ANTI-LOCK BRAKING SYSTEM (ABS) <FWD>

CONTENTS

35209000114

CONTINUED ON NEXT PAGE

WARNINGS REGARDING SERVICING OF SUPPLEMENTAL RESTRAINT SYSTEM (SRS) EQUIPPED VEHICLES

WARNING!

(1) Improper service or maintenance of any component of the SRS, or any SRS-related component, can lead to personal injury or death to service personnel (from inadvertent firing of the air bag) or to the driver and passenger (from rendering the SRS inoperative).

(2) Service or maintenance of any SRS component or SRS-related component must be performed only at an authorized MITSUBISHI dealer.

(3) MITSUBISHI dealer personnel must throughly review this manual, and especially its GROUP 52B - Supplemental Restraint System (SRS) and GROUP 00 - Maintenance Service before beginning any service or maintenance of any component of the SRS or any SRS-related component.

NOTE

The SRS includes the following components: SRS-ECU, SRS warning light, air bag module, clock spring and interconnecting wiring. Other SRS-related components (that may have to be removed/installed in connection with SRS service or maintenance) are indicated in the table of contents by an asterisk (*).

GENERAL INFORMATION

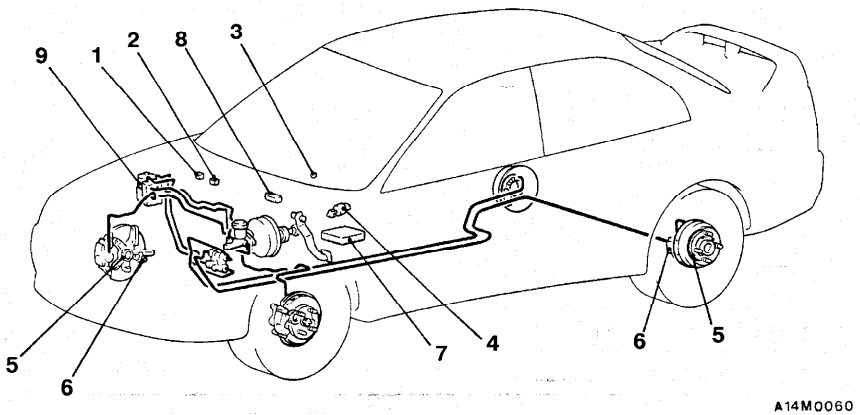
35200010116

The ABS consists of components such as the wheel speed sensors, stop light switch, hydraulic unit assembly, ABS control unit (ABS-ECU) and the ABS warning light. If a problem occurs in the system, the malfunctioning components can be identified and the trouble symptoms will be memorized by the diagnostic function.

In addition, reading of diagnostic trouble codes and data list and actuator testing are possible by using the Scan Tool.

Items		Specifications
Master cylinder	Type	Tandem type (with level sensor)
	I.D. mm (in.)	22.22 (.87)
Brake booster	Type	Vacuum type, single
	Effective dia. of power cylinder mm (in.)	230 (9.1)
	Boosting ratio	5.0
Proportioning valve	Type	Dual type
	Decompression ratio	0.25
Front brakes	Type	Floating caliper, 1-piston, ventilated disc
	Disc effective dia. x thickness mm (in.)	184 x 18 (7.2 x .71)
	Wheel cylinder I.D. mm (in.)	54.0 (2.13)
	Pad thickness mm (in.)	10.0 (.39)
	Clearance adjustment	Automatic
Rear drum brakes	Type	Leading trailing
	Drum I.D. mm (in.)	203 (8.0)
	Wheel cylinder I.D. mm (in.)	17.46 (.687)
	Lining thickness mm (in.)	4.38 (.172)
	Clearance adjustment	Automatic
Brake fluid		DOT-3 or DOT-4
ABS type		4-sensor, 4-channel method
Speed sensor		Magnet coil type on 4-wheels
Front rotor teeth		43
Rear rotor teeth		43

CONSTRUCTION DIAGRAM



A14M0060

1. ABS valve relay
2. ABS motor relay
3. ABS warning light
4. Stop light switch
5. Rotor
6. Wheel speed sensor
7. ABS-ECU
8. Data link connector
9. Hydraulic unit

SERVICE SPECIFICATIONS

35200030129

Items			Standard value	Limit
Rear drum brake	Lining thickness mm (in.)		4.38 (.172)	1.0 (.039)
	Drum inside diameter mm (in.)		203 (8.0)	205 (8.1)
Resistance between solenoid valve terminals Ω		IN	8.04 - 9.04	-
		OUT	4.04 - 4.54	-
Wheel speed sensor's internal resistance kΩ			1.4 - 1.8	-
Wheel speed sensor insulation resistance kΩ			100 or more	-
Clearance between the rear speed sensor mounting surface and the rotor mm (in.)			0.1 - 2.0 (.004 - .079)	-

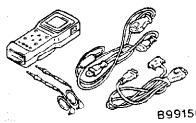
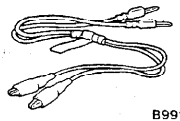
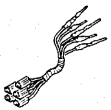
LUBRICANTS

35200050040

Items	Specified lubricant
Brake fluid	DOT-3 or DOT-4
Wheel cylinder body inner surfaces	Repair kit grease
Rear brake shoe and backing plate contact surfaces	Brake grease SAE J310, NLGI No. 1
Shoe assembly and auto adjuster assembly contact surfaces	
Shoe and lever assembly and auto adjuster assembly contact surfaces	

SPECIAL TOOLS

35200060128

Tool	Tool number and name	Supersession	Application
 B991502	MB991502 Scan Tool (MUT-II) sub assembly	MB991496-OD	For checking of ABS [diagnostic trouble code display when using the Scan Tool (MUT-II)]
 B991529	MB991529 Diagnostic trouble code check harness	Tool not necessary if Scan Tool (MUT-II) is available.	For checking of ABS (Diagnostic trouble code display when using the ABS warning light)
	MB991008 Piston cup installer		Installation of drum brake wheel cylinder piston cup
A  B991219	MB991223 Inspection harness set A: MB991219 Connector pin contact pressure inspection harness	MB991219	For checking of wheel speed sensor output voltage

TROUBLESHOOTING

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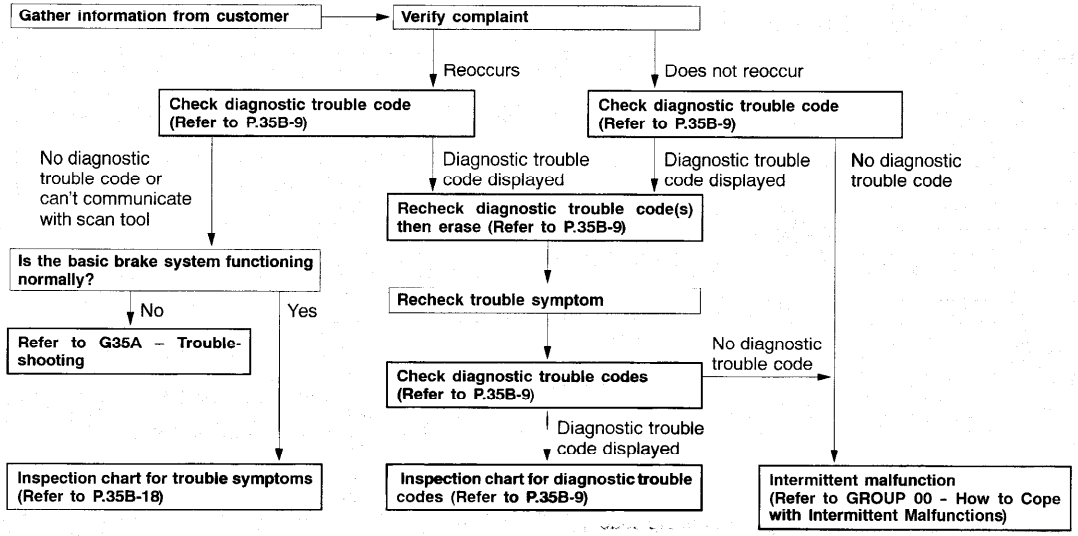
DIAGNOSTIC TROUBLESHOOTING FLOW

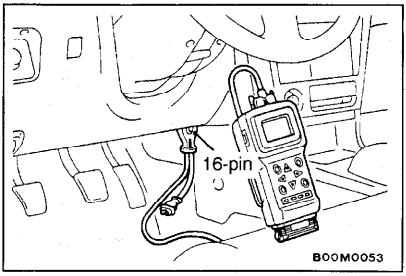


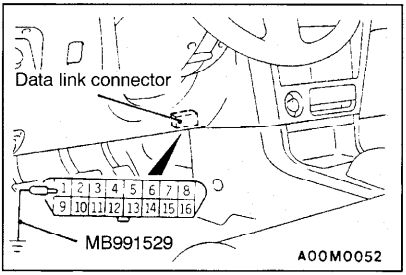
NOTES WITH REGARD TO DIAGNOSIS

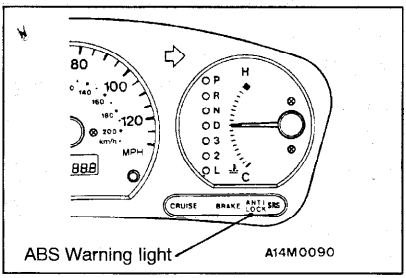
The condition listed in the following table are considered normal.

Condition	Explanation of condition
System check sound	When starting the engine, a thudding sound can sometimes be heard coming from inside the engine compartment, but this is because the system operation check is being performed. This is considered normal.
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 roads 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.

Diagnosis detection condition depends on the diagnostic trouble code.
When checking to see if the trouble symptom reoccurs after the diagnostic trouble code has been erased, check the "Detection conditions" column in the inpsection chart for diagnostic trouble codes (refer to P.35B-8) and the description in the "Comments" column of the inspection procedure chart for diagnostic trouble codes in order to carry out testing under driving conditions which satisfy each of the given conditions.







DIAGNOSTIC FUNCTION

35201120337

DIAGNOSTIC TROUBLE CODES CHECK

With the Scan Tool

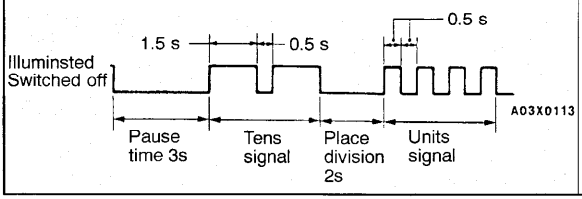
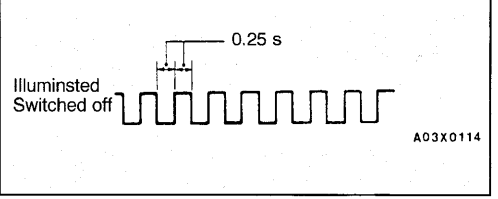
Connect the scan tool to the data link connector then check diagnostic trouble codes.

Caution
Turn the ignition switch off before connecting or disconnecting the scan tool.

With the ABS Warning Light

1. Use the special tool to ground No. 1 terminal of the data link connector.
2. To check ABS system, remove the valve relay.

   NOTE
   That is because the valve relay is off and the warning light remains illuminated if the ABS system is defective.
3. Turn off the ignition switch.
4. Read out a diagnostic trouble code by observing how the warning light flashes.

When the diagnostic trouble code No.24 is output	When no diagnostic trouble code is output*
	

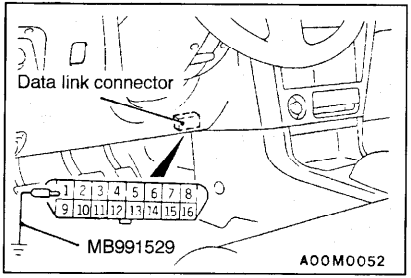
NOTE
*: Even if the ABS system is normal, removing the valve relay causes the diagnostic trouble code No. 51 to be output.

ERASING DIAGNOSTIC TROUBLE CODES

With the Scan Tool

Connect the scan tool to the data link connector (16-pin), then erase the diagnostic trouble codes.

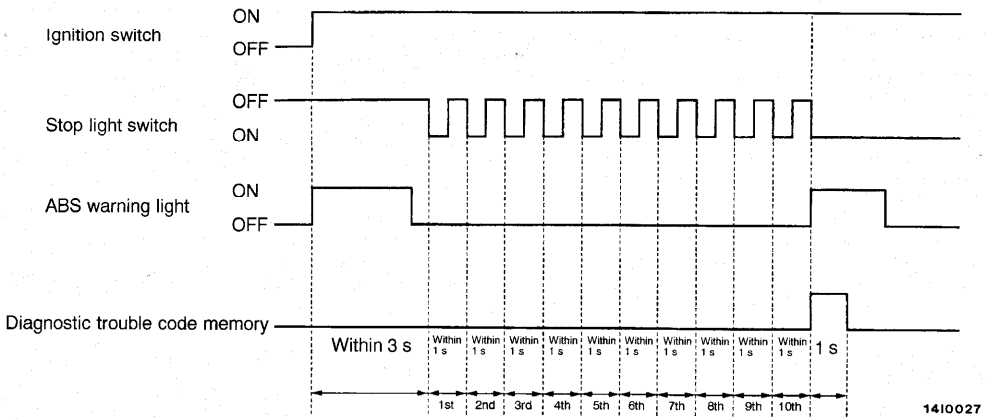
Caution
Turn off the ignition switch before connecting or disconnecting the scan tool.



Without the Scan Tool

1. Use the special tool to ground No.1 terminal of the data link connector.
2. Keep the vehicle from moving.
3. Turn the stop light switch "ON" (by depressing the brake pedal).
4. Keeping the conditions made in steps 1 to 3, turn the ignition switch "ON". Within 3 seconds after this, turn the stop light switch "OFF" (by releasing the brake pedal). Then, turn the stop light switch "ON" and "OFF" ten times successively.

   NOTE
   If the ABS-ECU functions have stopped due to the fail-sale function, the diagnostic code cannot be erased.



Erasing completed

INSPECTION CHART FOR DIAGNOSTIC TROUBLE CODES

35201130149

Inspect according to the inspection chart that is appropriate for the diagnostic trouble code.

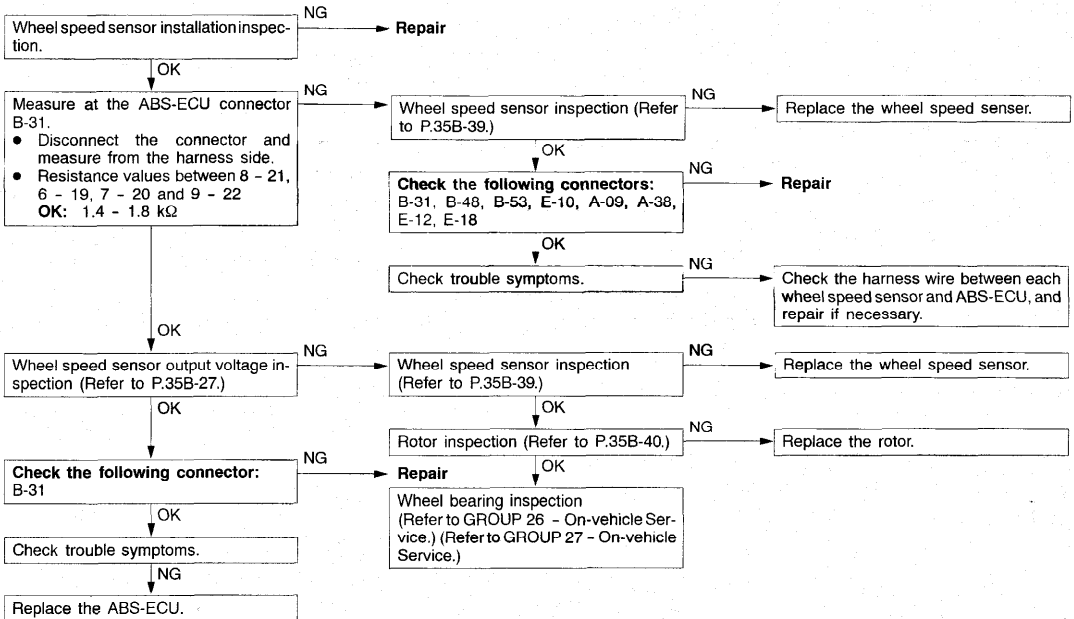
Diagnostic trouble code no.	Inspection item	Diagnostic content	Detection conditions	Reference page
11	Front right wheel speed sensor	Open circuit or short circuit	A, B	35B10
12	Front left wheel speed sensor			
13	Rear right wheel speed sensor			
14	Rear left wheel speed sensor			
15	Wheel speed sensor	Abnormal output signal	B	35B-11
16	Power supply system		A, B	35B-12
21	Front right wheel speed sensor		B	35B-10
22	Front left wheel speed sensor			
23	Rear right wheel speed sensor			
24	Rear left wheel speed sensor			
33	Stop light switch system		A, B	35B-13
41	Front right solenoid valve (inside)		A, B	35B-14
42	Front left solenoid valve (inside)			
43	Rear right solenoid valve (inside)			
44	Rear left solenoid valve (inside)			
51	Valve relay		A, B	35B-15
53	Motor relay, motor		B	35B-16
63	ABS-ECU		A, B	35B-41 (Replace the ABS-ECU)

Detection conditions

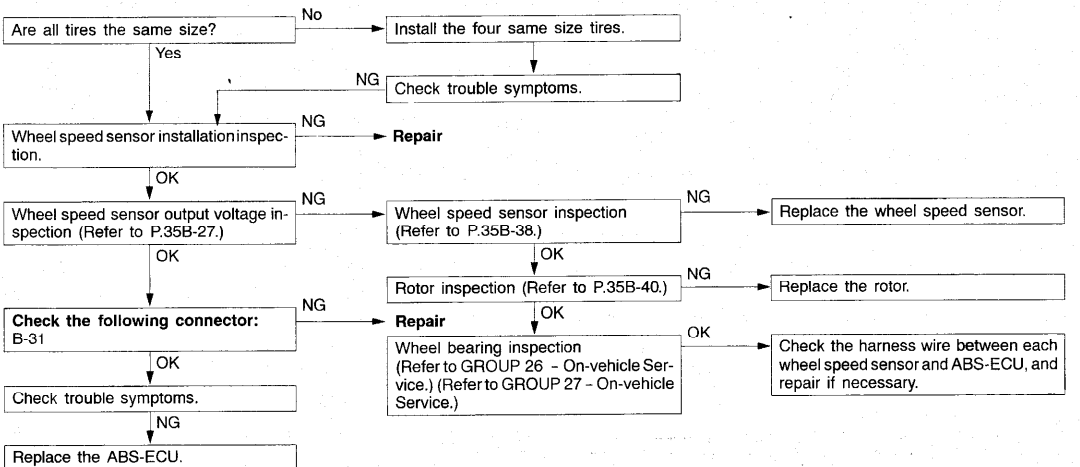
A: During system check immediately after starting
B: When driving

INSPECTION PROCEDURE FOR DIAGNOSTIC TROUBLE CODES

Code Nos. 11, 12, 13, 14 Wheel speed sensor open circuit or short circuit Code Nos.21, 22, 23, 24 Wheel speed sensor	Probable cause
Code Nos.11, 12, 13, 14 are output when the ABS-ECU detects an open circuit or short circuit in at least one of the four wheel-speed sensors.	• Malfunction of wheel speed sensor • Malfunction of wiring harness or connector • Malfunction of ABS-ECU
Code Nos.21, 22, 23, 24 are output under the following cases: • When an open circuit cannot be found, but more than one wheel-speed sensor does not output any signal during driving at 8 km/h (5 mph) or higher. • When a chipped or plugged-up rotor tooth, etc. is detected during driving at 40 km/h (25 mph) or more.	• Malfunction of wheel-speed sensor • Malfunction of rotor • Malfunction of wheel bearing • Malfunction of wiring harness or connector • Malfunction of ABS-ECU

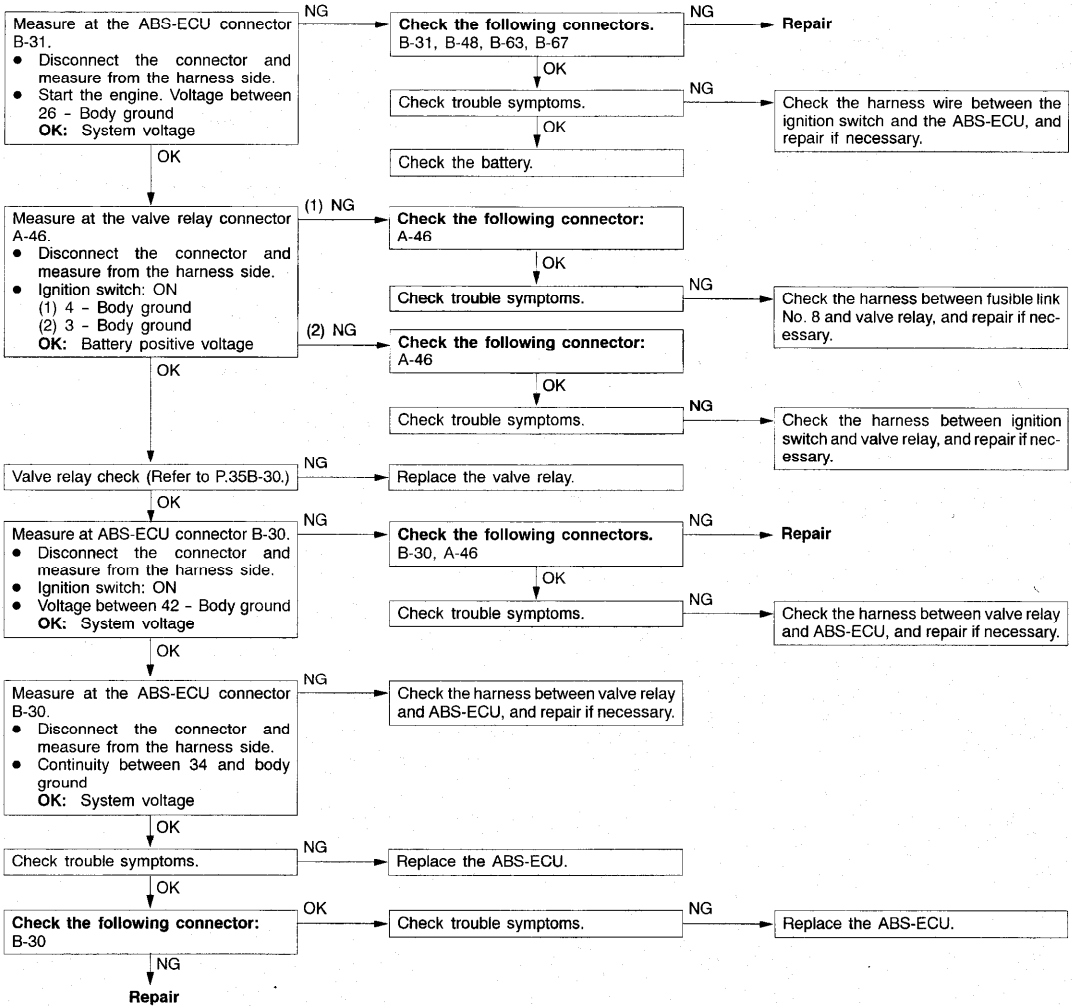


Code No. 15 Wheel speed sensor (Abnormal output signal)	Probable cause
A wheel speed sensor outputs an abnormal signal (other than an open or short-circuit).	• Improper installation of wheel speed sensor • Malfunction of wheel speed sensor • Malfunction of rotor • Malfunction of wheel bearing • Malfunction of wiring harness or connector • Malfunction of ABS-ECU

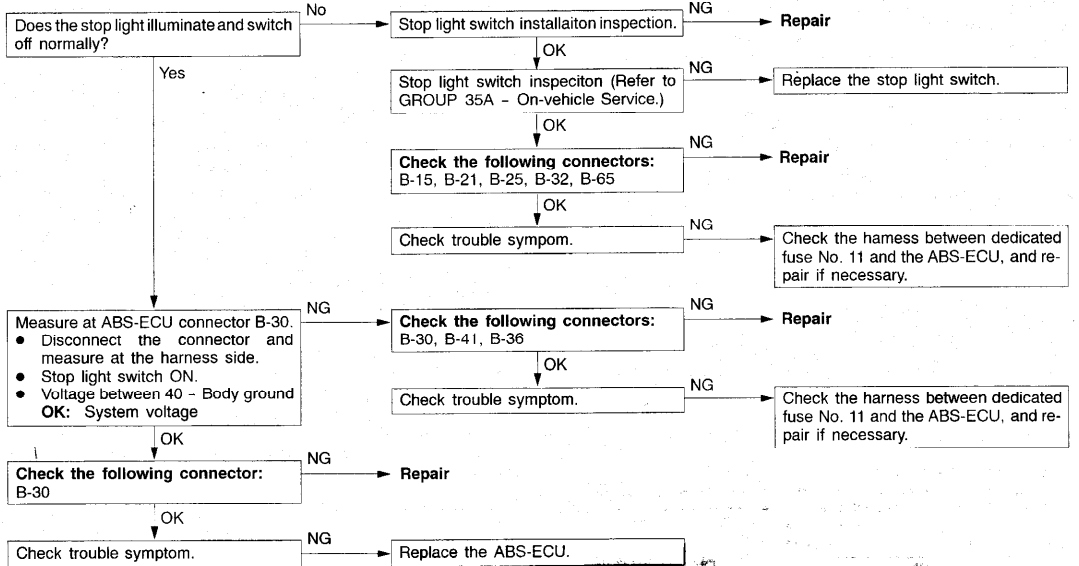


Code No. 16 Power supply system	Probable cause
The voltage of the ABS-ECU power supply or the voltage of the valve relay power supply drops lower or rises higher than the specified value. If the voltage returns to the specified value, this code is no longer output.	• Malfunction of wiring harness or connector. • Malfunction of ABS-ECU

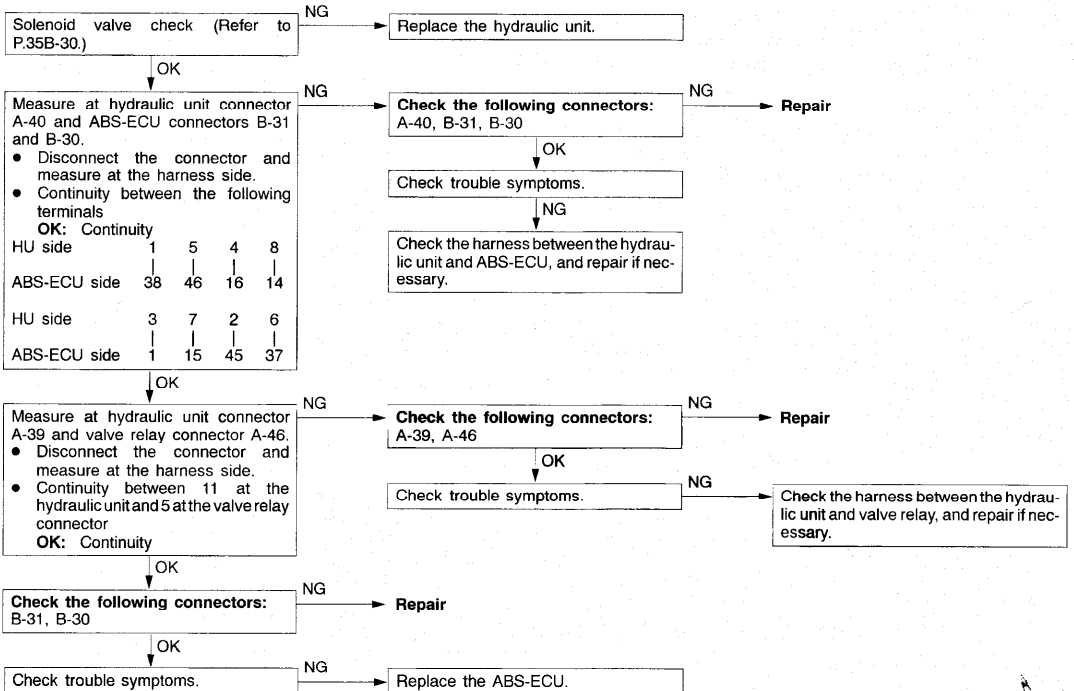
Caution
If battery voltage drops or rises during inspection, this code will be output as well. If the voltage returns to standard value, this code is no longer output.
Before carrying out the following inspection, check the battery level, and refill it if necessary.



Code No. 33 Stop light switch system	Probable cause
This code is output when the stop light switch is not be turned off (when the stop light switch stays on for 15 minutes or more although the ABS is not operating).	• Malfunction of stop light switch • Malfunction of harness or connector • Malfunction of ABS-ECU



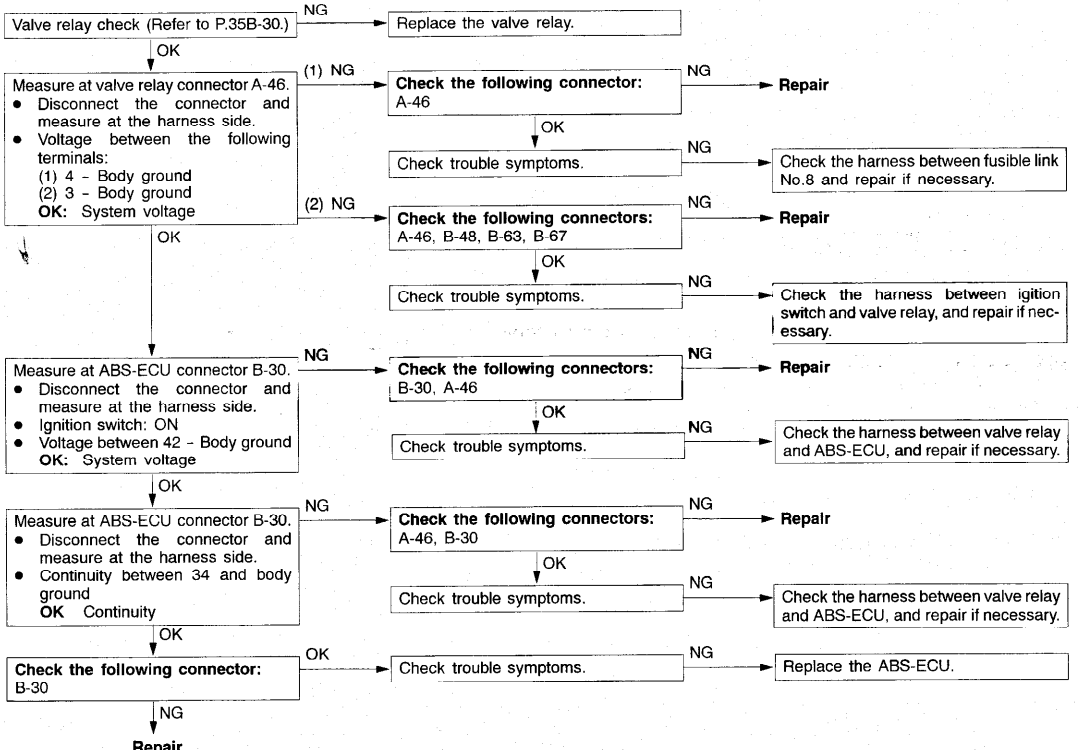
Code Nos.41, 42, 43, 44 Solenoid valve	Probable cause
The ABS-ECU always monitors the solenoid valve drive circuit. It determines that there is an open or short-circuit in the solenoid coil or in a harness: • When no current flows in the solenoid even though the ABS-ECU turns on it, and vice versa.	• Malfunction of wiring harness • Malfunction of hydraulic unit • Malfunction of ABS-ECU



Code No.51 Valve relay	Probable cause
When the ignition switch is turned to ON, the ABS-ECU switches the valve relay off and on during the initial check. In that way, the ABS-ECU compares the signals sent to the valve relay with the voltage in the valve relay monitor line. That is how to check if the valve relay is operating normally. The ABS-ECU always checks if current flows in the valve relay monitor line, too. It determines that there is an open circuit when no current flows. If no current flows in the valve relay monitor line, this diagnostic trouble code is output.	• Malfunction of valve relay • Malfunction of wiring harness or connector • Malfunction of ABS-ECU • Malfunction of hydraulic unit

NOTE

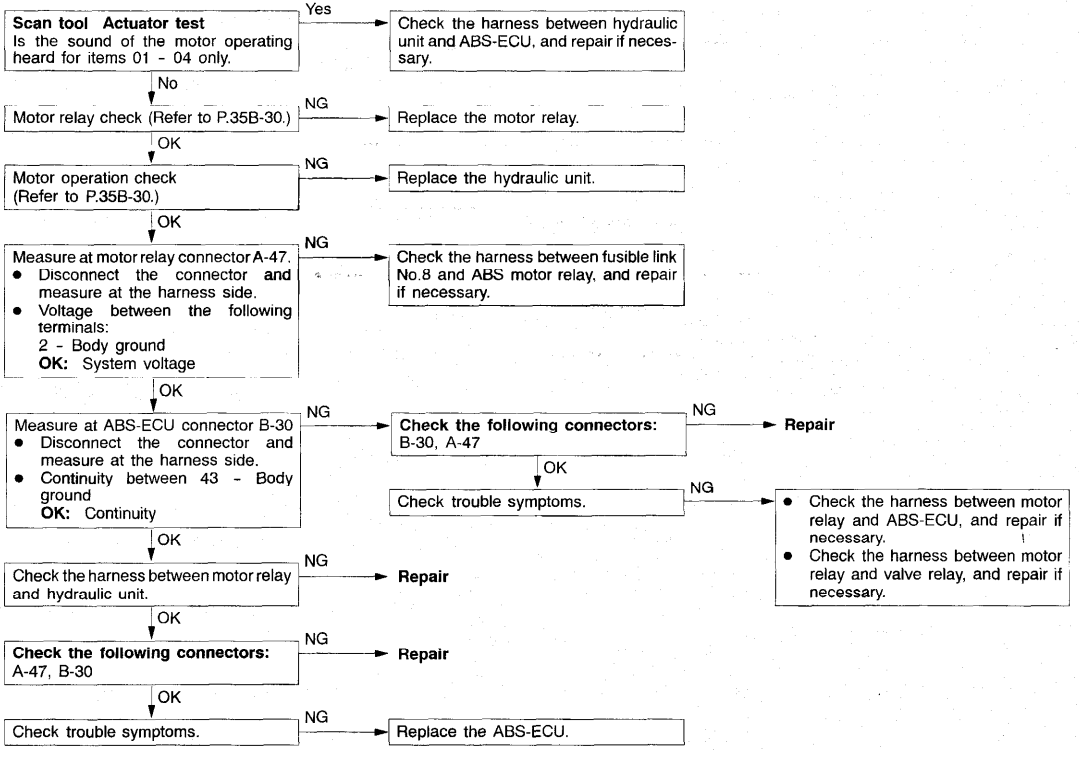
Whenever reading the diagnostic trouble codes using the ABS warning light (refer to P.35B-7), this diagnostic trouble code will be output. That is not a malfunction but because the valve relay connector is disconnected. After repairing all other malfunctions, connect the valve relay connector again to check the valve relay. Then check that the ABS warning light does not illuminate. If it illuminates, the valve relay may be defective. So carry out the following procedure.



Code No.53 Motor relay, motor	Probable cause
This code is output at the following times: • When the motor relay is on but no signal is input to the motor monitor line (motor is not operating, etc.) • When the motor relay is off but a signal is input to the motor monitor line (motor continues operating, etc.) • When the motor relay does not operate	• Malfunction of motor relay • Malfunction of wiring harness or connector • Malfunction of hydraulic unit • Malfunction of ABS-ECU

<When the motor does not run>

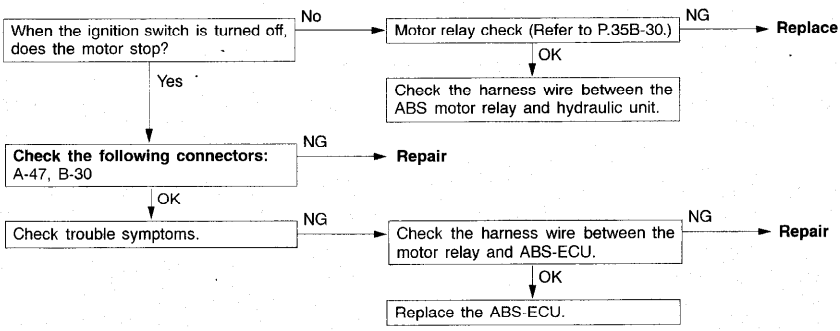
Caution
The engine should be started and left to run for a while after testing is completed, because force-driving of the motor by means of the actuator test will drain the battery.

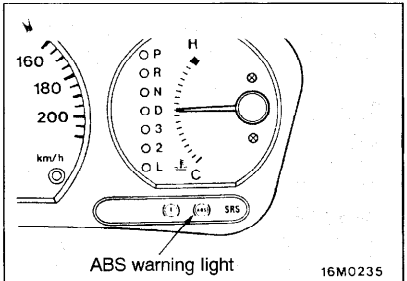


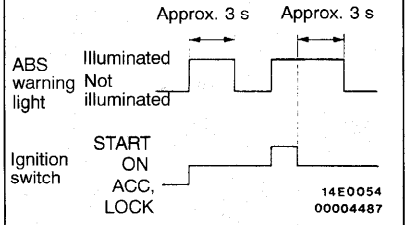
<When the motor keeps running>

Caution

If there is a melted contact in the motor relay, the motor will keep running, even if the ignition switch is turned off. In this case, immediately remove the fusible link No.8, or disconnect the hydraulic unit connector A-39 or motor relay connector A-47. Excessive running of the motor will waste the battery.







ABS WARNING LIGHT INSPECTION 35201200062

Check that the ABS warning light illuminates as follows.

1. When the ignition key is turned to "ON", the ABS warning light illuminates for approximately 3 seconds and then switches off.
2. When the ignition key is turned to "START", the ABS warning light remains illuminated.
3. When the ignition key is released from the "START" position, the ABS warning light illuminates for approximately 3 seconds and then switches off.
4. If the illumination is other than the above, check the diagnostic trouble codes.

INSPECTION CHART FOR TROUBLE SYMPTOMS

35201140135

Get an understanding of the trouble symptoms and check according to the inspection procedure chart.

Trouble symptoms		Inspection procedure No.	Reference page
Communication with scan tool is not possible.	Communication with all systems is not possible.	1	35B-19
	Communication with ABS only is not possible.	2	35B-19
When the ignition key is turned to "ON" (engine stopped), the ABS warning light does not illuminate.		3	35B-20
After the engine starts, the ABS warning light remains illuminated.		4	35B-20
When the ignition key is turned to "START", the ABS warning light does not illuminate.		5	35B-21
After the ignition key is turned to "ON", the ABS warning light blinks twice, and when turned to "START", it illuminates. When returned to "ON", the light flashes once, and then switches off.		6	35B-21
Faulty ABS operation	Unequal braking power on both sides	7	35B-22
	Insufficient braking power		
	ABS operates under normal braking conditions		
	ABS operates before vehicle stops under normal braking conditions		
	Large brake pedal vibration (Caution 2.)	-	-

Caution

1. **If steering movements are made when driving at high speed, or when driving on road surfaces with low frictional resistance, or when passing over bumps, the ABS may operate even though sudden braking is not being applied. Because of this, when getting information from the customer, check if the problem occurred while driving under such conditions as these.**
2. **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

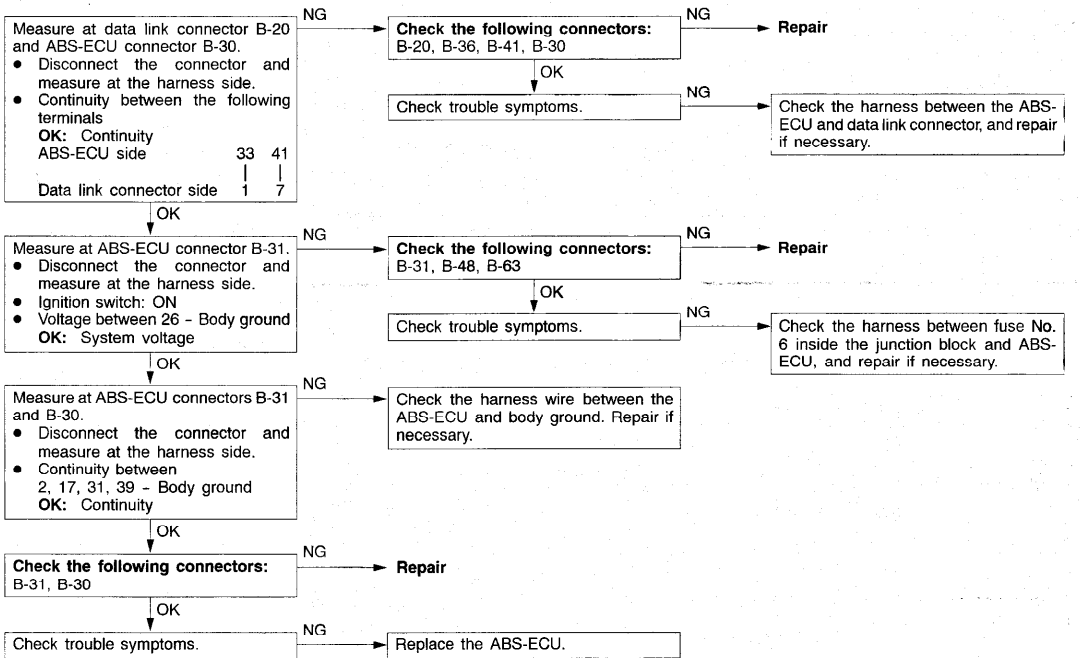
Inspection Procedure 1

Communication with scan tool is not possible. (Communication with all systems is not possible.)	Probable cause
The reason is probably defect in the power supply system (including ground) for the diagnostic line.	• Malfunction of wiring harness or connector

Refer to GROUP 13A - Troubleshooting

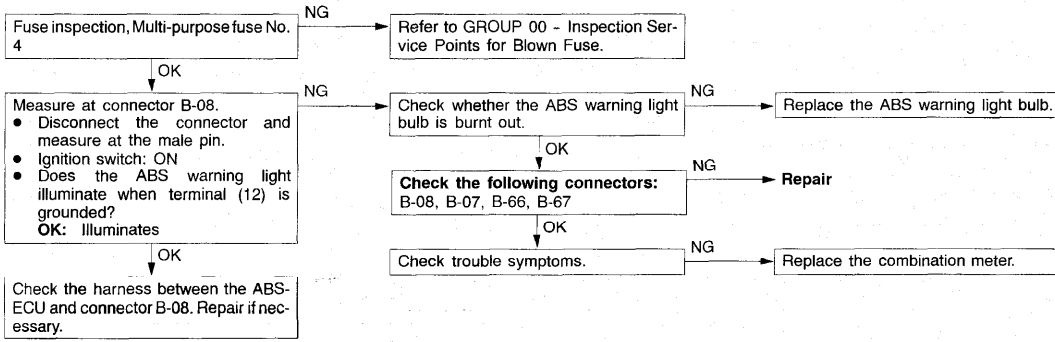
Inspection Procedure 2

Communication with scan tool is not possible. (Communication with ABS only is not possible.)	Probable cause
When communication with the scan tool is not possible, the cause is probably an open circuit in the ABS-ECU power circuit or an open circuit in the diagnostic output circuit.	• Blown fuse • Malfunction of wiring harness or connector • Malfunction of ABS-ECU



Inspection Procedure 3

When ignition key is turned to "ON" (engine stopped), ABS warning light does not illuminate.	Probable cause
The cause may be: an open circuit in the light power supply circuit, a blown light bulb, an open circuit in both the circuit between the ABS warning light and the ABS-ECU.	• Blown fuse • Burnt out ABS warning light bulb • Malfunction of wiring harness or connector

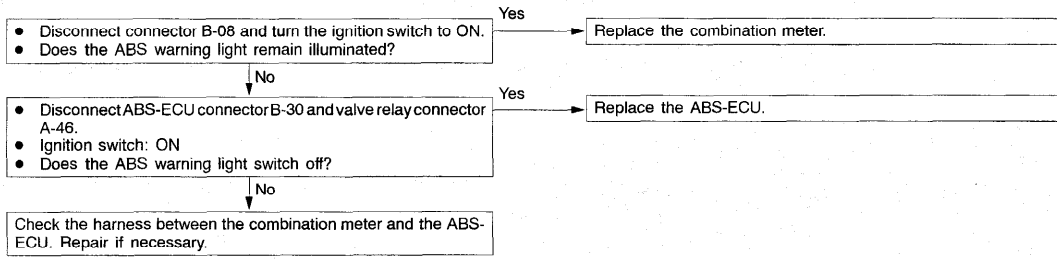


Inspection Procedure 4

Even after the engine is started, the ABS warning light remains illuminated.	Probable cause
The cause is probably a short-circuit in the ABS warning light illumination circuit.	• Malfunction of combination meter • Malfunction of ABS-ECU • Malfunction of wiring harness

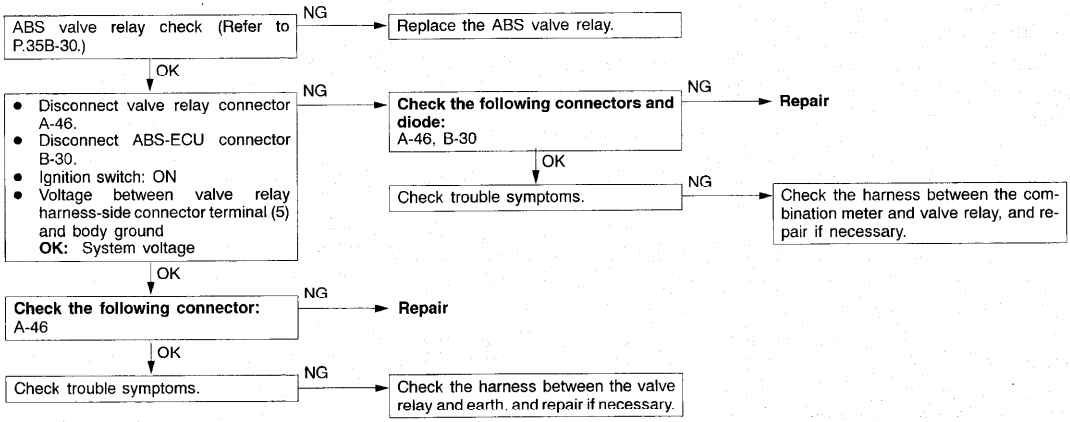
NOTE

This trouble symptom is limited to cases where communication with the scan tool is possible (ABS-ECU power supply is normal) and the diagnostic trouble code is a normal diagnostic trouble code.



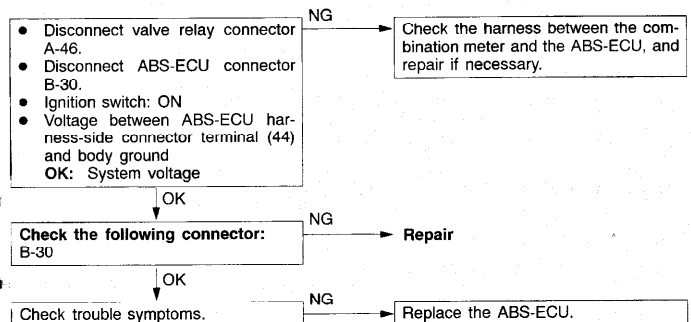
Inspection Procedure 5

When the ignition key is turned to "START", the ABS warning light does not illuminate.	Probable cause
Current does not flow in the ABS-ECU when the ignition switch is turned to "START". Current flows in the ABS warning light even when the ignition switch is turned to "START". Therefore, the valve relay, which current is supplied through the ABS-ECU, turns off when the ignition switch is at "START". However, the warning light circuit of the valve relay must turn on in turn. So the cause must be a defective circuit on valve relay side.	• Malfunction of wiring harness or connector • Malfunction of ABS-ECU



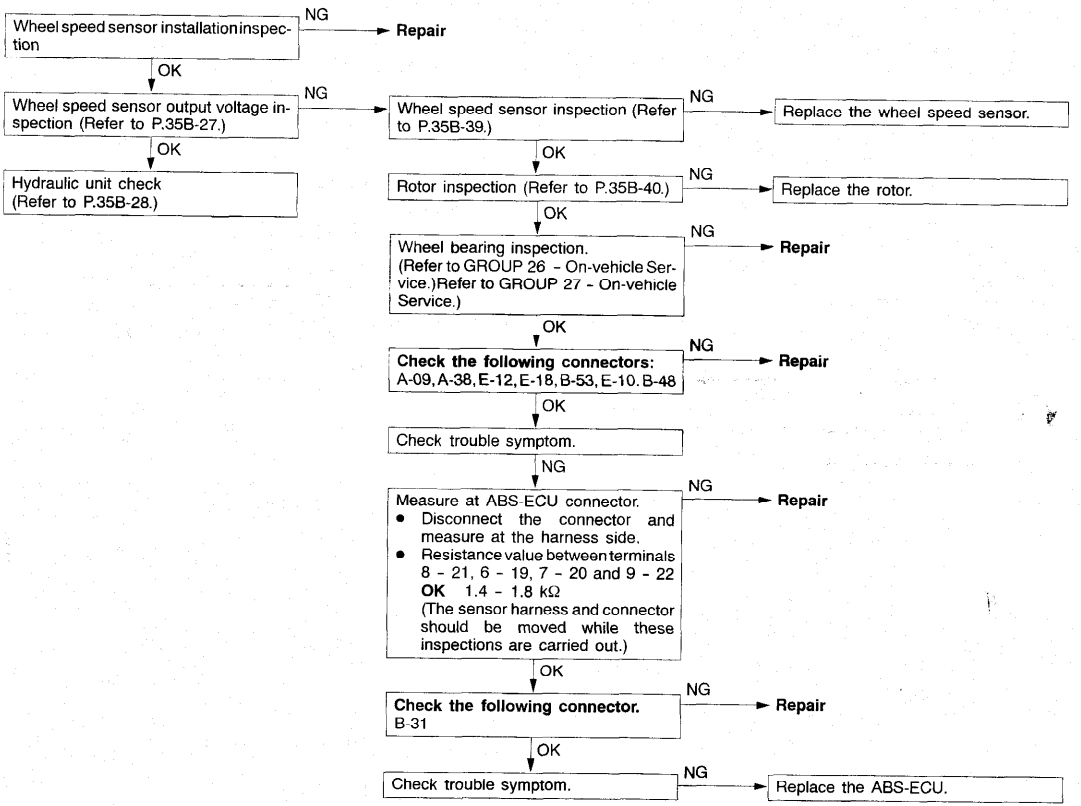
Inspection Procedure 6

After the ignition key is turned to "ON", the ABS warning light blinks twice, and when turned to "START", it illuminates. When returned to "ON", the light flashes once, and then switches off.	Probable cause
The ABS-ECU causes the ABS warning light to illuminate during the initial check (approx. 3 seconds). During the initial check, the valve relay turns from off to on, off and back to on again. If there is an open circuit in the harness between the ABS-ECU and the ABS warning light, the light will illuminate only when the valve relay is OFF during valve relay test, etc.	• Malfunction of wiring harness or connector • Malfunction of ABS-ECU



Inspection Procedure 7

Brake operation is abnormal.	Probable cause
This varies depending on the driving conditions and the road surface conditions, so problem diagnostic trouble is difficult. However, if a normal diagnostic trouble code is displayed, carry out the following inspection.	• Improper installation of wheel speed sensor • Incorrect sensor harness contact • Foreign material adhering to wheel speed sensor • Malfunction of wheel speed sensor • Malfunction of rotor • Malfunction of wheel bearing • Malfunction of hydraulic unit • Malfunction of ABS-ECU



DATA LIST REFERENCE TABLE

35201150084

The following items can be read by the scan tool from the ABS-ECU input data.

1. When the system is normal

Item No.	Check item	Checking requirements	Normal value
11	Front-right wheel speed sensor	Perform a test run	Vehicle speeds displayed on the speedometer and scan tool are identical.
12	Front-left wheel speed sensor		
13	Rear-right wheel speed sensor		
14	Rear-left wheel speed sensor		
16	ABS-ECU power supply voltage	Ignition switch power supply voltage and valve monitor voltage	9-16 V
33	Stop light switch	Depress the brake pedal.	ON
		Release the brake pedal.	OFF

2. When the ABS-ECU shut off ABS operation.

When the diagnostic trouble system stops the ABS-ECU, the scan tool display data will be unreliable.

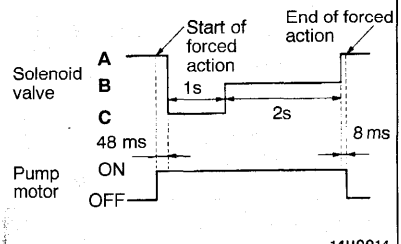
ACTUATOR TEST REFERENCE TABLE

35201160032

The scan tool activates the following actuators for testing.

NOTE
1. If the ABS-ECU runs down, actuator testing cannot be carried out.
2. Actuator testing is only possible when the vehicle is stationary. If the vehicle speed during actuator testing exceeds 10 km/h (6 mph), forced actuation will be canceled.
3. During the actuator test, the ABS warning light will illuminate and the anti-lock control will be cancelled.

Activation pattern



NOTE
A: Hydraulic pressure increase
B: Hydraulic pressure holds
C: Hydraulic pressure decrease

ACTUATOR TEST SPECIFICATIONS

No.	Item	
01	Solenoid valve for front-left wheel	Solenoid valves and pump motors in the hydraulic unit (simple inspection mode)
02	Solenoid valve for front-right wheel	
03	Solenoid valve for rear-left wheel	
04	Solenoid valve for rear-right wheel	

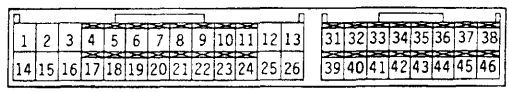
CHECK AT ABS-ECU

35201180113

TERMINAL VOLTAGE CHECK CHART

1. Measure the voltages between terminals (15), (25) and (42) (ground terminals) and each respective terminal.

   NOTE
   Do not measure terminal voltage for approx. 3 seconds after the ignition switch is turned on. The ABS-ECU performs the initial check for that period.
2. The terminal layouts are shown in the illustrations below.



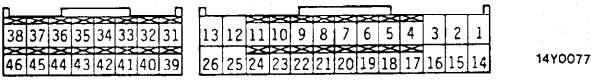
14Y0076

Connector terminal No.	Signal	Checking requirements		Normal condition
1	Output to rear-right solenoid valve (IN)	Ignition switch: ON (When solenoid valve is off)		System voltage
14	Output to front-left solenoid valve (OUT)			
15	Output to rear-right solenoid valve (OUT)			
16	Output to front-left solenoid valve (IN)			
25	Memory power supply	Always		System voltage
26	ABS-ECU power supply	Ignition switch: ON		System voltage
		Ignition switch: START		0 V
33	Input from diagnostic indication selection	Connect the scan tool.		0 V
		Do not connect the scan tool.		Approx. 12 V
34	Valve relay monitor	Ignition switch: ON		System voltage
35	Motor monitor	Ignition switch: ON	Motor is on.	System voltage
			Motor is off.	0.5V or less
37	Output to rear-left solenoid valve (OUT)	Ignition switch: ON (When solenoid valve is off)		System voltage
38	Output to front-right solenoid valve (IN)			
40	Input from stop light switch	Ignition switch: ON	Stop light switch ON	System voltage
			Stop light switch OFF	1 V or less

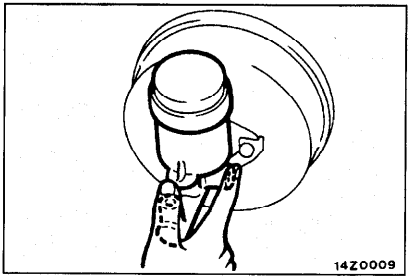
Connector terminal No.	Signal	Checking requirements		Normal condition
41	Scan tool	Connect the scan tool.		Serial communication with scan tool
		Do not connect the scan tool.		1 V or less
42	Output to valve relay	Ignition switch; ON	The relay is on.	2 V or less
			The relay is off. The system runs down.	System voltage
43	Output to motor relay	Ignition switch: ON	Motor is on.	2 V or less
			Motor is off.	System voltage
44	Output to ABS warning light	Ignition switch: ON	The light is switched off.	System voltage
			The light is illuminated.	3 V or less
45	Output to rear-left solenoid valve (IN)	Ignition switch: ON (When solenoid valve is off)		System voltage
46	Output to front-right solenoid valve (OUT)			

RESISTANCE AND CONTINUITY BETWEEN HARNESS-SIDE CONNECTOR TERMINALS

1. Turn the ignition switch off and disconnect the ABS-ECU connectors before checking resistance and continuity.
2. Check them between the terminals indicated in the table below.
3. The terminal layouts are shown in the illustrations below.



Connector terminal No.	Signal	Normal condition
2 - Body ground	ABS-ECU ground	Continuity
6-19	Front-left wheel speed sensor	1.4 - 1.8 kΩ
7-20	Rear-right wheel speed sensor	1.4 - 1.8 kΩ
8-21	Front-right wheel speed sensor	1.4 - 1.8 kΩ
9-22	Rear-left wheel speed sensor	1.4 - 1.8 kΩ
17 - Body ground	ABS-ECU ground	Continuity
31 - Body ground		
39 - Body ground		



ON-VEHICLE SERVICE

35200150092

BLEEDING

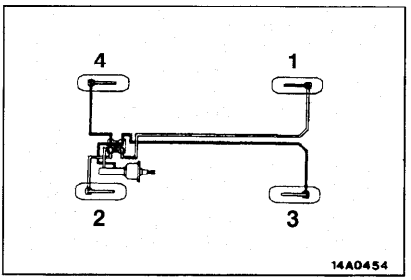
Caution
Use the specified brake fluid. Avoid using a mixture of the specified brake fluid and other fluid.

Specified brake fluid: DOT3 or DOT4

MASTER CYLINDER BLEEDING

The master cylinder used has no check valve, so if bleeding is carried out by the following procedure, bleeding of air from the brake pipeline will become easier. (When brake fluid is not contained in the master cylinder.)

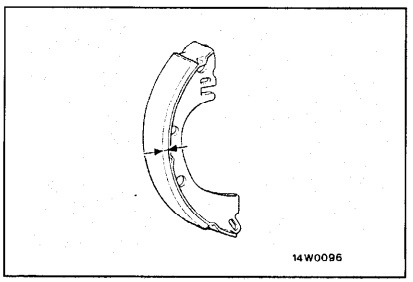
(1) Fill the reserve tank with brake fluid.
(2) Keep the brake pedal depressed.
(3) Have another person cover the master cylinder outlet with a finger.
(4) With the outlet still closed, release the brake pedal.
(5) Repeat steps (2) -(4) three or four times to fill the inside of the master cylinder with brake fluid.



BRAKE PIPE LINE BLEEDING

Start the engine and bleed the air in the sequence shown in the figure.

Caution
Be sure to install a filter to the master cylinder reservoir tank when supplying brake fluid.



BRAKE LINING THICKNESS CHECK

35100300128

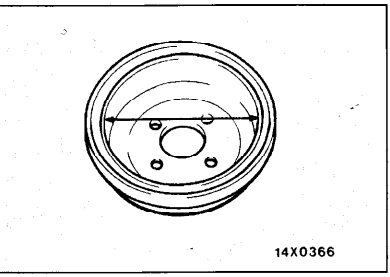
1. Remove the brake drum.
2. Measure the wear of the brake lining at the place worn the most.

   Standard value: 4.38 mm (.172 in.)

   Limit: 1.00 mm (.039 in.)

   Replace the shoe and lining assembly if brake lining thickness is less than the limit if it is not worn evenly. For information concerning the procedures for installation of the shoe and lining assembly, refer to P.35B-32.

   Caution
   1. **Whenever the shoe and lining assembly is replaced, replace both RH and LH assemblies as a set to prevent car from pulling to one side when braking.**
   2. **If there is a significant difference in the thickness of the shoe and lining assemblies on the left and right sides, check the sliding condition of the piston.**



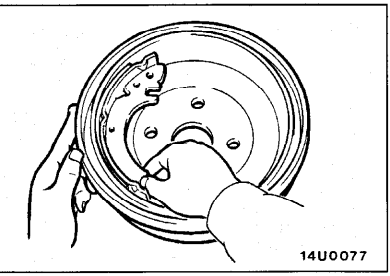
BRAKE DRUM INSIDE DIAMETER CHECK

35100320117

1. Remove the brake drum.
2. Measure the inside diameter of the brake drum at two or more locations.

   Standard value: 203 mm (8.0 in.)

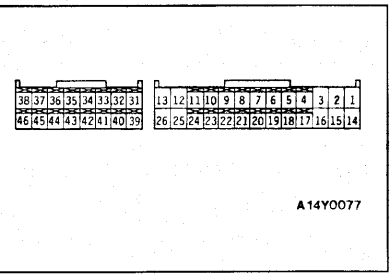
   Limit: 205 mm (8.1 in.)
3. Replace brake drums, shoe and lining assembly when wear exceeds the limit value or is badly imbalanced.



BRAKE LINING AND BRAKE DRUM CONTACT CHECK

35100310121

1. Remove the brake drum.
2. Remove the shoe and lining assembly. (Refer to P.35B-32.)
3. Chalk inner surface of brake drum and rub with shoe and lining assembly.
4. Replace shoe and lining assembly or brake drums if there are any irregular contact area.
   NOTE
   Clean off chalk after check.



WHEEL SPEED SENSOR OUTPUT VOLTAGE CHECK

35200160149

1. Lift up the vehicle and release the parking brake.
2. Disconnect the ABS-ECU connector, and then use the special tool (MB991219) to measure the output voltage at the harness-side connector.
3. Rotate the wheel to be measured at approximately 1/2-1 rotation per second, and check the output voltage using a circuit tester or an oscilloscope.

Wheel speed sensor	Front left	Front right	Rear left	Rear right
Terminal No.	6	8	9	7
	19	21	22	20

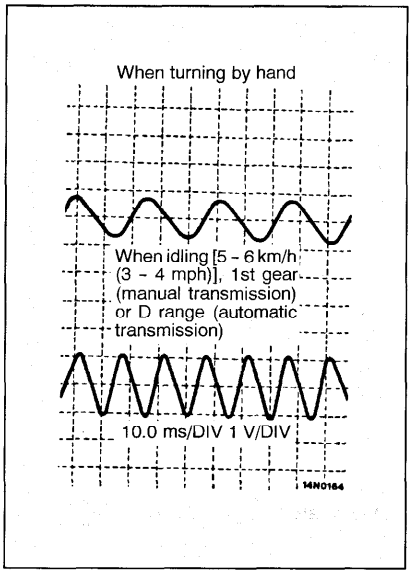
Output voltage

When measuring with a circuit tester:
50 mV or more

When measuring with an oscilloscope:
120 mV p-p or more

4. If the output voltage is lower than the above values, the reason could be as follow:
   - Faulty wheel speed sensor.

   So replace the wheel speed sensor.



Inspecting Waveforms With An Oscilloscope

Use the following method to observe the output voltage waveform from each wheel sensor with an oscilloscope.

- Start the engine, and rotate the front wheels by engaging 1st gear (vehicles with manual transmission) or D range (vehicles with automatic transmission). Turn the rear wheels manually so that they rotate at a constant speed.

NOTE

1. Check the connection of the sensor harness and connector before using the oscilloscope.
2. The waveform measurements can also be taken while the vehicle is actually moving.
3. The output voltage will be small when the wheel speed is low. Similarly, it will be large when the wheel speed is high.

Points In Waveform Measurement

Symptom	Probable causes	Remedy
Too small or zero waveform amplitude	Faulty wheel speed sensor	Replace sensor
Waveform amplitude fluctuates excessively (this is no problem if the minimum amplitude is 100 mV or more)	Axle hub eccentric or with large runout	Replace hub
Noisy or disturbed waveform	Open circuit in sensor	Replace sensor
	Open circuit in harness	Correct harness
	Incorrectly mounted wheel speed sensor	Mount correctly
	Rotor with missing or damaged teeth	Replace rotor

NOTE

The wheel speed sensor cable moves following motion of the front or rear suspension. Therefore, it is likely that it has an open circuit only when driving on rough roads and it functions normally when driving on smooth roads. It is recommended to observe sensor output voltage waveform also under special conditions, such as rough road driving.

HYDRAULIC UNIT (HU) CHECK

35200170159

Caution

Turn the ignition switch off before connecting or disconnecting the scan tool.

1. Jack up the vehicle and support the vehicle with jack stands placed at the specified jack-up points or place the wheels which are checked on the rollers of the braking force tester.

   Caution

   1. The roller of the braking force tester and the tire should be dry during testing.
   2. When testing the front brakes, apply the parking brake. When testing the rear brakes, stop the front wheels by using a wheel chock.

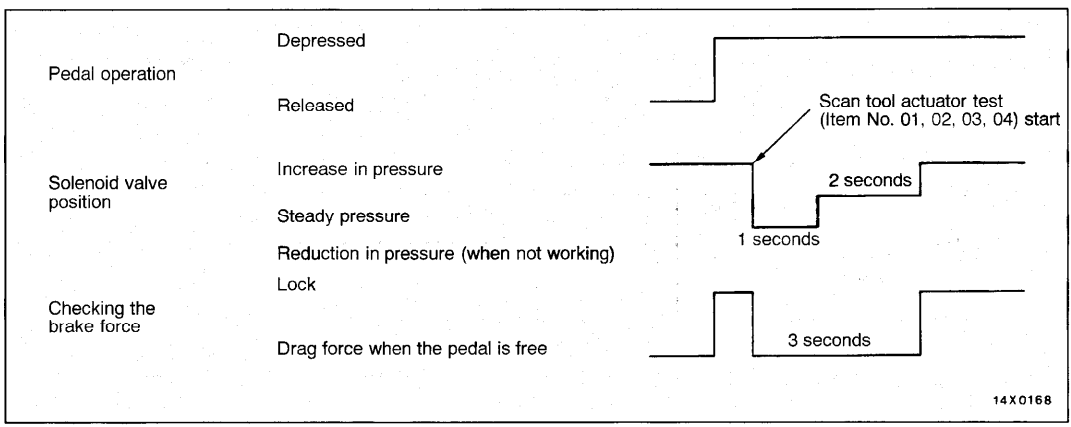
2. Release the parking brake, and feel the drag force (drag torque) on each road wheel. When using the braking force tester, take a reading of the brake drag force.
3. Turn the ignition key to the OFF position and set the scan tool.
4. After checking that the shift lever <M/T> or the selector lever <A/T> is in neutral, start the engine.
5. Use the scan tool to force-drive the actuator.

NOTE
1. During the actuator test, the ABS warning light will illuminate and the anti-lock control will be cancelled.
2. When the ABS has been interrupted by the fail-safe function, the scan tool actuator testing cannot be used.

6. Turn the wheel by hand and check the change in braking force when the brake pedal is depressed. When using the braking force tester, depress the brake pedal until the braking force is at the following values, and check that the braking force decreases when the actuator is force-driven.

Front wheel	785-981 N (176 - 220 lbs.)
Rear wheel	294-490 N (66 - 110 lbs.)

The result should be as shown in the following diagram.

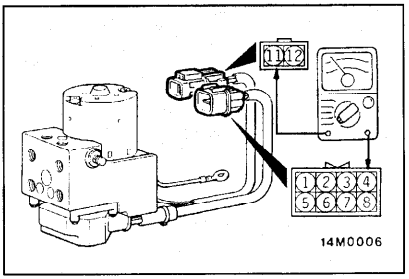


7. If the result of inspection is abnormal, correct according to the Diagnostic Table below.

Diagnostic Table

No.	Operation	Judgement - Normal	Judgement - Abnormal	Probable cause	Remedy
01	(1) Depress brake pedal to lock wheel. (2) Using the scan tool, select the wheel to be checked and force the actuator to operate. (3) Turn the selected wheel manually to check the change of brake force.	Brake force released for 3 seconds after locking.	Wheel does not lock when brake pedal is depressed.	Clogged brake line other than HU	Check and clean brake line
02				Clogged hydraulic circuit in HU	Replace HU assembly
03			Brake force is not released	Incorrect HU brake tube connection	Connect correctly
04				HU solenoid valve not functioning correctly	Replace HU assembly

8. After inspection, disconnect the scan tool immediately after turning the ignition switch to OFF.



14M0006

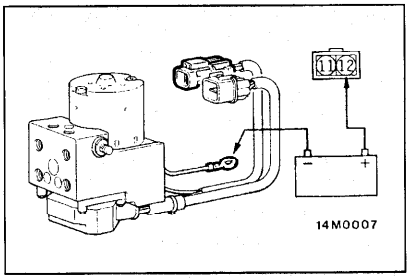
SOLENOID VALVE CHECK

35201070113

Measure the resistance between terminals.

Standard value:

Solenoid valve	Measurement terminals	Resistance between terminals.
Front IN (right side)	1-11	8.04 - 9.04 Ω
Front IN (left side)	4-11	
Rear IN (right side)	3-11	
Rear IN (left side)	2-11	
Front OUT (right side)	5-11	4.04 - 4.54 Ω
Front OUT (left side)	8-11	
Rear OUT (right side)	7-11	
Rear OUT (left side)	6-11	



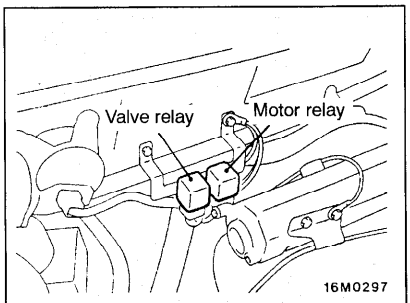
14M0007

MOTOR OPERATION CHECK

35200180114

Connect the battery and check to be sure that the sound of the hydraulic unit motor operating can be heard.

Caution
The battery power should not be applied for more than 1 second.

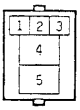


16M0297

Motor relay connector

20Z0004

Valve relay connector



20Z0003
00004684

MOTOR RELAY AND VALVE RELAY CONTINUITY CHECK

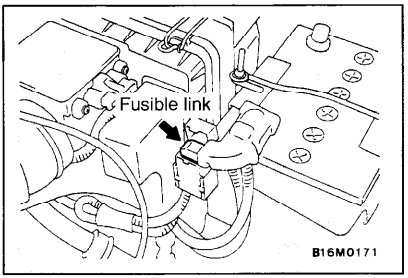
35201090126

Motor relay

Battery voltage	Terminal No.			
	1	2	3	5
Power is not supplied	○		○	
Power is supplied	⊕		⊖	
		○		○

Valve relay

Battery voltage	Terminal No.				
	1	2	3	4	5
Power is not supplied	○		○		
		○			○
Power is supplied	⊕		⊖		
				○	○



DISCHARGED BATTERY

35200350119

The ABS system consumes a large amount of battery current for its self-check function. If the battery is completely discharged and booster cables are used to start the engine, the engine must be allowed to idle for a few minutes to recharge. If the battery does not recharge, the engine may misfire or stall.

To prevent this condition,

- allow the engine to idle for a few minutes before driving the vehicle,
  or
- temporarily disable the ABS system by removing the fusible link for the ABS circuit. The ABS warning light will illuminate when the ABS fusible link is removed. After the battery is recharged, reinstall the ABS fusible link and check that the ABS warning light is not illuminated.

MASTER CYLINDER AND BRAKE BOOSTER

35200400142

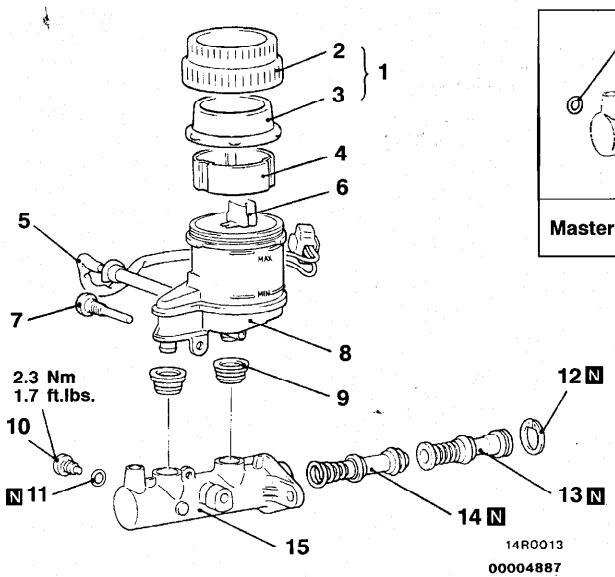
REMOVAL AND INSTALLATION

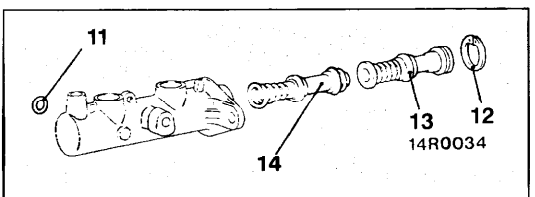
Refer to GROUP 35A - Master Cylinder and Brake Booster

MASTER CYLINDER

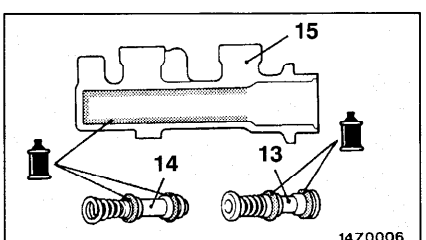
35200450093

DISASSEMBLY AND REASSEMBLY





Master cylinder kit



Brake fluid: DOT3 or DOT4

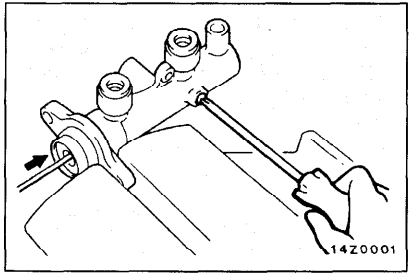
Disassembly steps

1. Reservoir cap assembly
2. Reservoir cap
3. Diaphragm
4. Filter
5. Brake fluid level sensor
6. Float
7. Reservoir stopper bolt

◀A▶

◀B▶

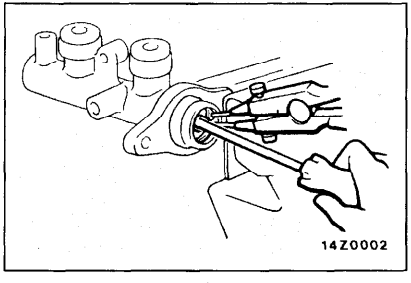
8. Reservoir tank
9. Reservoir seal
10. Piston stopper bolt
11. Gasket
12. Piston stopper ring
13. Primary piston assembly
14. Secondary piston assembly
15. Master cylinder body



DISASSEMBLY SERVICE POINTS

◀A▶ PISTON STOPPER BOLT DISASSEMBLY

While depressing the piston, remove the piston stopper bolt.



◀B▶ PISTON STOPPER RING DISASSEMBLY

While depressing the piston, remove the piston stopper ring.

INSPECTION

35200460027

- Check the inner surface of master cylinder body for rust or pitting.
- Check the primary and secondary pistons for rust, scoring, wear, damage or wear.
- Check the diaphragm for cracks and wear.

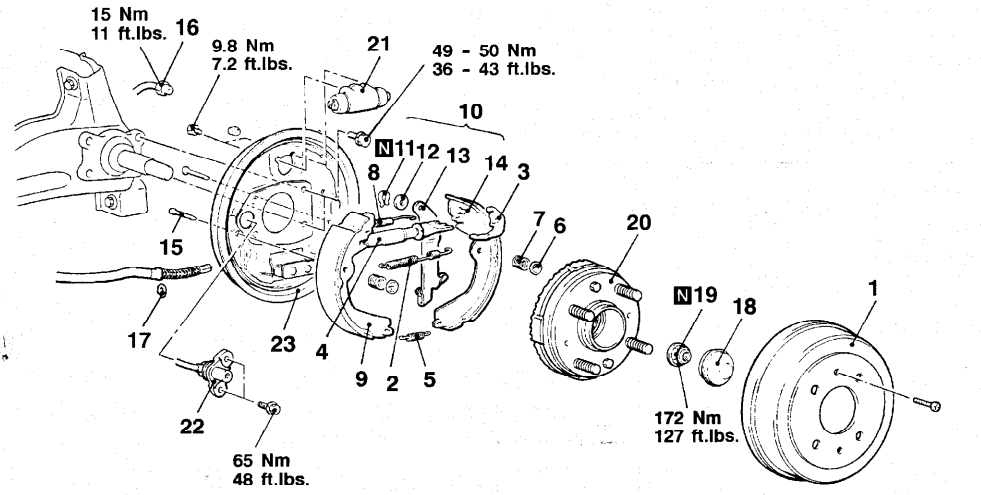
REAR DRUM BRAKE

35200700020

REMOVAL AND INSTALLATION

Pre-removal Operation
- Loosening the Parking Brake Cable Adjusting Nut.
- Brake Fluid Draining

Post-installation Operation
- Brake Line Bleeding (Refer to P.35B-26.)
- Parking Brake Lever Stroke Adjustment (Refer to GROUP 36 – On-vehicle Service.)



Rear drum brake removal steps

1. Brake drum
2. Shoe-to-lever spring
3. Adjuster lever
4. Auto adjuster assembly
5. Retainer spring
6. Shoe hold-down cup
7. Shoe hold-down spring
8. Shoe-to-shoe spring
9. Shoe and lining assembly
10. Shoe, lining and lever assembly
11. ◀A▶ ▶B◀ Retainer
12. ▶A◀ Wave washer
13. Parking lever
14. Shoe and lining assembly
15. Shoe hold-down pin
16. Brake pipe connection
17. Snap ring
18. Hub cap
19. Flange nut
20. Rear hub and rotor assembly
21. Wheel cylinder
22. Speed sensor
23. Backing plate

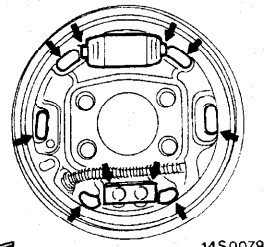
Wheel cylinder removal steps

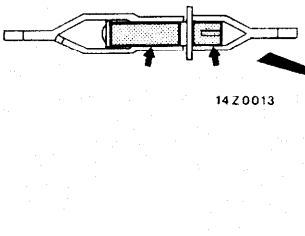
1. Brake drum
2. Shoe-to-lever spring
8. Shoe-to-shoe spring
16. Brake pipe connection
21. Wheel cylinder

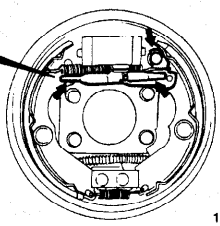
Caution

1. **Be careful when handling the pole piece at the tip of the speed sensor and the toothed edge of the rotor so as not to damage them by striking against other parts.**
2. **When removing the rear hub assembly, the wheel bearing inner race may be left at the spindle side. In this case, always replace the rear hub assembly, otherwise the hub will damage the oil seal, causing oil leaks or excessive play.**

LUBRICATION POINTS

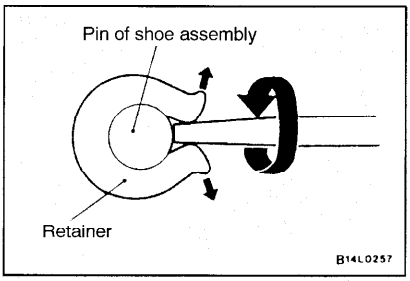






:

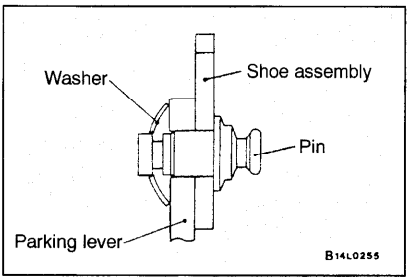
Specified grease: Brake grease SAE J310, NLGI No.1



REMOVAL SERVICE POINT

◀A▶ RETAINER REMOVAL

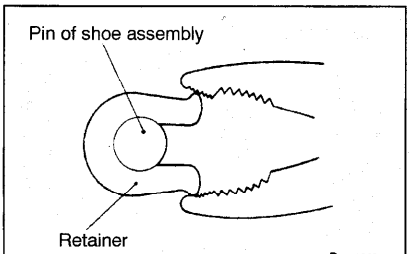
Use a flat-tipped screwdriver or the like to open up the retainer joint, and remove retainer.



INSTALLATION SERVICE POINTS

▶A◀ WAVE WASHER INSTALLATION

Install the washer in the direction shown in the illustration.

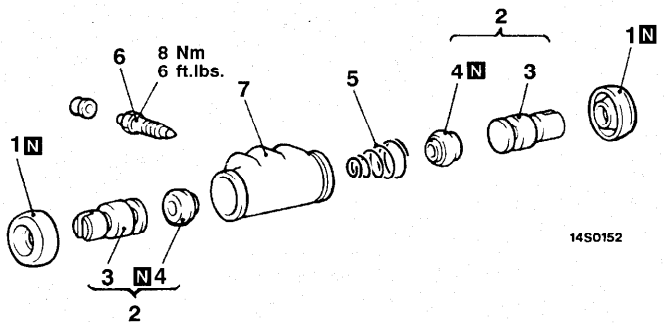


▶B◀ RETAINER INSTALLATION

Use pliers or the like to install the retainer or the pin positively.

WHEEL CYLINDER DISASSEMBLY AND REASSEMBLY

35200720026



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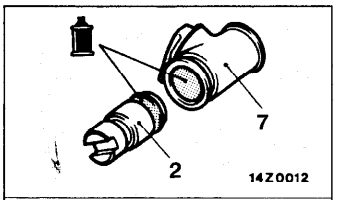
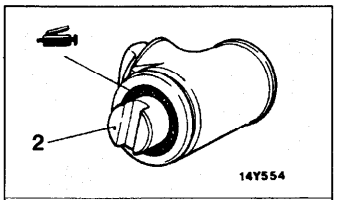
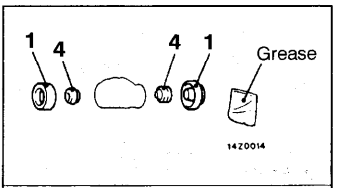


Brake fluid: DOT3 or DOT4



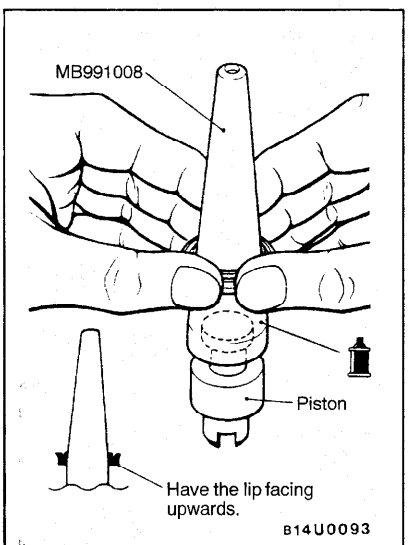
Grease: Repair kit grease



Wheel cylinder repair kit

Disassembly steps

1. Boots
2. Piston assembly
3. ▶A◀ Pistons
4. ▶A◀ Piston cups
5. Spring
6. Bleeder
7. Wheel cylinder body



REASSEMBLY SERVICE POINT

▶A◀ PISTON CUP/PISTON REASSEMBLY

(1) Use alcohol or specified brake fluid to clean the wheel cylinder and the piston.

(2) Apply the specified brake fluid to the piston cups and the special tool.

Specified brake fluid: DOT3 or DOT4

(3) Set the piston cup on the special tool with the lip of the cup facing up, fit the cup onto the special tool, and then slide it down the outside of the tool into the piston groove.

Caution
In order to keep the piston cup from becoming twisted or slanted, slide the piston cup down the tool slowly and carefully, without stopping.

INSPECTION

35100780038

Check the piston and wheel cylinder walls for rust or damage, and if there is any abnormality, replace the entire wheel cylinder assembly.

PROPORTIONING VALVE

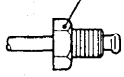
35200570096

REMOVAL AND INSTALLATION

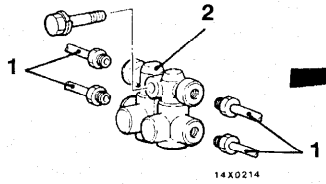
Pre-removal Operation
- Brake Fluid Draining
- Air Intake Hose Removal

Post-installation Operation
- Brake Fluid Supplying
- Brake Line Bleeding (Refer to P.35B-26.)
- Air Intake Hose Installation

Flared brake line nuts
15 Nm
11 ft.lbs.



14X0343



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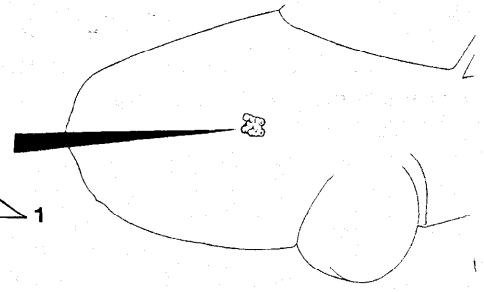

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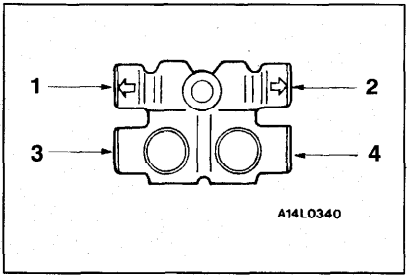
Removal steps

▶A◀ 1. Brake pipe
2. Proportioning valve
3. Bracket



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INSTALLATION SERVICE POINT

▶A◀ BRAKE PIPE CONNECTION

Connect the pipes to the hydraulic unit as shown in the illustration.

1. Proportioning valve – Rear brake (L.H.)
2. Proportioning valve – Rear brake (R.H.)
3. Proportioning valve – Hydraulic unit
4. Proportioning valve – Hydraulic unit

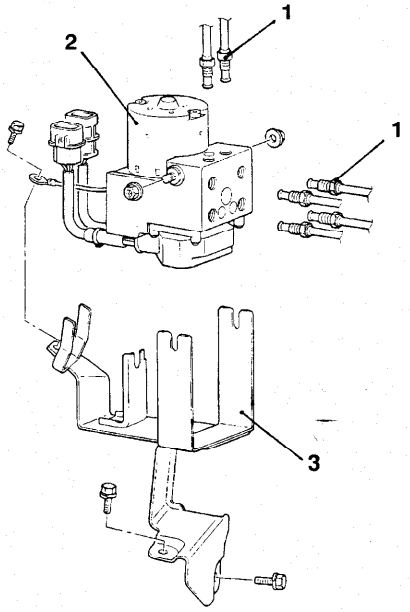
HYDRAULIC UNIT

35200860162

REMOVAL AND INSTALLATION

Pre-removal Operation
- Brake Fluid Draining
- Windshield Wiper Motor Removal (Refer to GROUP 51)

Post-installation Operation
- Windshield Wiper Motor Installation (Refer to GROUP 51)
- Brake Fluid Supplying
- Brake Line Bleeding (Refer to P35B-25.)
- Brake Pedal Adjustment (Refer to GROUP 35A - On-vehicle Service.)



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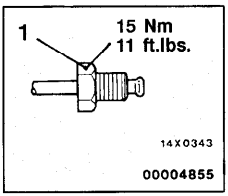


Removal steps

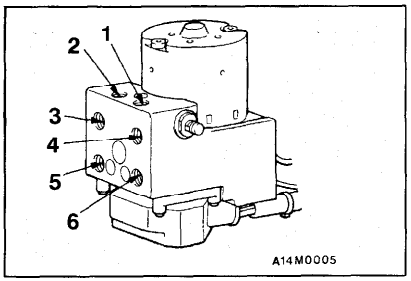
▶A◀ 1. Brake pipe connection
◀A▶ 2. Hydraulic unit assembly
3. Hydraulic unit bracket

REMOVAL SERVICE POINT

◀A▶ HYDRAULIC UNIT ASSEMBLY REMOVAL

Caution

1. **The hydraulic unit assembly is heavy, and so care should be taken when removing it.**
2. **The hydraulic unit assembly is not to be disassembled; its nuts and bolts should absolutely not be loosened.**
3. **The hydraulic unit assembly must not be dropped or otherwise subjected to impact shocks.**
4. **The hydraulic unit assembly must not be turned upside down or laid on its side.**



INSTALLATION SERVICE POINT

▶A◀ BRAKE PIPE CONNECTION

Connect the pipes to the hydraulic unit assembly as shown in the illustration.

1. To the proportioning valve (RH)
2. To the proportioning valve (LH)
3. From the master cylinder (Primary)
4. From the master cylinder (Secondary)
5. To the front brake (RH)
6. To the front brake (LH)

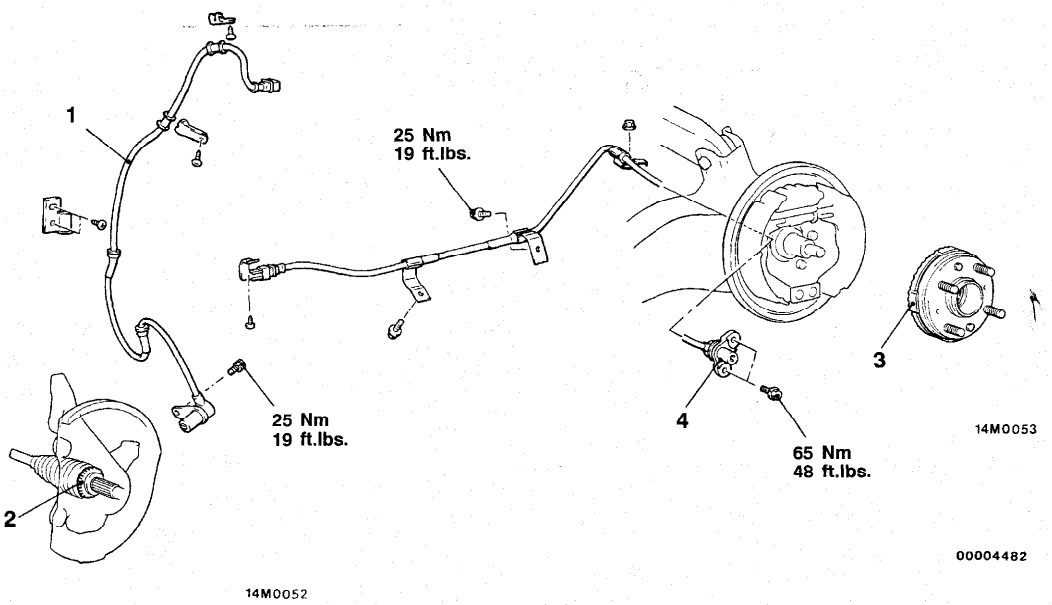
WHEEL SPEED SENSOR

35200830156

REMOVAL AND INSTALLATION

Post-installation Operation
- Wheel Speed Sensor Output Voltage Check (Refer to P.35B-27.)

<Front> <Rear>



Front speed sensor removal steps

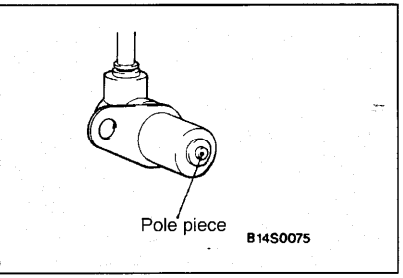
◀A▶ 1. Front speed sensor
2. Front rotor
(Refer to GROUP 26 - Drive shaft.)

NOTE
The front rotor is integrated with the drive shaft and is not disassembled.

Rear speed sensor removal steps

3. Rear rotor
(Refer to GROUP 27 - Rear Axle Hub.)

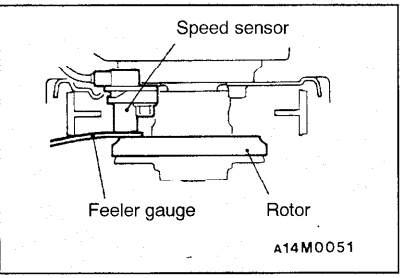
◀A▶ ▶A◀ 4. Rear speed sensor



REMOVAL SERVICE POINT

◀A▶ FRONT SPEED SENSOR/REAR SPEED SENSOR REMOVAL

Caution
Be careful when handling the pole piece at the tip of the speed sensor and the toothed edge of the rotor so as not to damage them by contacting other parts.



INSTALLATION SERVICE POINT

▶A◀ REAR SPEED SENSOR INSTALLATION

Caution
Be careful that the pole piece at the end of the speed sensor and the rotor teeth do not become damaged by striking them against the metal parts.

Insert a feeler gauge into the space between the speed sensor's pole piece and the rotor's toothed surface, and then tighten the speed sensor bracket at the position where the clearance is the standard value all around.

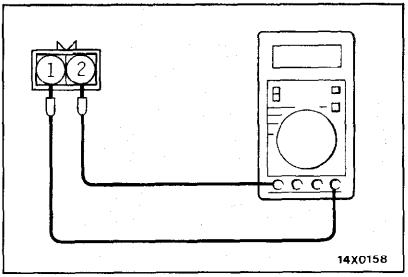
Standard value: 0.1 - 2.0 mm (.004 - .079 in.)

INSPECTION 35200840111

SPEED SENSOR

(1) Check whether any metallic foreign material has adhered to the pole piece at the speed sensor tip. Remove any foreign material.
Also check whether the pole piece is damaged. Replace it with a new one if it is damaged.

NOTE
The pole piece can become magnetized due to the magnet inside the speed sensor, causing foreign material to easily adhere to it. The pole piece may not be able to correctly sense the wheel rotation speed if foreign matter is on it or if it is damaged.



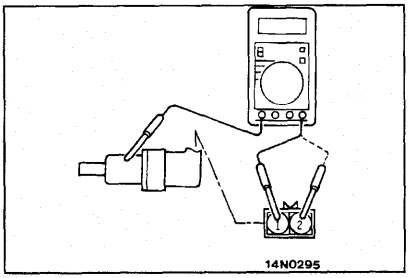
(2) Measure the resistance between the speed sensor terminals.

Standard value: 1.4 - 1.8 kΩ

If the internal resistance of the speed sensor is not within the standard value, replace with a new speed sensor.

(3) Check the speed sensor cable for breakage, damage or disconnection. Replace with a new one if a problem is found.

NOTE
When checking for cable damage, remove the cable clamp part from the body and then gently bend and pull the cable near the clamp to check whether or not temporary disconnection occurs.

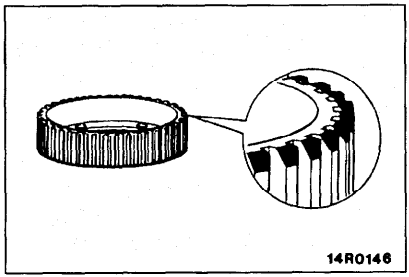


SPEED SENSOR INSULATION INSPECTION

(1) Remove all connections from the speed sensor, and then measure the resistance between terminals (1) and (2) and the body of the speed sensor.

Standard value: 100 kΩ or more

(2) If the speed sensor insulation resistance is outside the standard value range, replace with a new speed sensor.



TOOTHED ROTOR

Check whether rotor teeth are broken or deformed. Replace the rotor if the teeth are damaged or deformed.

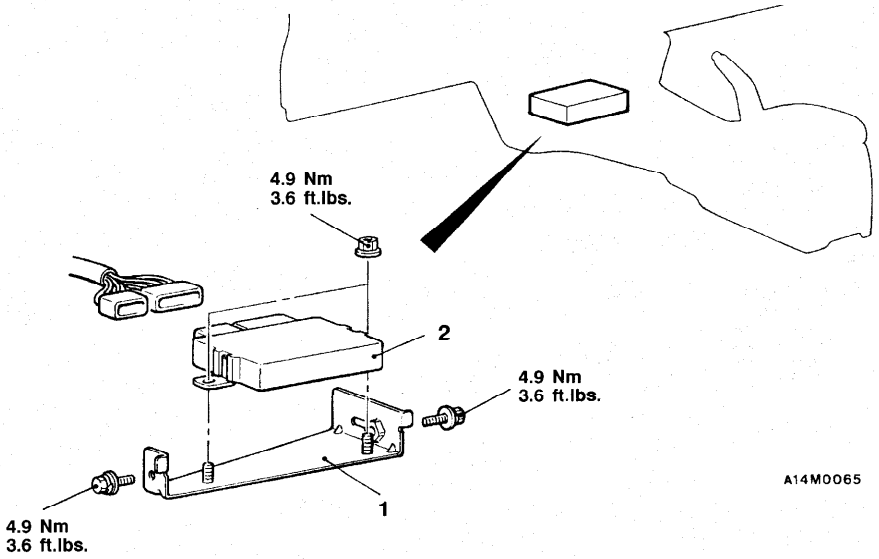
ABS-ECU

35200980134

REMOVAL AND INSTALLATION

CAUTION: SRS
When removing and installing the ABS-ECU from vehicles equipped with SRS, do not let it bump against the SRS-ECU or other components.

Pre-removal and Post-installation Operation
- Floor Console Removal and Installation (Refer to GROUP 52A.)



Removal steps
1. ABS-ECU bracket
2. ABS-ECU

INSPECTION

35200990090

Refer to P.35B-24.