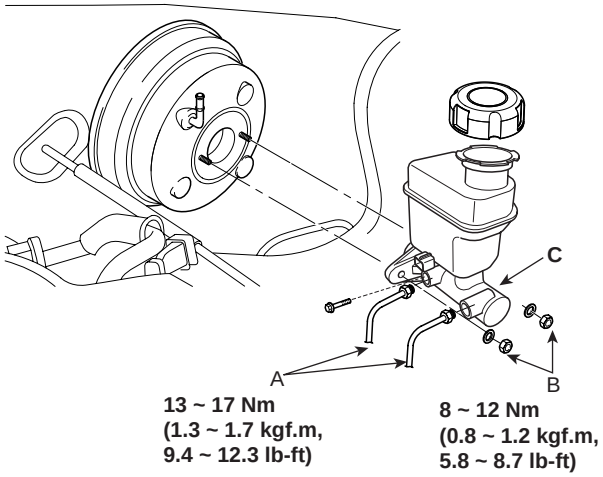


SGHBR6595D

3. Remove the brake fluid from the master cylinder reservoir (C) with a syringe.

4. Disconnect the brake lines (A) from the master cylinder. To prevent spills, cover the hose joints with rags or shop towels.

5. Remove the master cylinder mounting nuts (B) and washers.

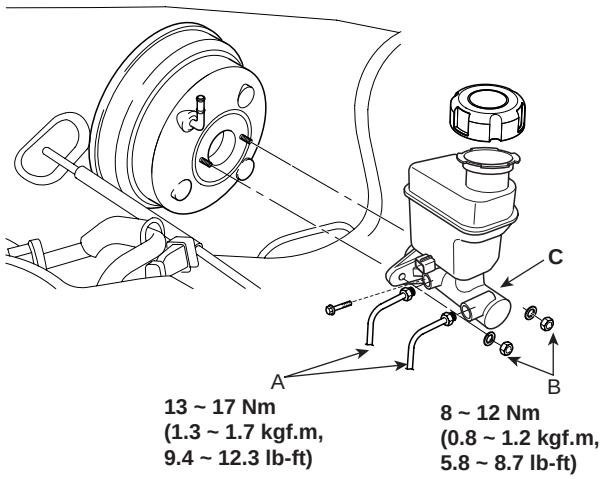


SGHBR6507N

6. Remove the master cylinder (C) from the brake booster. Be careful not to bend or damage the brake lines when removing the master cylinder.

INSTALLATION EA84810D

1. Install the master cylinder on the brake booster with 2 nuts.
2. Connect the two brake tubes and the brake fluid level sensor connector.

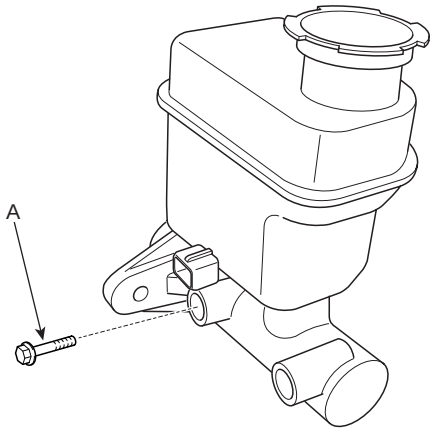


SGHBR6507N

3. Fill the brake reservoir with the brake fluid and bleed the brake system (Refer to 'Bleeding of brake system').

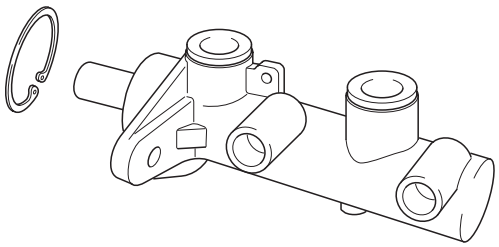
DISASSEMBLY E960F66F

1. Remove the reservoir cap and drain the brake fluid into a suitable container.
2. Remove the fluid level sensor.
3. Remove the reservoir from the master cylinder, after remove mounting screw (A).



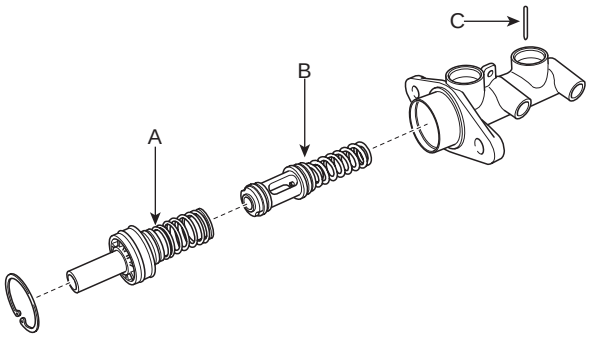
SGHBR6633D

4. Remove the retainer ring by using the snap ring pliers then remove the primary piston assembly.



EJRF703U

5. Remove the pin with the secondary piston pushed completely using a screwdriver. Remove the secondary piston assembly.



KJBF528A

NOTE

Do not disassemble the primary and secondary piston assembly.

INSPECTION EDB111F0

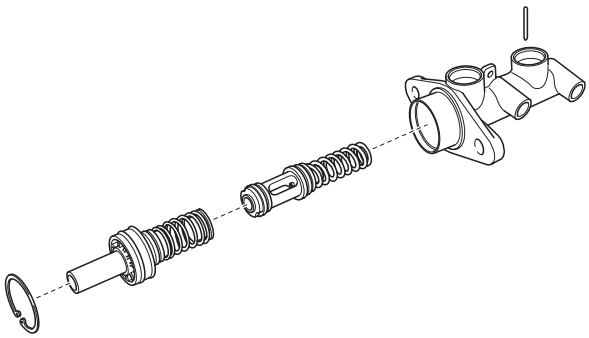
1. Check the master cylinder bore for rust or scratching.
2. Check the master cylinder for wear or damage. If necessary, clean or replace the cylinder.

CAUTION

- ***If the cylinder bore is damaged, replace the master cylinder assembly.***
- ***Wash the contaminated parts in alcohol.***

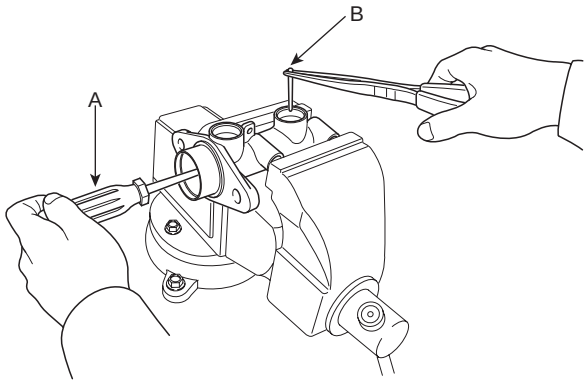
REASSEMBLY E5EC05B9

1. Apply genuine brake fluid to the rubber parts of the cylinder kit and grommets.
2. Carefully insert the springs and pistons in the proper direction.



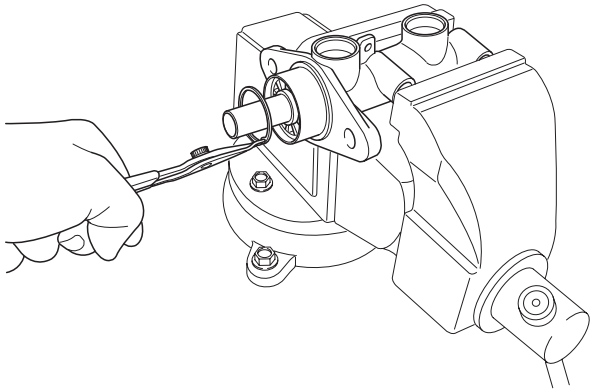
EJRF703V

3. Press the piston with a screwdriver (A) and install the cylinder pin (B).



EJRF703W

4. Press the piston with a screwdriver and install the retainer ring.

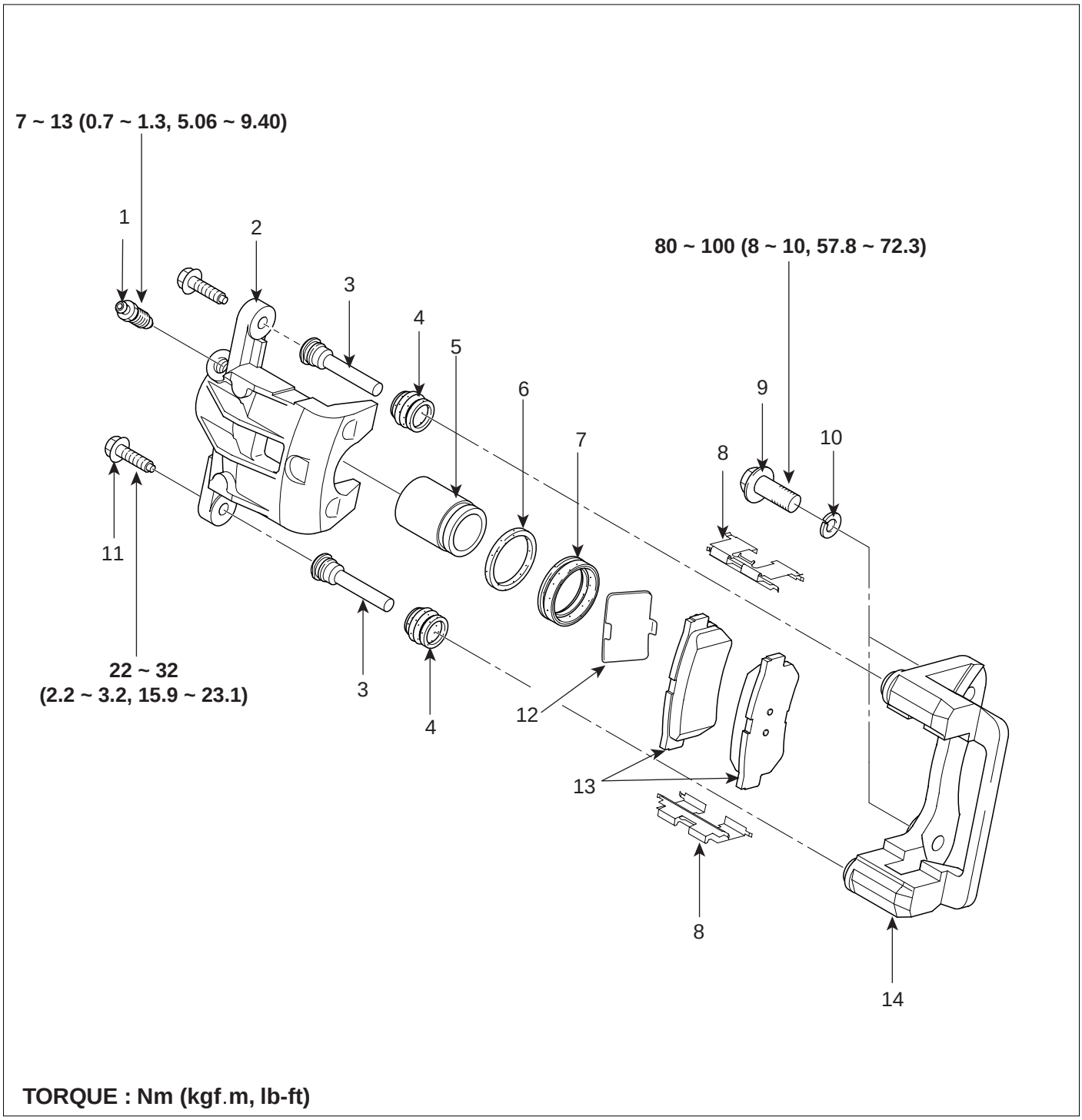


EJRF703X

5. Mount two grommets.
6. Install the reservoir on the cylinder.

REAR DISC BRAKE

COMPONENTS EB666DC2

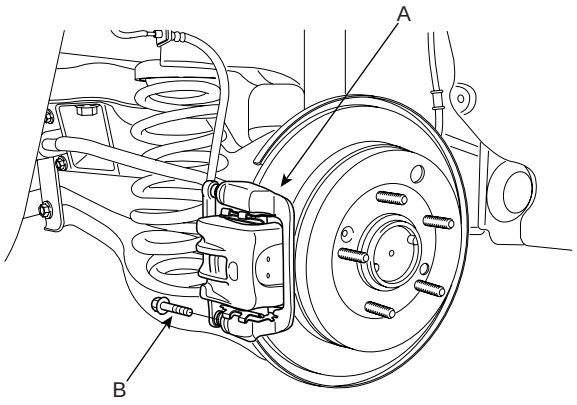


1. Bleeder screw
2. Caliper body
3. Guide rod
4. Boot
5. Piston
6. Piston seal
7. Piston boot
8. Pad retainer
9. Caliper mounting bolt
10. Washer
11. Guide rod bolt
12. Inner shim
13. Brake Pad
14. Caliper bracket

SGHBR6508N

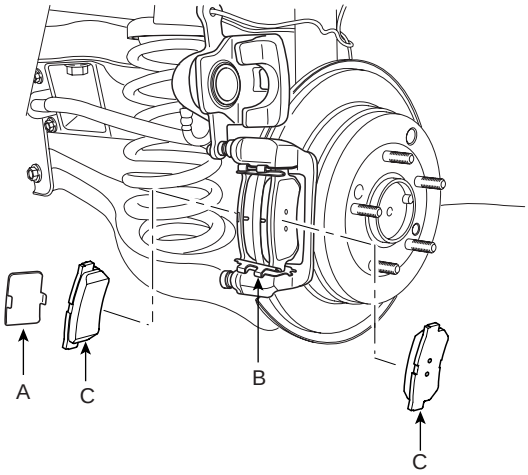
REMOVAL EDC98DCB

1. Raise the rear of the vehicle and make sure it is securely supported. Remove the rear wheel.
2. Remove the guide rod bolt (B), then raise the caliper assembly (A), and support it with a wire.



KJBF500Z

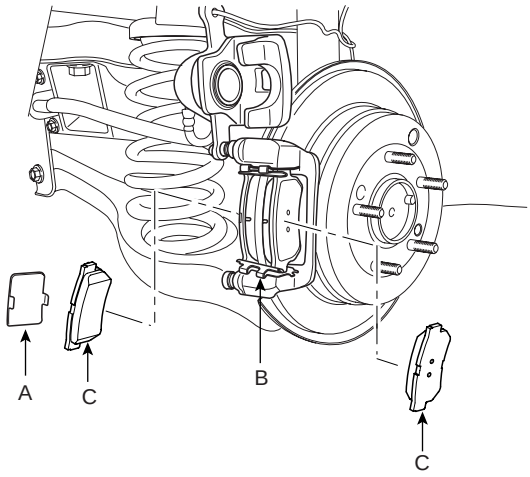
3. Remove pad shim (A), pad retainer (B) and pad assembly (C) in the caliper bracket.



SGHBR6596D

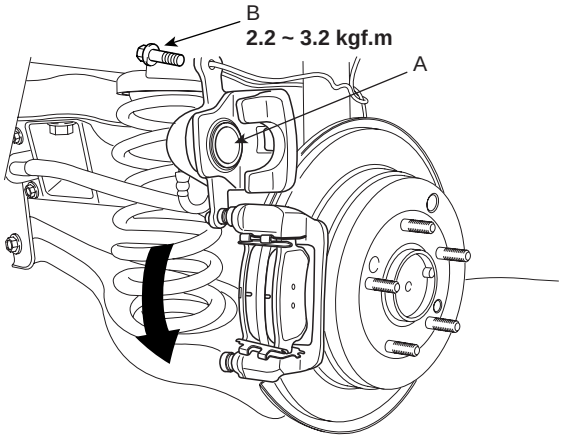
INSTALLATION E4514881

1. Install the pad retainers (A) on the caliper bracket.
2. Check for foreign material between the pad shim (A) and the back of the pads (B).



SGHBR6596D

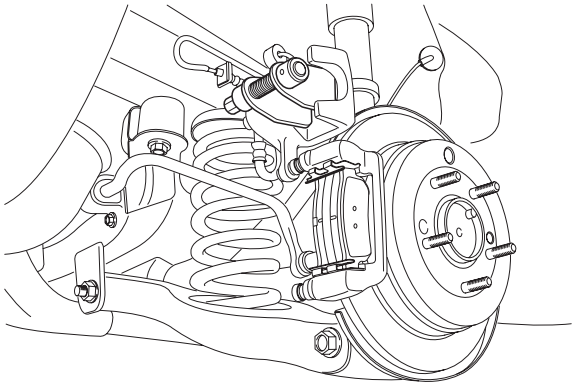
3. Contaminated brake discs or pads reduce stopping ability. Keep grease off the discs and pads.
4. Install the brake pads (B) and pad shims (A) correctly. Install the pad with the wear indicator (C) on the inside.
   If you are reusing the pads, always reinstall the brake pads in their original position to prevent a momentary loss of braking efficiency.
5. Push in the piston (A) so that the caliper will fit over the pads. Make sure that the piston boot is in position to prevent damaging it when pivoting the caliper down.
6. Pivot caliper down into position. Being careful not to damage the pin boot, install the guide rod bolt (B) and torque it to proper specification



KJBF501F

NOTE

Insert the piston in the cylinder using the special tool(09581-11000).



KJBF510A

7. Depress the brake pedal several times to make sure the brakes work, then test-drive.

NOTE

Engagement of the brake may require a greater pedal stroke immediately after the brake pads have been replaced as a set. Several applications of the brake will restore the normal pedal stroke.

8. After installaion, check for leaks at hose and line joints or connections, and retighten if necessary.

INSPECTION EE23F072

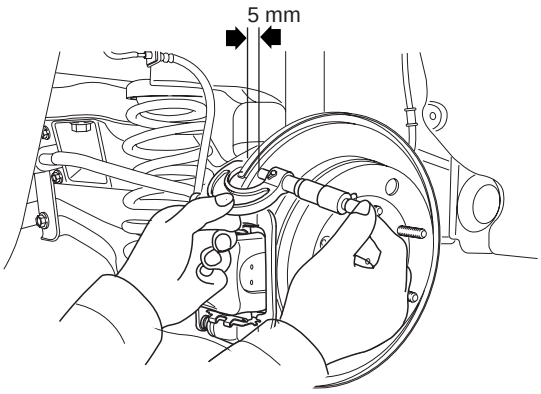
REAR BRAKE DISC THICKNESS CHECK

1. Remove all rust and contamination from the disc surface, and then measure the disc thickness at 8points, al least, of the same distance (5mm(0.12in)) from the brake disk outer circle.

Rear brake disc thickness Standard value : 10.0mm (0.39in) Limit : 8.0mm (0.31in)

2. Thickness variation should not exceed 0.01mm(0.0004in) (circumference) and 0.01mm(0.0004in) (radius) at any directions.

3. If wear exceeds the limit, replace the discs and pad assembly for left and right of the vehicle.

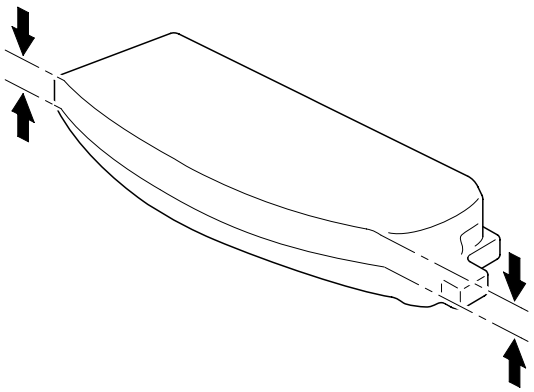


KJBF501C

REAR BRAKE PAD CHECK

1. Check the pad wear. Measure the pad thickness and replace it, if it is less than the specified value.

Pad thickness Standard value : 10mm (0.39in) Service limit : 2.0mm (0.08in)



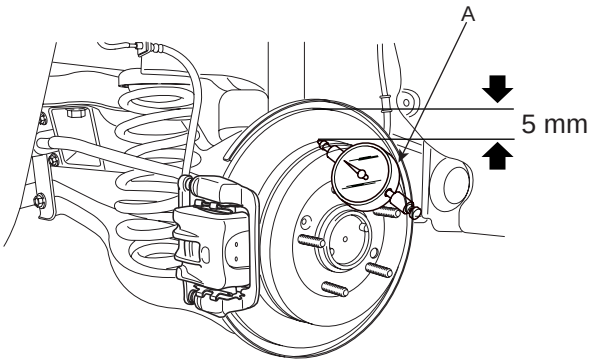
SGHBR6653D

2. Check that grease is applied, and the pad and backing metal for damage.

REAR BRAKE DISC RUN OUT CHECK

1. Place a dial gauge about 5mm (0.2in) from the outer circumference of the brake disc, and measure the run out of the disc.

Brake disc run out Limit : 0.05mm (0.002in) or less (new one)



KJBF501D

2. If the run out of the brake disc exceeds the limit specification, replace the disc, and then measure the run out again.

3. If the run out does not exceed the limit specification, install the brake disc after turning it 180° and then check the run out of the brake disc again.

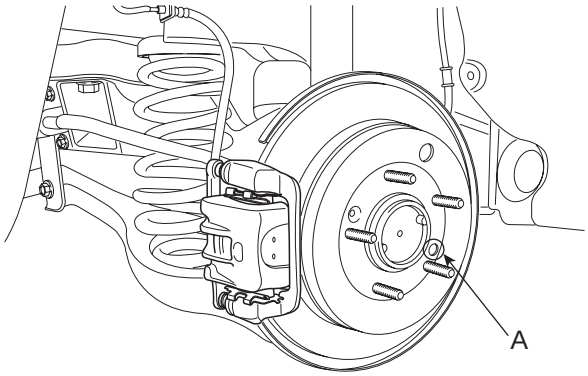
4. If the run out cannot be corrected by changing the position of the brake disc, replace the brake disc.

SEIZING OF REAR BRAKE DISC

1. Remove the brake disc from hub using an M8 screw (A) if the brake disc has been seized with the hub due to corrosion or overheating.

NOTE

Be careful not to use a hammer. The disc can be damaged if you remove the disc from the hub by hammering.

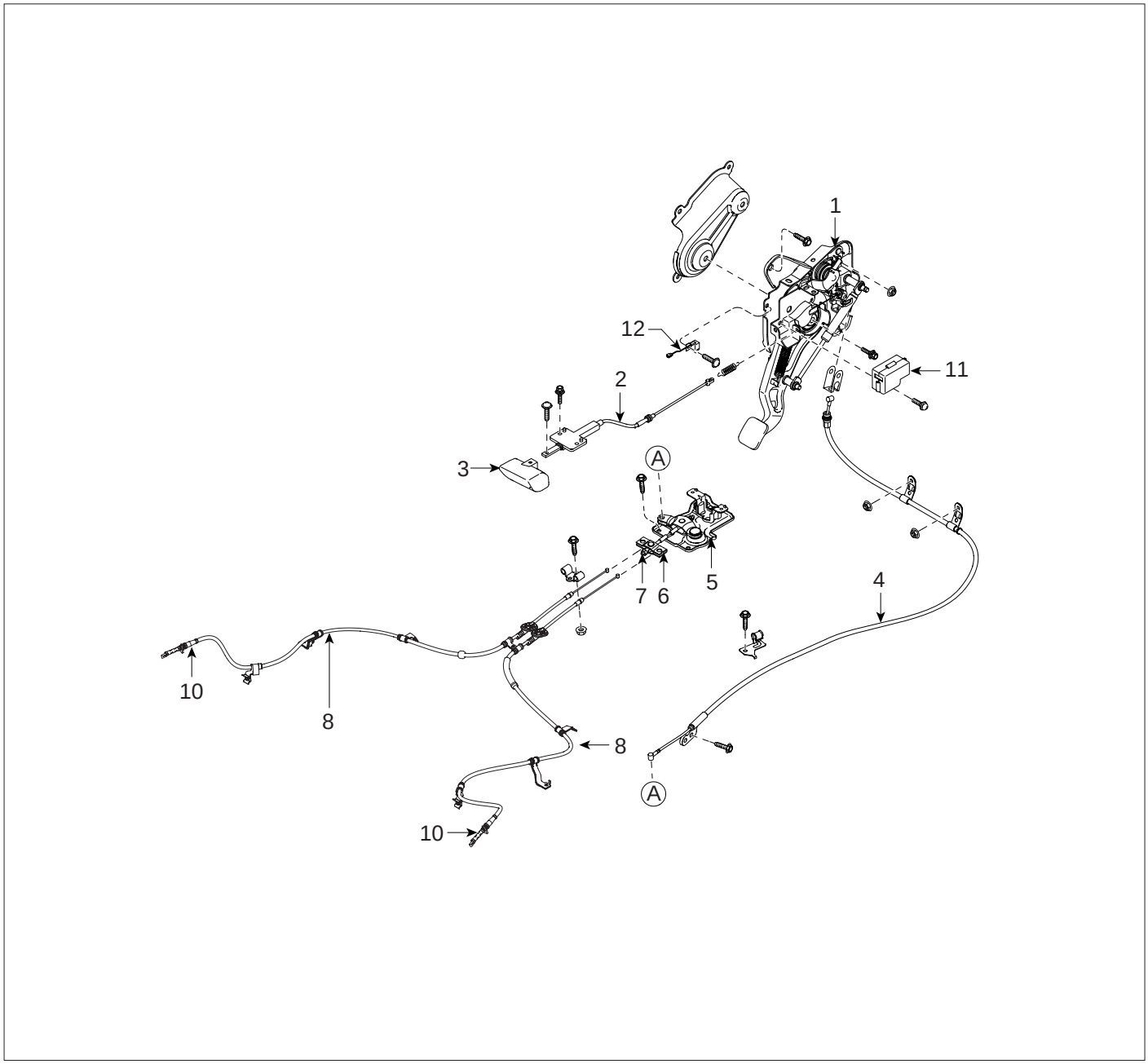


KJBF501E

PARKING BRAKE SYSTEM

PARKING BRAKE

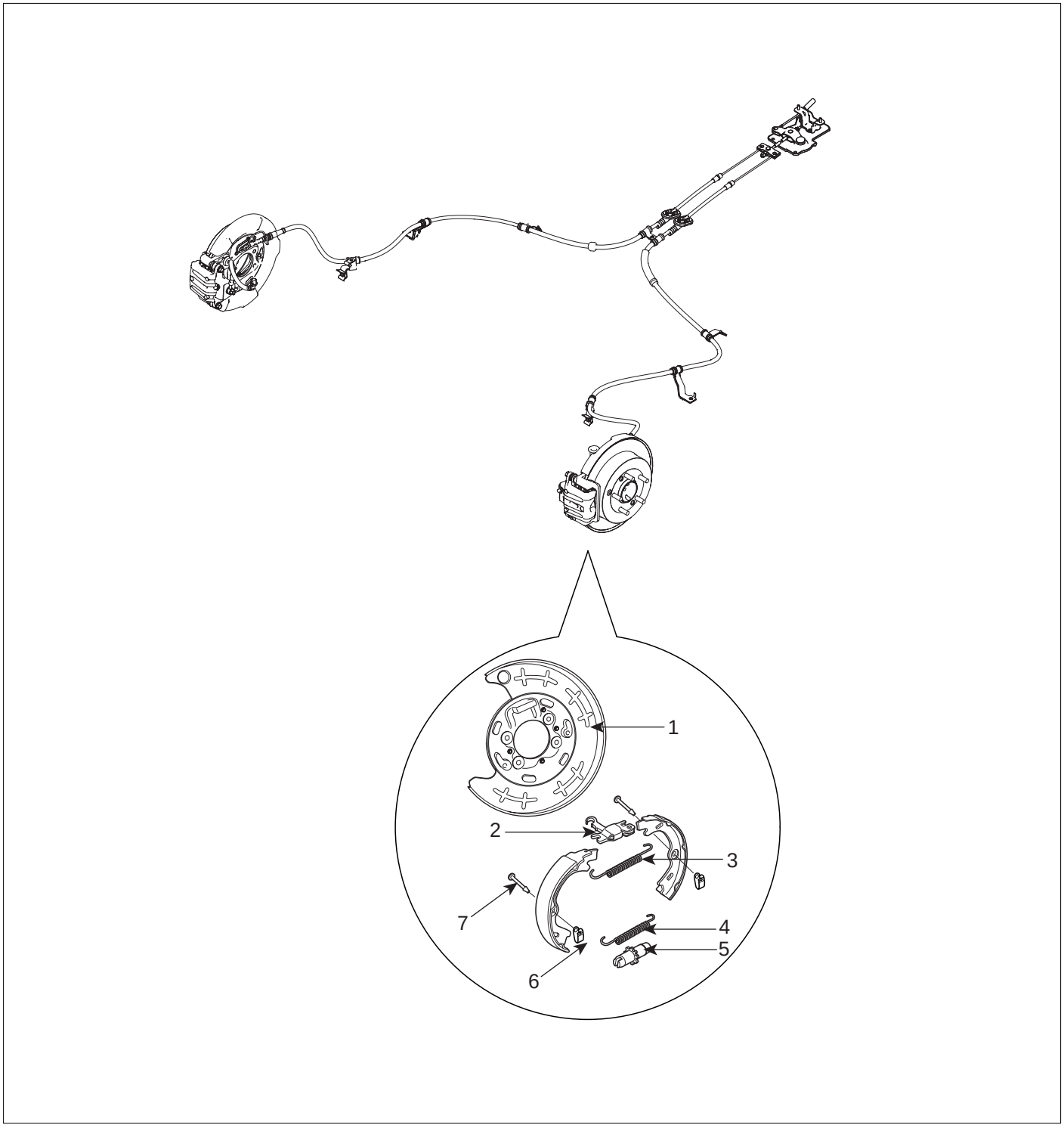
COMPONENTS(1) E159C1C7



1. Parking brake pedal assembly
2. Release cable assembly
3. Release knob
4. Front parking brake cable assembly
5. Rear cable bracket
6. Equalizer assembly
7. Adjusting nut
8. Rear parking brake cable assembly
9. Back plate
10. Cable retaining ring
11. Automatic release actuator
12. Parking brake switch

SGHBR6509N

COMPONENTS(2)

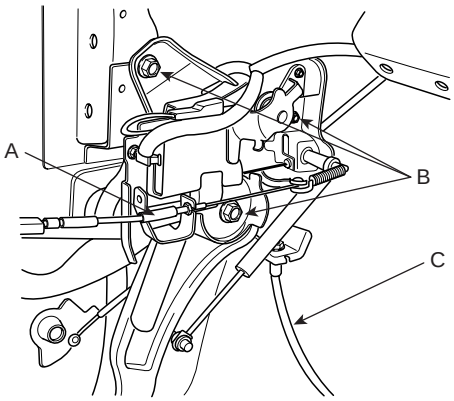


1. Backing plate
2. Operating lever
3. Upper spring
4. Lower spring
5. Adjuster
6. Shoe hold down spring
7. Shoe hold down pin

SGHBR6510N

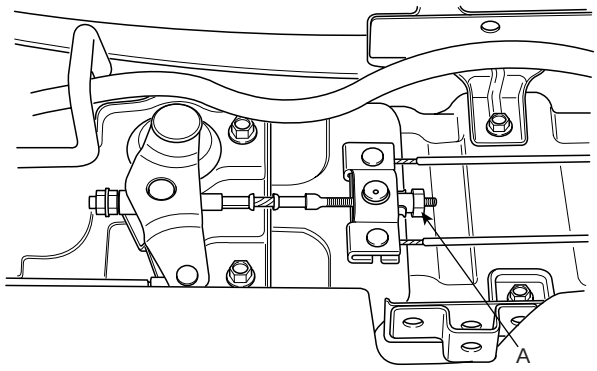
REMOVAL EB1A4FFD

1. Remove the lower panel, after loosening the parking lever (Refer to BD Gr. 'Crash pad')
2. Remove the release cable assembly (A).
3. Remove the parking brake mounting bolt (B) and the wire (C).



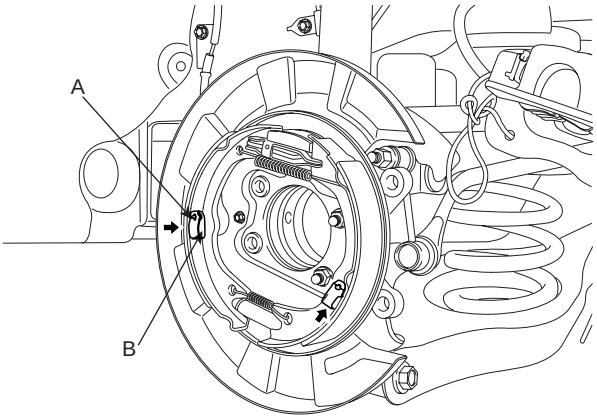
SGHBR6599D

4. Remove the floor console (Refer to BD Gr. 'Console').
5. Remove the parking brake wire by removing the adjusting nut (A).



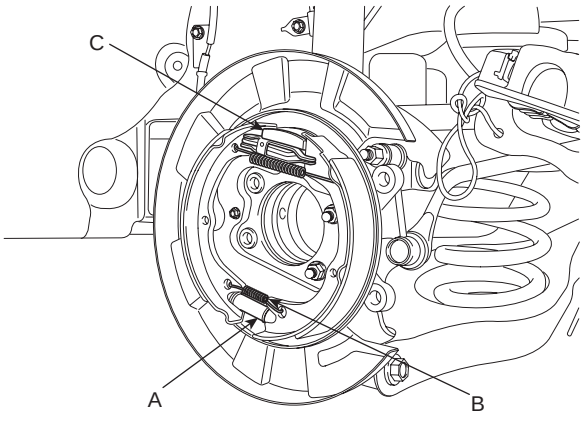
SGHBR6600D

6. Raise the front of the vehicle, and make sure it is securely supported.
7. Remove the rear wheel and tire from the rear hub.
8. Remove the caliper assembly from the carrier and suspend it with wire.
9. Remove the brake disk and the rear axle hub (Refer to DS Gr. 'Rear axle')
10. While fastening the spring, remove the shoe hold down pin (A) and spring (B).



SGHBR6601D

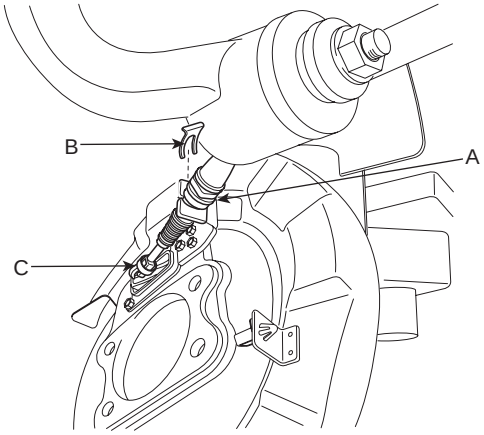
11. Remove the adjuster assembly (A) and the lower return spring (B).



KJBF501K

12. Remove the strut assembly (C).

13. Remove the retaining ring (B) from the parking brake wire (A) which is in the rear side of the backing plate.

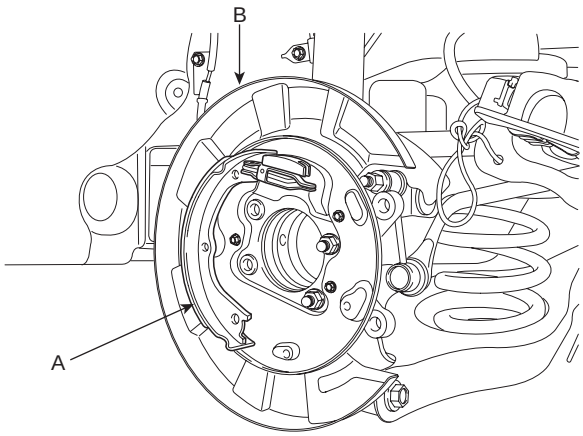


SGHBR6654D

14. Remove the parking brake wire connecting hook(C) from the brake shoe.

INSTALLATION E4F7F9A5

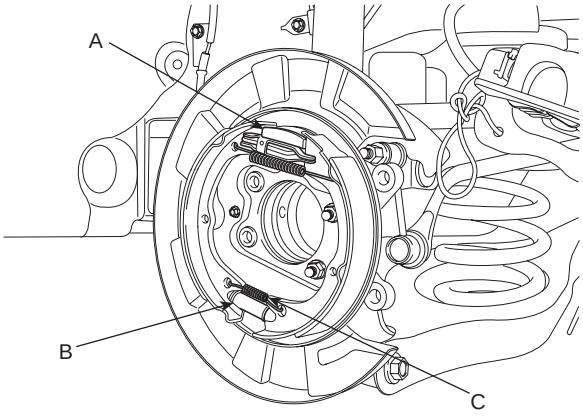
1. Install the brake shoe (A) to the backing plate (B).



KJBF501M

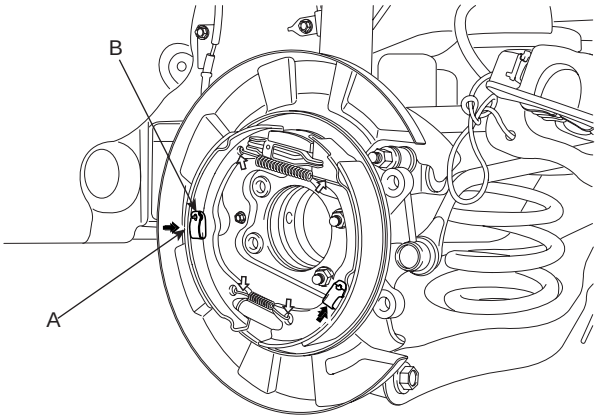
2. Connect the parking brake wire to the brake shoe.

3. After installing the strut assembly (A), install the adjuster assembly (B) and the lower return spring (C).



KJBF501N

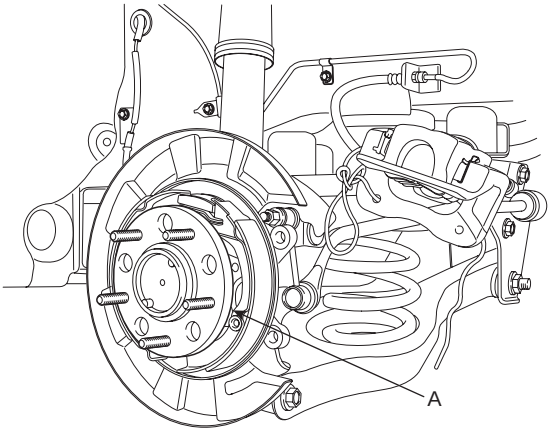
4. While pressing the spring, install the brake shoe hold down pin (A) and spring (B).



⇨: Grease

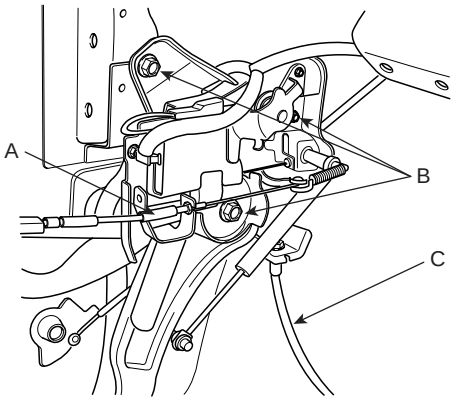
SGHBR6511N

5. Grease where it is necessary.
6. Install the rear axle hub (A) and the brake disk (Refer to DS Gr. 'Rear axle').



KJBF501P

7. Install the rear wheel and tire to the rear hub.
8. Tighten the parking brake adjusting nut.
9. Install the floor console (Refer to BD Gr. 'Console').
10. Install the parking brake mounting bolt (B) and the wire (C).

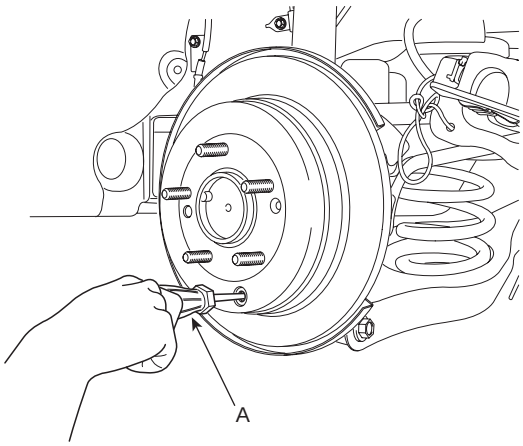


SGHBR6599D

ADJUSTMENT E227ABAD

ADJUSTMENT OF REAR BRAKE SHOE CLEARANCE

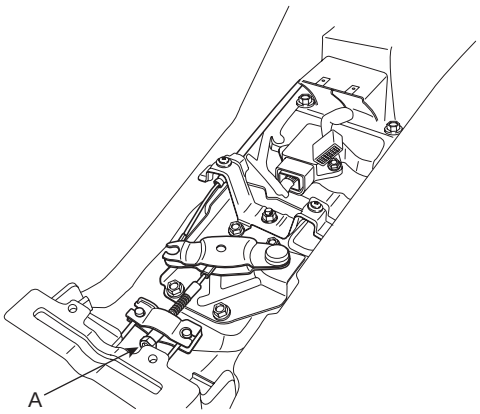
1. Raise the vehicle, and make sure it is securely supported.
2. Remove the rear wheel and tire from the rear hub.
3. After removing the plug from the disk, rotate the toothed wheel by a screw driver until the disk is not moving, and then return it by 5 notches.



KJBF501Q

ADJUSTMENT PRECEDURE OF DIH FOOT PARKING BRAKE

1. Push the parking brake pedal to its maximum point of travel. Release and repeat 2 additional times. Adjust the nut (A) so that the parking brake pedal stroke is 88 ~ 98mm(3.46 ~ 3.86in) at an operating effort of 196N(20kgf, 44lb).



KJBF501R

CAUTION

1. ***The parking brake adjustment must be carried out after adjusting the rear shoe.***
2. ***After adjusting parking brake, verify the following;***
   a) ***Must be free from interference between adjusting nut and pin.***
   b) ***Verify that the brake is not dragging***

BED-IN PROCEDURE FOR DIH FOOT PARKING BRAKE

1. While operating the parking brake pedal for 98N(10kgf, 22lb) effort, drive the vehicle 500meters (0.31miles) at the speed of 60kph (37.3mph).
2. Repeat the above procedure more than two times.
3. Must be held on at 30% grade.

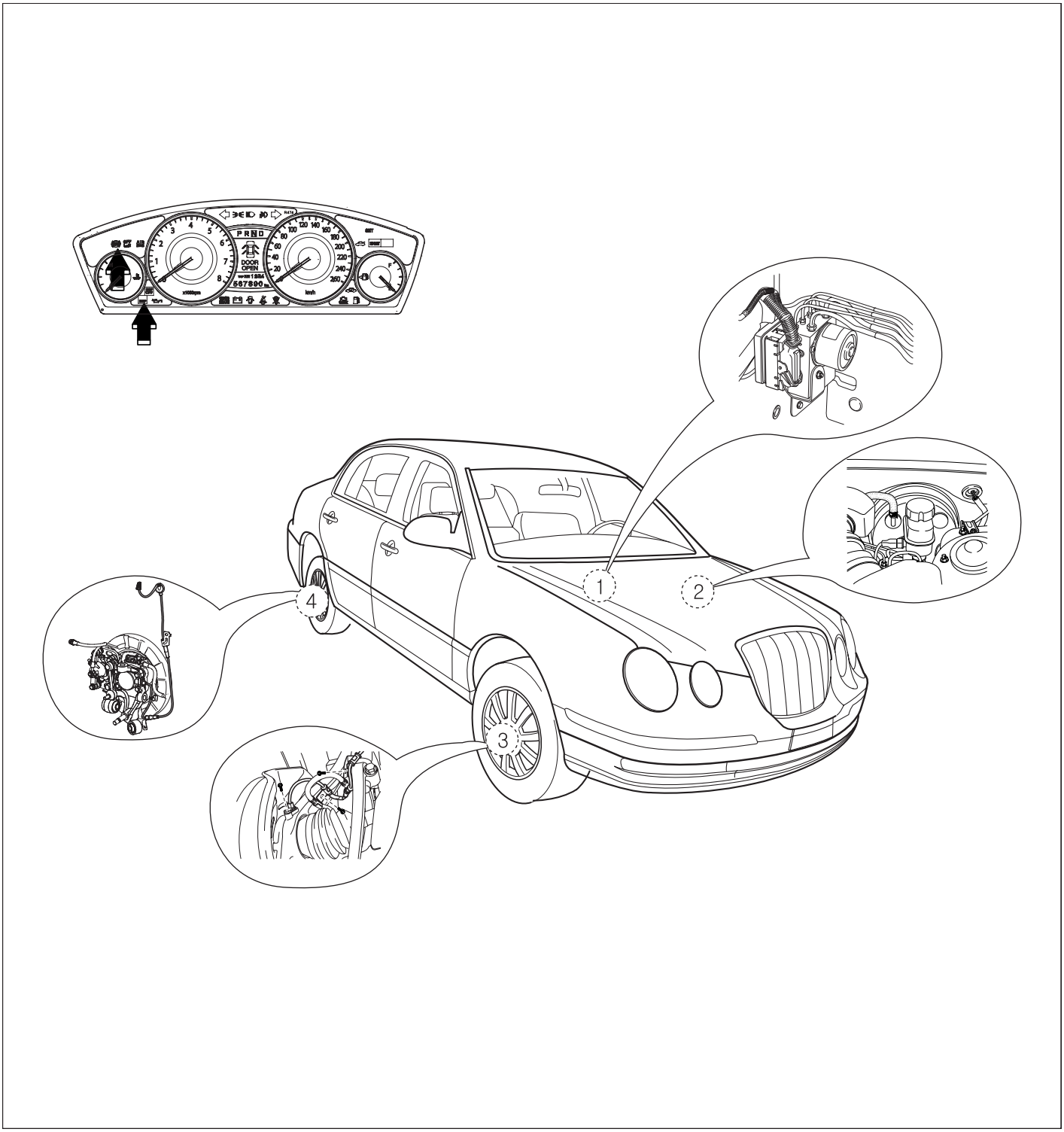
CAUTION

After adjusting parking brake, verify the following;

1. ***Must be free from malfunction when the parking pedal is operated at 1kN(100kgf, 220 lb).***
2. ***Check that all parts move smoothly.***
3. ***the parking brake indicator lamp must be on after the parking pedal is applied and must be off after the pedal is released.***

ABS (ANTI-LOCK BRAKE SYSTEM)

SYSTEM COMPONENT E9DECA28



1. HECU (Hydraulic & Electronic Control Unit)
2. Master cylinder
3. Front wheel speed sensor
4. Rear wheel speed sensor

SGHBR7500L

DESCRIPTION EACBED16

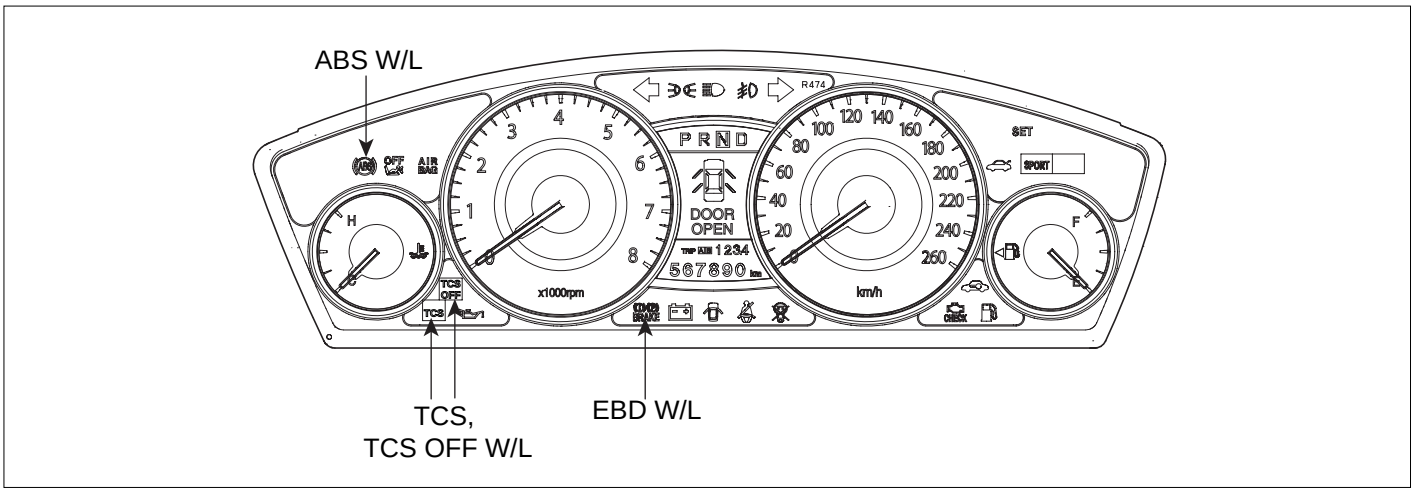
The Anti-Lock Brake System (ABS) controls the hydraulic brake pressure of all four wheels during braking on hazardous road surfaces, preventing the wheels from locking up. ABS provides the following benefits.

1. Enables steering around obstacles with a greater degree of certainty, even during emergency braking.
2. Enables stopping during emergency braking while keeping stability and steerability even on curves.

If a malfunction occurs, a diagnosis function and fail-safe system are included for serviceability.

The Hydraulic and Electronic Control Unit (HECU) receives signals about the vehicle's speed, direction and road conditions from sensors at the wheels.
Based on these signals, the control unit will determine the optimum amount of wheel spin.

WARNING LAMP CONTROL



SGHBR7501L

1. ABS warning lamp module
   The active ABS warning lamp module indicates the operating condition of the ABS.

   The ABS warning lamp is turned on under the following conditions.
   - During the initialization phase after ignition switch ON (3 seconds).
   - In the event of inhibition of ABS functions by failure.
   - When the system ECU is shut down even though ignition power is applied.
   - During diagnostic mode.

2. EBD warning lamp module
   The active EBD warning lamp module indicates the operating condition of the EBD. However, in case the parking brake switch is turned on, the EBD warning lamp is always turned on regardless of EBD functions.

   The EBD warning lamp is turned on under the following conditions.
   - During the initialization phase after ignition switch ON. (3 seconds).
   - When the system ECU is shut down even though ignition power is applied.
   - When the parking brake switch is ON or brake fluid is low level.
   - In the event of inhibition of EBD function.

3. TCS warning lamp module
   the passive TCS warning lamp module indicates the operating condition of the TCS.

   The TCS warning lamp is turned on under the following conditions :
   - During the initialization phase after ignition switch ON (3 seconds).
   - In the event of inhibition of TCS functions by failure.
   - During diagnostic mode.

4. TCS function lamp module
   The TCS function lamp indicates the operating condition of TCS function.

   The TCS function lamp is on under the following condition
   - During the initialization phase (3seconds).
     The TCS function lamp is blinking under the following conditions.
   - During TCS control.

SAFETY CONCEPT

1. ABS

When any failures are occurred in the ABS system, the ABS ECU turns on the warning lamps and inhibits the control corresponding that as follows.

CONDITION	Warning Lamp Combination		CONTROL	
	ABS_WL	EBD_WL	CBD_WL	ABS
Two or more WSS failures, valve failure, internal ECU failure, high/low supply voltage	ON	ON	Available	Inhibited
One WSS failure, pump failure	ON	-	Available	Inhibited

∗) "-" means "Warning Lamp OFF"

2. TCS

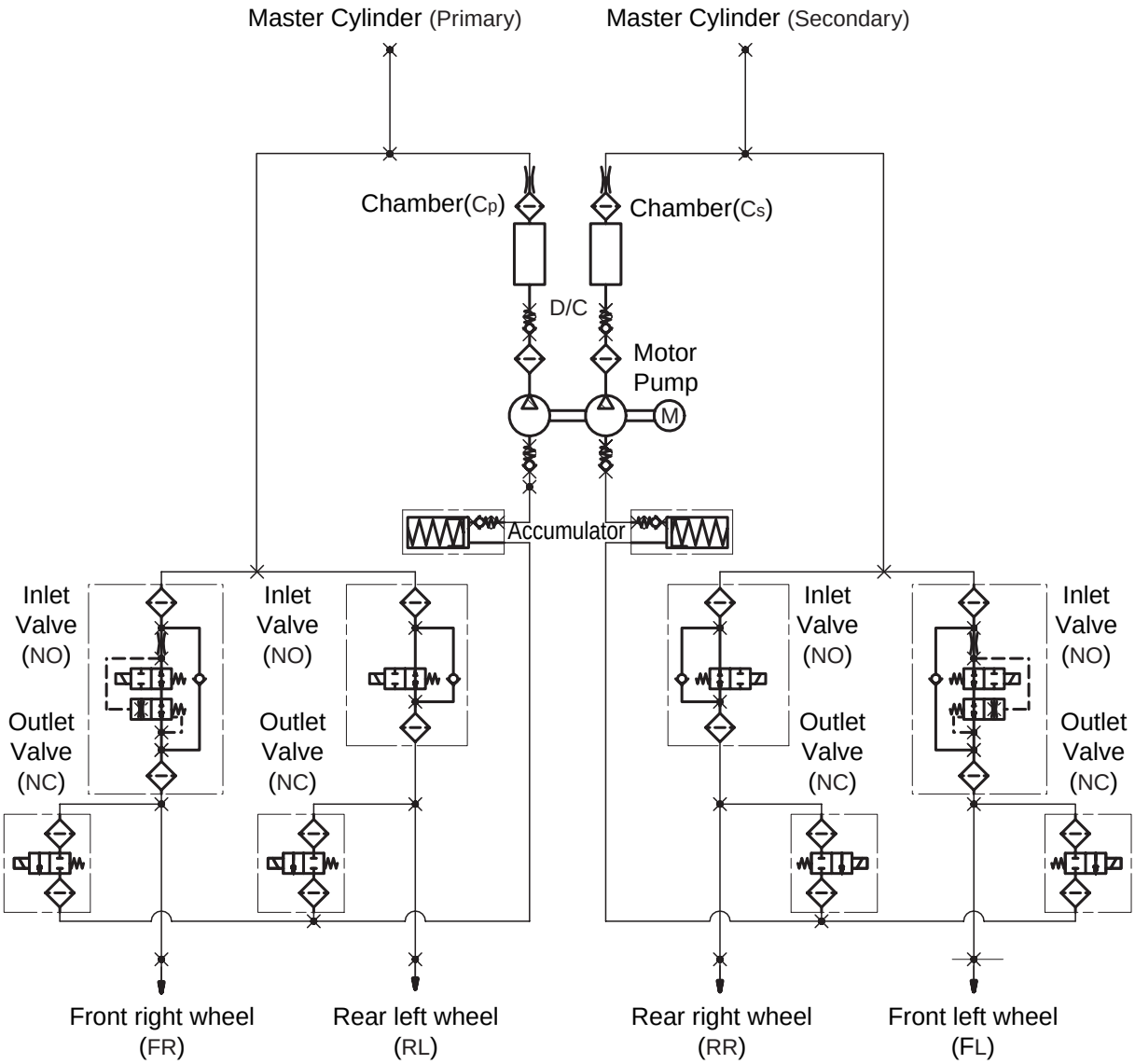
When any failures are occurred in the TCS system, the TCS ECU turns on the warning lamps and inhibits the control corresponding that as follows.

CONDITION	Warning Lamp Combination			CONTROL		
	ABS_WL	EBD_WL	TCS_WL	CBS	ABS	TCS
Two or more WSS failures, valve failure, internal ECU failure, high/low supply voltage	ON	ON	ON	Available	Inhibited	Inhibited
One WSS failure, pump failure	ON	-	ON	Available	Inhibited	Inhibited
CAN failure	-	-	ON	Available	Available	Inhibited

∗) "-" means "Warning Lamp OFF"

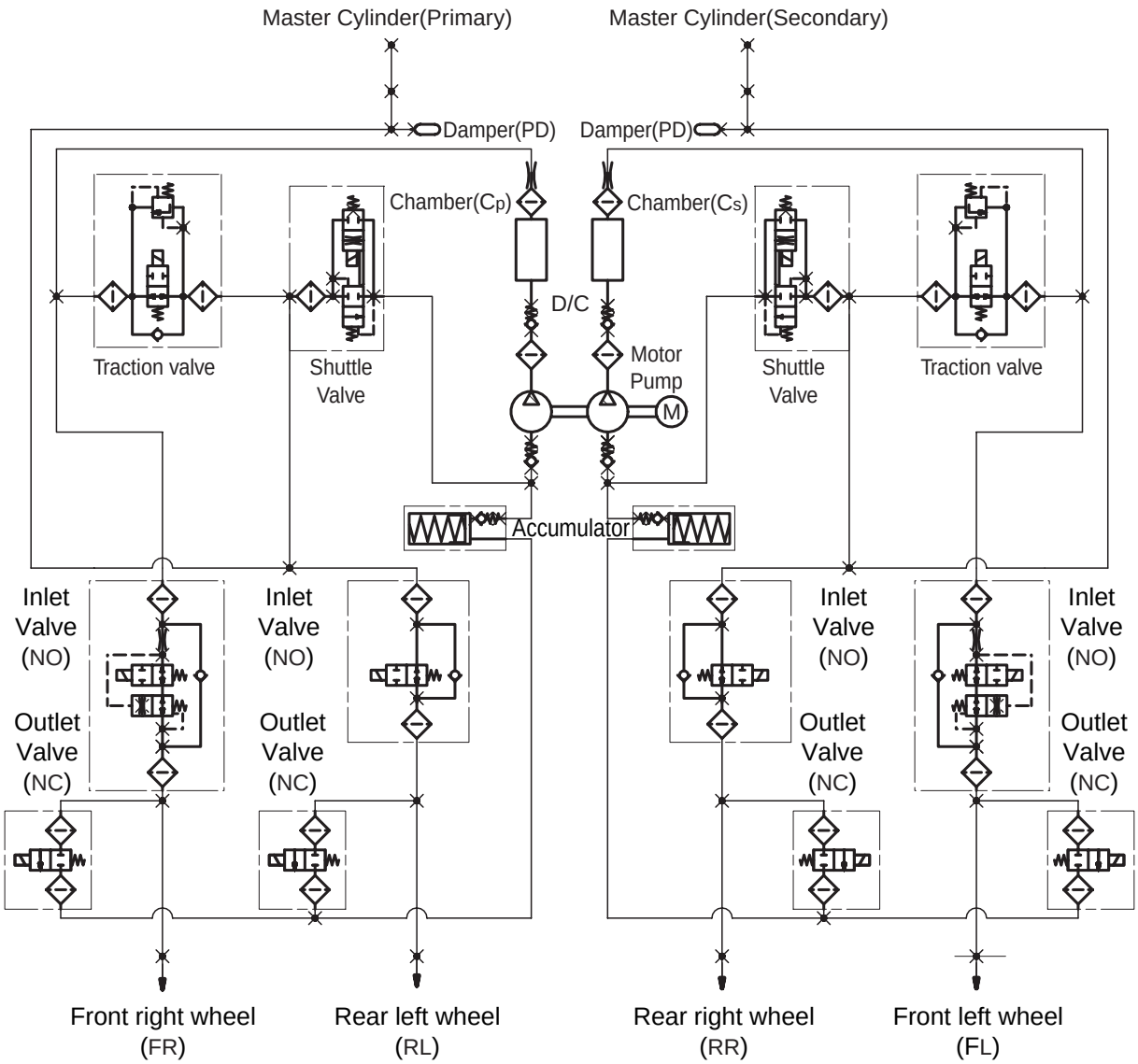
HYDRAULIC SYSTEM DIAGRAM E5C77BCB

[ABS HECU]



SGHBR7586N

[TCS HECU]



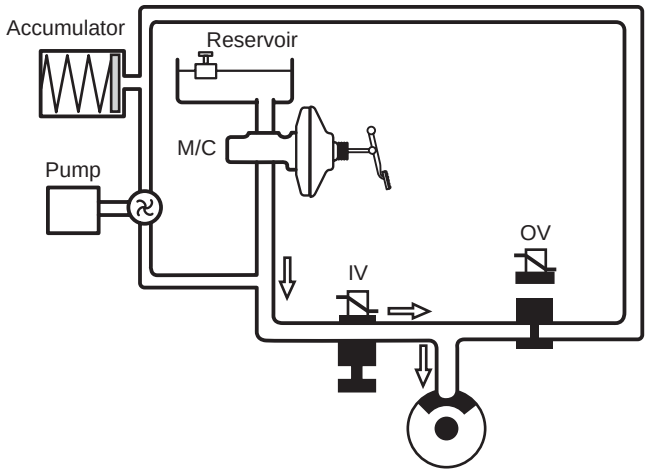
SGHBR7587N

ABS CONTROL EF04A470

1. NORMAL BRAKING

Solenoid valve	State	Valve	Passage
Inlet valve (NO)	OFF	OPEN	Master cylinder ⇔ Wheel cylinder
Outlet valve (NC)	OFF	CLOSE	Wheel cylinder ⇔ Reservoir

When braking, the hydraulic pressure in the TMC is increased. The pressure reaches the wheel brake via the current less open inlet valve IV. The current less closed outlet valve OV is closed. For the sake of simplicity the diagram is limited to only the solenoid valve pair of one brake circuit. The wheel speed is reduced as the brake pressure increases, in the extreme case until the wheel locks.

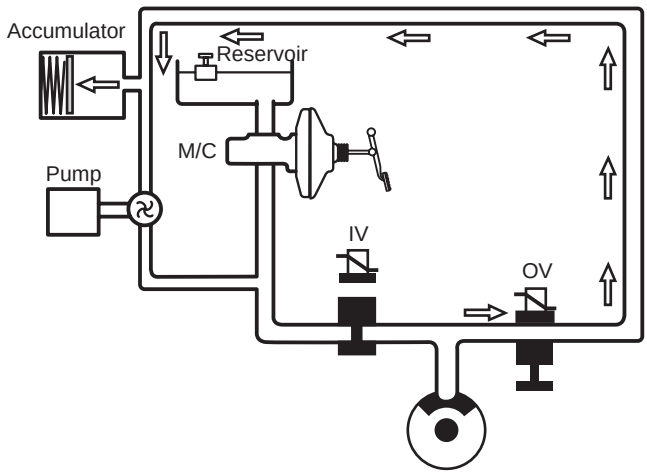


LJCD015A

2. DUMP MODE

Solenoid	State	Valve	Passage
Inlet valve (NO)	ON	CLOSE	Master cylinder ⇔ Wheel cylinder
Outlet valve (NC)	ON	OPEN	Wheel cylinder ⇔ Reservoir

If the wheel speed decreases, there is still a tendency to lock; the brake pressure on the corresponding wheel must be reduced accordingly. For this, the outlet valve OV is opened, the inlet valve IV remains closed.
The brake pressure to the low-pressure accumulator is reduced. The wheel in danger of locking gains speed again.

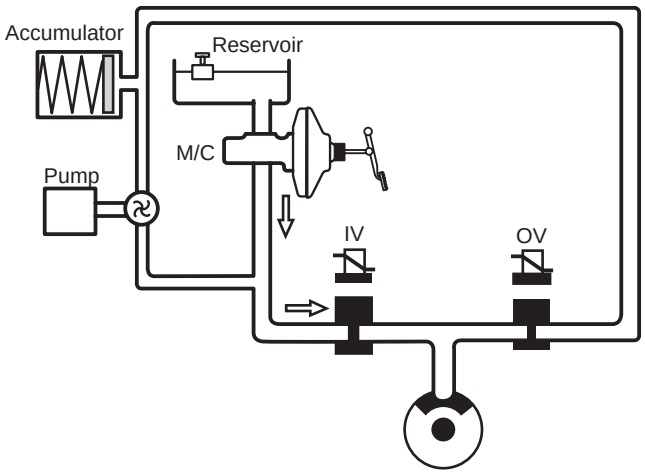


LJCD016A

3. HOLD MODE

Solenoid	State	Valve	Passage
Inlet valve (NO)	ON	CLOSE	Master cylinder ⇔ Wheel cylinder
Outlet valve (NC)	OFF	CLOSE	Wheel cylinder ⇔ Reservoir

When a wheel (or several) tends to lock the inlet valve IV is first closed to avoid a further increase in brake pressure. The outlet valve OV remains closed: the brake pressure is kept constant.



LJCD017A

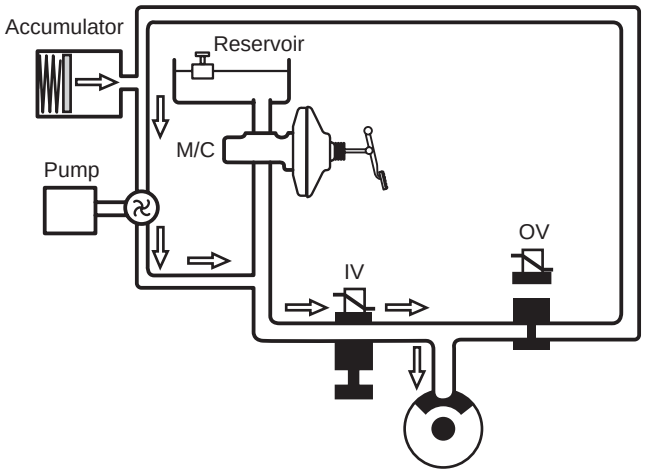
4. INCREASE MODE

Solenoid	State	Valve	Passage
Inlet valve (NO)	OFF	OPEN	Master cylinder ⇔ Wheel cylinder
Outlet valve (NC)	OFF	CLOSE	Wheel cylinder ⇔ Reservoir

For optimum brake from the certain wheel acceleration a brake pressure increase is necessary. For this, the inlet valve IV is opened and the outlet valve OV is closed. The pump of the unit starts to run and aspirates the necessary quantity of fluid from the Low-pressure accumulator, in order to produce the necessary brake pressure for the pressure increase phase in seconds.
With an increase in the brake pressure the wheel speed is reduced. These control phases are repeated until the ABS control unit no longer detects any tendency of the wheels to lock.

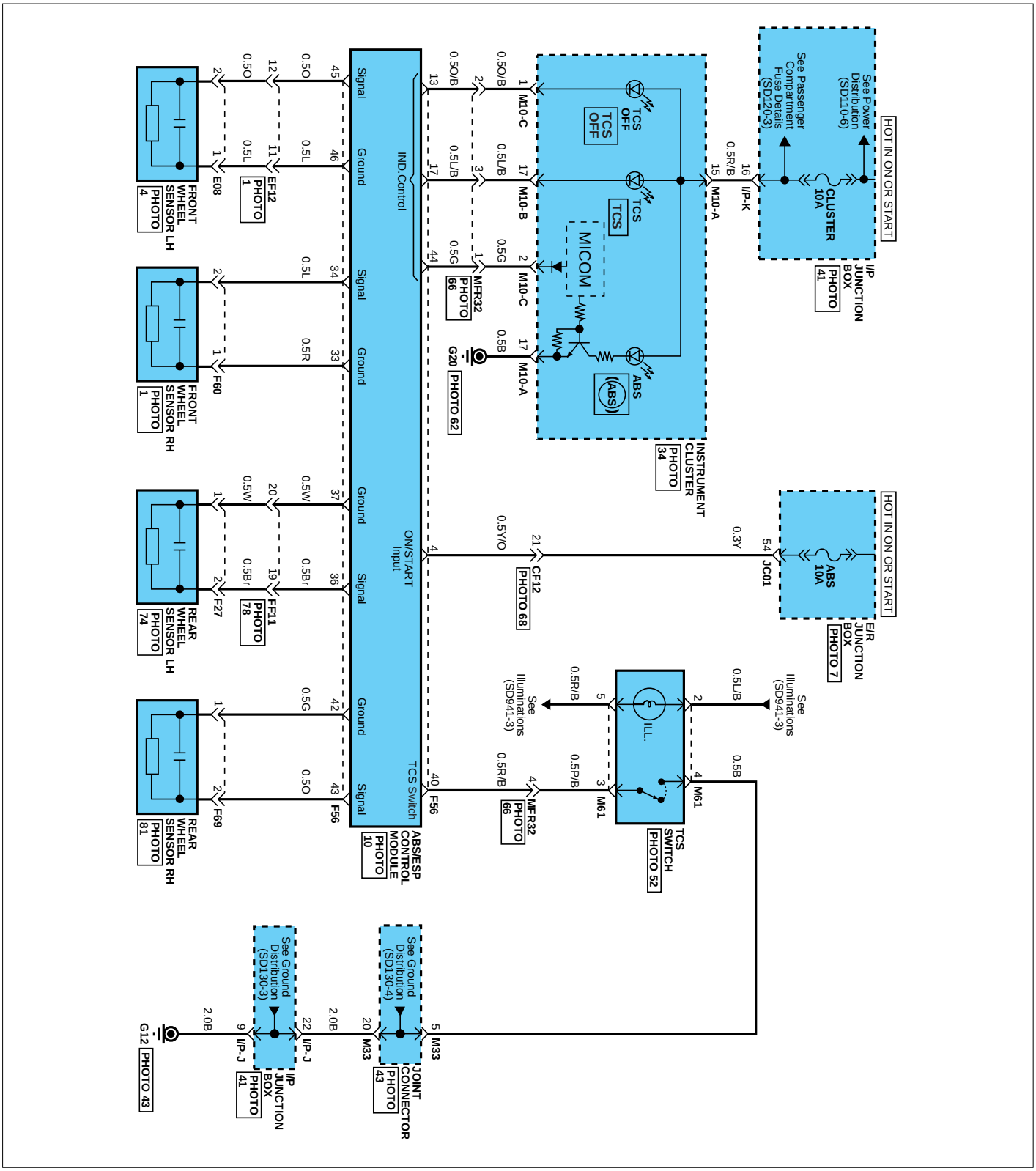
NOTE

During ABS control function, the brake pedal only moves in accordance with the volume requirement of the wheels. Because of a sudden change in friction coefficient this pedal movement may increase slightly.

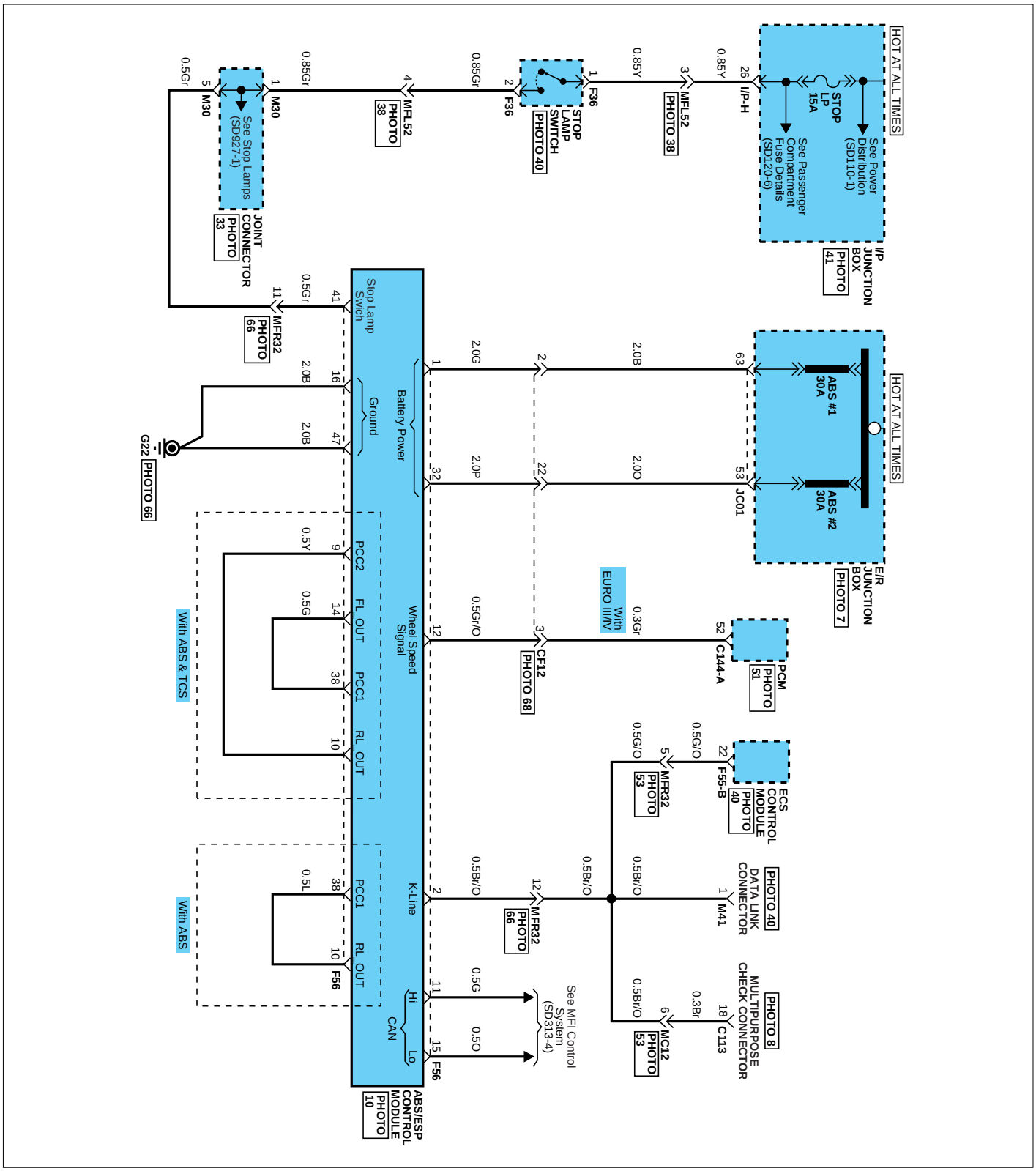


LJCD018A

CONTROL UNIT (HECU) WIRING DIAGRAM E6599508

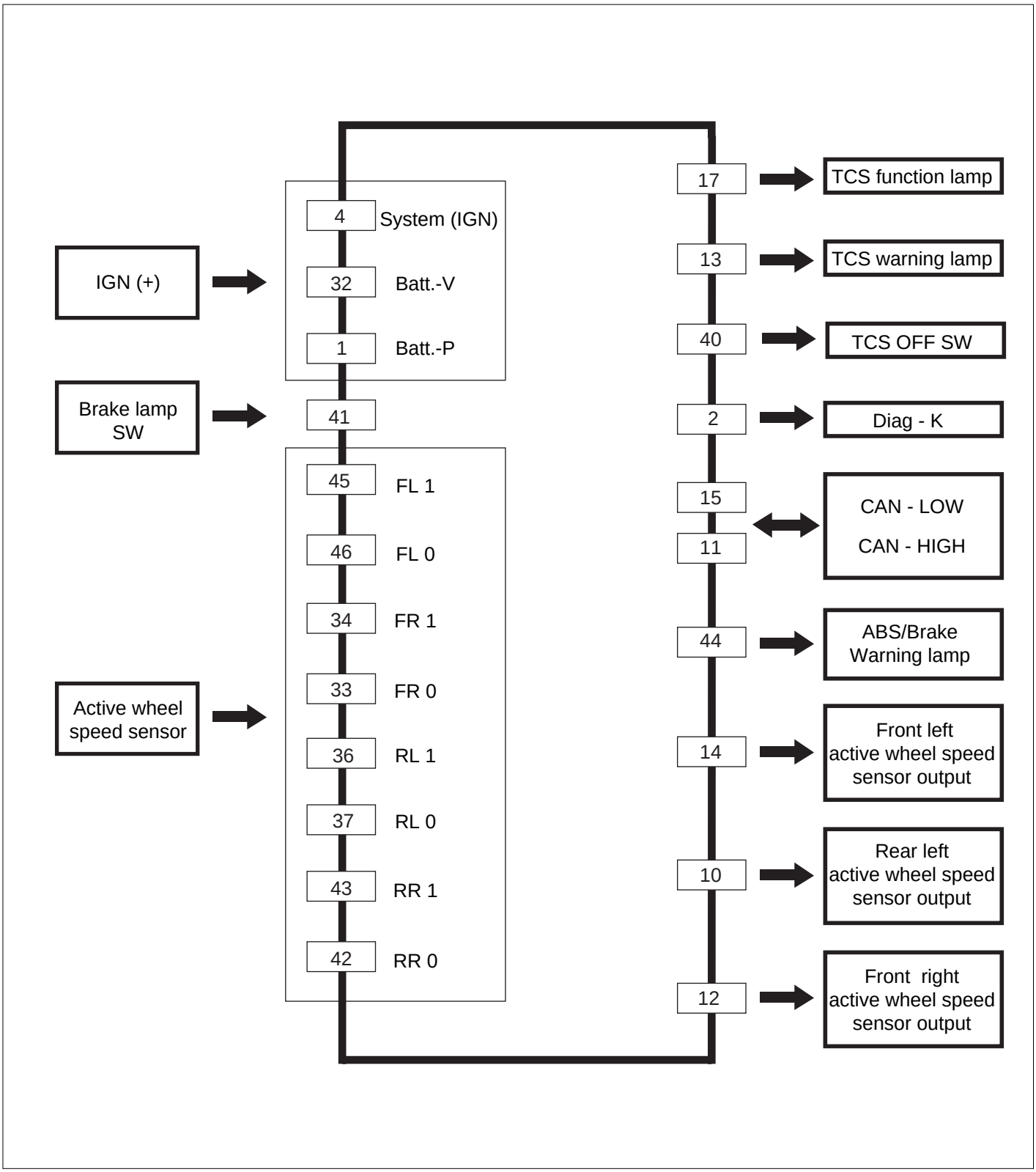


SGHBR7502L



SGHBR7503L

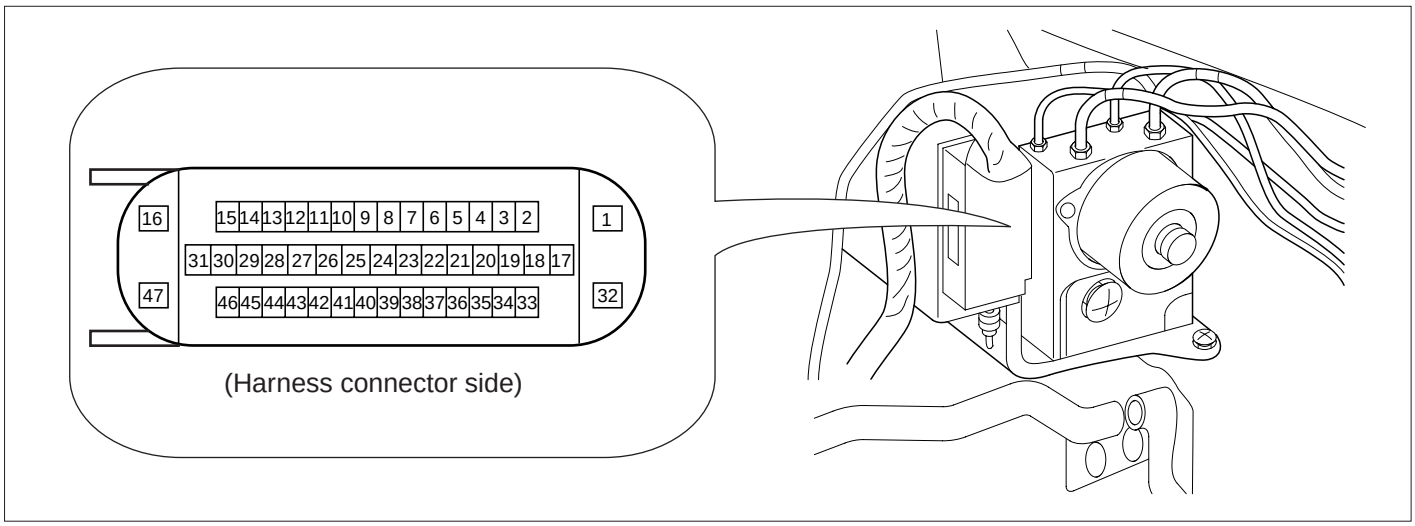
HECU INPUT/OUTPUT DIAGRAM E2BC1F46



SGHBR7588N

ABS/TCS CONTROL UNIT

HECU CONNECTOR INSPECTION



SGHBR7589N

Pin No.	Name	Current	Voltage	Remark
46,33,37,42	Wheel speed sensor (FL,FR,RL,RR) Ground	7-14mA	0-12V	
45,34,36,43	Wheel speed sensor (FL,FR,RL,RR) Signal	7-14mA	0-12V	
13	TCS Warning Lamp	Max.100mA	0-18V	-
4	IGN1	Max.150mA	0-18V	
16	Ground	Max.25A	0-18V	
40	TCS SW	Max.10mA	0-18V	
1	Battery (B+)	Max.30A	0-18V	
47	Ground	Max.30A	0-18V	
32	Battery (B+)	Max.25A	0-18V	
12	Wheel speed sensor output (FR)	Max.20mA	-	
10	Wheel speed sensor output (RL)	Max.20mA	-	
11	CAN (high)	Max.10mA	0-18V	
15	CAN (low)	Max.10mA	0-18V	
17	TCS function lamp	Max.100mA	-	-
2	Self diagnosis (Diag.K-line)	Max.100mA	0-18V	
41	Stop lamp SW	Max.10mA	0-18V	
44	ABS Warning lamp	Max.20mA	0-18V	
38	PCC1	Max.10mA	-	
9	PCC2	Max.10mA	-	

ACTUATOR DRIVING

ABS

NO.	Description	Recognition	Remark
01	Motor	Motor pump relay operation (Click sounds)	Actuation time is limited to MAX. 2 seconds
02	Front left valve (In)	Front left solenoid valve operation (Click sounds)	
03	Front right valve (In)	Front right solenoid valve operation (Click sounds)	
04	Rear left valve (In)	Rear left solenoid valve operation (Click sounds)	
05	Rear right valve (In)	Rear right solenoid valve operation (Click sounds)	
06	Front left valve (Out)	Front left solenoid valve operation (Click sounds)	
07	Front right valve (Out)	Front right solenoid valve operation (Click sounds)	
08	Rear left valve (Out)	Rear left solenoid valve operation (Click sounds)	
09	Rear right valve (Out)	Rear right solenoid valve operation (Click sounds)	

TCS

NO.	Description	Recognition	Remark
01	TC FL valve	Front left traction control valve operation	
02	TC FR valve	Front right traction control valve operation	

CURRENT DATA

ABS

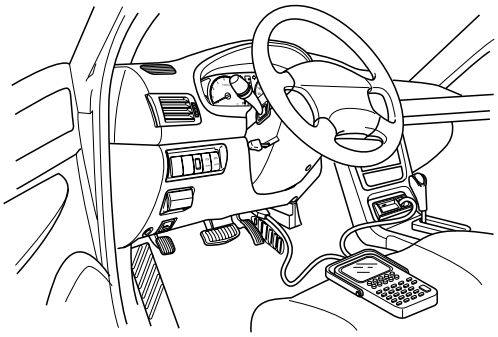
No.	Description	Recognition	Remark
01	FL wheel speed SNSR	Front left wheel speed sensor	Minimum level is V ≥ 6.2mph(10 km/h)
02	FR wheel speed SNSR	Front right wheel speed sensor	
03	RL wheel speed SNSR	Rear left wheel speed sensor	
04	RR wheel speed SNSR	Rear right wheel speed sensor	
05	ABS SRI status	Warning lamp	
06	Brake SW	Brake switch	
07	Motor pump relay	Motor relay	
08	Valve relay	Valve relay	
09	Motor pump status	Motor	
10	FL valve (In)	Front left valve (In)	
11	FR valve (In)	Front right valve (In)	
12	RL valve (In)	Rear left valve (In)	
13	RR valve (In)	Rear right valve (In)	
14	FL valve (Out)	Front left valve (Out)	
15	FR valve (Out)	Front right valve (Out)	
16	RL valve (Out)	Rear left valve (Out)	
17	RR valve (Out)	Rear right valve (Out)	

TCS

No.	Description	Recognition	Remark
01	FL wheel speed SNSR	Front left wheel speed sensor	
02	FR wheel speed SNSR	Front right wheel speed sensor	
03	RL wheel speed SNSR	Rear left wheel speed sensor	
04	RR wheel speed SNSR	Rear right wheel speed sensor	
05	TCS switch	TCS swtich	
06	FL TC valve (Out)	Front left traction control valve (Out)	
07	FR TC valve (Out)	Front right traction control valve (Out)	
08	ATPS sensor	Absolute Throttle Position Sensor	
09	Shift lever	Shift leven position	
10	TCS W/L	TCS Warning Lamp	
11	TCS F/L	TCS function Lamp	
12	ESV FL	Electric Reversing Valve Front Left	
13	ESV FR	Electric Reversing Valve Front Rigth.	

HI-SCAN (PRO) CHECK EAA0638E

1. Turn the ignition OFF.
2. Connect the Hi-Scan (Pro) to the Data Link Connector located underneath the lower crash pad panel.
3. Turn the ignition ON.
4. Use the Hi-Scan (Pro) to check for diagnostic trouble codes.
5. After completion of the repair or correction of the problem, erase the stored fault codes using the clear key on the Hi-Scan (Pro).
6. Disconnect the Hi-Scan (Pro).



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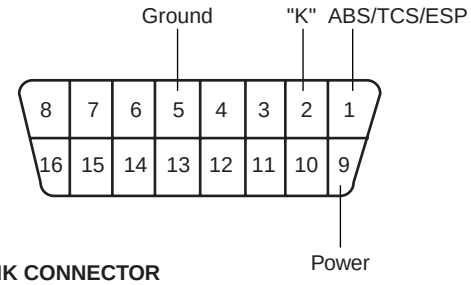
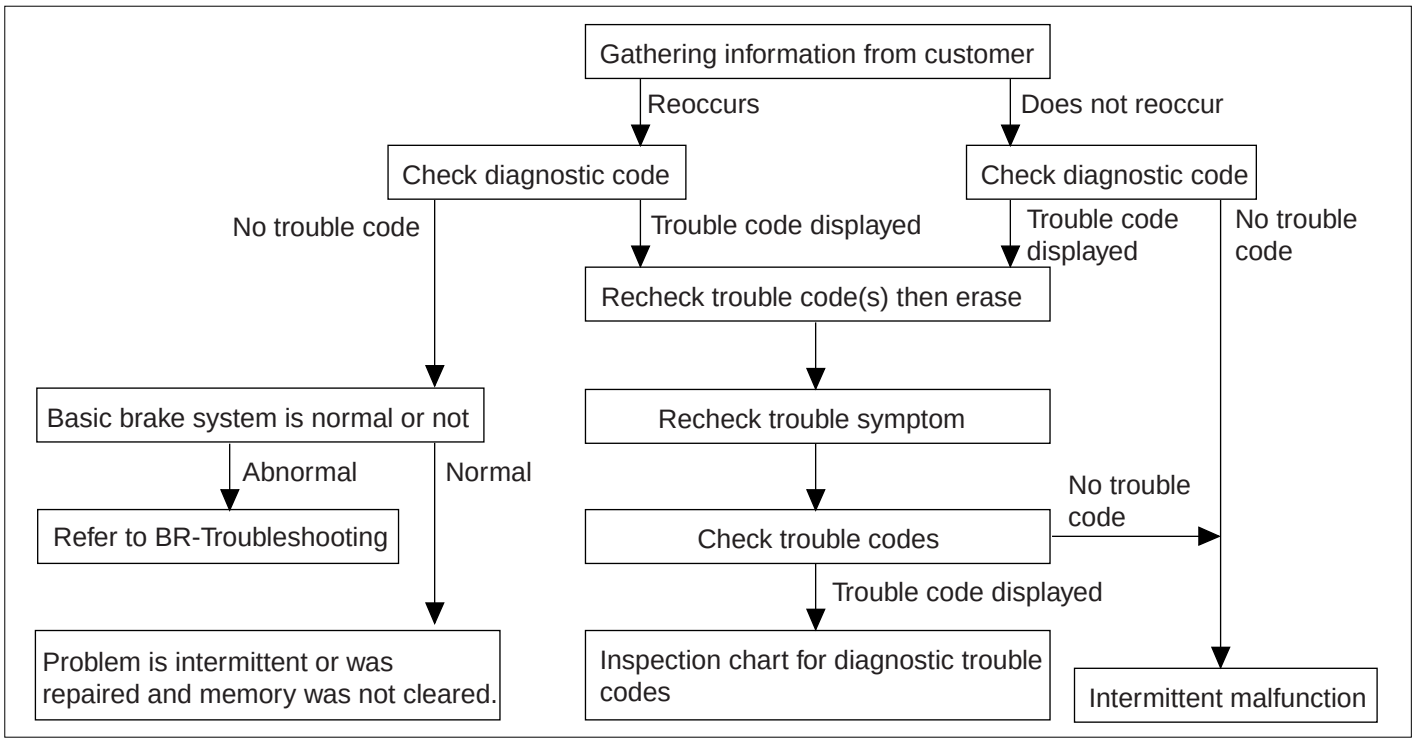


DATA LINK CONNECTOR (OBD connector)

SGHBR7504L

STANDARD FLOW OF DIAGNOSTIC TROUBLESHOOTING



SGHBR7590N

* Using the customer problem analysis check sheet for reference, ask the customer as much detail as possible about the problem.

NOTES WITH REGARD TO DIAGNOSIS

The phenomena listed in the following table are not abnormal.

Phenomenon	Explanation
System check sound	When starting the engine, a thudding sound can sometimes be heard coming from inside the engine compartment. This is because the system operation check is being performed.
ABS operation sound	1. Sound of the motor inside the ABS hydraulic unit operation (whine). 2. Sound is generated along with vibration of the brake pedal (scraping). 3. When ABS operates, sound is generated from the vehicle chassis due to repeated brake application and release (Thump : suspension; squeak: tires)
ABS operation (Long braking distance)	For road surfaces such as snow-covered and gravel roads, the braking distance for vehicles with ABS can sometimes be longer than that for other vehicles. Accordingly, advise the customer to drive safely on such roads by lowering the vehicle speed.
Pedal kick back	Pedal kick back is normal operation.
Diagnosis detection conditions can vary depending on the diagnosis code. When checking the trouble symptom after the diagnosis code has been erased, ensure that the requirements listed in "Comment" are met.	

ABS CHECK SHEET

ABS Check Sheet

Inspector's Name _____

Customer's Name		**Registration No.**	
		Registration Year	/ /
		VIN.	
Date Vehicle Brought In	/ /	**Odometer**	Km Miles

Date the Problem First Occurred	/ /
Frequency of Occurence of Problem	☐ Continuous ☐ Intermittent (times a day)

Symptoms	☐ ABS does not operate.	
	☐ ABS does not operate efficiently.	☐ Intermittent (times a day)
	ABS Warning Lamp Abnormal	☐ Remains ON ☐ Does not light up

Diagnostic Trouble Code Check	**1st Time**	☐ Normal Code	☐ Malfunction Code (Code)
	2nd Time	☐ Normal Code	☐ Malfunction Code (Code)

EJDA017A

INSPECTION CHART FOR TROUBLE SYMPTOMS

Find out the symptom and check according to the inspection procedure chart.

Trouble system		Inspection procedure No.
Communication with Hi-Scan (Pro) is not possible	Communication with any system is not possible.	1
	Communication with ABS only is not possible.	2
When the ignition key is turned to "ON" (engine OFF), the ABS warning lamp does not illuminate.		3
After the engine starts, the lamp remains illuminated.		4
Faulty ABS operation	Unequal braking power on both sides	5
	Insufficient braking power	
	ABS operates under normal braking conditions	
	ABS operates before vehicle stops under normal braking conditions	
	Large brake pedal vibration (See Caution)	-

CAUTION

During ABS operation, the brake pedal may vibrate or may not be able to be depressed. Such phenomena are due to intermittent changes in hydraulic pressure inside the brake line to prevent the wheels from locking and is not an abnormality.

INSPECTION PROCEDURE FOR TROUBLE SYMPTOMS

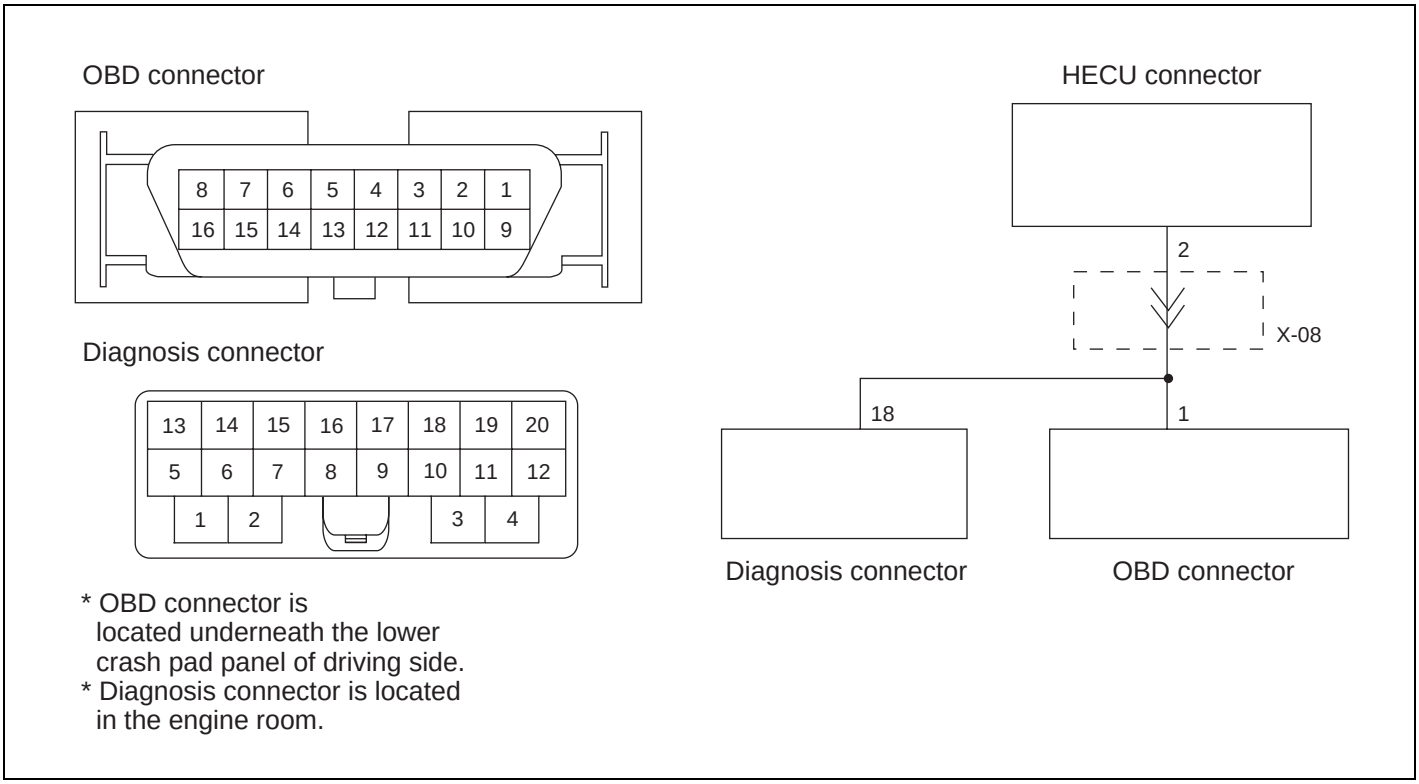
INSPECTION PROCEDURE 1

Communication with Hi-Scan (Pro) is not possible. (Communication with all systems is not possible.)	Probable cause
Possible defect in the power supply system (including ground) for the diagnosis line.	• Malfunction of connector. • Malfunction of wiring harness.

INSPECTION PROCEDURE 2

Communication with Hi-Scan (Pro) is not possible. (Communication with ABS only is not possible.)	Probable cause
When communication with Hi-Scan (Pro) is not possible, the cause may be probably an open circuit in the HECU power circuit or an open circuit in the diagnosis output circuit.	• Blown fuse. • Malfunction of wiring harness or connector. • Malfunction of HECU.

CIRCUIT DIAGRAM



* OBD connector is located underneath the lower crash pad panel of driving side.
* Diagnosis connector is located in the engine room.

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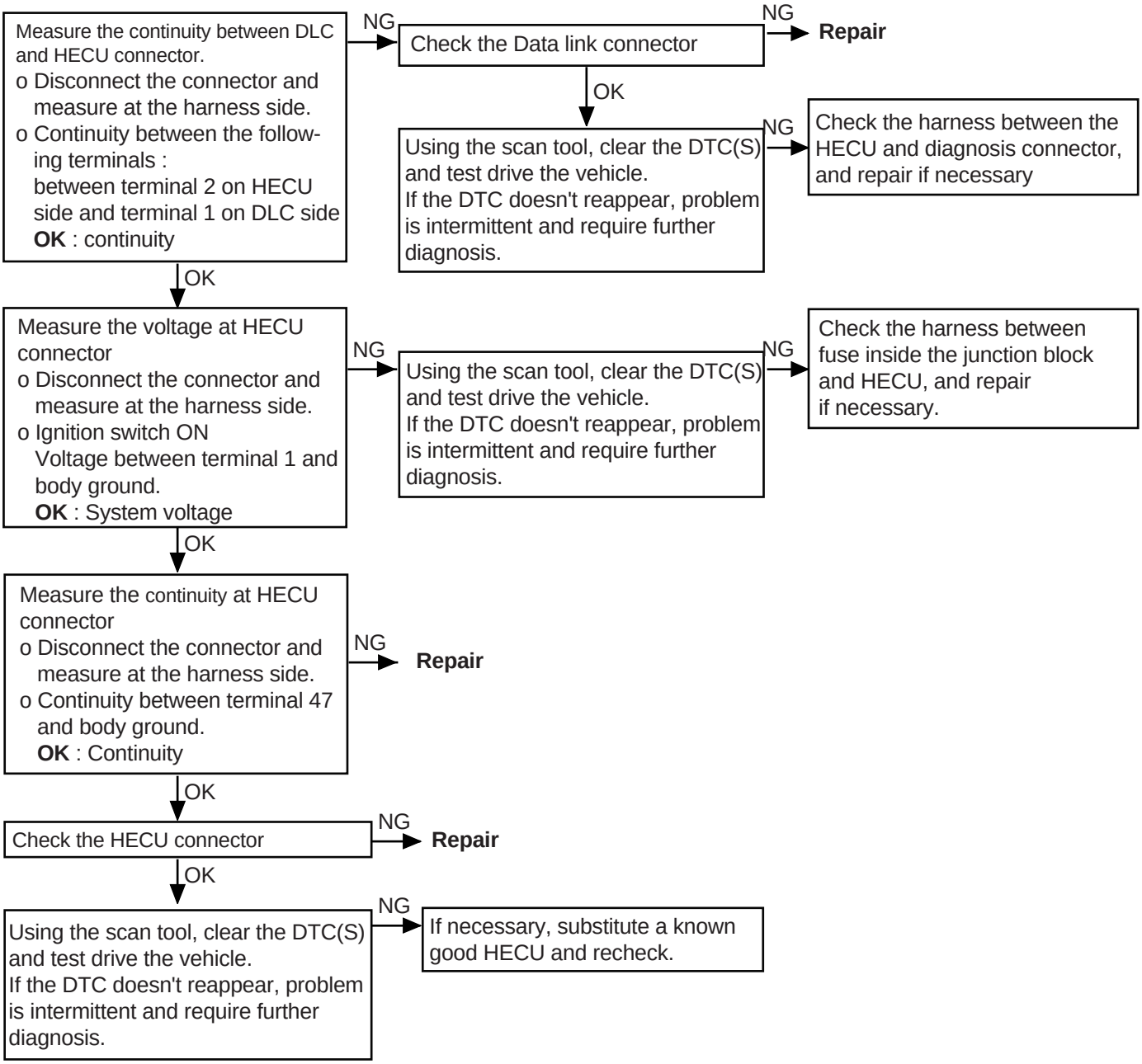
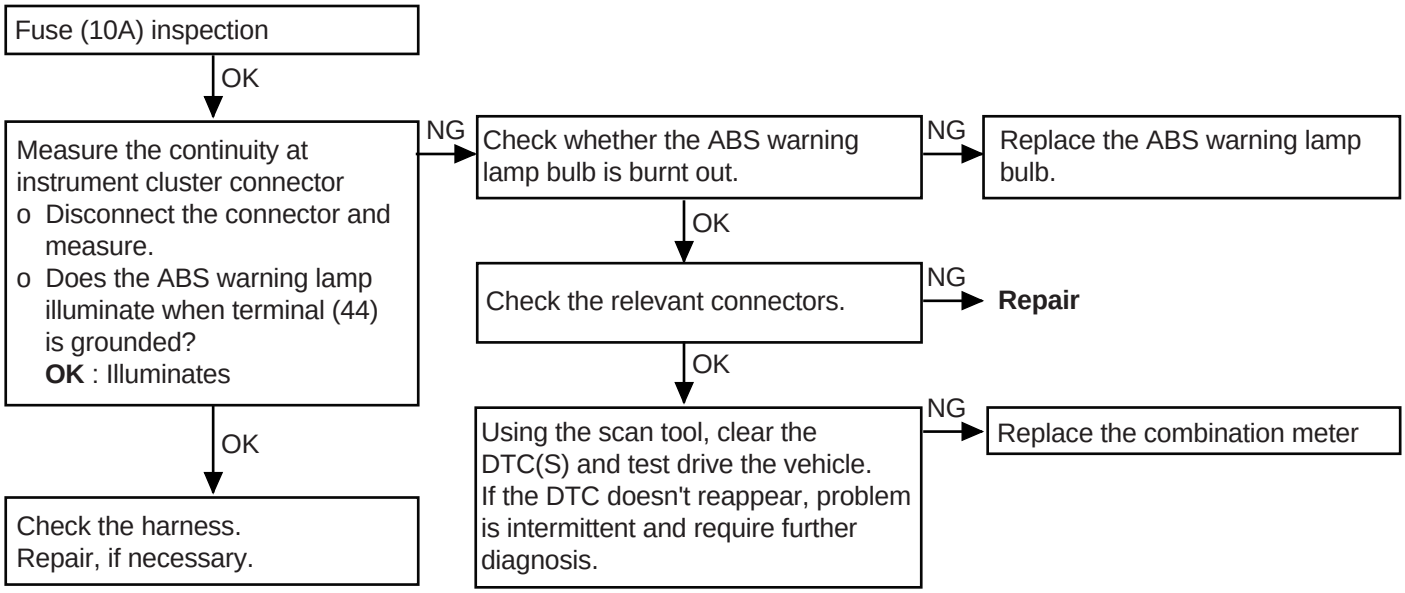


LJCD585A

INSPECTION PROCEDURE 3

When ignition key is turned "ON" (engine OFF), the ABS warning lamp does not illuminate.	Probable cause
When current flows in the HECU, the ABS relay turns from on to off as the initial check. The ABS warning lamp will illuminate when the ABS relay is off even if there is a problem with the circuit between the ABS warning lamp and the HECU. Therefore, if the lamp does not illuminate, the cause may be an open circuit in the lamp power supply circuit, a blown bulb, an open circuit in both the circuits between the ABS warning lamp and the HECU, and in the circuit between the ABS warning lamp and the ABS relay.	• Blown fuse. • Burnt out ABS warning lamp bulb. • Malfunction of wiring harness or connector.

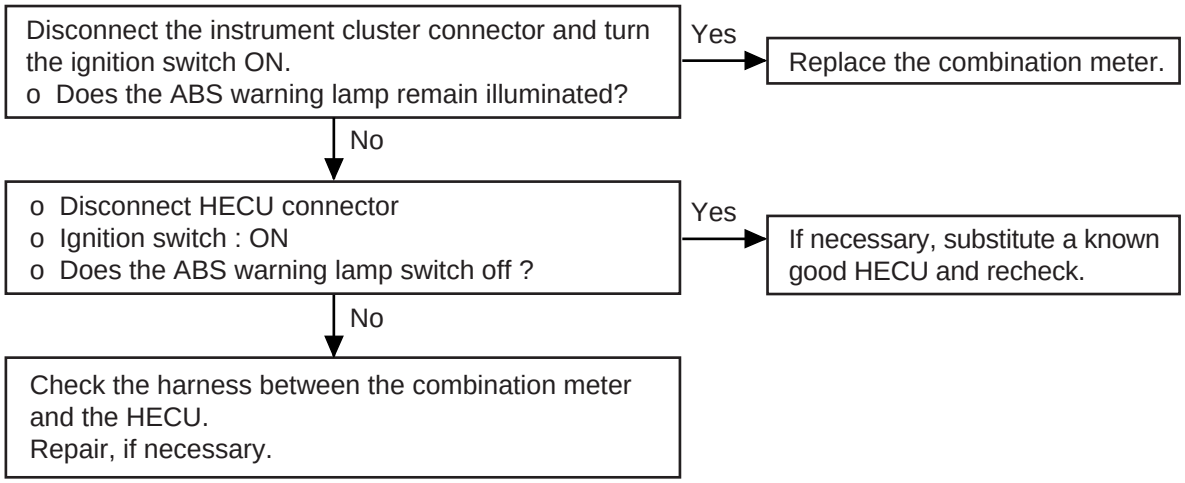


LJCD585B

INSPECTION PROCEDURE 4

Even after the engine is started, the ABS warning lamp remains illuminated.	Probable cause
A possible short-circuit in the ABS warning lamp illumination circuit	• Malfunction of combination meter. • Malfunction of HECU. • Malfunction of wiring harness.

This trouble symptom is limited to cases where communication with the Hi-Scan (Pro) is possible (HECU power supply is normal) and DTC is normal.



LJCD585C

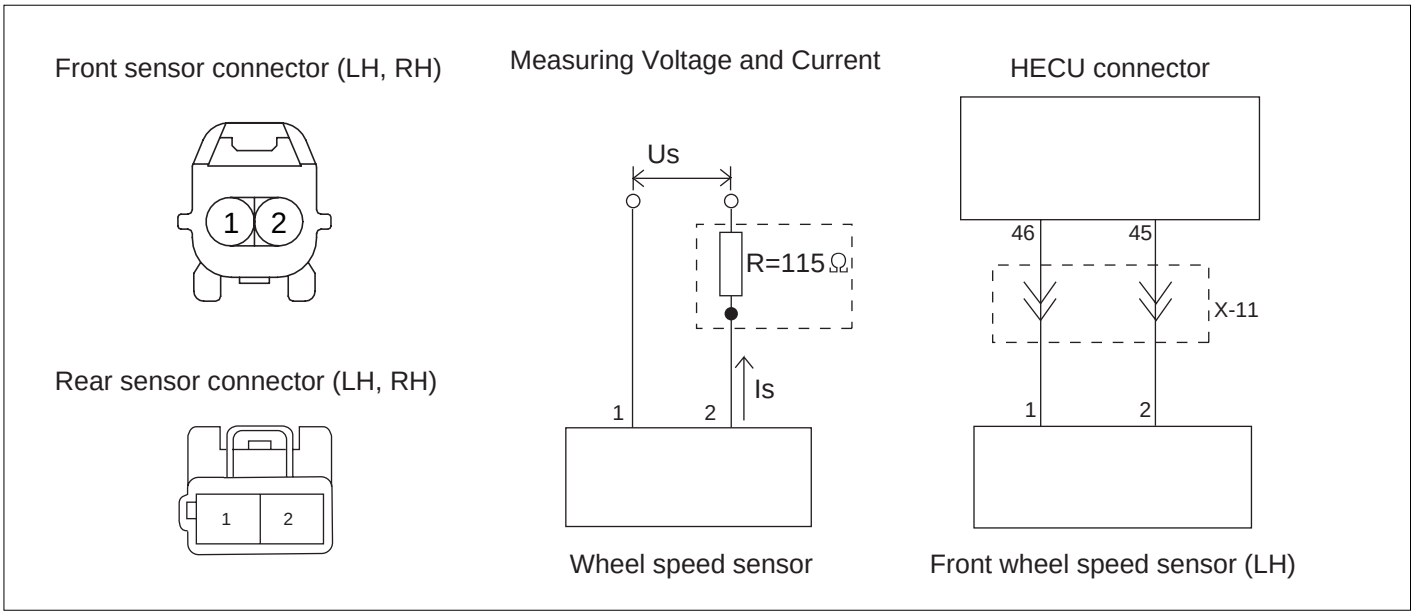
INSPECTION PROCEDURE 5

Brake operation is abnormal	Probable cause	
Brake operation varies depending on driving conditions and road surface conditions, so diagnosis can be difficult. However, if a normal DTC is displayed, carry out the following inspection.	• Improper installation of wheel speed sensor. • Incorrect sensor harness contact. • Foreign material on wheel speed sensor.	• Malfunction of wheel speed sensor. • Malfunction of rotor. • Malfunction of wheel bearing. • Malfunction of HECU.

CAUTION

- ***When measuring sensor current and operating voltage value, be sure to install resistance (R=115Ω) at active wheel sensor to prevent sensor damaging.***
- ***Be sure to remove resistance (R=115Ω) from sensor wiring harness after measuring, or ABS warning lamp will be turned ON.***

CIRCUIT DIAGRAM



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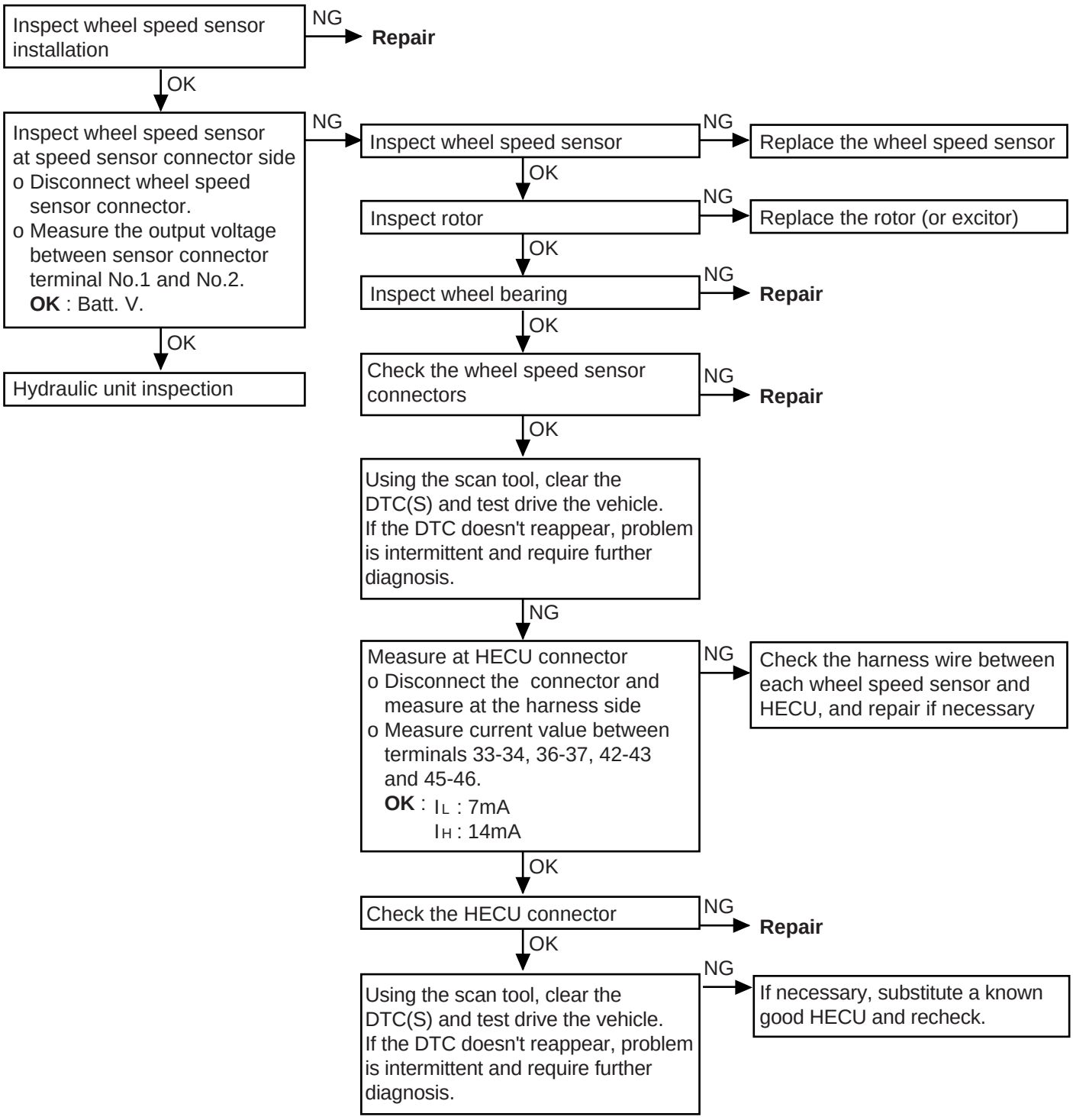


LJCD585D

ABS OPERATION INSPECTION

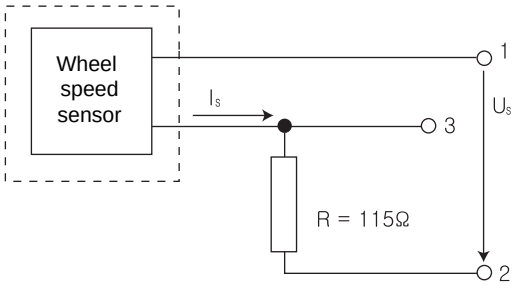
Wheel speed sensor output voltage inspection

1. Release parking brake after lifting vehicle.
2. Remove wheel speed sensor connector and measure current and voltage at the sensor side

CAUTION

When measuring sensor output voltage, be sure to install resistance (R=115Ω) at wheel speed sensor as shown in the picture to prevent sensor damaging.

3. Rotate the wheel to be measured approximately 1/2 to 1 rotation per second, and check the operating current and voltage between No.1 and No.2 using a circuit tester or an oscilloscope.

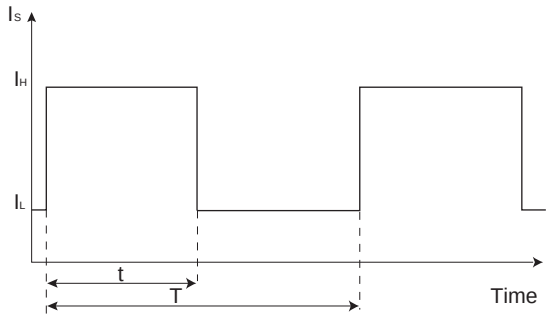


LJCD013A

OPERATING VOLTAGE

Sensor temperature [°C(°F)]	Operating Voltage	Service life
-40 to +60 (-40 to + 140)	7.5V to 20V	Unlimited
60 to +150 (140 to + 302)	7.5V to 16V	Unlimited
150 to +170°C (302 to + 338)	7.5V to 16V	10 min. total

SIGNAL CURRENT LEVEL



I_{Low} = 7mA, I_{High} = 14mA

LJCD013B

BLEEDING OF BRAKE SYSTEM

This procedure should be followed to ensure adequate bleeding of air and filling of the ABS unit, brake lines and master cylinder with brake fluid.

1. Remove the reservoir cap and fill the brake reservoir with brake fluid.

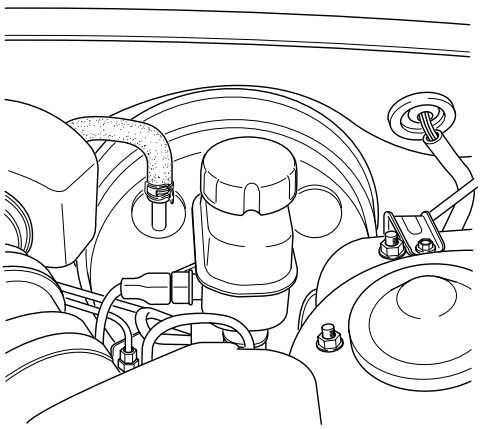
CAUTION

If there is any brake fluid on any painted surface, wash it off immediately.

NOTE

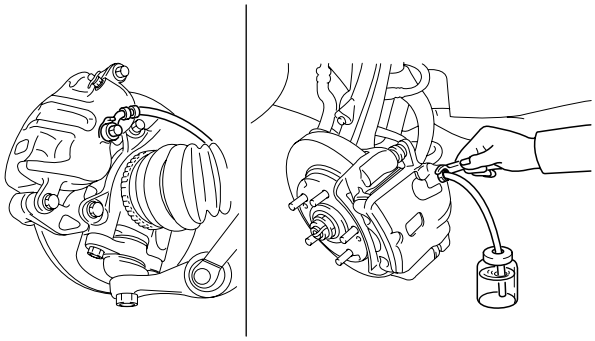
When pressure bleeding, do not depress the brake pedal.

Recommended fluid ..... DOT3 or DOT4



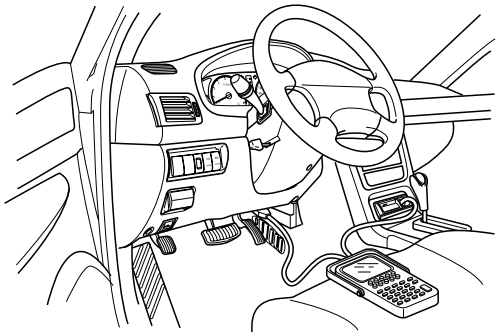
AJCD006J

2. Connect a clear plastic tube to the wheel cylinder bleeder plug and insert the other end of the tube into a half filled clear plastic bottle.



KJBC590B

3. Connect the Hi-Scan (Pro) to the Data Link Connector located underneath the dash panel.



KJBC590C

4. Select and operate according to the instructions on the Hi-Scan (Pro) screen.

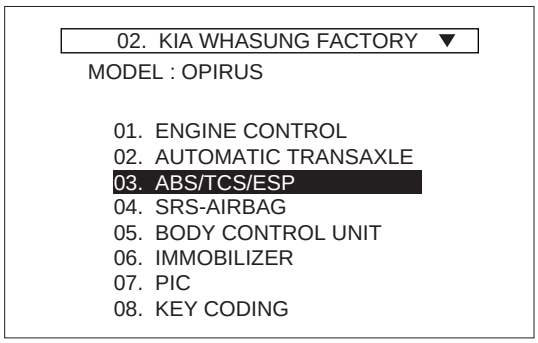
CAUTION

You must obey the maximum operating time of the ABS motor with the Hi-Scan (Pro) to prevent the motor pump from burning.

1) Select kia vehicle diagnosis.

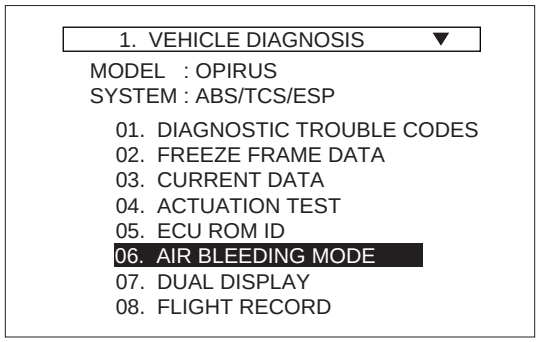
2) Select vehicle name.

3) Select Anti-Lock Brake system.



SGHBR7540L

4) Select air bleeding mode.



SGHBR7541L

5) Press 'YES' to operate motor pump and solenoid valve.

ABS AIR BLEEDING STATUS	
1. SOLENOID VALVE STATUS	CLOSE
2. MOTOR PUMP STATUS	OFF
3. AIR BLEEDING MAX. TIME	120 S
IF YOU ARE READY, PRESS [ENTER]	

LJCD003A

6) Wait 60 sec. before operating the air bleeding. (If not, you may damage the motor).

ABS AIR BLEEDING STATUS	
1. SOLENOID VALVE STATUS	OPEN
2. MOTOR PUMP STATUS	ON
3. AIR BLEEDING MAX. TIME	120 S
TIME :	

LJCD006A

1. IF BRAKE PEDAL PRESSURE IS NOT NORMAL, DO THE ABOVE AIR BLEEDING PROCEDURE SEVERAL TIMES. AFTER THEN, CHECK BARAKE PEDAL PRESSURE AGAIN.
2. PRESS [ENTER] TO START AIR BLEEDING AGAIN
3. PRESS [ESC] TO RETURN TO THE PREVIOUS MENU.

LJCD007A

5. Pump the brake pedal several times, and then loosen the bleeder screw until fluid starts to run out without bubbles. Then close the bleeder screw.
6. Repeat step 5 until there are no more bubbles in the fluid for each wheel.
7. Tighten the bleeder screw.

Bleeder screw tightening torque :
7~9 Nm (70~90 kg.cm, 5~6.6 lb-ft)

DIAGNOSTIC TROUBLE CODE CHART(DTC)

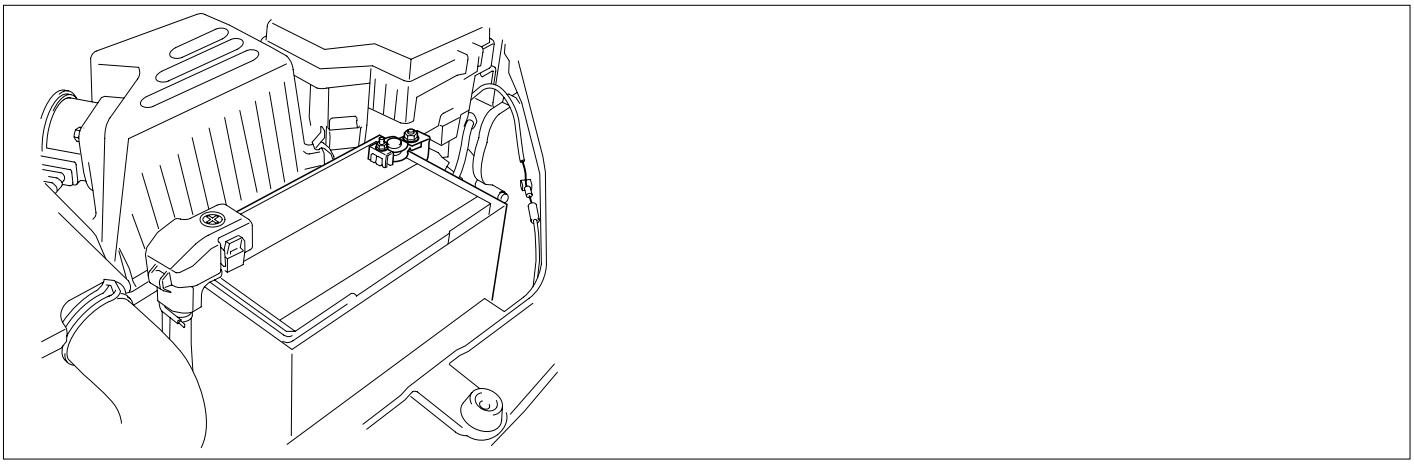
● : MIL ON ○ : MIL OFF

DTC	Trouble description		Warning lamp				See Page
			EBD	ABS	TCS	ESP	
C1101	Battery Voltage High	Steering wheel sensor failure	○	○	●	●	BR-74
		Other	●	●	●	●	
C1102	Battery Voltage Low	9.3±0.3V for 210ms	○	●	●	●	BR-79
		Steering wheel sensor failure	○	○	●	●	
		Other	●	●	●	●	
C1200	Wheel Speed Sensor Front-LH Open/Short		○/●	●	●	●	BR-85
C1201	Wheel Speed Sensor Front-LH Range / Performance / Intermittent		○/●	●	●	●	BR-92
C1202	Wheel Speed Sensor Front-LH Invalid/no Signal		○/●	●	●	●	BR-98
C1203	Wheel Speed Sensor Front-RH Open/Short		○/●	●	●	●	BR-85
C1204	Wheel Speed Sensor Front-RH Range / Performance / Intermittent		○/●	●	●	●	BR-92
C1205	Wheel Speed Sensor Front-RH Invalid/no Signal		○/●	●	●	●	BR-98
C1206	Wheel Speed Sensor Rear-LH Open/Short		○/●	●	●	●	BR-85
C1207	Wheel Speed Sensor Rear-LH Range / Performance / Intermittent		○/●	●	●	●	BR-92
C1208	Wheel Speed Sensor Rear-LH Invalid/no Signal		○/●	●	●	●	BR-98
C1209	Wheel Speed Sensor Rear-RH Open/Short		○/●	●	●	●	BR-85
C1210	Wheel Speed Sensor Rear-RH Range / Performance / Intermittent		○/●	●	●	●	BR-92
C1211	Wheel Speed Sensor Rear-RH Invalid/no Signal		○/●	●	●	●	BR-98
C1235	Primary Pressure Sensor-Electrical		○	○	●	●	BR-104
C1236	Secondary Pressure Sensor-Electrical		○	○	●	●	BR-104
C1237	Pressure Sensor-Signal		○		●	●	BR-110
C1259	Steering Angle Sensor-Electrical		○	○	●	●	BR-115
C1260	Steering Angle Sensor-Signal		○	○	●	●	BR-122

DTC	Trouble description		Warning lamp				See Page
			EBD	ABS	TCS	ESP	
C1282	Yaw Rate & Lateral G Sensor-Electrical		○	○	●	●	BR-129
C1283	Yaw Rate & Lateral G Sensor-Signal		○	○	●	●	BR-139
C1503	TCS/ESP Switch Error		○	○	○	○	BR-144
C1513	Brake Switch Error		○	○	○	○	BR-148
C1604	ECU Hardware Error	EEPROM fail	○	●	●	●	BR-153
		Sensor Supply Voltage Failure, CAN 1 or 2 Failure, ESP operation over 15sec.	○	○	●	●	
		Temperature sensor malfunction	○	○	○	○	
		Other	●	●	●	●	
C1611	CAN Time-out ECM		○	○	●	●	BR-156
C1612	CAN Time-out TCM		○	○	●	●	BR-159
C1616	CAN Bus off		○	○	●	●	BR-162
C1700	Byte Coding Error		○	●	●	●	BR-169
C2112	Valve Relay Error		●	●	●	●	BR-172
C2227	Excessive Temperature Of Brake Disc		○	○	●	●	BR-176
C2402	Motor Electrical		○	●	●	●	BR-178

DTC C1101 BATTERY VOLTAGE HIGH

COMPONENT LOCATION EAE16BD8



SBLBR6514D

GENERAL DESCRIPTION E61464CF

The ABS ECU(Electronic Control Unit) checks the battery voltage and generator output voltage to determine, as a safety issue, whether the ABS system can operate normally or not.
The normal battery voltage range is essential for controlling the ABS system as intended.

DTC DESCRIPTION EAD0442F

The HECU monitors battery voltage by reading the value of voltage.
When the voltage is higher than the expected normal value, this code is set, and the ABS/EBD/TCS/ESP functions are prohibited.
If the voltage recovers, to within normal operating range, then the controller returns to normal operation as well.

DTC DETECTING CONDITION EBE3ECC9

Item		Detecting Condition	Possible cause
DTC Strategy		• Operating Voltage Monitoring	• Poor connection in power supply circuit (ABS) • Faulty Generator • Faulty HECU
Monitoring Period		• Once per loop	
Case 1 (Over voltage)	Enable Conditions	• When Vign＞18.0V±1.0V is continued for 1 loop(7ms).	
	Fail Safe	• The ABS/EBD/TCS/ESP functions are deactivated. - The functions will remain deactivated for 50 loops(350ms) or until the end of control cycle respectively, if high voltage was detected during an active control cycle. • The ABS/EBD/TCS/ESP warning lamps are activated. - The warning lamps will be turned off if the control functions are available again.	
Case 2 (Power-Supply-Short-Term-Defect)	Enable Conditions	• Difference between measured steering-angle and expected-steering angle exceeds 6 degree. • Too high velocity of steering-angle is measured. • Expecting-steering-angle is made while power-supply state is out of range.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA E1C7CE2C

1. Connect scantool to Data Link Connector(DLC)
2. Engine "ON".
3. Monitor the "BATTERY VOLTAGE" parameter on the scantool.

Specification : Below. 18 ± 1.0V

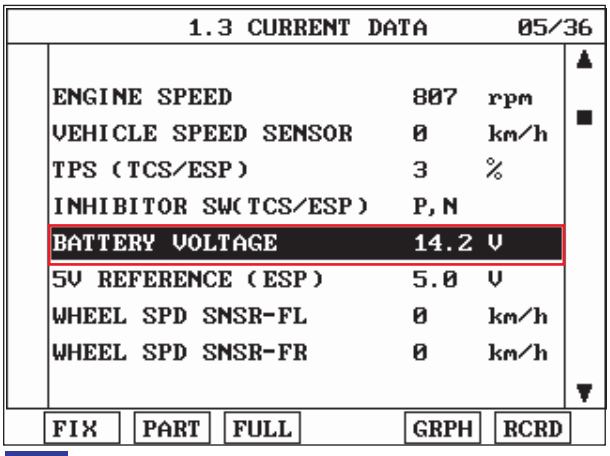


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "ON".
Normal Data

SGHBR7521L

4. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by poor connection in power harness (IGN+) and/or HECU's connector or was re-paired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "W/Harness Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION EBBBEA4E

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

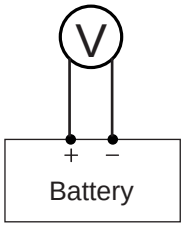
NO

▶ Verify presence of battery voltage codes in other ECUs (SRS, etc).
▶ If battery voltage codes are not present in other ECUs, go to "Power Circuit Inspection" procedure.
▶ If battery voltage codes are present in other ECUs, go to "Generator Output Voltage Inspection" procedure.

GENERATOR OUTPUT VOLTAGE INSPECTION E9619AA3

1. Engine "ON".
2. Measure voltage between the battery terminal(+) and the battery terminal(-) with maintaining ENG RPM 2,500RPM over 2 minutes.

Specification : Below. 18 ± 1.0V



1. Battery Terminal (+)
2. Battery Terminal (-)

SGHBR7519N

3. Is the measured voltage within specifications?

YES

▶ Go to "Power Circuit Inspection" procedure.

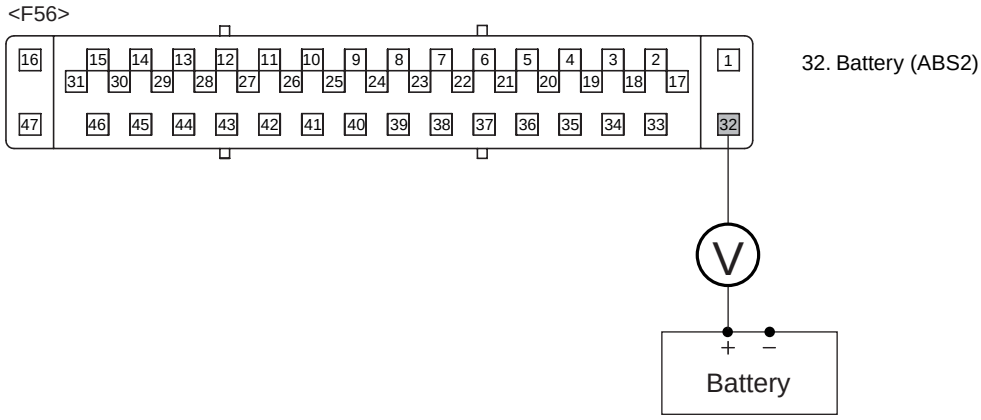
NO

▶ Check that the tension of drive belt, ENG RPM, fuse, terminal of battery, all terminals of generator are in good condition and Check for damaged harness and poor connection between generator and battery. If OK repair or replace generator and then go to "Verification Of Vehicle Repair" procedure.

POWER CIRCUIT INSPECTION EE7ABE93

1. Engine "ON".
2. Measure voltage between the battery terminal(+) and terminal "32" of the HECU harness connector.

Specification : Approx. below 0.2V



SGHBR7520N

3. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

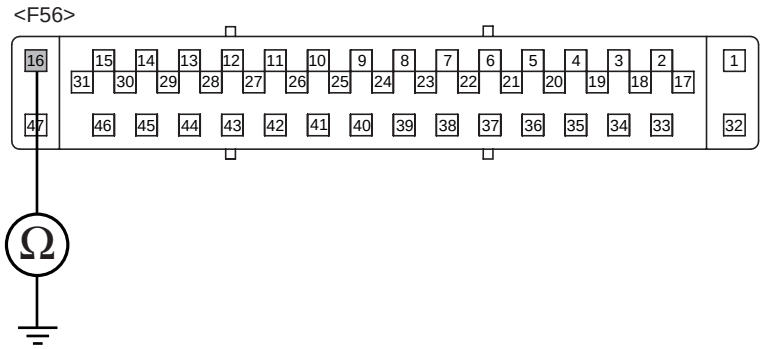
NO

▶ Check for damaged harness and poor connection between the battery terminal(+) and terminal "32" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION EF681F72

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "16" of the HECU harness connector and chassis ground.

Specification : Approx. below 1Ω



16. GROUND

SGHBR7521N

4. Is the measured resistance within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for damaged harness and poor connection between terminal "16" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E1C5EBC9

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

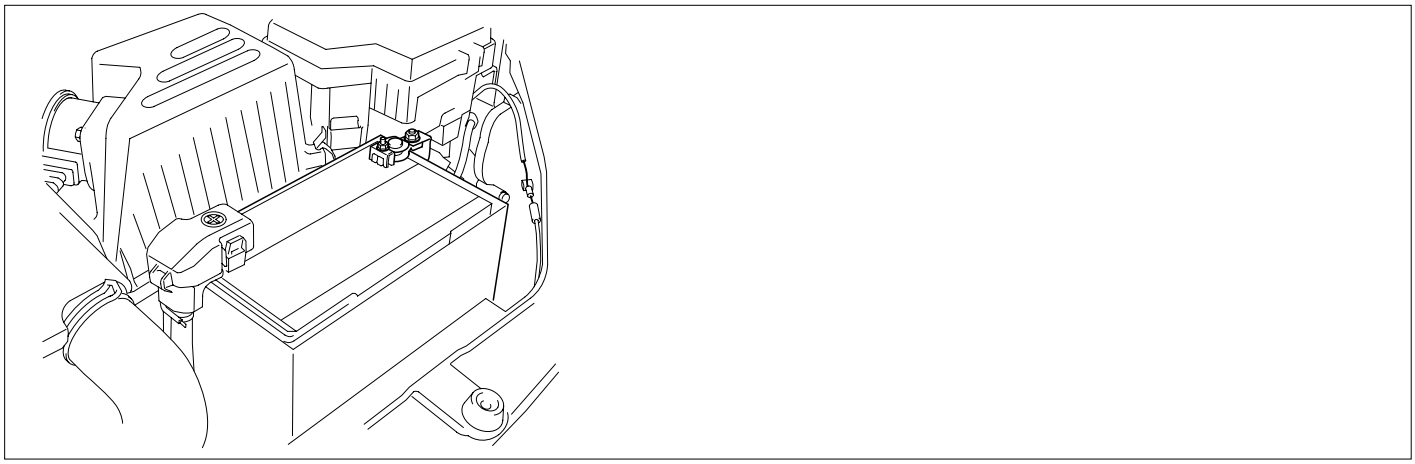
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1102 BATTERY VOLTAGE LOW

COMPONENT LOCATION EEFEE7D8



SBLBR6514D

GENERAL DESCRIPTION EB5FB407

The ABS ECU(Electronic Control Unit) checks the battery voltage and generator output voltage to determine, as a safety issue, whether the ABS system can operate normally or not.
The normal battery voltage range is essential for controlling the ABS system as intended.

DTC DESCRIPTION E9AFCA0F

The HECU monitors the battery voltage by reading the value of voltage.
When the voltage is lower than the expected normal value, this code is set.
The ABS/TCS/ESP functions are prohibited and the EBD function is allowed on LOW VOLTAGE CONDITION, the ABS/EBD/TCS/ESP function are prohibited on UNDER VOLTAGE CONDITION.
If the voltage recovers, to within normal operating ranges, then the controller returns to normal operations as well.

DTC DETECTING CONDITION EC939FF2

Item		Detecting Condition	Possible cause
DTC Strategy		• Operating Voltage Monitoring	• Poor connection in power supply circuit (ABS) • Faulty HECU
Monitoring Period		• Once per loop	
Case 1 (Low voltage)	Enable Conditions	• When Vign＜9.7V±0.3V is continued for 30 loops (210ms).	
	Fail Safe	• The ABS/TCS/ESP functions are deactivated. - The functions will remain deactivated up to 66 loops (462ms) or until the end of control cycle respectively, if low voltage was detected during an active control cycle. • The ABS/TCS/ESP warning lamps are activated. - The warning lamps activation will be delayed for 10s during vehicle standstill (vehicle and maximum wheel speed ＜20 kph). The warning lamps will be turned off if the control functions are available again.	
Case 2 (Under voltage)	Enable Conditions	• When Vign＜8.0V±0.5V is continued for 1 loop (7ms). - The under voltage information will only be stored if Vmax ＞ 20 kph	
	Fail Safe	• The ABS/EBD/TCS/ESP functions are deactivated. - The functions will remain deactivated up to 32 loops (224ms) after the operating voltage range has been reached. • The ABS/EBD/TCS/ESP warning lamps are activated. - The warning lamps activation will be delayed for 10s during vehicle standstill (vehicle and maximum wheel speed ＜ 20 kph). The warning lamps will be turned off if the control functions are available again.	

MONITOR SCANTOOL DATA E6C7BF54

1. Connect scantool to Data Link Connector(DLC)
2. Engine "ON".
3. Monitor the "BATTERY VOLTAGE" parameter on the scantool.

Specification : Above. 9.7± 0.3V

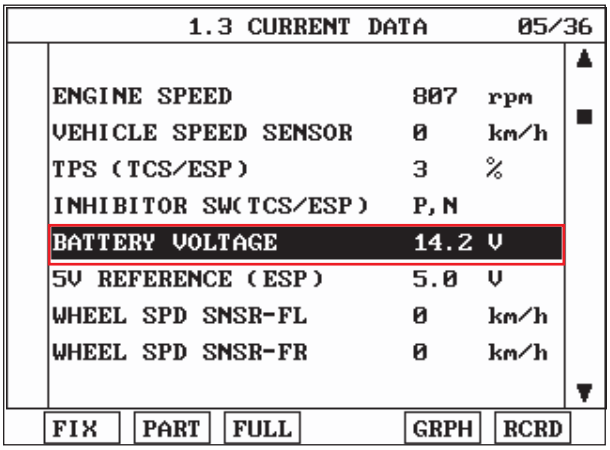


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "ON".
Normal Data

SGHBR7521L

4. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by poor connection in power harness (IGN+) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "W/Harness Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION EB15E535

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

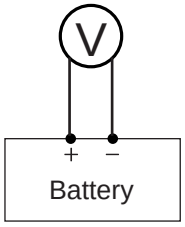
NO

▶ Go to "Alternator Output Voltage Inspection" procedure.

ALTERNATOR OUTPUT VOLTAGE INSPECTION E1ED41D5

1. Engine "ON".
2. Measure voltage between the battery terminal(+) and the battery terminal(-) with maintaining ENG RPM 2,500RPM over 2 minutes.

Specification : Above. 9.7± 0.3V



1. Battery Terminal (+)
2. Battery Terminal (-)

SGHBR7519N

3. Is the measured voltage within specifications?

YES

▶ Go to "Power Circuit Inspection" procedure.

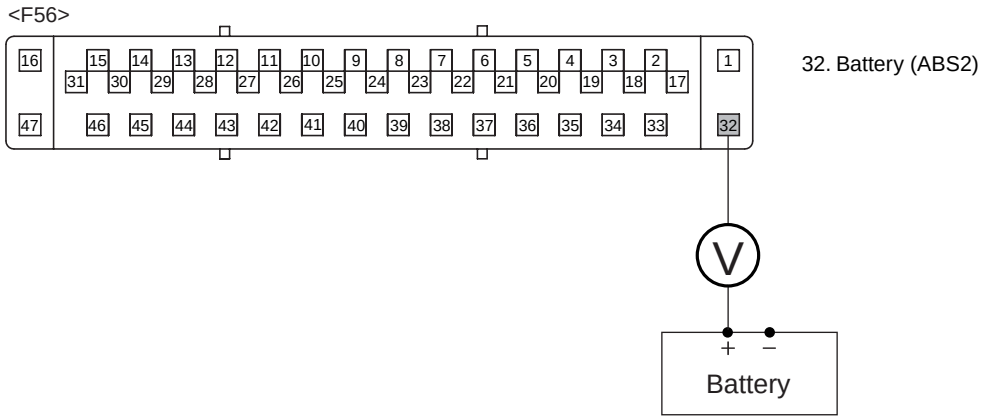
NO

▶ Check that the tension of drive belt, ENG RPM, fuse, terminal of battery, all terminals of generator are in good condition and Check for damaged harness and poor connection between generator and battery. If OK repair or replace generator and then go to "Verification Of Vehicle Repair" procedure.

POWER CIRCUIT INSPECTION EF78FB65

1. Ignition "OFF"
2. Disconnect HECU connector.
3. Ignition "ON" & Engine "OFF".
4. Measure voltage between terminal "32" of the HECU harness connector and chassis ground.

Specification : Approx. B+



SGHBR7520N

5. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

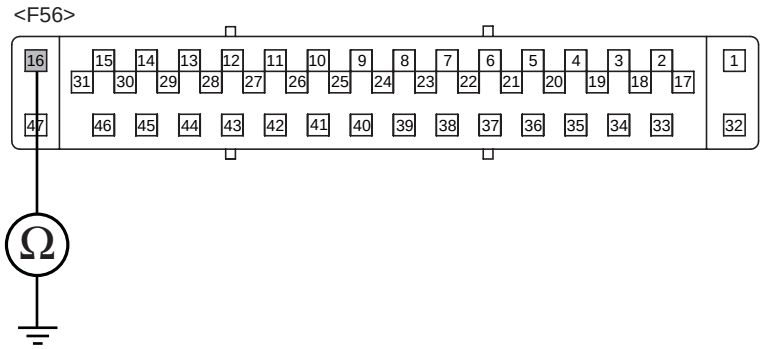
NO

▶ Check for damaged harness and poor connection between the battery terminal(+) and terminal "32" of the HECU harness connector. Check for open or blown 30A ABS2 fuse referring to "Circuit Diagram". Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION E0EF58DA

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "16" of the HECU harness connector and chassis ground.

Specification : Approx. below 1Ω



16. GROUND

SGHBR7521N

4. Is the measured resistance within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for damaged harness and poor connection between terminal "16" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR EE8ACFF3

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

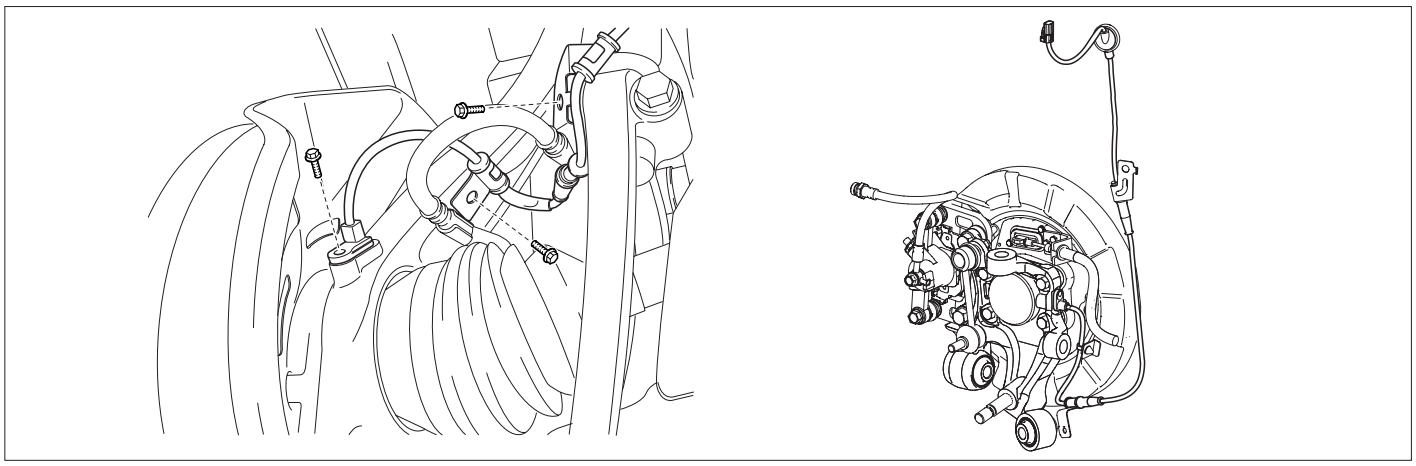
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1200 WHEEL SPEED SENSOR FRONT-LH OPEN/SHORT
DTC C1203 WHEEL SPEED SENSOR FRONT-RH OPEN/SHORT
DTC C1206 WHEEL SPEED SENSOR REAR-LH OPEN/SHORT
DTC C1209 WHEEL SPEED SENSOR REAR-RH OPEN/SHORT

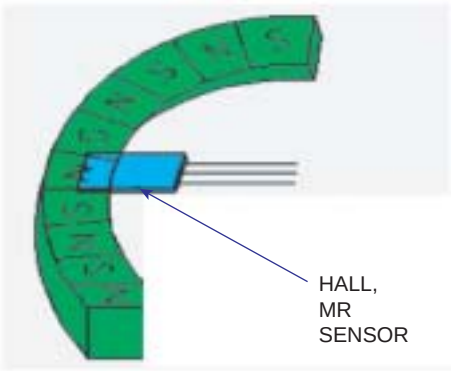
COMPONENT LOCATION EE171FED



SGHBR6507D

GENERAL DESCRIPTION EAFC6E3B

The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs.
For example, rear wheel speed signal is used as a referecnce value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed.
Wheel speed sensor is active hall-sensor type.



SGHBR6508D

DTC DESCRIPTION EBBCA991

The ABS ECU monitors the wheel speed sensor circuit continuously. Each wheel speed sensor is checked separately. A failure is detected if the measured sensor signal current is continuously out of the specified range for the specified min. fault duration.
Warning lamp is turned OFF unless additional faults are detected when the IG KEY is turned ON again, and wheel speed is more than 10 km/h. (6.2mph)

DTC DETECTING CONDITION EBA20989

Item	Detecting Condition	Possible cause
DTC Strategy	• Sensor Signal Current Monitoring	• Open or short of Wheel speed sensor circuit(FL, FR, RL, RR) • Faulty Wheel speed sensor(FL, FR, RL, RR) • Faulty HECU
Monitoring Period	• Continuously (once per loop) if supply voltage is not below 8.0±0.5V.	
Enable Conditions	• A failure is detected if the measured sensor signal current is continuously out of the specified range of about 4.5mA ±10% < Sensor Signal Current < 20mA ±10% for 19 loops(133ms).	
Fail Safe	• Sensor failure when ABS is inactive 1) Single wheel speed sensor failure The ABS/TCS/ESP functions are deactivated. The ABS/TCS/ESP warning lamps are activated and the EBD warning lamp is not activated. 2) Multiple wheel speed sensor failure The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated. • Sensor failure during active ABS control 1) One front wheel speed sensor failure Deactivate ABS on affected wheel. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 2) One rear wheel speed sensor failure Reduce brake pressure on rear axle. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 3) Multiple wheel speed sensor failure The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA EB19E0B7

1. Engine "ON".
2. Connect scantool to Data Link Connector(DLC).
3. Start and drive vehicle in gear and maintain vehicle speed at or above 10km/h. (6.2mph)
4. Monitor the "WHEEL SPD SNSOR(FL, FR, RL, RR)" parameter on the Scantool.

Specification : Compare with other parameters related to wheel speed sensor.
If it is the same as other parameters, it is in normal condition.

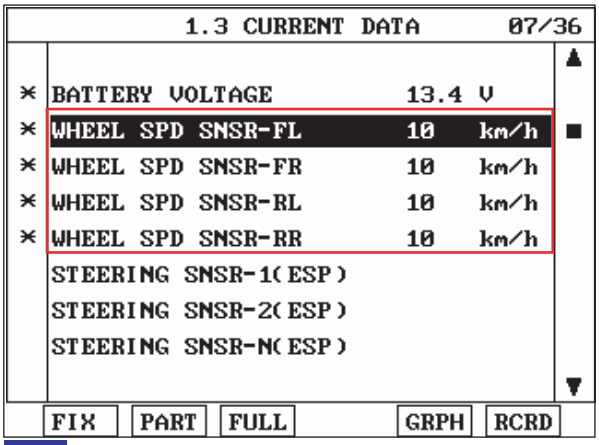


Fig1

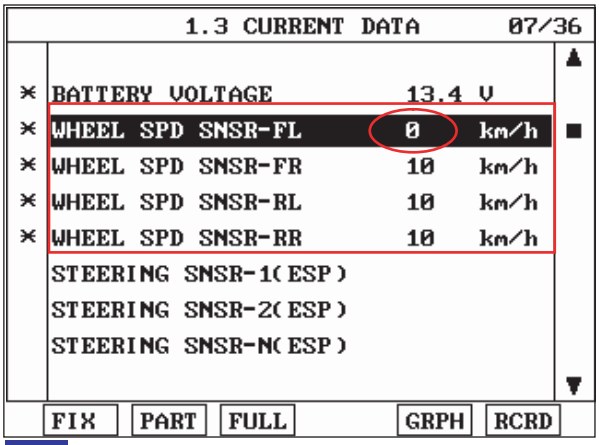


Fig2

Fig 1) Test Condition : Drive vehicle at a speed of 10km/h or more. (6.2mph or more) Normal Data
Fig 2) Test Condition : Drive vehicle at a speed of 10km/h or more. (6.2mph or more) Abnormal Data (Open)

SGHBR7522L

5. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by poor connection in wheel speed sensor harness (FL, FR, RL, RR) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "W/Harness Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION E6C0ACEE

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.

2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.

3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification of Vehicle Repair" procedure.

NO

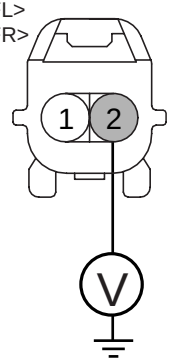
▶ Go to "Power Circuit Inspection" procedure.

POWER CIRCUIT INSPECTION EA1CE01E

1. Ignition "ON".
2. Measure voltage between terminal "2" of the wheel speed sensor(FL, FR, RL, RR) harness connector and chassis ground.

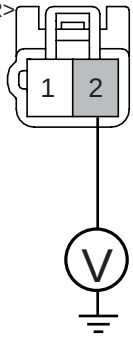
Specification : Approx. B+

<E08-FL>
<E60-FR>



1. Wheel speed sensor(FL-, FR-)
2. Wheel speed sensor(FL+, FR+)

<F27-RL>
<F69-RR>



1. Wheel speed sensor(RL-, RR-)
2. Wheel speed sensor(RL+, RR+)

SGHBR7524N

3. Is the measured voltage within specifications?

YES

▶ Go to "Signal Circuit Inspection" procedure.

NO

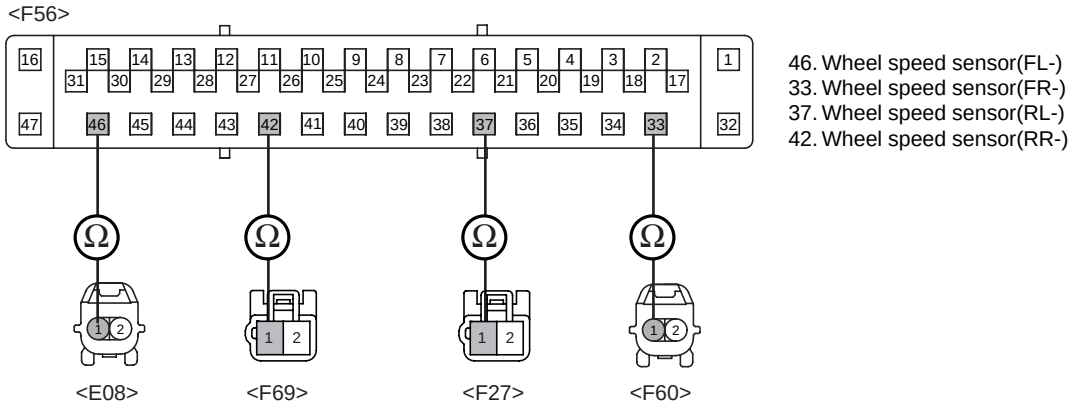
▶ Check for open or short to GND in wheel speed sensor harness(FL, FR, RL, RRL) between terminal "2" of the wheel speed sensor(FL, FR, RL, RR) harness connector and terminal (45, 34, 36, 43) of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

DTC	LOCATION	HECU harness connector terminal	
		ABS	ESP
DTC C1200	Front Left	45	45
DTC C1203	Front Right	34	34
DTC C1206	Rear Left	36	36
DTC C1206	Rear Right	43	43

SIGNAL CIRCUIT INSPECTION EE7AC7A9

1. Ignition "OFF".
2. Disconnect wheel speed sensor(FL, FR, RL, RR) and HECU connector.
3. Measure resistance between terminal (Refer to below table) of the HECU harness connector and terminal "1" of the wheel speed sensor(FL, FR, RL, RR) harness connector .

Specification : Approx. 0Ω



SGHBR7525N

DTC	LOCATION	HECU harness connector terminal	
		ABS	ESP
DTC C1200	Front Left	46	46
DTC C1203	Front Right	33	33
DTC C1206	Rear Left	37	37
DTC C1206	Rear Right	42	42

4. Is the measured resistance within specifications?

YES

▶ Check for short wheel speed sensor harness(FL-, FR-, RL-, RR-) between terminal "1" of the wheel speed sensor(FL, FR, RL, RR) harness connector and terminal (46, 33, 37, 42) of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.
▶ If OK, go to "Component Inspection" procedure.

NO

▶ Check for open wheel speed sensor harness(FL-, FR-, RL-, RR-) between terminal "1" of the wheel speed sensor(FL, FR, RL, RR) harness connector and terminal (46, 33, 37, 42) of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

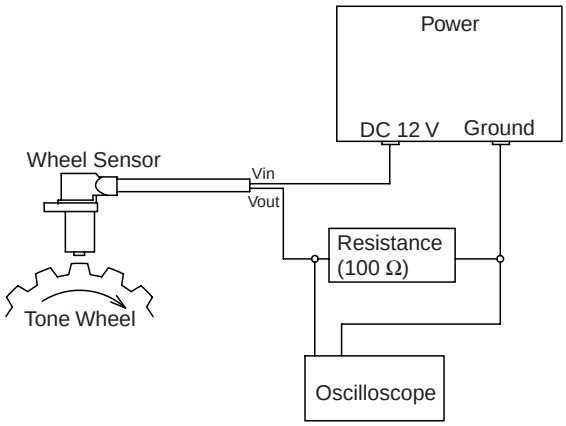
COMPONENT INSPECTION ECEC92AF

1. Ignition "OFF".
2. Disconnect the wheel speed sensor harness connector.
3. Connect resistance (approx. 100Ω) to the wheel speed sensor signal circuit.
4. Measure waveform of the wheel speed sensor signal harness while turnning the wheel.

Specification : High : Approx. 1.4V , Low : Approx. 0.7V (In case that 100Ω resistance is used)

NOTE

Voltage of the waveform can be calculated by using following expression.
Voltage = Resistance × Current (High : 1.4mA, Low : 0.7mA)



SGHBR7526N

5. Is the measured waveform within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

1) Check for improper installation of wheel speed sensor. If NG, repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
2) Check for damage of rotor teeth or wheel bearing. If NG, repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
3) Substitute with a known-good Wheel speed sensor and check for proper operation. If problem is corrected, replace Wheel speed sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E0356CBD

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed at or above 10km/h. (6.2mph))
4. Are any DTCs present ?

YES

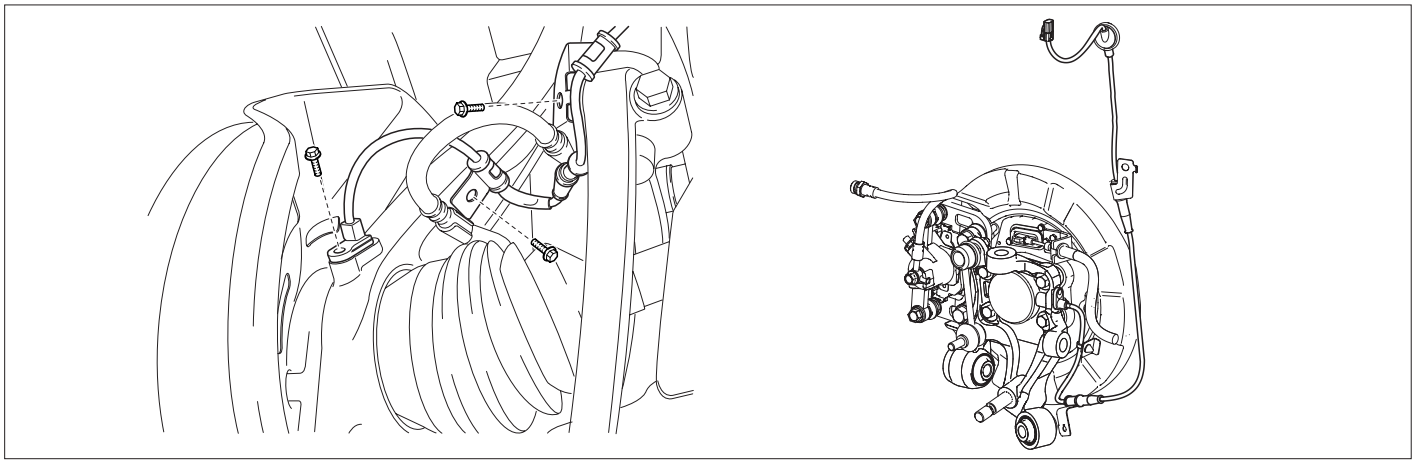
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1201 WHEEL SPEED SENSOR FRONT-LH RANGE / PERFORMANCE / INTERMITTENT
DTC C1204 WHEEL SPEED SENSOR FRONT-RH RANGE / PERFORMANCE / INTERMITTENT
DTC C1207 WHEEL SPEED SENSOR REAR-LH RANGE / PERFORMANCE / INTERMITTENT
DTC C1210 WHEEL SPEED SENSOR REAR-RH RANGE / PERFORMANCE / INTERMITTENT

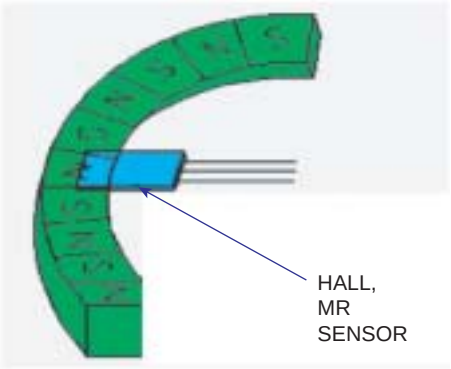
COMPONENT LOCATION E57D5A1D



SGHBR6507D

GENERAL DESCRIPTION E220B22D

The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs.
For example, rear wheel speed signal is used as a referecnce value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed.
Wheel speed sensor is active hall-sensor type.



SGHBR6508D

DTC DESCRIPTION EEA94EAC

The ABS ECU monitors the wheel speed sensor signal continuously.
The failure detection is started if the original wheel speed changes erratically with a signal step of |Vx(n) - Vx(n-1)| > 25 km/h (15.5mph). An offset of about 5 km/h (3.1mph) will be added to the threshold in case rough road is detected or the number of interrupts from the wheel speed sensor reach a value of 40 per loop. An extrapolated wheel speed signal will be calculated, the start value is set to the vehicle reference speed.
Further on, the extrapolated wheel speed signal follows the calculated speed signal with a limited gradient of max 0.57kph (0.4mph) per loop.
Warning lamp is turned OFF unless additional faults are detected when the IG KEY is turned ON again, and wheel speed is more than 10 km/h (6.2mph).

DTC DETECTING CONDITION EFBEB0DB

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Signal Monitoring	• Improper installation of wheel speed sensor • Abnormal Rotor and wheel bearing • Faulty Wheel speed sensor(FL, FR, RL, RR) • Faulty HECU
	Monitoring Period	• Once per loop (started after a settling time of 3.0s after power-on reset)	
	Enable Conditions	• A failure is detected after 22 loops if 1. The original wheel speed does not reach the extrapolated speed or the reference speed (Vref), 2. The number of interrupts from the wheel speed sensor are continuously >= 40 per loop. ※ If the original wheel speed changes erratically. **NOTE** *No failure will be stored at a vehicle speed < 20 kph (12.4mph). the extrapolated speed will be calculated to check the original wheel speed.The low voltage information will be stored instead of the wheel speed sensor failure when the failure is detected and the power supply voltage is below 8.0±0.5V.*	

Item		Detecting Condition	Possible cause
	Fail Safe	• Sensor failure when ABS is inactive 1) Single wheel speed sensor failure : The ABS/TCS/ESP functions are deactivated. The ABS/TCS/ESP warning lamps are activated and the EBD warning lamp is not activated. 2) Multiple wheel speed sensor failure : The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated. 3) If the vehicle speed is below 20kph : Deactivate all control functions at the corresponding wheel if the failure occurs at a front wheel. Deactivate all control functions at all wheels if the failure occurs at a rear wheel. • Sensor failure during active ABS control 1) One front wheel speed sensor failure : Deactivate ABS on affected wheel. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 2) One rear wheel speed sensor failure : Reduce brake pressure on rear axle. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 3) Multiple wheel speed sensor failure : The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated.	

Item		Detecting Condition	Possible cause
Case 2	DTC Strategy	• Signal Monitoring	
	Monitoring Period	• Continuously (once per loop), but not checked if the wheel speed ＜20 kph or supply voltage is below 8.0±0.5V.	
	Enable Conditions	• A failure is detected after 15 confirmations has been counted. ※ Confirmations starts if the comparison between the number of detected and the number of expected pulses shows at least one missing pulse. A confirmation counter will be incremented if the erroneous speed signal characteristic is detected.	
	Fail Safe	• Sensor failure when ABS is inactive 1) Single wheel speed sensor failure The ABS/TCS/ESP functions are deactivated. The ABS/TCS/ESP warning lamps are activated and the EBD warning lamp is not activated. 2) Multiple wheel speed sensor failure The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated. • Sensor failure during active ABS control 1) One front wheel speed sensor failure Deactivate ABS on affected wheel. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 2) One rear wheel speed sensor failure Reduce brake pressure on rear axle. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 3) Multiple wheel speed sensor failure The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA E8E2AFF9

1. Engine "ON".
2. Connect scantool to Data Link Connector(DLC).
3. Start and drive vehicle in gear and maintain vehicle speed at or above 20km/h. (12.4mph)
4. Monitor the "WHEEL SPD SNSOR(FL, FR, RL, RR)" parameter on the Scantool.

Specification : Compare with other parameters related to wheel speed sensor.
If it is the same as other parameters, it is in normal condition.

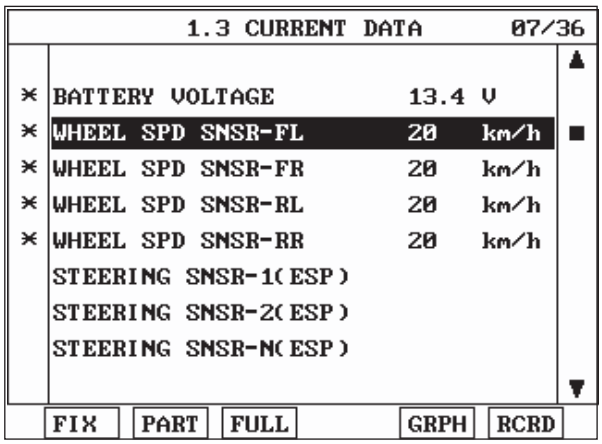


Fig1

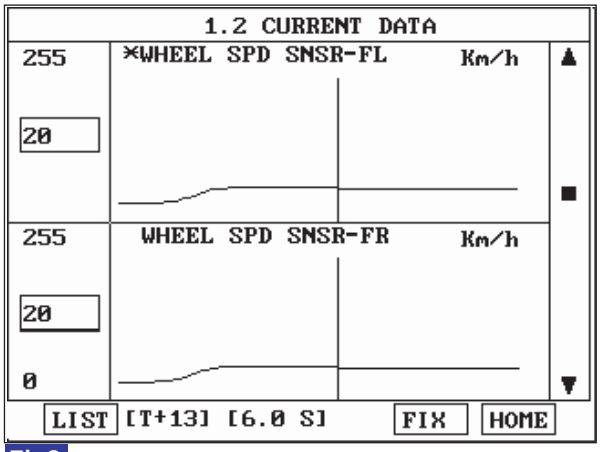


Fig2

Fig 1) Test Condition : Drive vehicle at a speed of 20km/h or more. (12.4mph or more) Normal Data
Fig 2) Test Condition : Drive vehicle at a speed of 20km/h or more. (12.4mph or more) Normal Graph

SGHBR7523L

5. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by poor connection in wheel speed sensor harness (FL, FR, RL, RR) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Component Inspection" procedure.

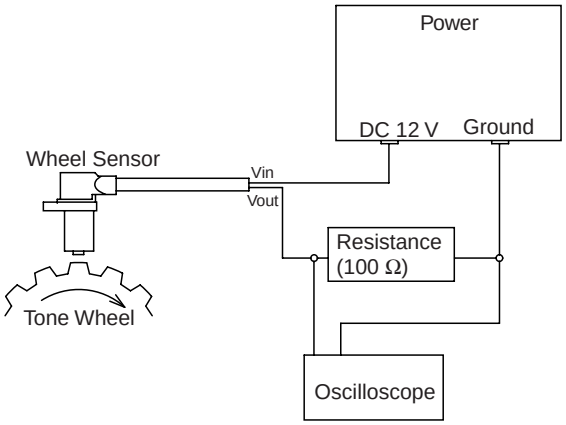
COMPONENT INSPECTION E6DC2E5D

1. Ignition "OFF".
2. Disconnect the wheel speed sensor harness connector.
3. Connect resistance (approx. 100Ω) to the wheel speed sensor signal circuit.
4. Measure waveform of the wheel speed sensor signal harness while turnning the wheel.

Specification :
High : Approx. 1.4V
Low : Approx. 0.7V (In case that 100Ω resistance is used)

NOTE

Voltage of the waveform can be calculated by using following expression.
Voltage = Resistance × Current (High : 1.4mA, Low : 0.7mA)



SGHBR7526N

5. Is the measured waveform within specifications and no missing signal?

YES

▶ Fault is intermittent caused by poor connection in wheel speed sensor harness (FL, FR, RL, RR) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
▶ If OK, Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for improper installation of wheel speed sensor. If NG, repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Check for damage of rotor teeth or wheel bearing. If NG, repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Substitute with a known-good Wheel speed sensor and check for proper operation. If problem is corrected, replace Wheel speed sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR ED87B3D8

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed at or above 20kmh. (12.4mph))
4. Are any DTCs present ?

YES

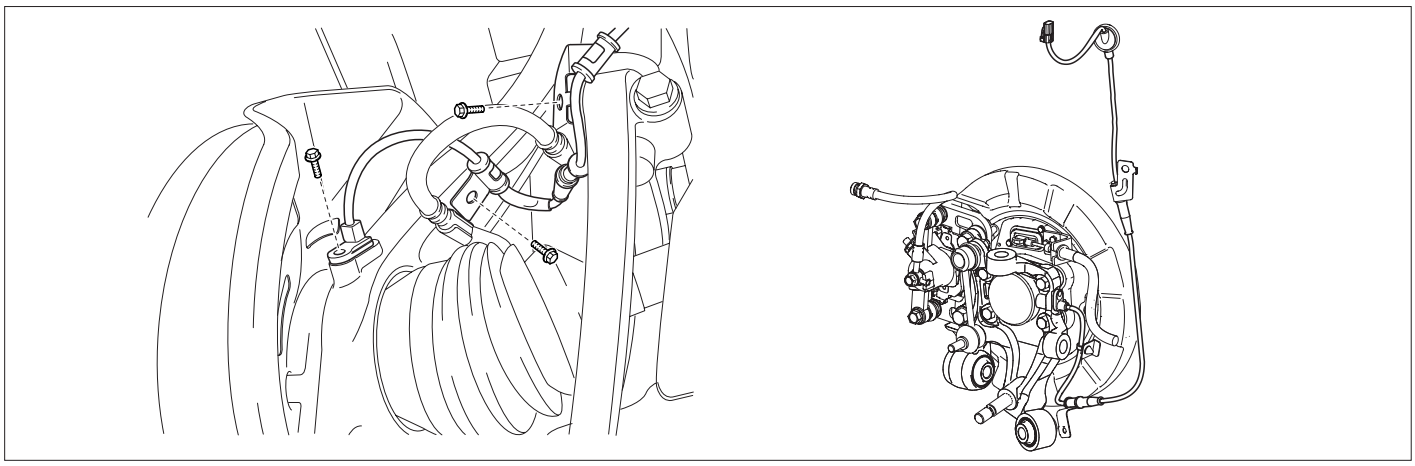
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1202 WHEEL SPEED SENSOR FRONT-LH INVALID/NO SIGNAL
DTC C1205 WHEEL SPEED SENSOR FRONT-RH INVALID/NO SIGNAL
DTC C1208 WHEEL SPEED SENSOR REAR-LH INVALID/NO SIGNAL
DTC C1211 WHEEL SPEED SENSOR REAR-RH INVALID/NO SIGNAL

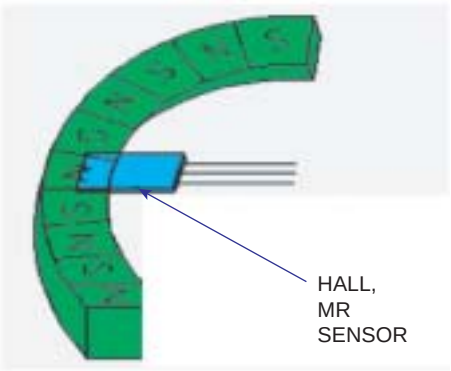
COMPONENT LOCATION E4565601



SGHBR6507D

GENERAL DESCRIPTION EEE70EBC

The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs.
For example, rear wheel speed signal is used as a referecnce value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed.
Wheel speed sensor is active hall-sensor type.



SGHBR6508D

DTC DESCRIPTION E61523C6

The ABS ECU monitors the wheel speed sensor signal continuously.
This code is set when wheel speed sensor signal is missing, continuously indicates a too low wheel speed or when the ABS control cycle is continued abnormally.
Warning lamp is turned OFF unless additional faults are detected when the IG KEY is turned ON again, and wheel speed is more than 10 km/h (6.2mph).

DTC DETECTING CONDITION E1EA1B4E

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Signal Comparison Monitoring	• Improper installation of wheel speed sensor • Abnormal Rotor and wheel bearing • Faulty Wheel speed sensor(FL, FR, RL, RR) • Faulty HECU
	Monitoring Period	• Continuously (once per loop), but not checked during diagnostics mode.	
	Enable Conditions	• Vehicle Speed > = 10 km/h (6.2mph) (Drive-Off Detection) A failure is detected at all wheel speed sensors with a speed of lower than 2 km/h if the speed of the fastest wheel (Vamx) is continuously above 10 km/h longer than 180 s. - The monitoring function is always started if Vmax drops below 10 km/h or if Vmin reaches 2 km/h (1.2mph) . • Vehicle Speed > = 15 km/h (9.3mph) (Drive-Off Detection) A failure is detected at all wheel speed sensors with a speed of lower than 6 in case of the following condition. 1. Immediately if the speed of a non-driven wheel reaches 15km/h. 2. Immediately if the speed of a fastest wheel(Vmax) reaches 15km/h without detected overspinning. 3. The speed of a fastest wheel(Vmax) is continuously above 15km/h with overspinning detected by deceleration phaes. 4. The speed of a fastest wheel(Vmax) is continuously above 15km/h with detected overspinning. - The monitoring function is always started if Vmax drops below 7 km/h (4.3mph) and Vref drops below 6 km/h (3.7mph) , and it is stopped if Vref reaches 6 km/h. The entry of the monitoring function may be delayed up to 5s if Vmin > 7 km/h has been detected before. The monitoring function is stopped if the fastest wheel reaches 13 km/h (8.1mph) and no gaspedalactivity is recognized. • Vehicle Speed > = 15 km/h (Extended Wheel Speed Comparison) A failure is detected at all wheel speed sensors satisfied with the following conditions for more than 120s. 1) Vmax > = 15km/h (9.3mph) and Vmin < = (0.4 * Vmax) 2) Vmax > = 40km/h (24.9mph) and Vmin < = (0.6 * Vmax)	

Item		Detecting Condition	Possible cause
Case 2	DTC Strategy	• Long-Time Monitoring	
	Monitoring Period	• Once per loop during active ABS control	
	Enable Conditions	• A failure is detected if the duration of permanent pressure reduction or pressure holding phases exceeds for 28s. ***NOTE*** *The low voltage information will be stored instead of the wheel speed sensor failure when the failure is detected and the power supply voltage is below 8.0±0.5V.*	
Fail Safe		• Sensor failure when ABS is inactive 1) Single wheel speed sensor failure The ABS/TCS/ESP functions are deactivated. The ABS/TCS/ESP warning lamps are activated and the EBD warning lamp is not activated. 2) Multiple wheel speed sensor failure The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated. • Sensor failure during active ABS control 1) One front wheel speed sensor failure Deactivate ABS on affected wheel. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 2) One rear wheel speed sensor failure Reduce brake pressure on rear axle. After active ABS control, deactivate all control functions but EBD on completion of ABS cycle. 3) Multiple wheel speed sensor failure The EBD/ABS/TCS/ESP functions are deactivated. The EBD/ABS/TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA E71ECF2D

1. Engine "ON".
2. Connect scantool to Data Link Connector(DLC).
3. Start and drive vehicle in gear and maintain vehicle speed at or above 40km/h. (24.9mph)
4. Monitor the "WHEEL SPD SNSOR(FL, FR, RL, RR)" parameter on the Scantool.

Specification : Compare with other parameters related to wheel speed sensor.
If it is the same as other parameters, it is in normal condition.

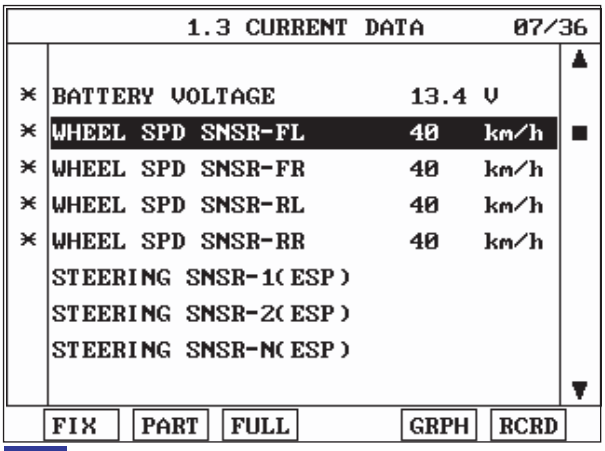


Fig1

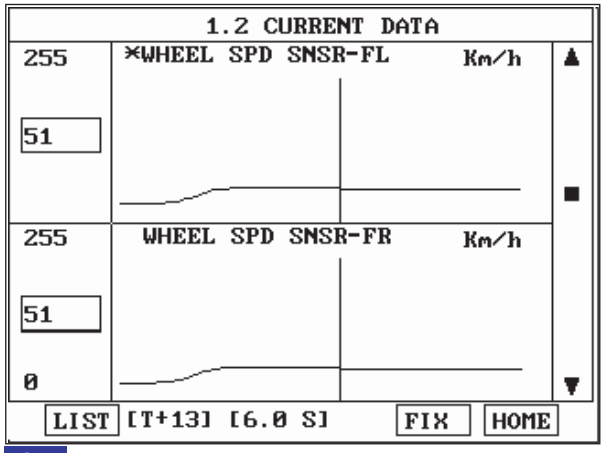


Fig2

SGHBR7524L

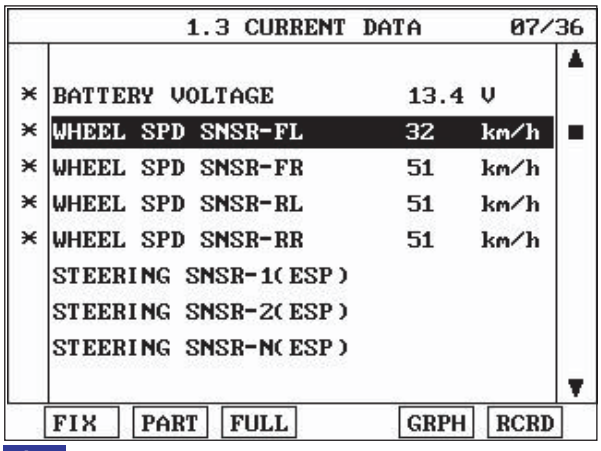


Fig3

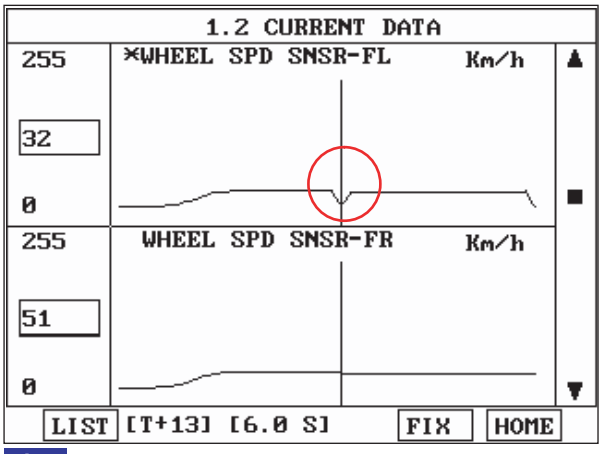


Fig4

Fig 1) Test Condition : Drive vehicle at a speed of 40km/h or more. (24.9mph or more) Normal Data
Fig 2) Test Condition : Drive vehicle at a speed of 40km/h or more. (24.9mph or more) Normal Graph
Fig 3) Test Condition : Drive vehicle at a speed of 51km/h or more. (31.6mph or more) Abnormal Data
Fig 4) Test Condition : Drive vehicle at a speed of 51km/h or more. (31.6mph or more) Abnormal Graph

SGHBR7525L

5. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by poor connection in wheel speed sensor harness (FL, FR, RL, RR) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Component Inspection" procedure.

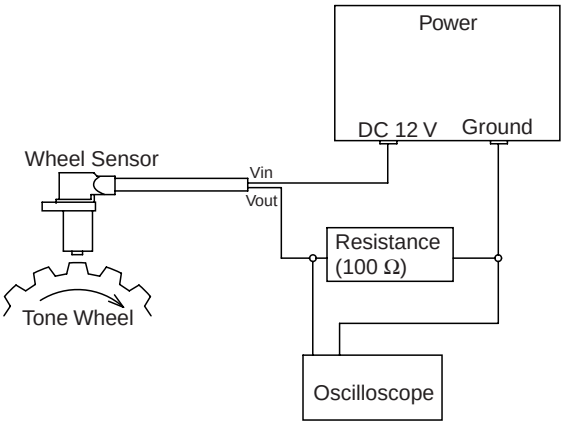
COMPONENT INSPECTION ECA177C4

1. Ignition "OFF".
2. Disconnect the wheel speed sensor harness connector.
3. Connect resistance (approx. 100Ω) to the wheel speed sensor signal circuit.
4. Measure waveform of the wheel speed sensor signal harness with turnning the wheel.

Specification :
High : Approx. 1.4V
Low : Approx. 0.7V (In case that 100Ω resistance is used)

NOTE

Voltage of the waveform can be calculated by using following expression.
Voltage = Resistance × Current (High : 1.4mA, Low : 0.7mA)



SGHBR7526N

5. Is the measured waveform within specifications?

YES

▶ Fault is intermittent caused by poor connection in wheel speed sensor harness (FL, FR, RL, RR) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, If OK, Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

NO

▶ Check for improper installation of wheel speed sensor. If NG, repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Check for damage of rotor teeth or wheel bearing. If NG, repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Substitute with a known-good Wheel speed sensor and check for proper operation. If problem is corrected, replace Wheel speed sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E073EB77

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed at or above 40kmh. (24.9mph))
4. Are any DTCs present ?

YES

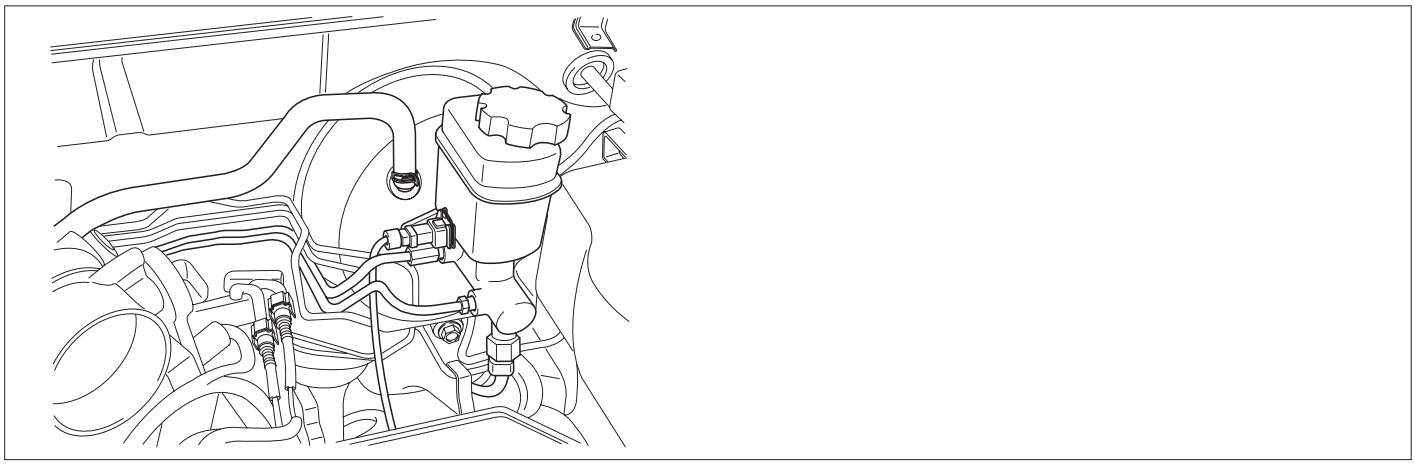
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1235 PRIMARY PRESSURE SENSOR-ELECTRICAL
DTC C1236 SECONDARY PRESSURE SENSOR-ELECTRICAL

COMPONENT LOCATION EEFC5C45



SGHBR6516D

GENERAL DESCRIPTION ECF4DBCF

The two pressure sensors, installed in the master cyclinder, sense the brake oil pressure to judge driver's brake intention when ESP is operating.

DTC DESCRIPTION EACD61CD

The pressure sensor signals are read via A/D converter once per loop.
Each unfiltered input signal value is monitored to be in the range of **5% sensor supply voltage** < **input signal value** < **95% sensor supply voltage**.
There is no restriction of the pressure sensor output voltage if the specified operating range is reached or exceeded.
The signal can therefore reach into a fault area without any fault being present in the sensor.
A failure is detected if the output signal stays in one of the fault areas longer than the monitoring time.

DTC DETECTING CONDITION E7B5FAD6

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Sensor Supply Voltage Monitoring	• Open or short of pressure sensor circuit • Faulty pressure sensor • Faulty HECU
	Monitoring Period	• Once per loop	
	Enable Conditions	• A failure is detected if the external sensor supply voltage is out of the 5.0±0.1V for more than 50ms.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated. - The low voltage information will be stored instead of the sensor supply voltage failure when the failure is detected and the supply voltage is below 8.0±0.5V.	
Case 2	DTC Strategy	• Pressure Sensor Signal Monitoring	
	Monitoring Period	• Continuously(once per loop), but not checked if the sensor supply voltage is out of range, started after a signal settling time of 0.5s if the sensor supply voltage is valid again.	
	Enable Conditions	• A failure is detected if the output voltage is in the lower fault area (0.0V < pressure sensor output voltage < 0.25V) for 0.1s. • A failure is detected if the output signal is in the upper fault area (4.75V < pressure sensor output voltage < 5.0V) for 0.1s and a positive signal step of Δ output signal > 46.0 V/s was detected. • A failure is detected if the output signal is in the upper fault area (4.75V < pressure sensor output voltage < 5.0V) for 0.5s and no positive signal step was detected. • A failure is detected if the output signal is in the upper fault area (4.75V < pressure sensor output voltage < 5.0V) for 60s and the output voltage of the redundant pressure sensor is higher than 2.8 V.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The ACC (Adaptive Cruise Control) function is deactivated. • The TCS/ESP warning lamps are activated.	

TERMINAL AND CONNECTOR INSPECTION E78DF8A9

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

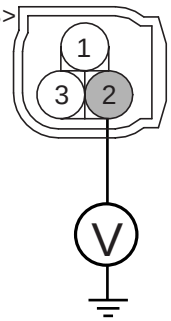
▶ Go to "Power Circuit Inspection" procedure.

POWER CIRCUIT INSPECTION E0DC70C4

1. Ignition "ON" & Engine "OFF".
2. Measure voltage between terminal "2" of the pressure sensor harness connector and chassis ground.

Specification : Approx. 5V

<C126-A>
<C126-B>



1. Pressure Sensor Signal
2. Pressure Sensor Power Supply
3. Pressure Sensor Ground

SGHBR7530N

3. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

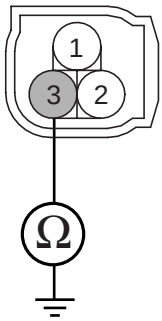
▶ Check for open or short to GND in pressure sensor harness between terminal "2" of the pressure sensor harness connector and terminal " 18, 22" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION EC95A968

1. Ignition "OFF".
2. Disconnect pressure sensor connector.
3. Measure resistance between terminal "3" of the pressure sensor harness connector and chassis ground.

Specification : Approx. below 1Ω

<C126-A>
<C126-B>



1. Pressure Sensor Signal
2. Pressure Sensor Power Supply
3. Pressure Sensor Ground

SGHBR7531N

4. Is the measured resistance within specifications?

YES

▶ Go to "Signal Circuit Inspection" procedure.

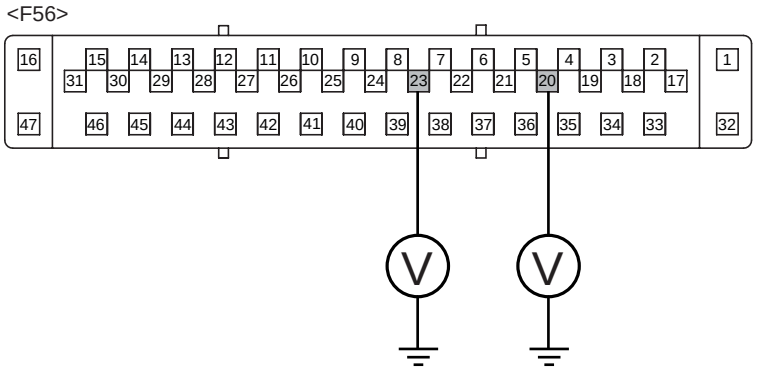
NO

▶ Check for open or short in pressure sensor harness between terminal "3" of the pressure sensor harness connector and terminal "19, 21" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

SIGNAL CIRCUIT INSPECTION EDDD5EEF

1. Ignition "ON" & Engine "OFF".
2. Measure voltage between terminal (Pressure Sensor " A" : 20, Pressure Sensor " B" : 23) of the HECU harness connector and chassis ground.

Specification : Approx. 0.5V



20. Pressure Sensor "A" Signal
23. Pressure Sensor "B" Signal

SGHBR7532N

3. Is the measured voltage within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

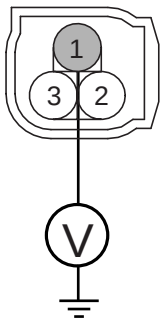
▶ Check for open or short in pressure sensor harness between terminal "1" of the pressure sensor harness connector and terminal (Pressure Sensor " A" : 20, Pressure Sensor " B" : 23) of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Go to "Component Inspection" procedure.

COMPONENT INSPECTION E47FCAFA

1. Ignition "ON" & Engine "OFF".
2. Measure voltage between terminal "1" of the pressure sensor harness connector and chassis ground.

Specification : Approx. 0.5V

<C126-A>
<C126-B>



1. Pressure Sensor Signal
2. Pressure Sensor Power Supply
3. Pressure Sensor Ground

SGHBR7533N

3. Is the measured voltage within specifications?

YES

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

NO

▶ Substitute with a known-good pressure sensor and check for proper operation. If problem is corrected, replace pressure sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E1D67D49

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

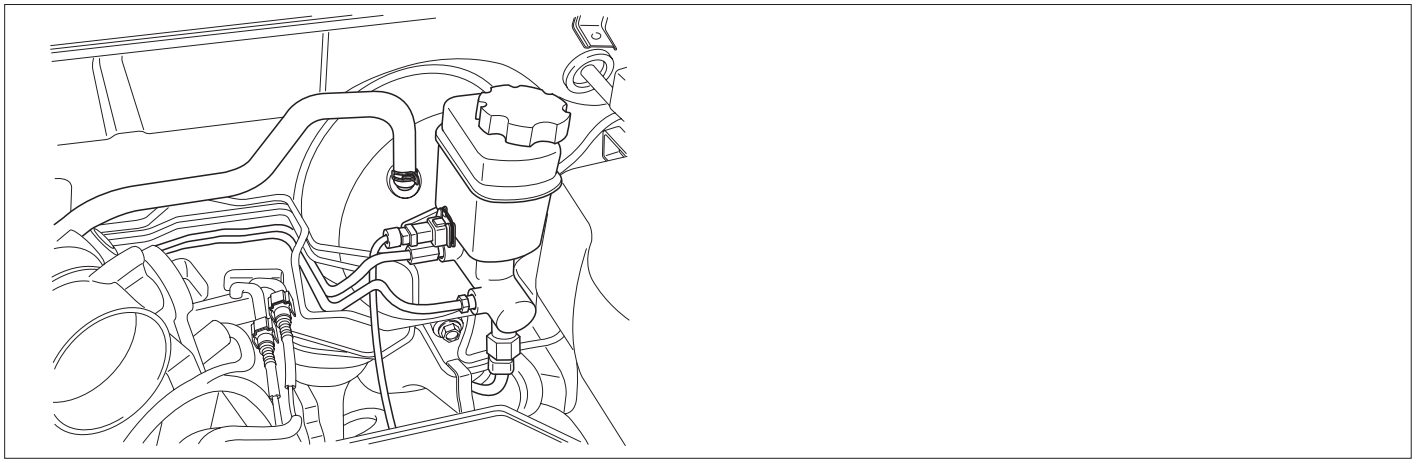
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1237 PRESSURE SENSOR-SIGNAL

COMPONENT LOCATION E52DCB5D



SGHBR6516D

GENERAL DESCRIPTION E7E12CDA

The two pressure sensors ,installed in the master cyclinder, sense the brake oil pressure to judge driver's brake intention when ESP is operating.

DTC DESCRIPTION E3CC9B45

The pressure sensor signal has an offset which is given by the specified sensor offset, an offset due to the sensor wiring and an offset due to the signal conditioning circuit in the ECU.
The total pressure sensor signal offset is calculated by lowpass filtering the sensor signal and it is stored in the non-volatile memory of the ECU. After each power-on reset the offset calculation starts with the stored offset value of the last ignition cycle. A failure is detected if the calculated pressure sensor signal offset is out of range.
The pressure sensor signal is filtered by a hardware low-pass filter in the ECU. This filtered signal is then connected to an A/D converter. The MCU reads the pressure sensor signal once per loop from the A/D converter.
A failure is detected if the pressure sensor signal noise is out of valid range or there is too high difference between both pressure sensor signals.

DTC DETECTING CONDITION E53FBD9B

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Signal Offset Monitoring	• High frequency interferences at pressure sensor signal • Faulty pressure sensor • Faulty HECU
	Monitoring Period	• Once per loop, but not checked 1) if a checksum failure of the stored offset values is detected 2) if the sensor supply voltage is out of range 3) if the pressure sensor signal is out of range	
	Enable Conditions	• A failure is detected if the absolute value of the calculated pressure sensor signal offset is higher than 8.0 bar.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The ACC (Adaptive Cruise Control) function is deactivated. • The TCS/ESP warning lamps are activated.	
Case 2	DTC Strategy	• Noise Monitoring	
	Monitoring Period	• Once per loop when no control cycle is active but not checked 1) If the sensor signal is out of range, if a driver brake apply is detected 2) if the HBA(Hydraulic Brake Assist) function is deactivated, 3) during activated pump motor 4) if the sensor supply voltage is out of range 5) during diagnostics mode. (started after a signal settling time of 3.0 s after power-on reset or after a signal settling time of 0.5 s if the sensor supply voltage is valid again)	
	Enable Conditions	• A failure is detected if the value of integrated signal noise exceeds 195mV for 70~280ms depending on noise level.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	
Case3	DTC Strategy	• Redundancy Monitoring	
	Monitoring Period	• Once per loop, but not checked 1) if the sensor supply voltage is out of valid range 2) if the pressure sensor signals are out of range 3) after a pressure sensor failure is detected. (started after a signal settling time of 0.5 s if the sensor supply voltage is valid again)	
	Enable Conditions	• A failure is detected if the difference between both pressure sensor signals is continuously higher than 20 bar for 0.5s.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The ACC (Adaptive Cruise Control) function is deactivated. • The TCS/ESP warning lamps are activated.	

TERMINAL AND CONNECTOR INSPECTION EADACB7A

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification of Vehicle Repair" procedure.

NO

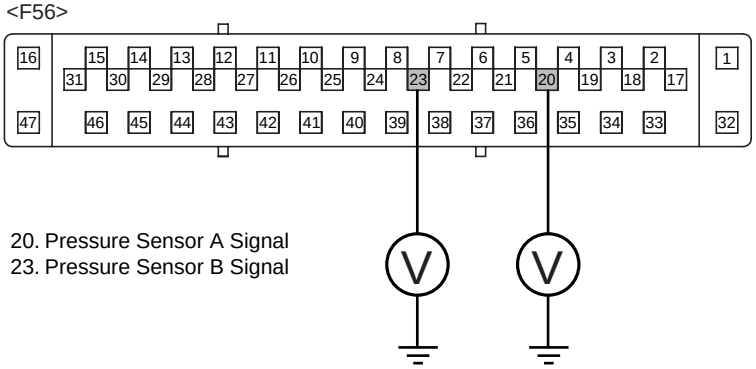
▶ Go to "Signal Circuit Inspection" procedure.

SIGNAL CIRCUIT INSPECTION EE0F0DA3

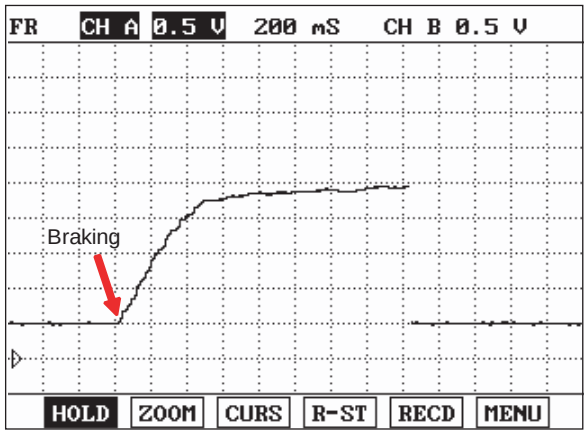
1. Ignition "ON" & Engine "OFF".
2. Put and release the brake pedal several times.
3. Measure voltage, waveform between terminal "20,23" of the HECU harness connector and chassis ground.

Specification :
0.5V ~ 4.4V
Approx. 0.5V (in case of no braking)

<F56>



20. Pressure Sensor A Signal
23. Pressure Sensor B Signal



Normal waveform of pressure sensor with braking

SGHBR7534N

4. Is the measured voltage within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

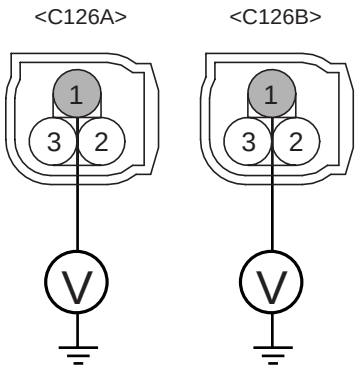
NO

▶ Check for open or short in pressure sensor harness between terminal "1" of the pressure sensor A,B harness connector and terminal "20,23" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Go to "Component Inspection" procedure.

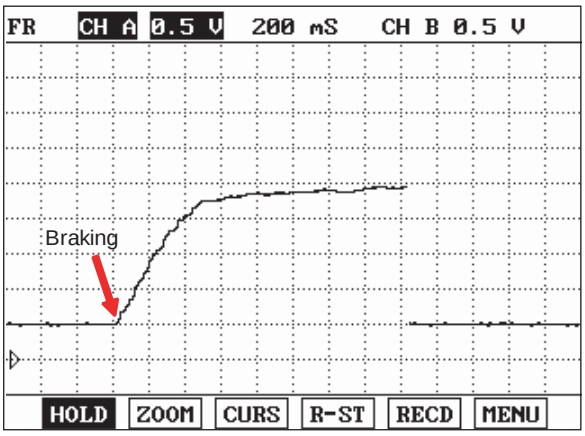
COMPONENT INSPECTION E13C45DD

1. Ignition "ON" & Engine "OFF".
2. Put and release the brake pedal several times.
3. Measure voltage, waveform between terminal "1" of the pressure sensor (primary and secondary) harness connector and chassis ground.

Specification :
0.5V ~ 4.4V
Approx. 0.5V (in case of no braking)



1. Pressure Sensor Signal
2. Pressure Sensor Power Supply
3. Pressure Sensor Ground



Normal waveform of pressure sensor with braking

SGHBR7535N

4. Is the measured voltage, waveform within specifications?

YES

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

NO

▶ Substitute with a known-good pressure sensor and check for proper operation. If problem is corrected, replace pressure sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E0BF69E6

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

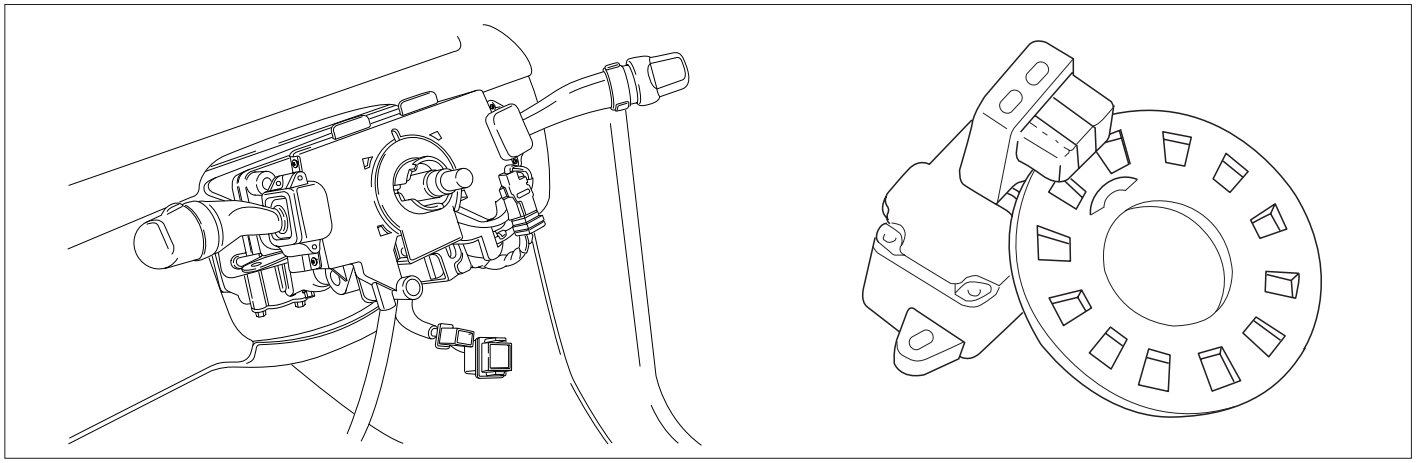
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1259 STEERING ANGLE SENSOR-ELECTRICAL

COMPONENT LOCATION EBA6731D



SGHBR6529D

GENERAL DESCRIPTION ECA30CFC

The Steering wheel angle sensor uses two sensors (A-sensor and B-sensor) to determine the direction of the rotation. The main components of each sensor are LED, photo transistor and slit plate. The slit plate, which has 45 holes, is installed between LED and photo transistor, and generates signals if slit plate rotates according to the steering wheel rotation. The sensor signals are generated by photo transistor which is driven whenever the light passes through the holes.
The HECU detects operating speed and direction of the steering wheel by this input signal, and this signal is used as input signal for anti-roll control.

DTC DESCRIPTION E5D9B323

The conformance of the yaw rate, lateral acceleration and steering angle signals dynamic is monitored by comparison of the signal shifts during curves.
The function is started when a curve is detected after driving straight ahead for at least 1 s. A curve is detected if 2 of the 3 signals exceed the following thresholds : (1.|Filtered yaw rate| $>$ 4.0 °/ s, 2.|Filtered lateral accel.| $>$ 0.15 g, 3.|Filtered steering angle| $>$ 1.0 °)
Due to the varying timing of signal changes, integrators are used to accumulate the signal's deviations from straight ahead driving. The signal changes are integrated separately. The integrated values are compared after a settling time of 2s.

DTC DETECTING CONDITION E4AC3478

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Sensor Supply Voltage Monitoring	• Open or short of steering wheel sensor circuit • Faulty steering wheel sensor
	Monitoring Period	• Once per loop	
	Enable Conditions	• A failure is detected if some signal voltage stays in abnormal voltage range(voltage＞4.40V and 2.30V＜ voltage＜ 2.70V and voltage＜ 1.10V) for more than 224ms.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated. - This monitoring is not done when power-supply state is not normal.	
Case 2	DTC Strategy	• Signal Comparison Monitoring of Yaw rate, Lateral acceleration and Steering wheel angle sensor	
	Monitoring Period	• After a signal settling time of 3.0 s after power-on reset. • Each time when a change from straight ahead driving into a curve is detected at vehicle speed above 10.8 kph, but not checked. 1. If the sensor supply voltage is out of range, during skidding, reverse driving or if ESP is deactivated.	
	Enable Conditions	• A failure is detected during a detection time if one integrator value is below the integrator “ low” threshold (indicating insufficient signal dynamic) while the integrator values of the 2 other signals are higher than the ” high” thresholds. - Detection time 1. 1 loop(7ms) - at vehicle speed ＜ 100 kph 2. 1 loop + 1s * (vehicle speed -100 kph) / 25 kph - at 100 kph ＜ vehicle speed ＜ 200 kph 3. 4s - at vehicle speed ＞ 200 kph - Low threshold 1. Yaw rate - 1.30 °/ s2 2. Lateral acceleration - 0.02 g 3. Steering angle - 0.17 ° - High threshold 1. Yaw rate - 5.70 °/ s2 2. Lateral acceleration - 0.16 g 3. Steering angle - 3.40 °	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA E98EADD5

1. Connect scantool to Data Link Connector(DLC)
2. Engine "ON".
3. Turn the steering wheel to the left or right.
4. Monitor the "STEERING SNSR" parameters on the Scantool.

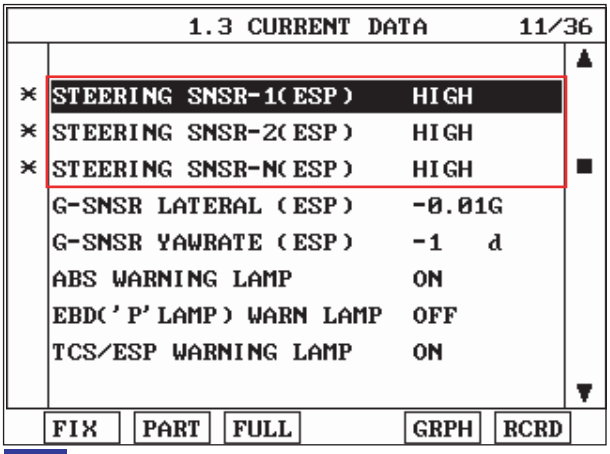


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "ON".
Normal data

SGHBR7526L

5. Whenever steering wheel is turned, is the steering sensor's scantool data changed?

YES

▶ Fault is intermittent caused by poor connection in steering sensor harness and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION EA43F8CD

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification of Vehicle Repair" procedure.

NO

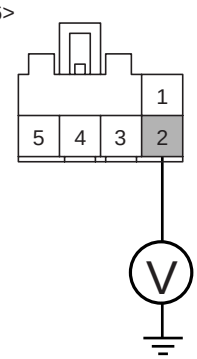
▶ Go to "Power Circuit Inspection" procedure.

POWER CIRCUIT INSPECTION E681DE84

1. Ignition "ON" & Engine "OFF".
2. Measure voltage between terminal "2" of the steering wheel angle sensor harness connector and chassis ground.

Specification : Approx. B+

<M56>



1. STN Signal
2. Power Supply (IG1)
3. Ground
4. ST2 Signal
5. ST1 Signal

SGHBR7537N

3. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

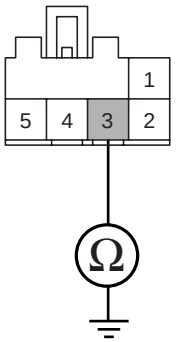
▶ Check for open or short to GND in steering angle sensor harness between terminal "7" of the HECU harness connector and terminal "2" of the steering angle sensor harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION E99FBD33

1. Ignition "OFF".
2. Disconnect steering wheel angle sensor connector.
3. Measure resistance between terminal "3" of the steering wheel angle sensor harness connector and chassis ground.

Specification : Approx. below 1Ω

<M56>



1. STN Signal
2. Power Supply (IG1)
3. Ground
4. ST2 Signal
5. ST1 Signal

SGHBR7538N

4. Is the measured resistance within specifications?

YES

▶ Go to "Signal Circuit Inspection" procedure.

NO

▶ Check for open or short in steering wheel angle sensor harness between terminal "3" of the steering angle sensor harness connector and terminal "5" of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

SIGNAL CIRCUIT INSPECTION E2A88FAC

1. Ignition "ON" & Engine "ON".
2. Turn the steering wheel to the left or right.
3. Measure signal waveform between terminal "3,28,30" of the HECU harness connector and chassis ground.

Specification :
High : 2.7~4.4V
Low : 1.1~2.3V

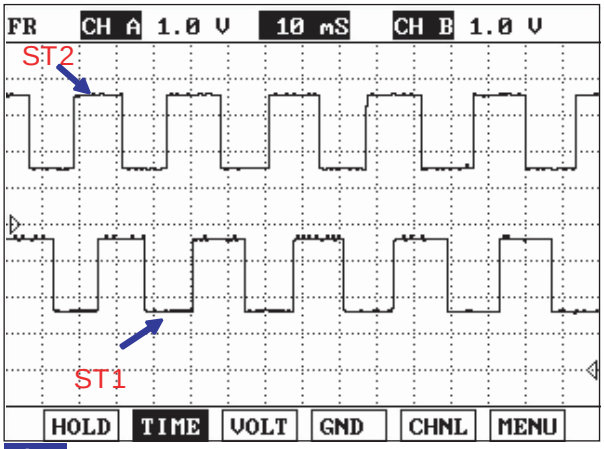


Fig1

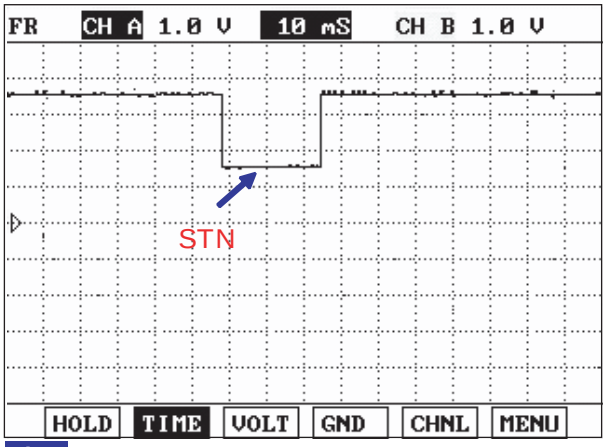
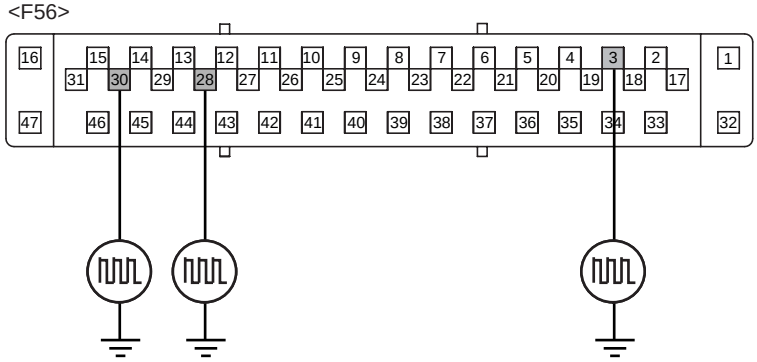


Fig2

Fig 1) Test Condition : Ignition "ON" & Engine "ON". Normal data (Approx. High : 3.5V , Low : 1.5V)
Fig 2) Test Condition : Ignition "ON" & Engine "ON". Normal data (Approx. High : 3.5V , Low : 1.5V)

SGHBR7539N



3. STN Signal
28. ST1 Signal
30. ST2 Signal

SGHBR7540N

4. Is the measured signal waveform within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for open or short in steering wheel angle sensor harness between terminal "1, 4, 5" of the steering wheel angle sensor harness connector and terminal "3, 30, 28" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, Go to "Component Inspection" procedure.

COMPONENT INSPECTION E4F4DDCF

1. Ignition "ON" & Engine "ON".
2. Turn the steering wheel to the left or right.
3. Measure signal waveform between terminal "1,4,5" of the steering wheel angle sensor harness connector and chassis ground.

Specification :
High : 2.7~4.4V
Low : 1.1~2.3V

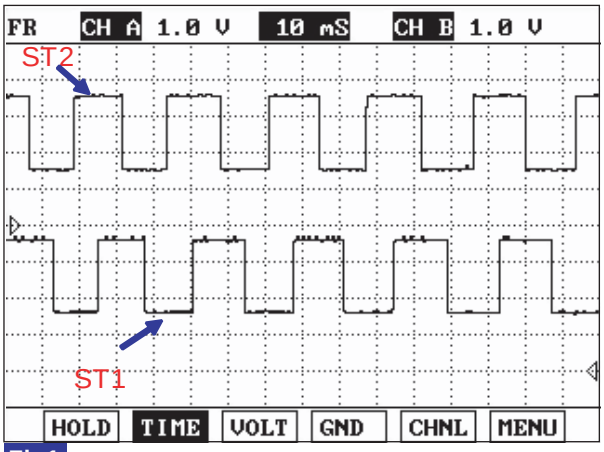


Fig1

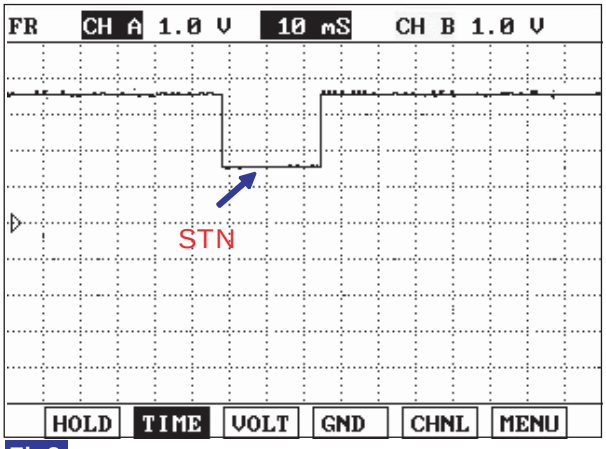
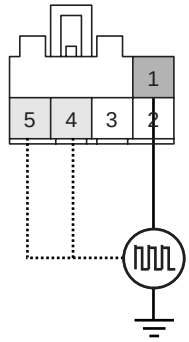


Fig2

Fig 1) Test Condition : Ignition "ON" & Engine "ON". Normal data (Approx. High : 3.5V , Low : 1.5V)
Fig 2) Test Condition : Ignition "ON" & Engine "ON". Normal data (Approx. High : 3.5V , Low : 1.5V)

SGHBR7539N

<M56>



1. STN Signal
2. Power Supply (IG1)
3. Ground
4. ST2 Signal
5. ST1 Signal

SGHBR7591N

4. Is the measured signal waveform within specifications?

YES

▶ Fault is intermittent caused by poor connection in steering sensor harness and/or HECU's connector or was repaired and HECU memory was not cleared. Go to "Verification Of Vehicle Repair" procedure.

NO

▶ Substitute with a known-good steering wheel angle sensor and check for proper operation. If problem is corrected, replace steering wheel angle sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E61115A7

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

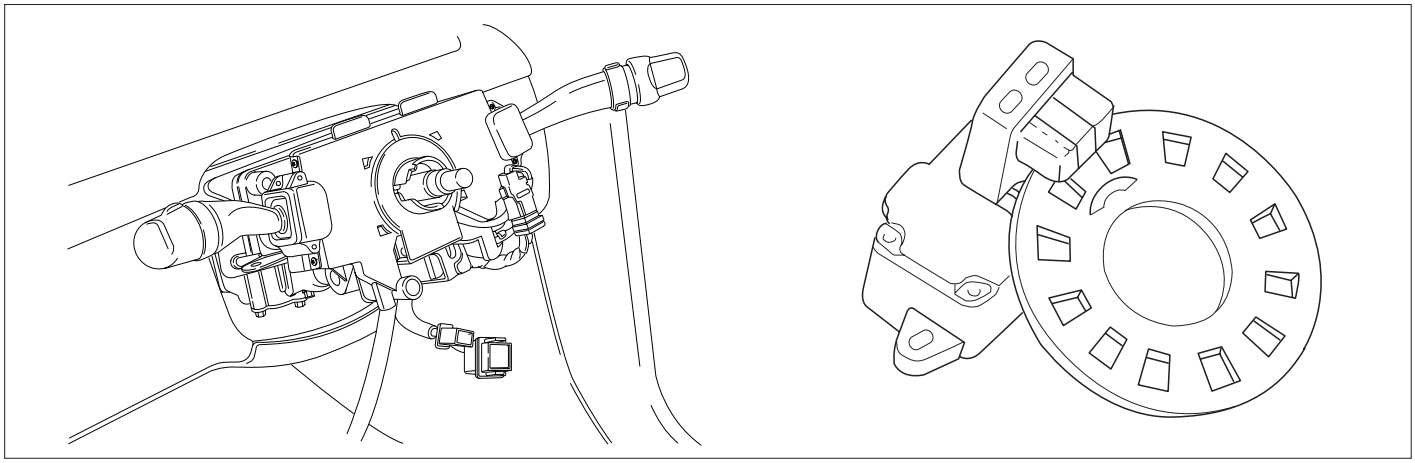
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1260 STEERING ANGLE SENSOR-SIGNAL

COMPONENT LOCATION EC71CDDE



SGHBR6529D

GENERAL DESCRIPTION E1C430CA

The Steering wheel angle sensor uses two sensors (A-sensor and B-sensor) to determine the direction of the rotation. The main components of each sensor are LED, photo transistor and slit plate. The slit plate, which has 45 holes, is installed between LED and photo transistor, and generates signals if slit plate rotates according to the steering wheel rotation. The sensor signals are generated by photo transistor which is driven whenever the light passes through the holes.
The HECU detects operating speed and direction of the steering wheel by this input signal, and this signal is used as input signal for anti-roll control.

DTC DESCRIPTION E6BC97D8

This monitoring function monitors the changing point of N-signal with measured steering angle from ST1 and ST2. If N-signal changing point differs more than 4degree, the failure is detected.
This monitoring function is prepared for the possibility of temporary SWAS(steering wheel angle sensor) signal defect caused by the power-supply or external environments. Because SWAS signal is not guaranteed for all situations that ESP-ECU working is guaranteed.
A failure is set if unplausible steering wheel angle sensor signal is detected.

DTC DETECTING CONDITION ED93539A

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• N-Signal Consistency Monitoring	• Open or short of steering wheel sensor circuit • Faulty steering wheel sensor
	Monitoring Period	• Once per loop	
	Enable Conditions	• N signal changing point must be specified position compared with last changing point. If the changing point differs more than 4degree, the failure is detected. - To avoid miss detection of failure, Changing point monitoring ignores the short term changing (less than 70ms). • If N signal does not change more than 352 degree, failure is fixed.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated. - This monitoring is not done when power-supply state is not normal.	
Case 2	DTC Strategy	• Power-Supply-Short-Term-Defect Monitoring	
	Monitoring Period	• Once per loop	
	Enable Conditions	• Difference between measured steering-angle and expected-steering angle exceeds 6 degree. • Too high velocity of steering-angle is measured. • Expecting-steering-angle is made while power-supply state is out of range.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

Case 3	DTC Strategy	• Signal Plausibility Monitoring	
	Monitoring Period	• Continuously(once per loop) if the vehicle speed is above 10.8kph(6.7mile), but not checked. 1) during detected low voltage 2) during maneuvers with variable speed and steering 3) during skidding or during reverse driving started after a signal setting time of 1.8s after power-on reset.	
	Enable Conditions	• A failure is detected during steady-state straight ahead driving if one of the following conditions is true longer than 1.75s. 1) |longitudinal acceleration| > 0.1g AND |difference| > 3.0 2) -0.1g < longitudinal acceleration < -0.05g OR 0.0g < longitudinal acceleration < 0.1g AND |difference| > 6.0 3) -0.05g < longitudinal acceleration < 0.0g AND|difference| > 9.0 - The difference : the difference between the reference signal and the steering angle sensor signal. - A steering angle reference signal is calculated from the wheel speeds, the lateral acceleration and the yaw rate to observe the steering wheel angle sensor.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA E2707A0F

1. Connect scantool to Data Link Connector(DLC)
2. Engine "ON".
3. Turn the steering wheel to the left or right.
4. Monitor the "STEERING SNSR" parameters on the Scantool.

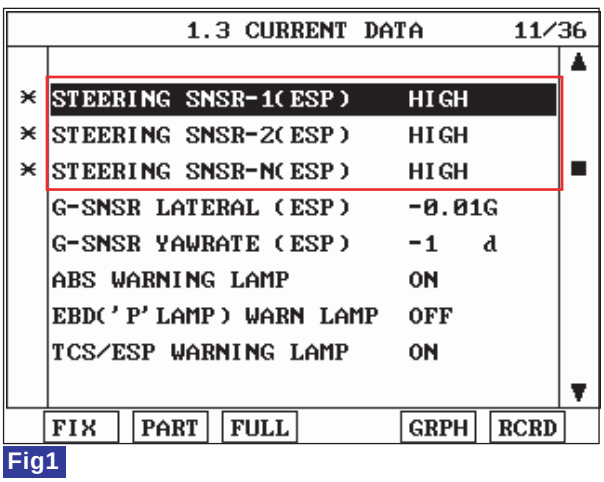


Fig1

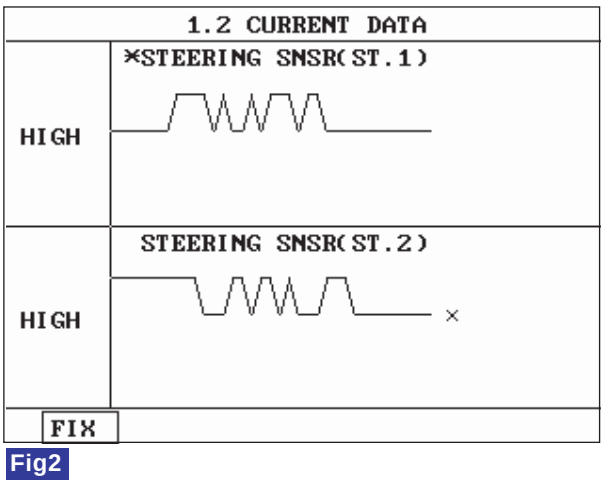


Fig2

SGHBR7527L

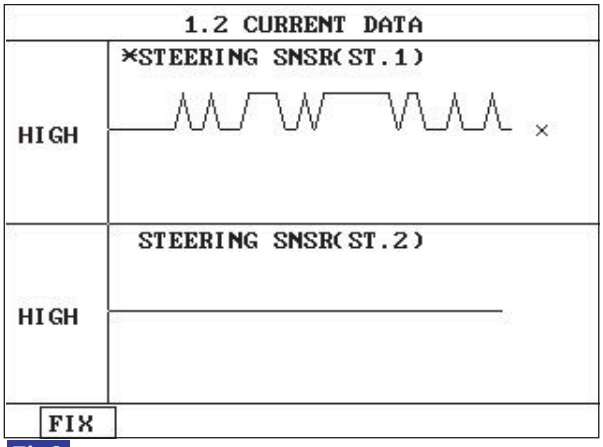


Fig3

Fig 1) Test Condition : Ignition "ON" & Engine "ON". Normal data
Fig 2) Test Condition : Ignition "ON" & Engine "ON". Normal graph
Fig 3) Test Condition : Ignition "ON" & Engine "ON". Abnormal graph

SGHBR7592N

5. Whenever steering wheel is turned, is the steering sensor's scantool data changed ?

YES

▶ Fault is intermittent caused by poor connection in steering sensor harness and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION EEB2840E

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Power Circuit Inspection" procedure.

SIGNAL CIRCUIT INSPECTION EDCD5559

1. Ignition "ON" & Engine "ON".
2. Turn the steering wheel to the left or right.
3. Measure signal waveform between terminal "3, 28, 30" of the HECU harness connector and chassis ground.

Specification : Check the voltage range (HIGH : 2.9±0.1V ~ 4.4±0.1V LOW : 1.2±0.1V ~ 2.1±0.1V) of the sensor signal in case of turning left, turning right, center position.
If normal waveforms such as fig1, 2, 3 are detected in each condition, It is normal.

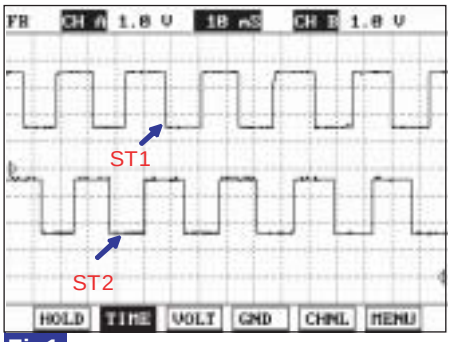


Fig1

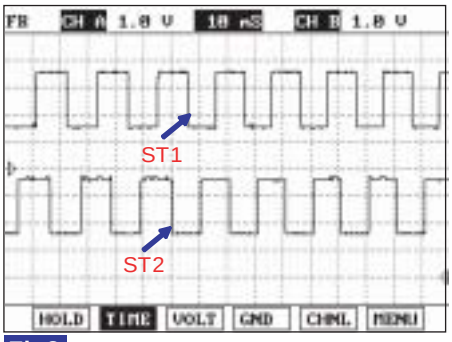


Fig2

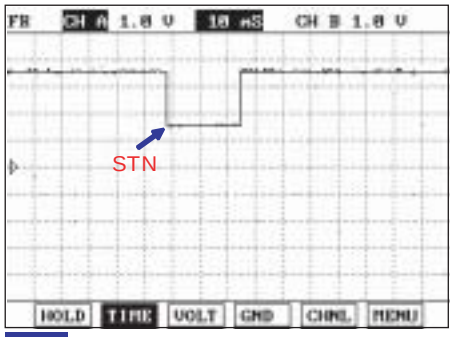
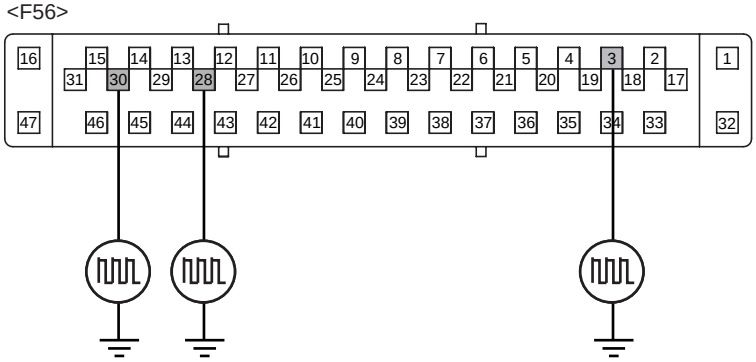


Fig3

Fig 1) Normal waveform of steering angle sensor while turinig left after ENG "ON" : Output signal change ("LOW" → "HIGH") is detected first in ST1.
Fig 2) Normal waveform of steering angle sensor while turinig right after ENG "ON" : Output signal change ("LOW" → "HIGH") is detected first in ST2.
Fig 3) Normal waveform of steering angle sensor being center position after ENG "ON" : Output signal change ("HIGH (approx 3.5V)" → "LOW)" is detected when steering wheel is passing by on center position.
※ "LOW" : approx 1.5V, "HIGH" : approx 3.5V.

SGHBR7542N

<F56>



3. STN Signal
28. ST1 Signal
30. ST2 Signal

SGHBR7540N

4. Is the measured signal waveform within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for open or short in steering wheel angle sensor harness between terminal "1, 4, 5" of the steering angle sensor harness connector and terminal "3,28,30" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Go to "Component Inspection" procedure.

COMPONENT INSPECTION EA1C64A2

1. Ignition "ON" & Engine "ON".
2. Turn the steering wheel to the left or right.
3. Measure signal waveform between terminal "1, 4, 5" of the steering wheel angle sensor harness connector and chassis ground.

Specification : Check the voltage range (HIGH : 2.9±0.1V ~ 4.4±0.1V LOW : 1.2±0.1V ~ 2.1±0.1V) of the sensor signal in case of turning left, turning right, center position.
If normal waveforms such as fig1, 2, 3 are detected in each condition, It is normal.

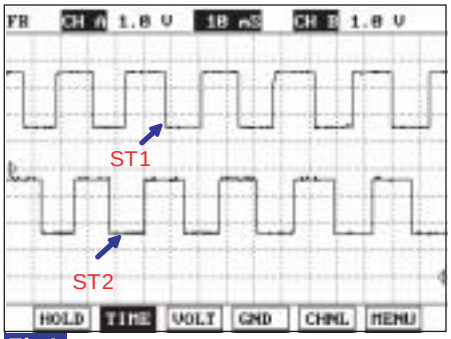


Fig1

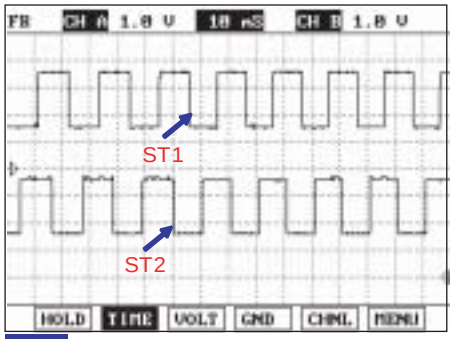


Fig2

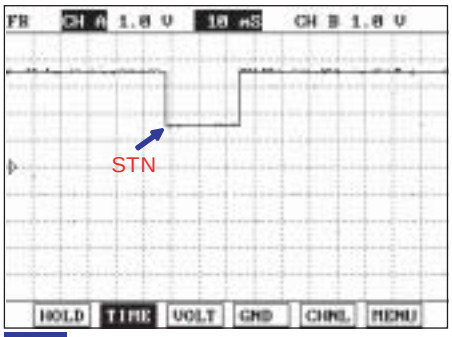
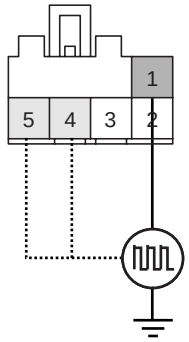


Fig3

Fig 1) Normal waveform of steering angle sensor while turinig left after ENG "ON" : Output signal change ("LOW" → "HIGH") is detected first in ST1.
Fig 2) Normal waveform of steering angle sensor while turinig right after ENG "ON" : Output signal change ("LOW" → "HIGH") is detected first in ST2.
Fig 3) Normal waveform of steering angle sensor being center position after ENG "ON" : Output signal change ("HIGH (approx 3.5V)" → "LOW)" is detected when steering wheel is passing by on center position.
※ "LOW" : approx 1.5V, "HIGH" : approx 3.5V.

SGHBR7542N

<M56>



1. STN Signal
2. Power Supply (IG1)
3. Ground
4. ST2 Signal
5. ST1 Signal

SGHBR7591N

4. Is the measured signal waveform within specifications?

YES

▶ Fault is intermittent caused by poor connection in steering sensor harness and/or HECU's connector or was repaired and HECU memory was not cleared. Go to "Verification Of Vehicle Repair" procedure.

NO

▶ If STN signal is HIGH on center position, Check for improper installation of steering angle sensor. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, substitute with a known-good steering angle sensor and check for proper operation. If problem is corrected, replace steering angle sensor and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E1FEBFA2

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

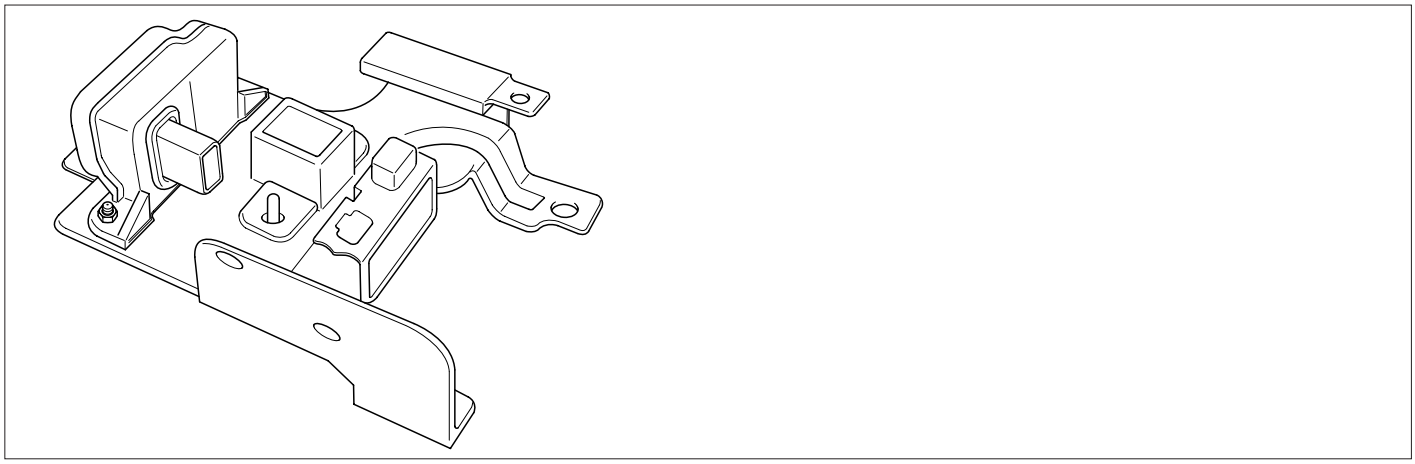
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1282 YAW RATE & LATERAL G SENSOR-ELECTRICAL

COMPONENT LOCATION EE6C0FC9



SGHBR6541D

GENERAL DESCRIPTION EA2C9FBE

The sensor cluster installed at floor under center console is composed of yaw rate sensor, lateral G sensor, microcontroller in a aluminum container.
When the vehicle is turning with respect to a vertical axis the yaw rate sensor detects the yaw rate electronicllly by the vibration change of plate fork inside the yaw rate sensor. If yaw velocity reaches the specific velocity(4deg/s) after it detects the vehicle' yawing, the ESP control is reactivated.
The yaw rate senser outputs 0V in case of a trouble.
Sensor cluster has a self diagnosis function, this information is outputted as yaw rate & lateral G signal to HECU through separate CAN.
The later G sensor senses vehicle's lateral G.
A small element inside the sensor is attached to a deflectable leverarm by later G. Direction and magnitude of lateral G loaded to vehicle can be known with electrostatic capacity changing according to lateral G.
The output voltage of the lateral G sensor is 2.5V when the vehicle is at a standstill. Only with lateral G sensor, the ESP can not be reactivated.

DTC DESCRIPTION E108CB8D

The Sensor Cluster is powered by the ECU via the power supply voltage line.
High voltage is detected immediately by the hardware, if the power supply voltage exceeds 18.0 V ± 1.0 V and Low voltage is detected immediately if the power supply voltage drops below 6.5 V ± 0.5 V.
The HECU receives the signal from Sensor Cluster via CAN bus line. A failure is detected if too many Bus Off event has occurred, CAN messages monitoring time exceeds the specified duration, the calculated and received checksum values differ.

DTC DETECTING CONDITION EE35D036

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Operating Voltage Monitoring	• Open or short of sensor cluster circuit • Faulty sensor cluster • Faulty HECU
	Monitoring Period	• Once per loop	
	Enable Conditions	• When Vign＞18.0V±1.0V is continued for 1 loop(7ms). • When Vign＜ 6.5V±0.5V is continued for 1 loop(7ms).	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated. ***NOTE*** *- The Sensor Cluster high or low voltage informations are only stored if Vmax ＞ 20 kph.* *- The ECU low voltage information will be stored instead of the Sensor Cluster information when the high or low voltage is detected by the Sensor Cluster and a voltage drop at power supply voltage was measured by the ECU within the last 3.0sec, indicating a failure at the vehicle electric system.*	
Case 2	DTC Strategy	• CAN Bus Off Monitoring	
	Monitoring Period	• Once per loop	
	Enable Conditions	• The MCU reset the CAN device after a CAN Bus Off event occurs. A failure is detected if the Bus Off event has occurred 15 times in succession.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated. - The failure is not stored during detected low voltage.	
Case 3	DTC Strategy	• Lateral Acceleration Sensor Monitoring	
	Monitoring Period	• Once per loop, but not checked 1) during active test function of the acceleration sensor module 2) if the sensor supply voltage is out of range (started after a signal settling time of 0.5 s if the sensor supply voltage is valid again)	
	Enable Conditions	• A failure is detected if the output signal is in the upper fault area (4.8V ＜ lateral acceleration sensor output voltage ＜ 5.0V) for 0.1s and |△output signal| ＞ 12V/s was detected. • A failure is detected if the output signal is in the lower fault area (0.0V ＜ lateral acceleration sensor output voltage ＜ 0.2V) for 0.1s and |△output signal| ＞ 12V/s was detected.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

Case 4	DTC Strategy	• Yaw Rate Sensor Monitoring	
	Monitoring Period	• Once per loop, but not checked 1) during active test function of the yaw rate sensor module or if the sensor supply voltage is out of range (started after a signal settling time of 1.0s if the sensor supply voltage is valid again)	
	Enable Conditions	• A failure is detected if the output signal is in the upper fault area (4.76V < yaw rate sensor output voltage < 5.0V) for 0.1s and |△output signal| > 14.58V/s was detected. • A failure is detected if the output signal is in the lower fault area (0.0V < yaw rate sensor output voltage < 0.24V) for 0.1s and |△output signal| > 14.58V/s was detected.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	
Case 5	DTC Strategy	• Signal Comparison Monitoring of Yaw rate, Lateral acceleration and Steering wheel angle sensor	
	Monitoring Period	• after a signal settling time of 3.0 s after power-on reset • each time when a change from straight ahead driving into a curve is detected at vehicle speed above 10.8 kph, but not check 1) if the sensor supply voltage is out of range 2) during skidding, reverse driving 3) if ESP is deactivated.	
	Enable Conditions	• A failure is detected during a detection time if one integrator value is below the integrator “ low” threshold (indicating insufficient signal dynamic) while the integrator values of the 2 other signals are higher than the ” high” thresholds. - Detection time 1. 1 loop(7ms) - at vehicle speed < 100 kph 2. 1 loop + 1s * (vehicle speed -100 kph) / 25 kph - at 100 kph < vehicle speed < 200 kph 3. 4s - at vehicle speed > 200 kph - Low threshold 1. Yaw rate - 1.30 °/ s2 2. Lateral acceleration - 0.02 g 3. Steering angle - 0.17 ° - High threshold 1. Yaw rate - 5.70 °/ s2 2. Lateral acceleration - 0.16 g 3. Steering angle - 3.40 °	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA EB7DAFBC

1. Connect scantool to Data Link Connector(DLC)
2. Engine "ON".
3. Maintain the vehicle standing still.
4. Monitor the "Lateral Acceleration Sensor, Yaw Rate Sensor" parameter on the Scantool.

Specification :
Approx. Lateral Acceleration Sensor : -0.01G
Approx. Yaw Rate Sensor : -1 deg/s

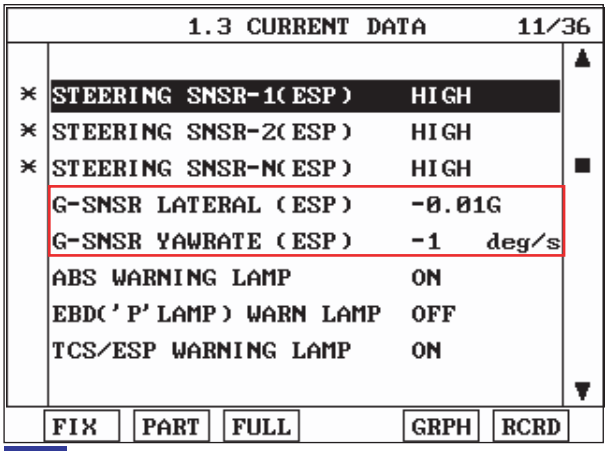


Fig1

Fig 1) Test Condition : Engine "ON".
Normal data

SGHBR7528L

NOTE

The parameters will be fixed when there is open in yaw & lateral G sensor circuit.

5. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by faulty sensor cluster and/or faulty HECU or was repaired and HECU memory was not cleared. Go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION EF558946

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

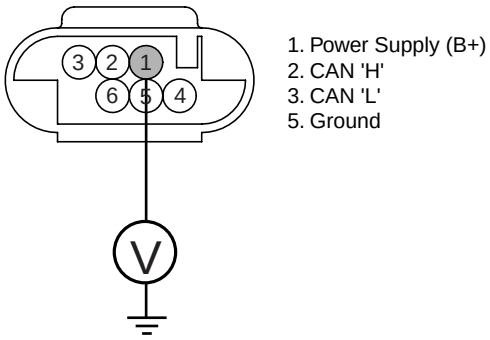
▶ Go to "Power Circuit Inspection" procedure.

POWER CIRCUIT INSPECTION E7DC5B88

1. Ignition "ON" & Engine "ON".
2. Measure voltage between terminal "1" of the sensor cluster harness connector and chassis ground.

Specification : Approx. B+

<F34>



1. Power Supply (B+)
2. CAN 'H'
3. CAN 'L'
5. Ground

SGHBR7545N

3. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

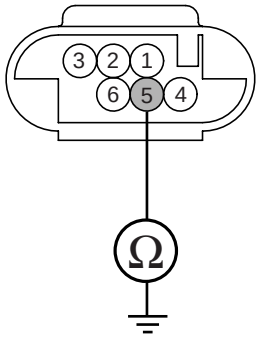
▶ Check for open or short to GND in sensor cluster harness between terminal "1" of the sensor cluster harness connector and terminal "6" of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION EFBB846C

1. Ignition "OFF".
2. Disconnect sensor cluster connector..
3. Measure resistance between terminal "5" of the sensor cluster harness connector and chassis ground.

Specification : Approx. below 1Ω

<F34>



1. Power Supply (B+)
2. CAN 'H'
3. CAN 'L'
5. Ground

SGHBR7546N

4. Is the measured resistance within specifications?

YES

▶ Go to "CAN Bus Short (to ground) Inspection" procedure.

NO

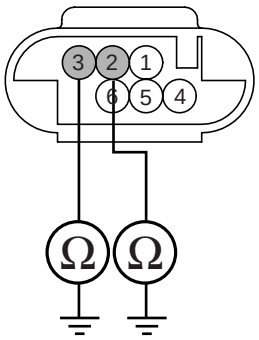
▶ Check for open or short in sensor cluster harness between terminal "5" of the sensor cluster harness connector and terminal "31" of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

CAN BUS SHORT (TO GROUND) INSPECTION

1. Ignition "OFF".
2. Disconnet the HECU harness connector.
3. Measure resistance between terminal "2, 3" of the sensor cluster harness connector and chassis ground.

Specification : Approx. ∞ Ω

<F34>



1. Power Supply (B+)
2. CAN 'H'
3. CAN 'L'
5. Ground

SGHBR7548N

4. Is the measured resistance within specifications?

YES

▶ Go to "CAN Circuit resistance Inspection" procedure.

NO

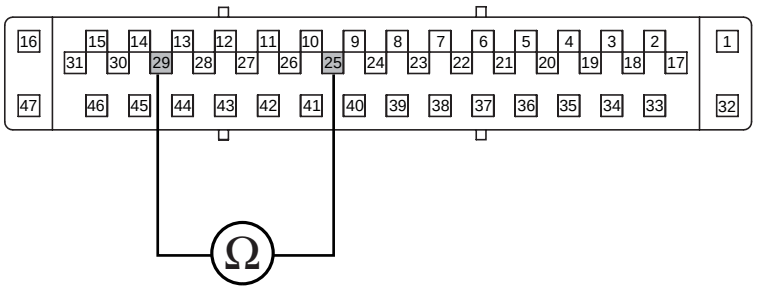
▶ Check for short to ground in CAN HIGH signal harness in case of abnormal voltage measured between terminal "2" of the sensor cluster harness connector and chassis ground. Repair as necessary and then go to "Verification of vehicle Repair" procedure.
▶ Check for short to ground in CAN LOW signal harness in case of abnormal voltage measured between terminal "3" of the sensor cluster harness connector and chassis ground. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

CAN CIRCUIT RESISTANCE INSPECTION

1. Ignition "ON" & Engine "OFF".
2. Disconnet the HECU harness connector.
3. Measure resistance between terminal "25" of the HECU connector and terminal "29" of the HECU connector.

Specification : Approx. 120Ω

<F56>



25. CAN 'Low'
29. CAN 'High'

SGHBR7529L

4. Is the measured resistance within specifications?

YES

▶ Go to "Component Inspection" procedure.

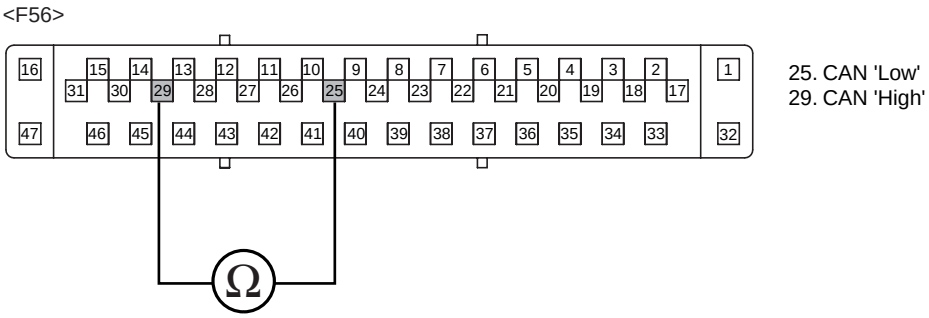
NO

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION E08A76DC

1. Ignition "OFF".
2. Disconnet the HECU harness connector.
3. Measure resistance between terminal "25" of the HECU harness connector and terminal "29" of the HECU harness connector.

Specification : Approx. 120Ω



SGHBR7529L

4. Are any DTCs present ?

YES

▶ Fault is intermittent caused by poor connection in sensor cluster harness or faulty sensor cluster. Go to "Verification of Vehicle Repair" procedure.

NO

▶ In case fo the resistance "approx. 1Ω " : Check for short in CAN signal harness between terminal "2" of the sensor cluster harness connector and terminal "3" of the sensor cluster harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.
▶ In case fo the resistance "∞ Ω " : Check for open in CAN signal harness between terminal "2" of the sensor cluster harness connector and terminal "3" of the sensor cluster harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.
▶ If there is no problem in harness condition, Substitute with a known-good sensor cluster and check for proper operation. If problem is corrected, replace sensor cluster and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR EE83FACA

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a Scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

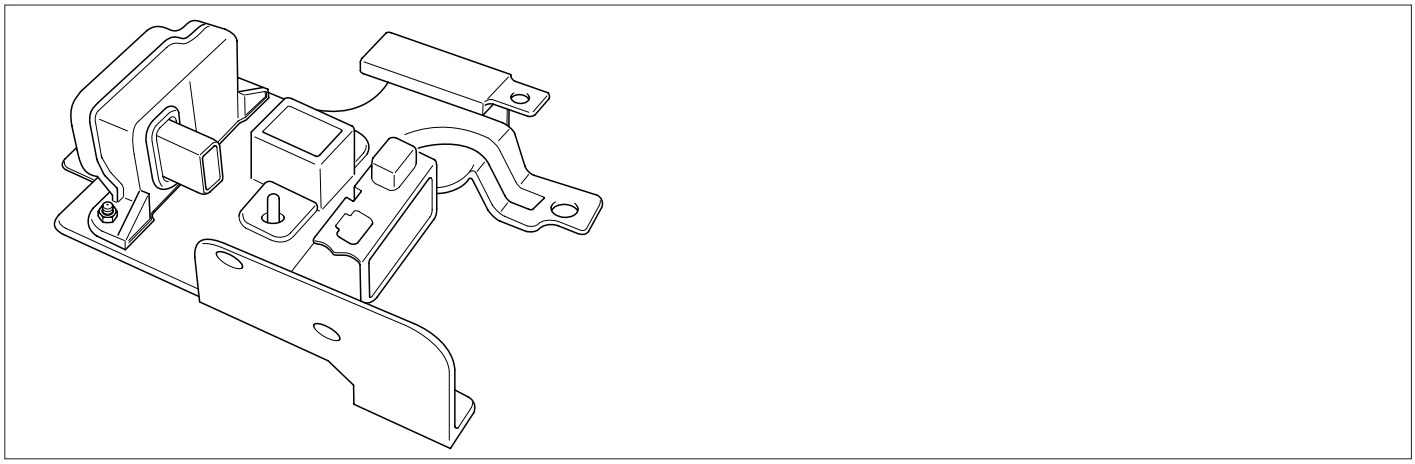
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1283 YAW RATE & LATERAL G SENSOR-SIGNAL

COMPONENT LOCATION E8CB2E1B



SGHBR6541D

GENERAL DESCRIPTION EC988461

The sensor cluster installed at floor under center console is composed of yaw rate sensor, lateral G sensor, microcontroller in a aluminum container.
When the vehicle is turning with respect to a vertical axis the yaw rate sensor detects the yaw rate electronicllly by the vibration change of plate fork inside the yaw rate sensor. If yaw velocity reaches the specific velocity(4deg/s) after it detects the vehicle' yawing, the ESP control is reactivated.
The yaw rate senser outputs 0V in case of a trouble.
Sensor cluster has a self diagnosis function, this information is outputted as yaw rate & lateral G signal to HECU through separate CAN.
The later G sensor senses vehicle's lateral G.
A small element inside the sensor is attached to a deflectable leverarm by later G. Direction and magnitude of lateral G loaded to vehicle can be known with electrostatic capacity changing according to lateral G.
The output voltage of the lateral G sensor is 2.5V when the vehicle is at a standstill. Only with lateral G sensor, the ESP can not be reactivated.

DTC DESCRIPTION EC41623F

The measured lateral acceleration is monitored if the vehicle is standing still and The lateral acceleration sensor signal offset is calculated and monitored by using a long time adjustment procedure.
A lateral acceleration reference signal is calculated from the wheel speeds, the steering angle and the yaw rate signals to observe the lateral acceleration sensor signal. The difference between the reference signal and the sensor signal is evaluated for failure detection.
The measured yaw rate sensor signal is monitored when the vehicle is standing still and the topical sensor signal value is latched once per loop if the signal is constant.
A yaw rate reference signal is calculated from the wheel speeds, the steering angle and the lateral acceleration signals to observe the yaw rate sensor signal. The difference between the reference signal and the sensor signal, and the gradient of the measured sensor signal is evaluated for the failure detection.
A DTC is set if one or more sensor signal among the above sensor signals is out of specified range.

DTC DETECTING CONDITION E4E7B1D2

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• Lateral Acceleration Sensor Signal Offset Monitoring	• Faulty Lateral Acceleration Sensor • Faulty Yaw Rate Sensor • Faulty HECU
	Monitoring Period	• Once per loop	
	Enable Conditions	• The measured lateral acceleration is monitored if the vehicle is standing still (vehicle speed < 1.0 kph). A failure is detected if |measured lateral acceleration| > 0.714G is continued for 0.1sec. • A failure is detected if the absolute value of the calculated lateral acceleration sensor signal offset is higher than 0.1734G for 7msec.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	
Case 2	DTC Strategy	• Lateral Acceleration Sensor Signal Plausibility Monitoring	
	Monitoring Period	• Once per loop if vehicle speed is above 10.8 kph, but not checked if the sensor signal is invalid (Sensor Cluster Status), during skidding or reverse driving.	
	Enable Conditions	• Constant speed without turning driving - A failure is detected if |The difference between the reference signal and the sensor signal| > 0.51G is continued for 0.5sec. • maneuvers with variable speed and steering - A failure is detected if |The difference between the reference signal and the sensor signal| > 1.12G is continued for 1.75sec.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	
Case 3	DTC Strategy	• Yaw Rate Sensor Signal Offset Monitoring	
	Monitoring Period	• Once per loop	
	Enable Conditions	• The measured yaw rate sensor signal is monitored when the vehicle is standing still. A failure is detected if the absolute value of the yaw rate sensor signal is continuously higher than 20°/s longer than 0.1sec or higher than 10°/s during the last 5.0s before vehicle drive-off. • A failure is detected during vehicle drive-off if the difference between the measured yaw rate sensor signal and the latched signal value during vehicle stand-still is higher than 13°/s. • A failure is detected if the absolute value of the calculated yaw rate sensor offset is higher than 6°/s for 7msec.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

Case 4	DTC Strategy	• Yaw Rate Sensor Signal Plausibility Monitoring	
	Monitoring Period	• Once per loop if vehicle speed is above 10.8 kph, but not checked if the sensor signal is invalid (Sensor Cluster Status), during skidding or reverse driving.	
	Enable Conditions	• Constant speed without turning driving - A failure is detected if |The gradient of the measured sensor signal| > 540°/s and |The difference between the reference signal and the sensor signal| > 10°/s are continued for 0.25sec. - A failure is detected if |The gradient of the measured sensor signal| < 540°/s and |The difference between the reference signal and the sensor signal| > 10°/s are continued for 0.5sec. • Fixed radius constant speed driving - A failure is detected if |The gradient of the measured sensor signal| > 540°/s and |The difference between the reference signal and the sensor signal| > 13°/s are continued for 0.25sec. - A failure is detected if |The gradient of the measured sensor signal| < 540°/s and |The difference between the reference signal and the sensor signal| > 13°/s are continued for 0.5sec. • Maneuvers with variable speed and steering - A failure is detected if |The gradient of the measured sensor signal| > 540°/s and |The difference between the reference signal and the sensor signal| > 53°/s are continued for 0.25sec. - A failure is detected if |The gradient of the measured sensor signal| < 540°/s and |The difference between the reference signal and the sensor signal| > 53°/s are continued for 1.75sec.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA EB82F557

1. Connect scantool to Data Link Connector(DLC)
2. Ignition "ON" & Engine "ON".
3. Maintain the vehicle standing still.
4. Monitor the "Lateral Acceleration Sensor, Yaw Rate Sensor" parameter on the Scantool.

Specification :
Approx. Lateral Acceleration Sensor : -0.01G
Approx. Yaw Rate Sensor : -1 deg/s

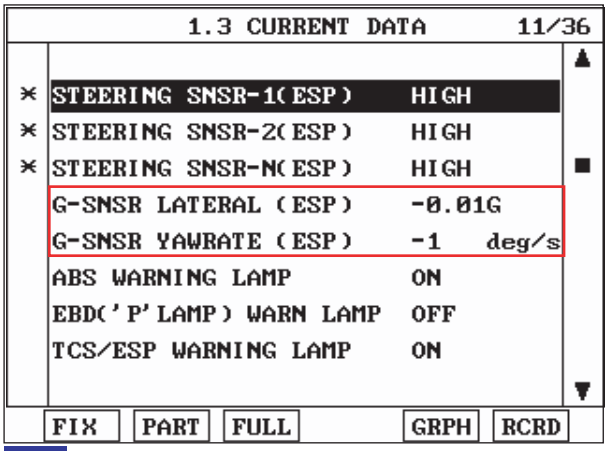


Fig1

Fig 1) Test Condition : Engine "ON".
Normal data

SGHBR7531L

5. Is parameter displayed within specifications?

YES

▶ Fault is intermittent caused by faulty sensor cluster and/or faulty HECU or was repaired and HECU memory was not cleared. Go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Component Inspection" procedure.

COMPONENT INSPECTION E2828D2C

1. Ignition "OFF".
2. Ignition "ON".
3. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
4. Using a scantool, Clear DTC.
5. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed at or above 20km/h. (12.4mph))
6. Select "Diagnostic Trouble Codes(DTCs)" mode again.
7. Are any DTCs present ?

YES

1) Substitute with a known-good sensor cluster and check for proper operation. If problem is corrected, replace sensor cluster and then go to "Verification Of Vehicle Repair" procedure.
2) Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is intermittent caused by poor connection in sensor cluster harness or faulty sensor cluster. Go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR EBDCABF1

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed at or above 20km/h. (12.4mph))
4. Are any DTCs present ?

YES

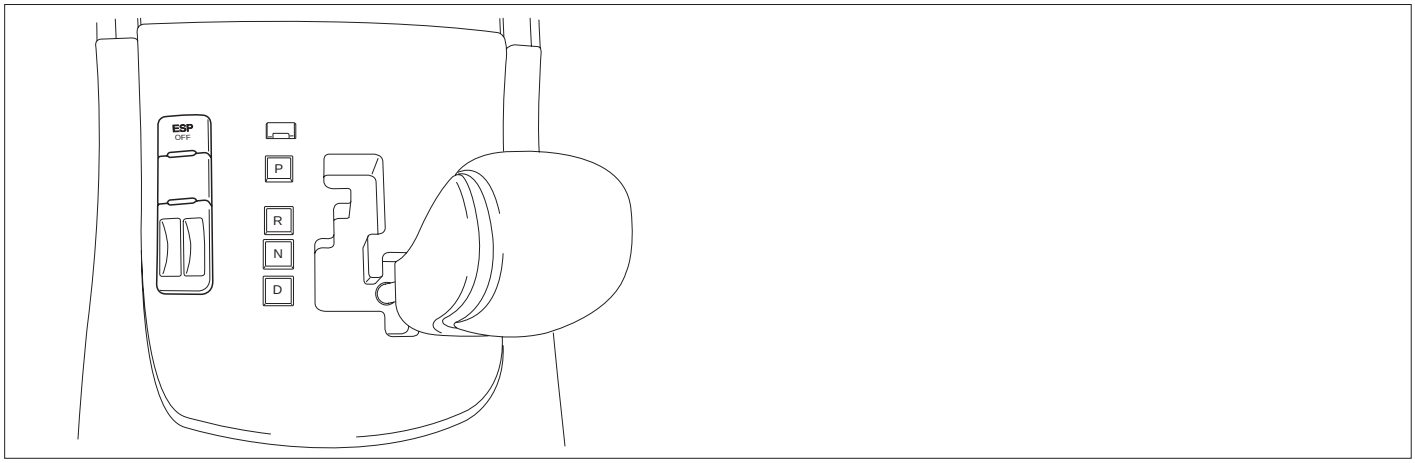
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1503 TCS/ESP SWITCH ERROR

COMPONENT LOCATION E6FAA1DC



SGHBR7542L

GENERAL DESCRIPTION E4CC9CC3

The ESP switch is used to temporarily deactivate ESP control.

DTC DESCRIPTION ED8A0464

Trouble code is set when the condition that the level of TCS/ESP switch is low is continued for 60sec. When the TCS/ESP switch failure is set, Warning lamps won't illuminate and HECU inhibits the TCS/ESP control and allow the ABS/EBD control.

DTC DETECTING CONDITION EDC32158

Item	Detecting Condition	Possible cause
DTC Strategy	• Fixation Monitoring	• Short of TCS/ESP off switch circuit • Faulty TCS/ESP off switch
Monitoring Period	• Continuous (once per loop)	
Enable Conditions	• In case of the signal from TCS/ESP off switch continuously on for 60 sec.	
Fail Safe	• HECU cancels TCS/ESP off mode. Permit TCS/ESP control after detecting switch failure. • The ABS/EBD/TCS/ESP warning lamps are not activated. • If the failure condition of TCS/ESP off switch is restored and signal changes on/off, then ECU uses the signal from ESP/TCS off switch again.	

MONITOR SCANTOOL DATA E243A19C

1. Connect scantool to Data Link Connector(DLC)
2. Ignition "ON" & Engine "OFF".
3. Press the TCS/ESP off switch.
4. Monitor the "TCS/ESP switch" parameter on the scantool.

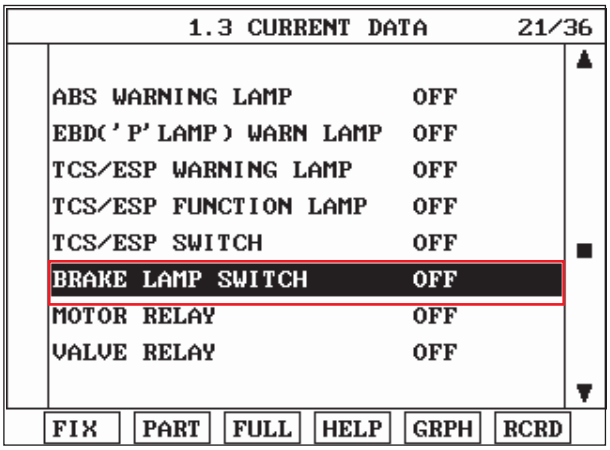


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "OFF".
Normal data

SGHBR7532L

5. Whenever TCS/ESP off switch is pushed down, is the TCS/ESP off switch's scantool data changed ON/OFF?

YES

▶ Fault is intermittent caused by poor connection in TCS/ESP off switch harness and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION EF9D5AEE

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

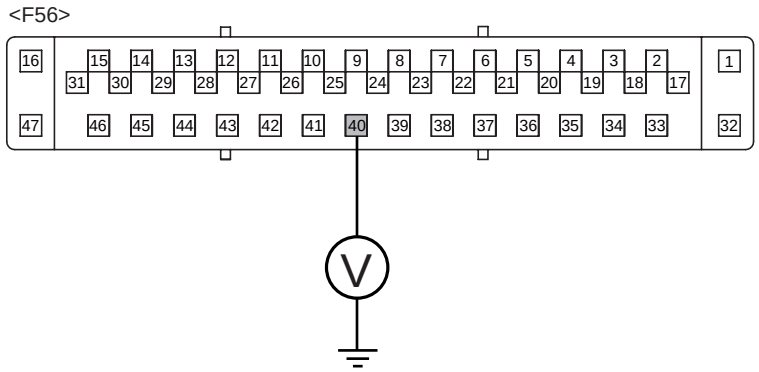
NO

▶ Go to "Signal circuit inspection" procedure.

SIGNAL CIRCUIT INSPECTION EFB9D0C0

1. Ignition "ON" & Engine "OFF".
2. Press the TCS/ESP off switch.
3. Measure voltage between the terminal "40" of the HECU harness connector and chassis ground.

Specification : Approx. 0V



40. TCS/ESP off switch

SGHBR7533L

4. Is the measured voltage within specifications?

YES

▶ Go to "Component Inspection" Procedure.

NO

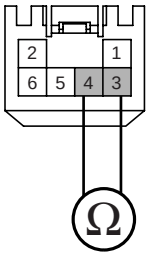
▶ Check for damaged harness and poor connection in the power harness between the chassis ground and the terminal "40" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, Go to "Component Inspection" Procedure.

COMPONENT INSPECTION E054D7BE

1. Ignition "OFF".
2. Disconnect TCS/ESP switch connector.
3. Press the TCS/ESP switch.
4. Measure resistance between terminal "3" of the TCS/ESP switch harness connector and terminal "4" of the TCS/ESP switch harness connector.

Specification :
Approx. below 1Ω - ESP switch is depressed.
Approx. ∞ Ω - ESP switch is not depressed.

<M92>



3. SIGNAL
4. GROUND

SGHBR7534L

5. Is the measured resistance within specifications?

YES

▶ Fault is intermittent caused by faulty TCS/ESP switch or was repaired and HECU memory was not cleared. Go to "Verification of Vehicle Repair" procedure.

NO

▶ Substitute with a known-good TCS/ESP switch and check for proper operation. If problem is corrected, replace TCS/ESP switch and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E84EDEE2

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

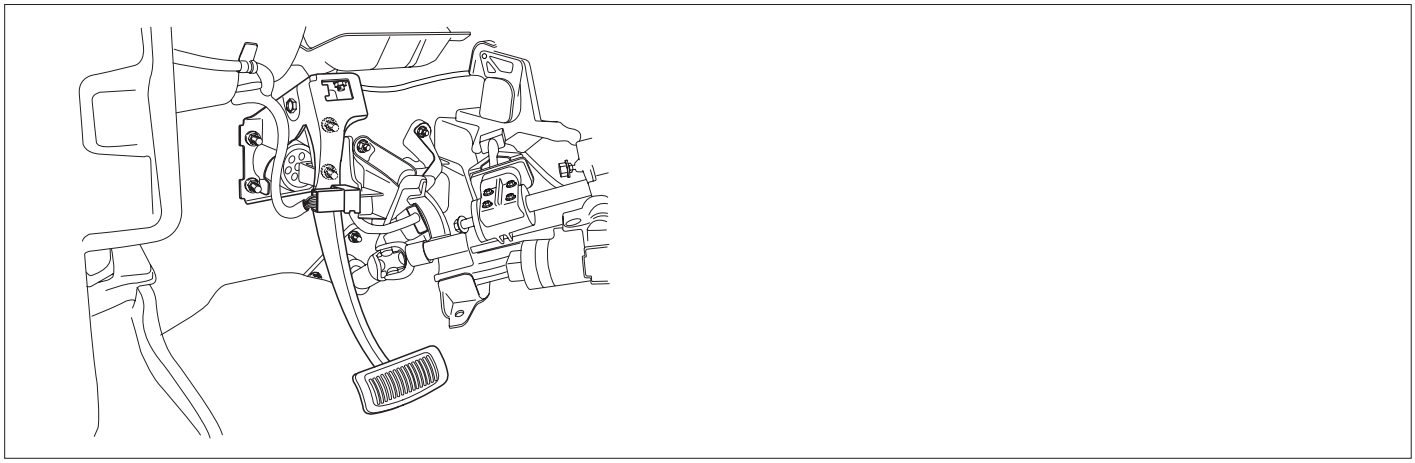
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1513 BRAKE SWITCH ERROR

COMPONENT LOCATION ECC0E6B7



SGHBR6553D

GENERAL DESCRIPTION EB975A2B

The brake light switch indicates brake pedal status to the ABS control unit. The switch is turned on when brake is depressed. The brake light switch is a normally-open contact which runs to battery voltage when active (brake depressed).

DTC DESCRIPTION E630055F

The brake light signal is a reference to judge driver's intention for braking. ABS ECU monitor open circuit of brake light switch for normal ABS control.

DTC DETECTING CONDITION E65F3E07

Item	Detecting Condition	Possible cause
DTC Strategy	• Plausibility Monitoring	• Open or short of brake light switch circuit • Faulty brake light switch
Monitoring Period	• Continuous (once per loop)	
Enable Conditions	• This code is set if the BLS is continuously active for more than 6 minutes when driving faster than 20 kph. • This code is set if no signal change from inactive to active brake light switch was detected after three cycles of acceleration up to a vehicle speed higher than 40 kph and deceleration down to a vehicle speed lower than 3 kph.	
Fail Safe	• The ABS/EBD/TCS/ESP functions are not inhibited. Fault recording for diagnostic purpose occurs immediately. • The ABS/EBD/TCS/ESP warning lamps are not activated.	

MONITOR SCANTOOL DATA E9B74007

1. Connect scantool to Data Link Connector(DLC)
2. Ignition "ON" & Engine "OFF".
3. Press the brake pedal.
4. Monitor the "Brake lamp switch" parameter on the scantool.

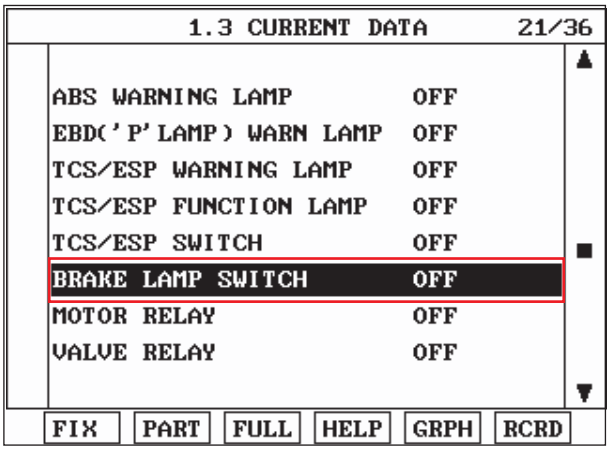


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "OFF".
Normal data

SGHBR7553N

5. Whenever Brake pedal is pushed down, is the brake lamp switch's scantool data changed ON/OFF?

YES

▶ Fault is intermittent caused by poor connection in brake light switch line and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION E8FC1D0C

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

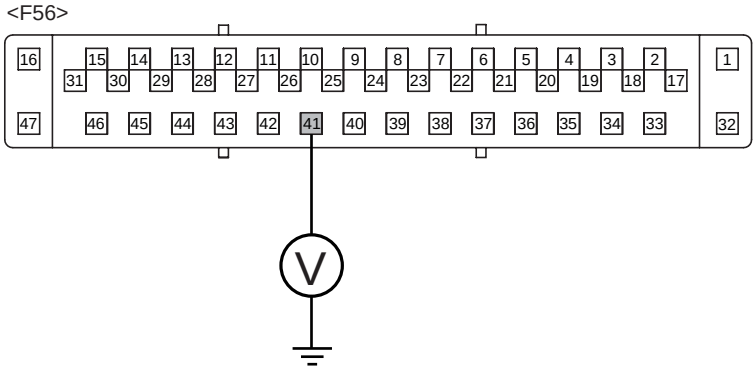
NO

▶ Go to "Signal circuit inspection" procedure.

SIGNAL CIRCUIT INSPECTION (BRAKE PEDAL ISN'T DEPRESSED) E887AD2D

1. Ignition "ON" & Engine "OFF".
2. Don't press the brake pedal.
3. Measure voltage between the terminal "41" of the HECU harness connector and chassis ground.

Specification : Brake Light Switch - Approx. 0V



41. Brake Light Switch

SGHBR7554N

4. Is the measured voltage within specifications?

YES

▶ Go to "Signal Circuit Inspection (brake pedal is depressed)" procedure.

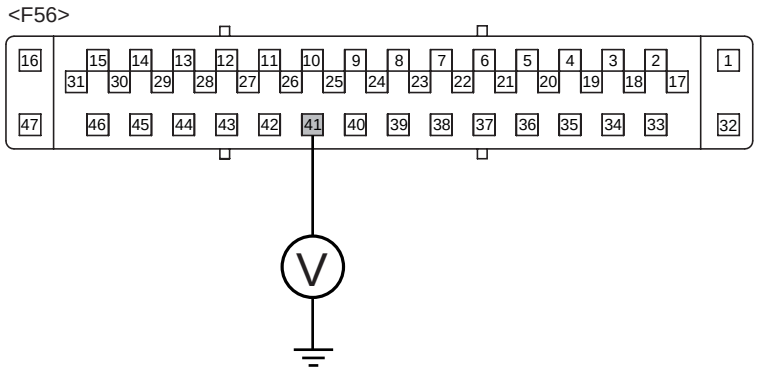
NO

▶ Check for open or blown 15A fuse referring to "Circuit Diagram". Check for open or short to battery between the battery terminal(+) and the terminal "41" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, Go to "Component Inspection" Precedure.

SIGNAL CIRCUIT INSPECTION (BRAKE PEDAL IS DEPRESSED)

1. Ignition "ON" & Engine "OFF".
2. Press the brake pedal.
3. Measure voltage between the terminal "41" of the HECU harness connector and chassis ground.

Specification : Brake Light Switch - Approx. B+



41. Brake Light Switch

SGHBR7554N

4. Is the measured voltage within specifications?

YES

▶ Fault is intermittent caused by open or short harness in brake light switch, faulty brake light switch or was repaired and HECU memory was not cleared. Go to "Verification Of Vehicle Repair" procedure.

NO

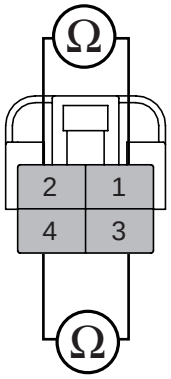
▶ Check for open or short to ground between the battery terminal(+) and the terminal "30" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ If OK, Go to "Component Inspection" Precedure.

COMPONENT INSPECTION EDE8A1F6

1. Ignition "OFF".
2. Disconnect brake switch connector.
3. Measure resistance between the terminal "1, 2", "3, 4" of the brake switch.

Specification :
Resistance between the terminal "1, 2" of the brake switch - ∞Ω (when the plunger is pushed down), 0Ω (when the plunger isn't pushed down).
Resistance between the terminal "3, 4" of the brake switch - ∞Ω (when the plunger is not pushed down), 0Ω (when the plunger is pushed down).

<F36>



1. brake light switch signal
2. brake light switch power supply
3. brake switch signal
4. brake switch power supply

SGHBR7555N

4. Is the measured voltage within specifications?

YES

▶ Fault is intermittent caused by open or short harness in brake light switch, faulty brake light switch or was repaired and HECU memory was not cleared. Go to "Verification Of Vehicle Repair" procedure.

NO

▶ Substitute with a known-good brake lamp switch and check for proper operation. If problem is corrected, replace brake light switch and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E4D2457C

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a Scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

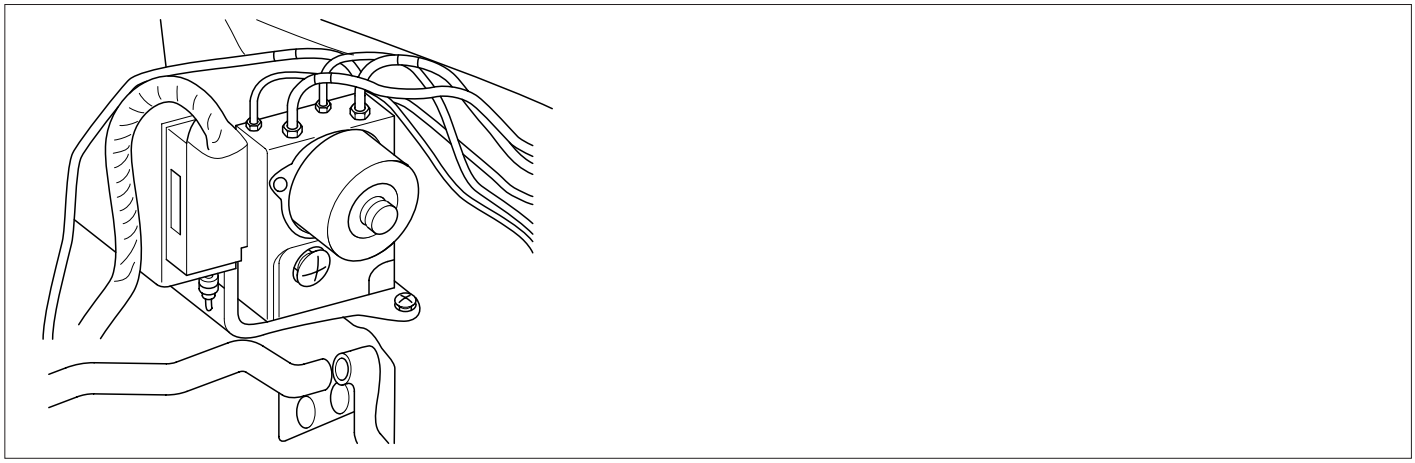
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1604 ECU HARDWARE ERROR

COMPONENT LOCATION E25CCAE9



SGHBR6559D

GENERAL DESCRIPTION EFBAD455

The HECU consists of an ECU (Electronic Control Unit) and a HCU(Hydraulic Control Unit).
The HCU portion of the assembly contains a pump motor, solenoid valves, and accumulator.
Increase and decrease of hydraulic pressure is opreated by electronic motor, according to a measured signal by wheel speed sensor.
The function of HCU is to increase, decrease or maintain the hydralic pressure supplied to a wheel cylinder by operating return pump according to HECU control signal while ABS control is active.
The ECU monitors various sensor and switch inputs.
These inputs are used to make decisions regarding HCU component operation.

DTC DESCRIPTION EF4B9ACB

This trouble code is set when the solenoid valves or operating circuit are malfunctioning as well as the trouble of HECU. The HECU moitors the operation of the valves by checking the drive circuit of the solenoid valves,and then sets this code when the unexpcted drain voltage is detected, and also sets this code when the HECU module itself is out of order. For example, when the EEPROM data read by master processor is different from the data sent before, or when the master/slave processor detects abnormal operation in RAM, Status Register, Interrupt ,Timer, A/D converter, cycle time,the HECU sets this code.

DTC DETECTING CONDITION EEFBDCB9

Item		Detecting Condition	Possible cause
Case 1	DTC Strategy	• EEPROM Check	• Faulty HECU
	Monitoring Period	• Once per loop during EEPROM write access	
	Enable Conditions	• The MCU checks the specified programming time with every write access to the EEPROM. The EEPROM device has to set a logical signal if a write procedure is completed. A failure is detected if this logical signals fails.	
	Fail Safe	• The ABS/TCS/ESP functions are deactivated. • The ABS/TCS/ESP warning lamps are activated.	
Case 2	DTC Strategy	• Monitoring the Valve Solenoids	
	Monitoring Period	• once every 200 to 300 ms	
	Enable Conditions	• A failure is detected if the valve relay is switched off and the reference voltage of solenoid valve ＞ 1.5V continuously for 56ms. • A failure is detected if the voltage drop at the activated low-side driver exceeds 2.0V or the voltage drop at one or more deactivated low-side drivers does not reach 2.0V continuously for 56ms.	
	Fail Safe	• The ABS/EBD/TCS/ESP functions are deactivated. • The ABS/EBD/TCS/ESP warning lamps are activated.	
Case 3	DTC Strategy	• Temperature Sensor Monitoring	
	Monitoring Period	• Cyclic every 1sec	
	Enable Conditions	• A temperature sensor failure is detected if the failure event has occurred 5 times.	
	Fail Safe	• The temperature value is set to -30 °C. • The all warning lamps are not activated.	
Case 4	DTC Strategy	• Long-Time Monitoring of the ESP Function	
	Monitoring Period	• once per loop during active ESP	
	Enable Conditions	• A failure is detected if the ESP function is active for more than 15s without a direction change of the calculated additional yaw torque.	
	Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

TERMINAL AND CONNECTOR INSPECTION EDBBE493

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.

2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Component Inspection" procedure.

COMPONENT INSPECTION EE0648AC

1. Ignition "OFF".
2. Ignition "ON".
3. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
4. Using a scantool, Clear DTC.
5. Select "Diagnostic Trouble Codes(DTCs)" mode again.
6. Are any DTCs present ?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR EB8ECBAF

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

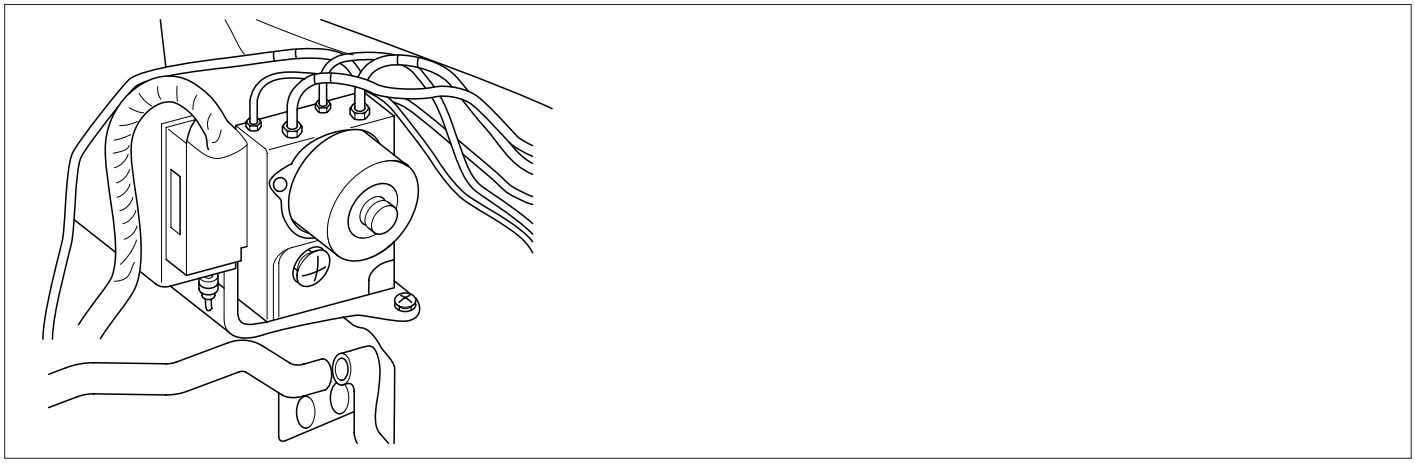
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1611 CAN TIME-OUT ECM

COMPONENT LOCATION EA2D1AFF



SGHBR6559D

GENERAL DESCRIPTION EFA8212E

The HECU sends requirement data, such as Torque reduction, the number of fuel cut cylinders, and ESP control requests, to the Engine PCM(ECM & TCM) through CAN bus line.
The Engine PCM(ECM) performs fuel cut functions according to requests from the HECU and retards ignition timing by torque reduction requests.
The PCM(TCM) maintains current gear positions during ESP control time, in order not to increase power which causes a Kickdown shift.

DTC DESCRIPTION E0D50D5F

The HECU checks the CAN communcation lines for normal TCS control, and sets this code if an ECM message is not received within 500ms. The HECU does not detect this code until 1.5 seconds after the IG KEY is turned to ON.

DTC DETECTING CONDITION E0926CF2

Item	Detecting Condition	Possible cause
DTC Strategy	• CAN Message Timeout Monitoring	• Faulty PCM(ECM) • Faulty HECU
Monitoring Period	• Continuously(once per loop), but not check during detected high, low voltage or the first 1.5s after the HECU power on.	
Enable Conditions	• The time between received valid CAN messages from the Engine ECU is monitored by the HECU. A failure is detected if the monitoring time exceeds appox. 500ms since last valid CAN message has been received.	
Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

TERMINAL AND CONNECTOR INSPECTION E4D78084

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

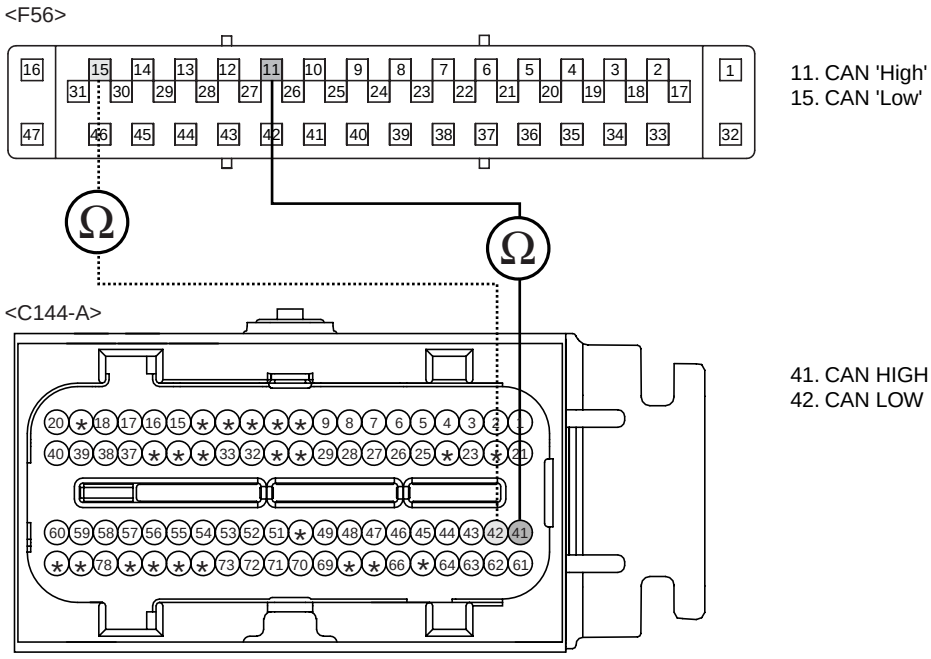
NO

▶ Go to "Signal circuit inspection" procedure.

SIGNAL CIRCUIT INSPECTION E054D8BE

1. Ignition "OFF" & Engine "OFF".
2. Disconnect HECU and PCM connector.
3. Measure resistance between the terminal "11, 15" of the HECU harness connector and the terminal "41, 42" of the PCM harness connector.

Specification : Approx. 0Ω



SGHBR7535L

4. Is the measured resistance within specifications?

YES

▶ Go to "Component inspection" procedure.

NO

▶ Check for open betweenthe terminal "11, 15" of the HECU harness connector and the terminal "41, 42" of the PCM harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

COMPONENT INSPECTION E4CF80A5

1. Ignition "OFF".
2. Ignition "ON".
3. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
4. Using a scantool, Clear DTC.
5. Select "Diagnostic Trouble Codes(DTCs)" mode again.
6. Are any DTCs present ?

YES

▶ Substitute with a known-good PCM(ECM) and check for proper operation. If problem is corrected, replace PCM(ECM) and then go to "Verification Of Vehicle Repair" procedure.
If NG, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E8FC384E

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

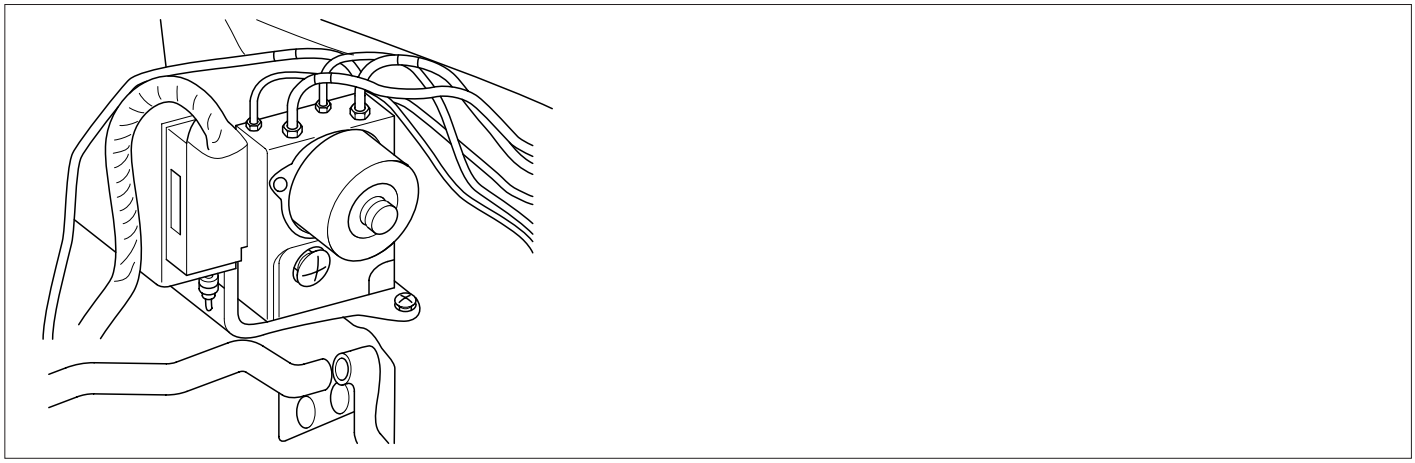
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1612 CAN TIME-OUT TCM

COMPONENT LOCATION EEB204B2



SGHBR6559D

GENERAL DESCRIPTION E7FDC1B0

The HECU sends requirement data, such as Torque reduction, the number of fuel cut cylinders, and ESP control requests, to the Engine PCM(ECM & TCM) through CAN bus line.
The Engine PCM(ECM) performs fuel cut functions according to requests from the HECU and retards ignition timing by torque reduction requests.
The PCM(TCM) maintains current gear positions during ESP control time, in order not to increase power which causes a Kickdown shift.

DTC DESCRIPTION E105233E

The HECU checks the CAN communcation lines for normal TCS control, and sets this code if a TCU message is not received within 500ms. The HECU does not detect this code until 1.5 seconds after the IG KEY is turned to ON.

DTC DETECTING CONDITION EBAA38DF

Item	Detecting Condition	Possible cause
DTC Strategy	• CAN Message Timeout Monitoring	• Faulty PCM(TCM) • Faulty HECU
Monitoring Period	• Continuously(once per loop), but not check during detected high, low voltage or the first 1.5s after the HECU power on.	
Enable Conditions	• The time between received valid CAN messages from the Transmission TCU is monitored by the HECU. A failure is detected if the monitoring time exceeds appox. 500ms since last valid CAN message has been received.	
Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

TERMINAL AND CONNECTOR INSPECTION E7AB5AC2

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

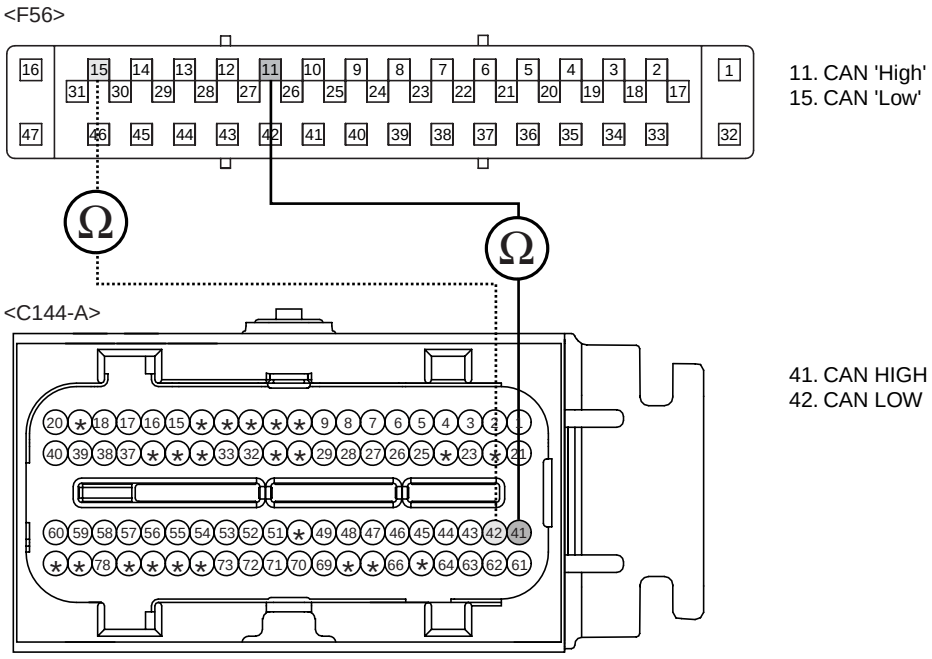
NO

▶ Go to "Signal circuit inspection" procedure.

SIGNAL CIRCUIT INSPECTION E054D9BE

1. Ignition "OFF" & Engine "OFF".
2. Disconnect HECU and PCM connector.
3. Measure resistance between the terminal "11, 15" of the HECU harness connector and the terminal "41, 42" of the PCM harness connector.

Specification : Approx. 0Ω



SGHBR7535L

4. Is the measured resistance within specifications?

YES

▶ Go to "Component inspection" procedure.

NO

▶ Check for open betweenthe terminal "11, 15" of the HECU harness connector and the terminal "41, 42" of the PCM harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

COMPONENT INSPECTION EB2B75C8

1. Ignition "OFF".
2. Ignition "ON".
3. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
4. Using a scantool, Clear DTC.
5. Select "Diagnostic Trouble Codes(DTCs)" mode again.
6. Are any DTCs present ?

YES

▶ Substitute with a known-good PCM(TCM) and check for proper operation. If problem is corrected, replace PCM(TCM) and then go to "Verification Of Vehicle Repair" procedure.
If NG, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E3EAD604

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

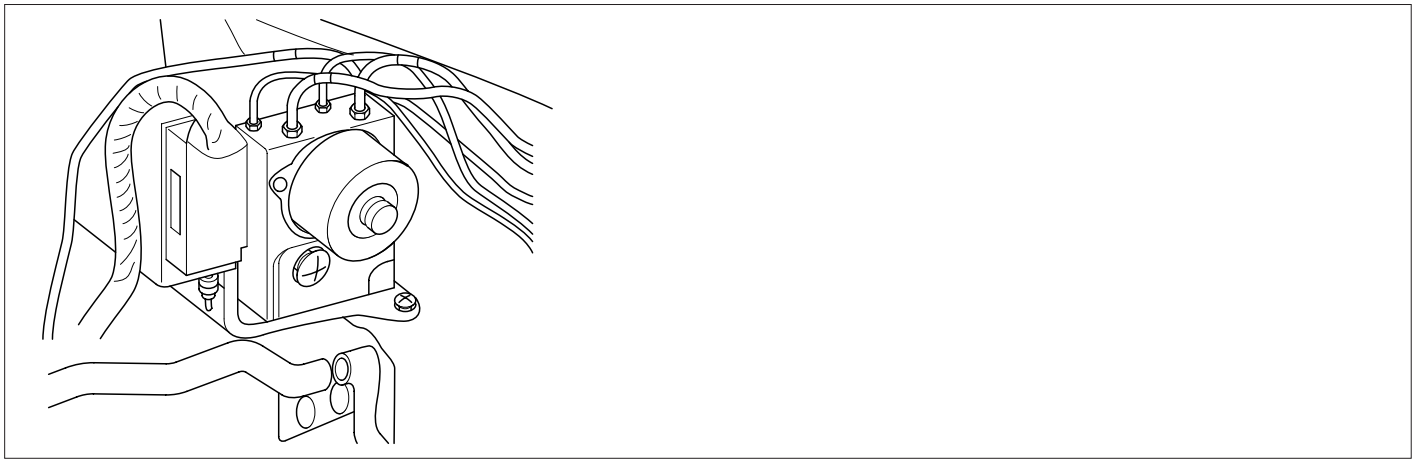
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1616 CAN BUS OFF

COMPONENT LOCATION E4BCDDD0



SGHBR6559D

GENERAL DESCRIPTION E3570A08

The HECU sends requirement data, such as Torque reduction, the number of fuel cut cylinders, and ESP control requests, to the Engine PCM(ECM & TCM) through CAN bus line.
The Engine PCM(ECM) performs fuel cut functions according to requests from the HECU and retards ignition timing by torque reduction requests.
The PCM(TCM) maintains current gear positions during ESP control time, in order not to increase power which causes a Kickdown shift.

DTC DESCRIPTION ECCEA179

The HECU monitor the CAN communication lines for normal TCS control, and sets this code if CAN BUS OFF status is detected.

DTC DETECTING CONDITION EFE7FC0D

Item	Detecting Condition	Possible cause
DTC Strategy	• CAN Bus off monitoring	• Open or short of CAN circuit • Faulty HECU
Monitoring Period	• Continuously(once per loop), but not check during detected high, low voltage or the first 1.5s after the HECU power on.	
Enable Conditions	• The HECU reset the CAN device after a CAN Bus Off event occurs. A failure is detected if the Bus Off event has occurred 15 times in succession.	
Fail Safe	• The TCS/ESP functions are deactivated. • The TCS/ESP warning lamps are activated.	

SIGNAL WAVEFORM & DATA EEBEBAA9

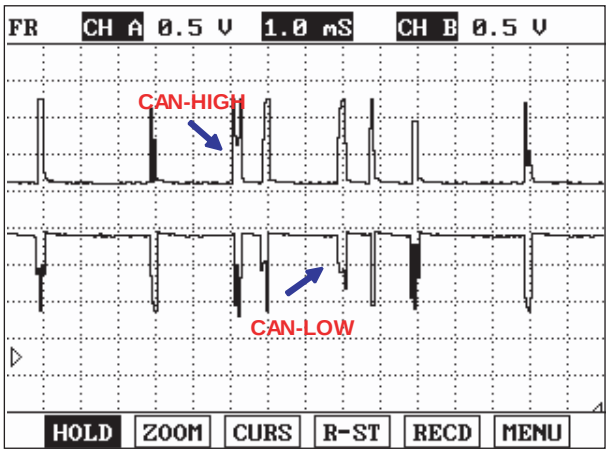


Fig1

Fig 1) Normal Waveform with Ignition "ON".

SGHBR7593N

TERMINAL AND CONNECTOR INSPECTION EBA1E6B0

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

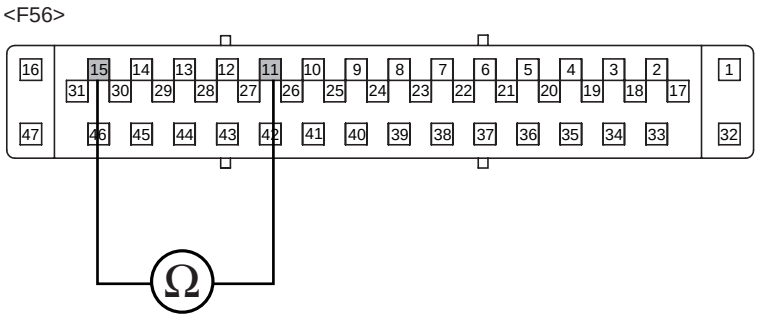
NO

▶ Go to "Signal Circuit Inspection" procedure.

SIGNAL CIRCUIT INSPECTION E977AE48

1. Ignition "OFF".
2. Disconnet the HECU harness connector.
3. Measure resistance between terminal "11" of the HECU harness connector and terminal "15" of the HECU harness connector.

Specification : Approx. 120Ω



SGHBR7556N

4. Is the measured resistance within specifications?

YES

▶ Go to "CAN Bus Short (to ground) Inspection" procedure.

NO

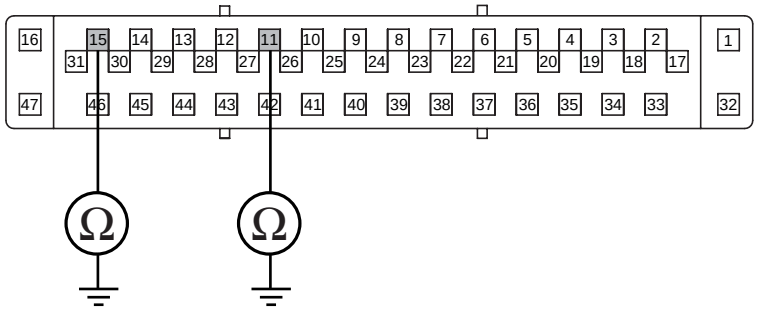
▶ Check for open or short in CAN signal harness between terminal "11" of the HECU harness connector and terminal "15" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

CAN BUS SHORT (TO GROUND) INSPECTION

1. Ignition "OFF".
2. Disconnet the HECU harness connector.
3. Measure resistance between terminal "11, 15" of the HECU harness connector and chassis ground.

Specification : Approx. ∞ Ω

<F56>



11. CAN 'High'
15. CAN 'Low'

SGHBR7557N

4. Is the measured resistance within specifications?

YES

▶ Go to "CAN Bus Short (to battery) Inspection" procedure.

NO

1) Check for short to ground in CAN HIGH signal harness in case of abnormal resistance measured between terminal "11" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

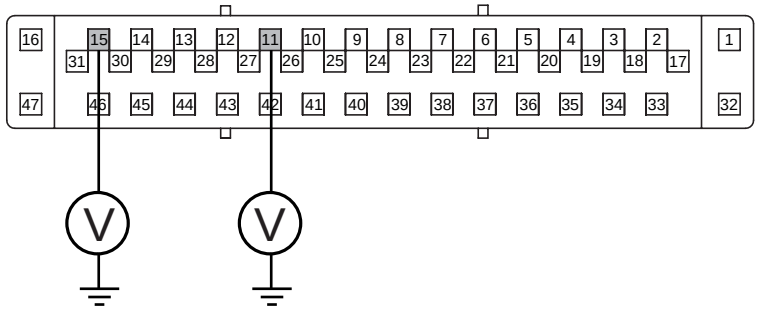
2) Check for short to ground in CAN LOW signal harness in case of abnormal resistance measured between terminal "15" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

CAN BUS SHORT (TO BATTERY) INSPECTION

1. Ignition "OFF".
2. Disconnet the HECU harness connector.
3. Measure voltage between terminal "11, 15" of the HECU harness connector and chassis ground.

Specification : Below. 0.2 V

<F56>



11. CAN 'High'
15. CAN 'Low'

SGHBR7558N

4. Is the measured voltage within specifications?

YES

▶ Go to "CAN Bus Short (between HIGH and LOW) Inspection" procedure.

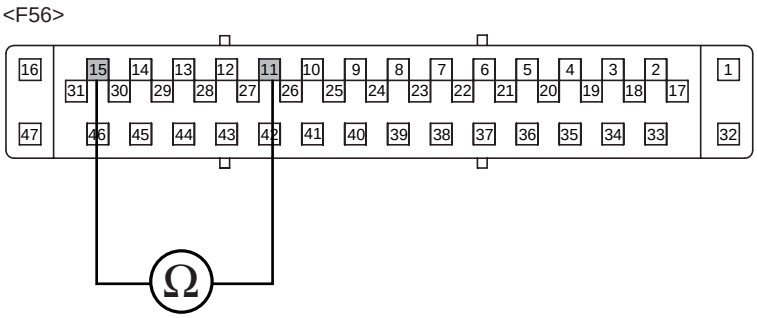
NO

▶ Check for short to battery in CAN HIGH signal harness in case of abnormal resistance measured between terminal "11" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.
▶ Check for short to battery in CAN LOW signal harness in case of abnormal resistance measured between terminal "15" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

CAN BUS SHORT (BETWEEN HIGH AND LOW) INSPECTION

1. Ignition "OFF".
2. Disconnet all the connetor related to CAN such as HECU, PCM, EPS, ECS harness connector.
3. Measure resistance between terminal "11, 15" of the HECU harness.

Specification : Approx. ∞ Ω



SGHBR7556N

4. Is the measured resistance within specifications?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Check for short in CAN signal harness between terminal "11" of the HECU harness connector and terminal "15" of the HECU harness connector. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

COMPONENT INSPECTION EF6BEBAB

1. Ignition "OFF".
2. Ignition "ON".
3. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
4. Using a scantool, Clear DTC.
5. Select "Diagnostic Trouble Codes(DTCs)" mode again.
6. Are any DTCs present ?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR EDFFB188

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

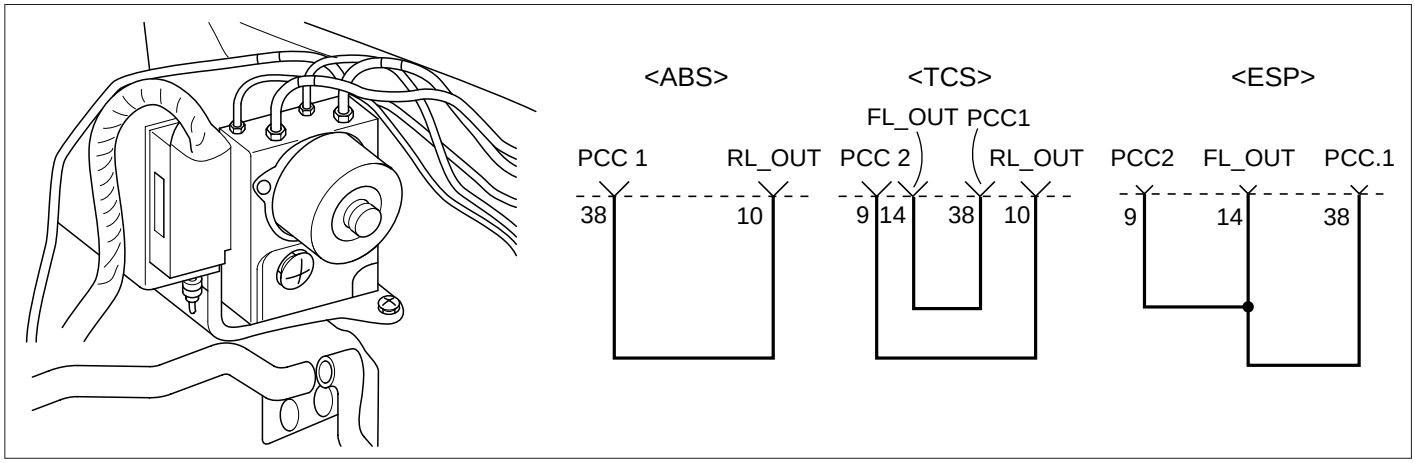
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C1700 BYTE CODING ERROR

COMPONENT LOCATION E205C642



SGHBR7538L

GENERAL DESCRIPTION E2BC7E15

A special coding by means of a vehicle specific contact bridge in the cable harness = pin coding provides verification capability of compliance between vehicle and parameter setting.
The stored parameter setting and the contact bridge are rechecked with each power-on or software reset.

DTC DESCRIPTION EFA83A7E

The voltage at the ignition line is monitored via a comparator. A failure is detected if the voltage stays below the comparator threshold longer than the specified min. fault duration.

DTC DETECTING CONDITION E443FC23

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitoring the Supply Voltage during Pin Code Comparison	• Open or short of pin coding circuit • Faulty HECU
Monitoring Period	• Once after each power-on or software reset	
Enable Conditions	• The voltage at the ignition line is monitored via a comparator. A failure is detected if the voltage stays below the comparator threshold (approx. 6.0 V) longer than one loop(7ms).	
Fail Safe	• Controller switch off. The ABS/EBD/TCS/ESP functions are inhibited. • The ABS/TCS/ESP warning lamps are activated.	

TERMINAL AND CONNECTOR INSPECTION EEAA95FA

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

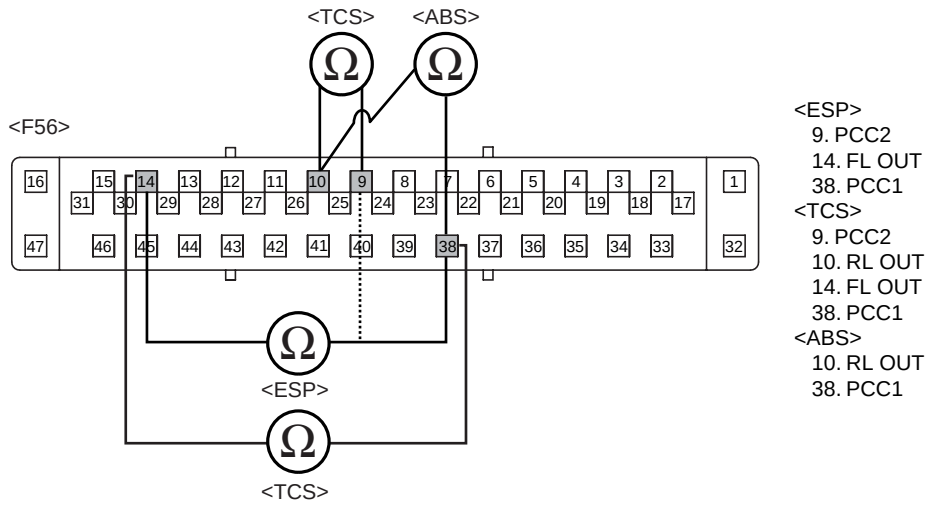
NO

▶ Go to "Signal Circuit Inspection" procedure.

SIGNAL CIRCUIT INSPECTION EBD65920

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal (ESP : 14 and 38, 14 and 9, TCS : 9 and 10, 14 and 38, ABS : 10 and 38) of the HECU harness connector.

Specification : Approx. below 1Ω



SGHBR7536L

4. Is the measured resistance within specifications?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Check for open or short to GND in pin coding harness. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

COMPONENT INSPECTION E25FFECC

1. Ignition "OFF".
2. Ignition "ON".
3. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
4. Using a scantool, Clear DTC.
5. Select "Diagnostic Trouble Codes(DTCs)" mode again.
6. Are any DTCs present ?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E6FFDA2A

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

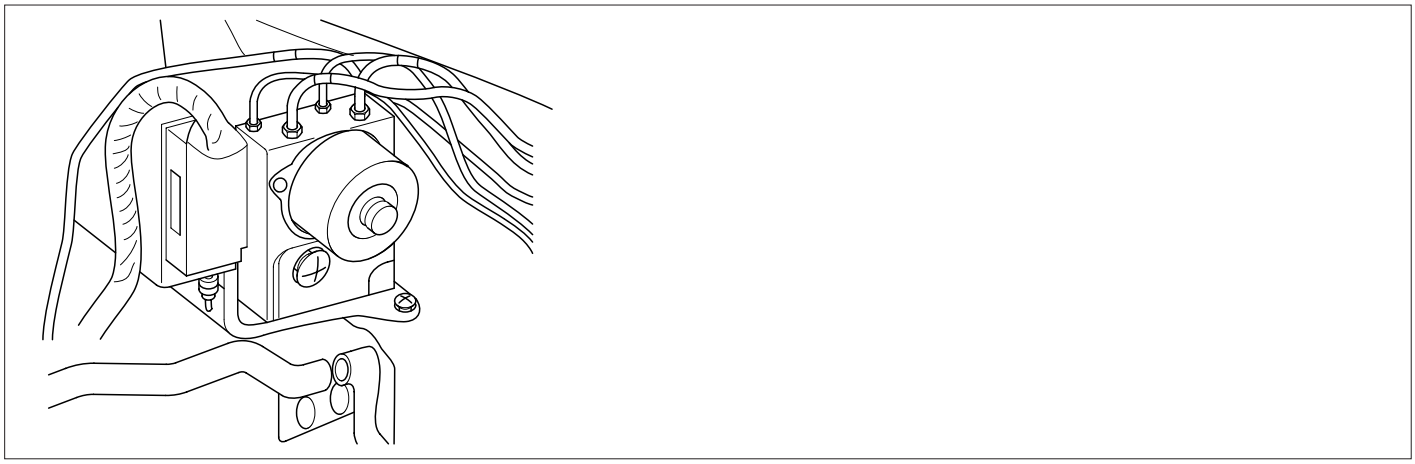
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C2112 VALVE RELAY ERROR

COMPONENT LOCATION EFCF318D



SGHBR6559D

GENERAL DESCRIPTION E83B79B0

The ABS ECU supplies battery power to all solenoid valves with a valve relay which is controlled by the Electronic Control UNIT(ECU). The valve relay and all solenoid valves are installed inside the HECU (Hydraulic and Electronic Control Unit).

DTC DESCRIPTION E178E35D

The ABS ECU monitors voltage of the solenoid valve relay to check if ABS ECU can perform ABS control normally. The HECU monitors the operation of the valves by checking the drive circuit of the solenid valves, and then sets this code when the unexpcted drive voltage is detected.

DTC DETECTING CONDITION EA182B81

Item		Detecting Condition	Possible cause
DTC Strategy		• Battery Voltage Monitoring	• Open or short of power supply circuit (ABS2) • Faulty HECU
Case1	Monitoring Period	• Continuously (once every 200 to 300 ms)	
	Enable Conditions	• If the valve relay is switched off and the reference voltage of solenoid valve > 3V continuously for 56ms, the failure is detected. • If the valve relay is switched on and the reference voltage of solenoid valve < 3V continuously for 56ms, the failure is detected.	
Case 2	Monitoring Period	• Once after power-on reset, during the initialization of HECU (FMON and PCU)	
	Enable Conditions	• A failure is detected if the solenoid valve relay is activated although the solenoid valve relay activation shall be inhibited by the HECU (PCU or FMON).	
Fail Safe		• Controller switch off. The ABS/EBD/TCS/ESP functions are inhibited. • The ABS/EBD/TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA EE4FEBED

1. Connect scantool to Data Link Connector(DLC)
2. Ignition "ON" & Engine "OFF".
3. Select the "Actuation Test" mode on the scantool.
4. Inspect operating status of all vlaves with Actuation Test.

Specification : It's normal if operating sound is heard.

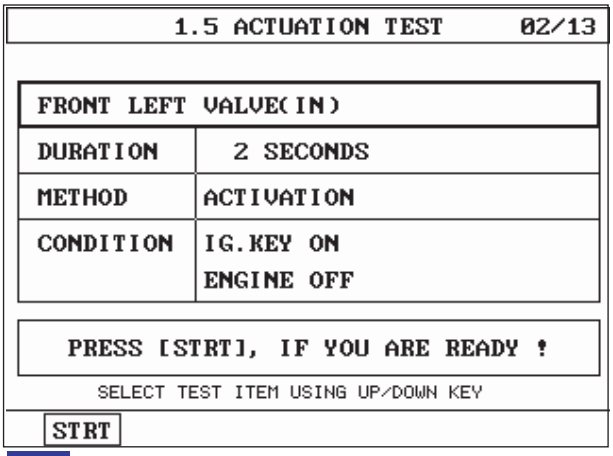


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "OFF".
Ex) Actuation Test on Front left valve(in)

SGHBR7559N

5. Do all valves operate normally?

YES

▶ Fault is intermittent caused by poor connection in power harness (ABS2) and/or HECU's connector or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION E3BAA39F

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

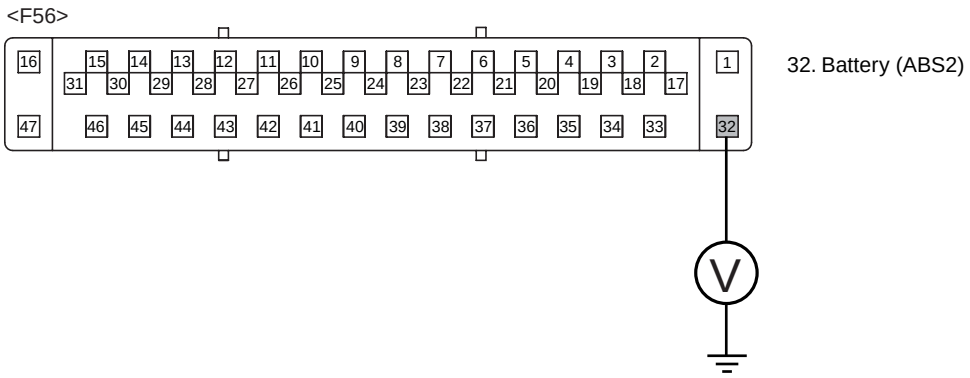
NO

▶ Go to "Power Circuit Inspection" procedure.

POWER CIRCUIT INSPECTION EBE7D7D3

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Ignition "ON" & Engine "OFF".
4. Measure voltage between terminal "32" of the HECU harness connector and chassis ground.

Specification : Approx. B+



SGHBR7560N

5. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

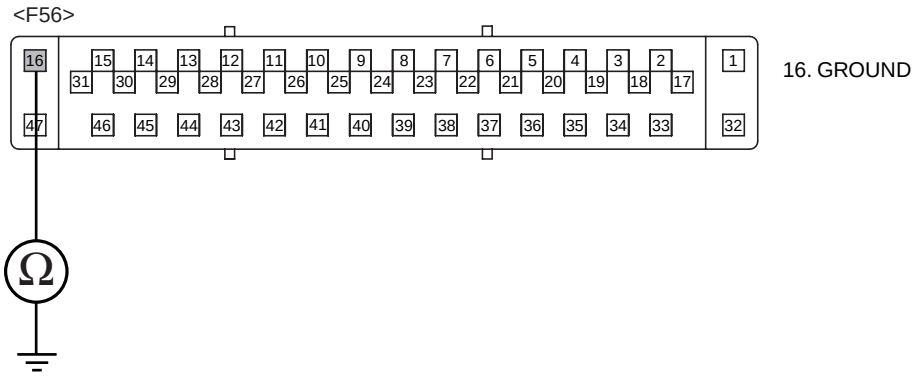
NO

▶ Check for damaged harness and open or short to GND between the battery terminal(+) and terminal "32" of the HECU harness connector. Check for open or blown 30A ABS2 fuse referring to "Circuit Diagram". Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION E26EDA8D

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "16" of the HECU harness connector and chassis ground.

Specification : Approx. below 1Ω



16. GROUND

SGHBR7561N

4. Is the measured resistance within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for damaged harness and poor connection between terminal "16" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR EBF8CACD

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

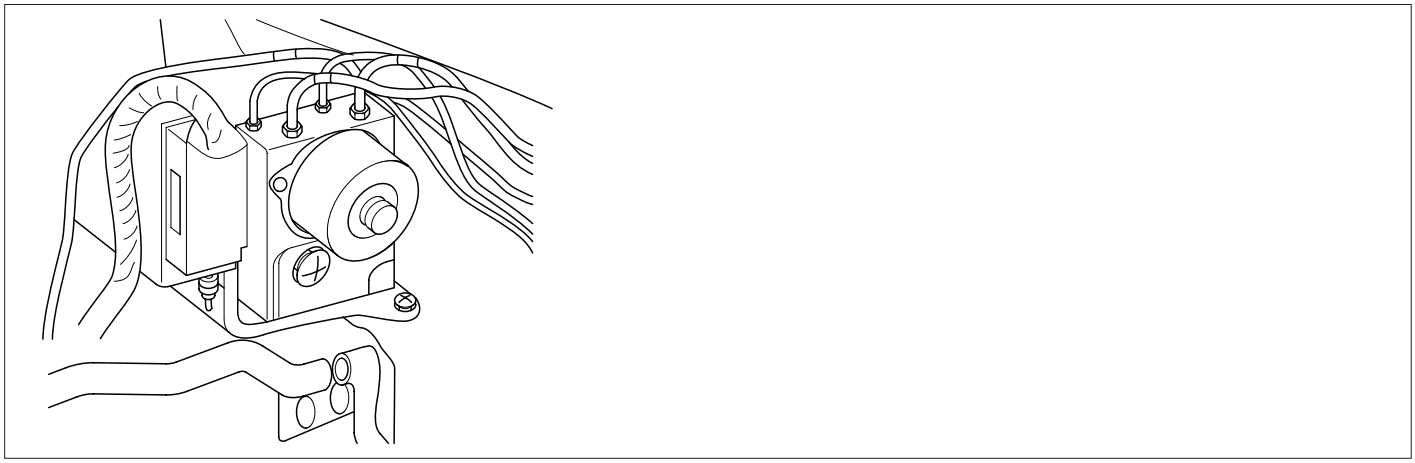
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C2227 EXCESSIVE TEMPERATURE OF BRAKE DISC

COMPONENT LOCATION ECF8E1F5



SGHBR6559D

GENERAL DESCRIPTION EDA1E690

The instantaneous brake disc temperature will be computed at the wheel brakes of all driven wheels with the following inputs : (1.vehicle and brake constants, 2.the vehicle speed, 3.all wheel speeds, 4.the computed brake pressure during active brake torque control, 5.the vehicle deceleration during braking with and without ABS control.)
A failure is detected if the computed brake disc temperature exceeds 500 °C at a minimum one wheel brake.
The BTCS remain deactivated until the computed brake disc temperature of all wheel brakes drops below 350 °C. With the ignition turned off, the ECU is supplied with energy via power supply voltage until the computed brake temperature at the driven wheels drops below 70 °C.

DTC DESCRIPTION E012C237

If the HECU decides that the Disc is over-heated (above 500 °C), then it turns the TCS lamp ON and inhibits BTCS operation to prevent overheating of the disc.
If the calculated temperature becomes lower than specified value (approx. 350 °C), then the HECU turns the TCS lamp OFF and operates the BTCS again.

DTC DETECTING CONDITION ECCDACAE

Item	Detecting Condition	Possible cause
DTC Strategy	• Brake Disc Temperature Monitoring	• Faulty HECU
Monitoring Period	• Continuously every 32 loops	
Enable Conditions	• A failure is detected if the computed brake disc temperature exceeds 500 °C at minimum one wheel brake.	
Fail Safe	• The BTCS remain deactivated until the computed brake disc temperature of all wheel brakes drops below 350 °C. • With the ignition turned off, the ECU is supplied with energy via power supply voltage until the computed brake temperature at the driven wheels drops below 70 °C. • The TCS/ESP warning lamps are activated.	

COMPONENT INSPECTION E5F9A2F4

1. Wait till the brake discs cool down sufficiently.
2. Ignition "OFF".
3. Ignition "ON" & Engine "OFF".
4. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
5. Using a scantool, Clear DTC.
6. Select "Diagnostic Trouble Codes(DTCs)" mode again.
7. Are any DTCs present ?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Fault is caused by Faulty HECU or was repaired and HECU memory was not cleared.
▶ The DTC code can be set by excessive TCS control in normal system status. Go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E521FA95

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.
4. Are any DTCs present ?

YES

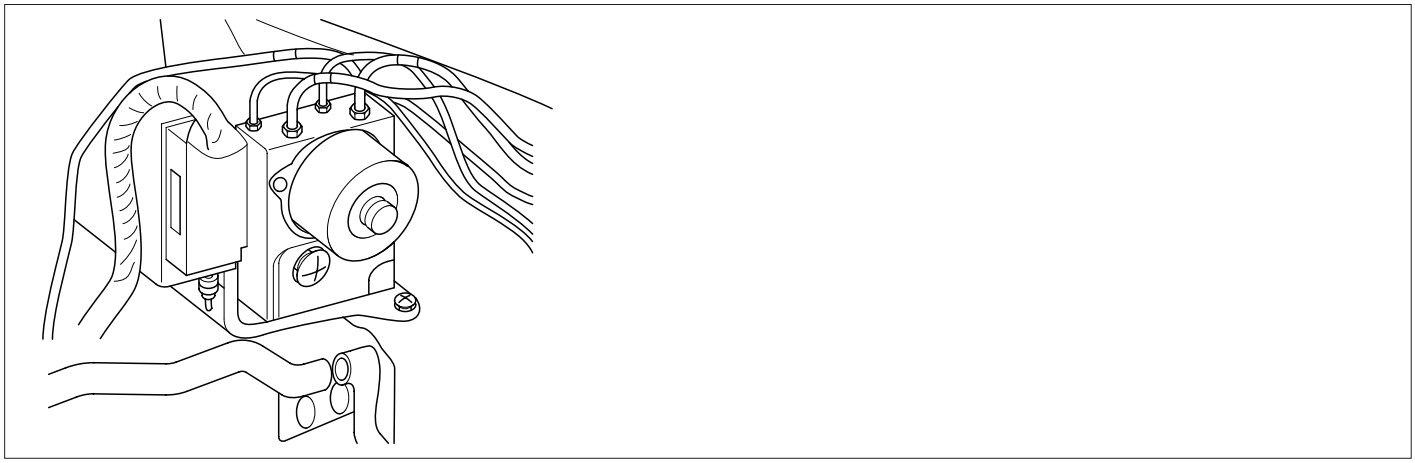
▶ Go to the applicable troubleshooting procedure.

NO

▶ System performing to specification at this time.

DTC C2402 MOTOR ELECTRICAL

COMPONENT LOCATION EF75E92C



SGHBR6559D

GENERAL DESCRIPTION EBAFD8DF

The ABS ECU supplies battery power to the electric motor with a motor relay which is controlled by the Electronic Control Unit(ECU).
The electric motor pump supplies hydraulic pressure to all wheel brake calipers by operating the piston inside the pump.

DTC DESCRIPTION E2AD4383

The ABS ECU monitors the pump motor relay or fuse open, open or short in motor or motor lock and then sets this code if a malfunction is detected.

DTC DETECTING CONDITION E8AB3F02

Item		Detecting Condition	Possible cause
DTC Strategy		• Voltage Monitoring	• Open or short of power supply circuit (ABS1) • Faulty HECU
Case 1	Monitoring Period	• Once per loop when pump motor is deactivated, but not check during detected high, low voltage or when the controller is switched off.	
	Enable Conditions	• A failure is detected if pump motor voltage > 0.93V continued for 1.8sec.	
Case 2	Monitoring Period	• Once per loop when pump motor is activated.	
	Enable Conditions	• A failure is detected if pump motor voltage < 7.3V continued for 1.8sec.	

Case 3	Monitoring Period	• Once per loop when pump motor is activated.	
	Enable Conditions	• A failure is detected if the short circuit event has continuously occurred 3 times. - The short circuit event is counted if pump switch voltage > 0.5V continued for about 1ms when the pump motor is activated • In case no electrical pump motor short circuit has been detected, a failure is detected if the mechanically locked pump event has continuously occurred 10 times. - A mechanically locked pump event is counted if pump switch voltage > 0.5V continued for about 20ms when the pump motor is activated.	
Case 4	Monitoring Period	• The active test is initiated by the controller once per IGN cycle in following conditions. 1) The vehicle speed exceeds 8 kph and the ABS warning lamp indicates that there was a failure detected during the previous IGN cycle. 2) The vehicle speed exceeds 20 kph and the brake is not applied. 3) The vehicle speed exceeds 40 kph. • The test is always done after the end of a pump activation by ABS/TCS/ESP functions.	
	Enable Conditions	• A defect of the pump is assumed if an insufficient generator voltage is detected within 14 or 21 ms after the deactivation. The pump motor will then be activated again for about 1.8 s (2nd pump test) and the generator voltage is evaluated again after deactivation. A failure is detected if this second evaluation also does not show sufficient generator voltage.	
Fail Safe		• When ABS is inactive - Inhibit pump motor activation, deactivate all control functions but EBD. • During active ABS control - Inhibit pump motor activation, deactivate all control functions but EBD on completion of ABS cycle. • The ABS/TCS/ESP warning lamps are activated.	

MONITOR SCANTOOL DATA E0CC6FC4

1. Connect scantool to Data Link Connector(DLC)
2. Ignition "ON" & Engine "OFF".
3. Select the "Actuation Test" mode on the scantool.
4. Inspect operating status of Motor with Actuation Test.

Specification : It's normal if operating sound is heard.

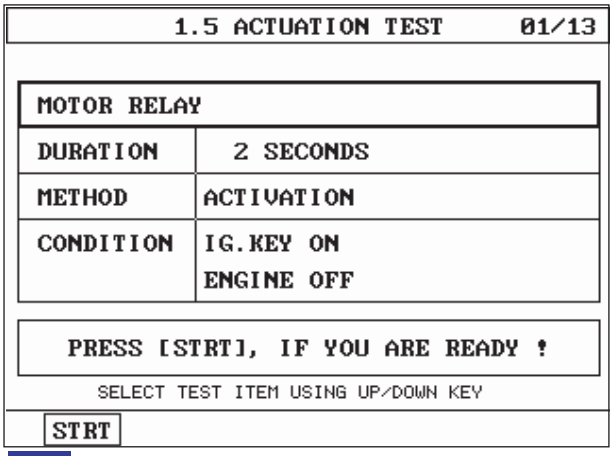


Fig1

Fig 1) Test Condition : Ignition "ON" & Engine "OFF".
Ex) Actuation Test on Motor

SGHBR7543L

5. Does motor operate normally?

YES

▶ Fault is intermittent caused by poor connection in motor circuit or was repaired and HECU memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Go to "Terminal and Connector Inspection" procedure.

TERMINAL AND CONNECTOR INSPECTION E3299D1A

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminal condition. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES

▶ Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

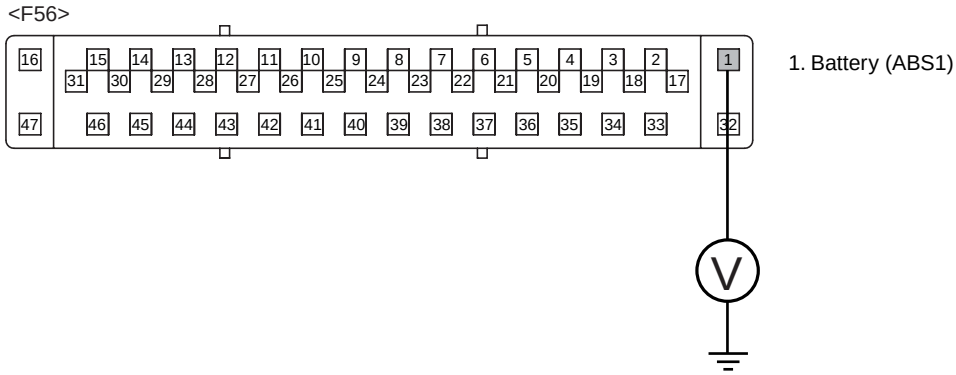
NO

▶ Go to "Power Circuit Inspection" procedure.

POWER CIRCUIT INSPECTION EE1CE44A

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Ignition "ON" & Engine "OFF".
4. Measure voltage between terminal "1" of the HECU harness connector and chassis ground.

Specification : Approx. B+



SGHBR7563N

5. Is the measured voltage within specifications?

YES

▶ Go to "Ground Circuit Inspection" procedure.

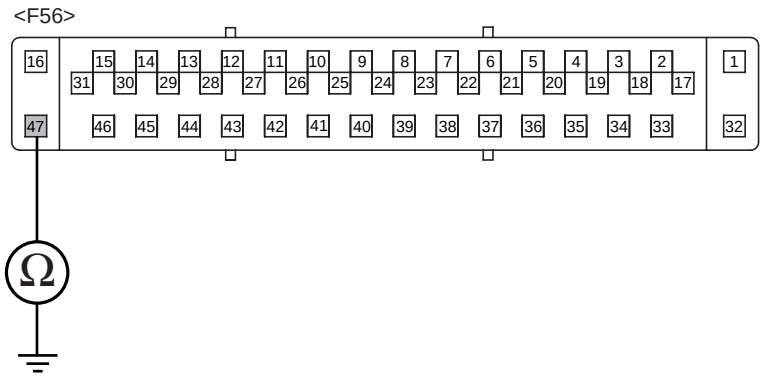
NO

▶ Check for damaged harness and open or short to GND between the battery terminal(+) and terminal "1" of the HECU harness connector. Check for open or blown 30A ABS fuse referring to "Circuit Diagram". Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION EBD0F97A

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "47" of the HECU harness connector and chassis ground.

Specification : Approx. below 1Ω



47. GROUND

SGHBR7564N

4. Is the measured resistance within specifications?

YES

▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification Of Vehicle Repair" procedure.

NO

▶ Check for damaged harness and poor connection between terminal "47" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification Of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR E5555D27

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed at or above 40km/h. (24.9mph)
4. Are any DTCs present ?

YES

▶ Go to the applicable troubleshooting procedure.

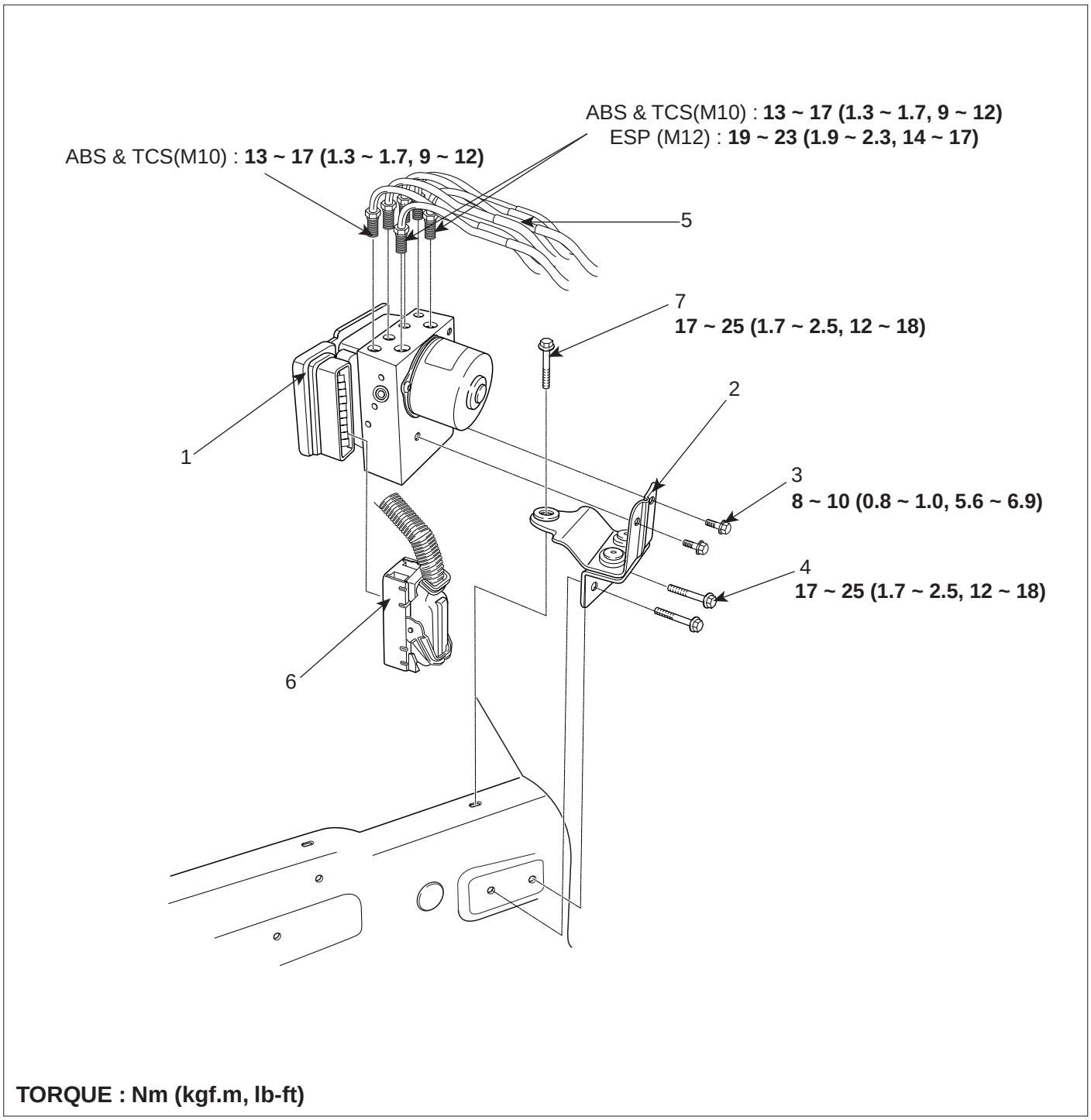
NO

▶ System performing to specification at this time.

ANTI-LOCK BRAKING SYSTEM CONTROL MODULE

HECU (HYDRAULIC AND ELECTRONIC CONTROL UNIT) EE9CEE2A

COMPONENTS



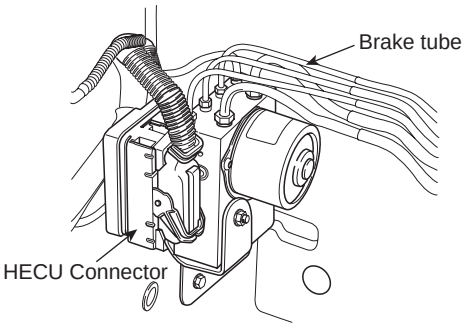
TORQUE : Nm (kgf.m, lb-ft)

1. HECU (Hydraulic & Electronic control unit)
2. HECU Bracket
3. HECU Bolt
4. Bracket bolt
5. Brake oil pipe
6. HECU Connector
7. Bracket bolt

SGHBR7565N

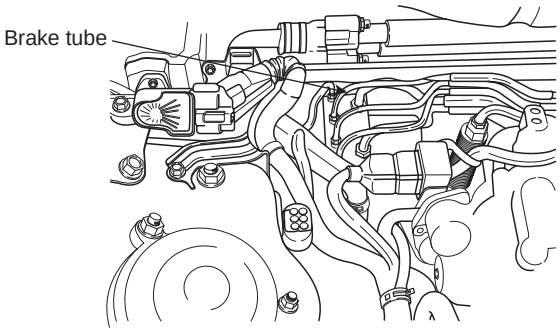
REMOVAL E0F910FE

1. Remove HECU (Hydraulic and Electronic Control Unit) connector.



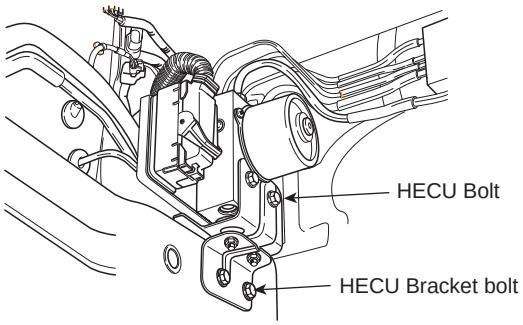
LJCD929A

2. Remove brake tubes from HECU.



LJCD929B

3. Remove HECU after loosening HECU bolt.



LJCD929C

CAUTION

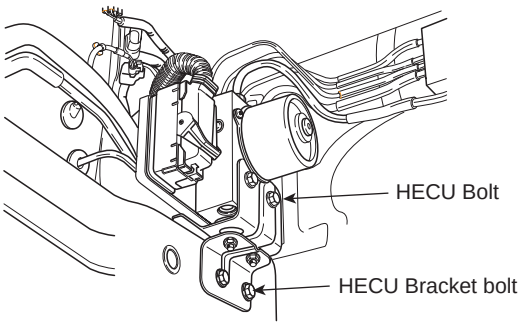
- ***Be careful to remove HECU because of too heavy.***
- ***Never attempt to disassemble the HECU.***
- ***The HECU must be transported and stored in an upright position and with the ports sealed.***

4. Remove HECU bracket if necessary.

REPLACEMENT EDCDCFE8

1. Tighten HECU bracket bolt.

Tightening torque
HECU bracket bolt : 17~25 N.m (1.7~2.5 kgf.m, 12-18 lb-ft)



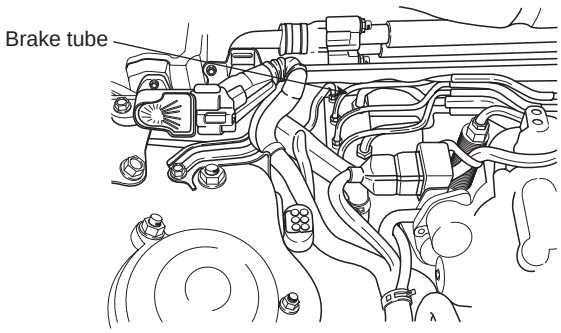
LJCD929C

2. Install HECU bolt.

Tightening torque
HECU bolt : 8~10 N.m (0.8~1.0 kgf.m, 5.6~6.9 lb-ft)

3. Install brake tubes to HECU.

Tightening torque
Brake tube nut(M10) for ABS & TCS : 13~17 N.m (1.3~1.7 kgf.m, 9~12 lb.ft)
Brake tube nut(M12) for ESP : 19~23 N.m (1.9~2.3 kgf.m, 14~17 lb.ft)

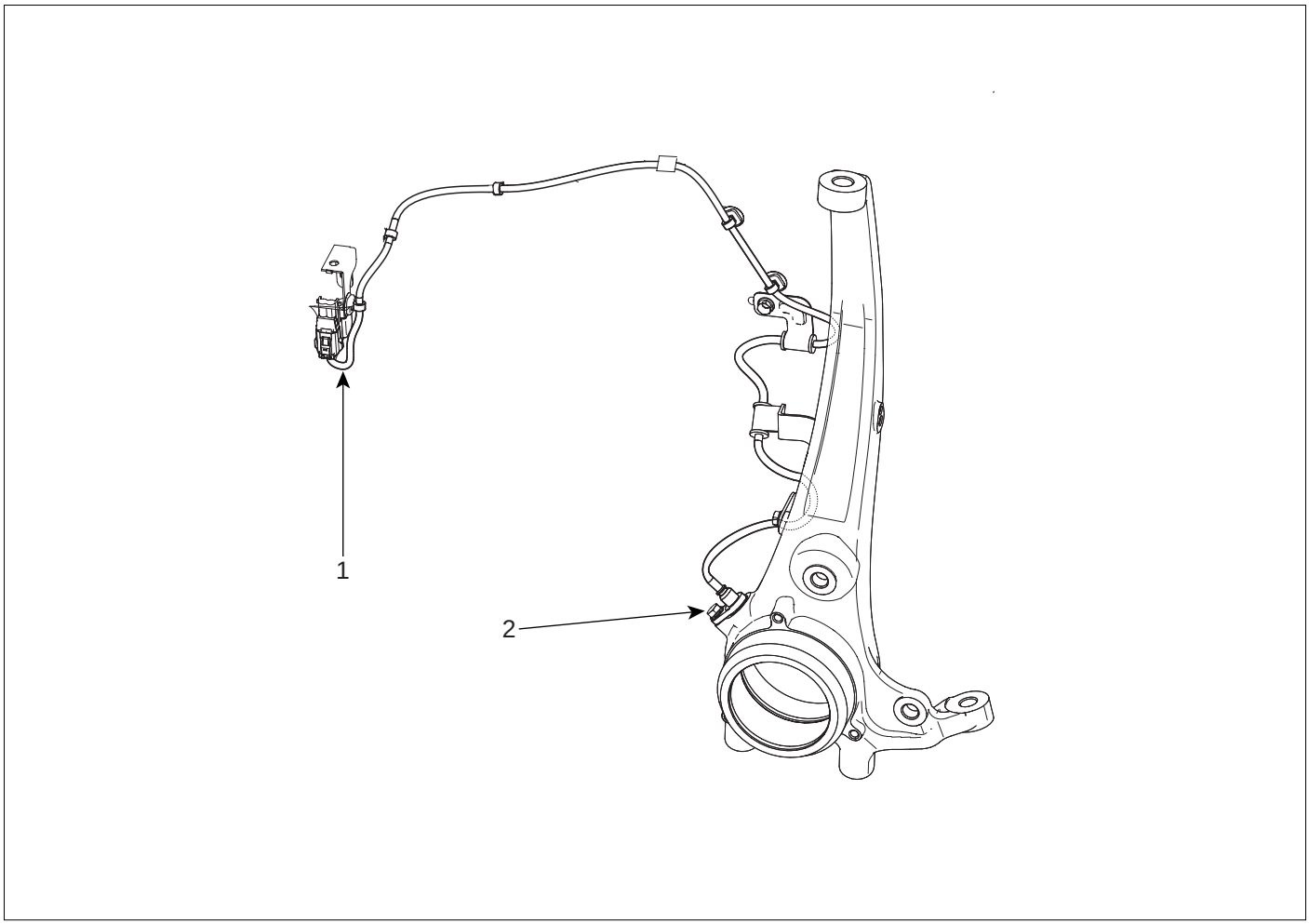


LJCD929B

4. Connect HECU connector to HECU.
5. If necessary, bleed the air and test driving.

FRONT WHEEL SPEED SENSOR

COMPONENTS EEC4478C

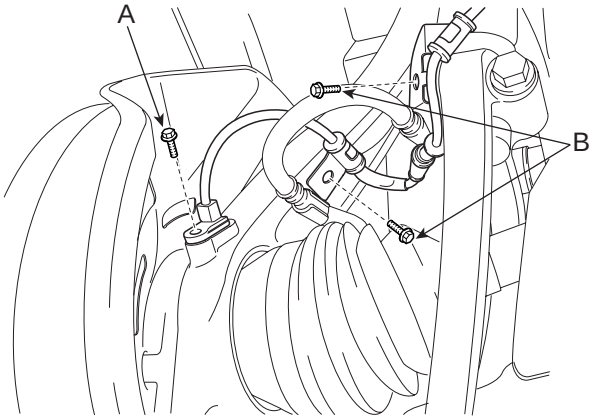


1. Front wheel speed sensor connector
2. Front wheel speed sensor

EJBF502L

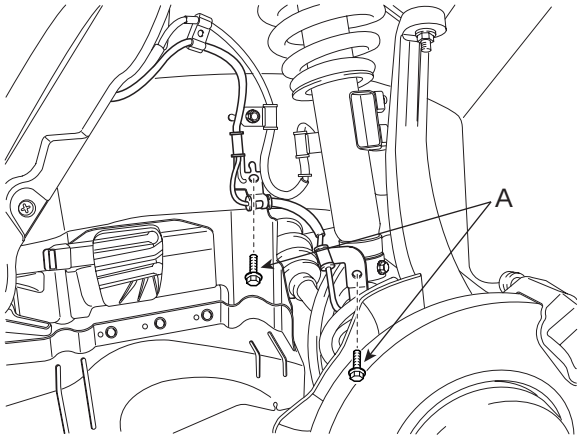
REMOVAL E5DAFCBE

1. Remove the front wheel speed sensor mounting bolt(A).



KJBF534A

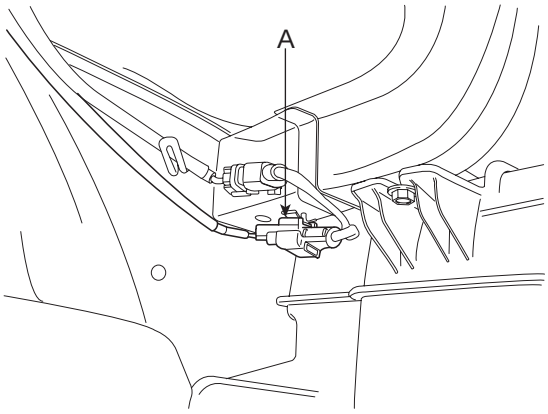
2. Remove the two wire bracket bolts(A).



EJBF500S

3. Remove the front wheel guard.

4. Remove the front wheel speed sensor after disconnecting the wheel speed sensor connector(A).



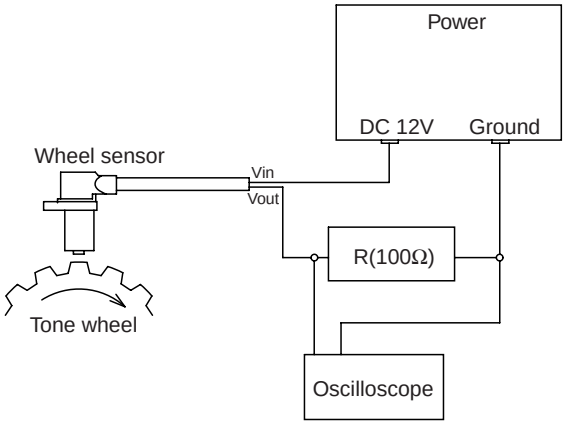
KJBF532A

INSPECTION E3D2CA0F

1. Measure the output voltage between the terminal of the wheel speed sensor and the body ground.

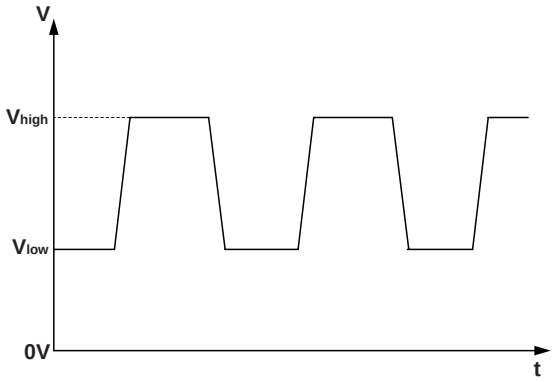
CAUTION

In order to protect the wheel speed sensor, when measuring output voltage, a 100Ω resistor must be used as shown.



SGHBR7566N

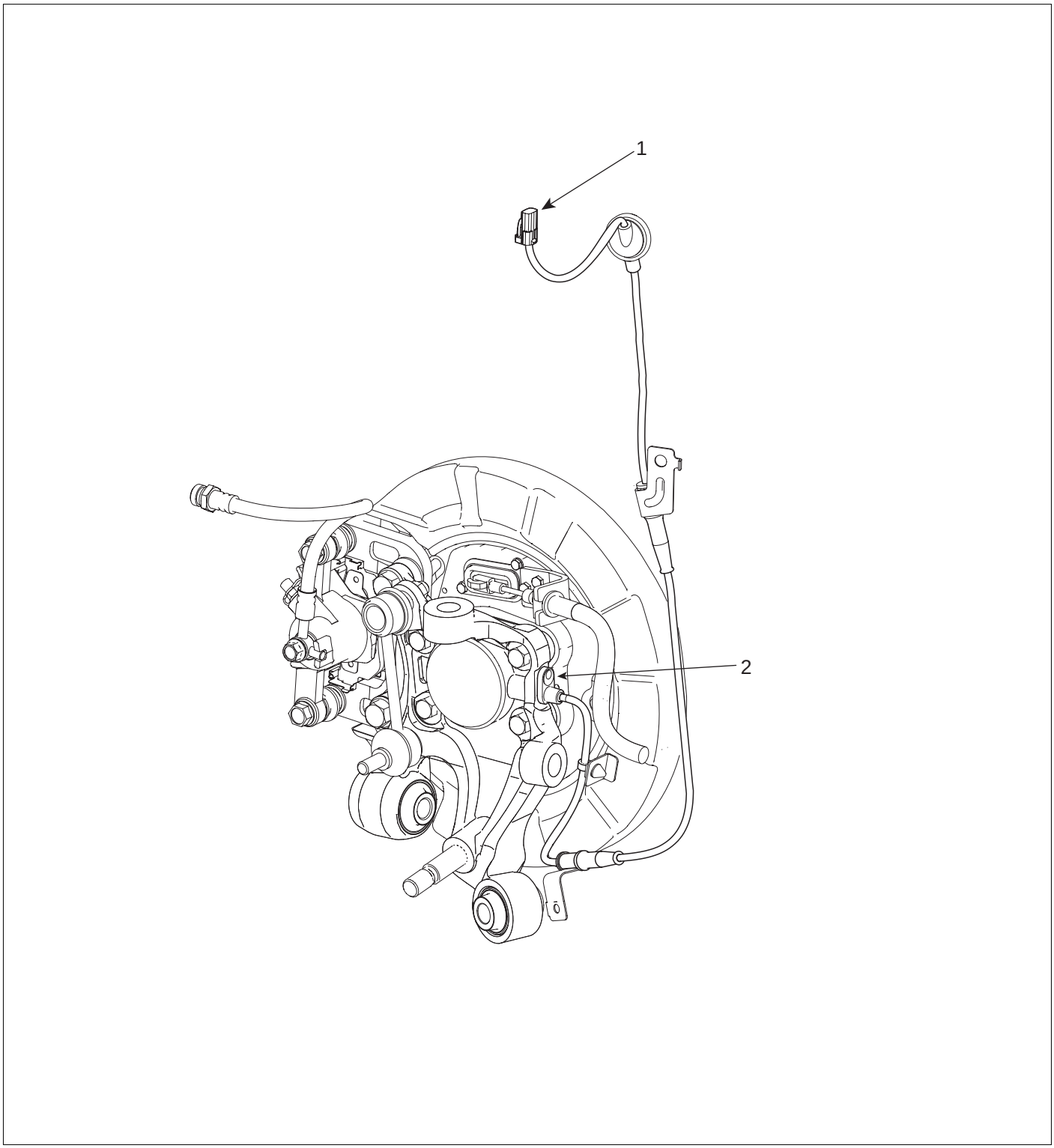
2. Compare the change of the output voltage of the wheel speed sensor to the normal change of the output voltage as shown below.



KJQE260B

REAR WHEEL SPEED SENSOR

COMPONENTS E7378BC2

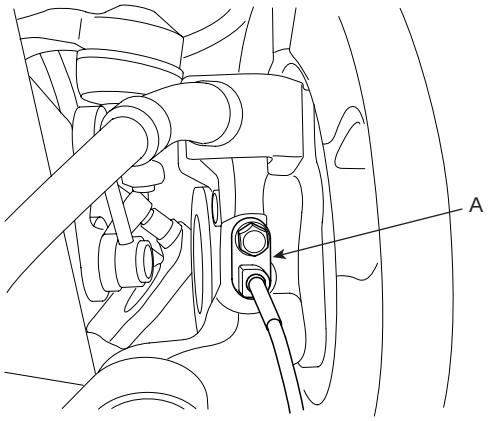


1. Rear wheel speed sensor connector
2. Rear wheel speed sensor

EJBF500T

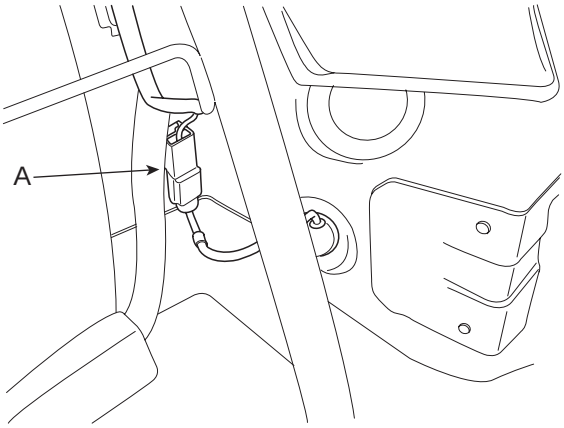
REMOVAL E6127B97

1. Remove the rear wheel speed sensor mounting bolt(A).



KJRE503W

2. Remove the rear seat side pad then disconnect the rear wheel speed sensor connector(A).



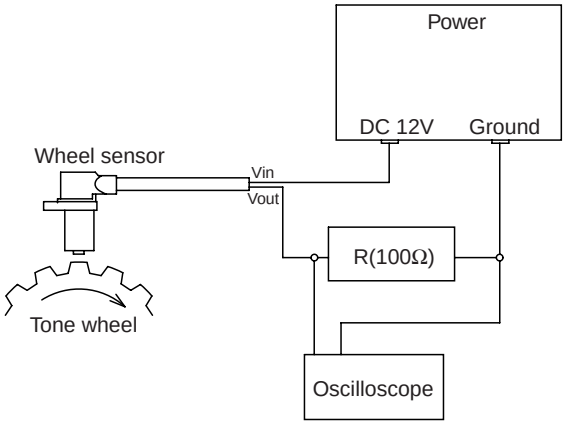
KJBF517A

INSPECTION E3D527D6

1. Measure the output voltage between the terminal of the wheel speed sensor and the body ground.

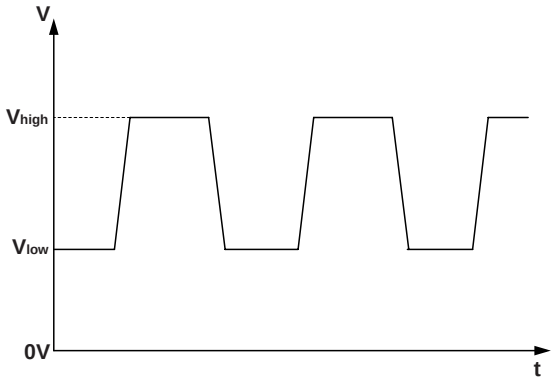
CAUTION

In order to protect the wheel speed sensor, when measuring output voltage, a 100Ω resistor must be used as shown.



SGHBR7566N

2. Compare the change of the output voltage of the wheel speed sensor to the normal change of the output voltage as shown below.



KJQE260B

TRACTION CONTROL SYSTEM

FUNCTION EDFF82B8

1. Main performance
   1) Traction: Lower vibration and higher launchability, acceleration and climbability by slip control.
   2) Cornering and passing: Stable cornering and passing.
   3) Steering stability: Control traction force traverse vector prior to provide easy turning when turning the steering wheel.
2. General TCS features
   1) Improved drivability. Minor operation of acceleration is not necessary in launching and acceleration on slippery read.
   2) More stable cornering by stable acceleration on normal road condition.
   3) TCS system will compare vehicle speed received from rear wheel speed sensor and driving wheel speed from front wheel speed sensor on slippery road condition, and provide optimum slipping rate of driving wheels.

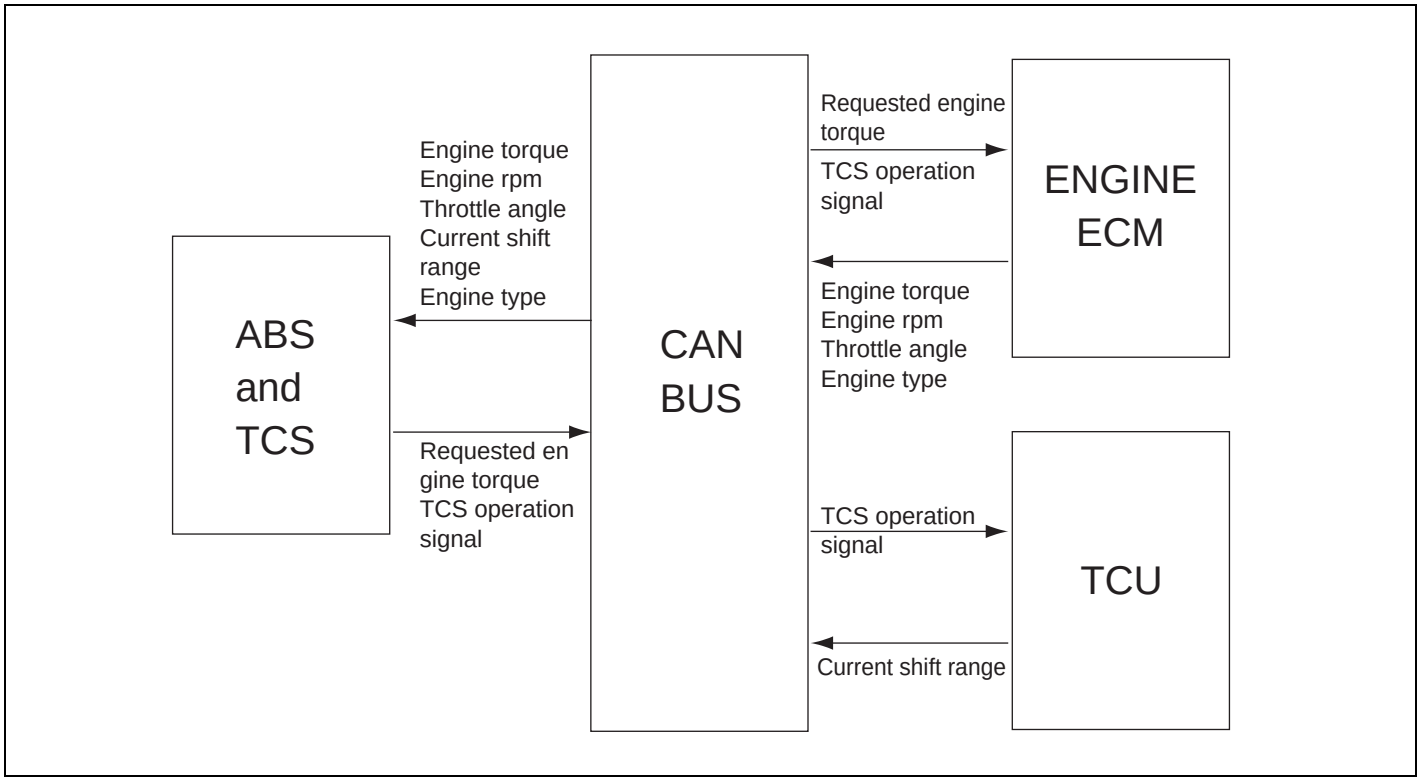
TYPE

FULL TRACTION CONTROL SYSTEM (FTCS)

1. ABS ECM controls TCS control too.
2. ECM will compare signals from front (driving) and rear wheel speed sensors to detect driving wheels slip.
3. Upon detecting driving wheels slip, ECM will perform TCS control. The TCS control will include brake TCS (BTCS) control.
4. ABS ECM will transmit engine torque reduction request, fuel cut cylinder number, and TCS control request signals in accordance with slip level to enging ECM and TCU through BUS line which will provide CAN communication for TCS control.
5. Engine ECM will perform fuel cut as requested by ABS ECM and retard ignition timing as per engine torque reduction request signal.
6. TCU will hold shift position by TCS control time according to TCS operation signal. Then enhanced acceleration by kick-down will not occur.

BRAKE TRACTION CONTROL SYSTEM (BTCS)

1. On TCS control, only brake control will be performed. (engine and TCU control will not happen)
2. Controlled by motor pump output pressure.



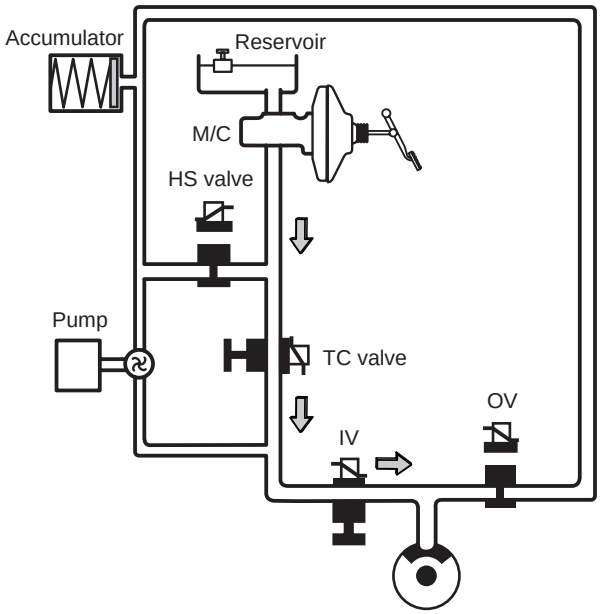
LJCD027A

TRACTION CONTROL SYSTEM (TCS) ED1BB49D

1. NORMAL MODE

Solenoid valve	State	Valve	Motor pump	TC valve
Inlet (NO)	OFF	OPEN	OFF	OFF
Outlet (NC)	OFF	CLOSE		

- In the normal driving condition, TC valve (normally open) is the passage between the master cylinder and the each wheel cylinder.
- When brake pedal is applied, brake pressure is delivered to the wheel cylinders via NO-TC valve and all solenoid valves inside the hydraulic unit are deactivated.
- In case of TCS malfunction, it does not affect brake operation.

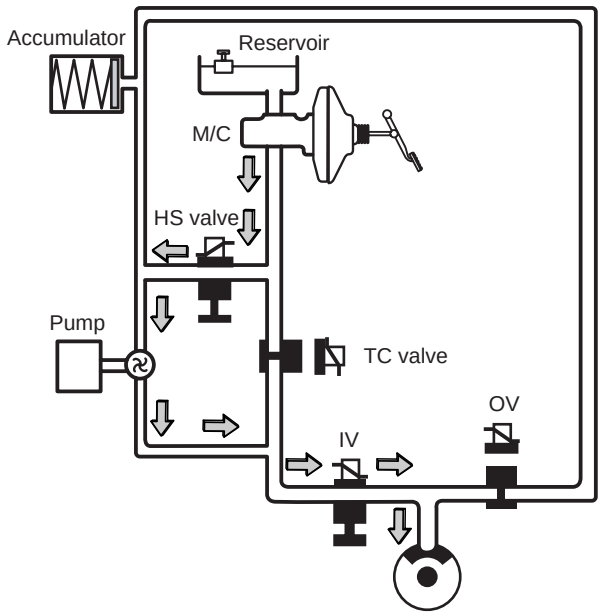


LJCD019A

2. PRESSURE INCREASE MODE

Solenoid valve	State	Valve	Motor pump	TC valve
Inlet (NO)	FRONT: OFF REAR: ON	FRONT: OPEN REAR: CLOSE	ON	ON
Outlet (NC)	OFF	CLOSE		

- If a front wheel spin is detected, TCS begins a brake control to decrease a wheel spin.
- Hydraulic shuttle valve (HSV) is opened.
  Brake fluid is supplied from the master cylinder by motor operation to the spin wheel via HSV.
- TC valve is closed (ON).
  Brake pressure generated from motor pump is delivered only to the front wheel.
- Inlet valve remains open to deliver the brake pressure generated from motor pump to the spinning wheels.

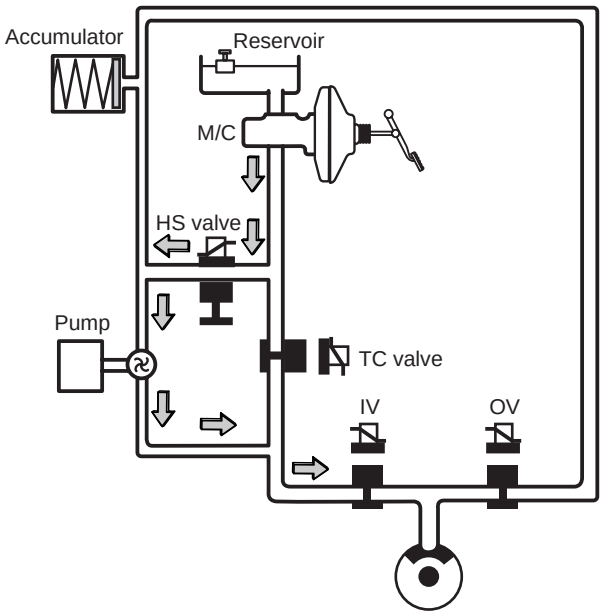


LJCD020A

3. PRESSURE DUMP MODE

Solenoid valve	State	Valve	Motor pump	TC valve
Inlet (NO)	ON	CLOSE	ON	ON
Outlet (NC)	FRONT : ON REAR : OFF	FRONT : OPEN REAR : CLOSE		

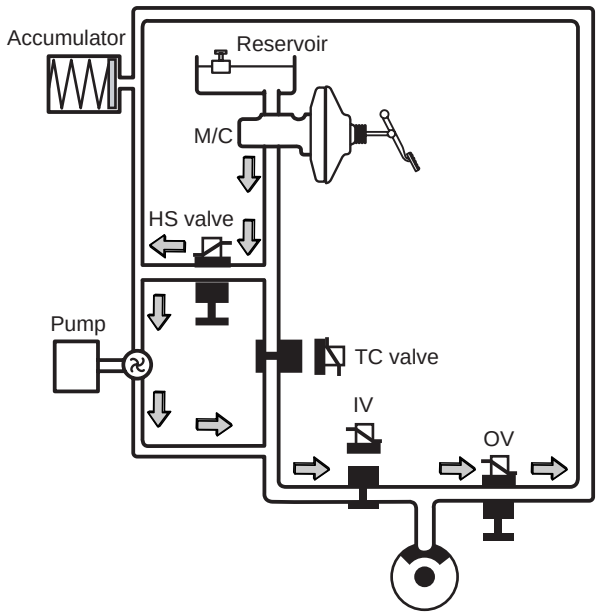
- When the wheel deceleration is under the threshold and the wheel spin is reduced under a slip threshold, applied brake pressure is reduced to get an optimum traction force.
- Outlet valve is open to release the brake pressure and inlet valve is closed to block the pressure increase from the motor pump.
- Hydraulic shuttle valve (HSV) remains opened, TC valve is ON.
- Motor is ON, to dump the brake fluid being released from the lock-up wheel.



LJCD021A

4. PRESSURE HOLD MODE

Solenoid valve	State	Valve	Motor pump	TC valve
Inlet (NO)	ON	CLOSE	ON	ON
Outlet (NC)	OFF	CLOSE		



LJCD022A

EBD (ELECTRONIC BRAKE-FORCE DISTRIBUTION)

DESCRIPTION EA2AAEF4

The EBD system (Electronic Brake force Distribution) as a sub-system of the ABS system is to control the effective adhesion utilization by the rear wheels.

It further utilizes the efficiency of highly developed ABS equipment by controlling the slip of the rear wheels in the partial braking range.

The brake force is moved even closer to the optimum and controlled electronically, thus dispensing with the need for the proportioning valve.

The proportioning valve, because of a mechanical device, has limitations to achieve an ideal brake force distribution to the rear wheels as well as to carry out the flexible brake force distribution proportioning to the vehicle load or weight increasing. And in the event of malfunctioning, driver cannot notice whether it fails or not.

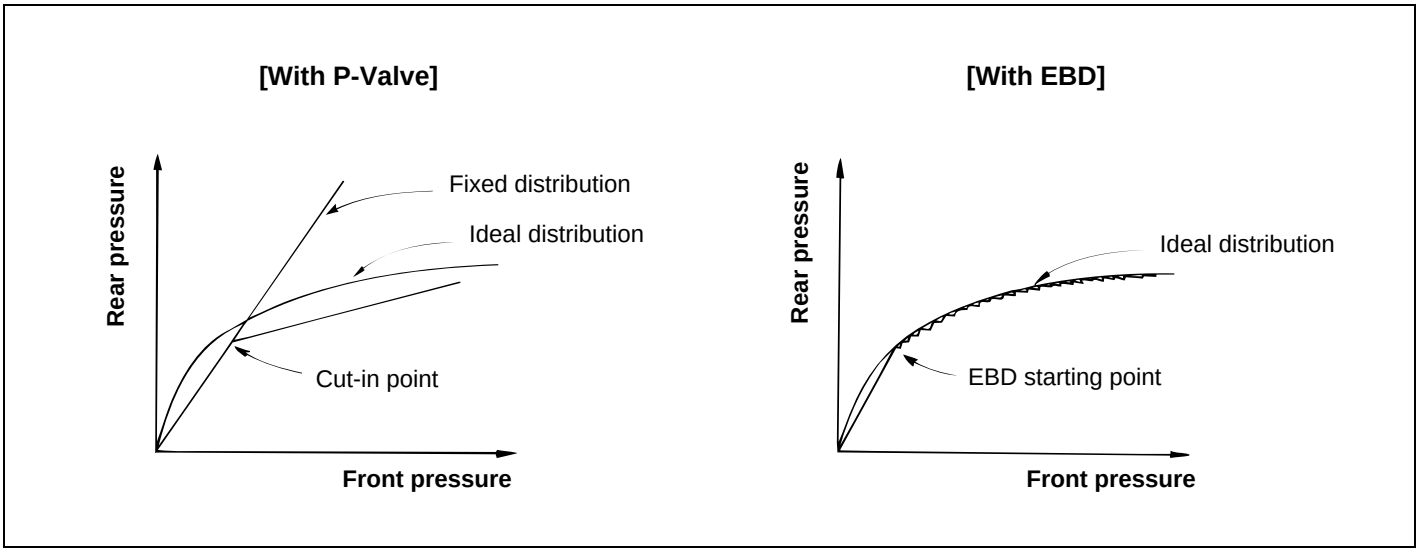
EBD controlled by the ABS Control Module, calculates the slip ratio of each wheel at all times and controls the brake pressure of the rear wheels not to exceed that of the front wheels.

If the EBD fails, the EBD warning lamp (Parking brake lamp) lights up.

ADVANTAGES

- Function improvement of the base-brake system.
- Compensation for the different friction coefficients.
- Elimination of the proportioning valve.
- Failure recognition by the warning lamp.

COMPARISON BETWEEN PROPORTIONING VALVE AND EBD



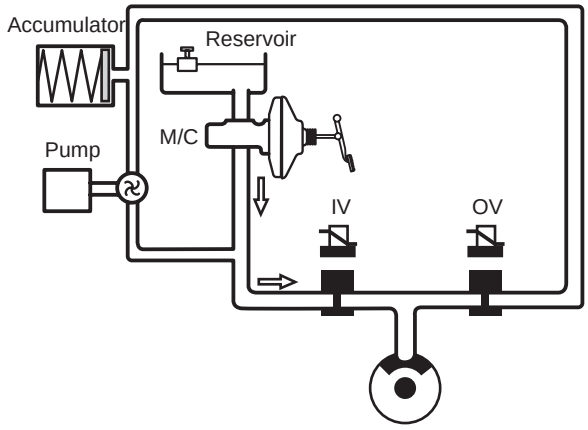
LJCD032A

EBD CONTROL E438EB7B

1. EBD operation-Hold mode

Solenoid valve		State	Valve	Passage
Rear wheel	Inlet (NO)	ON	CLOSE	Master cylinder ⇔ wheel cylinder
	Outlet (NC)	OFF	CLOSE	Wheel cylinder ⇔ Reservoir

The ABS/EBD controller should defect the rear wheels tending to lock, so the inlet valves to the rear brakes are activated to prevent further pressure increase.



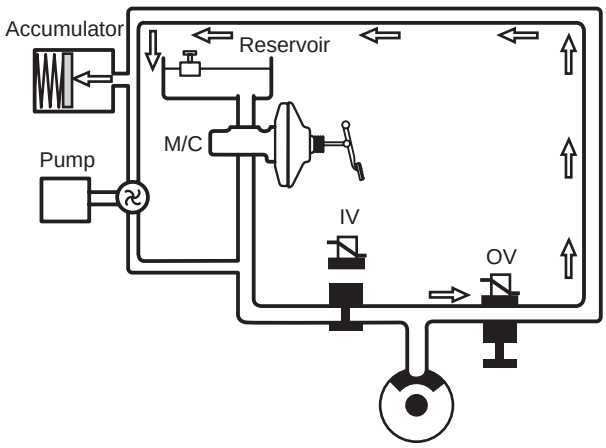
LJCD024A

2. EBD operation- Dump mode

Solenoid valve		State	Valve	Passage
Rear wheel	Inlet (NO)	ON	CLOSE	Master cylinder ⇔ wheel cylinder
	Outlet (NC)	ON	OPEN	Wheel cylinder ⇔ Reservoir

The deceleration should increase and also the locking tendency, so the ABS outlet valves are activated to reduce the pressure in the rear brakes. This pressure is released (as in an ABS stop) to the low pressure accumulators.

The accumulators are emptied after each braking action during the vehicle acceleration phase. This is achieved by switching the pump on.
This means that the driver of the vehicle is not aware of the pump operation noise.



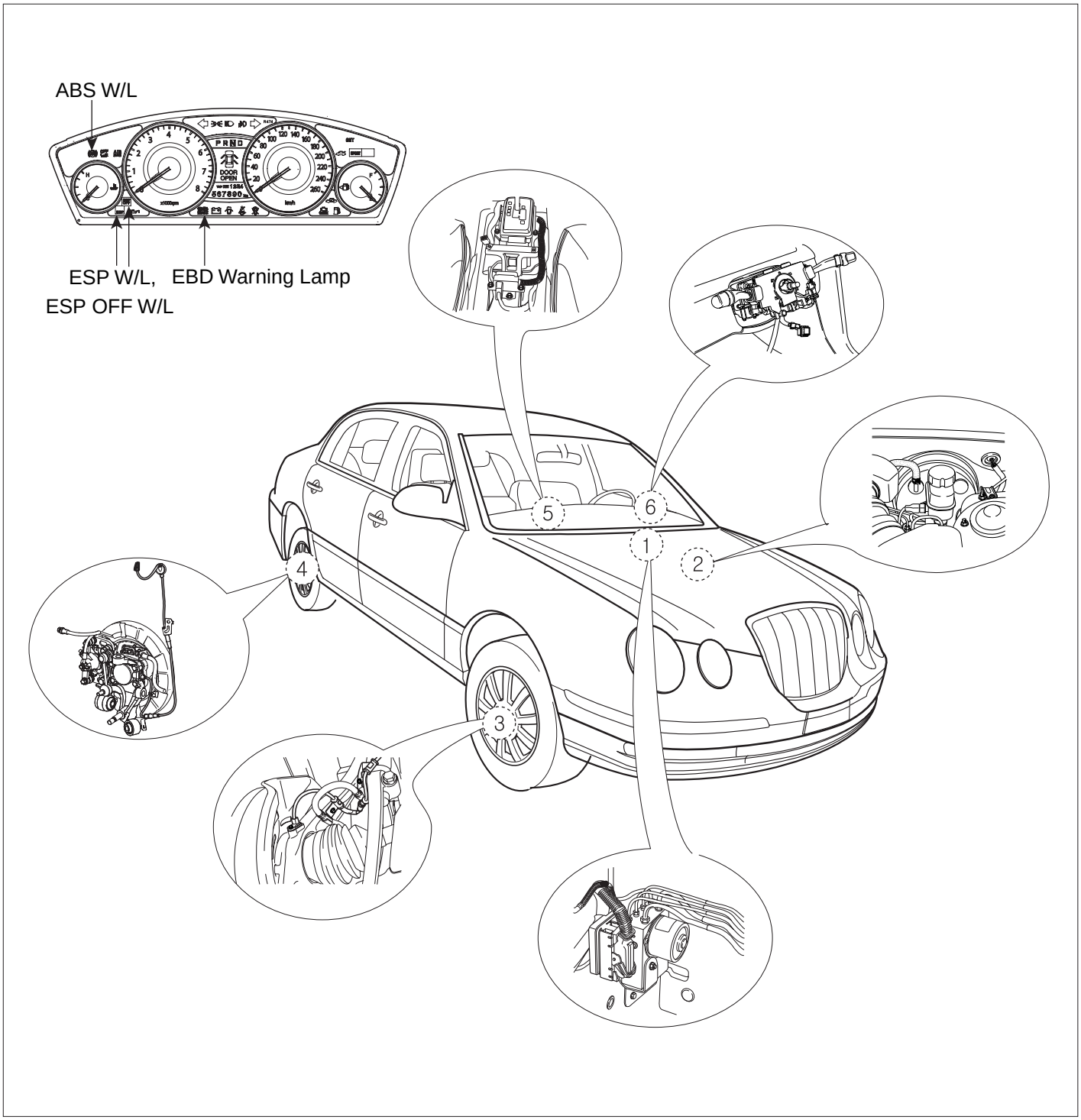
LJCD025A

FAIL SAFE

FAIL SAFE	SYSTEM		WARNING LAMP	
	ABS	EBD	ABS	EBD
None	ON	ON	OFF	OFF
1-Wheel speed sensor failure	OFF	ON	ON	OFF
Pump malfunction	OFF	ON	ON	OFF
Low voltage	OFF	ON	ON	OFF
2 or more wheel speed sensor failure Solenoid valve failure HECU malfunction Other failure	OFF	OFF	ON	ON

ESP/ESC SYSTEM

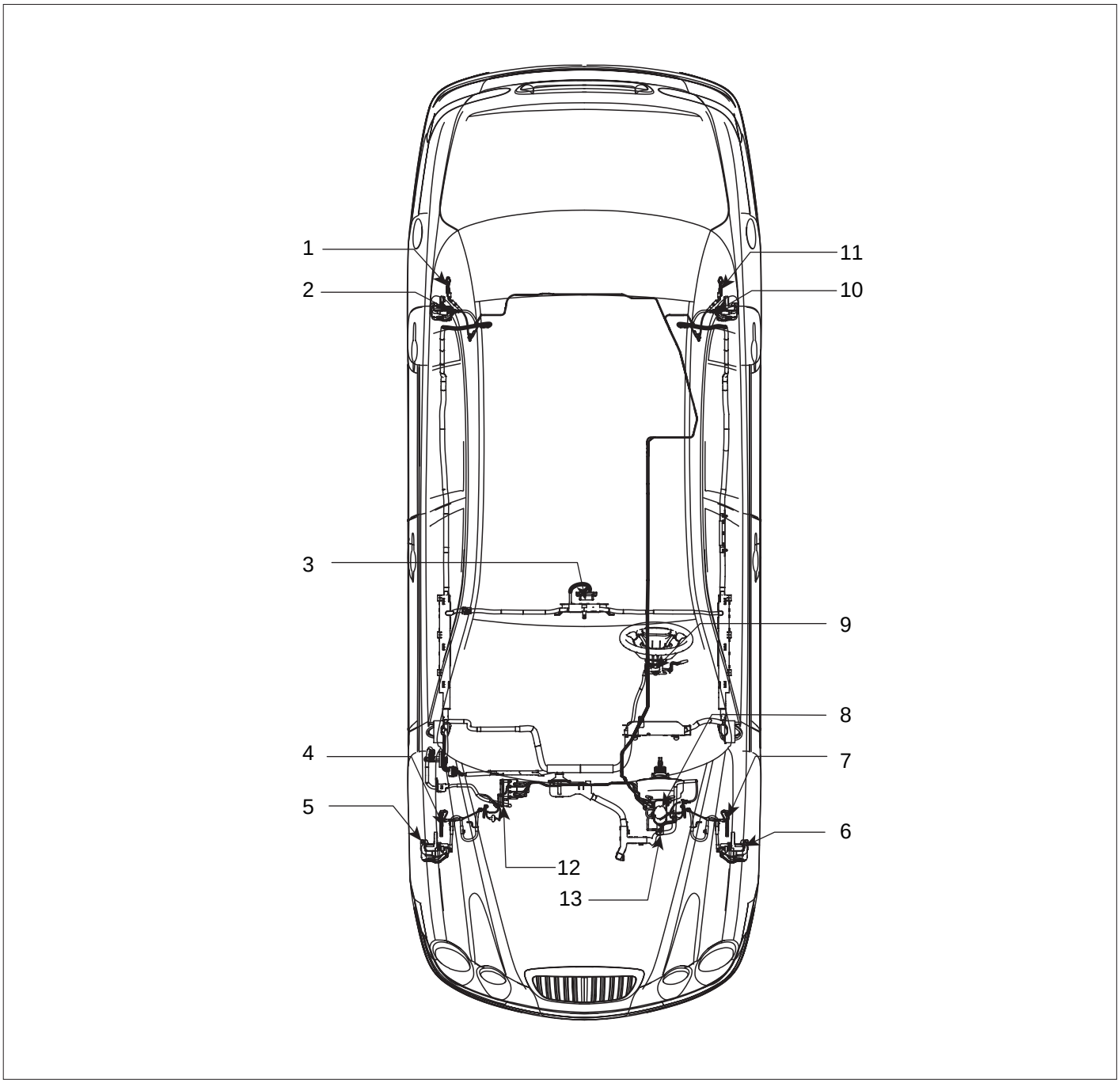
COMPONENTS (1) E4DFF4A8



1. ESP HECU
2. Master cylinder & pressure sensor
3. Front wheel speed sensor
4. Rear wheel speed sensor
5. Yaw-rate & Lateral acceleration sensor
6. Steering angle sensor

SGHBR7505L

COMPONENTS (2)



1. Rear brake (RR)
2. Wheel speed sensor (RR)
3. Yaw-rate & Lateral acceleration sensor
4. Wheel speed sensor (FR)
5. Front brake (FR)
6. Front brake (FL)
7. Wheel speed sensor (FL)
8. Booster & Master cylinder
9. Steering wheel angle sensor
10. Wheel speed sensor (RL)
11. Rear brake (RL)
12. ESP HECU
13. Pressure sensor (2)

SGHBR7537L

DESCRIPTION OF ESP EFB2843A

Optimum driving safety now has a name : ESP, the Electronic Stability Program.

ESP is based on the MK 25 ABS Hydraulic System. ESP recognizes critical driving conditions, such as panic reactions in dangerous situations, and stabilizes the vehicle by wheel-individual braking and engine control intervention with no need for actuating the brake or the gas pedal.

ESP adds a further function known as Active Yaw Control (AYC) to the ABS, TCS, EBD and EDC functions. Whereas the ABS/TCS function controls wheel slip during braking and acceleration and, thus, mainly intervenes in the longitudinal dynamics of the vehicle, active yaw control stabilizes the vehicle about its vertical axis.

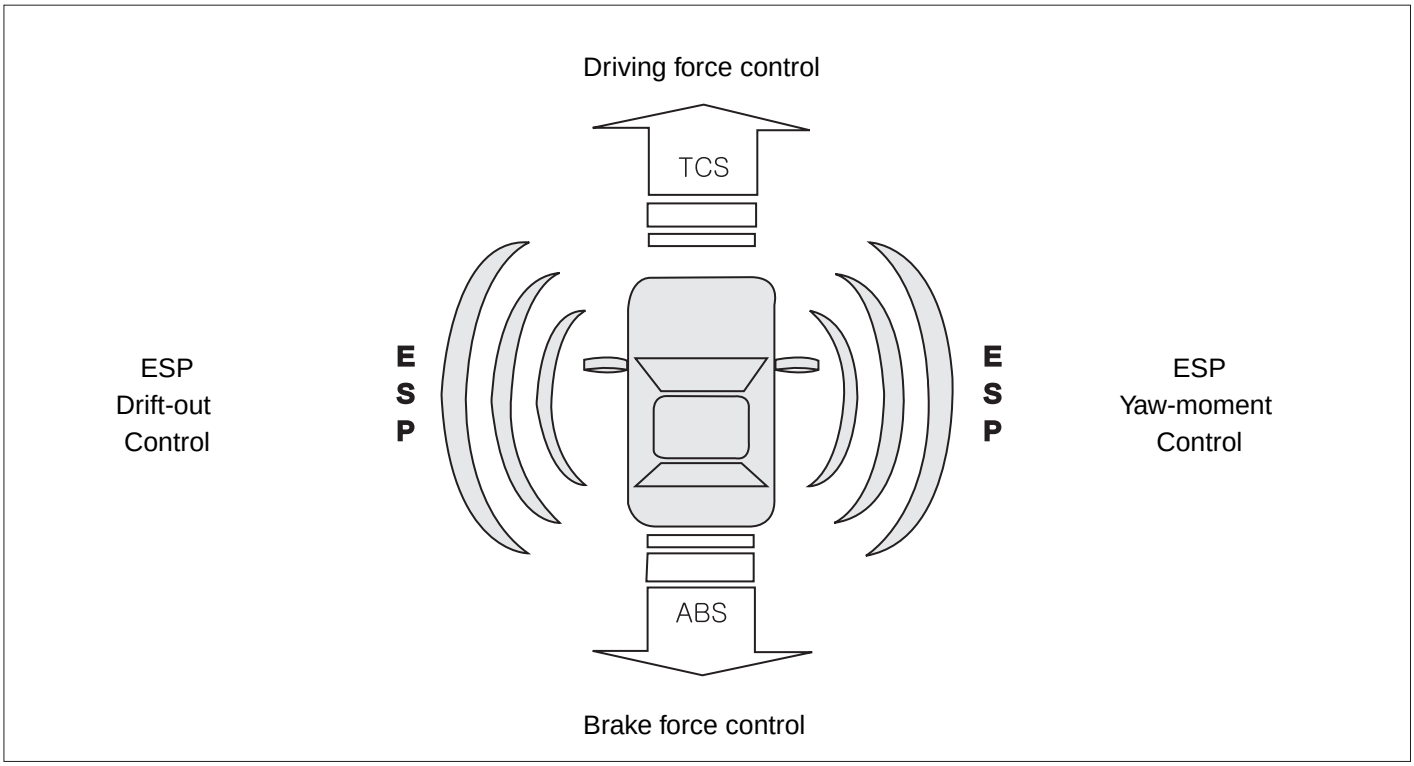
This is achieved by wheel individual brake intervention and adaptation of the momentary engine torque with no need for any action to be taken by the driver.

ESP essentially consists of three assemblies : the sensors, the electronic control unit and the actuators.

The electronic control unit incorporates the technological experience accumulated in connection with the MK 25 system, but has been substantially expanded in terms of capacity and monitoring concept in order to permit the additional sensor signals and arithmetic operations to be processed and converted into corresponding valve, pump and engine control commands. Two 16-bit processors and one 8-bit processor, which monitor each other, cooperate to handle these requirements.

Of course, the stability control feature works under all driving and operating conditions. Under certain driving conditions, the ABS/TCS function can be activated simultaneously with the ESP function in response to a command by the driver.

In the event of a failure of the stability control function, the basic safety function, ABS, is still maintained.



SGHBR7506L

DESCRIPTION OF ESP CONTROL

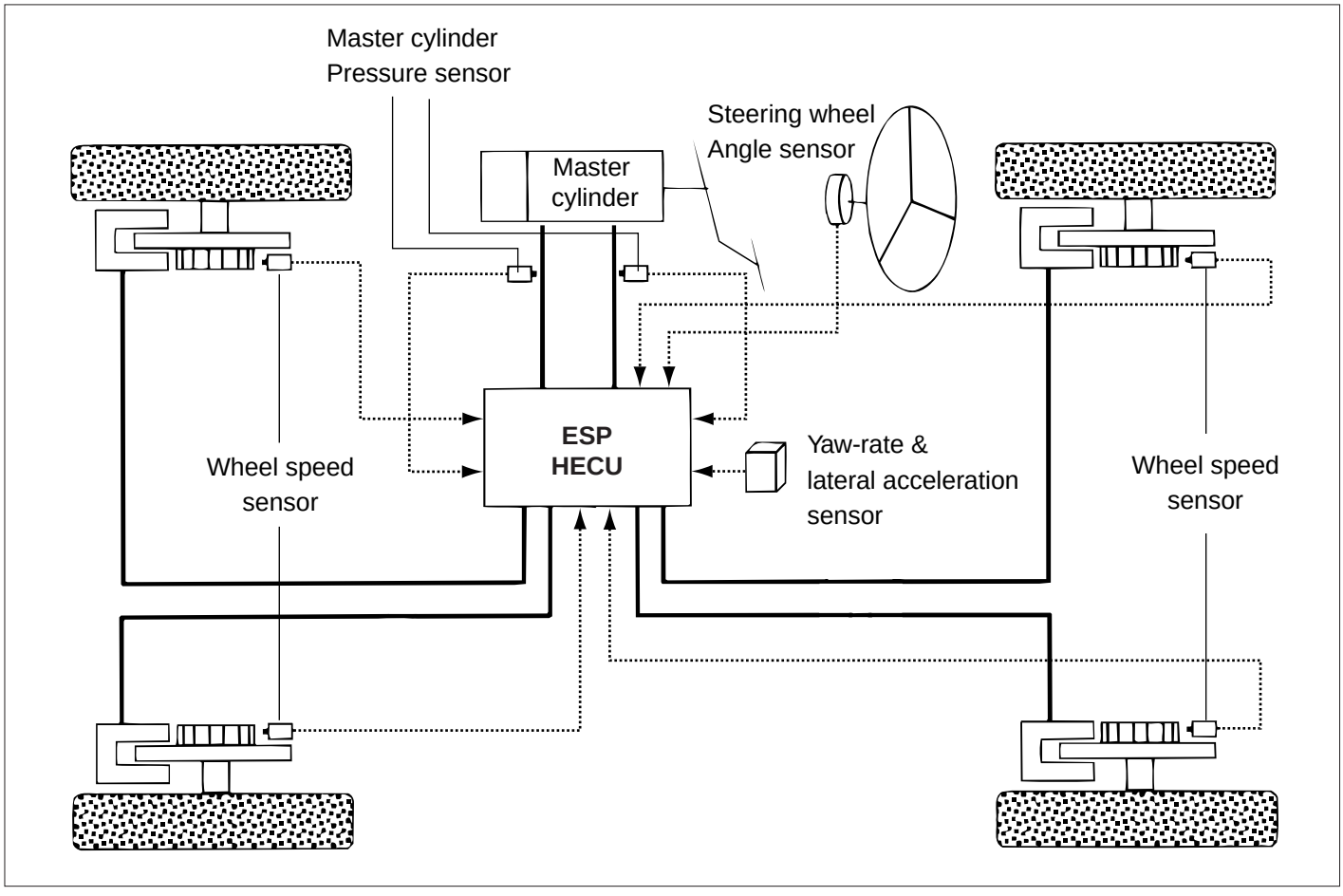
ESP system includes ABS/EBD, TCS and AYC function.

ABS/EBD function The ECU changes the active sensor signal (current shift) coming from the four wheel sensors to the square wave.
By using the input of above signals, the ECU calculates the vehicle speed and the acceleration & deceleration of the four wheels.
And, the ECU judges whether the ABS/EBD should be actuated or not.

TCS function prevents the wheel slip of drive direction by adding the brake pressure and engine torque reduction via CAN communication.
TCS function uses the wheel speed sensor signal to determine the wheel slip as far as ABS function.

AYC function prevents unstable maneuver of the vehicle. To determine the vehicle maneuver, AYC function uses the maneuver sensor signals
(Yaw Rate Sensor, Lateral Acceleration Sensor, Steering Wheel Angle Sensor).
If vehicle maneuver is unstable (Over Steer or Under Steer), AYC function applies the brake pressure on certain wheel, and send engine torque reduction signal by CAN.

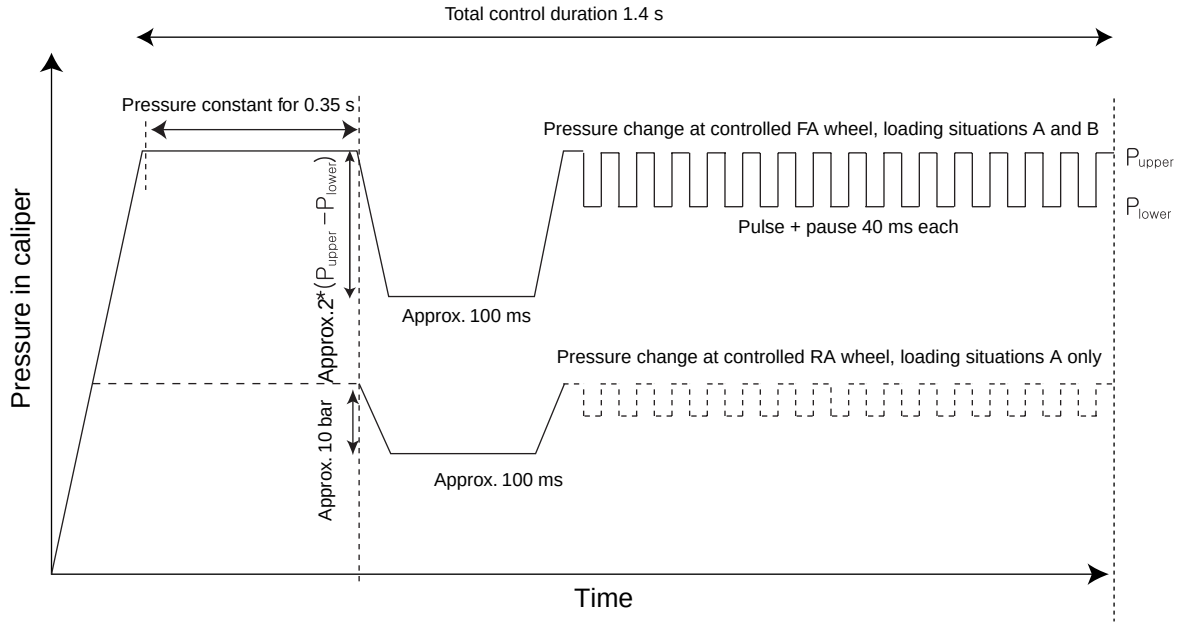
After the key-on, the ECU continually diagnoses the system failure. (self-diagnosis)
If the system failure is detected, the ECU informs driver of the system failure through the BRAKE/ABS/ESP warning lamp. (fail-safe warning)



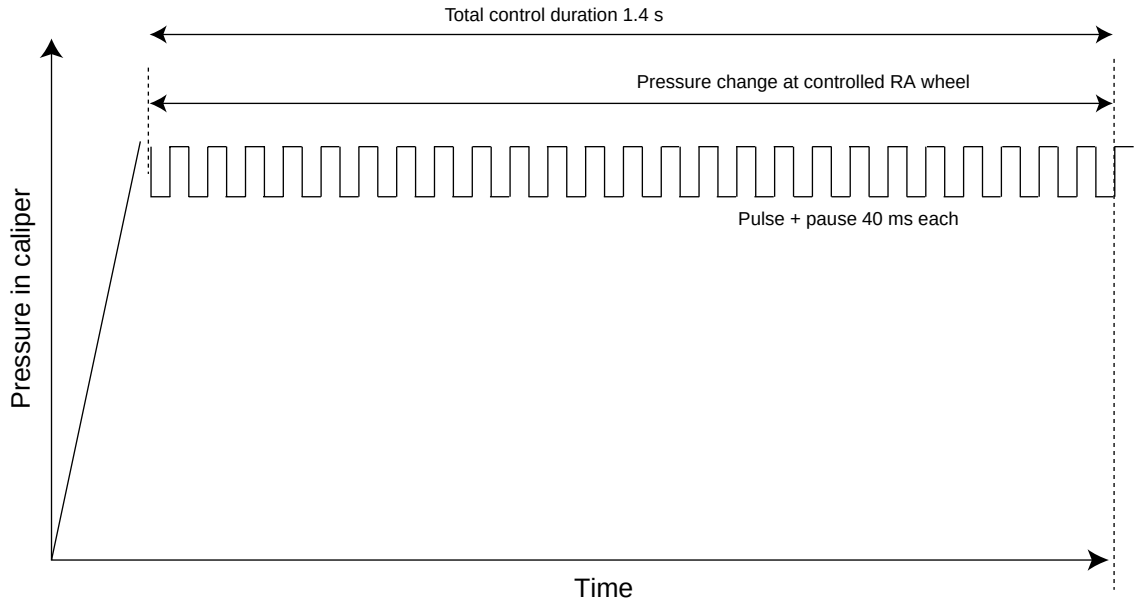
SGHBR7507L

ESP CONTROL CYCLES

Basic pattern of an ESP control cycle
Pressure change during loading situations A and B, no RA control in situation B



Pressure change, loading situation D



SGHBR7508L

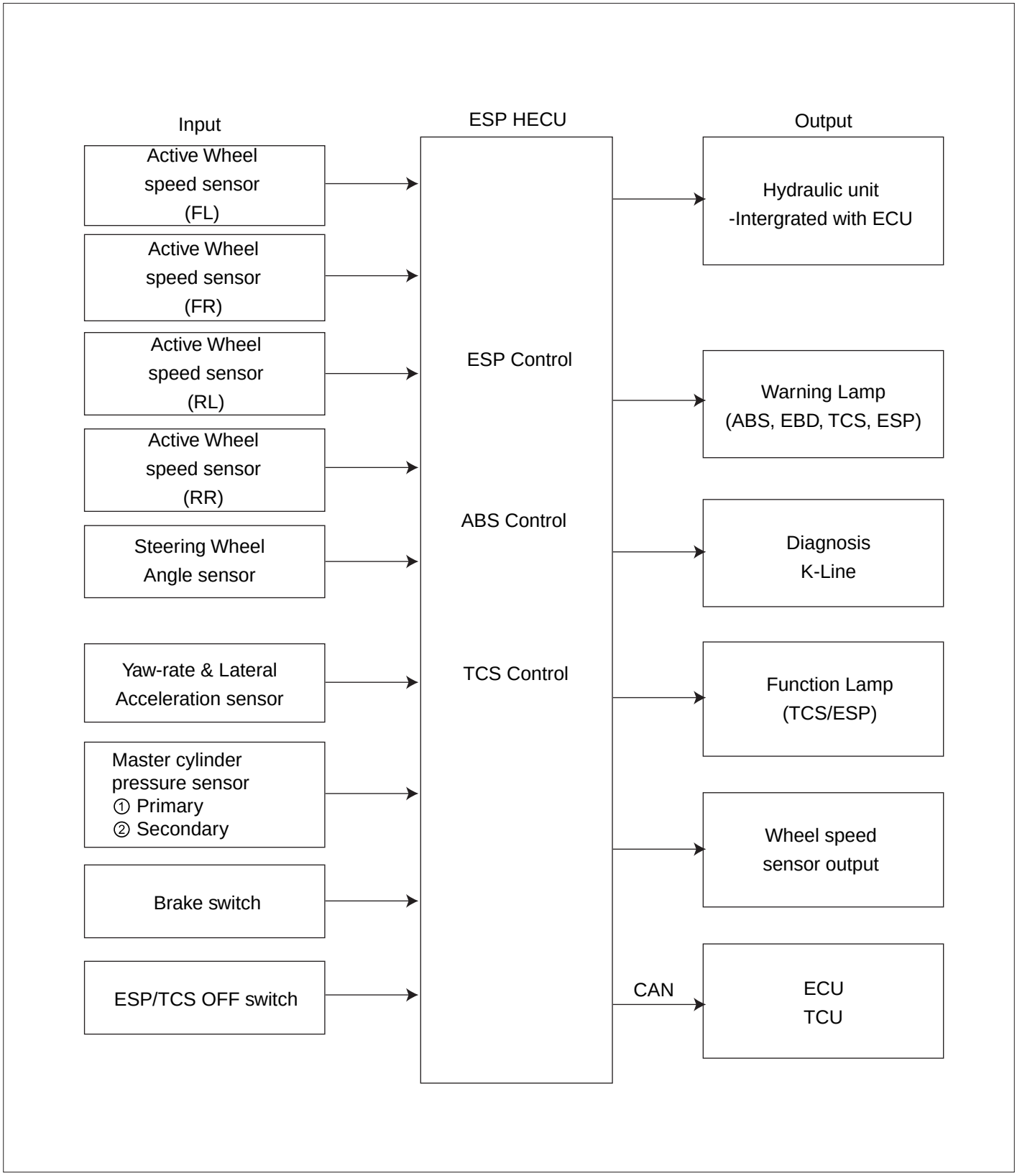
WHEEL PRESSURE MODULATION :

Loading situation	Control duration	Pressure applied by braking while an ESP cycle is in progress	Controlled FA pressure, one wheel only	Controlled RA pressure, one wheel only
A	1.4 s	0 MPa	7.0 ~ 8.5	0.7 ~ 1.3
		5.0 MPa	10.0 ~ 12.0	5.5 ~ 6.5
		10.0 MPa	10.0 ~ 12.0	5.5 ~ 6.5
B	1.4 s	0 MPa	2.5 ~ 3.5	uncontrolled
		5.0 MPa	7.5 ~ 8.5	uncontrolled
D	1.4 s	0 MPa	uncontrolled	3.0 ~ 4.0
		5.0 MPa	uncontrolled	5.5 ~ 6.5

The ESP control cycles may be inserted into the ABS/TCS load collective at any point as long as the duty cycle for the electric motor does not exceed 20%.

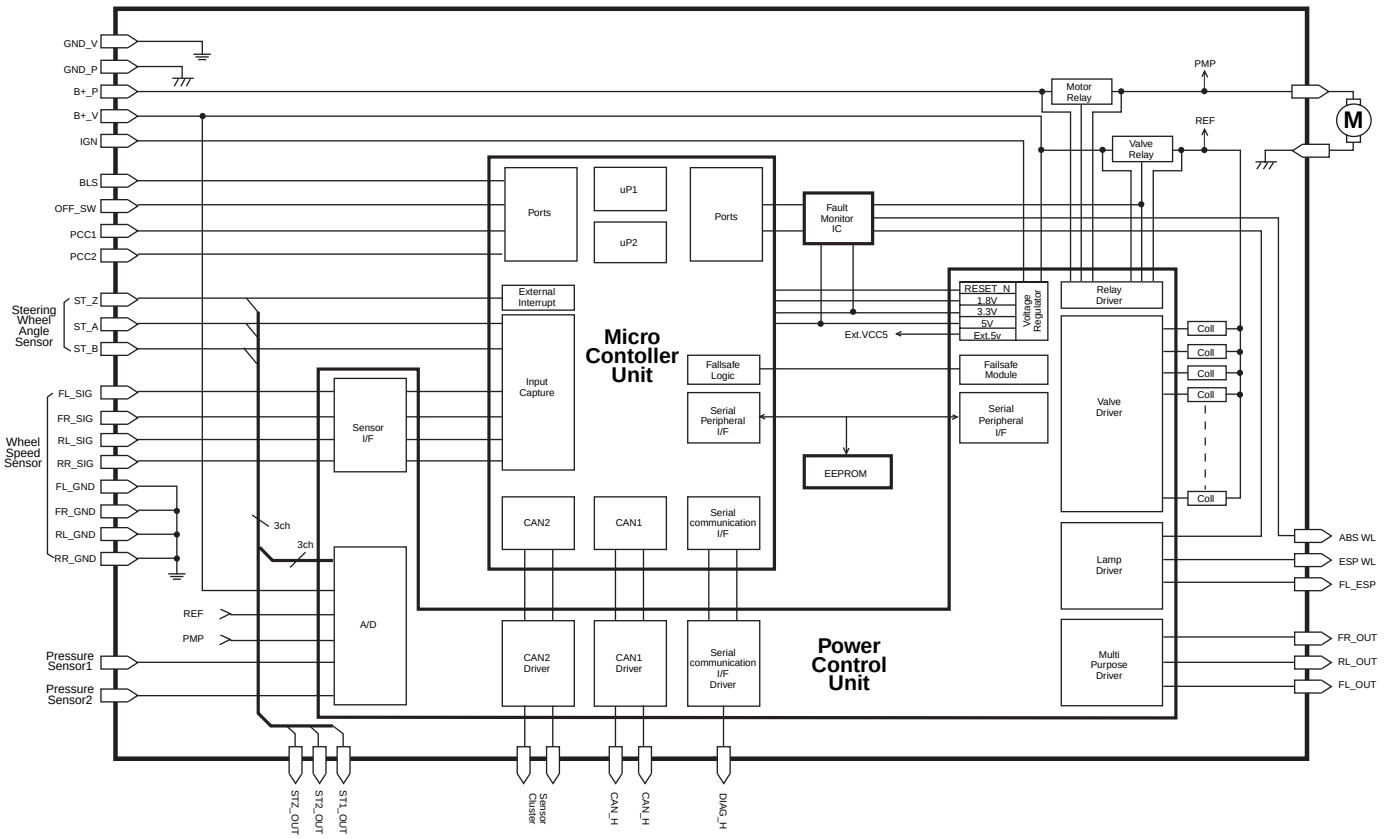
Temperature [°C]	Pressure applied by braking while an ESP cycle is in progress 0 Mpa		Pressure applied by braking while an ESP cycle is in progress 5.0 Mpa			Pressure applied by braking while an ESP cycle is in progress 10.0 MPa
	Cycles		Cycles			Cycles
	B	D	A	B	D	A
RT	850	450	70	1300	700	50
100	300	150	40	400	250	30
-30	100	50	0	150	100	10
Total:	1250	650	110	1850	1050	90

INPUT AND OUTPUT DIAGRAM



SGHBR7509L

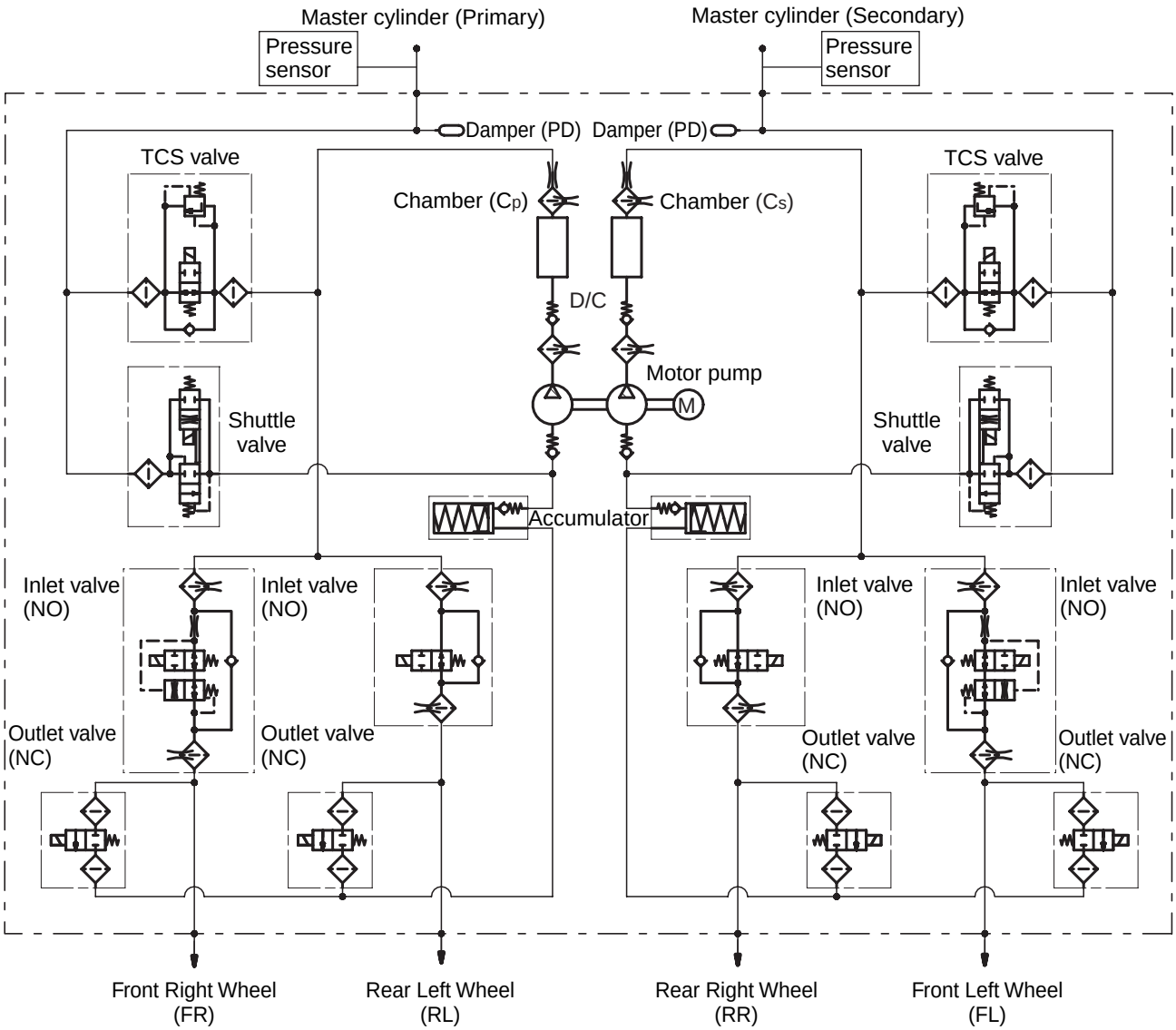
INTERNAL BLOCK DIAGRAM



LJCD812A

HYDRAULIC SYSTEM DIAGRAM EF63B9F6

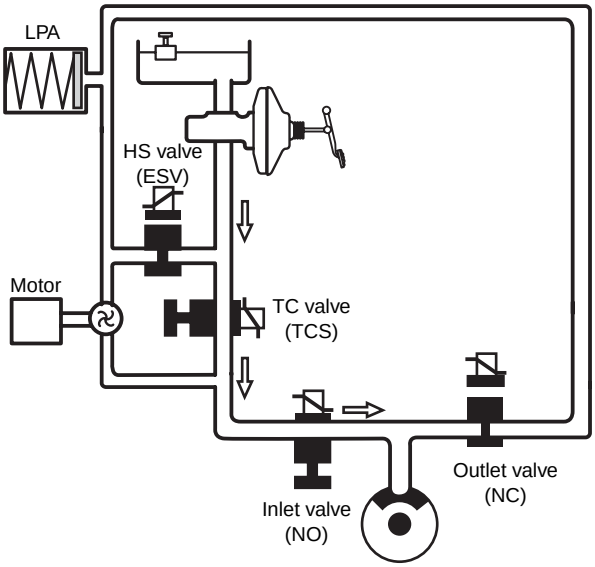
[ESP HECU]



SGHBR7510L

ESP OPERATION MODE E90336E9

1. ESP Non-operation-Normal braking



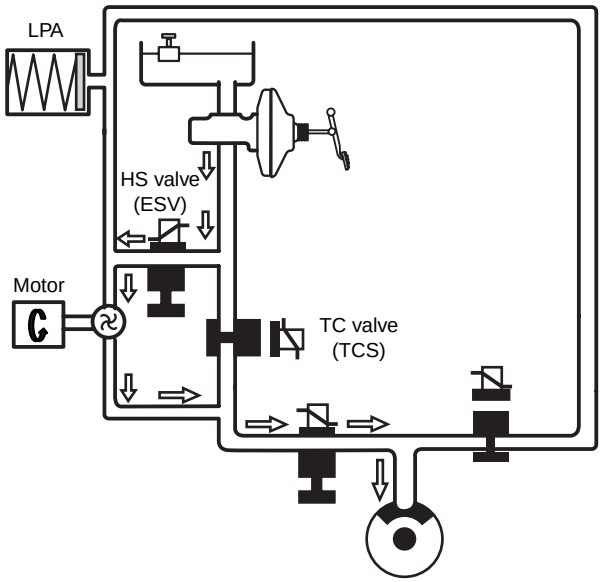
LJCD207A

Operation

In this position, the inlet valve and the TCS valve are open, the electrically operated shuttle valve and the outlet valve are closed.
∗ESV : Electric reversing valve.

Solenoid valve	Continuity	Valve	Motor pump	TC Valve
IN (NO)	OFF	OPEN	OFF	OFF
OUT (NC)	OFF	CLOSE		

2. ESP operation



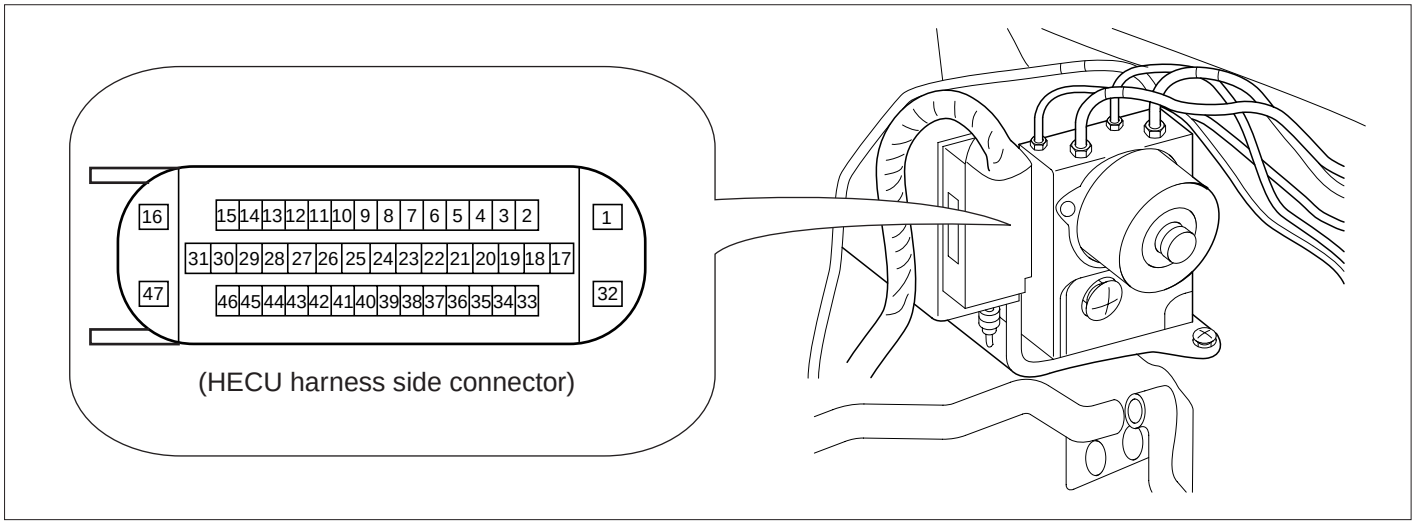
LJCD208A

Operation

The on/off booster builds up a pressure of approx. 10 bar in order to enable the ESP pump to suck brake fluid at low temperatures. In this position, the inlet valve is driven in a pulsed cycle. The TCS valve is closed. The outlet valve remains closed. The electrically operated shuttle valve is opened. The hydraulic pressure is led to the wheel brakes which are to be applied for a brief period of time.

Solenoid valve		Continuity	Valve	Motor pump	TC Valve
Oversteering <Only insede of rear wheel>	IN(NO)	OFF	OPEN	ON	ON
	OUT(NC)	OFF	CLOSE		
Understeering <Only outside of front wheel>	IN(NO)	OFF	OPEN		
	OUT(NC)	OFF	CLOSE		

ESP CONTROL UNIT (HECU) EDCD9AF8



LJCD201B

HECU CONNECTOR INSPECTION

Pin No.	Name	Current range (12V/20°C standard)	Voltage range	Remark
46,33,37,42	Wheel speed sensor (FL,FR,RL,RR) Ground	7-14 mA	0-12V	
45,34,36,43	Wheel speed sensor (FL,FR,RL,RR) Signal	7-14 mA	0-12V	
13	ESP(TCS) Warning lamp	Max.100mA	0-18V	With ESP
4	IGN1	Max.150mA	0-18V	
16	Ground	Max.25A	0-18V	
40	ESP(TCS) Switch	Max.10mA	0-18V	
1	Battery (B+)	Max.30A	0-18V	
19	Pressure sensor(No.1) Ground	Max.20mA	5V	With ESP
20	Pressure sensor(No.1) Signal	Max.10mA	5V	With ESP
18	Pressure sensor(No.1) Power	Max.20mA	5V	With ESP
21	Pressure sensor(No.1) Ground	Max.20mA	5V	With ESP
23	Pressure sensor(No.1) Signal	Max.10mA	5V	With ESP
22	Pressure sensor(No.1) Power	Max.20mA	5V	With ESP
47	Ground	Max.30A	0-18V	
32	Battery (B+)	Max.20A	0-18V	
12	Wheel speed sensor output (FR)	Max.10mA	-	
10	Wheel speed sensor output (RL)	Max.10mA	-	
28	Steering wheel angle sensor (ST1)	Max.10mA	0-18V	With ESP
30	Steering wheel angle sensor (ST2)	Max.10mA	0-18V	With ESP
5	Steering wheel angle sensor Ground	Max.100mA	0-18V	With ESP
11	CAN (High)	Max.10mA	0-18V	
15	CAN (Low)	Max.10mA	0-18V	

Pin No.	Name	Current range (12V/20°C standard)	Voltage range	Remark
17	ESP(TCS) Function lamp	Max.100mA	0-18V	With ESP
3	Steering-wheel angle sensor (STN)	Max.10mA	0-18V	With ESP
2	Self-Diagnosis (Diag.k line)	Max.100mA	0-18V	
41	Brake switch	Max.10mA	0-18V	
44	ABS Warning lamp	Max.20mA	0-18V	
25	Yaw-rate & lateral acceleration sensor (CAN Low)	Max.10mA	0-18V	With ESP
29	Yaw-rate & lateral acceleration sensor (CAN High)	Max.10mA	0-18V	With ESP
6	Yaw-rate & lateral acceleration sensor Power	Max.250mA	0-18V	With ESP
31	Yaw-rate & lateral acceleration sensor Ground	Max.250mA	0-18V	With ESP
38	PCC1	Max.10mA	-	
9	PCC2	Max.10mA	-	
8	Steering wheel angle sensor (ST1) output	-	5V	With ESP
39	Steering wheel angle sensor (ST2) output	-	5V	With ESP

SENSOR OUTPUT DATA

Item	Unit	Remark
Engine rpm	RPM	
Vehicle speed sensor	MPH	
Throttle position sensor	%	
Shift lever position	P.R.N.D	Sports mode
Battery voltage	V	
5V standard voltage	V	
Active wheel sensor (FL)	MPH	
Active wheel sensor (FR)	MPH	
Active wheel sensor (RL)	MPH	
Active wheel sensor (RR)	MPH	
Steering wheel angle sensor-1	Low/High	Only ESP
Steering wheel angle sensor-2	Low/High	Only ESP
Steering wheel angle sensor-N	Low/High	Only ESP
Lateral Acceleration Sensor	G	Only ESP
Yaw-rate Sensor	deg/s	Only ESP
ABS Warning Lamp	ON/OFF	
EBD Warning Lamp	ON/OFF	P/Brake
ESP(TCS) Warning Lamp	ON/OFF	
ESP(TCS) Function Lamp	ON/OFF	

Item	Unit	Remark
ESP OFF(TCS OFF) Switch	ON/OFF	
Brake lamp switch	ON/OFF	
Motor relay	OFF/ON	
Valve relay	OFF/ON	
Motor	OFF/ON	
Inlet valve (FL)	OFF/ON	
Inlet valve (FR)	OFF/ON	
Inlet valve (RL)	OFF/ON	
Inlet valve (RR)	OFF/ON	
Outlet valve (FL)	OFF/ON	
Outlet valve (FR)	OFF/ON	
Outlet valve (RL)	OFF/ON	
Outlet valve (RR)	OFF/ON	
TC Valve (FL)	OFF/ON	
TC Valve (FR)	OFF/ON	
Shuttle valve (FL)	OFF/ON	Only ESP
Shuttle valve (FR)	OFF/ON	Only ESP

ACTUATOR DRIVING

Item	Driving condition	Time	Remark
Motor	KEY ON, ENG OFF / Driving	2 SEC	
Inlet valve (FL)	KEY ON, ENG OFF / Driving	2 SEC	
Inlet valve (FR)	KEY ON, ENG OFF / Driving	2 SEC	
Inlet valve (RL)	KEY ON, ENG OFF / Driving	2 SEC	
Inlet valve (RR)	KEY ON, ENG OFF / Driving	2 SEC	
Outlet valve (FL)	KEY ON, ENG OFF / Driving	2 SEC	
Outlet valve (FR)	KEY ON, ENG OFF / Driving	2 SEC	
Outlet valve (RL)	KEY ON, ENG OFF / Driving	2 SEC	
Outlet valve (RR)	KEY ON, ENG OFF / Driving	2 SEC	
TC Valve (FL)	KEY ON, ENG OFF / Driving	2 SEC	
TC Valve (FR)	KEY ON, ENG OFF / Driving	2 SEC	
Shuttle Valve (FL)	KEY ON, ENG OFF / Driving	2 SEC	Only ESP
Shuttle Valve (FR)	KEY ON, ENG OFF / Driving	2 SEC	

FREEZE FRAME

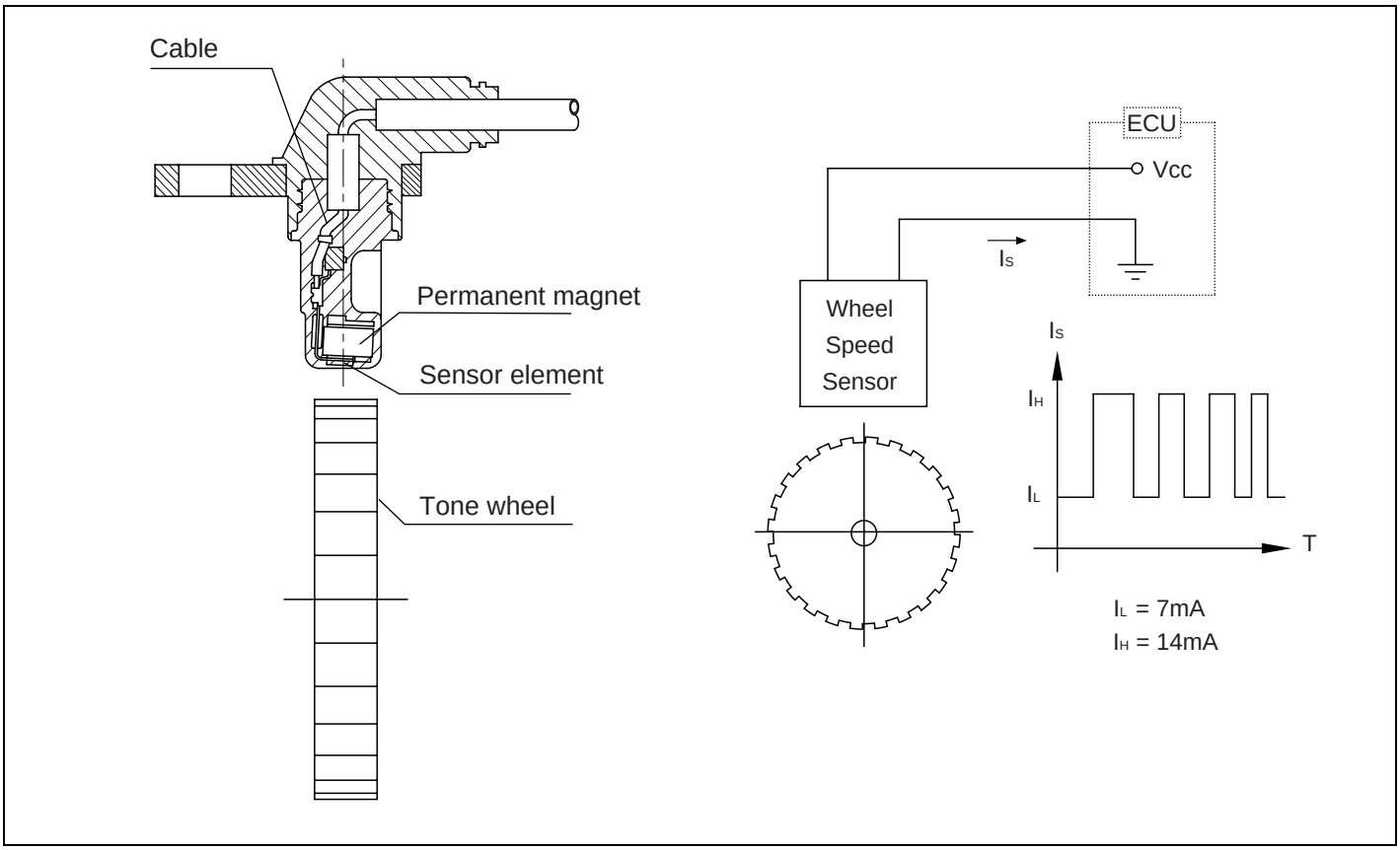
Item	Unit	Remark
Battery voltage	V	
Vehicle speed sensor	Km/h	
ABS operation	ACT/NOT ACT	
EBD operation	ACT/NOT ACT	
TCS operation	ACT/NOT ACT	
ESP OFF switch (TCS OFF switch)	OFF/ON	Only ESP
AYC Operation	ACT/NOT ACT	Only ESP
Brake switch	OFF/ON	

COMPONENT INSPECTION EF1A7BAB

ACTIVE WHEEL SPEED SENSOR

The wheel speed sensor assembly consists of a permanent magnet attached to a sensor element (IC), which is molded into plastic. The sensor element is connected to the sensor cable. The sensor cable ensures an electric connection of the sensor element to the electronic control unit (ECU).

A toothed rotor is fixed to the rotating member of the wheel, the sensor to the static member of the suspension. As the wheel rotates the toothed rotor causes magnetic flux changes in the magnetic field of the permanent magnet. The sensor element senses these changes. Depending on the flux changes the sensor sends a signal out to the ECU. The change in magnet flux thus the sensor signal is directly correlated to the wheel speed.
The controller monitors the sensor signal, compares the four wheel-speed signals and initiates action as required.



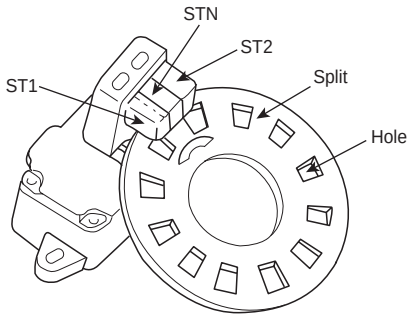
LJCD206D

SPECIFICATION

Item			Standard Value	Remark
Supply voltage			DC 12V	
Operating voltage			7.5 ~ 20V (DC)	R=115Ω
Output current range			7mA ~ 14mA	R=115Ω
Tightening torque			0.8 ~ 0.95kg·m	
Airgap			0.2 ~ 1.15mm	
Tone wheel	Number		47	
	Height		2.5mm	
	Width	Front	12mm	
		Rear	10mm	
	Outer Diameter	Front	Ø89	
		Rear	Ø63.95	

STEERING WHEEL ANGLE SENSOR

Steering wheel angle sensor detects the operating speed of handle and is composed of the three photo transister. Steering wheel angle sensor is located in the multifunction switch of steering wheel. The specifications of sensor are as following.



LJCD129A

1. Specification

Item	Standard Value	Remark
Pulse duty	50±10%	Operating Temp. range : -30 ~ 75°C
Pulse width	8deg/1 pulse	
Operating voltage	9 ~ 16V	
Consumption current	Max.100mA	
HIGH voltage	3.0V ~ 4.1V	
LOW voltage	1.3V ~ 2.0V	
Steering angular velocity	Max.1500deg/sec	

2. Neutural position detect

1) It should remain the satisfied condition as followed more than 2 seconds in order to detect neutral position.

2) The vehicle speed should be above 10 km/h.

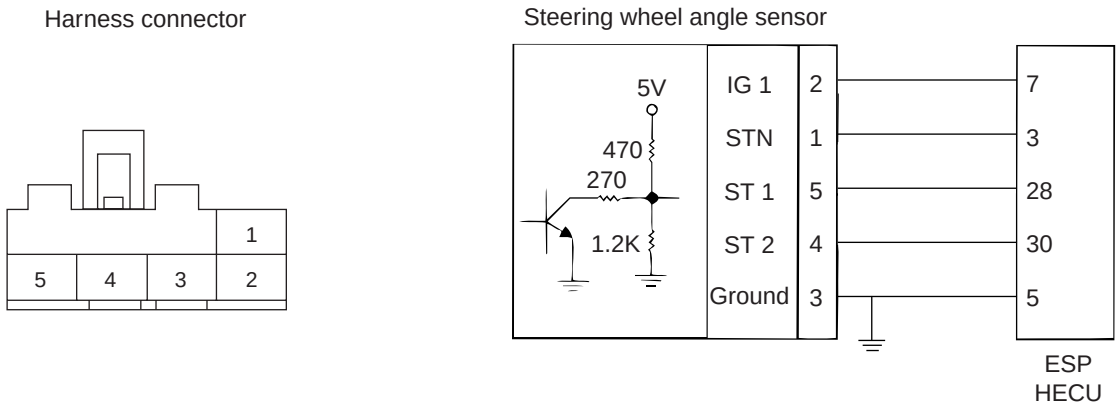
3) The brake switch should be in position “ OFF” .

4) It should be lasted more than two seconds after turning ignition “ OFF” .

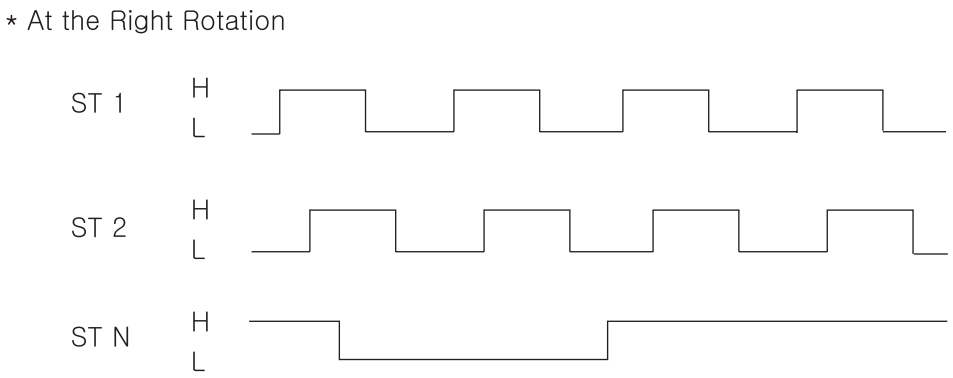
5) The neutral signal(STN) valve should be “ O” .

3. Output characteristic

Output characteristic



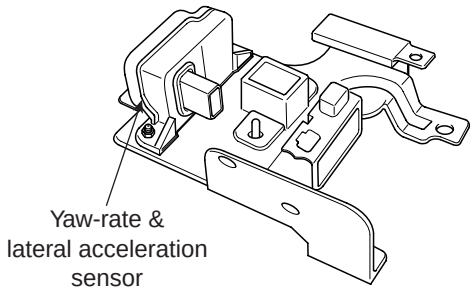
SGHBR7511L



LJCD204A

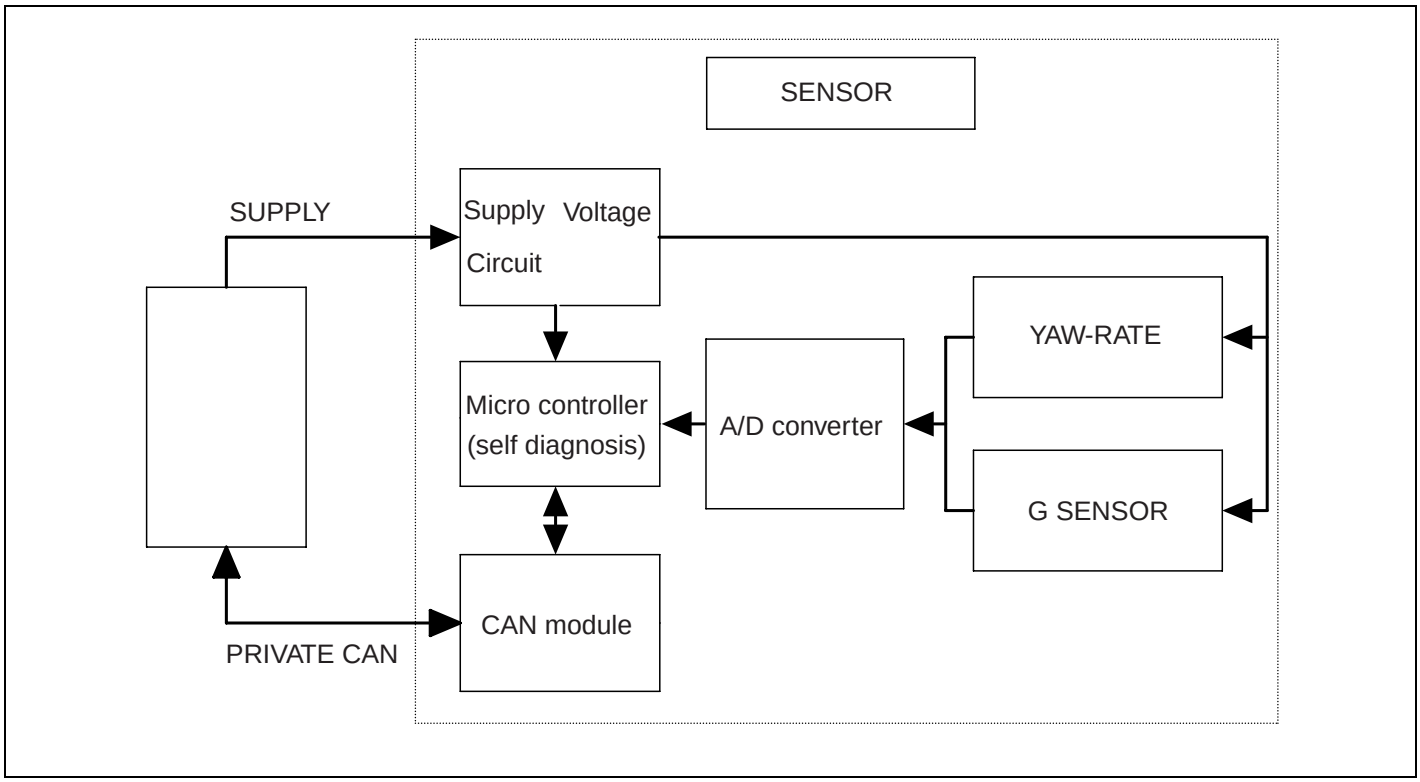
YAW-RATE & LATERAL ACCELERATION SENSOR (SENSOR CLUSTER)

Sensor cluster consists of yaw-rate sensor, lateral acceleration sensor and micro controller in alluminum case and is installed in the lower floor of center crash pad.



LJCD016E

BLOCK DIAGRAM



LJCD201C

YAW-RATE SENSOR

Application
Detect the yawing motion of the vehicle, triggering an ESP control intervention if the yaw velocity reaches round about 4°/s (=full circle in 90 s)

Design and function
The yaw-rate sensor relies on the action of microscopic tuning forks.
The plane in which these forks vibrate shifts when the car turns about its vertical axis. This shift is evaluated electronically.

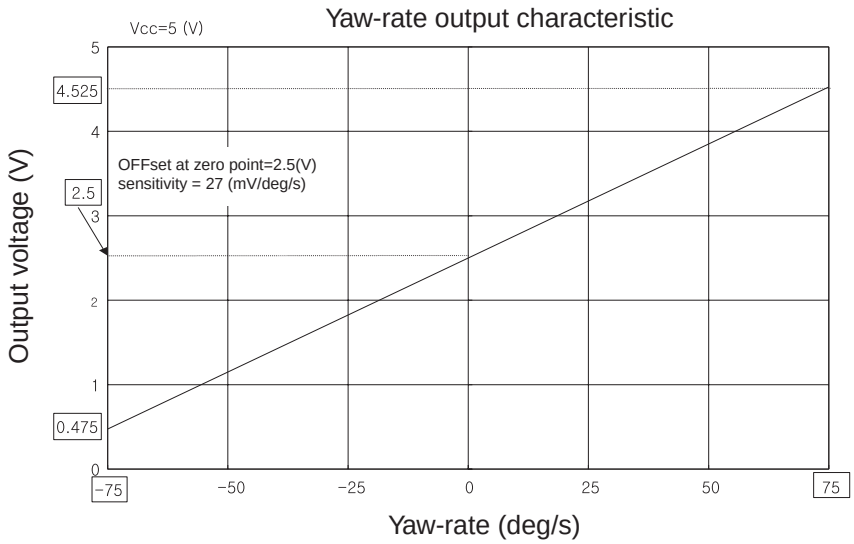
Failsafe
- A faulty yaw rate sensor produces an output signal of 0V.

Installation position
- Tuning forks vertical.
- Required accuracy of position : max. 3° tolerance to maintain full comfort.
- Failure to maintain the specified installation position will result in asymmetrical control.

1. Specification

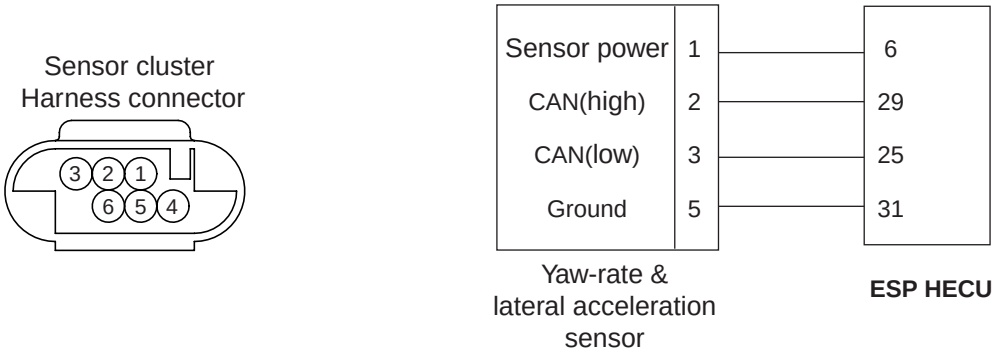
Item	Standard value	Remark
Supply voltage	8V ~ 16V	
Supply current	Below 250mA	
Output voltage (at stop)	2.5V	
Output range	0.475 ~ 4.525V	Sensitivity = 27mV/deg/s
Operating speed (at start)	4°/s	
Angular velocity detection range	-75 ~ 75deg/sec	
Operating temp.	-40 ~ 85°C	

2. Output voltage



LJCD206A

3. Circuit Diagram



SGHBR7512L

LATERAL ACCELERATION SENSOR

Application
Sense the lateral acceleration of the vehicle

Design
In the interior of the sensor, a small mass element is attached to a movable lever arm which is deflected by lateral acceleration.

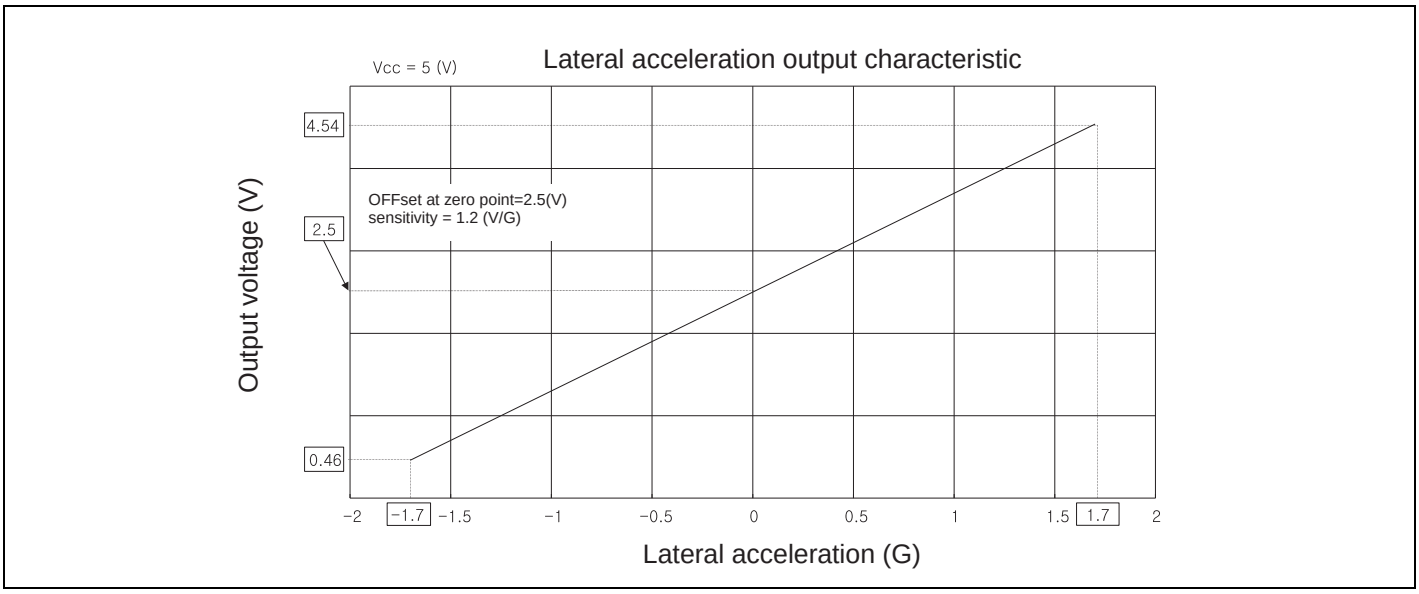
Function
- Between two electrically charged stationary plates having the same polarity, an electrically charged silicon element having the opposite polarity is attached to the end of a cantilever arm.
- Between these three plates, two electric fields are generated by the capacitances C1 and C2.
- The capacitances C1 and C2 change in response to lateral acceleration. This change can be used to calculate the direction and amount of lateral acceleration acting on the vehicle.
- The same sensor can also be used as longitudinal acceleration sensor if it is installed in the direction of travel (e.g. VW 4 motion with Haldex clutch).
- For 0 g lateral acceleration, the sensor produces an output signal with a voltage of 2.5 V.

Other
- The signal of the lateral acceleration sensor alone cannot trigger an ESP intervention.
  The sensor is mainly used for estimating the coefficient of friction.
- The installation location of the lateral acceleration sensor is more critical than that of the yaw-rate sensor (lever arm).
- The installation location may not be changed after repairs.

1. Specification

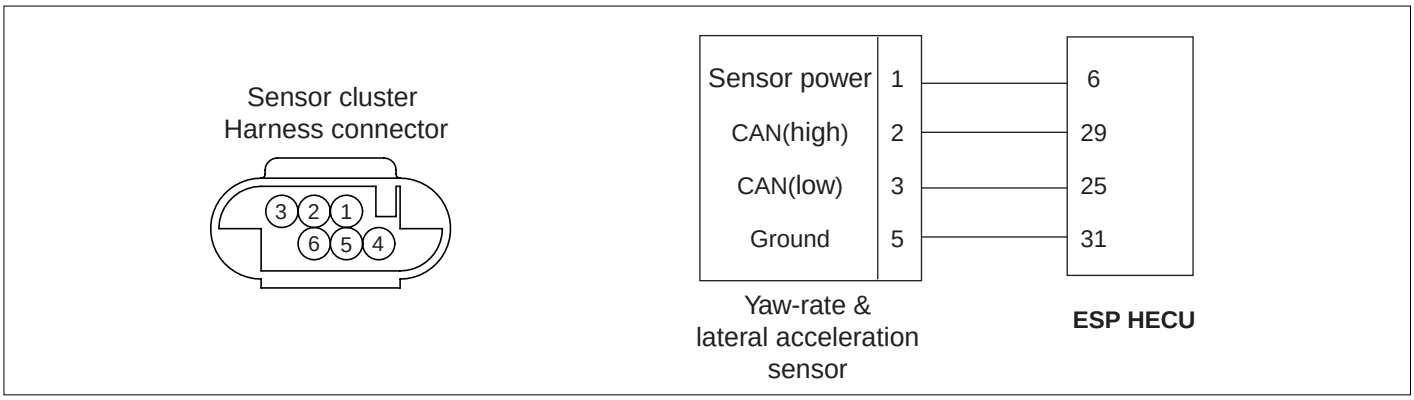
Item	Standard value	Remark
Supply voltage	8V ~ 16V	
Output voltage (at stop)	2.5V	
Output range	0.46V ~ 4.54V	
Acceleration range	-1.7 ~ 1.7 gN	
Acceleration detection range	-16.7 ~ 16.7 m/s^2	
Operating temperature	-40 ~ 85°C	

2. Output voltage



LJCD206B

3. Circuit Diagram



SGHBR7513L

PRESSURE SENSORS

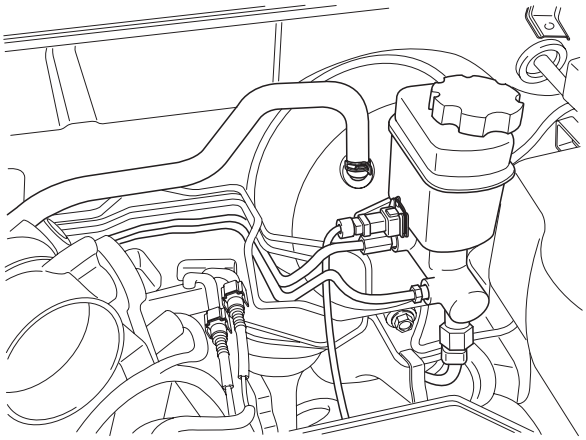
Application
- Sense the driver's braking intentions (braking while an ESP intervention is in progress)
- Control the precharging pressure

Design
The sensor consists of two ceramic disks, one of which is stationary and the other movable. The distance between these disks changes when pressure is applied.

Function
- The pressure sensors operate on the principle of changing capacitance (a).
- The distance (s) between the disks and, thus, the capacitance changes when pressure is applied to the movable disk by a braking intervention.
- The fluid displacement of the sensor is negligible.
- Max. measurable pressure : 170 bar

Failsafe
Guaranteed by redundant installation

Installation location
The sensors are mounted on the TMC (primary and secondary circuits).

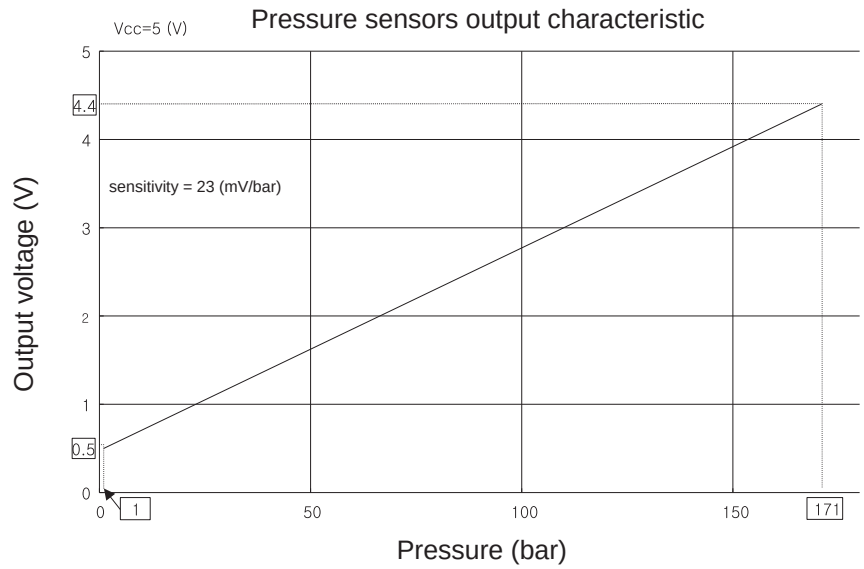


SGHBR6640D

1. Specification

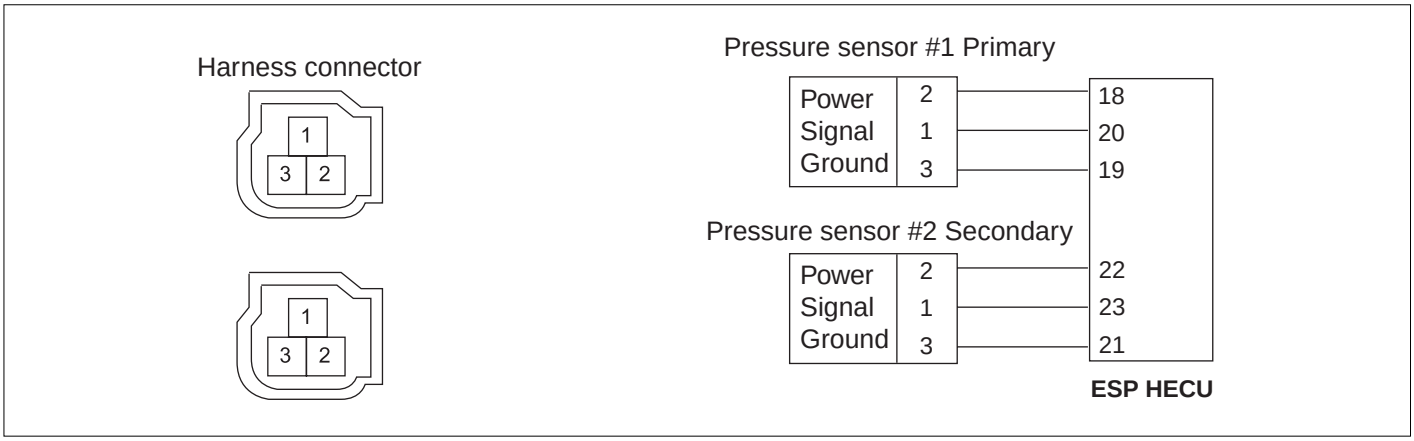
Item	Standard value	Remark
Supply voltage	4.75V ~ 5.25V	
Output range	0.5V ~ 4.4V	Sensitivity = 23mV/bar
Output voltage(at stop)	0.5V	
Operating pressure range	0 ~ 171 bar	
Operating temperature	-30℃ ~ 120℃	

2. Output voltage



LJCD206C

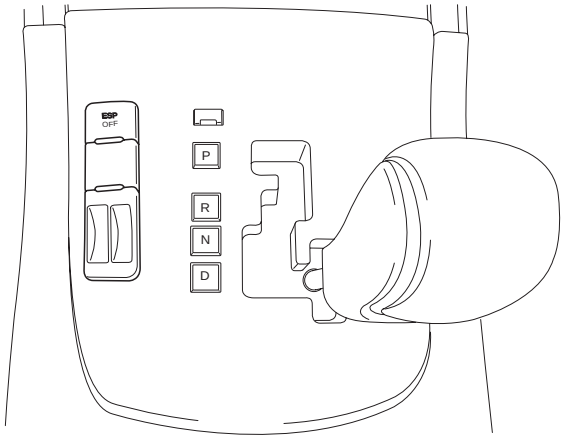
3. Circuit Diagram



SGHBR7514L

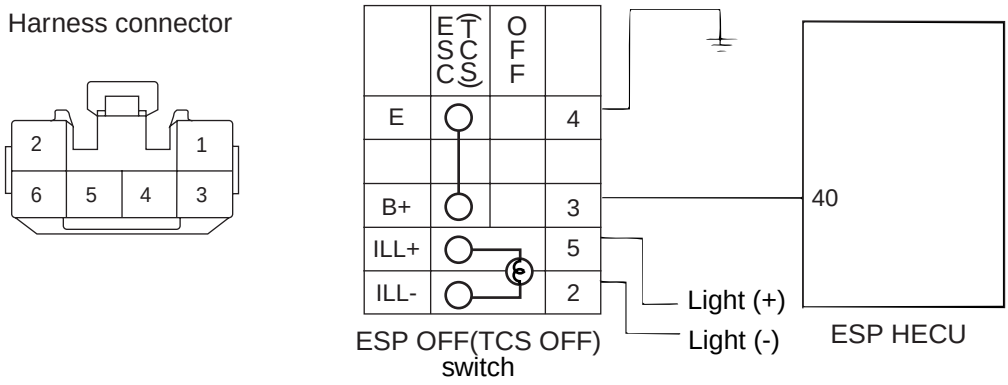
ESP OFF (TCS OFF) SWITCH

1. ESP OFF (TCS OFF) switch is installed on crash pad switch plate of driver's side.
2. A driver can choose at driver's option.
3. When forbidding the ESP(TCS) control, the driver can operate the ESP OFF(TCS OFF) switch.
4. When choosing, ESP OFF (TCS OFF) function lamp is turned on.



SGHBR7516L

5. Circuit Diagram

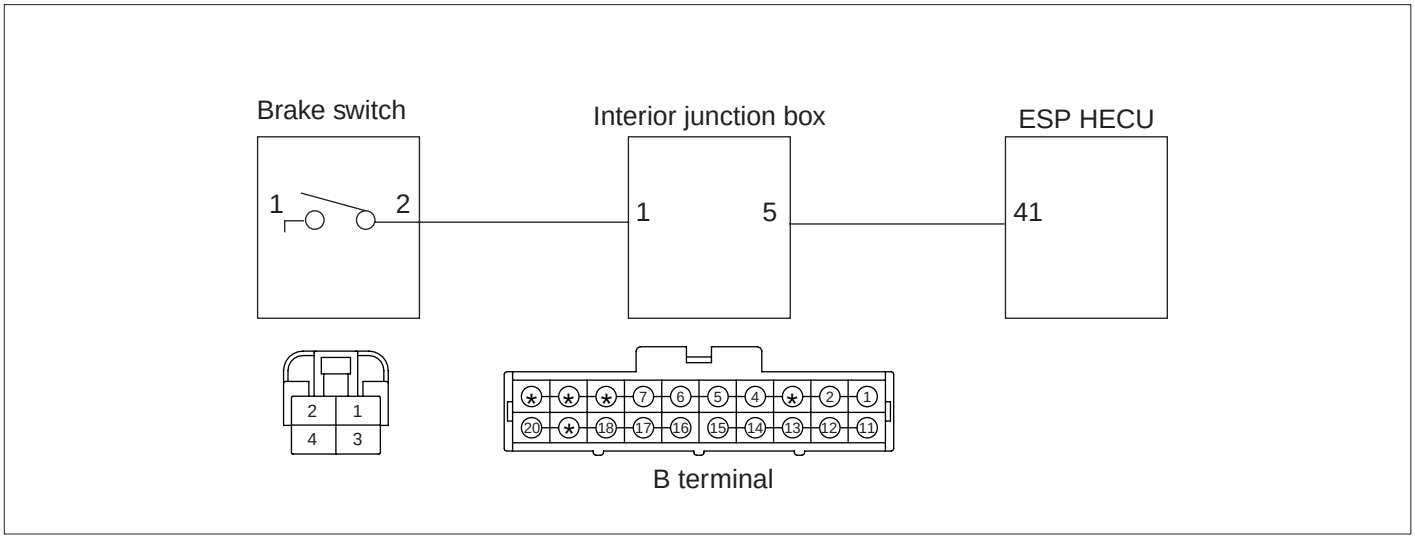


SGHBR7515L

BRAKE LAMP SWITCH

1. The brake lamp switch determines to judge if ESP and ABS should be controlled by transmitting whether braking should be tried to HECU.
2. The brake lamp switch uses as the basic signal of ABS & ESP braking control.
3. Circuit diagram.

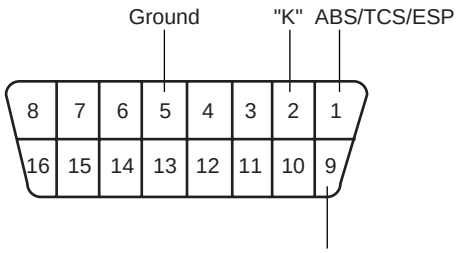
CIRCUIT DIAGRAM



SGHBR7517L

HI-SCAN (PRO) CHECK E1014D12

1. Turn the ignition OFF.
2. Connect the Hi-Scan(pro) to the Data Link connector located underneath the lower crash pad panel.
3. Turn the ignition ON.
4. Use the Hi-Scan (Pro) to check for diagnosis trouble codes.
5. After completion of the repair or correction of the problem, erase the stored fault codes using the clear key on the Hi-Scan (Pro).
6. Disconnect the Hi-Scan (Pro).



DATA LINK CONNECTOR (OBD connector)

LJCD546A

FAILURE DIAGNOSIS

GENERAL

1. In principle, ESP and TCS controls are prohibited in case of ABS failure.
2. When ESP or TCS is fail, only the failed system control is prohibited.
3. However, when the solenoid valve relay should be turned off in case of ESP fail, refer to the ABS fail-safe.
4. Information on ABS fail-safe is identical with the fail-safe in which ESP is not installed.

MEMORY OF FAIL CODE

1. It keeps the code as far as the backup lamp power is connected. (O)
2. It keeps the code as far as the HCU power is on. (X)

FAILURE CHECKUP

1. Initial checkup is performed immediately after the HECU power on.
2. Valve relay checkup is performed immediately after the IG2 ON.
3. It executes the checkup all the time while the IG2 power is on.
4. Initial checkup is made in the following cases.
   1) When the failure is not detected now
   2) When ABS and ESP are not in control.
   3) Initial checkup is not made after ECU power on.
   4) If the vehicle speed is over 409 mph(8 km/h) when the brake lamp switch is off.
   5) When the vehicle speed is over 24.8 mph(40 km/h).
5. Though, it keeps on checkup even if the brake lamp switch is on.
6. When performing ABS or ESP control before the initial checkup, stop the initial checkup and wait for the HECU power input again.
7. Judge fail in the following cases.
   1) When the power is normal.
   2) From the point in which the vehicle speed reaches 4.9 mph(8 km/h) after HECU power on.

COUNTERMEASURES IN FAIL

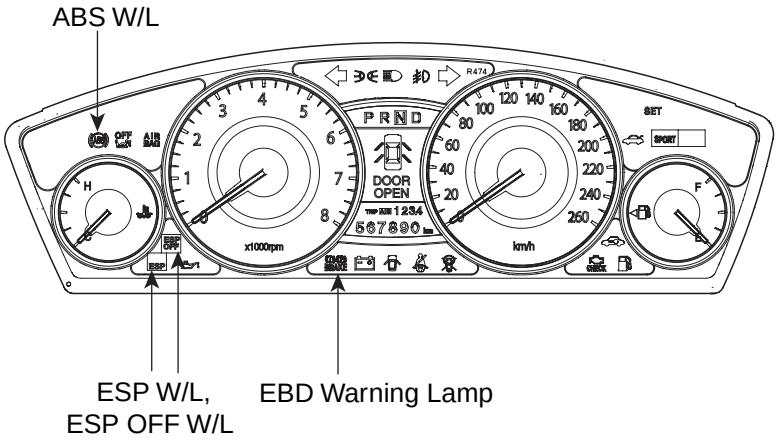
1. Turn the system down and perform the following actions and wait for HECU power OFF.
2. Turn the valve relay off.
3. Stop the control during the operation and do not execute any until the normal condition recovers.

WARNING LAMP ON

1. ABS warning lamp turns on when ABS is fail.
2. TCS warning lamp turns on when TCS is fail.
3. ESP operation lamp turns on and TCS OFF warning lamp blinks when ESP is fail.

When power voltage and valve relay voltage are abnormal, input/output related failure judgment is not made.

WARNING LAMP & FUNCTION LAMP



SGHBR7518L

1. **EBD warning lamp control**
   The EBD warning lamp indicates the operating condition of the EBD function.
   The EBD warning lamp is on :
   - During the initialization phase (3seconds)
   - In the event of inhibition of EBD functions.
   - Depending on the warning lamp module, when the controller is switched off as long as voltage is applied at the ignition terminal (IG1).

2. **ABS warning lamp control**
   The ABS warning lamp indicates the operating condition of the ABS function.
   The ABS warning lamp is on :
   - During the initialization phase (3seconds)
   - In the event of inhibition of ABS functions
   - Depending on the warning lamp module, when the controller is switched off as long as voltage is applied at the ignition terminal (IG1).
   - During diagnostics.

3. **TCS/ESP warning lamp control**
   The TCS/ESP warning lamp indicates the operating condition of the TCS/ESP function.
   The TCS/ESP warning lamp is on :
   - During the initialization phase (3seconds)
   - In the event of inhibition of TCS/ESP functions
   - During diagnostics.

4. **TCS/ESP function lamp control**
   The TCS/ESP function lamp indicates the operating condition of the TCS/ESP function.
   The TCS/ESP function lamp is on :
   - During the initialization phase (3seconds)

   The TCS/ESP function lamp is blinking :
   - During TCS/ESP control
   - At the ESP off mode depending on ESP off switch, ESP control is available and ESP function lamp is blinking only when brake is turned on by driver.

SAFETY CONCEPT (ESP)

When any failures are occurred in the ESP system, the ESP ECU turns on the warning lamps and inhibits the control corresponding that as follows.

CONDITION	Warning Lamp Combination			CONTROL		
	ABS_WL	EBD_WL	ESP_WL	CBS	ABS	ESP
Two or more WSS failures, valve failure, internal ECU failure, high/low supply voltage	ON	ON	ON	Available	Inhibited	Inhibited
One WSS failure, pump failure	ON	-	ON	Available	Inhibited	Inhibited
CAN failure, pressure sensor failure, steering angle sensor failure, Yaw-rate & G sensor failure	-	-	ON	Available	Available	Inhibited

*)"-" means "Warning Lamp OFF"

BRAKE BLEEDING AT THE DEALERS (WORKSHOPS)

NOTE

In section 1.1 to 4.3, the bleeding procedure is described without bleed machine. Ensure that always sufficient brake fluid is in the reservoir. Using a bleed machine simplifies these sections analog to section 5 "Brake fluid renewal". Thenthe bleeding process should be accompanied by additional pedal strokes (about 5x per wheel circuit) with the connected bleed machine.

1. System bleeding after replacement of TMC.
   1.1 Preparation of actuation
   a. Connect new TMC to booster assembly
   b. Assemble reservoir to TMC.
   c. Assemble brake tubes to TMC brake line ports.
   d. Fill reservoir with new DOT4 brake fluid.

   1.2 Conventional bleeding of brake system.
   a. Connect bleeder bottle tube to FL caliper bleeder screw.
   b. Actuate brake pedal with a pedal force of 150N to 200N.
   c. Open bleeder screw until pressure is released, close bleeder screw, then release brake pedal.
   d. After pedal release wait 2s until brake fluid is flown into the master cylinder.
   e. Repeat this procedure till clear, bubble free brake fluid streams out.

Lead value: 10 to 20 times.

NOTE

Watch brake fluid level in reservoir and refill if necessary (mind the pad wear).
According 1.2 repeat procedure for caliper FR, RL and RR.
(Only for ESP vehicles).When manual bleeding in IG ON.
Warning Lamp is ON due to malfunction of pressure sensor.
Erase Warning Lamp using Hi-scan tool.
There is No problem when IG is OFF.

1.3 Vehicle disconnection
a. Fill reservoir to "MAX" level and mount reservoir cap (mind pad wear)
b. Start engine to generate vacuum in the booster.
c. Check brake pedal travel and pedal feeling.

NOTE

If the pedal travel is too long after the bleeding, check the brake system for leaks, or if O.K., repeat procedure 1.2
(only for ESP vehicles) Trim the pressure sensor(s) via diagnose.

d. Remove bleeder hoses and retighten wheel bleeder screws to correct torque.

Tightening torque : 7~13N.m(70~130 kg.cm, 5~9 lb-ft)

2. System bleeding after replacement of one (both) TMC pressure sensor(s)
   (Only for ESP vehicles)
   2.1 Preparation of actuation

   1)
   a. Assemble new pressure sensor(s) to TMC

NOTE

After assembling, trim the new pressure sensor(s) via diagnosis.

   b. Fill reservoir with new DOT4 brake fluid.

   2.2 Bleeding conventional brake system
   See section 1.2

   2.3 Vehicle disconnection according to 1.3

3. Bleeding brakes after replacement of the Hydraulic Control Unit (HCU)

NOTE

The repair part HCU is completely filled

3.1 Vehicle preparation

1)

a. Connect bleeder bottle tube to bleed screws of FL and RL caliper and open them.
b. Actuate the brake pedal ＞60mm) and secure it by using a pedal support. This closes the TMC central valves and prevents fluid flowing out of the opened brake system.
c. Close FL and RL caliper bleeder screws and remove bleeder bottle.
d. Remove defective HCU.

NOTE

Remove brake tubes which lead from the HCU to the TMC first and close open ports of the HCU with protection caps immediately. Then remove brake tubes from HCU to the brakes and close these ports of the HCU with protection caps, too.

e. Install new HCU

NOTE

The new repair part HCU is totally pre-filled. To keep the brake fluid inside the HCU, remove port protection caps of the brake circuit connections first and assemble these brake tubes. When all brake circuits are connected, remove port protection caps of TMC ports of HCU and connect TMC tubes to HCU.

f. Remove pedal support.
g. Remove fluid reservoir cap and fill reservoir to "MAX" with new DOT 4 brake fluid.
h. Lift vehicle or use inspection pit.

3.2 Bleeding conventional brake system
See section 1.2
3.3 Vehicle disconnection according to 1.3

4. Brake bleeding after caliper replacement.
4.1 Vehicle preparation

1)

a. Connect bleeder bottle tube to bleed screw of FL and RL caliper and open them.
b. Actuate the brake pedal ＞60mm) and secure if by using a pedal support. This closes the TMC central valves and prevents fluid flowing out of the opened brake system.
c. Close FL and RL caliper bleeder screws and remove bleeder bottle.
d. Replace defective caliper with a new one.
e. Remove fluid reservoir cap and fill reservoir to "MAX" with new DOT 4 brake fluid.

4.2 Bleed procedure
Only the new caliper has to be bled according to the conventional bleeding method. (see section 1.2)
4.3 Vehicle disconnection according to 1.3

5. Brake fluid renewal
5.1 Vehicle preparation

1)

a. Connect bleeder unit to brake fluid reservoir. Fill pressure max. 3 bar.
b. Lift vehicle

5.2 Bleed procedure

2)

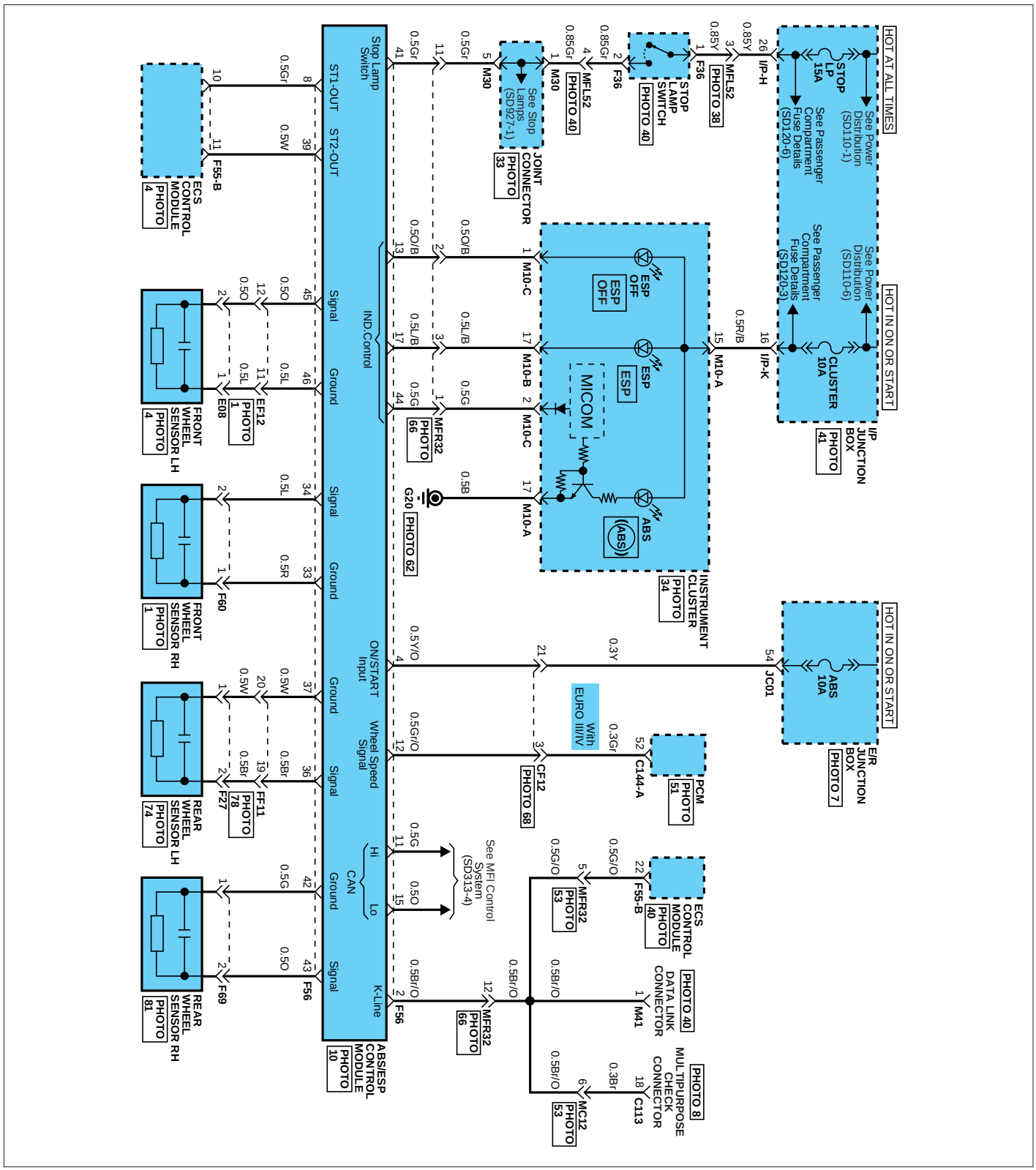
a. Connect bleeder bottle tube to FL caliper bleed screw and open it.
b. Leave screw open until new, clear, bubble-free fluid is observed in tube.
c. Close bleed screw.
d. Repeat above procedure for the remaining wheel calipers.

5.3 Vehicle disconnection

3)

a. Remove the bleeder unit.
b. Act according to 1.3

HECU CONTROL UNIT (ESP) CIRCUIT DIAGRAM EE2DA978



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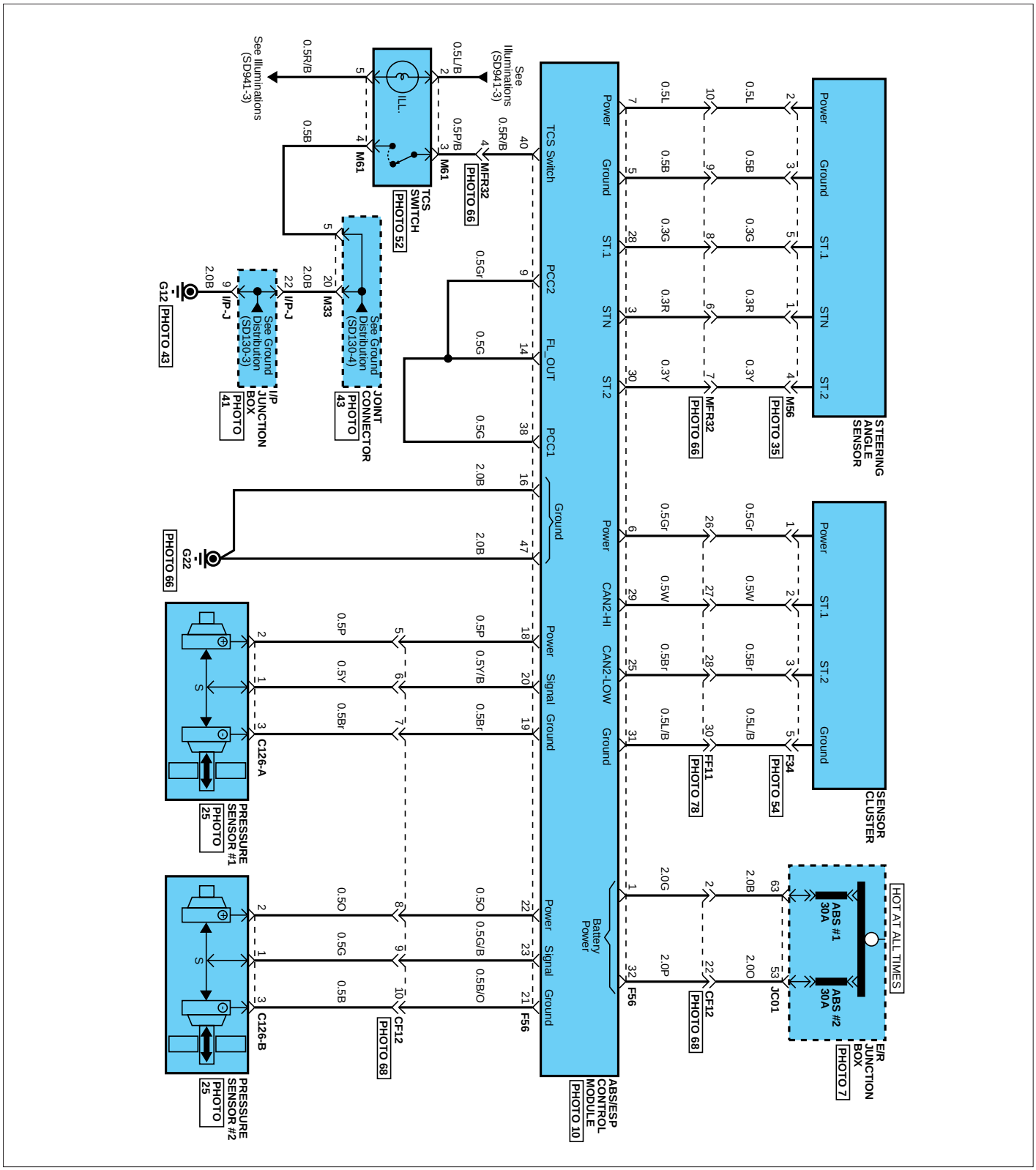

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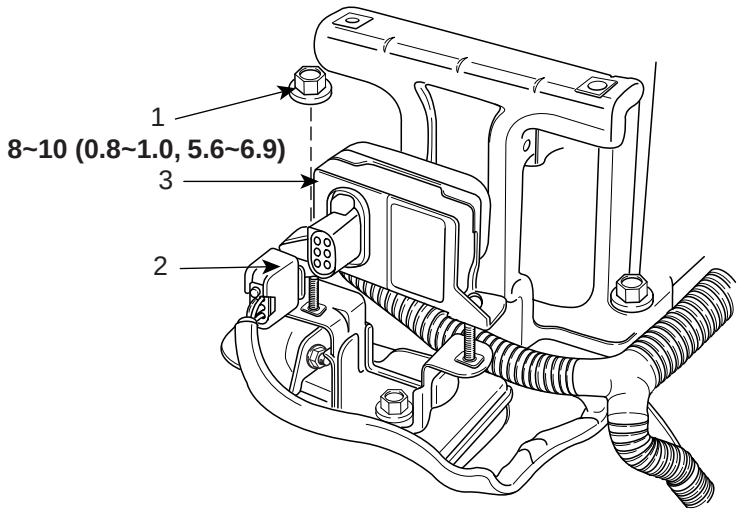
YAW-RATE SENSOR

COMPONENTS E2734DBE



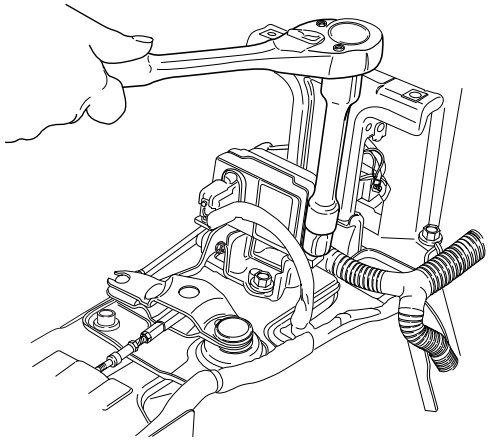
TORQUE : Nm (kgf.m, lb-ft)

1. Nut
2. Connector
3. Yaw-rate & lateral accereration sensor

SGHBR7583N

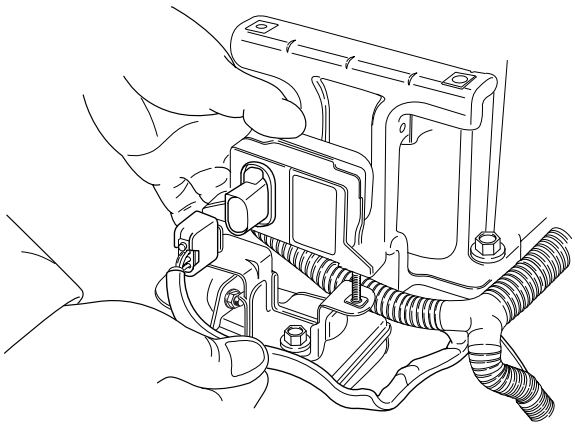
REMOVAL E1DA77B5

1. Remove the center console.
   (Refer to transaxle lever disassembly installation of TR group)
2. Remove the yaw-rate & lateral acceleration sensor mounting bolt.



ARCD211B

3. Disconnect the yaw-rate & lateral acceleration sensor connector.



ARCD211C

INSTALLATION E4DD5CF0

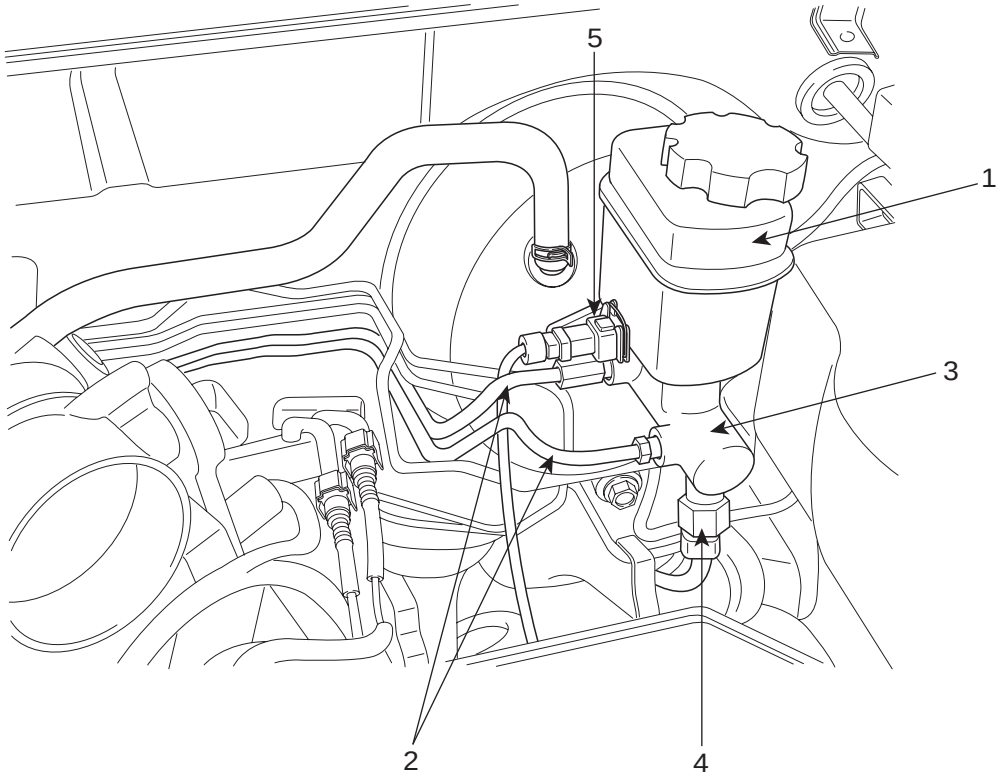
1. Connect the yaw-rate & lateral acceleration sensor connector.
2. Install the yaw-rate & lateral acceleration sensor.

Tightening torque :
Yaw-rate & lateral acceleration sensor mounting bolt :
8~10 N.m(0.8~1.0 kgf.m, 5.6~6.9 lb-ft)

3. Install the center console.

MASTER CYLINDER PRESSURE SENSOR

COMPONENTS E6AB634A



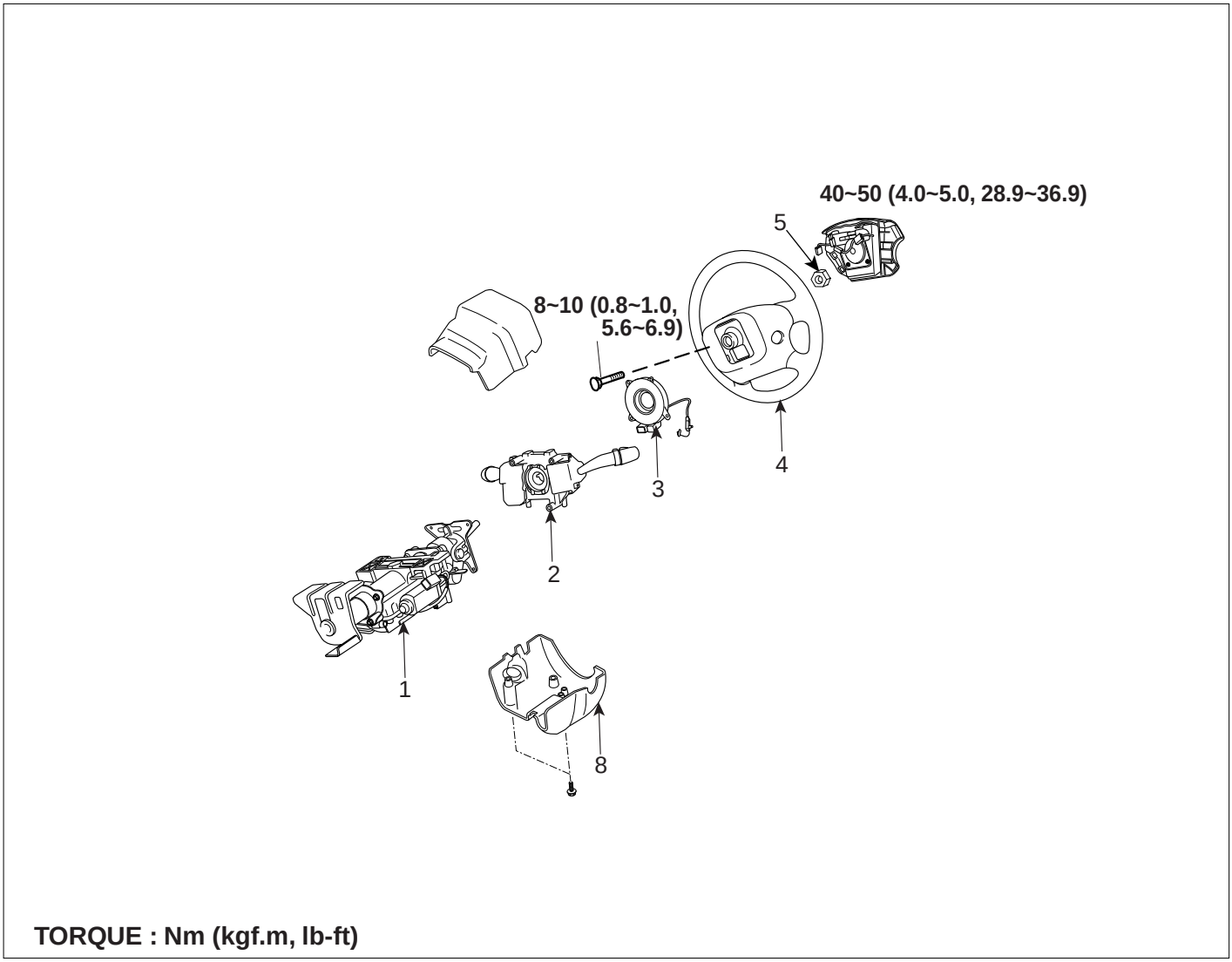
TORQUE : Nm (kgf.m, lb-ft)

1. Brake reserve tank
2. Brake tube
3. Master cylinder
4. Master cylinder pressure sensor
5. Reserve tank level switch

SGHBR7584N

STEERING WHEEL ANGLE SPEED SENSOR

COMPONENTS E3ABFB89

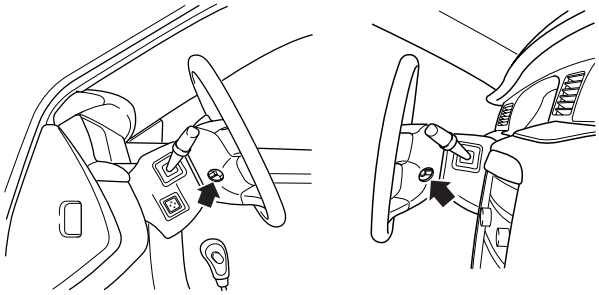


1. Steering column
2. Combination switch
3. Clock spring & steering wheel angle sensor
4. Steering wheel
5. Steering wheel nut

SGHBR7585N

REMOVAL EDF9DC69

1. Remove the bolt cover from both down side the steering wheel cover
2. Loosen two bolts using the hex wrench.

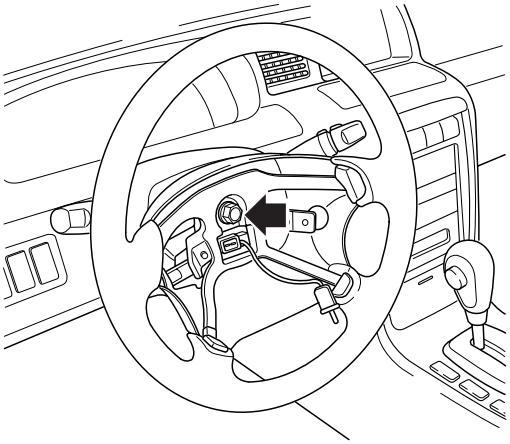


APCD007A

3. Using the special tool (09561-1101), remove the steering wheel.

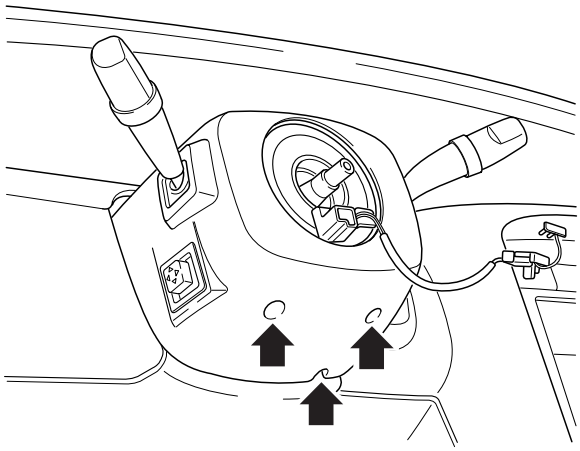
CAUTION

Do not hammer on the steering wheel to remove it; doing so may damage the collapsible shaft.



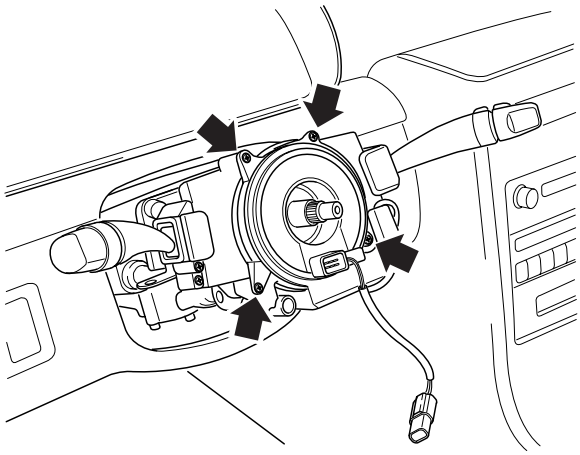
APCD007B

4. Remove the steering column lower shroud and upper shrould.
5. Remove the lower cover.



APCD007C

6. Remove the steering wheel angle sensor after loosening the clock spring mounting bolt.



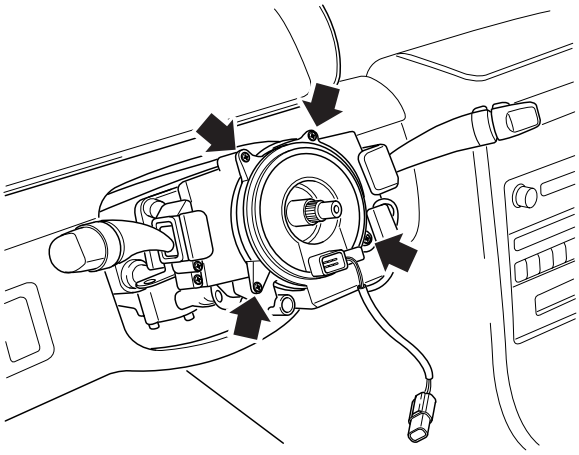
APCD007D

INSTALLATION E3C667F7

1. Tighten the four mounting bolts after installing the clock spring and steering wheel angle sensor.

CAUTION

Turn clock spring and angular sensor to the end of both direction, return to the opposite direction two and a half rounds.
Install the steering wheel after aligning clock spring and angle sensor to be '><' form

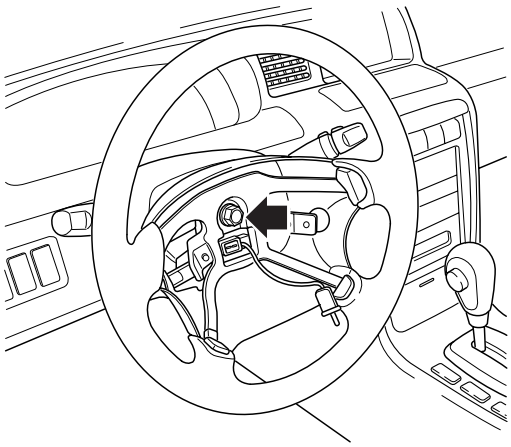


APCD007D

2. Install the steering wheel.

3. Tighten the steering wheel nut.

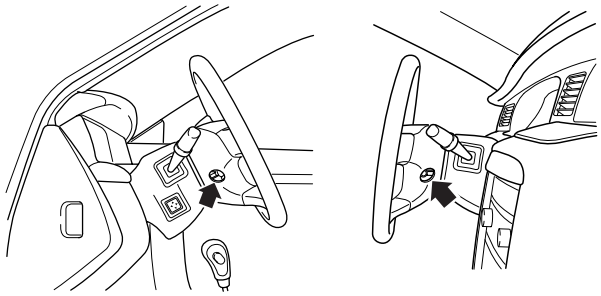
Tightening torque : 40~50 N.m (4.0~5.0 kgf.m, 28.9~36.9 lb-ft)



APCD007B

4. Tighten two bolts after installing the air module.

Tightening torque : 8~11 N.m (0.8~1.1 kgf.m, 5.6~7.0 lb-ft)



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