Mando MGH-25 Anti-Lock Brake System
User's Manual

CONTENT

Common Abbreviations and Acronyms in This Manual

FL——*Front Left*

FR——*Front Right*

RL——*Rear Left*

RR——*Rear Right*

ABS——*Anti-lock Brake System*

EBD——*Electronic Brake Distribution*

ECU——*Electronic Control Unit*

HU、**HCU**——*Hydraulic (Control) Unit*

HECU——*ECU+HCU*

LPA——*Low Pressure Accumulator*

MCP——*Master Cylinder Primary, one of two outlet of master cylinder. P refers to primary.*

MCS——*Master Cylinder Secondary, one of two outlet of master cylinder. S refers to secondary*

SDL——*Serial Data Link*

I. Product Instruction

1. ABS Overview

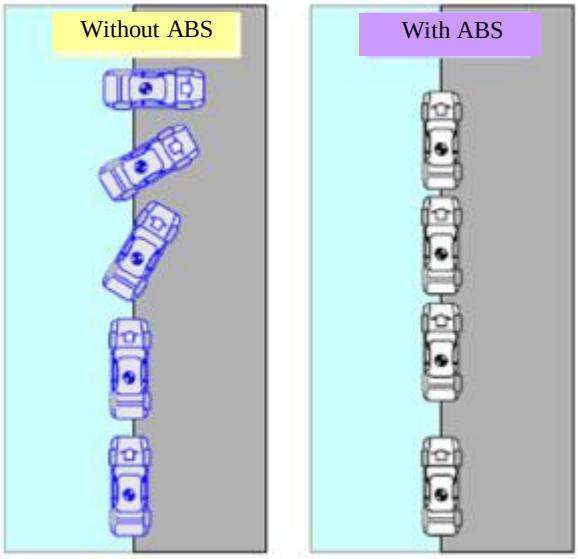
1.1 System Function

① Promotion of vehicle stability;

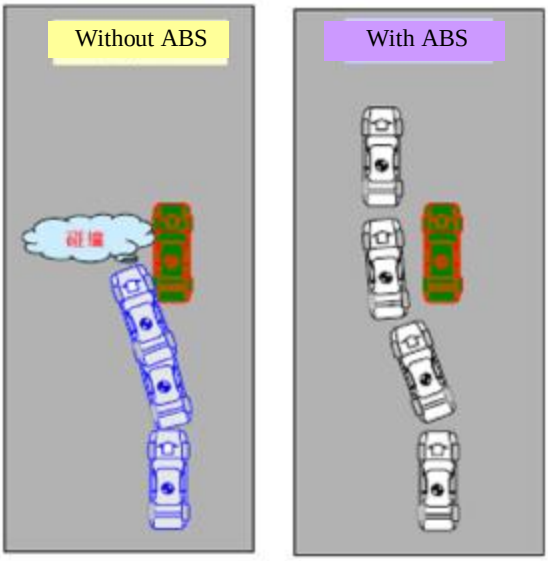
② Guarantee of vehicle steering ability;

③ Guarantee of shortest brake distance.

1.2 Comparison between with and without ABS braking effects

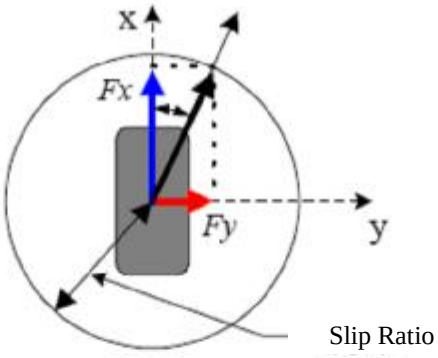


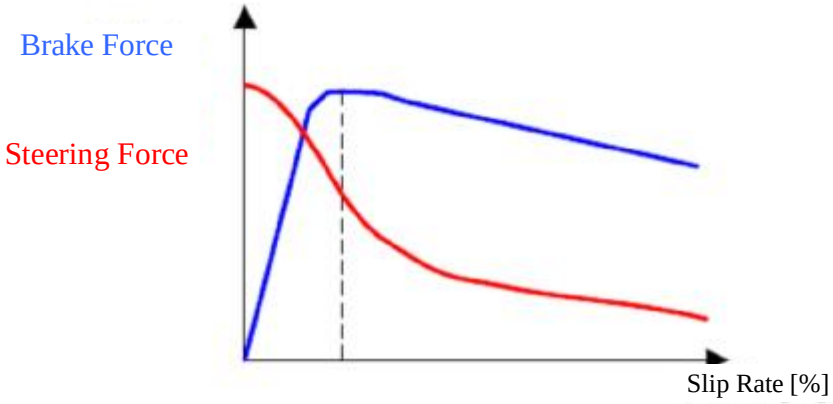
Braking on Bisectional Roads (Split)



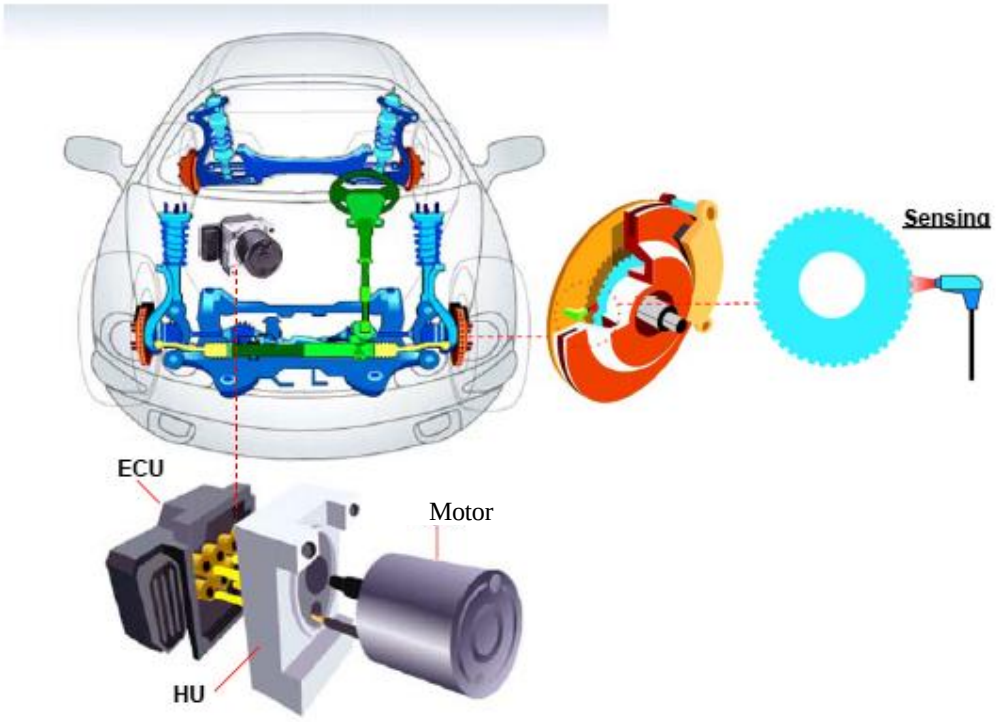
Evading the obstacles during braking

1.3 Tire Dynamic Characteristics





2. System Structure

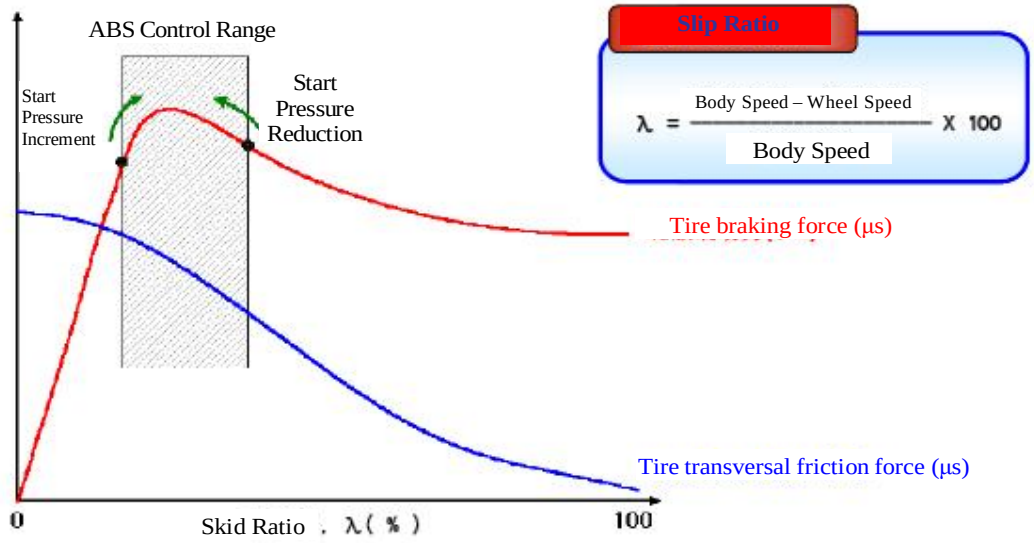


Including:

Electronic Control Unit	The sensor will calculate the speed and acceleration/deceleration of four wheels and judge the skid status of the wheels and therefore drive the electromagnetic valve and motor, control the pressure increment and pressure reduction, maintain the status, and etc.
Hydraulic Unit	The basic hydraulic circuit is comprised of the 1st circuit and the 2nd circuit that is active only when the ABS is functioning and is the integral part that controls the hydraulic parts transmitted to various wheels. Depending on the transmitted signal output of the sensor, the ECU performs the calculation and judges the skid status to determine if it's necessary to run the ABS. Therefore, depending on the control procedure of the ECU, the electromagnetic valve and the motor will be started to control the pressure increment and pressure reduction, maintain the status, and etc.
Sensor	In order to make the ECU to calculate the speed and acceleration/ deceleration of the four wheels, it always transmits the revolution measurement of the gear ring to the ECU.
Motor	When the ABS is functioning, the motor will rotate following the ECU signal and convert the rotation movement into linear reciprocated movement via the bearing to circulate the brake oil.

3. System Functioning Theory

3.1 ABS Control Theory



λ= 0%: The status that the brake is not functioning

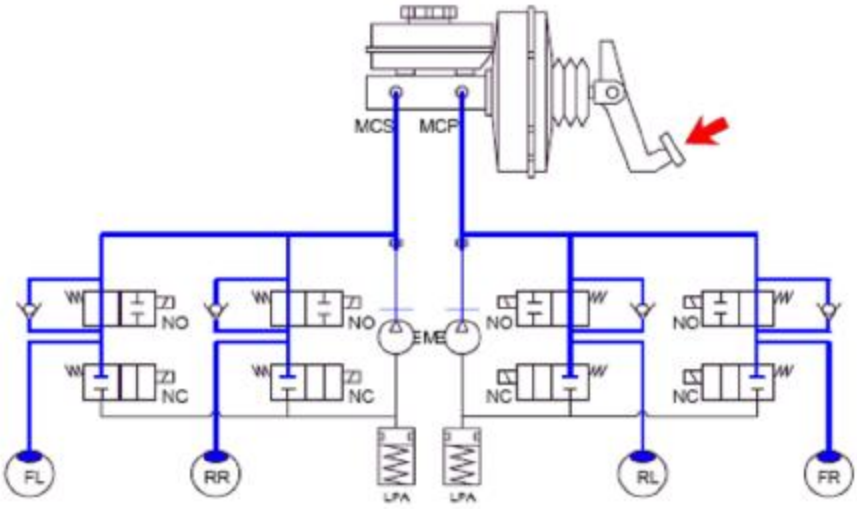
λ= 100%: The status that the wheels are locked

3.2 ABS Control Mode

① Functioning Status of General Brake

For the vehicles equipped with ABS, if the braking pressure applied onto the wheels is not enough to lock the wheels, the pressure generated by the general pump will transmit to the wheel branch pump via the normal open valve to obtain the braking effects. When it's unnecessary for further braking, the driver will reduce the pressure on the brake pedal and then the brake liquid of various wheels will return to the general pump to reduce the braking pressure.

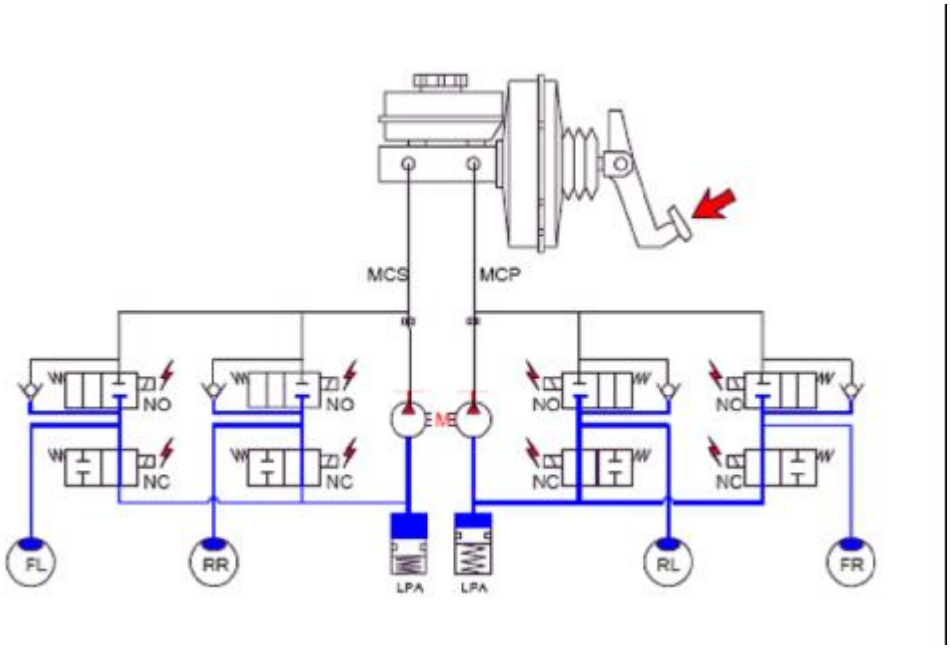
Solenoid Valve	Power Status	Solenoid Valve Status
Normal Open Valve (NO Valve)	OFF	Open
Normal Close Valve (NC Valve)	OFF	Close



② ABS Functioning (Pressure Reduction) Status

For the vehicles equipped with ABS, if the applied braking pressure is too big, the wheels will have rapider deceleration than that of vehicle body, which will be ready to result the lock of the wheels. Under such case, the ECU will transmit the code for wheel pressure reduction to the HCU, namely turn off the normal open valve and turn on the normal close valve to reduce the pressure of wheel branch pump. In such case, the brake oil released by the wheel branch pump is temporarily stored in the low pressure accumulator (LPA). The brake oil stored in the LPA will be sucked back to the general pump by the oil pump started following the rotation of the motor. The brake liquid will return to the high pressure accumulator (HPA) in the pipeline and reduce the high pressure pulse generated by the running of the oil pump by means of the orifice hydraulic resistance.

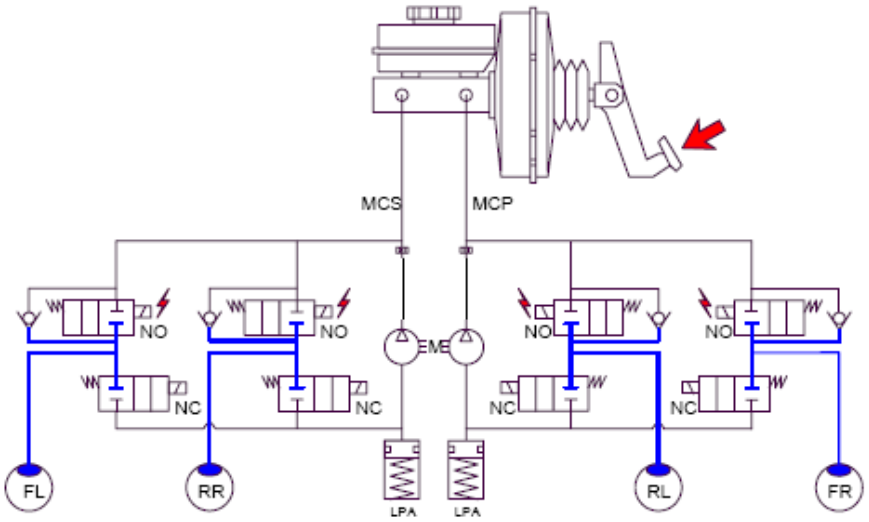
Solenoid Valve	Power Status	Solenoid Valve Status
Normal Open Valve (NO Valve)	ON	Close
Normal Close Valve (NC Valve)	ON	Open



③ ABS Functioning (Maintaining) Status

When the branch pumps of the wheels are applied with proper pressure via the pressure reduction or pressure increment, the normal open valve and the normal close valve will be turned off to maintain the pressure of the wheel branch pumps. For the operations mentioned in above ② ~ ④, depending on that wheels are locked or not, the ABS will function till the vehicle is fully stopped and therefore the safety and steering capability of the vehicle are guaranteed.

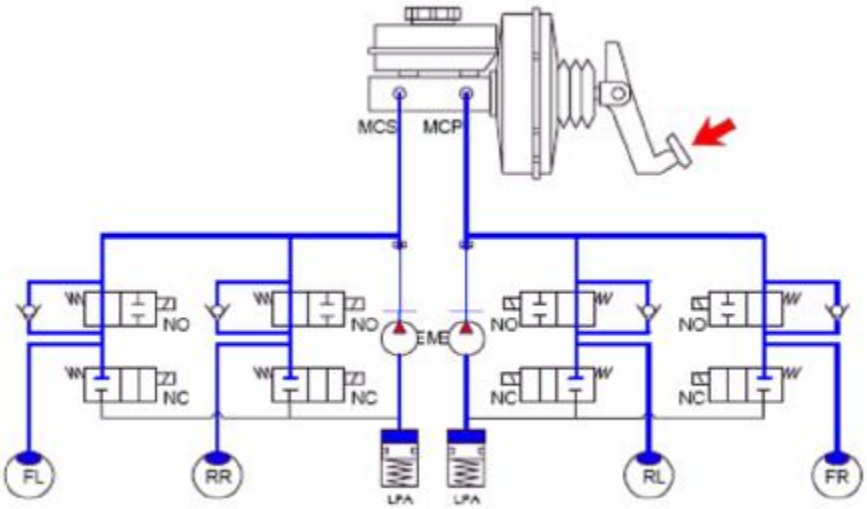
Solenoid Valve	Power Status	Solenoid Valve Status
Normal Open Valve (NO Valve)	ON	Close
Normal Close Valve (NC Valve)	OFF	Close



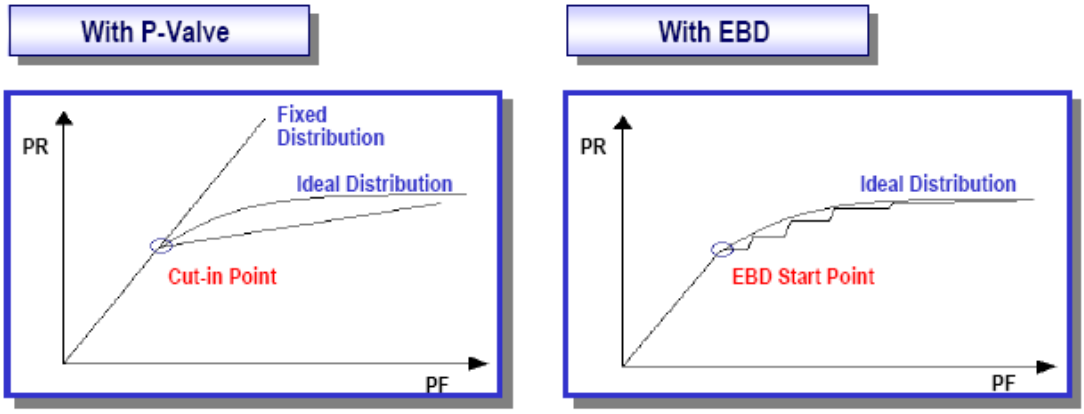
④ ABS Functioning (Pressure Increment) Status

During the implementation of the pressure reduction, if the excessive brake liquid is drained or the friction coefficient between the wheels and the road is increased, it's necessary to increase the pressure of various wheels. Under such case, the ECU will transmit the code for wheel pressure increment to the HCU, namely turn on the normal open valve and turn off the normal close valve to increase the pressure of wheel branch pump. During the implementation of the pressure reduction, the brake liquid stored in the low pressure accumulator (LPA) will continue to rotate the motor to drain the brake liquid under the pressure increment status. In such case, the brake liquid is supplied to branch pump of various wheels via the general pump and normal open valve. The brake liquid will return to the high pressure accumulator (HPA) in the pipeline and reduce the high pressure pulse generated by the running of the oil pump by means of the orifice hydraulic resistance.

Solenoid Valve	Power Status	Solenoid Valve Status
Normal Open Valve (NO Valve)	OFF	Open
Normal Close Valve (NC Valve)	OFF	Close



3.3 EBD Control Mode



In order to guarantee the operation stability, the EBD function is designed in such manner that front wheels are stopped ahead of the rear wheels. As the front brakes undertake more works than that of the rear brakes, it will cause that the rear wheels will be stopped firstly when apply with same braking pressure. In order to preventing the occurrence of above thing, a device to reduce the braking pressure applied on the rear wheels under certain pressure is required, of which this function is fulfilled by the pressure reducing valve (P-Valve). The special pressure reducing valve is not required for the vehicles equipped with ABS as the procedure supplemented to the ABS will fulfill the control function on the braking pressure of the rear wheels so as to effect the improvement of vehicle operation stability.

II. Removal and Installation

1. Spare Part Supply Status

① Differentiation between Dry Type HECU and Wet Type HECU

The biggest differentiation between the dry type HECU and wet type HECU is that the no air discharge is conducted in the 2nd circuit (namely the circuit from the normal close valve to the general pump) of the dry type HECU. Therefore, when the spare part is of wet type HECU, it's only necessary to conduct the air discharge and oil refill in accordance with the regular brake system after the replacement. When the spare part is of dry type HECU, besides that the air discharge and oil refill are required in accordance with the regular brake system after the replacement, it's necessary to conduct the air discharge and oil refill to the 2nd circuit of the HECU. In addition, for the appearance, the wet type HECU has the bolts for sealing purpose and the dry type HECU has the protection film. The product label located on the motor is marked with the part number of the products, through which the dry type HECU and wet type HECU can be differentiated.

Take the S21 model for instance, the dry type Mando product number is BH601-086-00 and the wet type Mando product number is BH602-386-00.

Dry Type

Wet Type

② Notices

If the bolts on the wet type HECU are fallen off (such as during the transportation), besides that the air discharge and oil refill must be conducted for 1st circuit, maybe it's necessary to conduct the air discharge and oil refill to the 2nd circuit.

2. Notices for Removal and Installation

① Notices for HECU Assembling

During the assembling of brake pipeline:

- † Remove the protection film attached onto the HECU before the operation.
- † Confirm the pipeline of general pump and wheel branch pump before the operation.

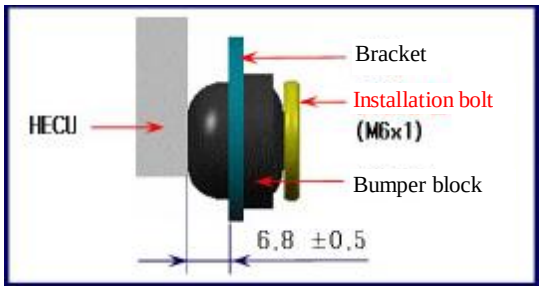
  (General pump: MCP, MCS Wheel branch pump: FR, FL, RR, RL)
- † Confirm if the brake hose is tightened to 120~160 kgf·cm with special tool or torque wrench.
- † Notice to keep away the impurity ingress into the HECU hole and brake hose during operation.

② Notices for HECU Bracket Assembling

During the assembling of HECU bracket:

† During the tightening of the bolt (3 pcs), it may cause the incorrect assembling due to the friction resistance of the cushion pad. It's preferable to use the lubricating oil with the physical properties that will not impair the cushion pad.

† Insert the bolts (3 pcs) onto the cushion pad installed onto the bracket before install to the HECU, which will help the operation.



† Confirm if the bolts (3 pcs) are tightened to 80~100 kgf·cm with special tool or torque wrench.

③ Notices for Installation of HECU and Bracket Assembly

During the installation to vehicle body:

† Attach the components of brake hose and bracket to the HECU and install to the vehicle body with the body fixing bolts.

† Confirm if the body fixing bolts are tightened to 190~260 kgf·cm with special tool or torque wrench.

† Again confirm if the pipeline installation of general pump and wheel branch pump is correct.

(General pump: MCP, MCS; Wheel branch pump: FR, FL, RR, RL)

† Tighten the brake hose not fully tightened to the specified torque (120 ~ 160 kgf·cm) with special tool or torque wrench.

④ Other Notices

† Find out the trouble cause with diagnosis instrument before repair.

† The package of the spare parts should be unwrapped only before the installation.

† Only use the parts supplied by the original manufacturer.

† Notice the cleanliness during removal and only use the non-fuzz cloth for cleaning.

† Use the detergent not containing the mineral oil to clean the appearance before removal.

† Do not use the compressed air or move the vehicle when the system is opened.

† After the removal of the ABS assembly, plug various hydraulic outlets with plugs as soon as possible.

† Remove other components interfering the operation.

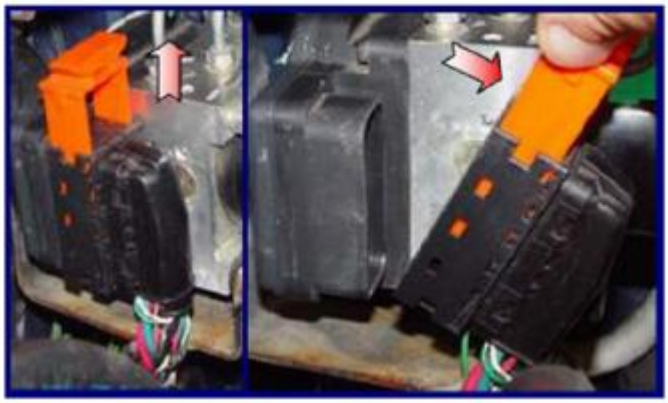
† Use DOT#3 brake liquid.

† Immerse the seals with brake liquid, instead of engine oil or braking ointment.

† Check all hydraulic connectors for leakage.

3. HECU Replacement

① When the vehicle is stopped, remove the 25-pin connector and harness wiring of the HECU located within the engine compartment.



25-Pin Connector Used in MGH-25 ABS

(P/No：AMP 368482-1)

② Screw off in counter clockwise direction the 6 bolts (M10x1.0) connected to the HECU brake hose with 11mm tool (wrench) (rotate in clockwise direction during refit). The tightening torque for the brake hose is 120 ~ 160 kgf·cm.

③ Screw off in counter clockwise direction the 3 bolts or nuts connected to the bracket with 12mm tool (wrench) (rotate in clockwise direction during refit). The tightening torque for the fixing bolts or nuts of the bracket is 190 ~ 260 kgf·cm.

④ After the removal of the product, screw off in counter clockwise direction the 3 embedded bolts (M6x1.0) attached to the HECU with 5mm tool (hex wrench) (see the figure in next page).

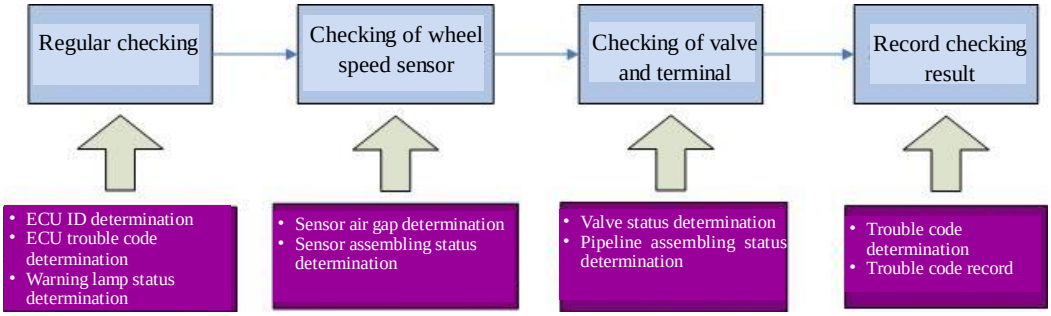
⑤ Screw off in counter clockwise direction the 6 bolts from the after-service HECU with 6mm tool (hex wrench).

⑥ Screw on in clockwise direction 3 embedded bolts to assemble the after-service HECU and the bracket with 5mm tool (hex wrench). The tightening torque for the embedded bolts is 80 ~ 100 kgf·cm.

⑦ With reference to above item ①~ ③, install the replacement after-service HECU to the vehicle in reverse order.

III. Trouble Diagnosis and Troubleshooting

1. Checking Sequence



2. Trouble Diagnosis and Troubleshooting of MGH-25 ABS

2.1 Checking of ABS and EBD Warning Lamp

Check if the ABS and EBD warning lamps are illuminated in accordance with following:

① Rotate the vehicle key to turn on the power. The ABS warning lamp will illuminate and then go off in 3s.

② It indicates the trouble if the status mentioned in ① is not present and it's necessary to check the trouble code with reference to the trouble code checklist.

③ If the warning lamps are completely not illuminated, please refer to the trouble checklist without trouble code.

2.2 Table for Common Troubles

Position	Cause	Structure	Warning lamp	
			ABS	**EBD**
Vehicle harness	Incorrect assembling of brake hose	Locked wheels and brake off-tracking	Off	Off
	Brake oil leakage	Poor start of ABS and EBD		
	Incorrect wiring installation	Brake failure		
	Air discharge trouble	Deteriorated ABS performance		
Motor	Motor trouble	ABS start failure	On	Off
ECU	Trouble of ECU power line	Start failure of ABS and EBD	On	On
	Trouble of valve power line	Start failure of ABS and EBD		
	Poor grounding of ECU	Start failure of ABS and EBD		
	ECU trouble	Start failure of ABS and EBD		
	Trouble of motor wire line	ABS start failure	On	Off
Speed sensor	Sensor open-circuit/short-circuit	In event of whichever trouble: ABS start failure	On	Off
		In event of both troubles: Start failure of ABS/EBD	On	On
	Gear ring trouble, sensor interference trouble, air gap trouble	In event of whichever trouble: Incorrect start of ABS	On	Off
		In event of both troubles: Start failure of ABS/EBD	On	On

2.3 Trouble Code Readout and Deletion without Trouble Diagnosis Instrument

① Purpose and condition of trouble code readout without trouble diagnosis instrument

If without the trouble diagnosis instrument, it may display the trouble status of the ABS via the ABS warning lamp and read out the trouble code to facilitate the trouble determination and troubleshooting. In such case, the trouble code will be displayed in 2-digit number. Please refer to the numbers in parentheses in the trouble checklist of trouble code in succeeding section 2.4.

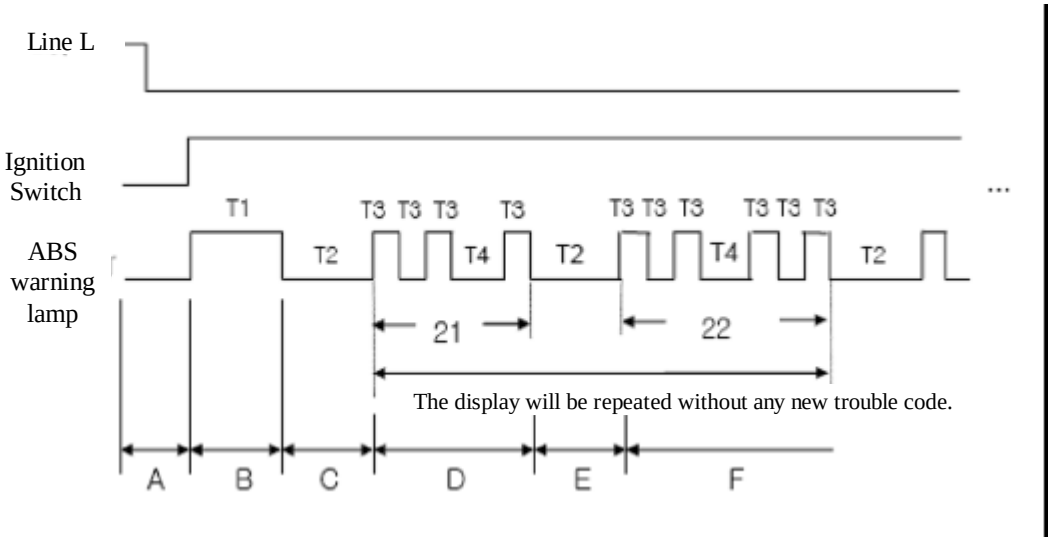
The service conditions are as follows:

† Vehicle speed below 2km/h;
† Without connection of trouble diagnosis instrument;
† The line L (namely the pin 7 of interior diagnosis socket) should be always grounded during the diagnosis process.

In addition, at finish of the trouble code readout, restore the ECU status of the ABS to the normal mode (previously, it's the diagnosis status), of which the method is as follows: At finish of the diagnosis operation, disconnect the grounding status of the line L, rotate the key to power off status, and then re-connect.

② Readout method of trouble code without trouble diagnosis instrument

Read out the trouble code in accordance with following procedure when the service conditions for trouble code readout without trouble diagnosis instrument are met:



The steps in above figure are respectively:

A. Rotate the vehicle key to power on position after the line L is grounded;

B. When the ABS warning lamp illuminates and lasts for 3s, it indicates the start of diagnosis;

C. When the ABS warning lamp is off for 3s, it indicates that it enters into the trouble code display phase;

D. Trouble code display and readout;

E. When the ABS warning lamp is off for 3s, it indicates that it enters into next trouble display phase or circulated display phase;

F. The display and readout of new trouble code and the circulated display of last trouble code.

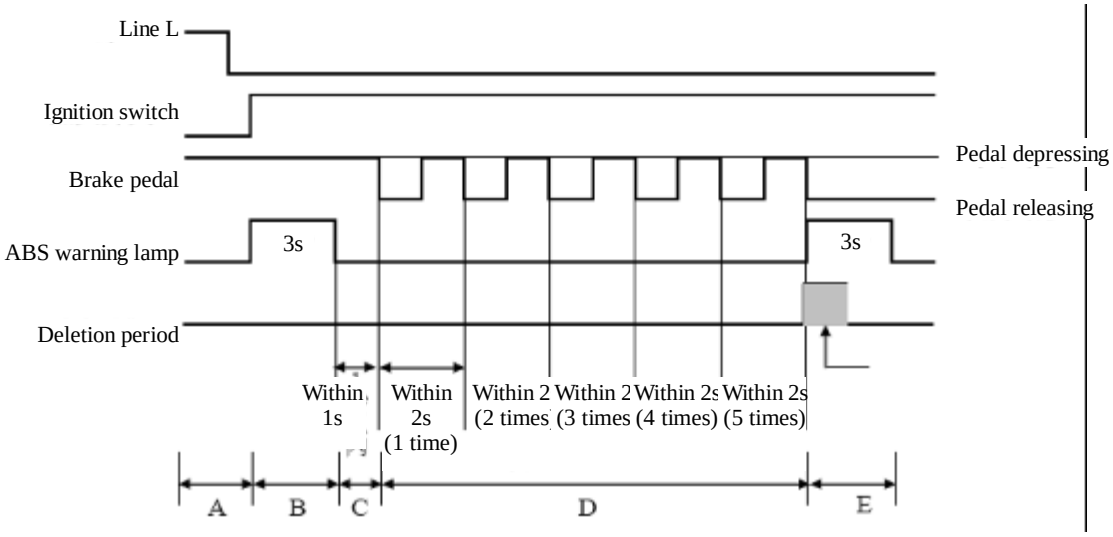
The meaning of symbols in the figure is as follows:

Code	Symbol Description	Duration
T1	The symbol for diagnosis start. The warning lamp starts flashing	3.0s
T2	For differentiation of the duration of various trouble codes during the display of multi trouble codes	3.0s
T3	Flashing interval of warning lamp at the presence of trouble code	0.5s
T4	For differentiation of the interval of various digits of trouble code during the display of certain trouble code (for this interval, the first digit is for tens digit and the second digit is for ones digit)	1.5s

Take the process shown in above figure for instance. Within the display span of the first trouble code, before the presence of T4 (namely, 1.5s before the off of the warning lamp), since the warning lamp flashes twice (the duration for each on and off is both T3, namely 0.5s), the first digit of the 2-digit trouble code (tens digit) is at 2; after the presence of T4 (namely 1.5s after the off of the warning lamp), since the warning lamp flashes once, the second digit of the 2-digit trouble code (ones digit) is at 1. After that, the warning lamp will be off for 3s (namely T2 duration). Therefore, the display of first trouble code is completed with the trouble code of 21. The detailed description of the trouble is shown in the trouble code checklist in section 2.4. Also, the second trouble code of 22 can be obtained.

③ Deletion of trouble code without trouble diagnosis instrument

After the trouble code readout and troubleshooting based on the trouble code checklist, it's necessary to delete the previous trouble code before the re-checking of the trouble code. The condition for trouble code deletion is same with that of the trouble code readout. The detailed operation method is as follows:



The steps in the above figure are respectively as follows:

A. After the brake pedal is depressed, ground the line L and rotate the vehicle key to the power on position;

B. The ABS warning lamp illumination and go off in 3s;

C. Start to release the pedal within 1s after the ABS warning lamp goes off;

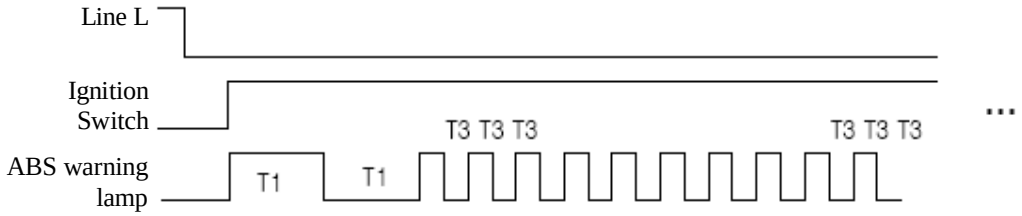
D. After the pedal is released for approximate 1s, re-depress the pedal for approximate 1s. Repeat the above operation for 5 times. During this operation, the warning lamp will not be illuminated;

E. The ABS warning lamp illuminates and lasts for 3s. During this period, the trouble code within this process will be deleted.

At the finish of the trouble code deletion, restore the ECU status of the ABS to the normal mode,

of which the operation method is same with that of the trouble code diagnosis.

In addition, when the ECU of the ABS has no trouble code, ground the line L and rotate the key to the power on position. The flashing of the ABS warning lamp is conducted in accordance with the type in following figure, of which the symbol meaning is same with the foregoing section.



2.4 Trouble Checklist of Trouble Code

① Contents of Trouble Code

Trouble code	Contents	Trouble code	Contents
C1 200 (11)	Open-circuit/short-circuit of left front sensor	C1 206 (31)	Open-circuit/short-circuit of left rear sensor
C1 201 (12)	Interference of left front sensor or gear ring	C1 207 (32)	Interference of left rear sensor or gear ring
C1 202 (13)	Air gap error of left front sensor	C1 208 (33)	Air gap error of left rear sensor
C1 203 (21)	Open-circuit/short-circuit of right front sensor	C1 209 (41)	Open-circuit/short-circuit of right rear sensor
C1 204 (22)	Interference of right front sensor or gear ring	C1 210 (42)	Interference of right rear sensor or gear ring
C1 205 (23)	Air gap error of right front sensor	C1 211 (43)	Air gap error of right rear sensor
C1 101 (51)	Battery voltage too high (above 17V)	C2 112 (54)	Trouble of electromagnetic valve fuse or electromagnetic relay
C1 102 (52)	Battery voltage too low (below 9.4V)	C2 402 (55)	Trouble of motor fuse or motor
C1 604 (53)	Trouble of ECU internal circuit or electromagnetic valve coil		

② Trouble checklist of trouble code

Table 1

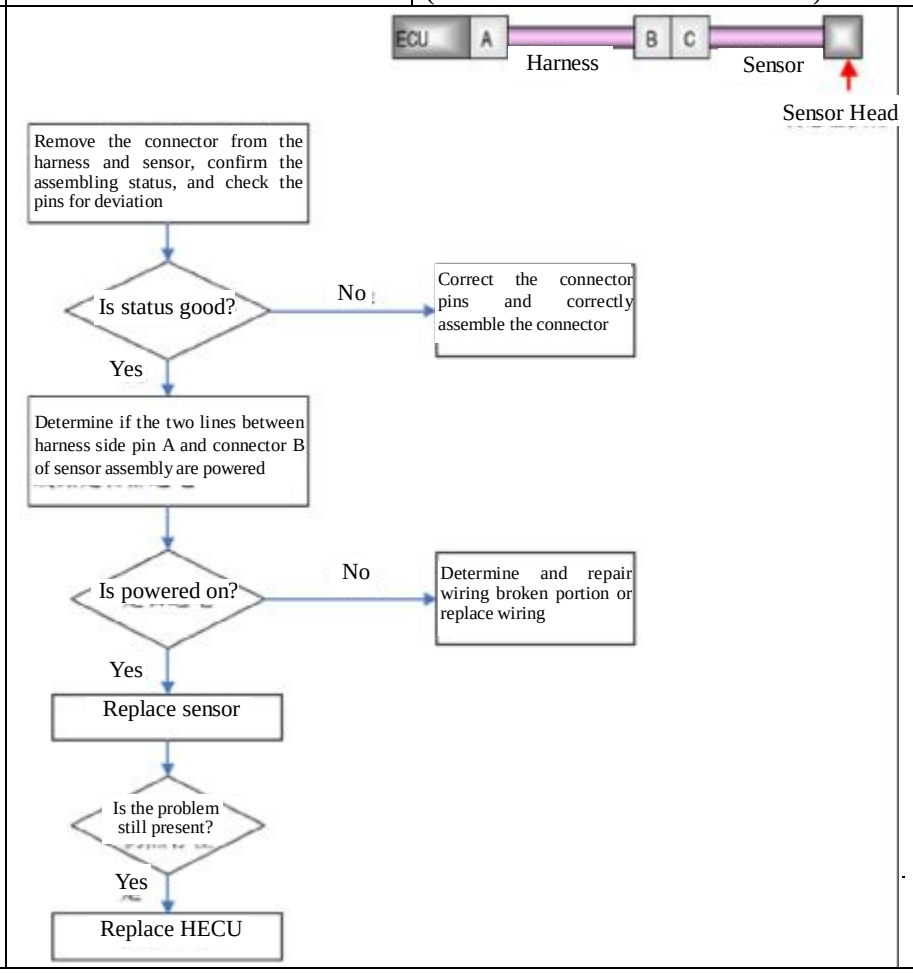
Trouble Code	C1 200(11) C1 203(21) C1 206(31) C1 209(41)	Note: If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).
Possible Case	Open-circuit/short-circuit of sensor: At short-circuit or open-circuit of battery anode or cathode of sensor.	
Troubleshooting Flow		

Table 2

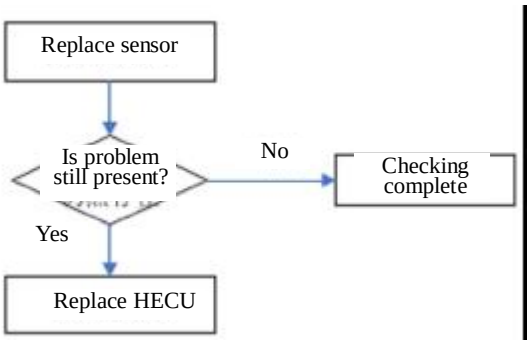
Trouble Code	C1 202(13) C1 205(23) C1 208(33) C1 211(43)	Note: ①The air gap refers to the gap between the gear ring and the sensor; ② If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).
Possible Case	Air gap error: Air gap too big or self short-circuit of sensor (resistance value at 0) that results no signal or the gear ring not properly installed.	
Troubleshooting Flow		

Table 3

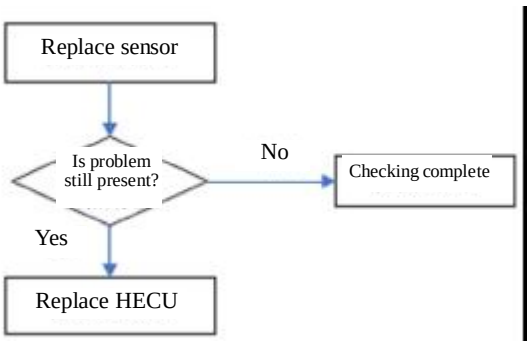
<table>
<tr><td>Trouble Code</td><td>C1 201(12) C1 204(22)
C1 207(32) C1 210(42)</td><td rowspan="2">Note: ① The sensor signal is not uniform when the gears are adhered with engine oil and the impurities such as slag;
② The air gap refers to the air gap between the gear ring and the sensor;
③ If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).</td></tr>
<tr><td>Possible Cause</td><td>Interference of gear ring or sensor: Occurred when installed with non-standard specification gear rings.</td></tr>
<tr><td>Troubleshooting Flow</td><td colspan="2"> 
</td></tr>
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Table 4

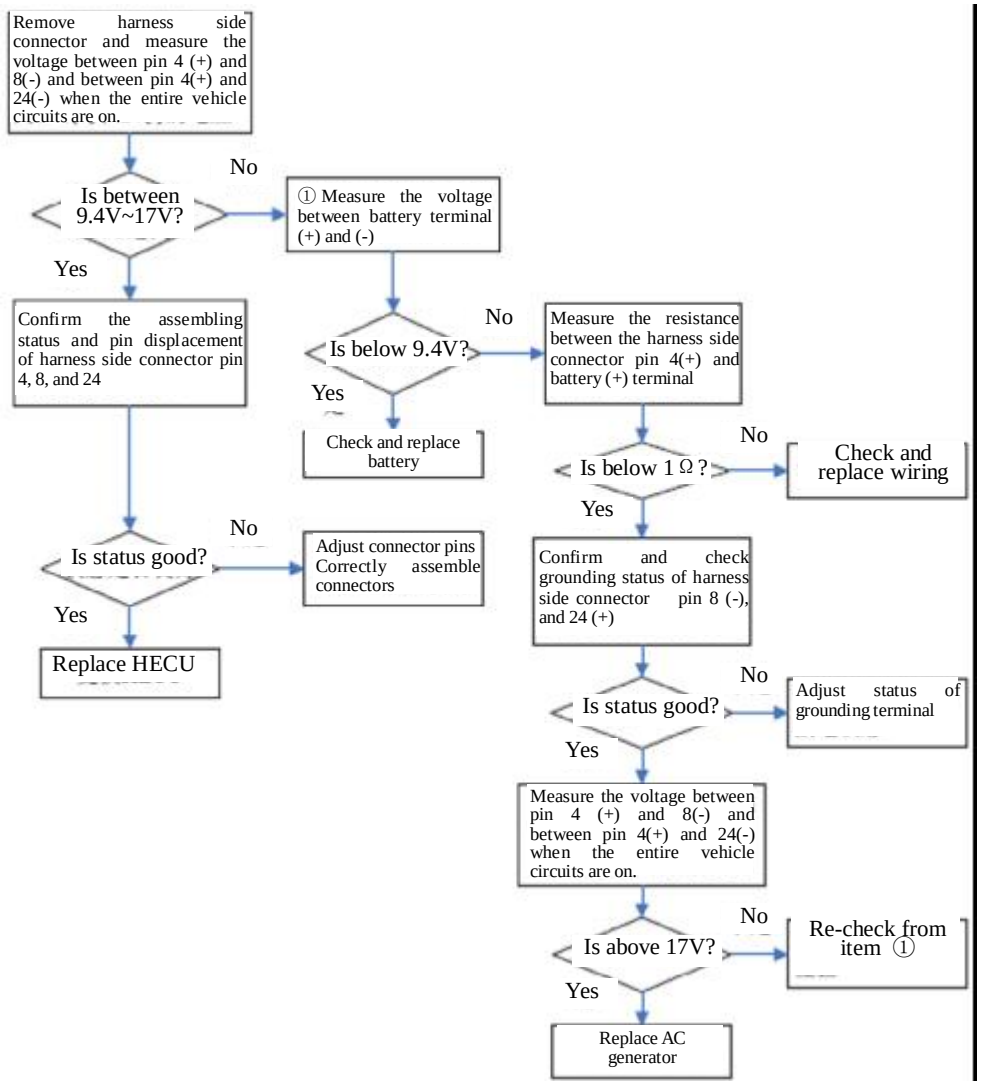
Trouble Code	C1 101(51) C1 102(52)	Note: If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).
Possible Cause	Abnormal battery voltage: Occurred when the voltage is too high or too low	
Troubleshooting Flow		

Table 5

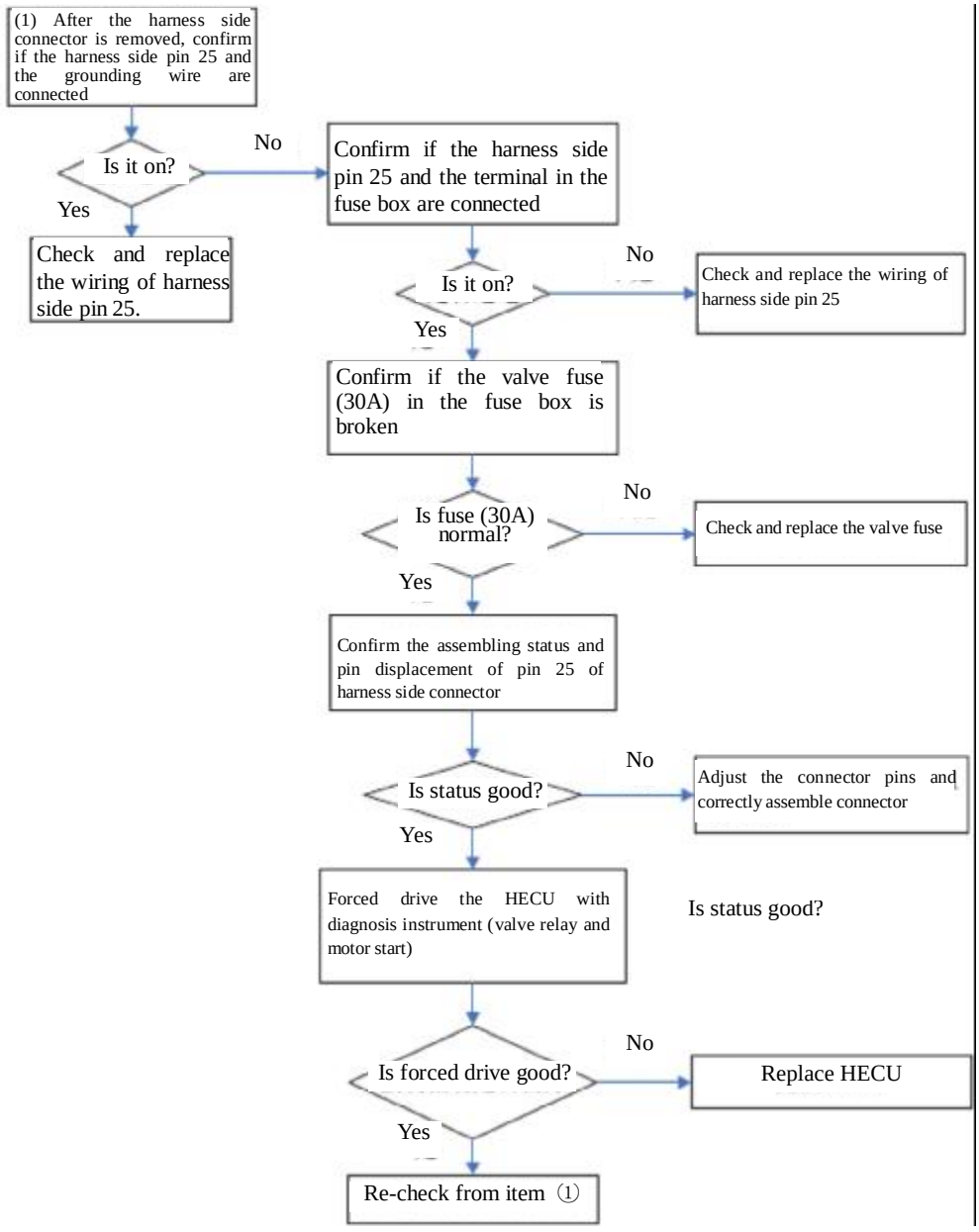
Trouble Code	C2 402(55)	Note: If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).
Possible Cause	Malfunction of motor fuse/motor	
Troubleshooting Flow		

Table 6

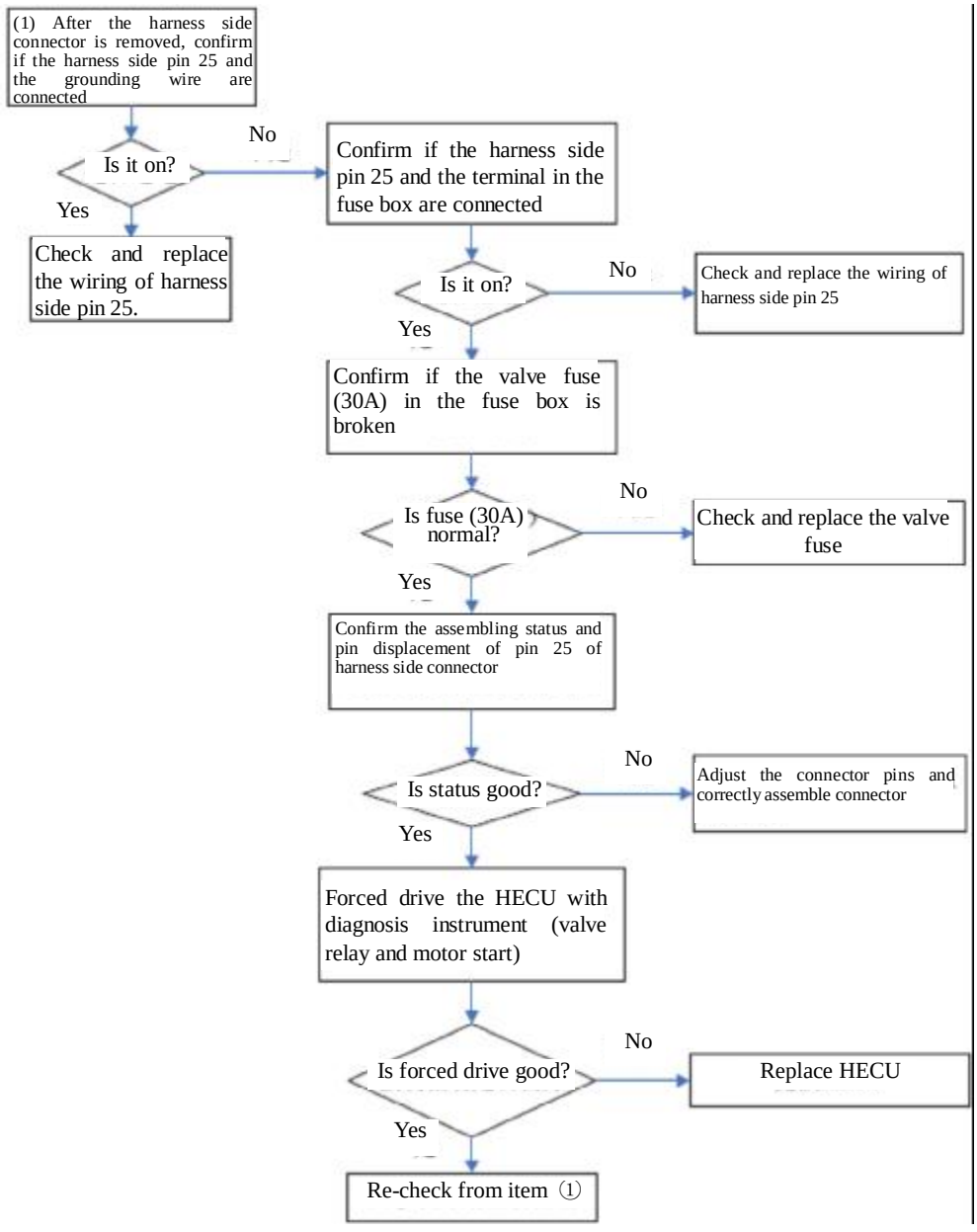
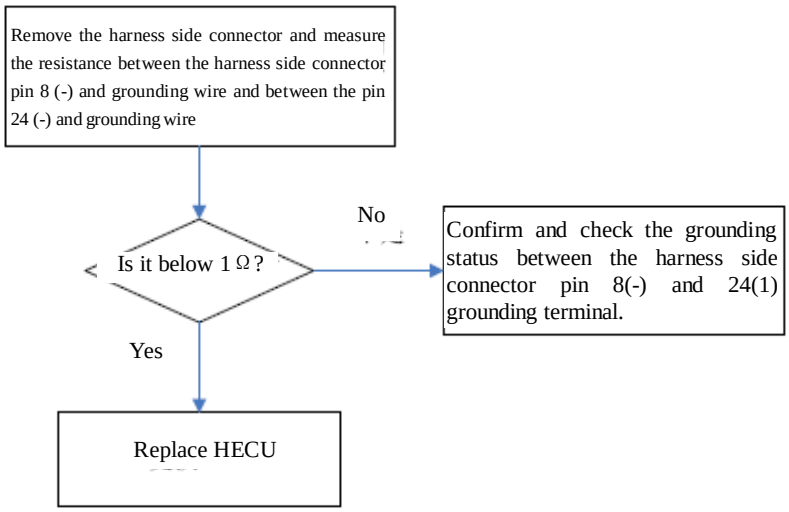
Trouble Code	C2 112(54)	Note: If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).
Possible Cause	Malfunction of valve fuse and relay: a) Broken of primary relay or fuse b) Short-circuit of primary relay	
Troubleshooting Flow		

Table 7

Trouble Code	C1 604(53)	Note: If the malfunctions corresponding to more than 2 trouble codes can be determined, after the trouble codes are deleted (erasable trouble codes), drive the vehicle to above 40km/h to determine the malfunctions to that the trouble codes correspond and check in accordance with the registered trouble codes (determine the same one trouble code).
Possible Cause	Malfunction of ECU internal circuit and valve coil	
Troubleshooting Flow		

2.5 Trouble Checklist without Trouble Code

Table 1

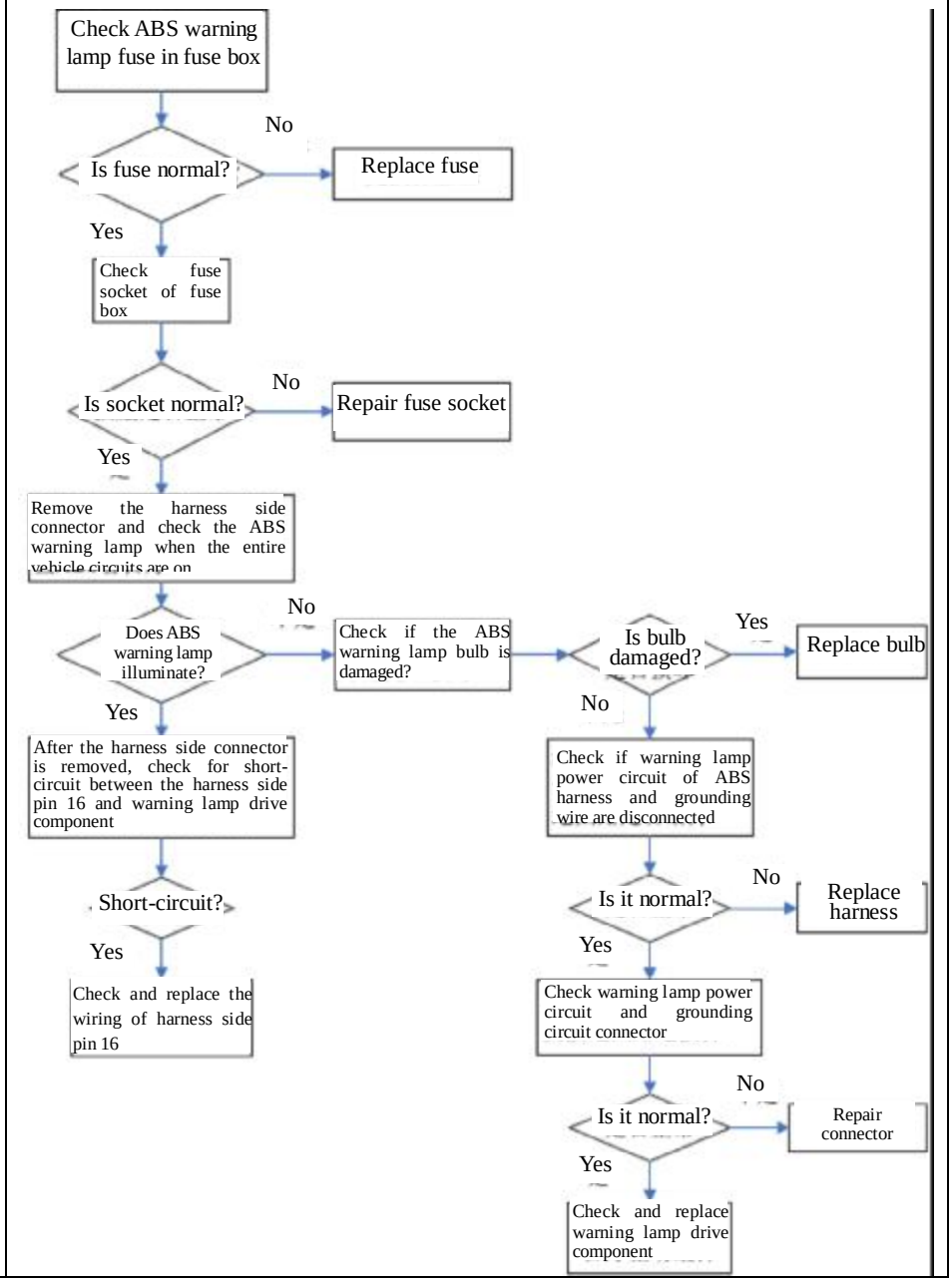
Trouble Evidence	The ABS warning lamp doesn't illuminate when the engine is started	
Possible Cause	• Burn of fuse • Open-circuit of power line	• Burn of ABS warning lamp bulb • Damage of ABS warning lamp control
Troubleshooting Flow		

Table 2

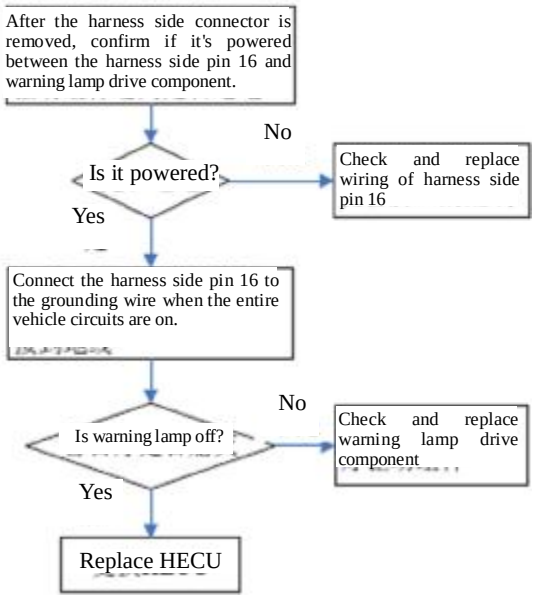
Trouble Evidence	The ABS warning lamp constantly illuminates after the vehicle start
Possible Cause	● Damage of ABS warning lamp control ● Open-circuit of ABS warning lamp control circuit ● ECU damage of ABS
Troubleshooting Flow	

Table 3

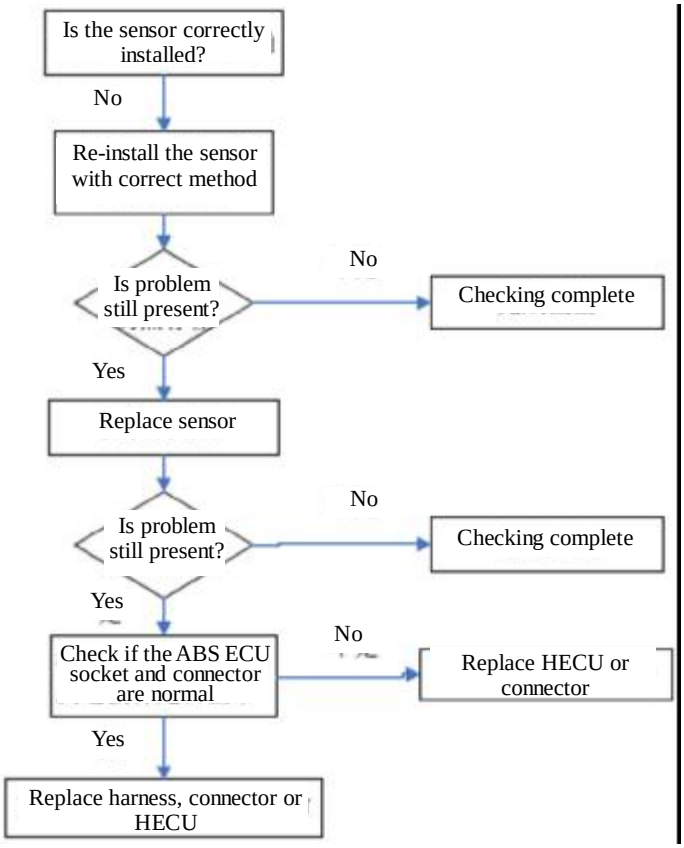
Trouble Evidence	Abnormal functioning of ABS
Possible Cause	● Damage of sensor ● Improper installation of sensor ● Problem of sensor harness ● Impurity adherence on sensor ● Damage of gear ring ● Damage of wheel bearing ● HCU damage of ABS ● ECU damage of ABS
Troubleshooting Flow	

Table 4

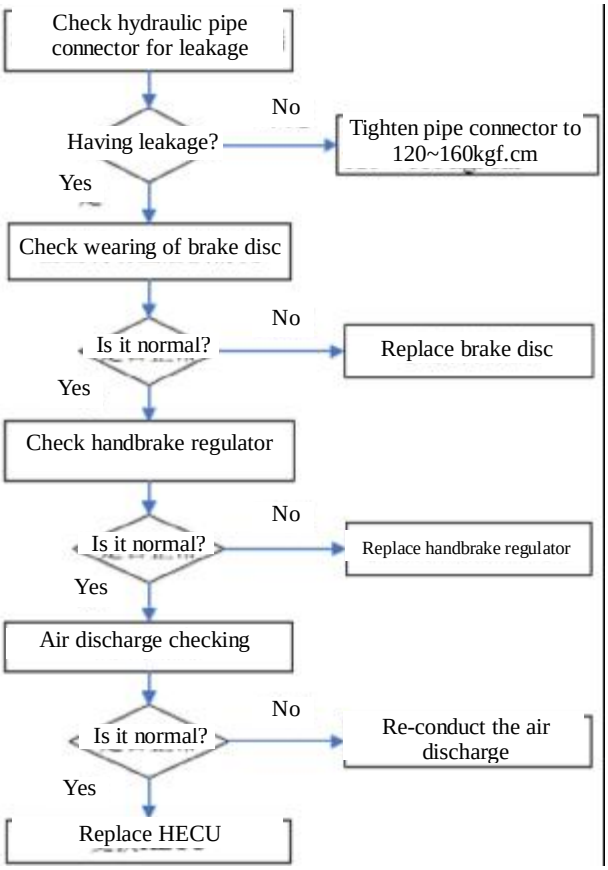
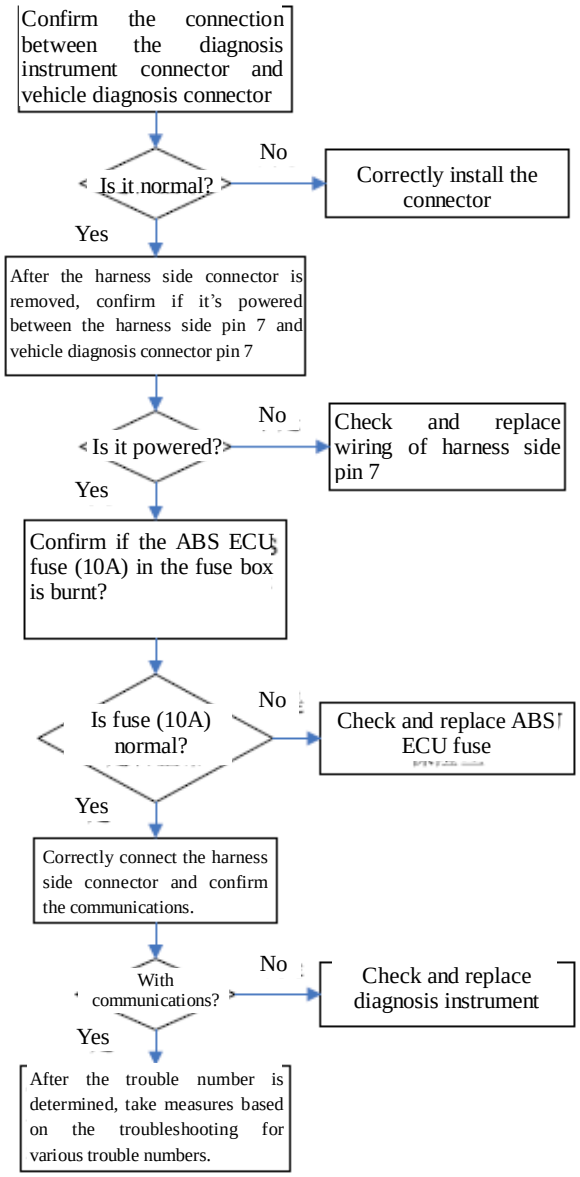
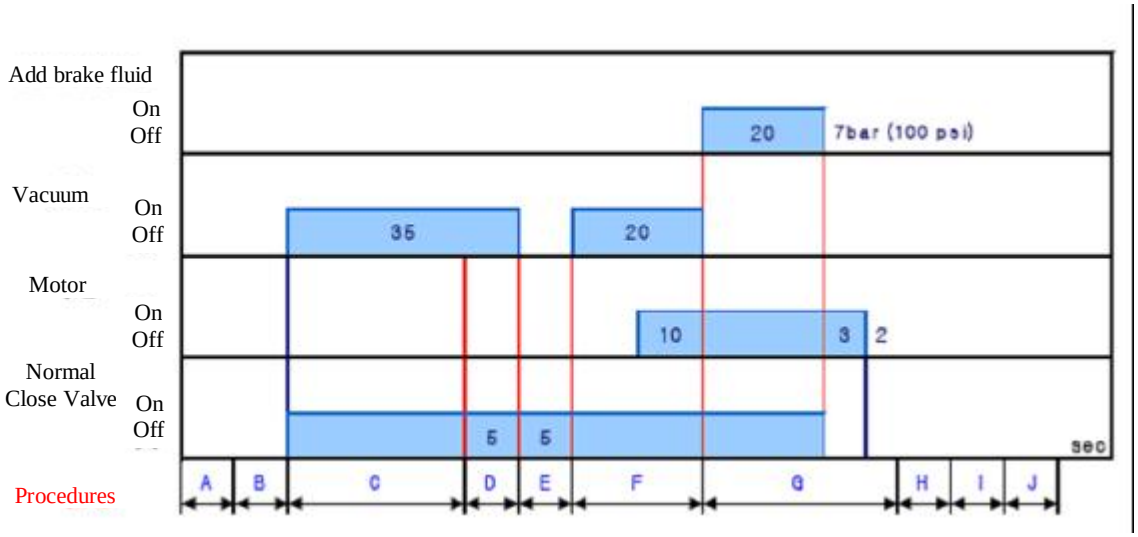
Trouble Evidence	Brake pedal travel too long
Possible Cause	● Improper adjustment of handbrake ● Leakage of brake liquid ● Severe wearing of brake friction disc ● Leakage of normal close valve ● Air in the system
Troubleshooting Flow	

Table 5

Trouble Evidence	Without diagnosis code output (communication failure with trouble diagnosis instrument)
Possible Cause	● Problem of diagnosis instrument ● Burn of fuse ● Broken of diagnosis line or loosening of connector ● ECU damage of ABS
Troubleshooting Flow	

IV. Air Discharge and Oil Refill

1. Regular Operation Procedure



The regular operation procedure of air discharge and oil refill is shown in the figure, of which:

A : Move the vacuum device and brake oil refill device;
B : Start after connected with vacuum and brake oil refill device and SDL;
C : Drive normal close electromagnetic valve and apply the 1st vacuum;
D : Excessive leakage test;
E : Minor leakage test after the 1st vacuum cut-off;
F : Applicable for 2nd vacuum and drive motor;
G : After the oil refill and maintaining of pressurization on the brake oil, relieve the brake oil pressure, stop the normal close electromagnetic valve and motor, and adjust the brake oil level;
H : Disconnect the vacuum device and brake liquid refiller;
I : Screw on the oil reservoir lid/disconnect the SDL;
J : Transfer to next step.

2. Checking Device

① The vacuum supplied to the oil reservoir should be as lower as possible, provided that the oil gun must supply at least below 1mm Hg vacuum.

② Confirm if the air discharge screw portion of the rear wheel hydraulic device (drum brake or brake caliper) forms the vacuum within the specified period. (It should be below 5~10mm Hg after connected with vacuum for 20~25s).

③ Confirm if the working voltage supplied to the HECU is at specified 10~12V.

④ Confirm the circulation time (C/T). Confirm the working time setting of the electromagnetic valve meets with the specified value.

- † C/T< 90: Run the electromagnetic valve continually;
- † 90≤C/T≥180: Start the electromagnetic valve for 2s and stop the electromagnetic valve for 2s. continually repeat above cycles;
- † C/T>180: The total running period setting of the electromagnetic valve is below 90s.

3. Notices for Air Discharge and Oil Refill

① During the refilling of brake oil, if the refilling pressure is not maintained for certain period or above, the oil level within the oil reservoir will lower at the finish of the refilling. Therefore, it's required to refill more brake oil or maintain the refilling pressure for certain period.

② The time period marked in the regular operations refers to the general circulation period.

③ The inside of after-service HECU is at moisture status, therefore, it may not conduct the air discharge mode operation (see succeeding item 5⑥ for the definition of air discharge mode) but directly conduct the air discharge operation on all wheels (However, in order to meet with the performance and pedal comfort, it's preferable to conduct the air discharge mode operation).

④ During the air discharge mode operation, the voltage supplied to HECU is preferably at 10~12V. However, during the use of checking devices, it will be OK to use the vehicle amounted battery. (The repeated air discharge mode operation with high voltage may damage the coil of ECU components).

4. Determination Method for Vehicles with Air Discharge Trouble

Differentiation / Category	ECU functioning or not	Leakage test		Note
		Excessive leakage	Minor leakage	
Case 1	Normal functioning	O.K	O.K	Normal functioning, no separate repetition required
Case 2	Normal functioning	O.K	N.G	Abnormal functioning, separate repetition required
Case 3	Normal functioning	N.G	N.G	Abnormal functioning, separate repetition required
Case 4	Not functioning	O.K	O.K	Abnormal functioning, separate repetition required
Case 5	Not functioning	O.K	N.G	Abnormal functioning, separate repetition required
Case 6	Not functioning	N.G	N.G	Abnormal functioning, separate repetition required

† Case 1 : The status at finish of normal functioning.
† Case 2 : The status that the connection of brake (HECU hole portion/brake pipe/brake hose) is poor and therefore needs rework.
† Case 3 : The status same with Case 2, but it may cause the status incapable of repetition when the leakage is really severe.
† Case 4 : Internal circuit air discharge trouble of HECU. It's the status necessary for repetition as the ABS may cause the sponge phenomenon after functioning for one time.
† Case 5 : The comprehensive trouble of Case 2 and Case 4. The status necessary for repetition.
† Case 6: The status similar to Case 5, but it may cause the status incapable of repetition when the leakage is really severe.

5. Measures in Event of Troubles during Air Discharge and Oil Refill (for internal dry status of brake system)

① Implementation of trouble determination. It's required to determine the connection portions of all components from the general pump to the wheel branch pump: HECU hole portion, connection portion of brake pipe, connection portion of brake hose, brake caliper and the air discharge screw portion of brake, and etc.

② After the determination of the trouble, re-assemble in accordance with the provisions in order to avoid the further occurrence of leakage.

③ Connect the repetition device to the 25-pin connector of the ECU or connect the checking device to the line K (pin 7). Use the specific wiring to connect to the connectors. During the connection to line K (pin 7), make the vehicle at power on or start status. The oil reservoir of the general pump is connected with the device for continual supply of brake oil or it's required that the oil reservoir should have enough oil during the supply of brake oil.

④. Check the HECU with repetition device or checking device and determine the existence of trouble code. If with trouble code, firstly conduct the operation for deletion of the trouble code (if the trouble in above item ① is not determined, it's necessary to determine the existence of trouble code). When the trouble code can't be deleted, operate with reference to the Trouble Checklist of Trouble Code in section 2.4 (In case of trouble of HU, motor and ECU, the air discharge and oil refill can't be conducted at the inside of the HECU).

⑤ After the brake pedal is depressed, open the air discharge screw attached onto the wheel brake caliper or drum brake to discharge the air. Conduct this operation on all wheels, till that the brake oil discharged from the air discharge screw is free of air and the brake pedal is properly rigid. Refer to the operation in item ⑩ in using the repetition device capable of vacuum formation and refilling of brake liquid.

⑥ Conduct the air discharge mode by means of the repetition device or the checking device. If there has no reaction force when the brake pedal is depressed, then repeat the operation of pedal depressing and pedal releasing, till the air discharge mode is completed (air discharge mode: repeat the start in 2s interval, stop the normal close valve of HECU for 1min, and continually drive the motor. The repeated operation of pedal depressing and pedal releasing is conducted within the period of normal close electromagnetic valve and motor drive).

⑦ The operation in item ⑤ (air discharge) should be repeated for all wheels.

⑧ Measure the brake pedal travel. If not meet with the provisions, repeat the operations in item ⑥ (air discharge mode) and item ⑤ (air discharge). If the brake pedal travel doesn't meet with the provisions after the air discharge mode and air discharge are repeated for above 10 times, replace with after-service HECU (wet type) and then repeat the operations from the beginning.

⑨ Connect the repetition device and checking device to the HECU and again determine the existence of trouble code. If with trouble code, delete the trouble code and then disconnect the repetition device or checking device.

⑩ During the use of other repetition devices (the equipment capable of vacuum formation and liquid refilling), the implementation method is as follows:

- † Conduct in accordance with the contents in above item ①～④;
- † When the vacuum pump is sufficiently driving for approximate 60s, the inside of brake system will form the vacuum status.
  - **C** Start the operation of air discharge mode in above item ⑥ 10s before the vacuum cut-off.
  - **C** Without the repeated operations of pedal depressing and pedal releasing.
- † Conduct the brake liquid refilling operation (above 7bar/100Psi) for above 20s at the same time of vacuum cut-off.
- † Complete the brake liquid refill and air discharge mode.
- † Conduct the operation based on the contents in above item ⑧～⑨.

6. Measures in Event of Trouble during Checking and ABS Functioning Test (for internal wet status of brake system)

① Connect the repetition device or checking device. The following conditions must be guaranteed:

- † Use the specific wiring while connecting to the 25-pin connector of ECU.
- † The vehicle should be at power on status or start status while connecting to line K (pin 7).
- † The oil reservoir of the general pump is connected with the device for continual supply of brake oil or it's required that the oil reservoir should have enough oil during the supply of brake liquid.

② Check the HECU with repetition device or checking device and determine if it has trouble code.

- † If with trouble code, firstly conduct the operation to delete the trouble code.
- † If the trouble code can't be deleted, implement with reference to section 2.4 "trouble checklist of trouble code" (If the HU, motor or ECU has trouble, the inside of HECU can't conduct the air discharge and oil refill).

③ After the brake pedal is depressed, open the air discharge screw attached on the wheel brake caliper or drum brake to discharge the internal air. It's required to conduct this operation on all wheels, till that the brake oil discharged from the air discharge screw is free of air and the brake pedal is properly rigid.

④ Conduct the air discharge mode by means of the repetition device or the checking device. If there has no reaction force when the brake pedal is depressed, then repeat the operation of pedal depressing and pedal releasing, till the air discharge mode is completed

⑤ The operation in item ③ (air discharge) should be repeated for all wheels.

⑥ Measure the brake pedal travel. If not meet with the provisions, repeat the operations in item ④ (air discharge mode) and item ③ (air discharge). If the brake pedal travel doesn't meet with the provisions after the air discharge mode and air discharge are repeated for above 10 times, replace with after-service HECU (wet type) and then repeat the operations from the beginning.

⑦ Connect the repetition device and checking device to the HECU and again determine the existence of trouble code. If with trouble code, delete the trouble code and then disconnect the repetition device or checking device.

Annex I Malfunction Cases and Incorrect Repair Cases

1. HECU Incorrect Repair Cases

① HECU replacement relating to ABS functioning noise

The HECU replacement case that deemed the noise of electromagnetic valve and motor as the malfunction during the functioning of the ABS.

- † During the functioning of ABS, the noise generated during the relieving or enhancing of the braking pressure on various wheels is of normal functioning status. The noise level will vary depending on the braking pressure applied on various wheels, other than the product malfunction. Therefore, we should persuade the customers to understand that.
- † When the vehicle reaches 10km/h speed at the first time after vehicle start, the sensitive customers may hear the noise at the time when the ECU diagnoses the motor drive, which is also the normal functioning of the ABS.

② HECU replacement relating to EBD functioning noise

The HECU replacement case that deemed the clattering noise of rear wheels that other than the ABS functioning noise during the braking as the malfunction.

- † The ABS is also equipped with EBD function, which will effect the relieving of braking pressure on the rear wheels when the rear wheels are locked ahead of the front wheels. The noise generated during the above mentioned process is of normal functioning status.

③ HECU replacement relating to braking off-tracking

HECU replacement case due to the vehicle braking off-tracking towards one side during the braking.

- † ABS is the braking assisted device that functioning in such manner that the ECU will calculate the speed of various wheels in order to maintain the best braking force and control stability during the braking. In the event of malfunction of the HECU, the ECU will illuminate the warning lamp by means of the diagnosis. Therefore, in the event of braking off-tracking without the illumination of ABS warning lamp, it's necessary to check other braking hydraulic devices.
- † In the event of incorrect assembling of the braking hose, the braking off-tracking may occur during the functioning of the ABS.

④ Replacement case that the ABS is functioning during barking at low speed (below 40km/h)

HECU and sensor replacement case that the ABS is always functioning during the braking at low speed.

- † During the braking at low speed, the ABS may also function depending on the road conditions and braking pressure. If the ABS is always functioning at each time, it's necessary to check if the sensor air gap of various wheels is too large, if it has interference with the gear ring, and if the tooth shape of the gear ring is damaged.
- † Air gap adjustment method. For the improper air gap, after the determination of the parts related to the problem, replace or grind the installation surface (junction portion) of the sensor to the specified air gap; in the event of interference, place the thin gasket onto the sensor installation surface so as to adjust to the specified air gap.

2. Incorrect Repair Cases for Wheel Speed Sensor

① Open-circuit and short-circuit related to sensor

The sensor replacement case without product checking when the ABS warning lamp is illuminated and the trouble code of the vehicle is determined.

- † The ABS trouble code is prepared based on the ABS products. Therefore, during the open-circuit or short-circuit of the sensor, it's necessary to conduct the problem checking, such as confirm the connection status from the ECU to the wiring and connectors of the sensor, measure the sensor resistance, and etc. During the malfunction checking of sensor, it's preferable to use the tetrastyle jack, which will facilitate the confirmation of short-circuit problems such as the pinned wiring.

† The union status of the sensor must be checked before the removal of the connectors of connecting wiring (such as incomplete union, pin displacement, with impurity, and etc.)After confirm that the sensor resistance and head are free of abnormalities, centrally check the wiring and connectors.

② Notices for sensor checking

Case of sensor head line break arisen from over-pulling of sensor cable.

† When the connectors are removed during the checking of sensor, the instantaneous pulling of cable under the condition that the sensor head is fixed will cause the falloff of the internal cable of the sensor head to cause line break problem. Therefore, during the checking of sensor, do not pull the cable with the force above the specified one.

† Sensor head cable: It may be damaged when applied with above 12kgf tension force; Cable at connectors: it may be damaged when applied with above 4.5kgf tension force.

Annex II ABS Basics

Will the braking distance be shortened when equipped with ABS?

† The testing data show that the braking distance will be shortened on most road conditions (approximately 5%~20%). However, under some special road conditions (such as snowy road, non-asphalt road and rough road), the braking distance will be lengthened. However, the steering stability can be guaranteed.

What's the main objective of ABS?

† The main objective of ABS is to prevent the wheels to be locked, which has following effects:

① Maintain the vehicle stability on roads during the braking

② Capable of controlling the vehicle driving direction during braking in order to avoid the occurrence of the collision.

③ Maintain the best braking pressure, disregarding the driving skills of the driver.

Why is the ABS warming lamp illuminated?

† After the driver starts the vehicle, the warning lamp will be off when the automatic diagnosis of ABS ECU shows no trouble. If the warning lamp is illuminated during driving or the warning lamp is always on, it indicates the trouble of ABS. Please drive your vehicle to the designated service station for checking of ABS as soon as possible. However, when the warning lamp is illuminated that indicates the ABS trouble, the brake system still has the basic braking capability.

Will there be free of accident when equipped with ABS?

† ABS is the one device capable of increasing the driving safety, rather than the device used to avoid the accidents arising from the driving mistake or variation of traffic conditions. Therefore, insist on the safe driving all along rather than the excessive reliance on the ABS.

The vehicle will lean to one side during braking on the one-side-slippery road, is this phenomenon caused by ABS?

† This phenomenon is resulted from the different friction coefficients between the left and right wheels on the roads. Under such condition, the ABS will exert the special effects on the stability of the vehicle body. However, even under such condition, make sure to operate the steering wheel with car in order to avoid the occurrence of accidents.

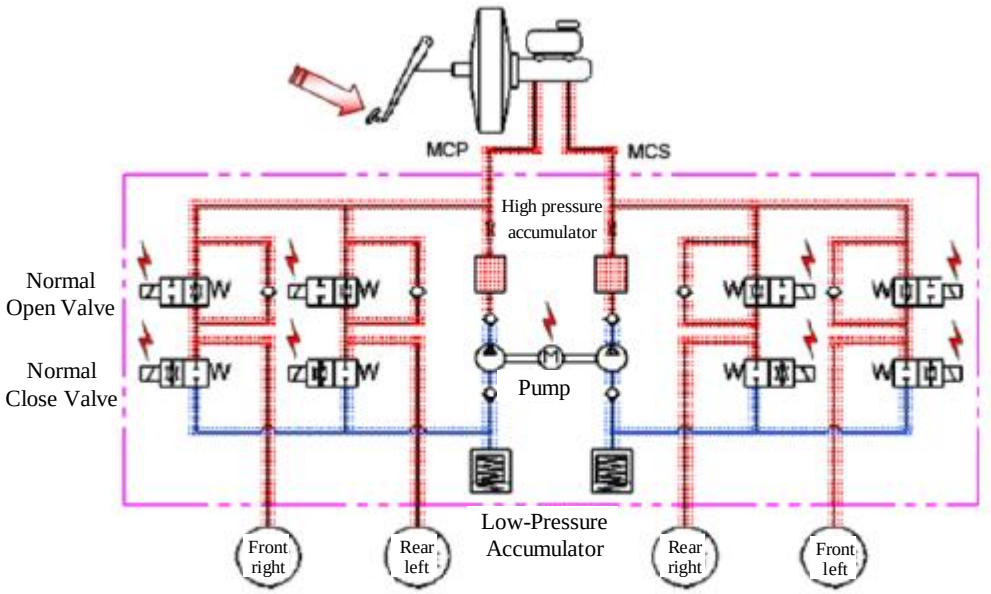
The vehicle will present the slippery phenomenon before braking during the turning on the slippery road, will the ABS function effectively when the brake pedal is depressed at that time?

† The ABS will function effectively to provide certain help depending on the vehicle speed. However, under most conditions, the outward cornering force is really big due to the vehicle inertia and therefore the body correction will have limit even the ABS is functioning.

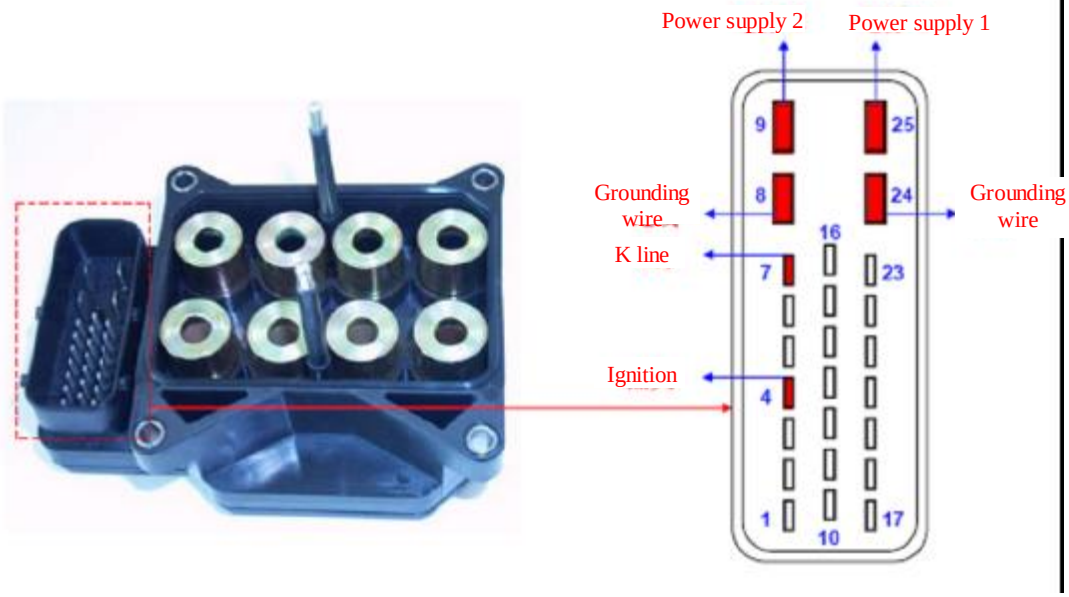
† Generally, the tires will be applied with two kinds of forces during cornering: One is the force required by driving and braking; another is the force required for vehicle steering and stability maintaining. In fact, the driving, braking and steering of the vehicle are completed though the coordination of above two forces and the two forces are in reverse ratio. Therefore, during the braking at cornering, the braking force will be increased and the force required for steering and stability maintaining will be reduced. The vehicles equipped with ABS will best coordinate these two forces. For the vehicles without the ABS, the steering performance and the stability are really weak as these two forces are not in good coordination.

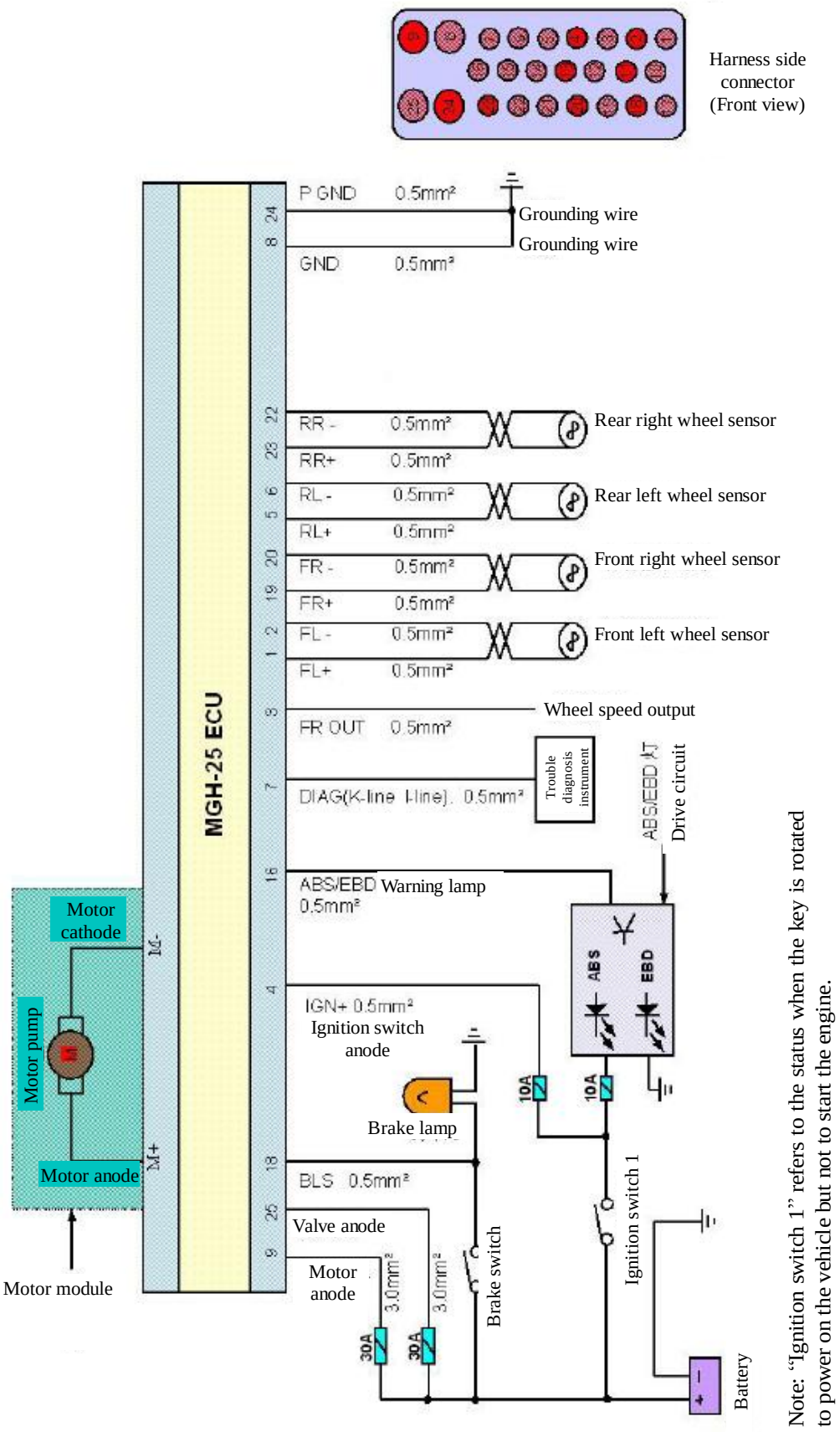
† However, under the condition that the above two forces are really small (such as: off-tracking due to excessive speed during the vehicle skid), the force for body correction is really small. Therefore, the ABS will not exert the effects. In conclusion, deceleration in advance and safe cornering is the best method.

Annex III ABS Internal hydraulic Flow Diagram



Annex IV Connector Pin Layout of MGH-25 ABS ECU





Note: "Ignition switch 1" refers to the status when the key is rotated to power on the vehicle but not to start the engine.