
ANTI-SKID BRAKING SYSTEM (ABS) <4WD>

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ANTI-SKID BRAKING SYSTEM (ABS) <4WD>

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GENERAL INFORMATION

ABS has been adopted as standard equipment in all vehicles to maintain directional stability and steering performance during sudden braking. The ABS control method used is a 4-sensor, 4-channel method (previous models: 4-sensor, 3-channel method) which allows the brake pressures for all four wheels to be controlled independently of each other. The system has the following features.

- EBD* (Electronic Brake force Distribution system) control has been added to provide the ideal braking force for the rear wheels.

- The hydraulic unit function has been integrated with the hydraulic brake booster (HBB).
- Select solenoid valves (two valves for FL and FR) have been adopted in order to reduce the pedal kickback and improve the operation feeling when the ABS is operating.
- Independent 4-wheel control is carried out while the vehicle is turning in order to increase the braking force.

NOTE

*EBD: Electronic Brake-force Distribution

EBD CONTROL

In ABS, electronic control method is used whereby the rear wheel brake hydraulic pressure during braking is regulated by rear wheel control solenoid valves in accordance with the vehicle's rate of deceleration and the front and rear wheel slippage which are calculated from the signals received from the various wheel sensors. EBD control is a control system which provides a high level of control for both vehicle braking force and vehicle stability. The system has the following features.

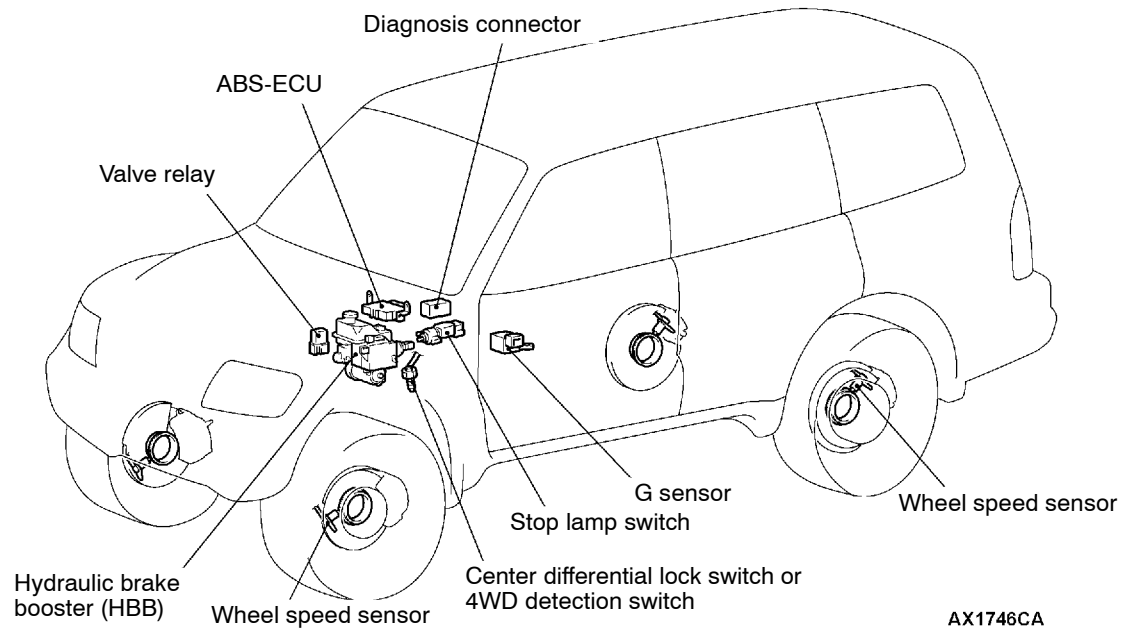
- Because the system provides the optimum rear wheel braking force regardless of the vehicle laden condition and the condition of the road surface, the system reduces the required pedal depression force, particularly when the vehicle is heavily laden or driving on road surfaces with high frictional coefficients.

- Because the duty placed on the front brakes has been reduced, the increases in pad temperature can be controlled during front brakes applying to improve the wear resistance characteristics of the pad.
- Control valves such as the proportioning valve are no longer required.

SPECIFICATIONS

Item		Specifications
ABS control method		4-sensor, 4-channel
No. of ABS rotor teeth	Front	50
	Rear	50
ABS speed sensor	Type	Magnet coil type
	Gap between sensor and rotor mm	0.9 (non-adjustable type)

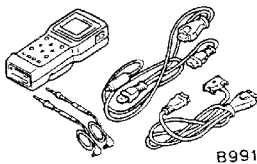
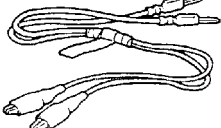
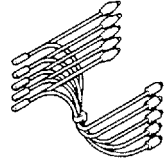
STRUCTURAL DIAGRAM



SERVICE SPECIFICATIONS

Item		Standard value
Control solenoid valve resistance Ω	IN	4.75 - 5.25
	OUT	2.0 - 2.4
Select solenoid valve resistance Ω		3.5 - 3.9
Wheel speed sensor terminal resistance $k\Omega$		1.0 - 1.5
Wheel speed sensor insulation resistance $k\Omega$		100 or more

SPECIAL TOOLS

Tools	No.	Name	Application
 B991502	MB991502	MUT-II sub assembly	Checking the ABS (Diagnosis display using the MUT-II)
 B991529	MB991529	Diagnosis code checking harness	Checking the ABS (Diagnosis display using the ABS warning lamp)
 B991348	MB991348	Test harness set	Checking the G sensor

TROUBLESHOOTING

STANDARD FLOW OF DIAGNOSTIC TROUBLESHOOTING

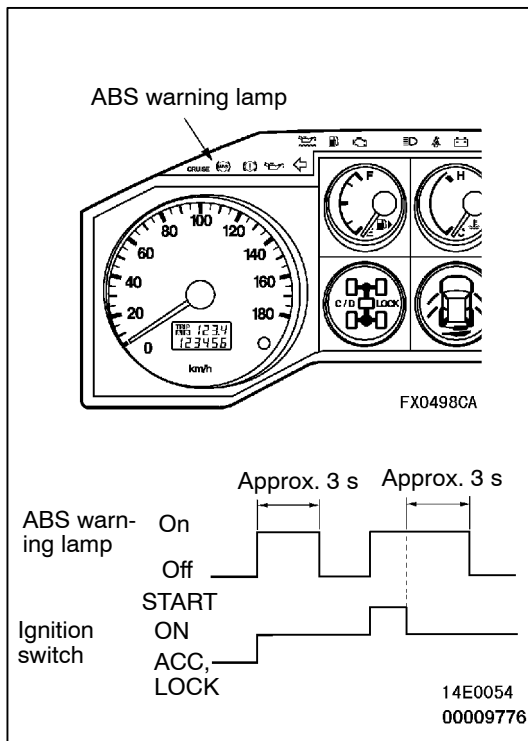
Refer to GROUP 00 - How to Use Troubleshooting/Inspection Service Points.

PRECAUTIONS WHEN CARRYING OUT DIAGNOSIS

- (1) The ABS is a system which controls the brake pressure by means of the operation of the ECU. Accordingly, the following symptoms may occur at times, but these are a sign of normal ABS operation, and do not indicate a malfunction.

Symptom	Explanation of symptom
When the engine starts, a knocking sound can be heard coming from the engine compartment.	This sound occurs as a result of system operation checking, and is not a malfunction.
1. The brake pedal feeling changes and noise is generated. (Rattling) 2. When the ABS is operating, noise is generated by parts of the vehicle chassis as control turns on and off. (Thump: suspension; squeak: tyres)	This is the sound of normal system operation, and is not a malfunction.
Shocks are felt if the brake pedal is depressed when driving at low speed.	This is due to system operation checking (starting-of check when the vehicle speed reaches a certain number of km/h) and is not a malfunction.

- (2) 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 and not being too overconfident.
- (3) Diagnosis detection conditions vary according to the diagnosis code. When re-checking trouble symptoms, the conditions given in the "Explanation" column of the Inspection Chart Classified by Trouble Symptoms must always be satisfied.



ABS WARNING LAMP INSPECTION

Check that the ABS warning lamp illuminates in the following way.

Even if the pressure inside the accumulator of the hydraulic brake booster (HBB) is below the specified value, the ABS warning lamp will illuminate because ABS operation has been stopped. In such cases, if the HBB pump is driven by the accumulated pressure inside the accumulator and causes the ABS warning lamp to switch off, it does not indicate a system malfunction.

- (1) When the ignition switch is turned to the ON position, the ABS warning lamp illuminates* for approximately 3 seconds, and then switches off.
- (2) When the ignition switch is turned to the START position, the ABS warning lamp remains illuminated.
- (3) When the ignition switch returns from the START to the ON position, the ABS warning lamp illuminates* for approximately 3 seconds, and then remains switched off.
- (4) If any of the above do not occur, check the diagnosis codes.

NOTE

*: The ABS warning lamp may remain illuminated after the ignition switch is turned to the ON position and the vehicle starts moving until the vehicle speed reaches a speed of several km/h. This only occurs if a diagnosis code from No. 21 to No. 24 relating to a wheel speed sensor malfunction was generated when the ignition switch was last turned to the ON position and is still stored in the ABS-ECU. The ABS-ECU will cause the ABS warning lamp to illuminate until the point where it can ascertain (during the starting-off check) that the problem associated with this diagnosis code has returned to normal.

DIAGNOSIS FUNCTION

READING DIAGNOSIS CODES

Use the MUT-II or the ABS warning lamp to read the diagnosis codes.

(Refer to GROUP 00 - How to Use Troubleshooting/Inspection Service Points.)

NOTE

Connect the MUT-II to the 16-pin diagnosis connector.

ERASING DIAGNOSIS CODES**When using the MUT-II**

Connect the MUT-II to the diagnosis connector and erase the diagnosis codes.

Caution

Turn the ignition switch to the LOCK (OFF) position when connecting and disconnecting the MUT-II.

NOTE

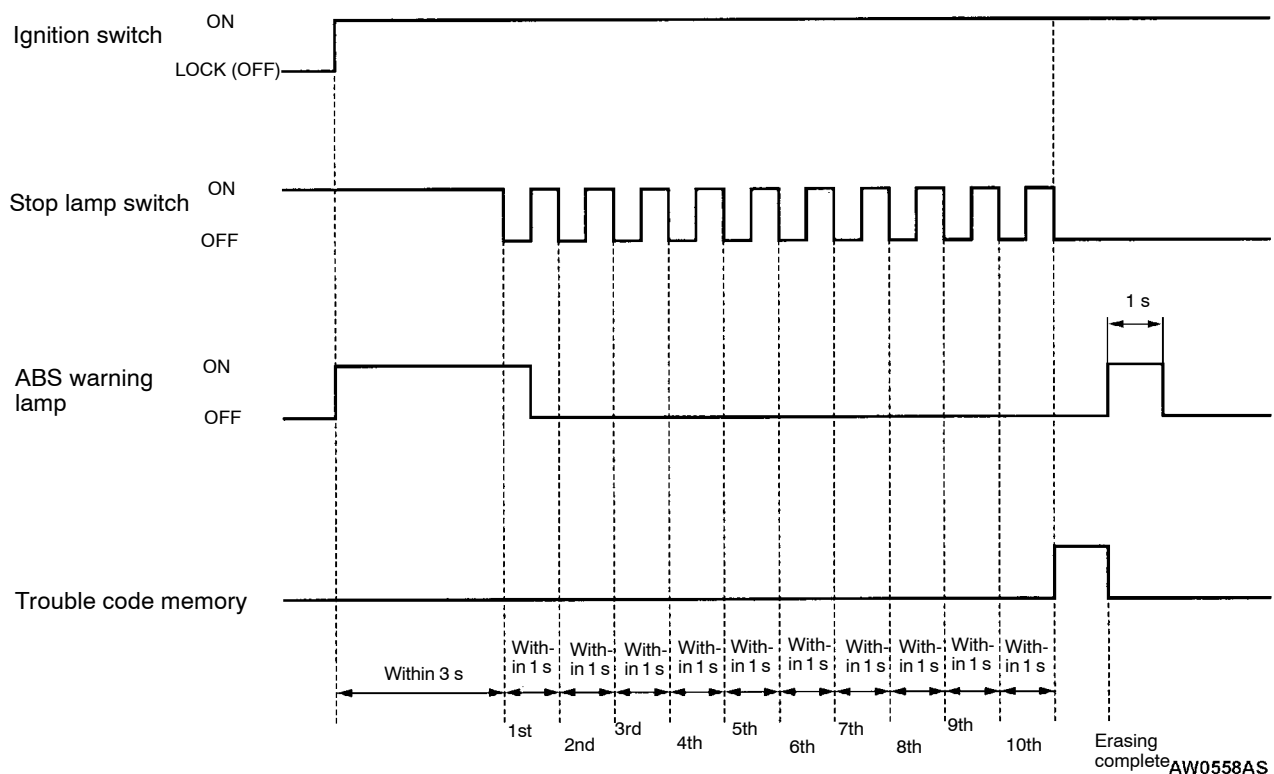
Connect the MUT-II to the 16-pin diagnosis connector.

When not using the MUT-II

- (1) Stop the vehicle.
- (2) Turn the stop lamp switch to ON (brake pedal depressed).
- (3) In this condition (after carrying out steps 1) to 2)), turn the ignition switch to the ON position. Then turn off the stop lamp switch (release the brake pedal) within 3 seconds, and then turn the stop lamp switch on and off again a further 10 times.

NOTE

If the functioning of the ABS-ECU has been stopped by the fail-safe function, the diagnosis codes cannot be erased.



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INSPECTION CHART FOR DIAGNOSIS CODES

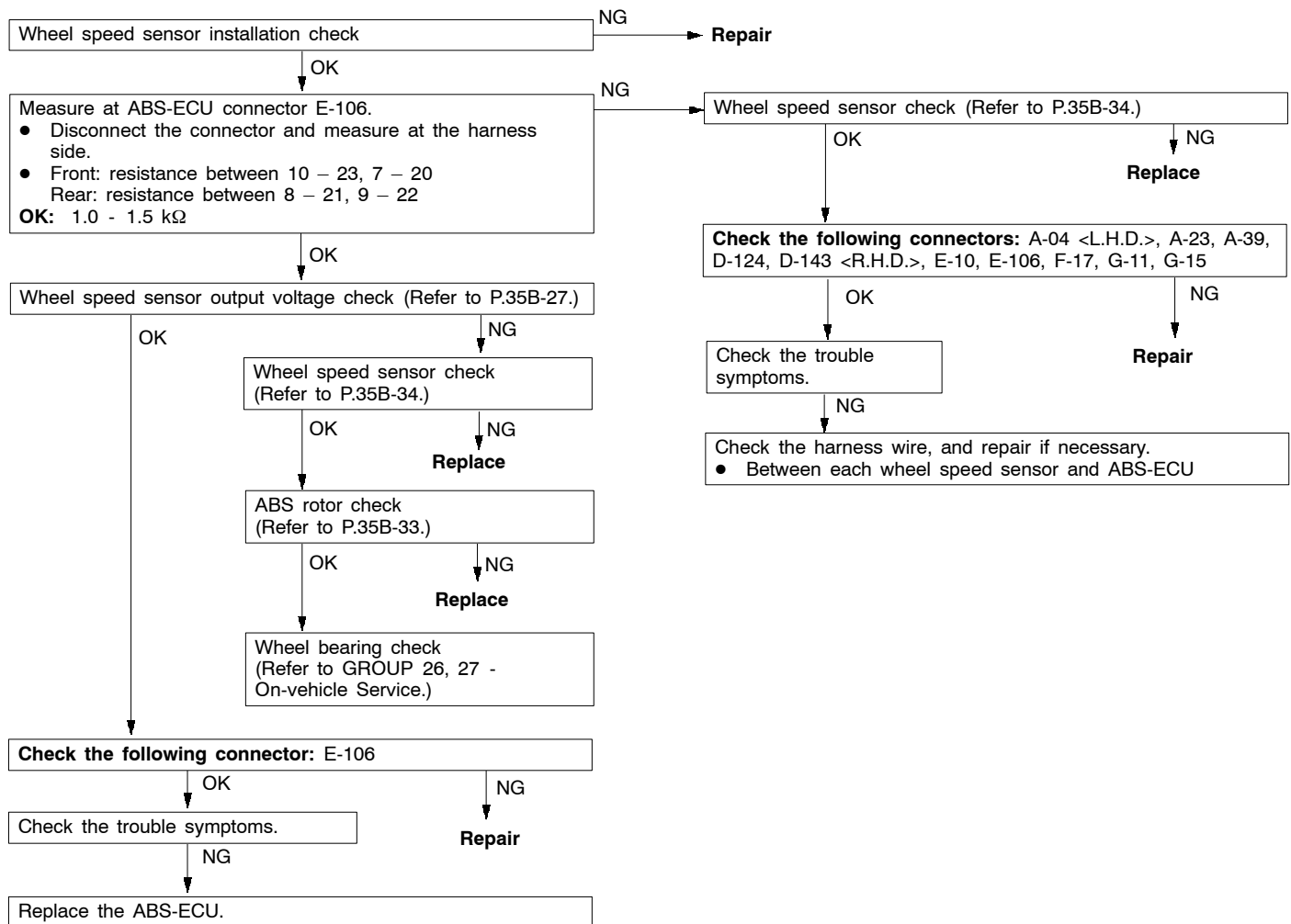
Diagnosis code No.	Diagnosis item		Reference page
11	Wheel speed sensor (FR) system (open circuit or short-circuit)		35B-8
12	Wheel speed sensor (FL) system (open circuit or short-circuit)		35B-8
13	Wheel speed sensor (RR) system (open circuit or short-circuit)		35B-8
14	Wheel speed sensor (RL) system (open circuit or short-circuit)		35B-8
15	Wheel speed sensor system (output signal abnormality)		35B-9
16	ABS-ECU or valve relay power supply system (abnormal voltage drop or rise)		35B-10
21	Wheel speed sensor (FR) system		35B-8
22	Wheel speed sensor (FL) system		35B-8
23	Wheel speed sensor (RR) system		35B-8
24	Wheel speed sensor (RL) system		35B-8
26	Center differential lock switch system		35B-11, 12
27	Rear differential lock switch system		35B-11, 12
32	G sensor system		35B-13
33	Stop lamp switch system		35B-14
41	Control solenoid valve (FR) system	If there is no response to the solenoid valve drive signal corresponding to each respective item	35B-15
42	Control solenoid valve (FL) system		
43	Control solenoid valve (RR) system		
44	Control solenoid valve (RL) system		
45	Changeover solenoid valve (FR) system		
46	Changeover solenoid valve (FL) system		
51	Valve relay system (ON problem)		35B-16
52	Valve relay system (OFF problem)		35B-17
55	HBB system		Carry out HBB troubleshooting. (Refer to GROUP 35A.)
63	ABS-ECU system		35B-32 (ABS-ECU replacement)

NOTE

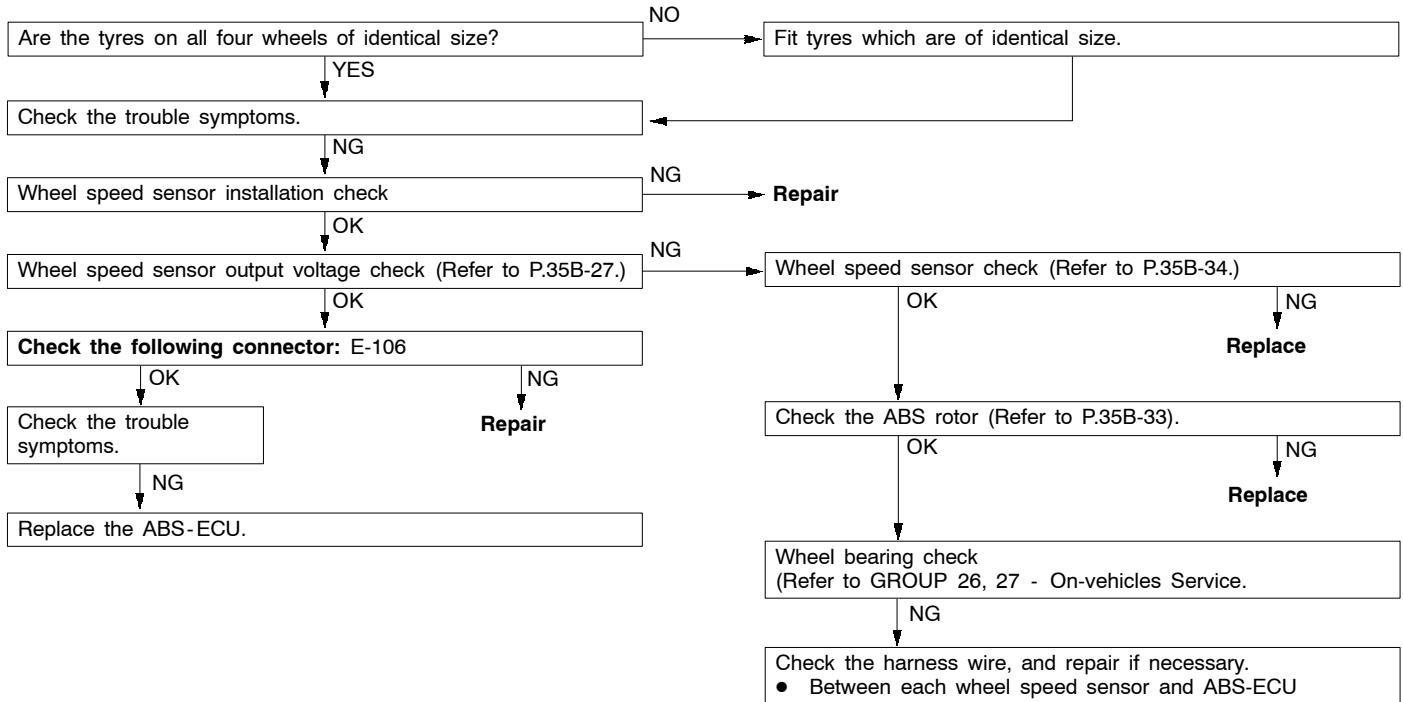
*: Code No.16 is erased from the memory if the condition returns to normal.

INSPECTION PROCEDURE CLASSIFIED BY DIAGNOSIS CODE

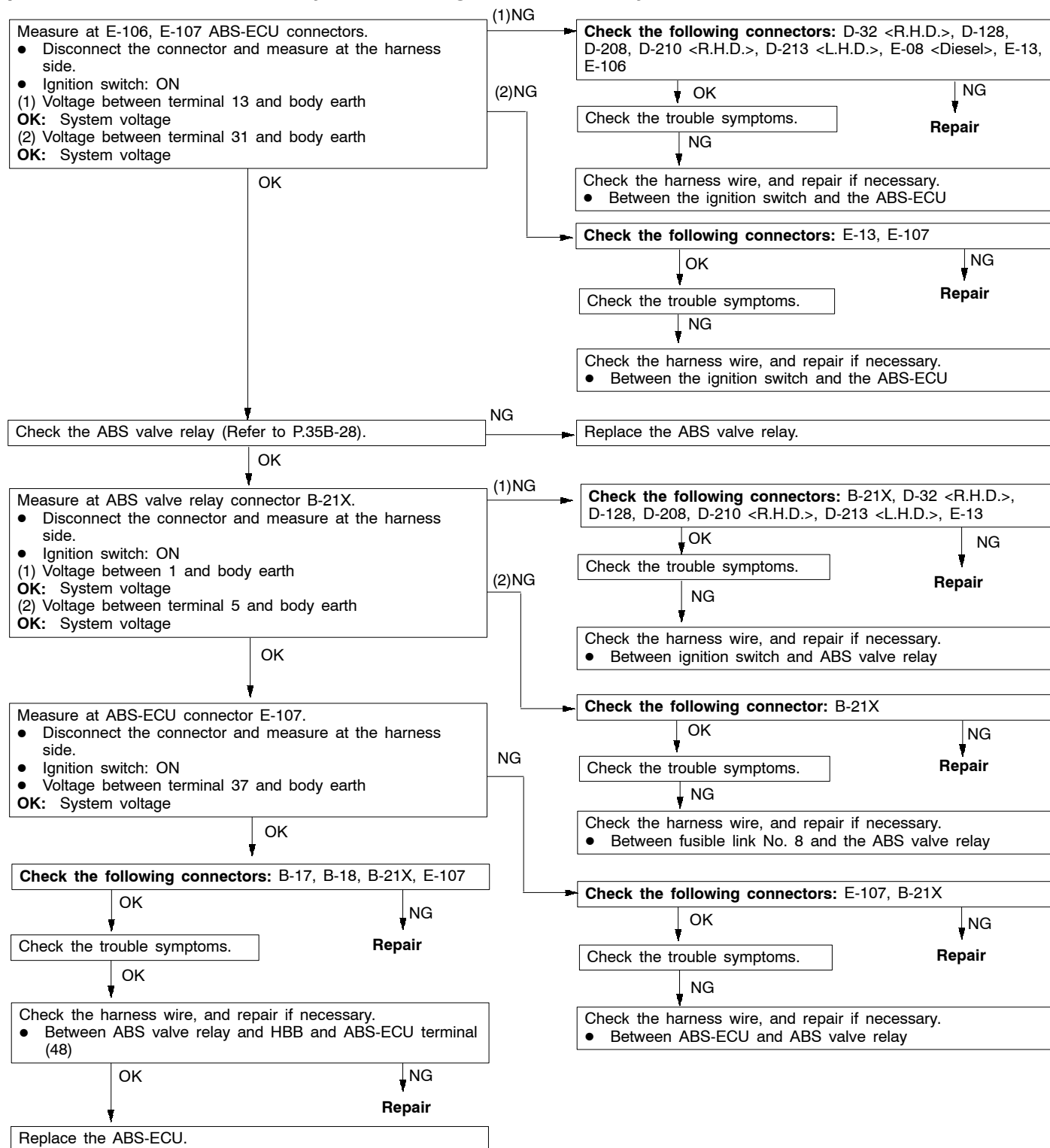
Code No. 11, 12, 13, 14 Wheel speed sensor system (open circuit or short-circuit)	Probable cause
Code No. 21, 22, 23, 24 Wheel speed sensor system	
Code Nos. 11, 12, 13, 14 are output when the open circuit or short-circuit detection carried out by the ABS-ECU hardware circuit detects that there is an open circuit or short-circuit in the (+) or (-) wire in one of the four wheel speed sensors and signals are consequently not being input.	<ul style="list-style-type: none"> • Malfunction of wheel speed sensor • Malfunction of harness or connector • Malfunction of the ABS-ECU
Code No. 21, 22, 23, 24 are output at the following times: <ul style="list-style-type: none"> • If an open circuit cannot be verified, but one or more of the wheel speed sensors does not output any signal when the vehicle speed is a certain number of km/h or higher. • When a problem such as chipped or plugged-up rotor tooth is detected, or if the sensor output drops and anti-skid control is continuously carried out due to a malfunctioning sensor or a warped ABS rotor. 	<ul style="list-style-type: none"> • Malfunction of wheel speed sensor • Malfunction of harness or connector • Malfunction of ABS rotor • Excessive clearance between sensor and ABS rotor • Malfunction of the ABS-ECU • Malfunction of wheel bearing



Code No. 15 Wheel speed sensor system (output signal abnormality)	Probable cause
This malfunction code is output when any one of the wheel speed sensor output signals during driving is abnormal (except open and short circuit).	<ul style="list-style-type: none"> • Uneven tyre size for all four wheels • Incorrect wheel speed sensor installation • Malfunction of wheel speed sensor • Malfunction of harness or connector • Malfunction of ABS rotor • Malfunction of wheel bearing • Malfunction of the ABS-ECU

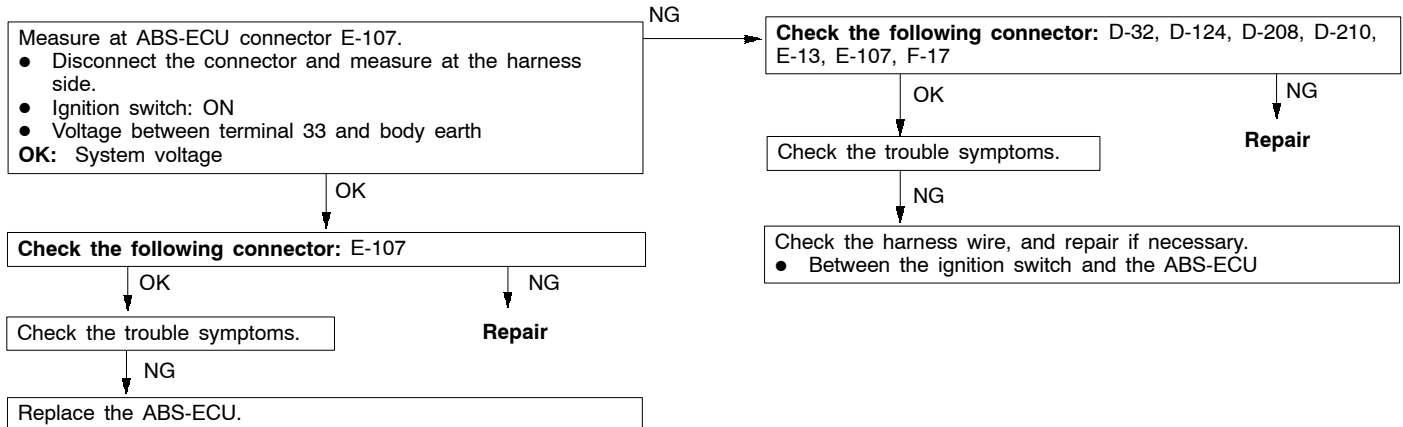


If the system voltage drops or rises during inspection, this code will be output to indicate a current problem. And correct problem diagnosis will not be possible. Before carrying out the following procedure, check the battery and recharge it if necessary.



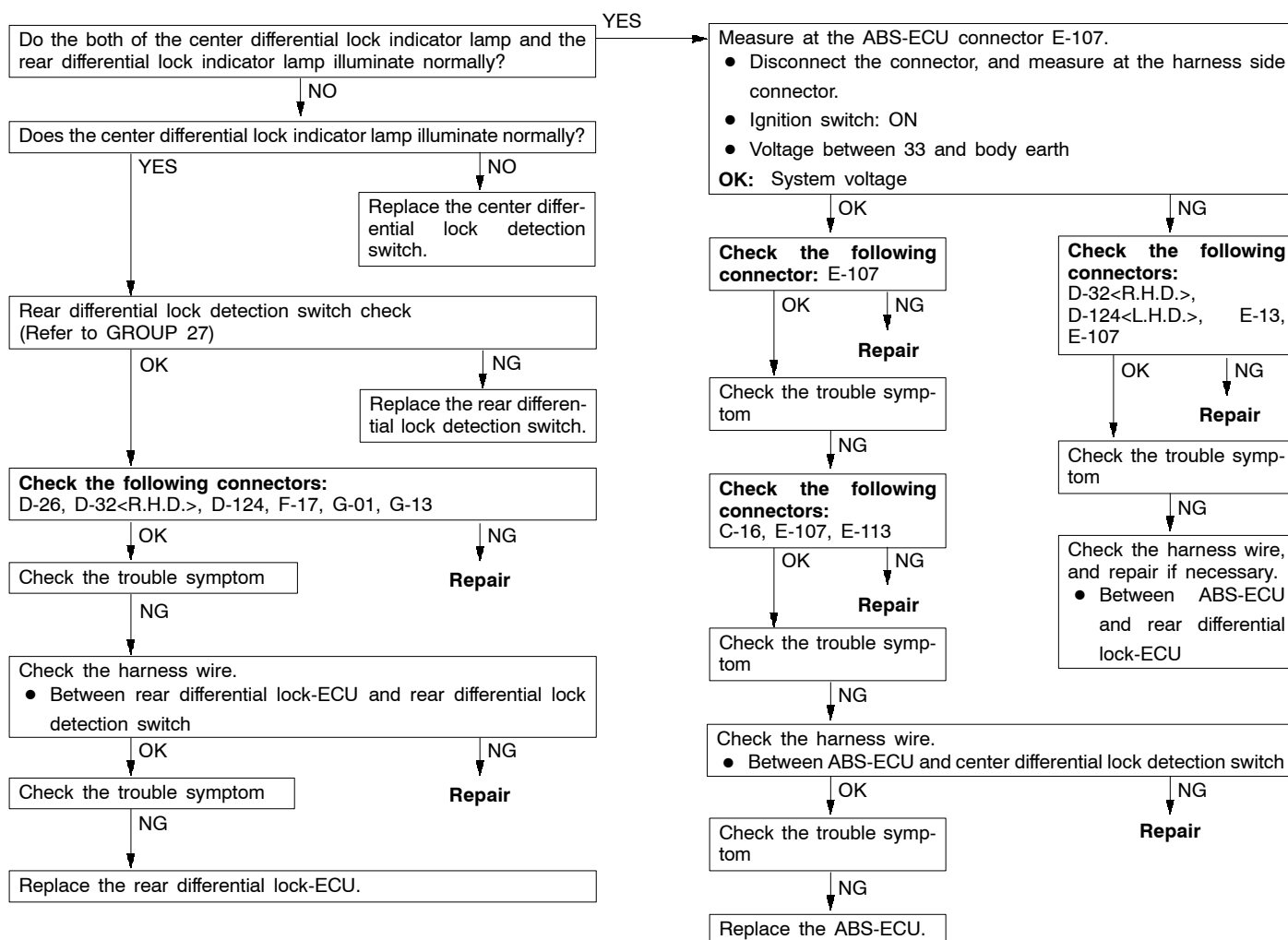
<Vehicles without rear differential lock system>

Code No. 26 Center differential lock switch system	Probable cause
Code No. 27 Rear differential lock switch system	
The ABS-ECU is designed to accommodate the fitting of a rear differential lock. Because of this, for vehicles which are not equipped with a rear differential lock, system voltage is applied to terminal (33) of the ABS-ECU instead of the rear differential lock switch signal. If there is an open circuit in the lines by which this system voltage is applied, the ABS-ECU outputs code Nos. 26 and 27.	<ul style="list-style-type: none">● Malfunction of harness or connector● Malfunction of the ABS-ECU



<Vehicles with rear differential lock system>

Code No.26 Center differential lock detection switch	Probable cause
Code No.27 Rear differential lock detection switch	
<p>On vehicles with rear differential lock system, these codes will be set under the following conditions:</p> <ul style="list-style-type: none"> • The ABS-ECU detects an open-circuit in the center differential lock detection switch and the rear differential lock detection switch systems, so no signal is sent. • The vehicle has been driven at 20 km/h or more for five minutes or more while the center differential lock detection switch is off and the rear differential lock detection switch is on, and then the vehicle speed decreases to 2 km/h in that condition. 	<ul style="list-style-type: none"> • Malfunction of harness or connector • Malfunction of the center differential lock detection switch • Malfunction of the rear differential lock detection switch • Malfunction of the rear differential lock-ECU • Malfunction of the ABS-ECU



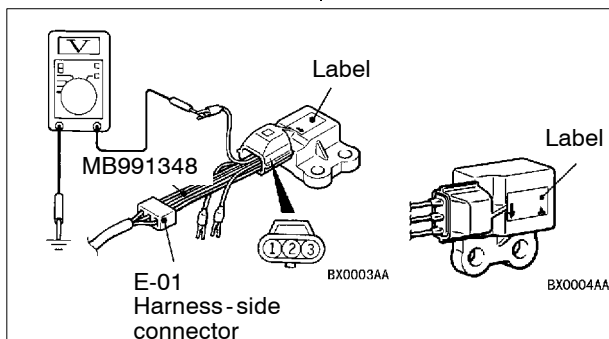
Code No. 32 G sensor system	Probable cause
<p>This code is output at the following cases:</p> <ul style="list-style-type: none"> When the G sensor output is lower than 0.5 V or higher than 4.5 V (Open circuit or short-circuit in G sensor circuit) When there is no variation in the G sensor output voltage (G sensor output seized) 	<ul style="list-style-type: none"> Malfunction of G sensor Malfunction of harness or connector Malfunction of the ABS-ECU

Measure at G sensor connector E-01.

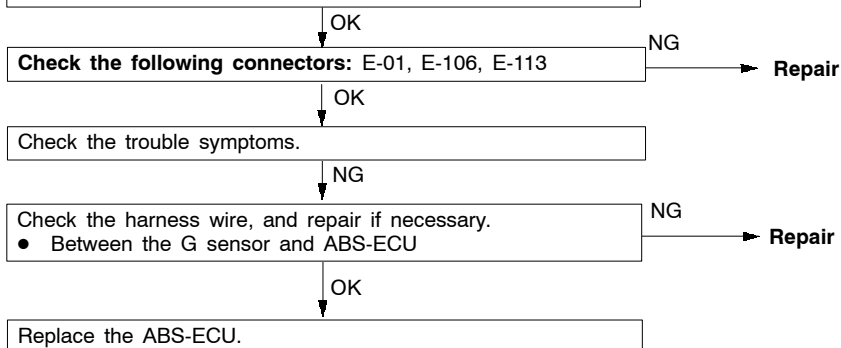
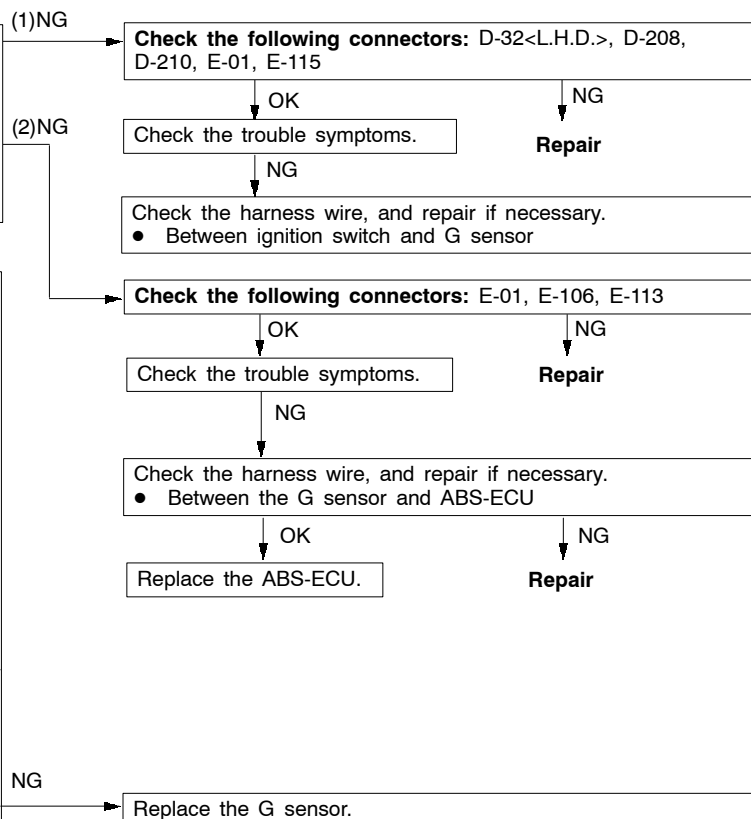
- Disconnect the connector and measure at the harness side.

(1) Voltage between terminal 1 and body earth (Ignition switch: ON)
OK: System voltage

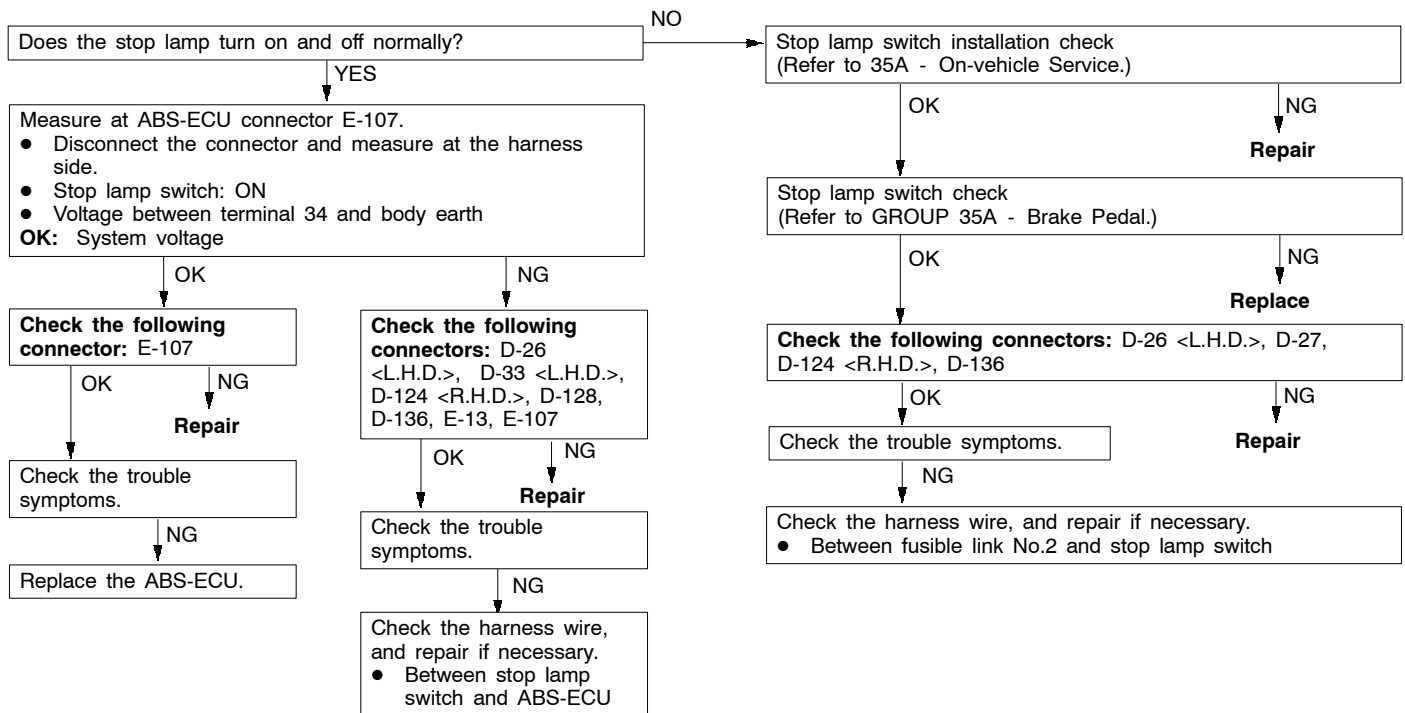
(2) Continuity between terminal 3 and body earth
OK: Continuity



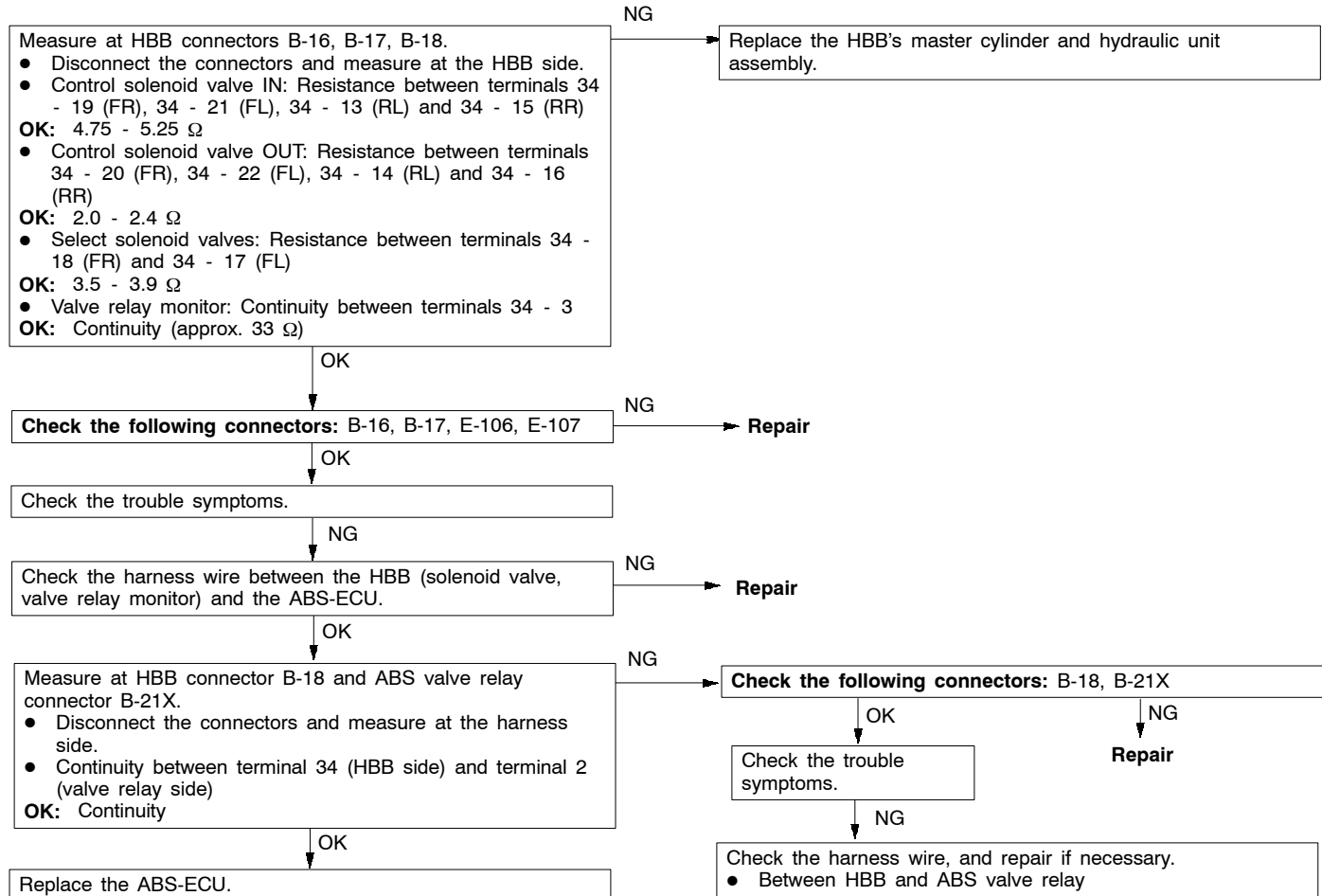
- Remove the G sensor (Refer to P.35B-36).
 - Connect the special tool between the G sensor harness-side connector E-01 and the G sensor.
 - Ignition switch: ON
 - Voltage between terminal 2 and body earth when the G sensor is placed on a level surface
- OK:** 2.4 - 2.6 V
- Voltage between terminal 2 and body earth when the G sensor is placed so that the label is facing straight up
- OK:** 3.3 - 3.7 V



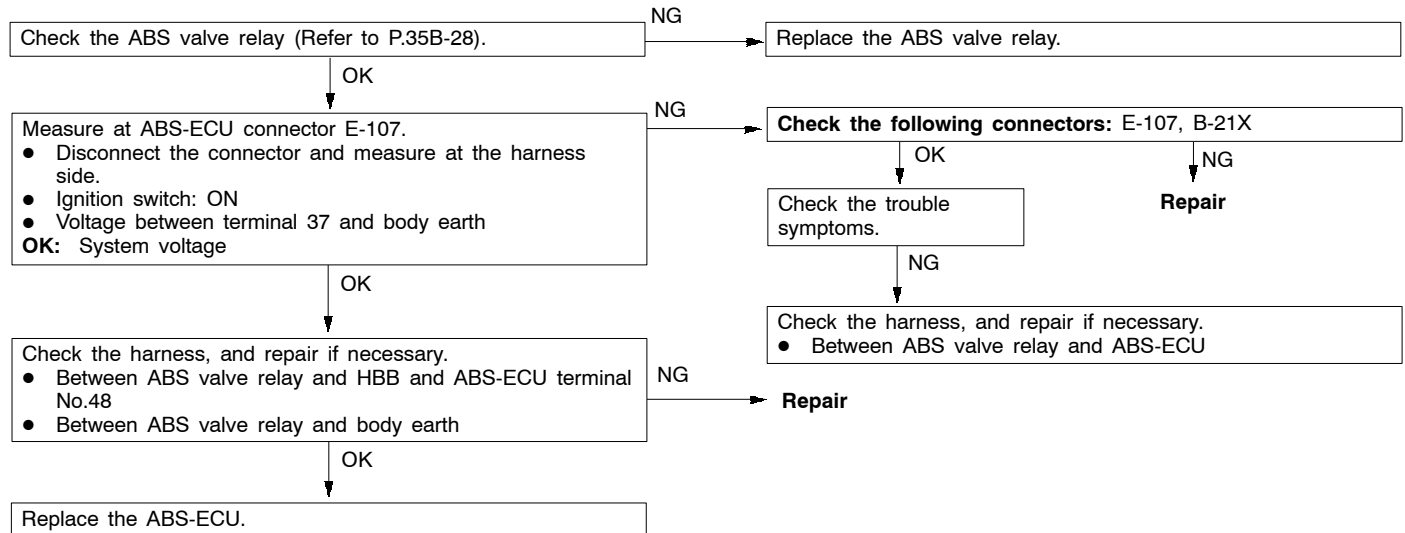
Code No. 33 Stop lamp switch system (open circuit or ON problem)	Probable cause
This code is output at the following cases: <ul style="list-style-type: none"> • If the stop lamp switch is continuously on for 15 minutes or more while driving • If there is an open circuit in the stop lamp switch input circuit harness 	<ul style="list-style-type: none"> • Malfunction of stop lamp switch • Malfunction of harness or connector • Malfunction of ABS-ECU



Code No. 41, 42, 43, 44 Control solenoid valve system	Probable cause
Code No. 45, 46 Select solenoid valve system	
<p>The ABS-ECU constantly monitors the solenoid valve drive circuits. These codes are output if the ABS-ECU judges that there is an open circuit or short-circuit in a solenoid coil or harness because the solenoid valve is on but no current flows to the solenoid valve, or if current continues flowing to the solenoid valve even though the solenoid valve is off.</p>	<ul style="list-style-type: none"> • Malfunction of harness or connector • Malfunction of HBB's master cylinder and hydraulic unit assembly • Malfunction of the ABS-ECU



Code No. 51 Valve relay system (ON problem)	Probable cause
This code is output when the ABS-ECU judges during the initial check when the ignition switch is turned to the ON position and the valve relay is OFF that there is a fused relay contact or a short-circuit in the valve relay drive circuit when power is being supplied to the solenoid valve.	<ul style="list-style-type: none"> • Malfunction of harness or connector • Malfunction of ABS valve relay • Malfunction of the ABS-ECU

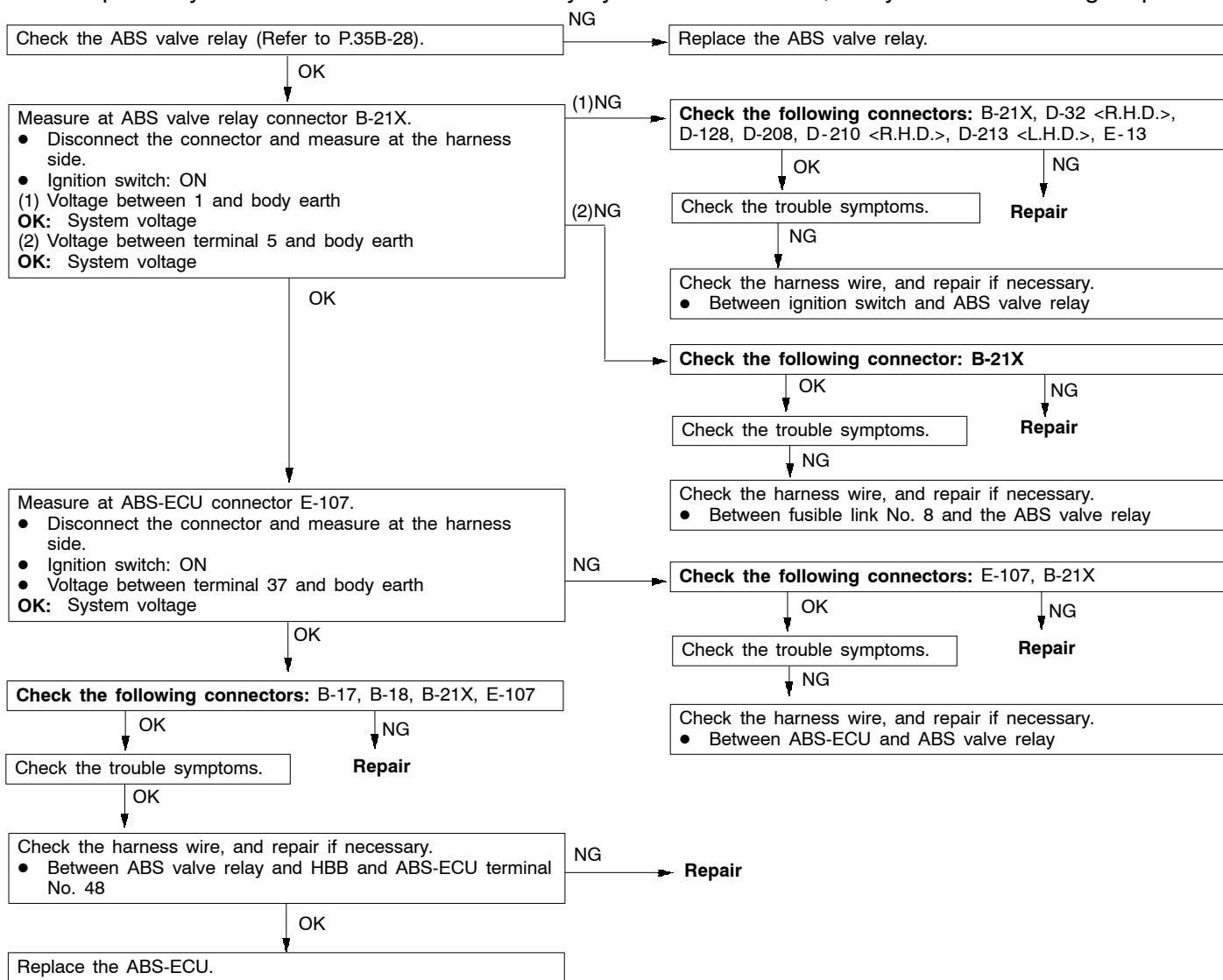


Code No. 52 Valve relay system (OFF problem)	Probable cause
This code is output if the ABS-ECU judges that there is a valve relay OFF problem when the valve relay is on and power is supplied to the solenoid valve.	<ul style="list-style-type: none"> • Malfunction of harness or connector • Malfunction of ABS valve relay • Malfunction of the ABS-ECU

NOTE

When reading the diagnosis codes using the ABS warning lamp (Refer to P.35B-5.), the valve relay connector is disconnected during inspection, with the result that this problem code will be output in addition to any other problem codes.

After the problem locations indicated by the problem diagnosis codes have been checked and repaired but the ABS warning lamp remains illuminated and no diagnosis codes other than code No. 52 are displayed, there is probably a malfunction of the valve relay system. In this case, carry out the following inspection.



INSPECTION CHART FOR TROUBLE SYMPTOMS

Trouble Symptom	Inspection procedure No.	Reference page
Communication with MUT-II is not possible.	1	35B-18
Communication with MUT-II and the ABS-ECU is not possible.	2	35B-19
The ABS warning lamp does not illuminate when the ignition key is turned to ON (engine stopped).	3	35B-20
The ABS warning lamp remains illuminated after the engine has started.	4	35B-20
The brake warning lamp does not illuminate when the ignition switch is turned ON (engine stopped).	Refer to GROUP 35A.	
The brake warning lamp remains illuminated after the engine has started.		
Abnormal brake operation	5	35B-21

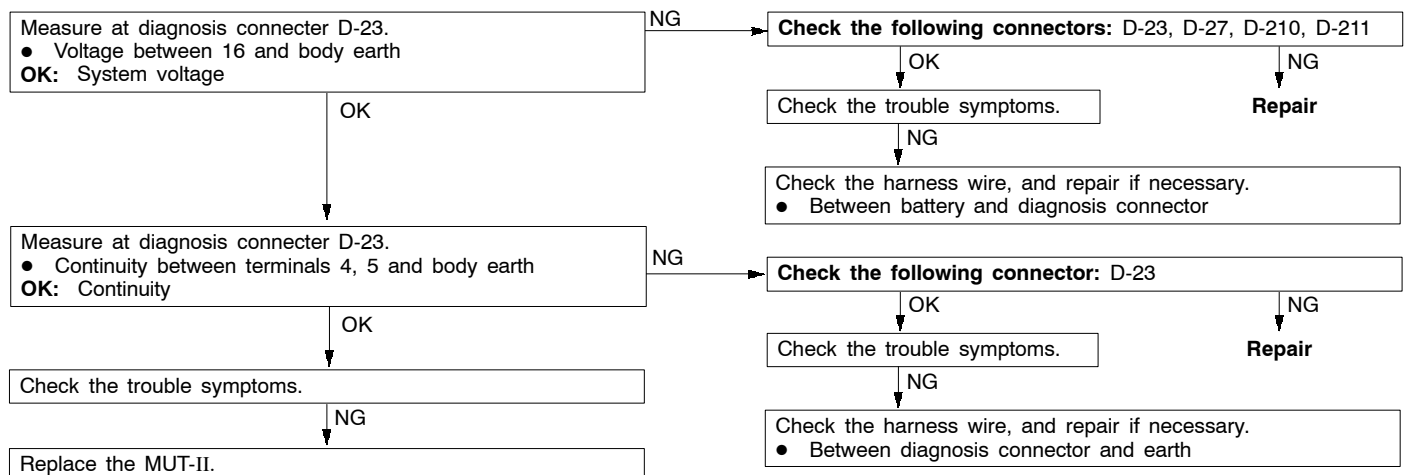
Caution

- (1) Because the ABS may also operate at times when sudden braking is not being carried out, such as when driving on low frictional coefficient roads, when turning at high speed or during high-speed overtaking, check with the customer that the problems are not occurring when driving under conditions such as these.
- (2) When the ABS is operating, changes in the brake pedal feel (vibration and difficulty depressing the pedal) may occur. This happens because the hydraulic pressure inside the brake line is continually changing in order to stop the wheels from locking up, and is not a malfunction.

INSPECTION PROCEDURES FOR TROUBLE SYMPTOMS

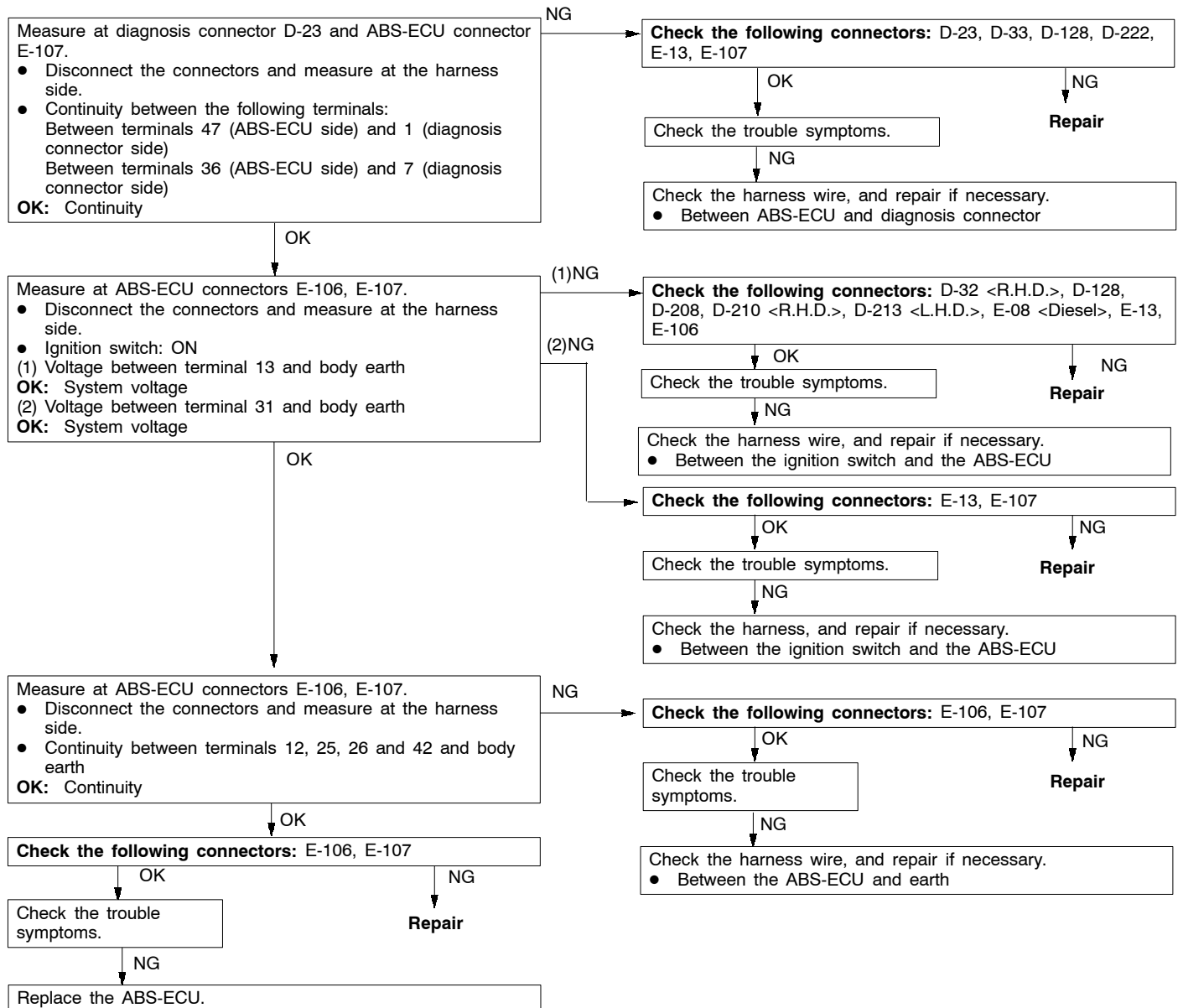
Inspection procedure 1

Communication with MUT-II is not possible.	Probable cause
The cause is probably a malfunction of the diagnosis connector power supply circuit or earth circuit.	<ul style="list-style-type: none"> • Malfunction of diagnosis connector • Malfunction of harness or connector



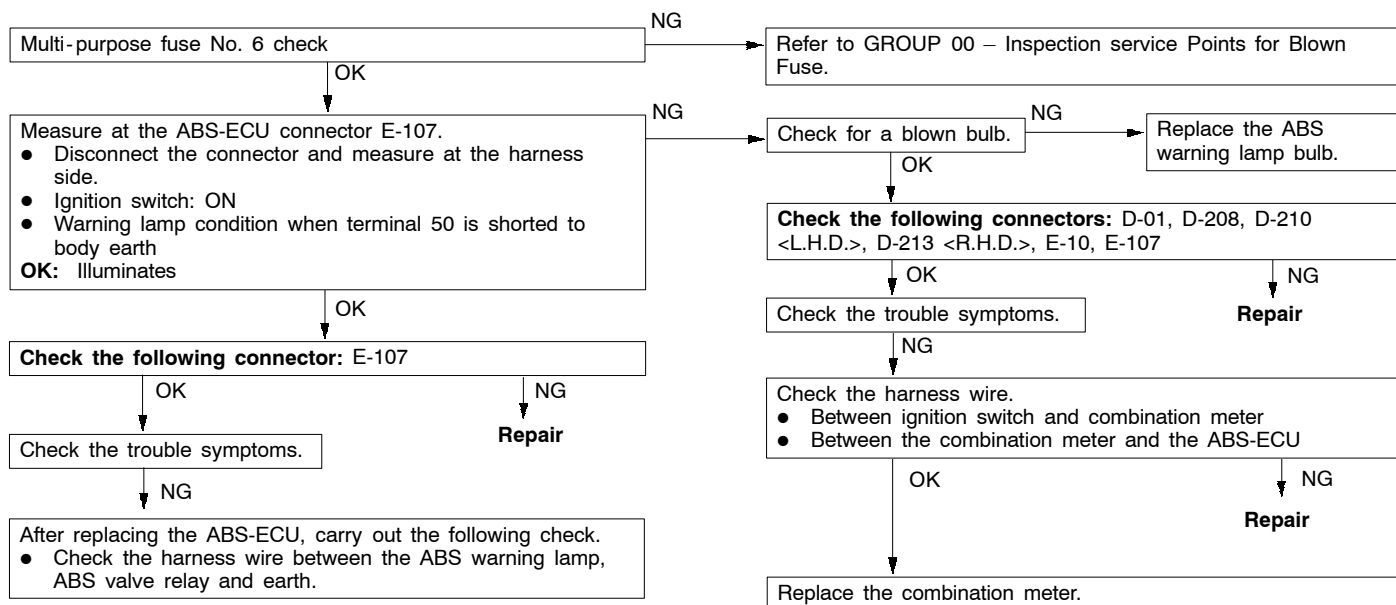
Inspection procedure 2

Communication with MUT-II and the ABS-ECU is not possible.	Probable cause
The cause is probably an open circuit in the ABS-ECU power supply circuit or an open circuit in the diagnosis output circuit.	<ul style="list-style-type: none"> Blown fuse Malfunction of harness or connector Malfunction of the ABS-ECU



Inspection procedure 3

The ABS warning lamp does not illuminate when the ignition key is turned to ON (engine stopped).	Probable cause
When power is first supplied to the ABS-ECU, the ABS-ECU turns the ABS-ECU valve relay from off to on, off and back to on again as part of its initial check. Accordingly, if the ABS warning lamp does not illuminate, the cause is probably an open circuit in the ABS warning lamp power supply circuit, a blown lamp bulb or an open circuit between the ABS warning lamp and the ABS-ECU.	<ul style="list-style-type: none"> • Blown fuse • Blown ABS warning lamp bulb • Malfunction of ABS valve relay • Malfunction of harness or connector • Malfunction of combination meter • Malfunction of the ABS-ECU

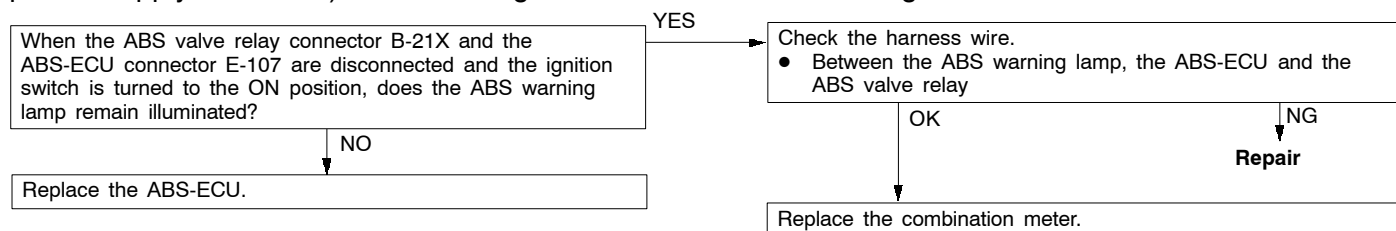


Inspection procedure 4

The ABS warning lamp remains illuminated after the engine has started.	Probable cause
The cause is probably a short-circuit in the ABS warning lamp illumination circuit.	<ul style="list-style-type: none"> • Malfunction of combination meter • Malfunction of harness (short-circuit) • Malfunction of the ABS-ECU

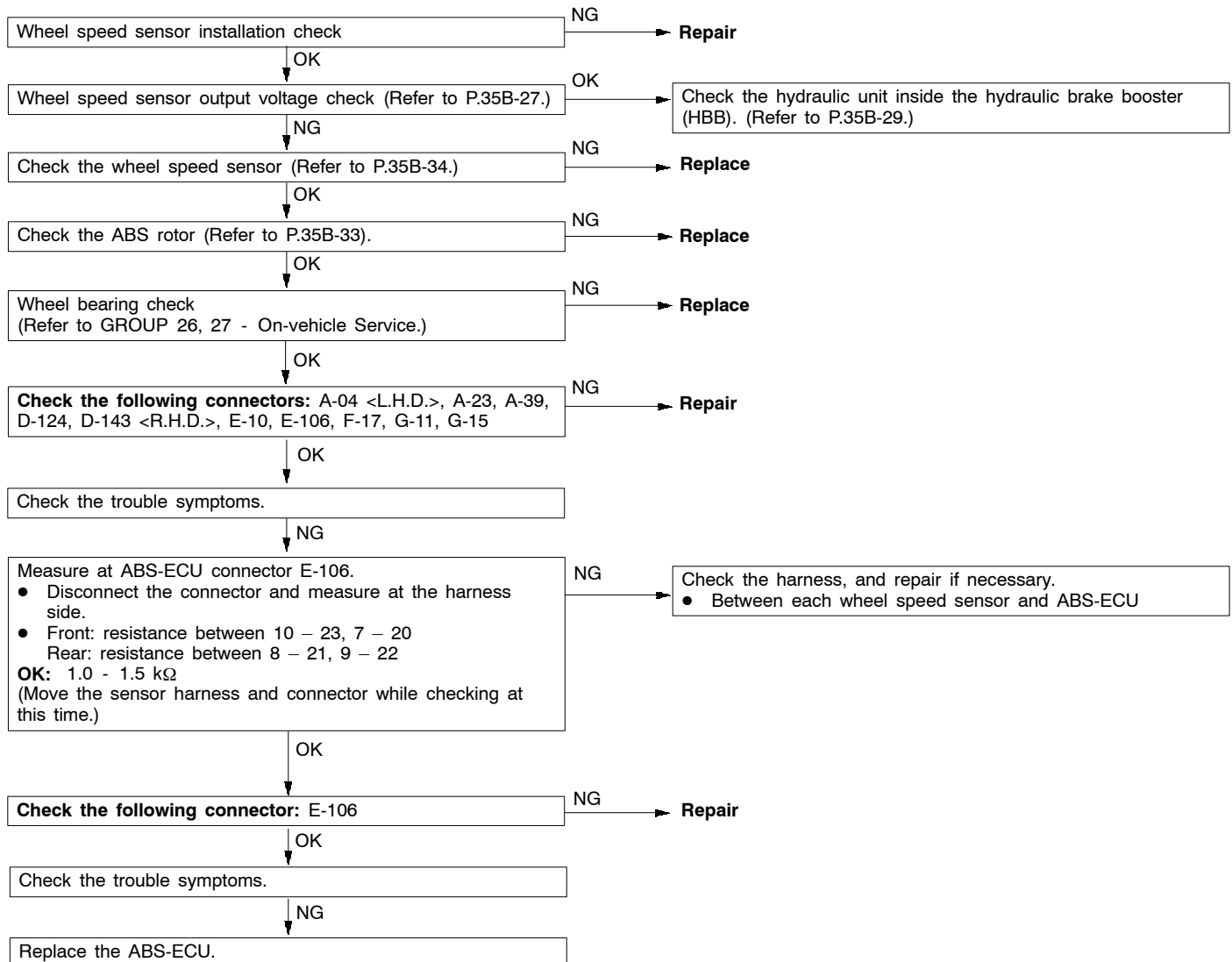
NOTE

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



Inspection procedure 5

Abnormal brake operation	Probable cause
Braking operation varies depending on the driving conditions and the road surface, which can make it difficult to diagnose a problem. However, if the diagnosis codes displayed are normal, carry out the following inspection procedure.	<ul style="list-style-type: none"> ● Incorrect wheel speed sensor installation ● Malfunction of harness or connector ● Malfunction of wheel speed sensor ● Malfunction of ABS rotor ● Foreign material adhering to speed sensor ● Malfunction of wheel bearing ● Malfunction of HBB ● Malfunction of the ABS-ECU



DATA LIST REFERENCE TABLE

The following ECU input data items can be read using the MUT-II.

(1) When system is normal

Item No.	Check item	Inspection conditions		Normal condition
11	Front-right wheel speed	When vehicle is being driven		Speedometer display and MUT-II display are identical.
12	Front-left wheel speed			
13	Rear-right wheel speed			
14	Rear-left wheel speed			
16	System voltage	Ignition switch: ON		6.5-22.3 V
26	Center differential lock switch	Ignition switch: ON	Transfer selector lever position: 2H, 4H	OFF
			Transfer selector lever position: 4HLc, 4LLc	ON
27	Rear differential lock switch	Ignition switch: ON		OFF
32	G sensor	<ul style="list-style-type: none"> Ignition switch: ON When vehicle is stationary (level) 		2.4-2.6 V
		When vehicle is being driven		1.0-4.0 V
33	Stop lamp Switch	Ignition switch: ON	When brake pedal is depressed	ON
			When brake pedal is released	OFF

(2) When system is interrupted by the ECU

When the diagnosis function has caused the operation of the ABS-ECU to be stopped, the MUT-II display data may be different from the actual condition.

ACTUATOR TEST TABLE

The following actuators can be force-driven using the MUT-II.

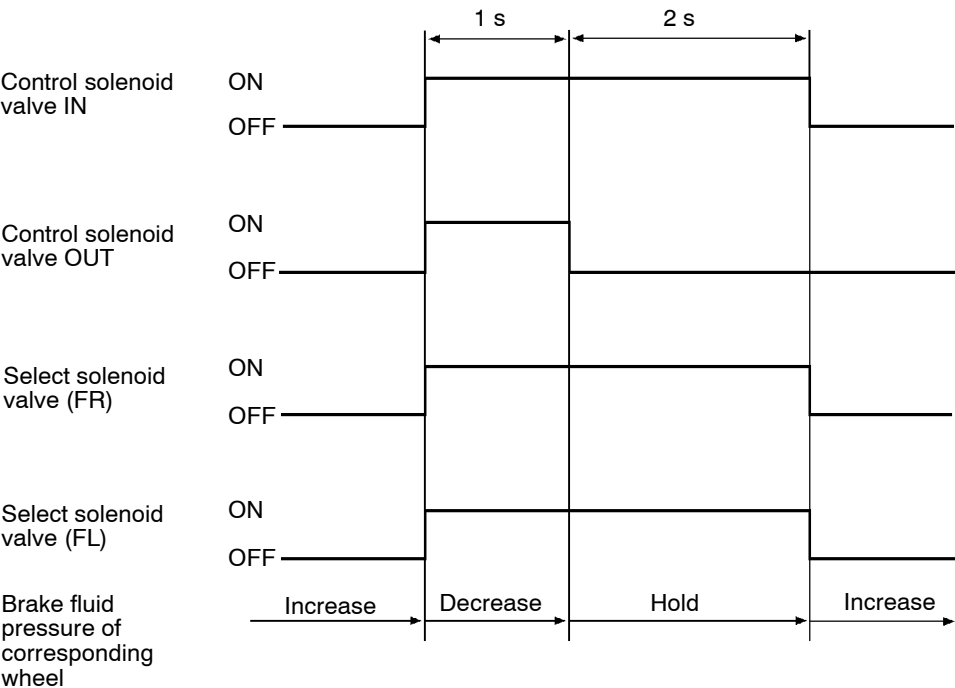
NOTE

- (1) Actuator tests cannot be carried out when the operation of the ABS-ECU has been stopped by the fail-safe function.
- (2) Actuator tests can only be carried out while the vehicle is stopped.

ACTUATOR TEST SPECIFICATIONS

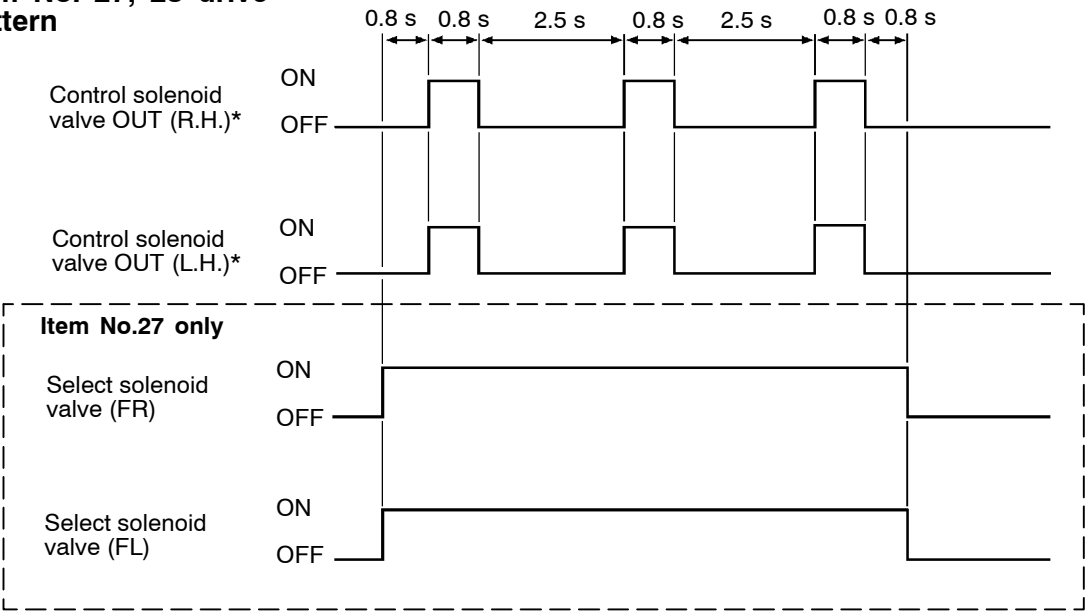
Item No.	Check item	Drive Contents
01	FR wheel solenoid valve	HBB select solenoid valves and control solenoid valves for the respective channel
02	FL wheel solenoid valve	
03	RR wheel solenoid valve	
04	RL wheel solenoid valve	
27	Air bleeding (1)	HBB select solenoid valves and control solenoid valve OUT (FR, FL)
28	Air bleeding (2)	HBB control solenoid valve OUT (RR, RL)

Item No. 01 - 04 drive pattern



X1266CA

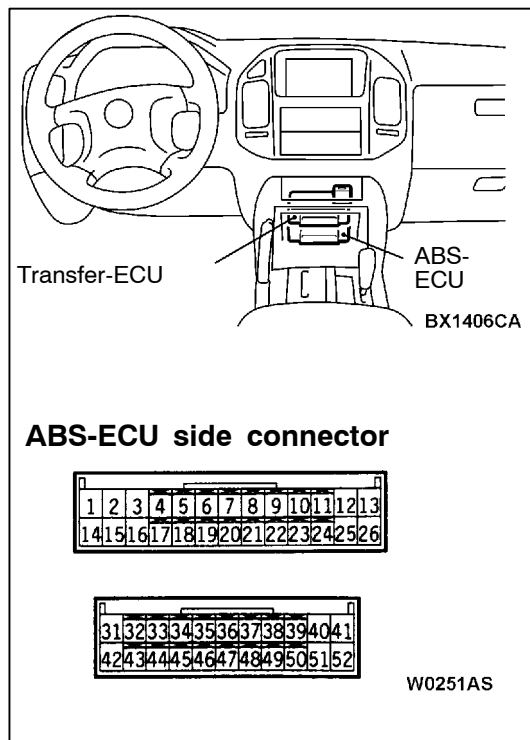
Item No. 27, 28 drive pattern



X1267CA

NOTE

*: When carrying out item No. 27, the front wheels are driven, and when carrying out item No. 28, the rear wheels are driven.

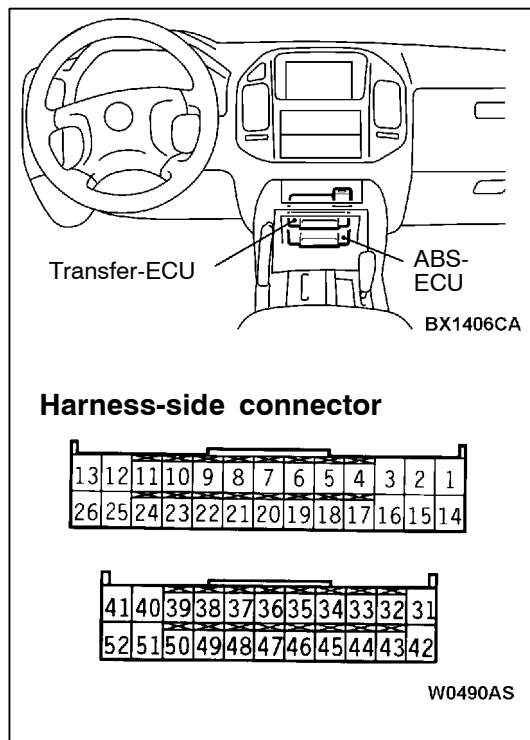
**CHECK AT ABS-ECU TERMINAL****TERMINAL VOLTAGE TABLE****NOTE**

There are two ECUs with the same shape inside the floor console, one above the other. The upper ECU is the ABS-ECU and has a blue connector. The lower ECU is the transfer-ECU and has a green connector.

- (1) Measure the voltages between the respective terminal and earth.
- (2) The terminal layout is shown in the illustration.

Terminal No.	Check item	Inspection conditions		Normal condition
1	Control solenoid valve OUT (FL)	Ignition switch: ON		System voltage
2	Control solenoid valve OUT (RR)	Ignition switch: ON		System voltage
3	Select solenoid valve (FL)	Ignition switch: ON		System voltage
4	G sensor input	Ignition switch: ON Vehicle horizontal position		2.4 - 2.6 V
13	ABS-ECU power supply	Ignition switch: ON		System voltage
		Ignition switch: START		0 V
14	Control solenoid valve IN (FL)	Ignition switch: ON		System voltage
15	Control solenoid valve IN (RR)	Ignition switch: ON		System voltage
16	Select solenoid valve (FR)	Ignition switch: ON		System voltage
18	G sensor earth	At all times		0.5 V or less
31	ABS-ECU power supply	Ignition switch: ON		System voltage
		Ignition switch: START		0 V
33	Rear differential lock switch	Ignition switch: ON		System voltage
34	Stop lamp switch input	Ignition switch: ON	Stop lamp switch: ON	System voltage
			Stop lamp switch: OFF	2 V or less
36	MUT-II	When the MUT-II is connected		Serial communication with the MUT-II
		When the MUT-II is not connected		1 V or less

Terminal No.	Check item	Inspection conditions		Normal condition
37	ABS valve relay output	Ignition switch: ON	When system abnormality is detected and relay is off	System voltage
			When relay is on approx. 1 second after engine starts	2 V or less
39	Brake warning lamp output	Ignition switch: ON	When lamp is switched off	2 V or less
			When lamp is illuminated	System voltage
40	Control solenoid valve OUT (RL)	Ignition switch: ON		System voltage
41	Control solenoid valve OUT (FR)	Ignition switch: ON		System voltage
46	Center differential lock switch input <Super Select 4WD-II>	Ignition switch: ON	Transfer selector lever position: 2H, 4H	System voltage
			Transfer selector lever position: 4HLc, 4LLc	2 V or less
	4WD detection switch input <Part time 4WD>	Ignition switch: ON	Transfer selector lever position: 2H	System voltage
			Transfer selector lever position: 4H	2 V or less
47	Diagnosis select input	When the MUT-II is connected		1 V or less
		When the MUT-II is not connected		Approx. 12 V
48	Valve relay monitor	Ignition switch: ON		System voltage
50	ABS warning lamp output	Ignition switch: ON	When lamp is switched off	System voltage
			When lamp is illuminated	2 V or less
51	Control solenoid valve IN (RL)	Ignition switch: ON		System voltage
52	Control solenoid valve IN (FR)	Ignition switch: ON		System voltage



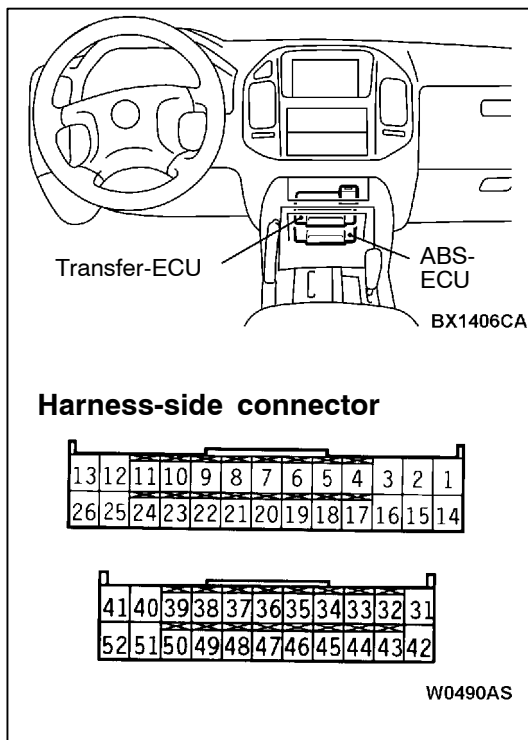
CHECK CHART FOR RESISTANCE AND CONTINUITY BETWEEN TERMINALS

NOTE

There are two ECUs with the same shape inside the floor console, one above the other. The upper ECU is the ABS-ECU and has a blue connector. The lower ECU is the transfer-ECU and has a green connector.

- (1) Turn the ignition switch to the LOCK (OFF) position.
- (2) Check the resistances and continuity with the ABS-ECU connector disconnected.
- (3) Check the resistances and continuity between the terminals listed in the table below.
- (4) The terminal layout is shown in the illustration.

Terminal No.	Signal name	Normal condition
7 - 20	Wheel speed sensor (FL)	1.0 - 1.5 kΩ
8 - 21	Wheel speed sensor (RR)	
9 - 22	Wheel speed sensor (RL)	
10 - 23	Wheel speed sensor (FR)	
Between terminal 12 and body earth	Earth	Continuity
Between terminal 25 and body earth	Earth	
Between terminal 26 and body earth	Earth	
Between terminal 42 and body earth	Earth	



ON-VEHICLE SERVICE

WHEEL SPEED SENSOR OUTPUT VOLTAGE MEASUREMENT

NOTE

There are two ECUs with the same shape inside the floor console, one above the other. The upper ECU is the ABS-ECU and has a blue connector. The lower ECU is the transfer-ECU and has a green connector.

- (1) Lift up the vehicle and release the parking brake.
- (2) Disconnect the ABS-ECU connector and measure at the harness-side connector.
- (3) Rotate the wheel to be measured by 1/2 to 1 turn, and use a multimeter (AC mV range) or an oscilloscope to check the output voltage at this time.

Terminal No.

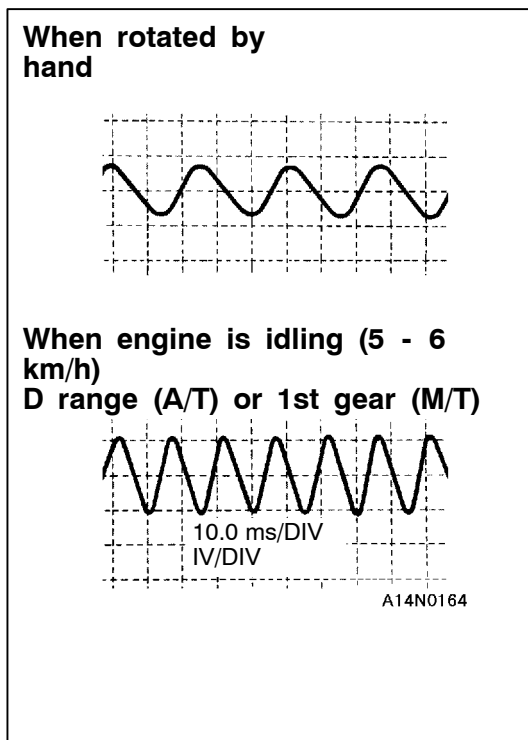
Front-left	Front-right	Rear-left	Rear-right
7	10	9	8
20	23	22	21

Output voltage:

42 mV or higher when measured using a multimeter

120 mVP-P or more when measured using an oscilloscope

- (4) If the output voltage is lower than that given above, the cause may be the following, so check or replace the wheel speed sensor if necessary.
 - Excessive clearance between pole piece of wheel speed sensor and ABS rotor
 - Malfunction of wheel speed sensor



WAVE PATTERN INSPECTION USING AN OSCILLOSCOPE

After checking the connection of the wheel speed sensor harness and the connector, take a reading of the output voltage wave patterns for each wheel speed sensor using an oscilloscope as follows.

Start the engine, move the transfer selector lever to the 4H position and the transmission selector lever to D range (A/T) or 1st gear (M/T), and then spin the wheel.

NOTE

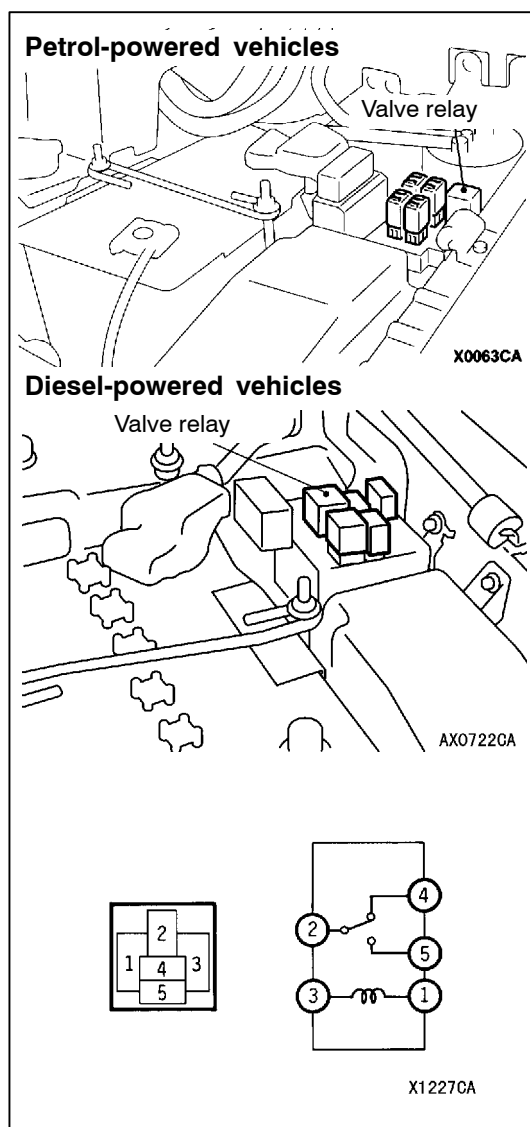
- (1) You can also take a reading of the wave pattern by actually driving the vehicle in this condition.
- (2) The output voltage will be lower when the wheel speed is lower, and will become higher as the wheel speed becomes higher.

WAVE PATTERN OBSERVATION POINTS

Symptom	Cause	Remedy
Wave pattern amplitude is too small or is non-existent.	Malfunction of wheel speed sensor	Replace the sensor.
Excessive variation in wave pattern amplitude (However, this is not a problem if the minimum amplitude is 120 mV or higher.)	Excessive axle hub runout or offset	Replace the hub.
	Malfunction of ABS-ECU earth	Repair
Noise appearing in wave pattern, or distorted wave pattern	Open circuit in sensor	Replace the sensor.
	Open circuit in harness	Repair the harness.
	Incorrect wheel speed sensor installation	Install the sensor correctly.
	Chipped or broken ABS rotor teeth	Replace the ABS rotor.

Caution

The wheel speed sensor cables move together with the movement of the front and rear suspension. Accordingly, you should shake the sensor harnesses while observing the wheel speed sensor output voltage wave patterns.



ABS VALVE RELAY CONTINUITY CHECK

Battery voltage	Terminal No.				
	1	2	3	4	5
When no current is supplied	○	○	○	○	
When current is supplied	⊕	○	⊖		○

HYDRAULIC BRAKE BOOSTER (HBB) - HYDRAULIC UNIT CHECK**Caution**

Turn the ignition switch to the LOCK (OFF) position when connecting and disconnecting the MUT-II.

- (1) Jack up the vehicle, and support it in the specified location using a rigid rack, or place the vehicle on the rollers of a brake force tester.

Caution

1. The rollers of the brake force tester and the vehicle tyres should be dry during checking.
 2. If using a brake force tester, apply the parking brake when testing the front brakes, and use a wheel lock to lock the front wheels when testing the rear brakes.
- (2) Turn the ignition switch to the LOCK (OFF) position, and connect the MUT-II to the diagnosis connector.
- (3) After checking that the selector lever is in the N position, start the vehicle's engine.
- (4) Operate the MUT-II to carry out the actuator tests.

NOTE

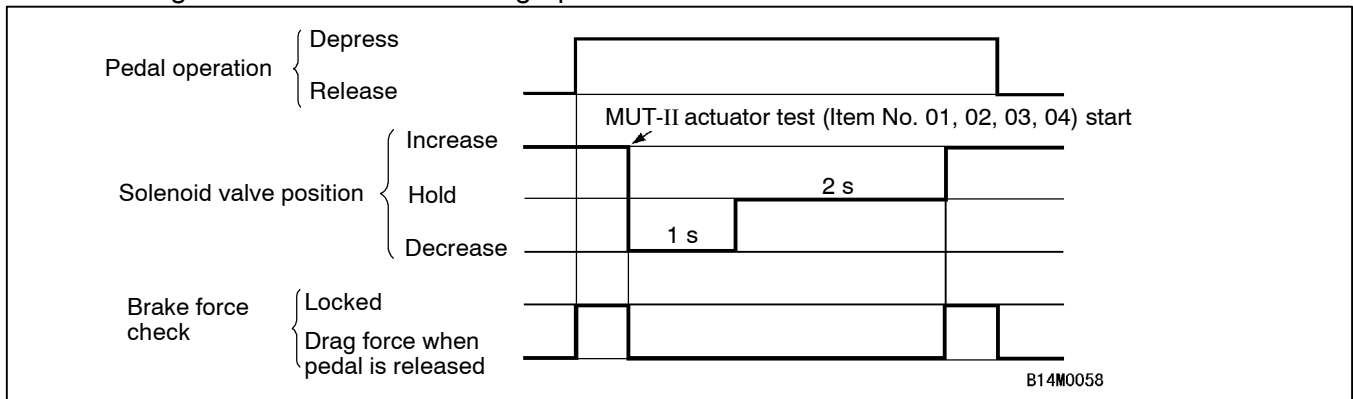
- 1) When actuator tests are being carried out, the ABS warning lamp will illuminate and ABS control will be stopped.
 - 2) MUT-II actuator tests cannot be carried out when the operation of the ABS-ECU has been stopped by the fail-safe function.
- (5) Rotate the wheel by hand and check that the brake force changes when the brake pedal is depressed. If using a brake force tester, depress the brake pedal until the brake force reaches the following value, and then check that the brake force changes when the actuator test is carried out.

Front wheels	785 - 981 N
Rear wheels	785 - 981 N

Caution

The solenoid valves should be driven one wheel at a time, and the brake pedal should be released each time a wheel is checked.

The following illustration shows this in graphical form.

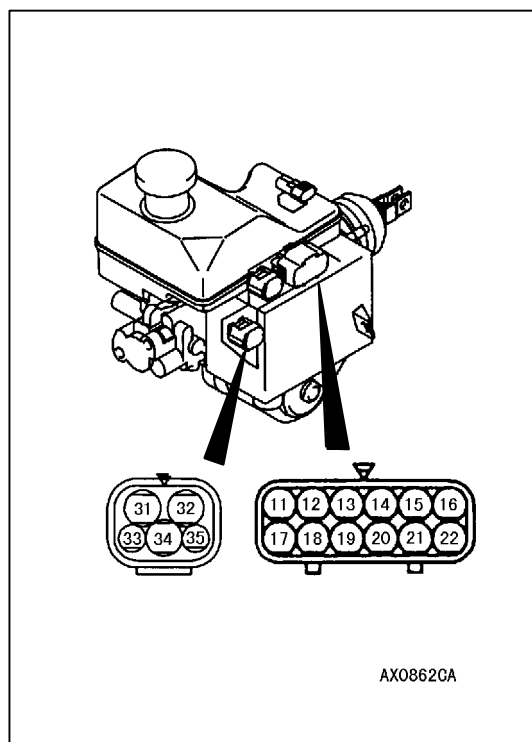


(6) If the results of checking show an abnormality, fix the problem by following the “Judgment Table” below.

Judgment Table

No.	MUT-II display	Operation	Judgment		Cause	Remedy
			Normal	Problem		
01	FR valve	(1) Depress the brake pedal to lock the wheels. (2) Use the MUT-II to select the wheel to be checked, and then force-drive the actuator. (3) Check the brake force for the selected wheel using a brake force tester or by rotating the wheel by hand.	Brake force lessens for 3 seconds after locking.	Wheel does not lock when brake pedal is depressed.	Blocked brake line other than HBB line	Check and clean the brake line.
02	FL valve			Brake force does not lessen.	Blocked hydraulic circuit inside HBB	Replace the HBB.
03	RR valve				HBB brake tubes connected incorrectly	Connect the tubes correctly.
04	RL valve				Malfunction of HBB solenoid valve	Replace the HBB.

(7) After checking, turn the ignition switch to the LOCK (OFF) position and then disconnect the MUT-II.



SOLENOID VALVE CHECK

Measure the resistance between the following solenoid valve terminals.

- Control solenoid valve IN (FR):
Between terminals 19 - 34
- Control solenoid valve OUT (FR):
Between terminals 20 - 34
- Control solenoid valve IN (FL)
: Between terminals 21 - 34
- Control solenoid valve OUT (FL)
: Between terminals 22 - 34
- Control solenoid valve IN (RR)
: Between terminals 15 - 34
- Control solenoid valve OUT (RR)
: Between terminals 16 - 34
- Control solenoid valve IN (RL)
: Between terminals 13 - 34
- Control solenoid valve OUT (RL)
: Between terminals 14 - 34
- Select solenoid valve (FR)
: Between terminals 18 - 34
- Select solenoid valve (FL)
: Between terminals 17 - 34

Standard value:

Control solenoid valve IN: 4.75 - 5.25 Ω

Control solenoid valve OUT: 2.0 - 2.4 Ω

Select solenoid valve: 3.5 - 3.9 Ω

WHEN THE BATTERY IS FLAT

If the engine is started using a booster cable when the battery is completely flat, and the vehicle is then driven without waiting for the battery to be recharged, the engine may misfire and it may not be possible to drive the vehicle. This is because the ABS consumes a large amount of current when carrying out its initial checks. If this happens, recharge the battery fully.

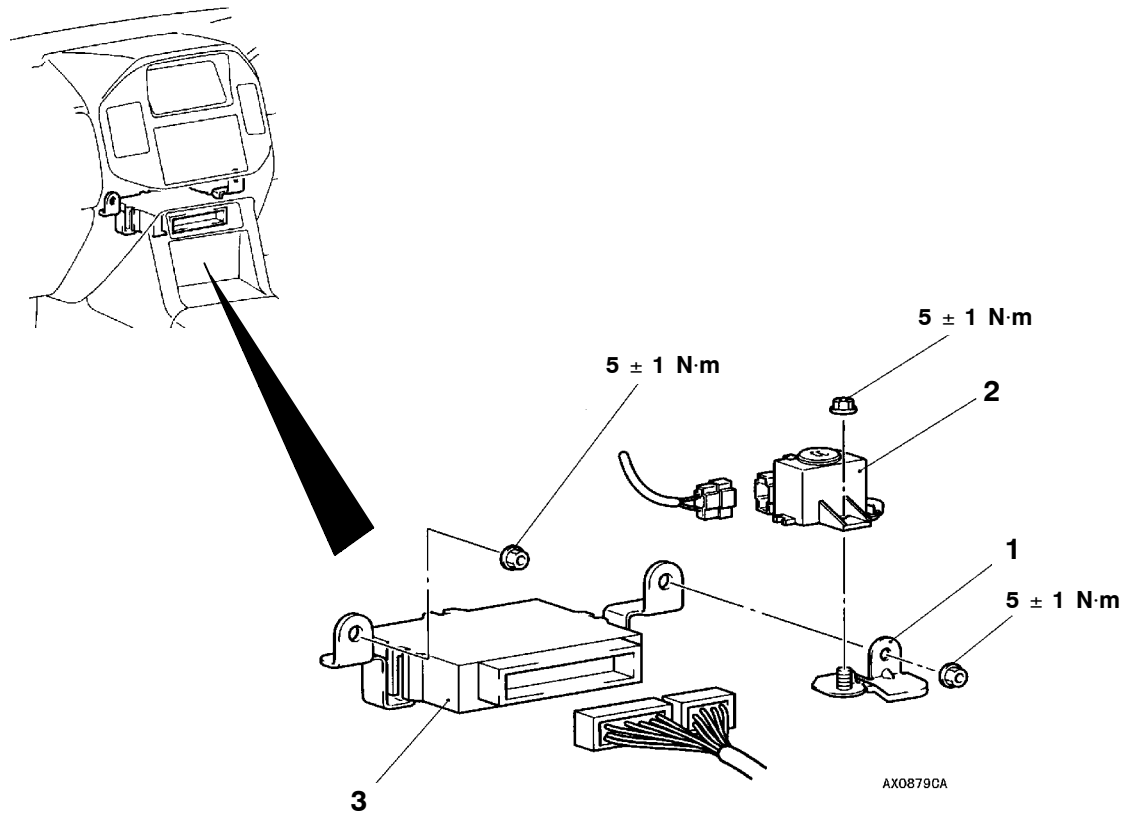
Caution

The vehicle posture will be unstable during braking, so do not drive the vehicle with the ABS-ECU connector disconnected or with the ABS not operating for any other reason.

ABS-ECU

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operations
Indicator panel and front panel removal and installation
(Refer to GROUP 52A - Floor Console.)



Removal steps

1. Buzzer bracket
2. Buzzer
3. ABS-ECU

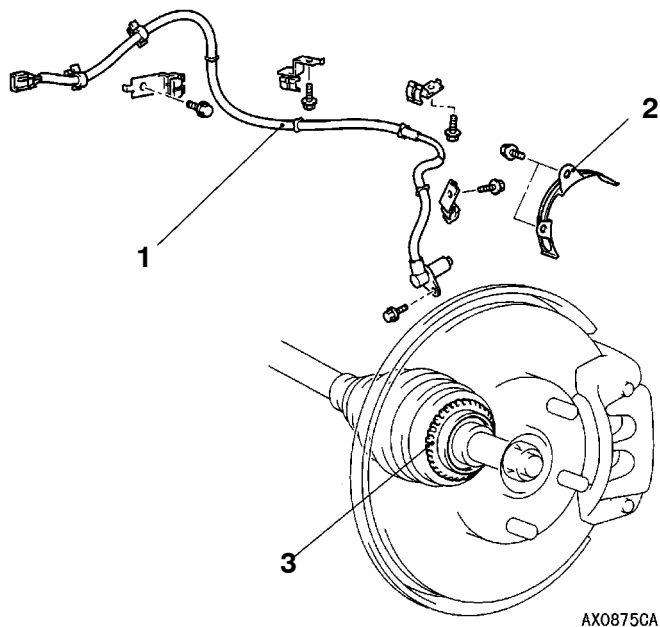
WHEEL SPEED SENSOR

REMOVAL AND INSTALLATION

Post-installation Operations

Wheel speed sensor output voltage measurement
(Refer to P.35B-27.)

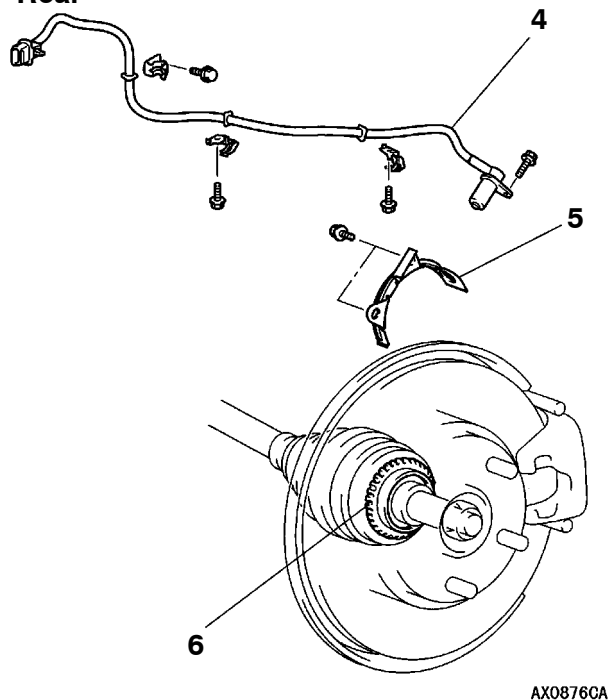
Front



Front wheel speed sensor removal steps

1. Front wheel speed sensors
2. Front ABS rotor protector
3. Front ABS rotor
(Refer to GROUP 26 - Drive Shaft.)

Rear

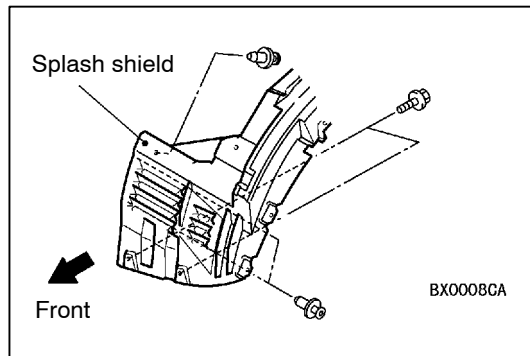


Rear wheel speed sensor removal steps

4. Rear wheel speed sensor
5. Rear ABS rotor protector
6. Rear ABS rotor
(Refer to GROUP 27 - Drive Shaft.)

NOTE

The front and rear ABS rotors are integrated with the drive shaft and cannot be disassembled.



REMOVAL SERVICE POINTS

◀A▶ FRONT WHEEL SPEED SENSOR REMOVAL

- (1) Remove the three splash shield clips and the two bolts shown in the illustration, and then disconnect the front wheel speed sensor connector.
- (2) Remove the front wheel speed sensor.

Caution

When removing the wheel speed sensor, be careful not to strike the pole piece at the end against the teeth of the ABS rotor or against any other nearby parts.

◀B▶ REAR WHEEL SPEED SENSOR REMOVAL

Caution

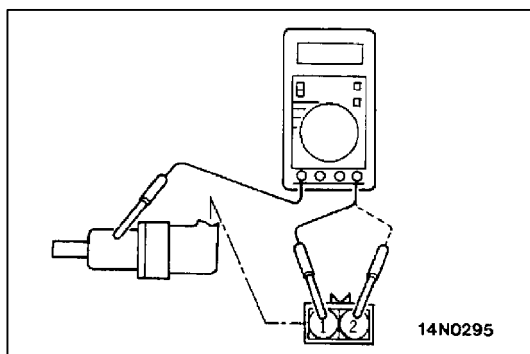
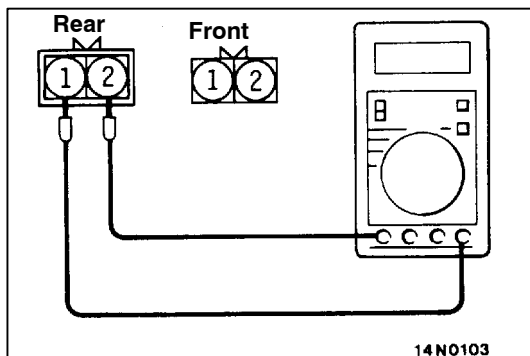
When removing the wheel speed sensor, be careful not to strike the pole piece at the end against the teeth of the ABS rotor or against any other nearby parts.

INSPECTION

WHEEL SPEED SENSOR TERMINAL RESISTANCE CHECK

Caution

The wheel speed sensors have magnets built into the sensors which magnetize the pole pieces. Because of this, care should be taken not to let metallic foreign particles get onto the pole pieces. In addition, if the poles become damaged, the sensors may not be able to detect the wheel speed correctly.



- (1) Measure the resistance between the wheel speed sensor terminals.

Standard value: 1.0 - 1.5 k Ω

If the internal wheel speed sensor resistance is outside the standard value range, replace the wheel speed sensor with a new one.

- (2) Check for open circuits in the wheel speed sensor cable. If a problem is found, replace the cable with a new one.

NOTE

When carrying out open circuit checks, remove the cable clamps from the vehicle, and flex the cable near the clamp locations to see if there are any transient open circuits. Also check the connection of the connector and that the terminals are inserted correctly.

WHEEL SPEED SENSOR INSULATION CHECK

- (1) After removing the wheel speed sensor, measure the insulation resistance between terminals (1) and (2) and the wheel speed sensor body.

Standard value: 100 k Ω or more

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

ABS ROTOR CHECK

Check that none of the ABS rotor teeth are chipped, broken or bent. If any damage is found, replace the ABS rotor with a new one.

G SENSOR

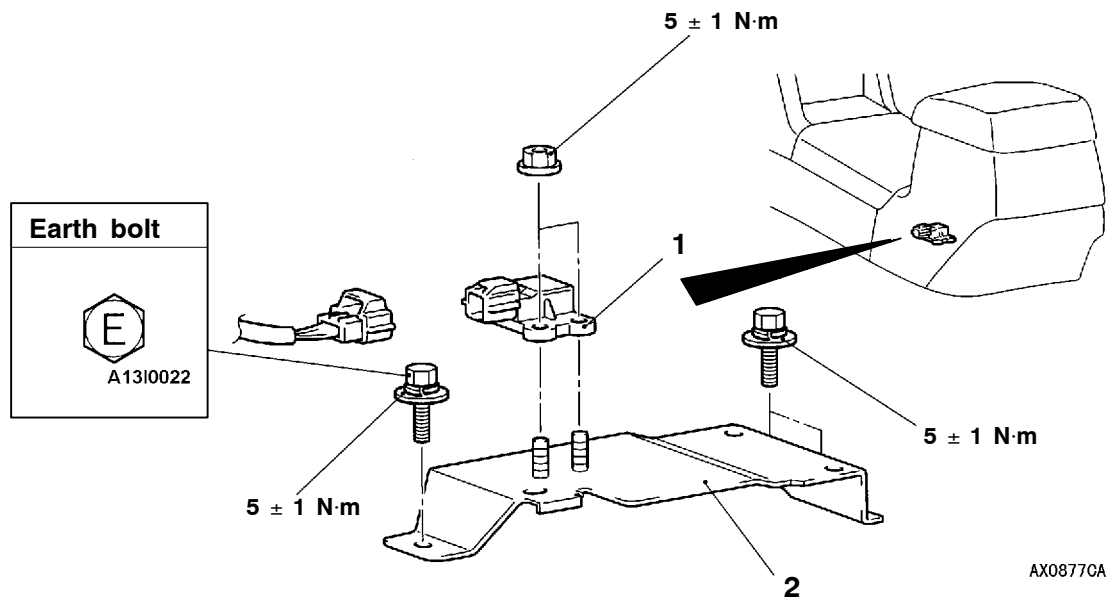
REMOVAL AND INSTALLATION

Caution

Do not drop the G sensor or subject it to any shocks.

Pre-removal and Post-installation Operations

Floor console removal and installation
(Refer to GROUP 52A.)



Removal steps

1. G sensor
2. G sensor bracket

ANTI-SKID BRAKING SYSTEM (ABS) <4WD>

CONTENTS

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Outline of Changes 2

TROUBLESHOOTING

<VEHICLES WITH M-ASTC> 2

ON-VEHICLE SERVICE

<VEHICLES WITH M-ASTC> 21

ABS Sensor Output Voltage Measurement 21

GENERAL

OUTLINE OF CHANGES

Due to the addition of MITSUBISHI Active Stability & Traction Control System (M-ASTC), the following service procedures have been established. Operation must be carried out in the same manner as before except for the items described below:

TROUBLESHOOTING <VEHICLES WITH M-ASTC>

DIAGNOSTIC FUNCTIONS

How to read diagnosis code:

Read the diagnostic codes using MUT-II .
(Refer to GROUP00 - How to Use Troubleshooting/Inspection Service Points.*)

NOTE:

- Connect MUT-II to the 16-pin diagnosis connector.
- *: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001 (1/2)].

How to erase diagnosis code:

Connect MUT-II to the diagnosis connector and erase the diagnosis code.

Caution

Connection and disconnection of MUT-II must be carried out after the ignition switch is turned to the LOCK (OFF) position.

NOTE:

Connect MUT-II to the 16-pin diagnosis connector.

INSPECTION CHART FOR DIAGNOSIS CODES

Diagnosis code No.	Item	Refer to Page
11	ABS sensor (FR) open circuit or short circuit	35B-5
12	ABS sensor (FL) open circuit or short circuit	35B-5
13	ABS sensor (RR) open circuit or short circuit	35B-5
14	ABS sensor (RL) open circuit or short circuit	35B-5
16*	Excessive decrease or increase in the power supply voltage of the M-ASTC-ECU	Refer to GROUP 35A
17	MITSUBISHI Active Stability Control Switch System	Refer to GROUP 35C
21	ABS sensor (FR) system	35B-5
22	ABS sensor (FL) system	35B-5
23	ABS sensor (RR) system	35B-5
24	ABS sensor (RL) system	35B-5
25	Defective tyre with different diameter	35B-6
31	Ignition switch (IG2) system	Refer to GROUP 35A
33	Stop lamp switch system	35B-6
34	CAN communication error	Refer to GROUP 35C
35	Engine system fault	Refer to GROUP 35C
36	Engine-ECU communication error	Refer to GROUP 35C
37	A/T system fault	Refer to GROUP 35C
38	A/T-ECU communication error	Refer to GROUP 35C
41	Control solenoid valve (FR) system	In the case of no response for solenoid valve drive signals corresponding to individual items: 35B-7 35B-7 35B-7 35B-7 35B-7
42	Control solenoid valve (FL) system	
43	Control solenoid valve (RR) system	
44	Control solenoid valve (RL) system	
45	Switch solenoid valve (SA1) system	
46	Switch solenoid valve (SA2) system	
47	Switch solenoid valve (SA3) system	Refer to GROUP 35C
48	Switch solenoid valve (STR) system	Refer to GROUP 35C
51	Valve relay ON defective	35B-8
52	Valve relay OFF defective	35B-9

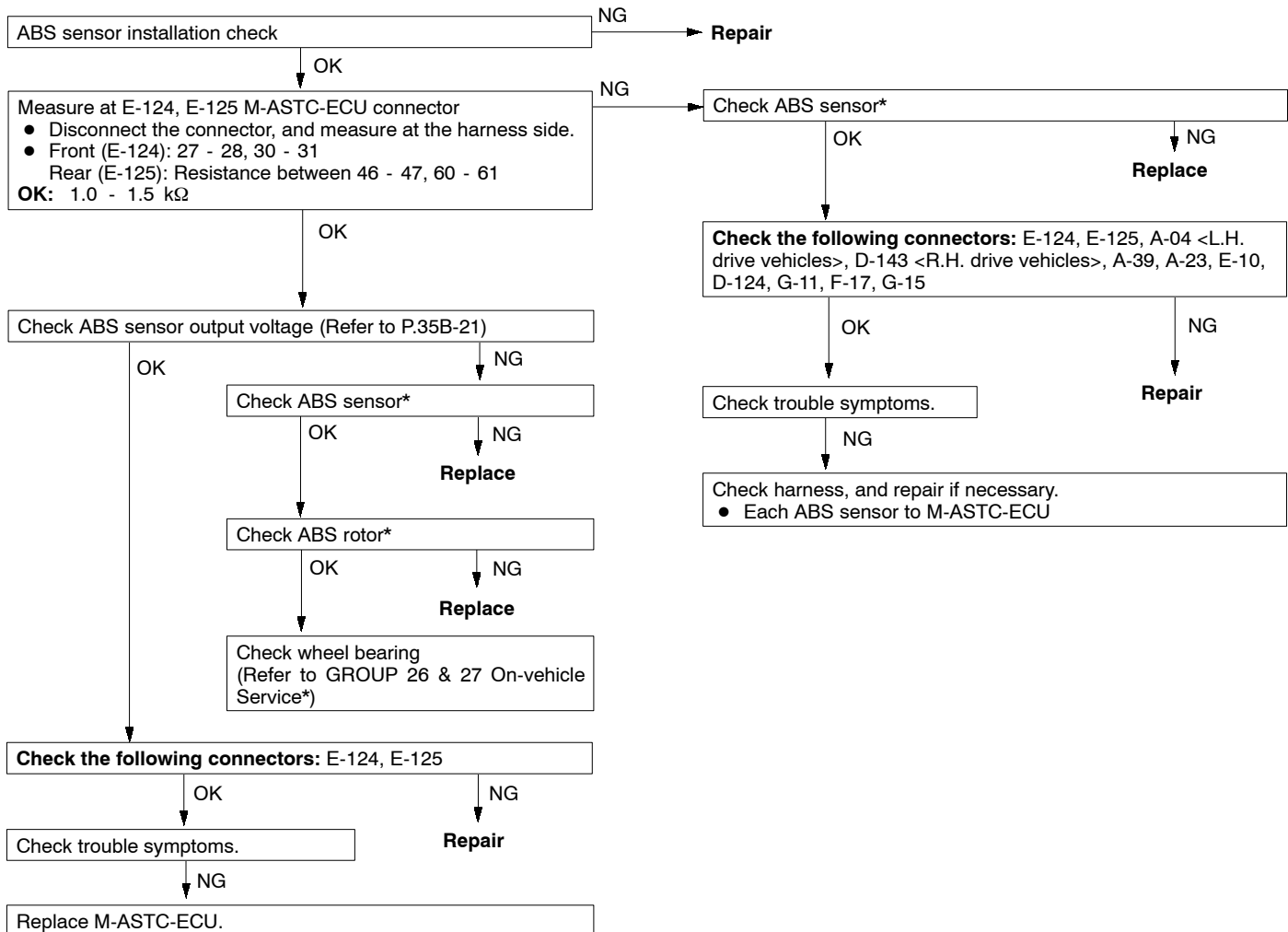
Diagnosis No.	code	Item	Refer to Page
53		Motor system	Refer to GROUP 35A
54		Motor relay system	Refer to GROUP 35A
55		Motor system	Refer to GROUP 35A
56		Pressure switch system	Refer to GROUP 35A
57		Accelerator pressure sensor system	Refer to GROUP 35A
58		Power supply drive circuit system	Replace ASTC-ECU (Refer to GROUP 35C)
61		Master cylinder pressure sensor system	35B-10
63		G sensor output error	Refer to GROUP 35C
64		G sensor clogging defect	Refer to GROUP 35C
65		G sensor self-diagnosis error	Refer to GROUP 35C
66		Steering wheel sensor self-diagnosis error	Refer to GROUP 35C
67		Steering wheel sensor communication line error	Refer to GROUP 35C
68		Steering wheel sensor output error	Refer to GROUP 35C
71		Yaw rate sensor self-diagnosis error	Refer to GROUP 35C
72		Yaw rate sensor 0-point error	Refer to GROUP 35C
73		Yaw rate sensor output error	Refer to GROUP 35C
74		G and Yaw rate sensor communication error	Refer to GROUP 35C
75		Transfer switch defect	Refer to GROUP 35C
76		G sensor error	Refer to GROUP 35C
77		Yaw rate sensor error	Refer to GROUP 35C
78		Engine-ECU inappropriately installed	Refer to GROUP 35C
81		G sensor initialization incomplete	Refer to GROUP 35C
82		Yaw rate sensor initialization incomplete	Refer to GROUP 35C
83		Steering wheel sensor initialization incomplete	Refer to GROUP 35C
84		Transfer switch initialization incomplete	Refer to GROUP 35C
85		Master cylinder pressure sensor initialization incomplete	Refer to GROUP 35C

NOTE

*: For Code No. 16, memory is erased if the system is returned to the normal status.

INSPECTION PROCEDURE FOR DIAGNOSTIC CODE

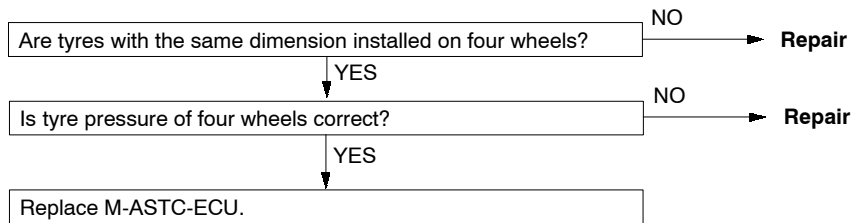
Code No. 11, 12, 13, 14 ABS sensor system (open or short circuit)	Probable cause
Code No. 21, 22, 23, 24 ABS sensor system	
Code No. 11, 12, 13 and 14 are output when open and short hardware circuit of M-ASTC-ECU is detected, and open or short circuit on the (+) or (-) line of either of 4 ABS sensors is detected.	<ul style="list-style-type: none"> • Malfunction of ABS sensor • Malfunction of harness or connector • Malfunction of the M-ASTC-ECU
Code No. 21, 22, 23 and 24 are output in the following cases: <ul style="list-style-type: none"> • When any open circuit is not detected, but either of 4 ABS sensors cannot be input even if the vehicle speed reaches over the specified speed (km/h). • When any ABS rotor gear is broken or clogged (one gear), and when anti-locking control continuously occurs by decrease of sensor output due to sensor defect and deformed rotor. 	<ul style="list-style-type: none"> • Malfunction of ABS sensor • Malfunction of harness or connector • Malfunction of ABS rotor • Extreme large gap between sensor and ABS rotor • Malfunction of the M-ASTC-ECU • Malfunction of wheel bearing



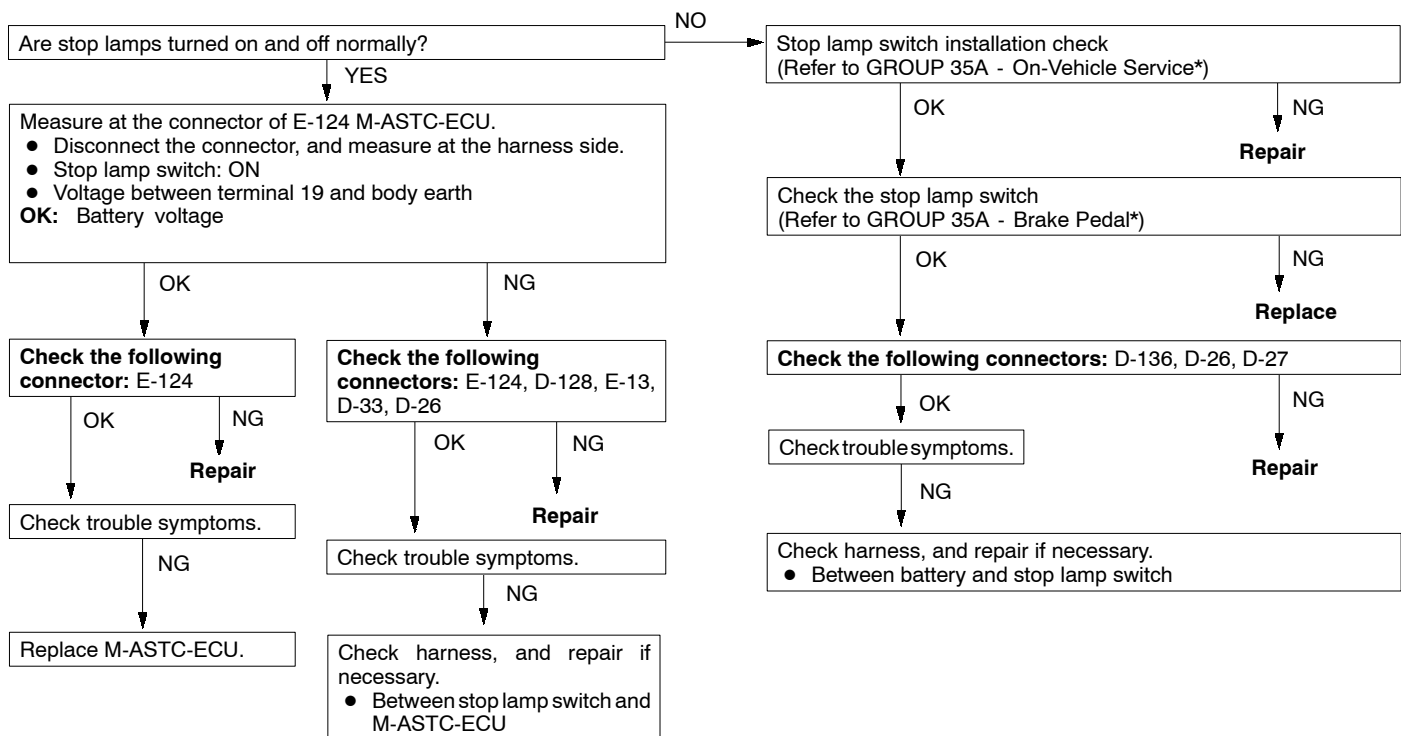
NOTE

*: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001(2/2)]

Code No. 25: Defect tyre with different diameter	Probable cause
With Code No. 11, 12, 13, 14, 21, 22, 23, or 24 not yet generated and the latest wheel running at the speed of over 30 km/h, this code is output when the value of either of ABS sensor output signals is 1.2 times larger than that of the latest wheel.	<ul style="list-style-type: none"> • Tyre pressure too large or small • Sizes of 4 tires not matched • Punctured tyre • Malfunction of the M-ASTC-ECU



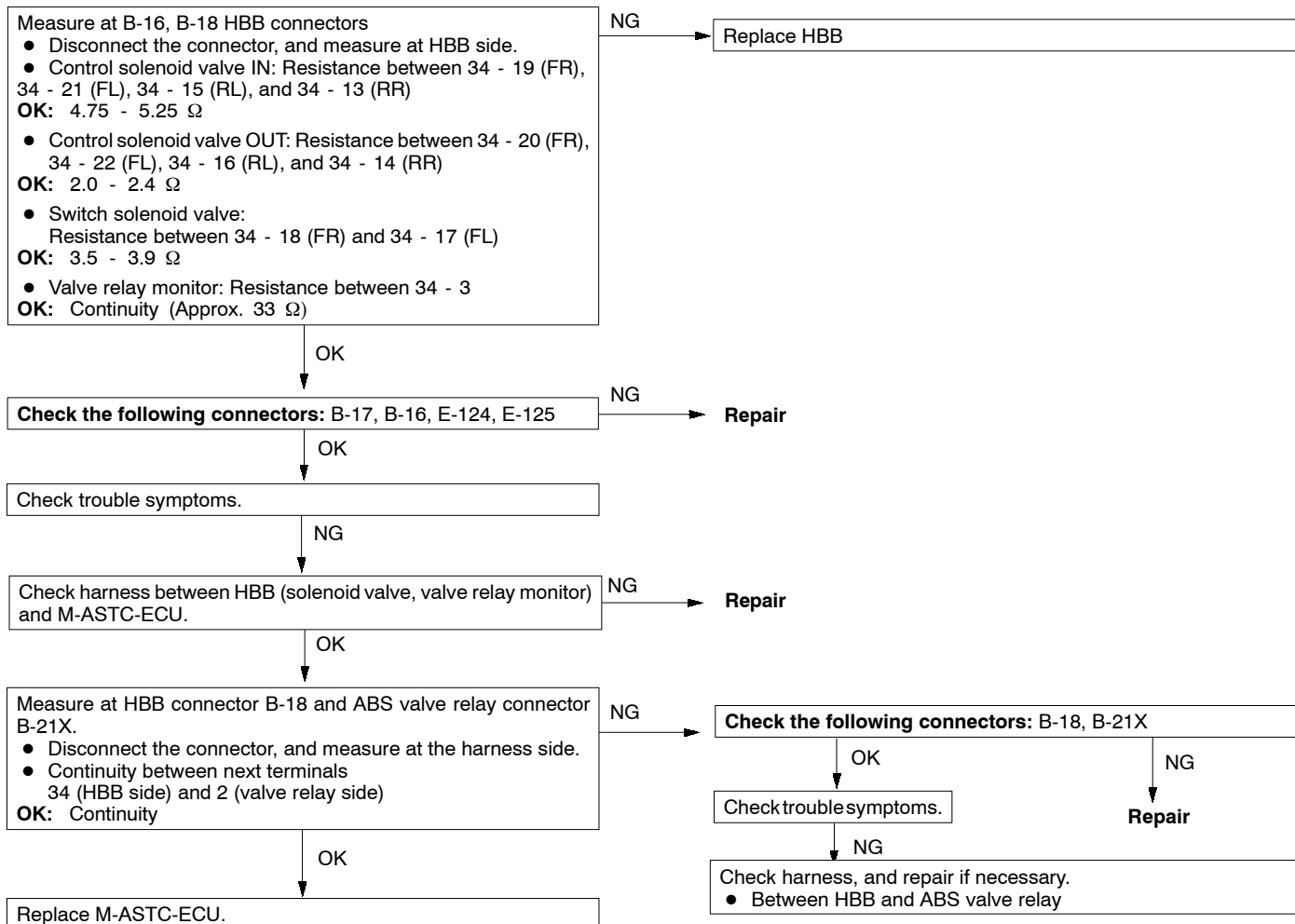
Code No. 33: Stop lamp switch system (defect by open circuit or always-ON)	Probable cause
This code is output in the following cases: <ul style="list-style-type: none"> • When stop lamp switch keeps ON for over 15 minutes on the road. • When harness is open on stop lamp switch input circuit. 	<ul style="list-style-type: none"> • Malfunction of stop lamp switch • Malfunction of harness or connector • Malfunction of the M-ASTC-ECU



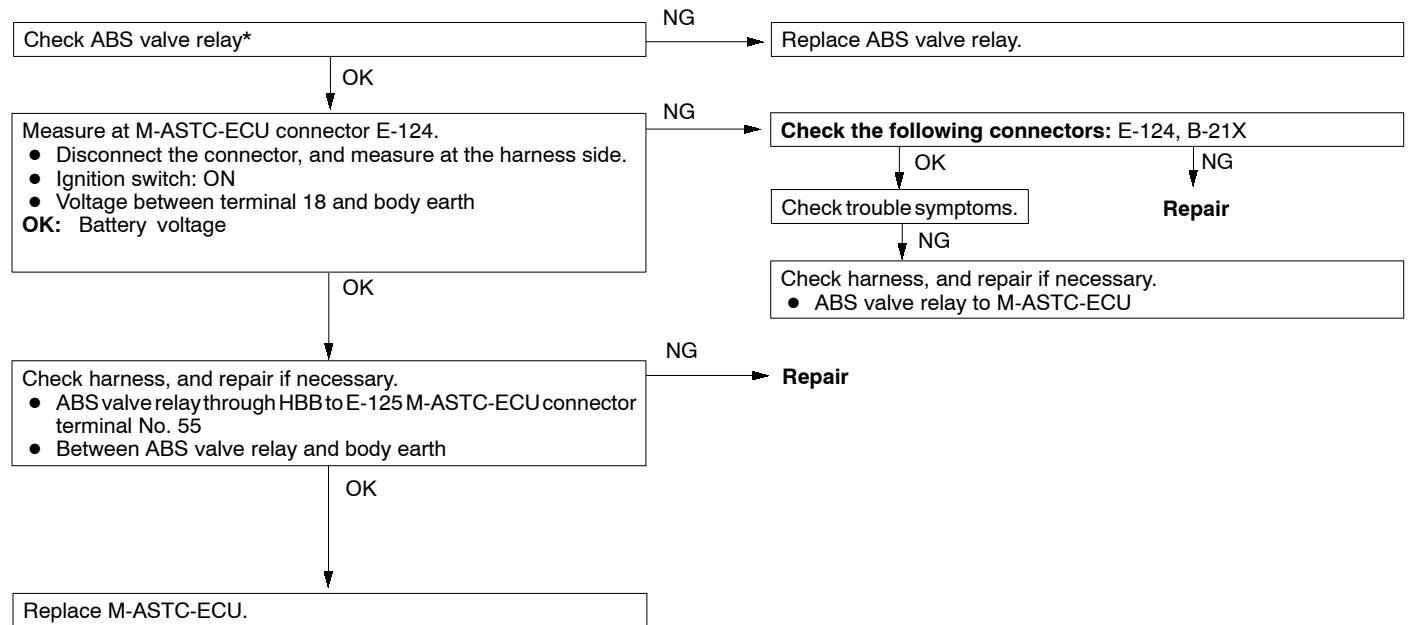
NOTE

*: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001(2/2)]

Code No. 41, 42, 43 or 44: Control solenoid valve system	Probable cause
Code No. 45 and 46: Switch solenoid valve system	
M-ASTC-ECU is always monitoring the solenoid valve drive circuit. This code is output by determination of open/short circuit on the solenoid coil or harness when the solenoid is not energized even if M-ASTC-ECU activates it, or the solenoid keep energized even if either of the ECU's switches it off.	<ul style="list-style-type: none"> ● Malfunction of harness or connector ● Malfunction of hydraulic brake booster (HBB) ● Malfunction of the M-ASTC-ECU

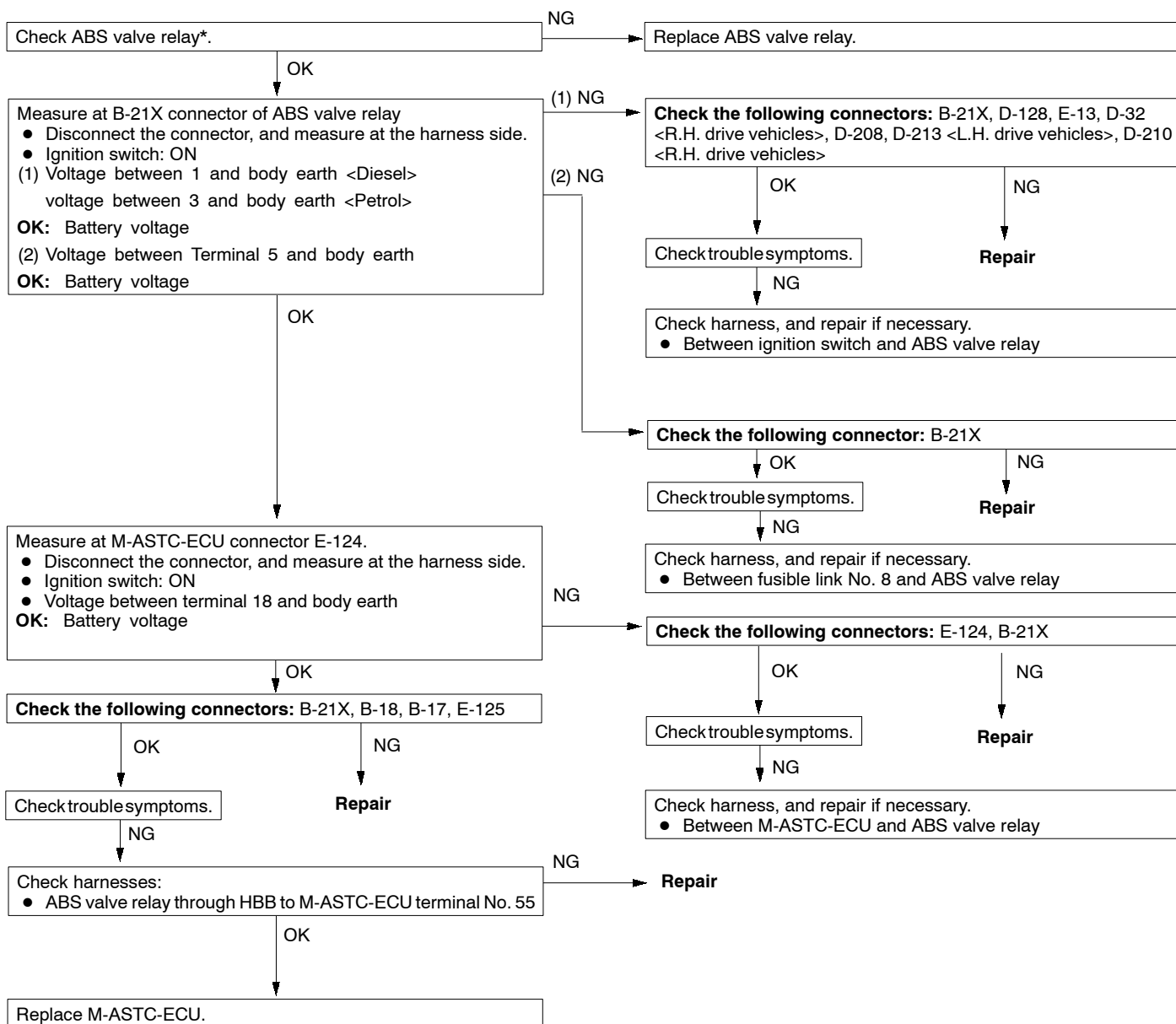


Code No. 51: Valve relay system (always-ON defect)	Probable cause
This code is output by determination of fused relay contacts or short relay drive circuit when the power is supplied to the solenoid valve even if the valve relay is deactivated in initial check with the ignition switch activated by M-ASTC-ECU.	<ul style="list-style-type: none"> ● Malfunction of harness or connector ● Malfunction of ABS valve relay ● Malfunction of the M-ASTC-ECU

**NOTE**

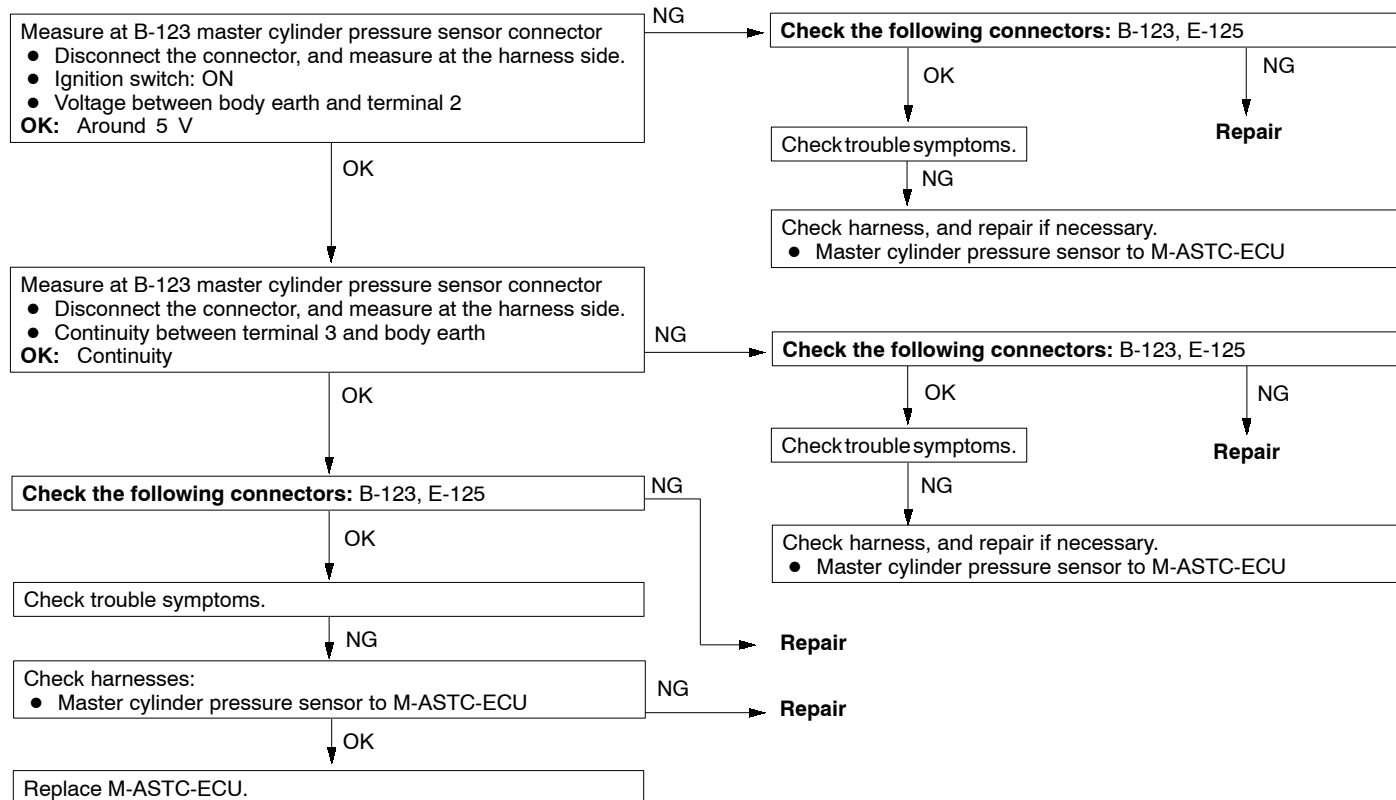
*: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001(2/2)]

Code No. 52: Valve relay system (always-OFF defect)	Probable cause
This code is output by determination of valve relay defect (always-OFF) when the power is not supplied to the solenoid valve even if M-ASTC-ECU activated the valve relay.	<ul style="list-style-type: none"> • Malfunction of harness or connector • Malfunction of ABS valve relay • Malfunction of the M-ASTC-ECU

**NOTE**

*: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001(2/2)]

Code No. 61: Master cylinder pressure sensor system	Probable cause
This code is output in the following cases: <ul style="list-style-type: none"> • When input voltage is too high or low • When output voltage is too high or low 	<ul style="list-style-type: none"> • Malfunction of harness or connector • Malfunction of master cylinder pressure sensor • Malfunction of the M-ASTC-ECU



INSPECTION CHART FOR TROUBLE SYMPTOMS

Trouble symptom	Inspection procedure No.	Reference page
MUT-II cannot communicate with other systems.	Refer to GROUP 13A.	
Communication between MUT-II and M-ASTC-ECU cannot be achieved.	1	35B-11
When the ignition switch is turned to ON position (with the engine not running), ABS warning lamp does not illuminate.	2	35B-12
The ABS warning lamp remains illuminated after the engine has started.	3	35B-12
After the engine is started, ABS warning lamp does not illuminate.	4	35B-13
When the ignition switch is turned to the "ON" position (with the engine not running), ABS warning lamp flashes twice. When the ignition switch is returned to the "ON" position (with the engine running) after further turning it to "START" position, ABS warning lamp flashes once.	5	35B-13
ABS malfunction	6	35B-14

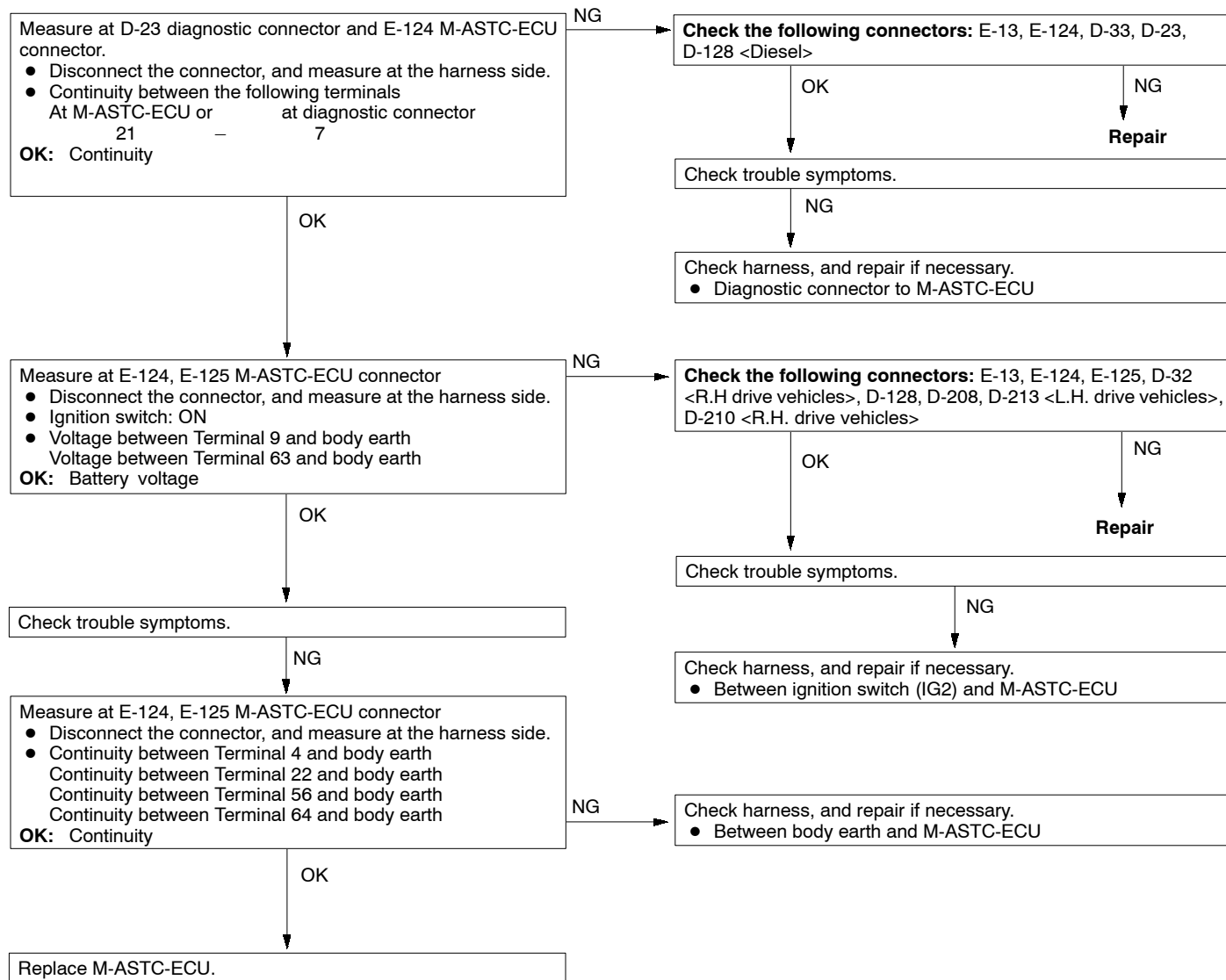
Caution

- (1) Other than in full braking, ABS system may operate on slippery roads, in fast cornering, or on bumpy roads. When asking your customer about the symptom, check whether ABS is triggered under these driving conditions or not.
- (2) When ABS system is triggered, brake pedal feel is varied (i.e. vibration is generated, and the brake pedal cannot be depressed). This is not a defect because the fluid pressure is continuously fluctuated in the brake lines to prevent wheel locking.

INSPECTION PROCEDURES FOR TROUBLE SYMPTOMS

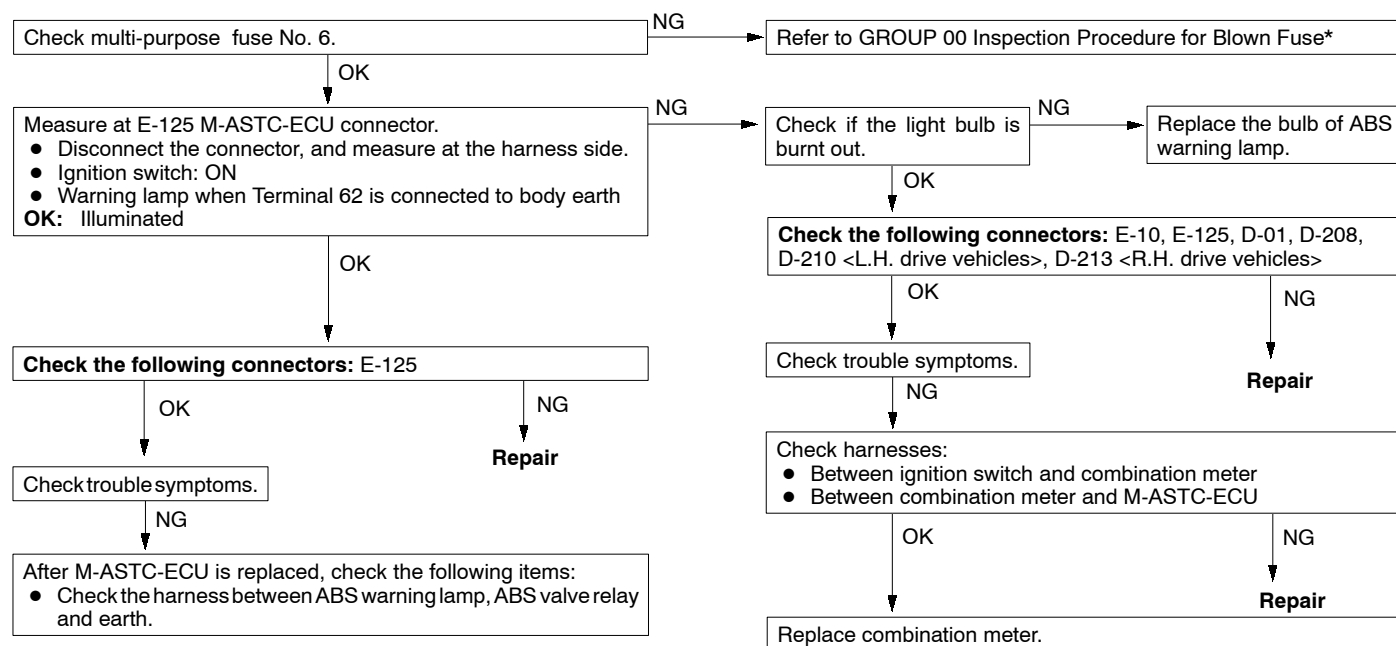
Inspection Procedure 1

Communication between MUT-II and M-ASTC-ECU cannot be achieved	Probable cause
M-ASTC-ECU power circuit open, or diagnosis output circuit open	<ul style="list-style-type: none"> ● Fuse blown out ● Malfunction of harness or connector ● Malfunction of the M-ASTC-ECU



Inspection Procedure 2

When the ignition switch is turned to ON position (with the engine not running), ABS warning lamp does not illuminate.	Probable cause
When M-ASTC-ECU is activated, it drives ABS valve relay from its OFF state to ON→OFF→ON for initial check. Therefore, when the lamp is not illuminated, lamp power circuit may be open, lamp bulb may be burnt out, or the circuit between ABS warning lamp and M-ASTC-ECU may be open.	<ul style="list-style-type: none"> ● Fuse blown out ● ABS warning lamp bulb burnt out ● Malfunction of ABS valve relay ● Malfunction of harness or connector ● Malfunction of combination meter ● Malfunction of the M-ASTC-ECU



NOTE

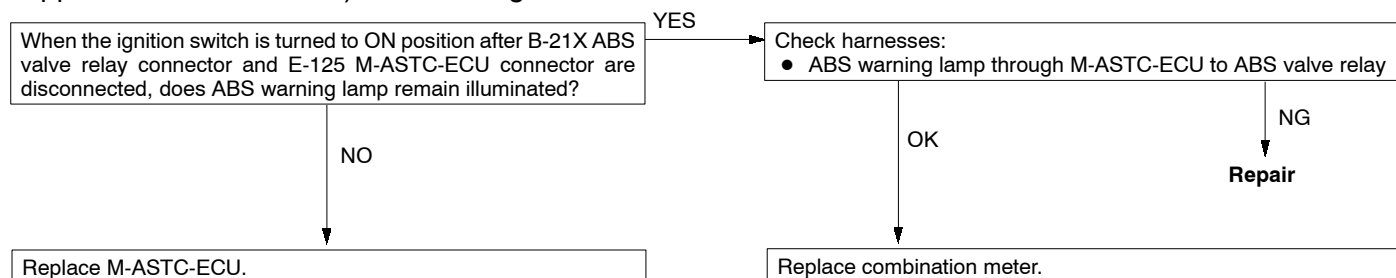
*: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001(1/2)]

Inspection Procedure 3

The ABS warning lamp remains illuminated after the engine has started.	Probable cause
ABS warning lamp ON circuit may be short.	<ul style="list-style-type: none"> ● Malfunction of combination meter ● Malfunction of harness (short-circuit) ● Malfunction of the M-ASTC-ECU

NOTE

This fault symptom occurs only when the system can be communicated with MUT-II (i.e. power appropriately supplied to M-ASTC-ECU) and the diagnostic code is correct.

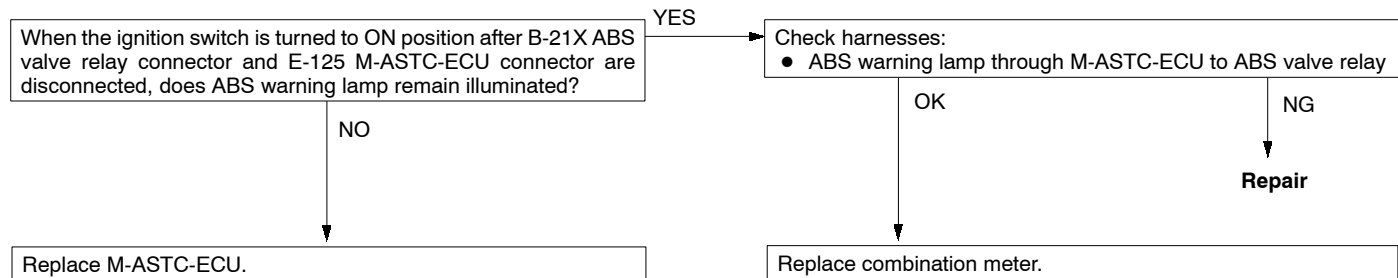


Inspection Procedure 4

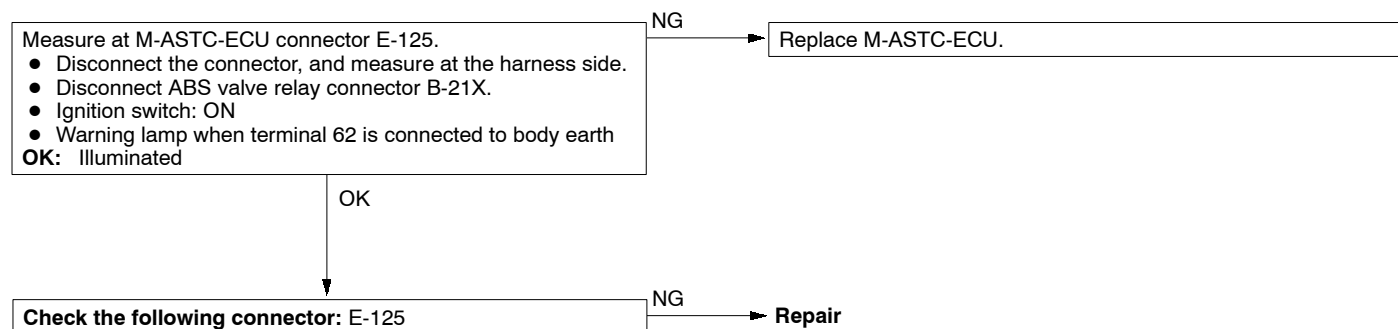
After the engine is started, ABS warning lamp does not illuminate.	Probable cause
ABS warning lamp ON circuit may be short	<ul style="list-style-type: none"> ● Malfunction of combination meter ● Malfunction of harness (short-circuit) ● Malfunction of the M-ASTC-ECU

NOTE:

This fault symptom occurs only when the system can be communicated with MUT-II (i.e. power appropriately supplied to M-ASTC-ECU) and the diagnostic code is correct.

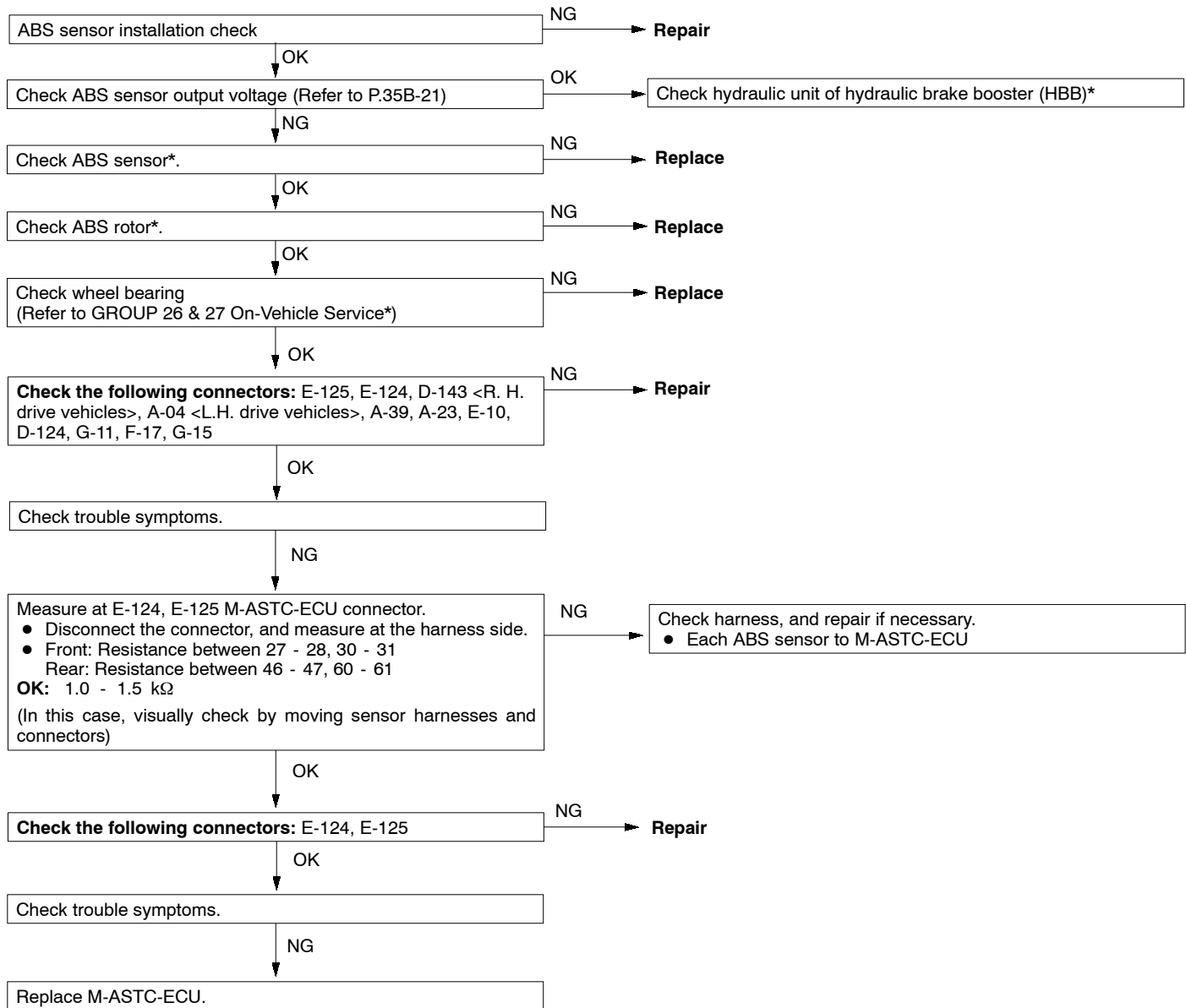
**Inspection Procedure 5**

When the ignition switch is turned to the “ON” position (with the engine not running), ABS warning lamp flashes twice. When the ignition switch is turned to the “ON” position (with the engine running) after further turning it to “START” position, ABS warning lamp flashes once.	Probable cause
M-ASTC-ECU illuminates ABS warning lamp during initial check for 3 seconds. It also drives the valve relay from its OFF state to ON→OFF→ON. In this fault symptom, ABS warning lamp is only illuminated when the valve relay is deactivated for valve relay inspection, which may lead to ABS warning lamp drive circuit malfunction of M-ASTC-ECU.	<ul style="list-style-type: none"> ● Malfunction of harness or connector ● Malfunction of the M-ASTC-ECU



Inspection Procedure 6

ABS malfunction	Probable cause
It is not easy to locate the trouble cause, depending on the driving conditions and road surfaces. If the diagnostic code indicates a normal code, perform the following inspections:	<ul style="list-style-type: none"> • ABS sensor not installed properly • Malfunction of harness or connector • Malfunction of ABS sensor • Malfunction of ABS rotor • Foreign object attached on speed sensor • Malfunction of wheel bearing • Malfunction of HBB • Malfunction of the M-ASTC-ECU



NOTE

*: Refer to 2001 PAJERO Workshop Manual [Pub. No. PWJE0001(2/2)]

DATA LIST REFERENCE TABLE

The following items from ECU input data can be read with MUT-II.

When the system normally operates:

Item no.	Check item	Inspection conditions		Normal condition
11	Front right wheel speed	Actually drive the vehicle		Indication of speedometer is almost matched with that of MUT-II
12	Front left wheel speed			
13	Rear right wheel speed			
14	Rear left wheel speed			
17	Engine Speed	Actually drive the vehicle		Indication of tachometer is almost matched with that of MUT-II
19	G sensor output voltage (Front & Rear)	Actually drive the vehicle		Indication varies between -14.7 and 14.7 m/s ²
20	G sensor output voltage (Left & Right, Diagonal)			
22	G sensor output voltage 1			
23	G sensor output voltage 2			
24	Master cylinder pressure sensor	Ignition switch: ON	Depress brake pedal gradually	The value of voltage rises to 0.5 V - 4.5 V
26	Transmission gear position	Actually drive the vehicle		Indication of shift lever position indicator is almost matched with that of MUT-II
27	Shift lever position	Actually drive the vehicle		Shift lever position is almost matched with indication of MUT-II
30	Transfer position	Actually drive the vehicle		Transfer shift lever position is almost matched with indication of MUT-II
31	Battery voltage	Ignition switch: ON		Display battery voltage
32	Steering wheel operation	Ignition switch: ON	Turn the steering wheel from the neutral position	Approximately the same value as turning angle of steering wheel is displayed
36	Stop lamp Switch	Ignition switch: ON	When depressing brake pedal	ON
			When releasing brake pedal	OFF
37	Active stability control switch	Ignition switch: ON	Active stability control switch neutral position	OFF
			Active stability control switch OFF position	ON

Item no.	Check item	Inspection conditions		Normal condition
38	Active stability control switch	Ignition switch: ON	Active stability control switch neutral position	OFF
			Active stability control switch ON position	ON
75	Accelerator pedal position switch	Ignition switch: ON	Depress accelerator pedal	ON
			Release accelerator pedal	OFF
76	Pressure switch (for low pressure warning)	With the pressure of pressure switch at 10.8 MPa or less		ON
77	Pressure switch (for pump control)	With the pressure of pressure switch at 16.1 MPa or less		ON
		With the pressure of pressure switch at 18.3 MPa or more		OFF
78	Valve relay	Valve relay activated		ON
		Valve relay deactivated		OFF
79	Motor relay	Motor relay activated		ON
		Motor relay deactivated		OFF

LIST OF ACTUATOR TESTS

By using MUT-II, the next actuator can be driven forcibly.

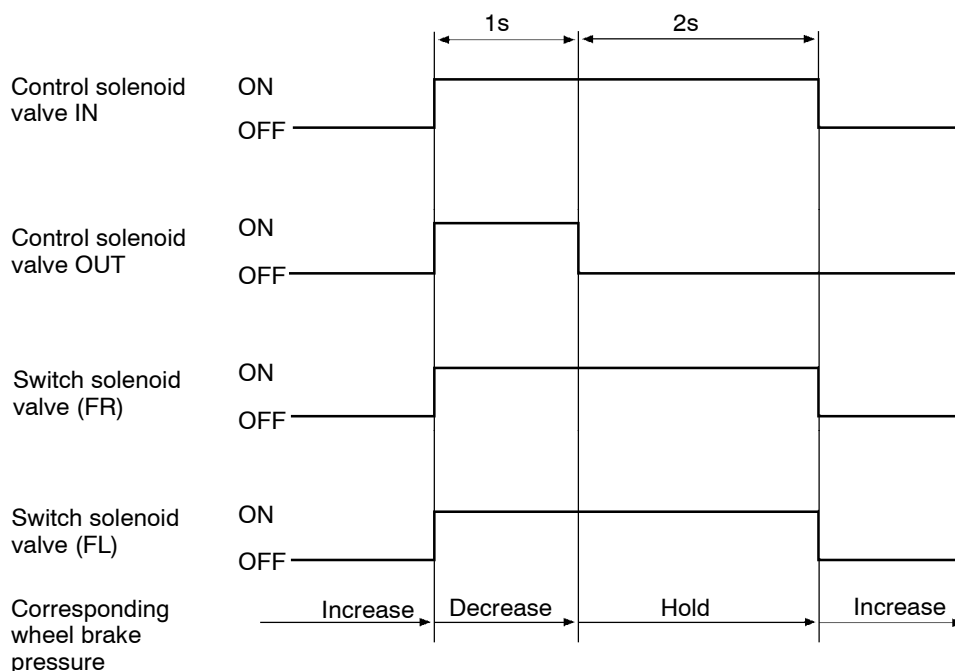
NOTE

1. When M-ASTC-ECU is deactivated by the fail safe function, the actuator test cannot be performed.
2. Actuator test can be performed only when the vehicle is stationed.

ACTUATOR TEST SPECIFICATIONS

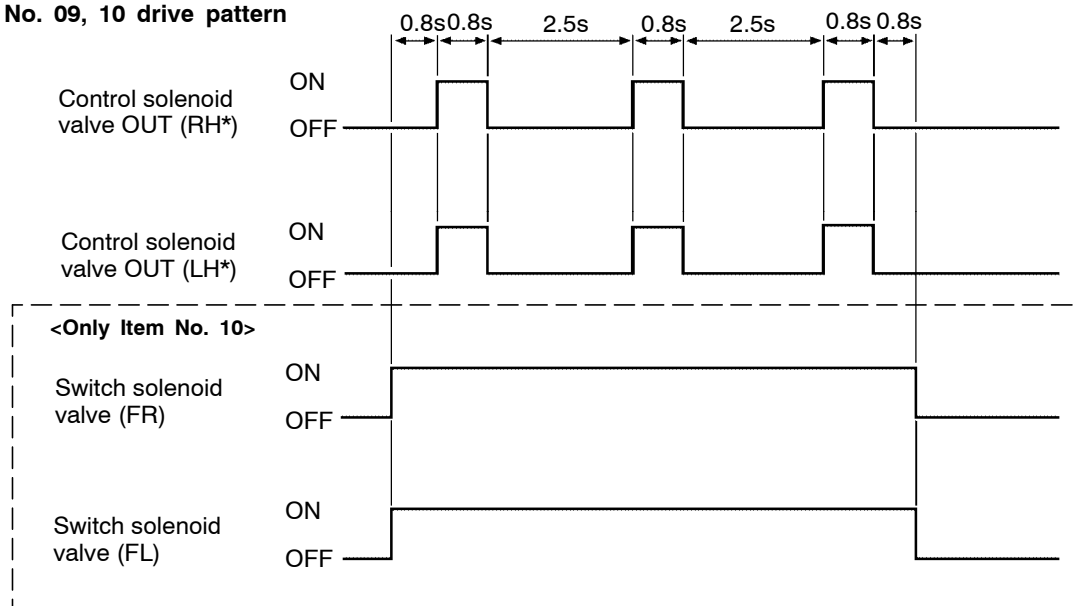
Item no.	Check Item	Drive content
01	Solenoid valve for front right wheel	Switch solenoid valve for HBB, and control solenoid valve corresponding to each channel
02	Solenoid valve for front left wheel	
03	Solenoid valve for rear right wheel	
04	Solenoid valve for rear left wheel	
09	Bleeding (1)	Switch solenoid valve for HBB, and control solenoid valve OUT (FR, FL)
10	Bleeding (2)	Control solenoid valve for HBB OUT (RR, RL)

Item No. 01 - 04 drive pattern



X1266CA

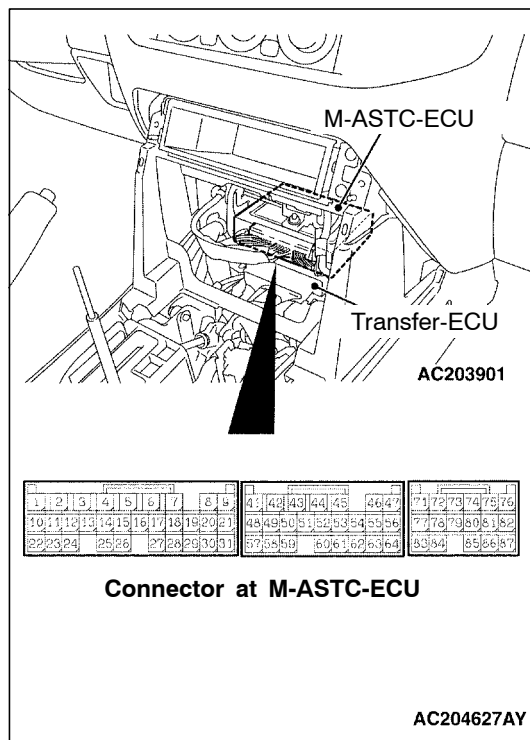
Item No. 09, 10 drive pattern



X1267CA

NOTE

*: Solenoid valves for front wheels are driven when Item No. 09 is driven, and solenoid valves for rear wheels are driven when Item No. 10 is driven.

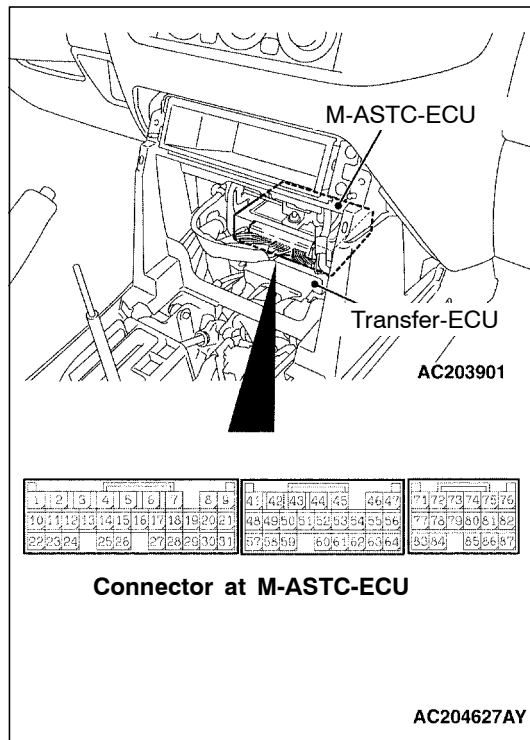
**CHECK AT M-ASTC-ECU TERMINAL****TERMINAL VOLTAGE TABLE****NOTE**

ECU's with the same profile are located at the upper and lower rear of the floor console. The upper ECU is M-ASTC-ECU, while the lower ECU is transfer-ECU.

1. Voltage is measured between individual terminals and earth terminals.
2. Individual terminals are arranged as shown in the figure.

Terminal No.	Check Item	Inspection Conditions		Normal Condition
1	Control solenoid valve OUT (RR)	Ignition switch: ON		Battery voltage
2	Control solenoid valve IN (RR)	Ignition switch: ON		Battery voltage
3	Control solenoid valve OUT (FL)	Ignition switch: ON		Battery voltage
5	Booster valve	Ignition switch: ON		Battery voltage
6	Cut-off valve	Ignition switch: ON		Battery voltage
7	Switch solenoid valve (FR)	Ignition switch: ON		Battery voltage
8	Switch solenoid valve (FL)	Ignition switch: ON		Battery voltage
10	Control solenoid valve IN (FL)	Ignition switch: ON		Battery voltage
19	Stop lamp switch input	Ignition switch: ON	Stop lamp switch: ON	Battery voltage
			Stop lamp switch: OFF	2 V or below
24	Power Supply of M-ASTC-ECU	Ignition switch: ON		Battery voltage
		Ignition switch: START		0 V
42	Control solenoid valve IN (FR)	Ignition switch: ON		Battery voltage
43	Control solenoid valve OUT (FR)	Ignition switch: ON		Battery voltage
44	Control solenoid valve IN (RL)	Ignition switch: ON		Battery voltage
45	Control solenoid valve OUT (RL)	Ignition switch: ON		Battery voltage
50	Pressure sensor power supply	Ignition switch: ON		Approx. 5 V
55	Valve relay monitor	Ignition switch: ON		Battery voltage
59	Pressure sensor	Ignition switch: ON		Approx. 0.14 - 4.85 V
62	ABS warning lamp output	Ignition switch: ON	With lamp OFF	Battery voltage
			With lamp ON	2 V or below

Terminal No.	Check Item	Inspection Conditions		Normal Condition
74	Active stability control system indicator/active traction control system indicator output	Ignition switch: ON	With active stability control switch OFF	Battery voltage
			With active stability control switch ON	2 V or below
75	2WD/4WD switch input	Ignition switch: ON	Transfer lever position: 2H, 4H	Battery voltage
			Transfer lever position: 4HLc, 4LLc	2 V or below
76	4LLc switch input	Ignition switch: ON	Transfer lever position: 4LLc	Battery voltage
			Transfer lever position: 2H, 4H, 4HLc	2 V or below
80	Center differential lock switch input	Ignition switch: ON	Transfer lever position: 2H, 4H	Battery voltage
			Transfer lever position: 4HLc, 4LLc	2 V or below
81	Brake warning lamp output	Ignition switch: ON	With lamp OFF	2 V or below
			With lamp ON	Battery voltage
86	2WD switch input	Ignition switch: ON	Transfer lever position: 2H	Battery voltage
			Transfer lever position: 4H, 4HLc, 4LLc	2 V or below
87	4H switch input	Ignition switch: ON	Transfer lever position: 2H, 4LLc	Battery voltage
			Transfer lever position: 4H, 4HLc	2 V or below



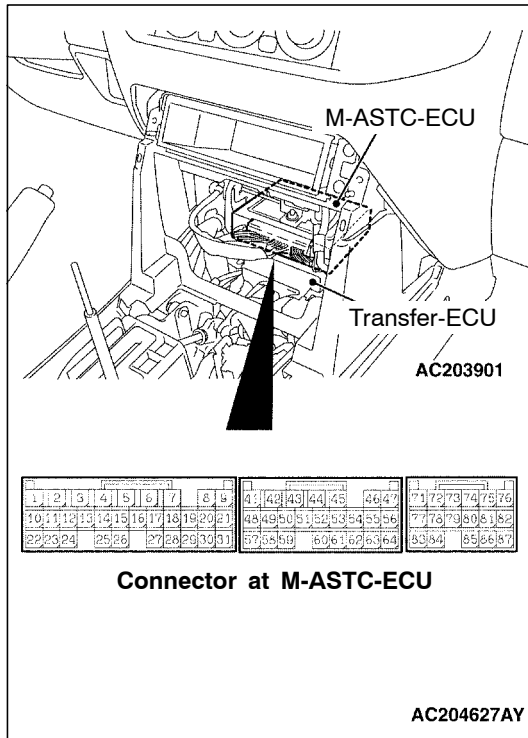
CHECK CHART FOR RESISTANCE AND CONTINUITY BETWEEN CONNECTOR TERMINALS AT HARNESS SIDE

NOTE

ECU's with the same profile are located at the upper and lower rear of the floor console. The upper ECU is M-ASTC-ECU, while the lower ECU is transfer-ECU.

1. Turn the ignition switch to the LOCK (OFF) position.
2. Resistance measurement and continuity inspection must be performed with M-ASTC-ECU connector disconnected.
3. Resistance measurement and continuity inspection is performed between the terminals shown in the following table.
4. Individual terminals are arranged as shown in the figure:

Terminal No.	Signal Name	Normal State
30 - 31	ABS sensor (FL)	1.0 - 1.5 kΩ
60 - 61	ABS sensor (RR)	
46 - 47	ABS sensor (RL)	
27 - 28	ABS sensor (FR)	
4 - body earth	Earth	Continuity
22 - body earth	Earth	
56 - body earth	Earth	
64 - body earth	Earth	



ON-VEHICLE SERVICE <VEHICLES WITH M-ASTC>

ABS SENSOR OUTPUT VOLTAGE MEASUREMENT

NOTE

ECU's with the same profile are located at the upper and lower rear of the floor console. The upper ECU is M-ASTC-ECU, while the lower ECU is transfer-ECU.

1. Lift up the vehicle and release the packing brake.
2. Disconnect connector of M-ASTC-ECU and measure voltage at harness connector.
3. Turn the wheel to be measured at the speed of about 1/2 - 1 turn/sec., and use multimeter (ACmV range) or oscilloscope to the output voltage.

Terminal No.

Front left	Front right	Rear left	Rear right
30	27	46	60
31	28	47	61

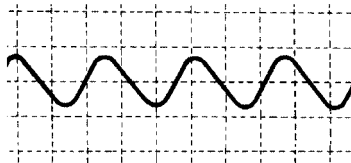
Output voltage:

For multimeter: 42 mV or more

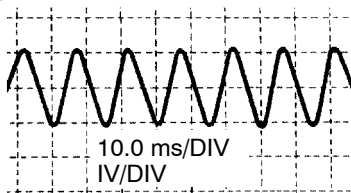
For oscilloscope: 120 mVP - P or more

4. When the output voltage is lower than the above value, check or replace ABS sensor due to the following possible causes:
 - Gap between ABS sensor ball piece and ABS rotor too large
 - Malfunction of ABS sensor

When rotated by hand



When engine is idling (5 - 6 km/h) D range



A14N0164

WAVE PATTERN INSPECTION USING AN OSCILLOSCOPE

Ensure that ABS sensor harness and connector are properly connected. Use oscilloscope to measure the waveform with each ABS sensor set to the following output voltage waveform. Start the engine, and move the transfer lever to 4H, and shift the gear selector to D range to rotate the wheels.

NOTE

1. You can measure the waveform by actually driving the vehicle.
2. Output voltage is decreased at lower wheel speed, while it is increased at higher wheel speed.

WAVE PATTERN OBSERVATION POINTS

Symptom	Cause	Remedy
Waveform amplitude is too small, or no amplitude	Malfunction of ABS sensor	Replace the sensor
Fluctuation of waveform amplitude too large (however, no problem with minimum amplitude of 120 mV or more)	Axle hub vibration too large or off center	Replace the axle hub
	M-ASTC-ECU not properly connected to body earth	Repair
Noise added to the waveform, or waveform fluctuated	Sensor open-circuit	Replace the sensor
	Harness open-circuit	Repair the harness
	ABS sensor not installed properly	Reinstall the sensor
	Gear of ABS rotor is broken or collapsed	Replace the ABS rotor

Caution

ABS sensor cable moves according to the motion of the front or rear suspension. Output voltage waveform of ABS sensor, therefore, should be also measured with the sensor harness oscillating.