LD ABS/FTCS

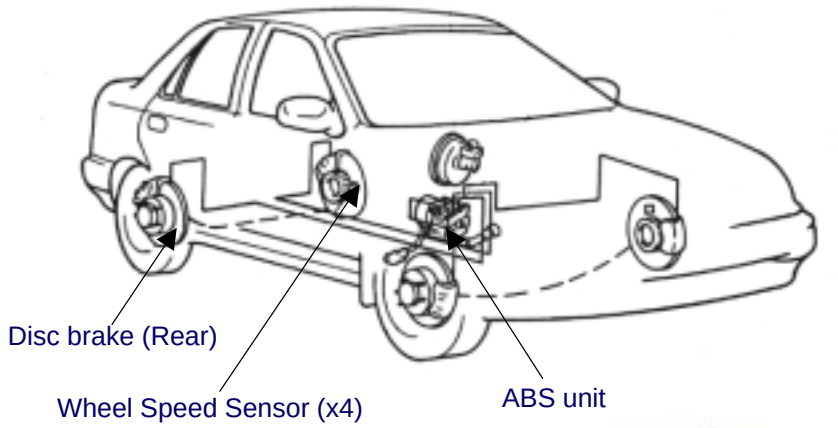
1. ABS

The ABS of the CERATO is the MGH-20 manufactured by MANDO applied to the CARENS F/L(Face Lift) and the CARNIVAL F/L(SEDONA). Comparing with the MGH-10 applied to the CARENS and the SPECTRA, it is smaller and lighter in size and weight. And the operation noises and the kick-back while ABS operation are reduced in functional aspect.

The ABS is the standard specification in Europe, however, in the other areas, it is an option item.

1.1. BRAKE SYSTEM CONSTRUCTION

ABS



CBS

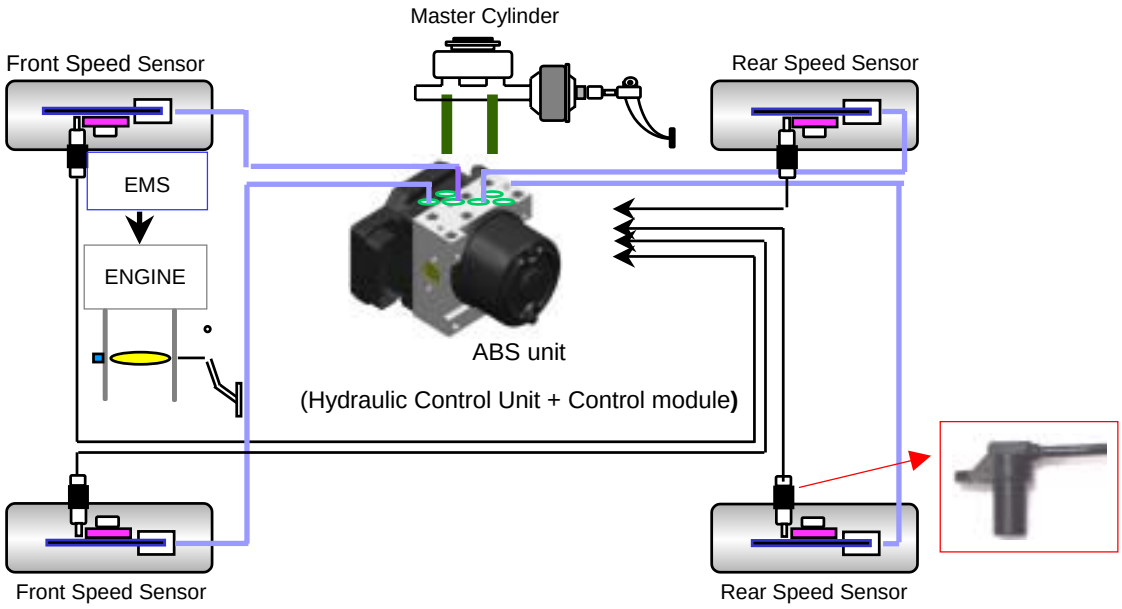
Booster & Master Cylinder

Caliper Brake (Front)

Drum Brake (Rear)

1.2. ABS CONSTRUCTION

System Construction : ABS unit + Wheel Speed Sensors



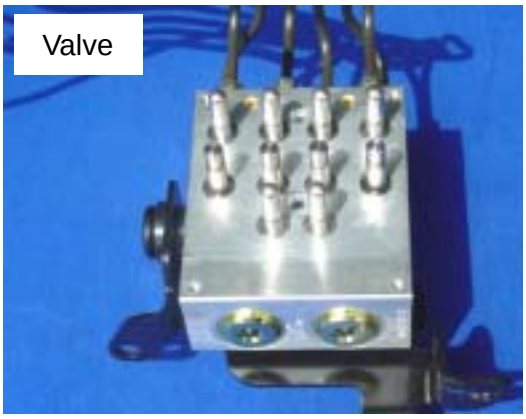
1.3. SPECIFICATION OF MGH-20

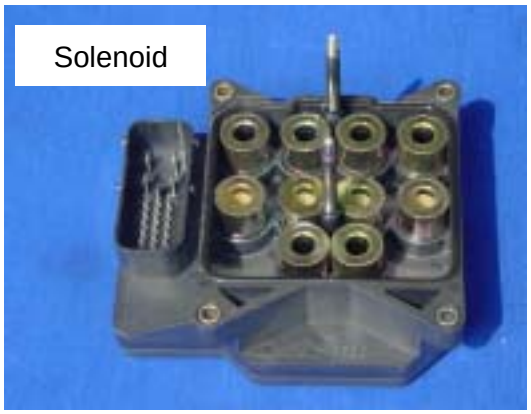
[MGH-20]

ABS	1.8kg / 1.6kg
	W118×H81×L127
TCS	2.1kg
	W118×H96×L127
Motor	250W / 180W, 120W

1.4. ABS CONSTRUCTION

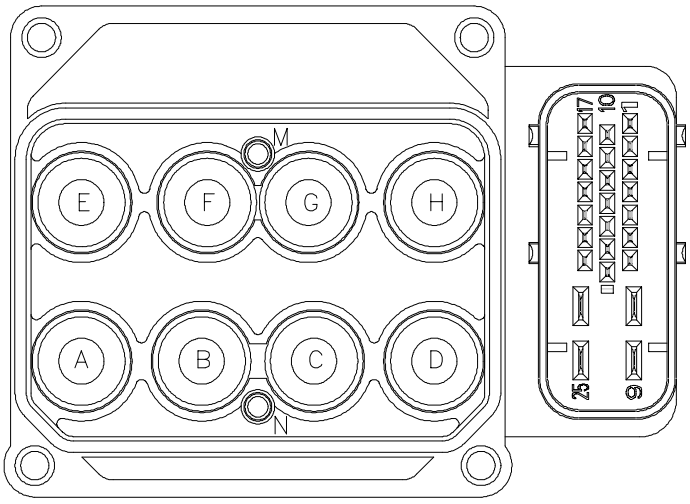
ABS Unit





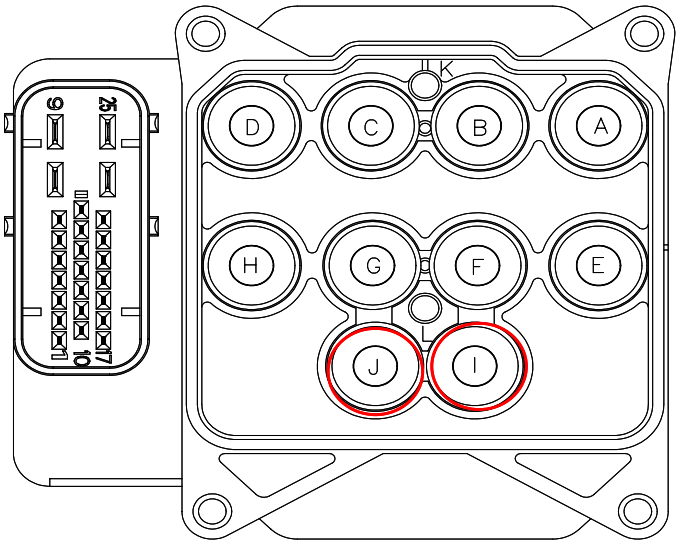
1.5. ABSCM

Section view



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

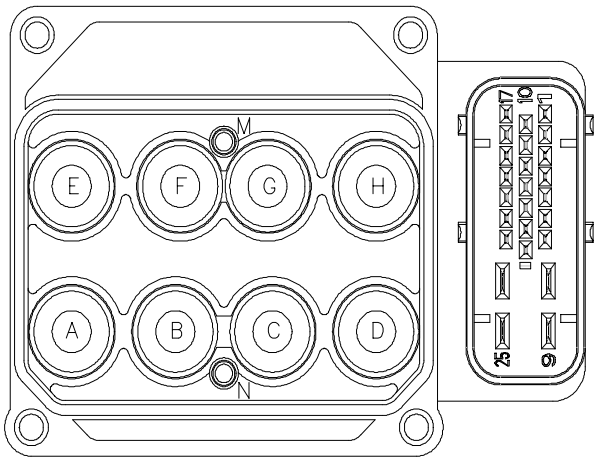
1.6. TCSCM



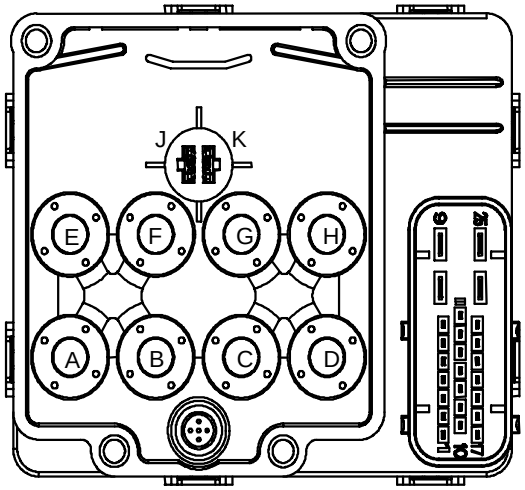
A : INLET VALVE (FR)
B : INLET VALVE (RL)
C : INLET VALVE (RR)
D : INLET VALVE (FL)
E : OUTLET VALVE (FR)
F : OUTLET VALVE (RL)
G : OUTLET VALVE (RR)
H : OUTLET VALVE (FL)
I : TRACTION VALVE(TCR)
J : TRACTION VALVE(TCL)
L: MOTOR(+)
K: MOTOR(GND)

1.7. COMPARISON

MGH-20 vs. MGH10



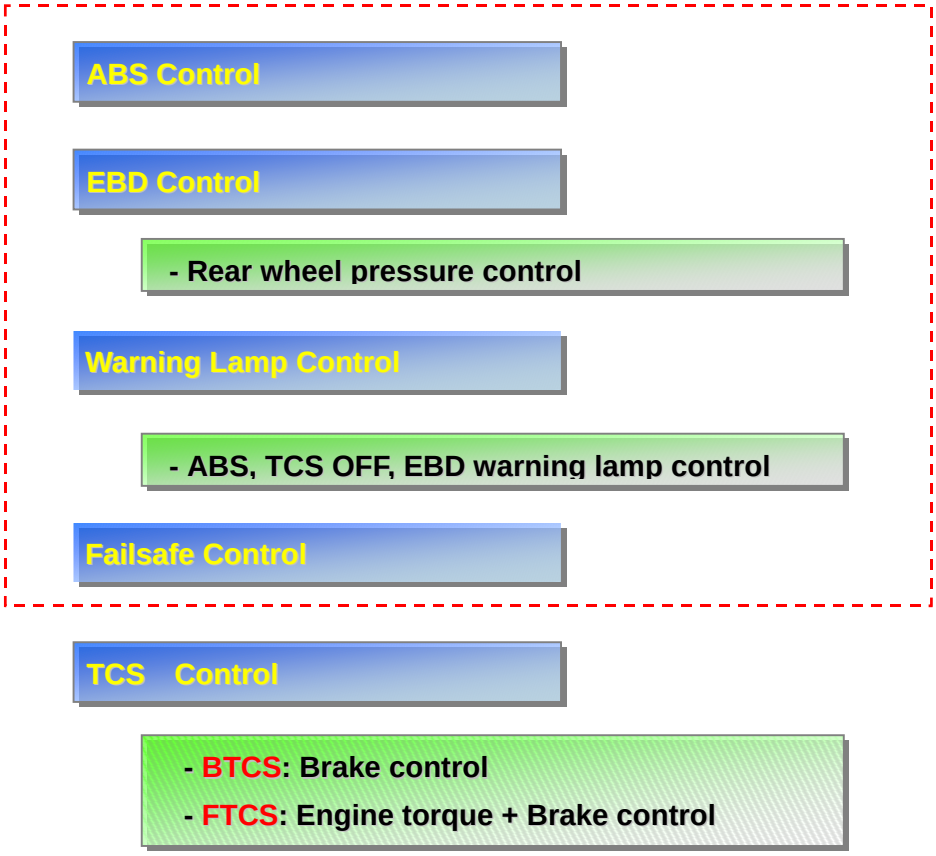
[MGH-20]



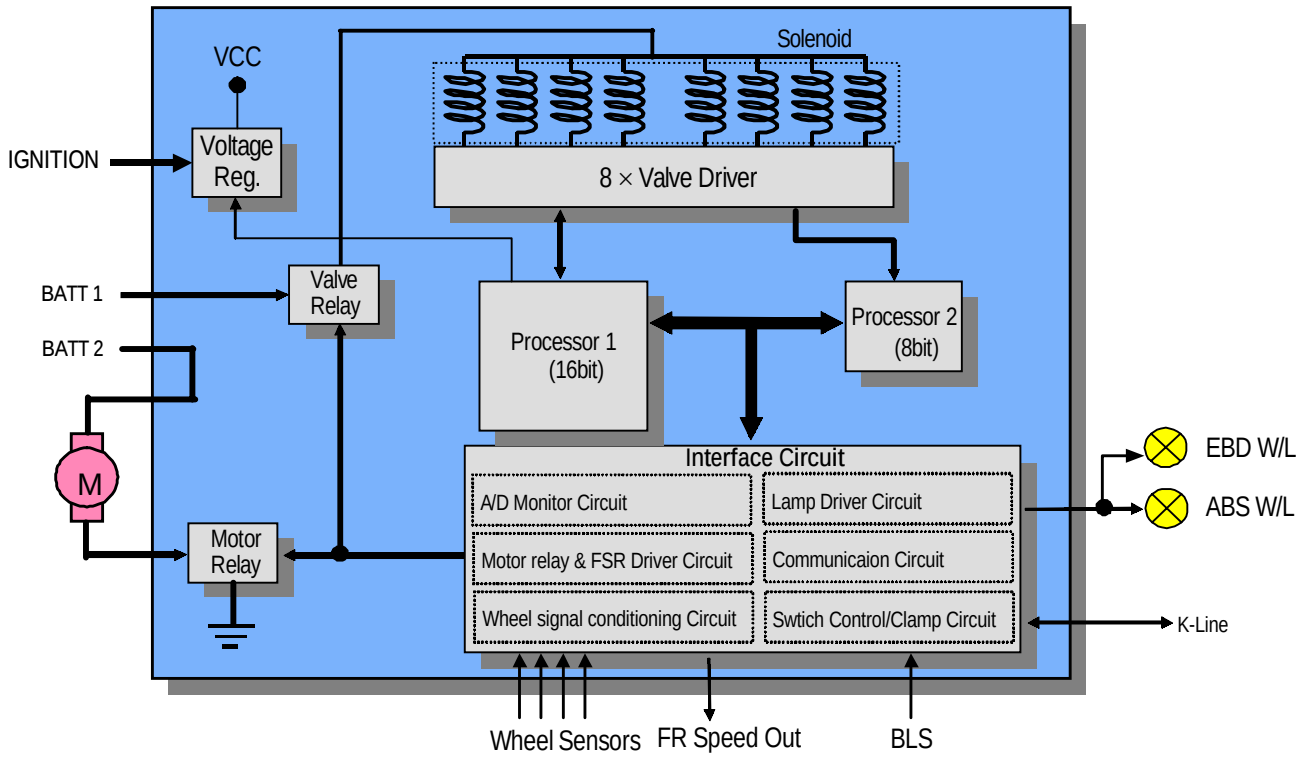
[MGH-10]

Features		Description
Lay out	Size & Weight	35% Size down, More efficient installation
HCU	Hydraulic Parts & circuit	Small sized solenoid valve
		Small sized components with better performance
		Enhanced motor connector installation process
ECU	ECU part & H/W design	More reliability by Dual Micom application
		Shortened stopping distance,
		Enhanced stability while braking,
		Reduced pedal pulsation
		Reduced noise by motor speed control

1.8. FUNCTION OF ABSCM & TCSCM



1.9. ABSCM BLOCK DIAGRAM



1.10. ABSCM OPERATION

1) Switch on procedure

The control module shall be put into operation by switching on the operating voltage (IGN). On completion of the initialization phase, the control module shall be ready for operation.

2) Operating mode

In the operating condition, the control module shall be ready, within the specified limits (voltage and temperature), to process the signals offered by the various sensors and switches in accordance with the control algorithm defined by the software and to control the hydraulic and electrical actuators.

3) Solenoid Valve Control

When one side of the valve coil is connected to the positive voltage that is provided through the valve relay and the other side is connected to the ground by the MOSFET, the solenoid valve goes into operation.

4) Solenoid Valve Checking

The electrical function of the solenoid valves is always monitored by the valve test pulse under normal operation conditions.

5) Pump Motor Checking

The control module performs a pump motor test at a speed of 20km/h once after IGN is switched on.

6) Voltage limits

① Overvoltage

When overvoltage is detected(above 16V), the control module switches off the valve relay and shuts down the system. When voltage is returned to operating range, the system goes back to the normal condition after the initialization phase.

② Undervoltage

In the event of undervoltage(below 10V), ABS control shall be inhibited and the warning lamp shall be turned on. When voltage is returned to operating range, the warning lamp is switched off and the control module returns to normal operating mode.

7) ABS Warning Lamp module

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

The ABS warning lamp shall be on:

- During the initialization phase after IGN ON. (3 seconds).
- In the event of inhibition of ABS functions by failure.
- When the system ECU is shut down even though IG power is applied.
- During diagnostic mode.

8) EBD Warning Lamp module

The active EBD warning lamp module indicates the operating condition of the EBD. However, in case the Parking Brake Switch is turned on, the EBD warning lamp is always turned on regardless of EBD functions.

The EBD warning lamp shall be on:

- During the initialization phase after IGN ON. (3 seconds).
- When the system ECU is shut down even though IG power is applied.
- When the Parking Brake Switch is ON or brake fluid is low level.

9) FTCS Lamp module

The passive FTCS warning lamp module indicates the operating condition of the FTCS

The FTCS warning lamp is turned on under the following conditions :

- During the initialization phase after IGN ON. (3 seconds)
- In the event of inhibition of BTCS functions by failure.

The FTCS warning lamp blinks under the following conditions :

- When the FTCS functions are operating. (Blinking - 2Hz)

10) Wheel Sensor signal processing

The control module shall receive wheel speed signal from the four inductive wheel sensors. The wheel signals are converted to square wave by the signal conditioning circuit and given as input to the μ- processor. The sensor connections shall be monitored for short-circuit and interruption and then in the event of 2 sensor failure, the control module shall be shut down the system.

11) Diagnostic Interface

Malfunctions or failures are encoded on the control module stored in a EEPROM and read out by diagnostic equipment when the ignition switch is turned on.

The diagnosis interface can also be used for testing the control module and for actuating the HCU in the test line of manufactories (Air-bleeding line or Roll and Brake Test line).

1.11. WHEEL SPEED SENSOR

Wheel speed sensor of CERATO is an inductive type. There are 4 wheel speed sensors are installed on the wheels.

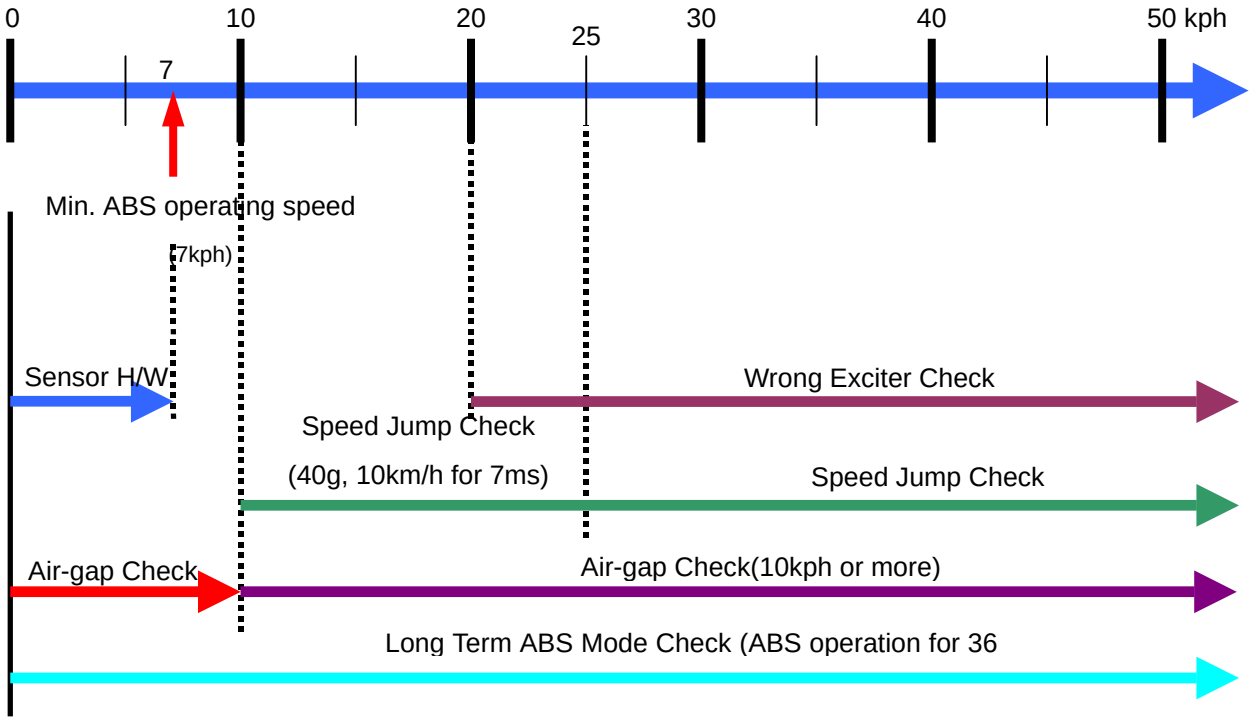
Front

Air gap: 0.65 +0.3, - 0.05mm

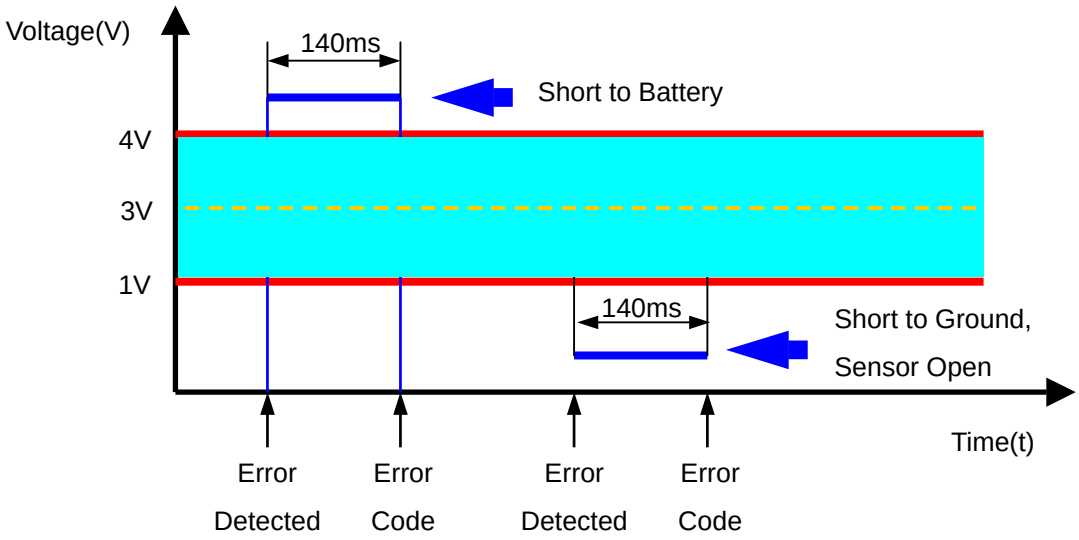
Rear

Air gap: 0.5 +0.4, -0.15mm

*** SENSOR CHECK FLOW**

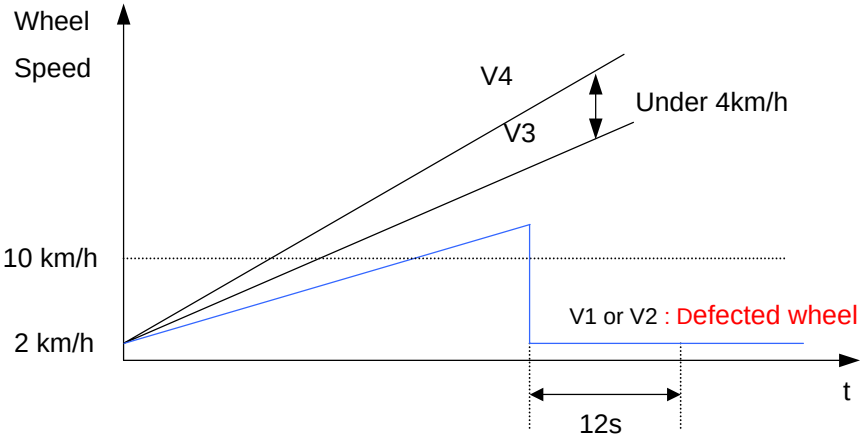


*** SENSOR OPEN/SHORT CHECK (under 7km/h)**



- Error code: C1200(FL), C1203(FR), C1206(RL), C1209(RR)

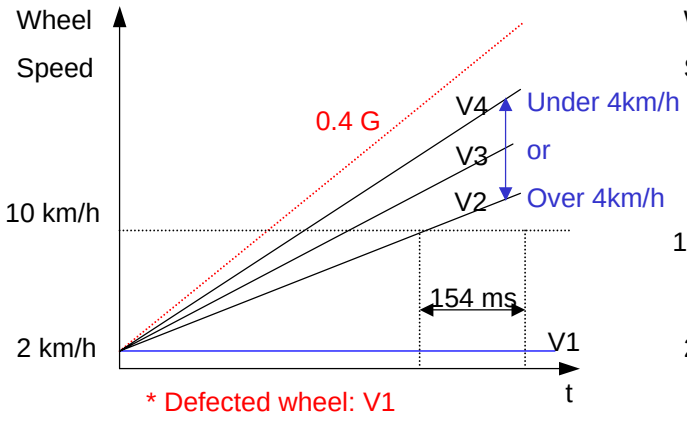
*** SENSOR AIR-GAP FAILURE**

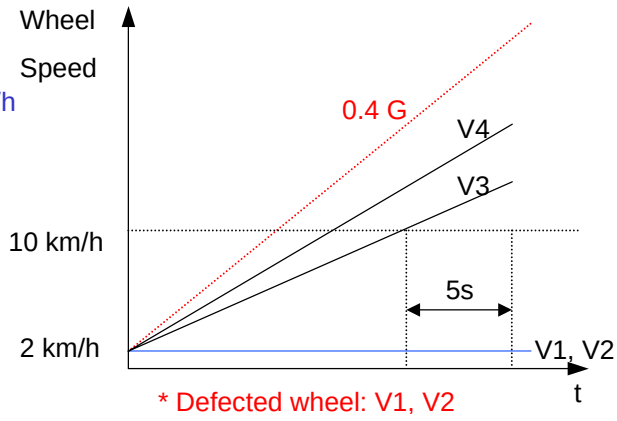


- Error code: C1202(FL), C1205(FR), C1208(RL), C12011(RR)

*** SENSOR AIR-GAP FAILURE (Under 0.4G)**

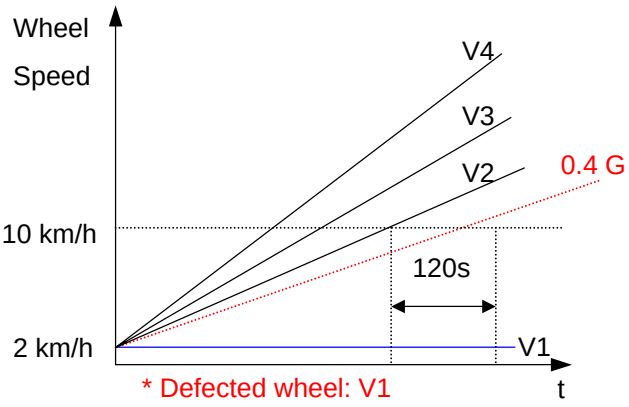
- Error code: C1202(FL), C1205(FR), C1208(RL), C12011(RR)

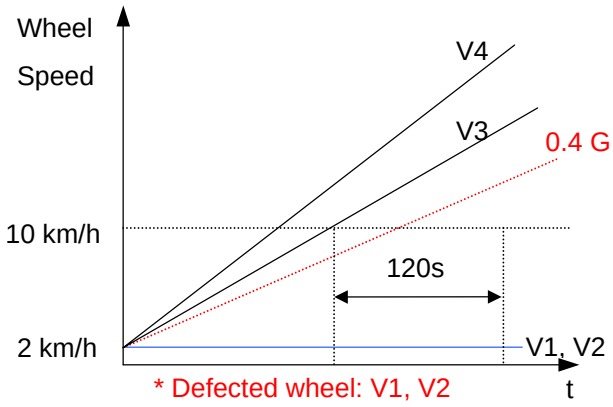




*** SENSOR AIR-GAP FAILURE (Over 0.4G)**

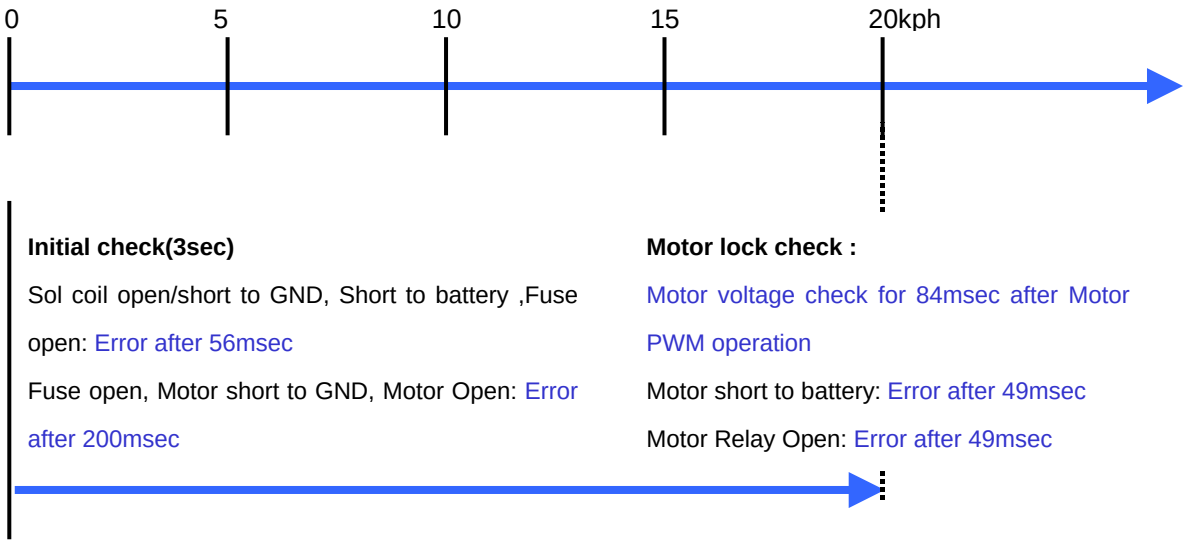
- Error code: C1202(FL), C1205(FR), C1208(RL), C12011(RR)





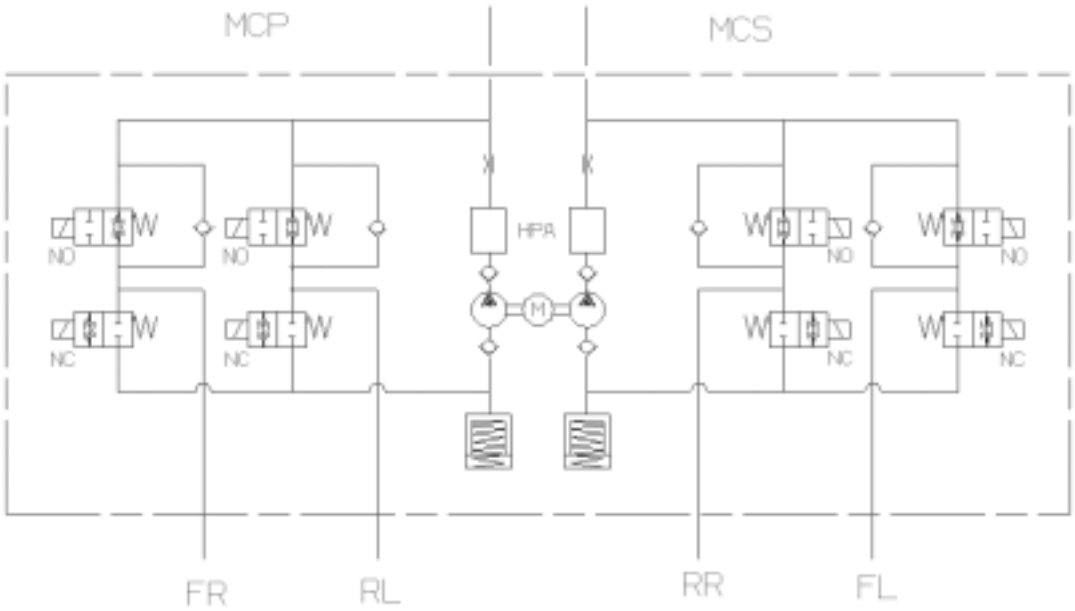
1.12. ACTUATOR MONITORING

* MOTOR/SOLENOID CHECK



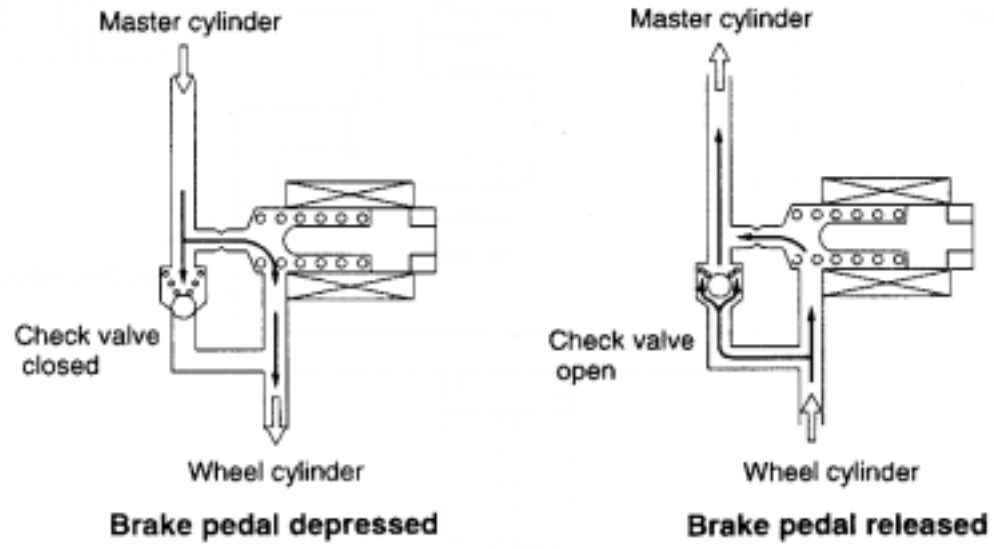
1.13. ABS OPERATION

1) HYDRAULIC CIRCUIT

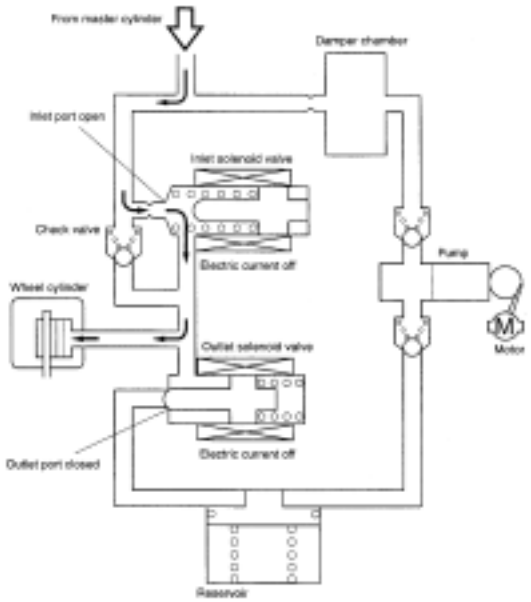


2) CHECK VALVE

The check valve allows the flow of brake fluid in a single direction. When the brake pedal is depressed, brake fluid flows through solenoid valves to the wheel cylinders. At this time the check valve is closed. When the brake pedal is released, wheel cylinder brake fluid opens the check valve, which cause the wheel cylinder brake fluid to return to the master cylinder through the check valve and solenoid valves. Check valve operation allows wheel cylinder brake fluid to bypass the narrow passage of the solenoid valves and return to the master cylinder more quickly.



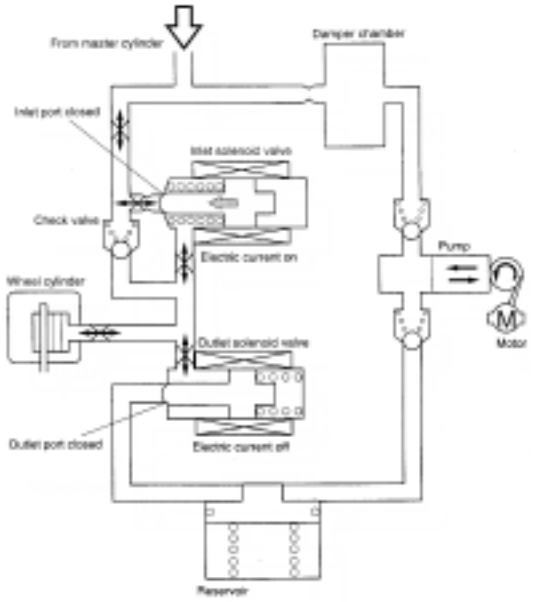
3) NORMAL BRAKING



As well known from the conventional brake system, the pedal force applied by the driver is assisted by a vacuum booster. Actuation of pedal is built up in the brake circuits.

Out of ABS range, no current flows from the ABSCM to the inlet and outlet solenoid valves. The braking pressure from the master cylinder is delivered to each wheel cylinder via the inlet solenoid valve.

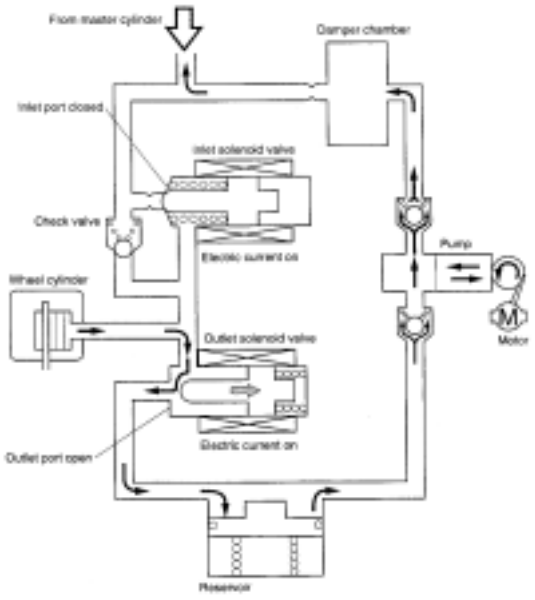
4) PRESSURE HOLD



When a wheel lock-up begins, the ABSCM sends electrical current to the inlet solenoid valve. This allows the valve to overcome the spring force closing the inlet port and cutting off the passage between the master cylinder and the wheel cylinder.

This time outlet valve is not activated remaining it closed. Therefore Brake fluid pressure acting on the wheel cylinder is hold at its current level.

5) PRESSURE DUMP

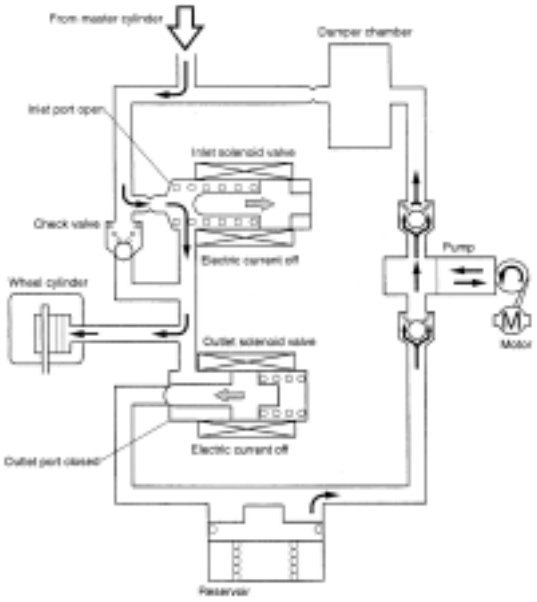


Wheel speed decreases further while brake pressure is held at its current level, the ABSCM sends electrical current to the outlet solenoid valve as well as the inlet solenoid valve.

Outlet port remains open and the passage between the wheel cylinder and the low pressure accumulator.

Brake fluid inside the wheel cylinder flows out to the low pressure accumulator, reducing brake pressure in the wheel cylinder. The fluid in the low pressure accumulator dumps out to the master cylinder by the plunger pump.

6) PRESSURE INCREASE



Wheel speed start to increase during the brake fluid pressure hold or after the pressure decrease, the ABSCM assumes that there is no possibility of wheel lock-up, and so it turns off current to the inlet solenoid and outlet solenoid. This causes both vales to be returned to their home position by their springs, opening the inlet port and closing the outlet port.

Since the inlet port is open and the outlet port is closed, the brake fluid pressure of the master cylinder reaches the wheel cylinder just as with normal braking, so wheel cylinder brake fluid pressure increases.

1.14. EBD (Electronic Brake-force Distribution)

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

It further utilizes the efficiency of highly developed ABS equipment by controlling the slip of the rear wheels in the partial braking range. The brake force is moved even closer to the optimum and controlled electronically, thus dispensing with the need for the proportioning valve.

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

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

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

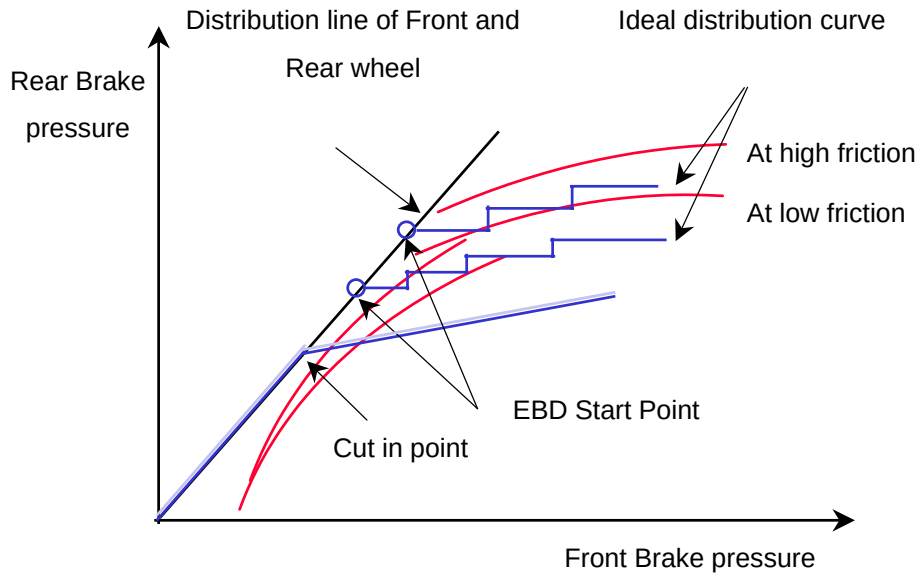
CONCEPT

- Utilization of existing ABS components
- Function achieved by software extension

ADVANTAGES

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

BRAKE FORCE DISTRIBUTION OF FRONT & REAR



1.15. FAILSAFE

FAIL CAUSE	SYSTEM		SRI	
	ABS	EBD	ABS	EBD
None	ON	ON	OFF	OFF
1-Wheel speed sensor failure	OFF	ON	ON	OFF
Pump malfunction	OFF	ON	ON	OFF
Low Voltage	OFF	ON	ON	OFF
2 or more WSS failure Solenoid valve failure ABSCM malfunction Other failure	OFF	OFF	ON	ON

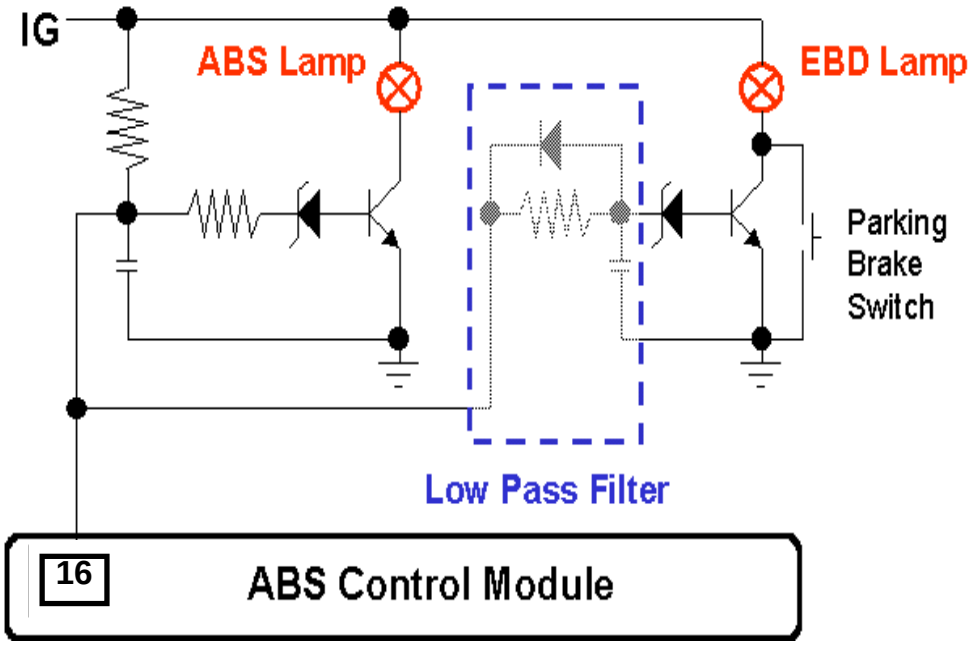
1.16. ACTIVE WARNING LAMP MODULE

ACTIVE CIRCUIT (ABS/EBD warning lamp)

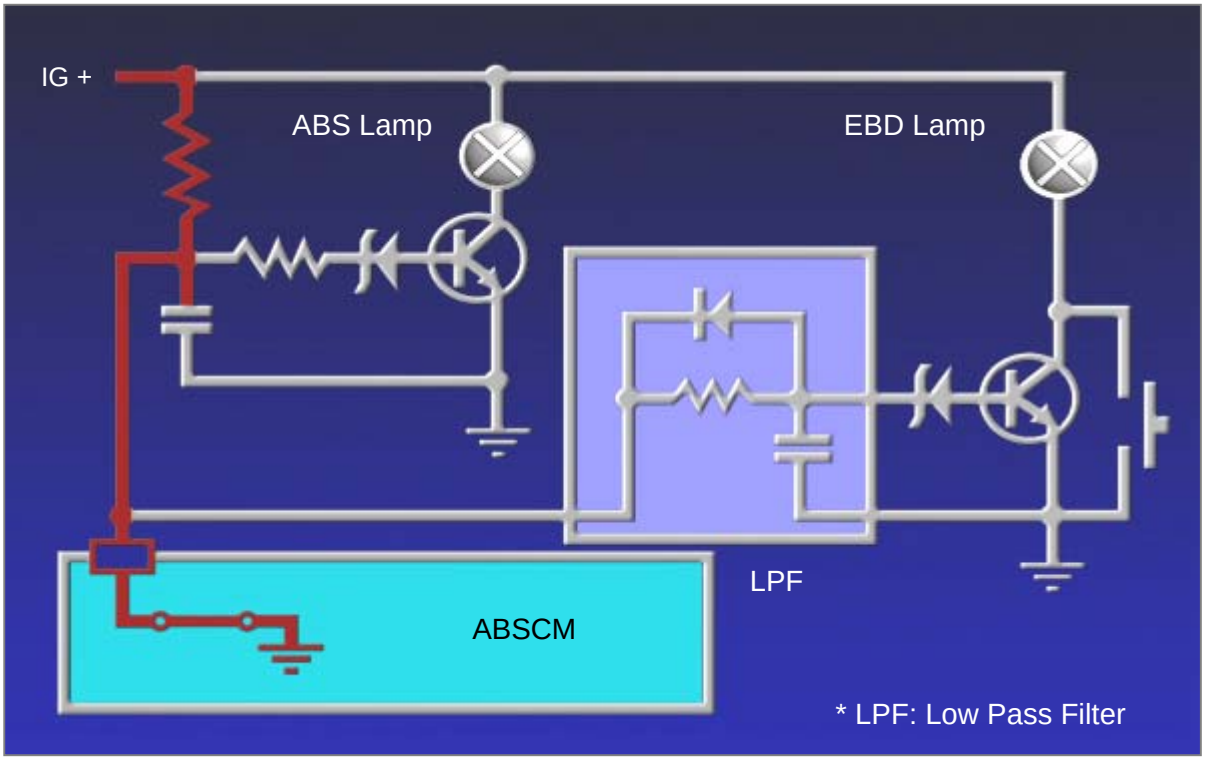
: Warning lamp is turned on due to the activation of transistor, which is energized by ABSCM, on the cluster. And even in case that ABSCM connector is removed, warning lamp can turn on by cluster circuit.

ABS & EBD Warning Lamp

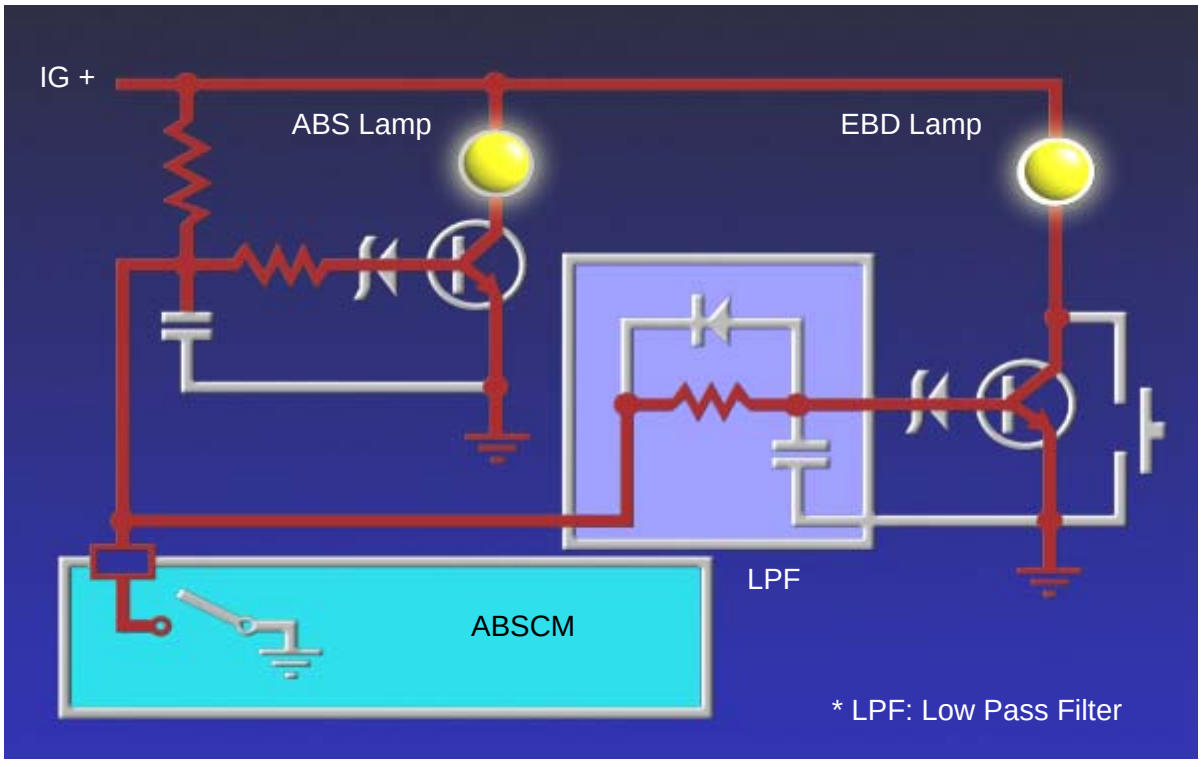
ABS & EBD WARNING LAMP CIRCUIT



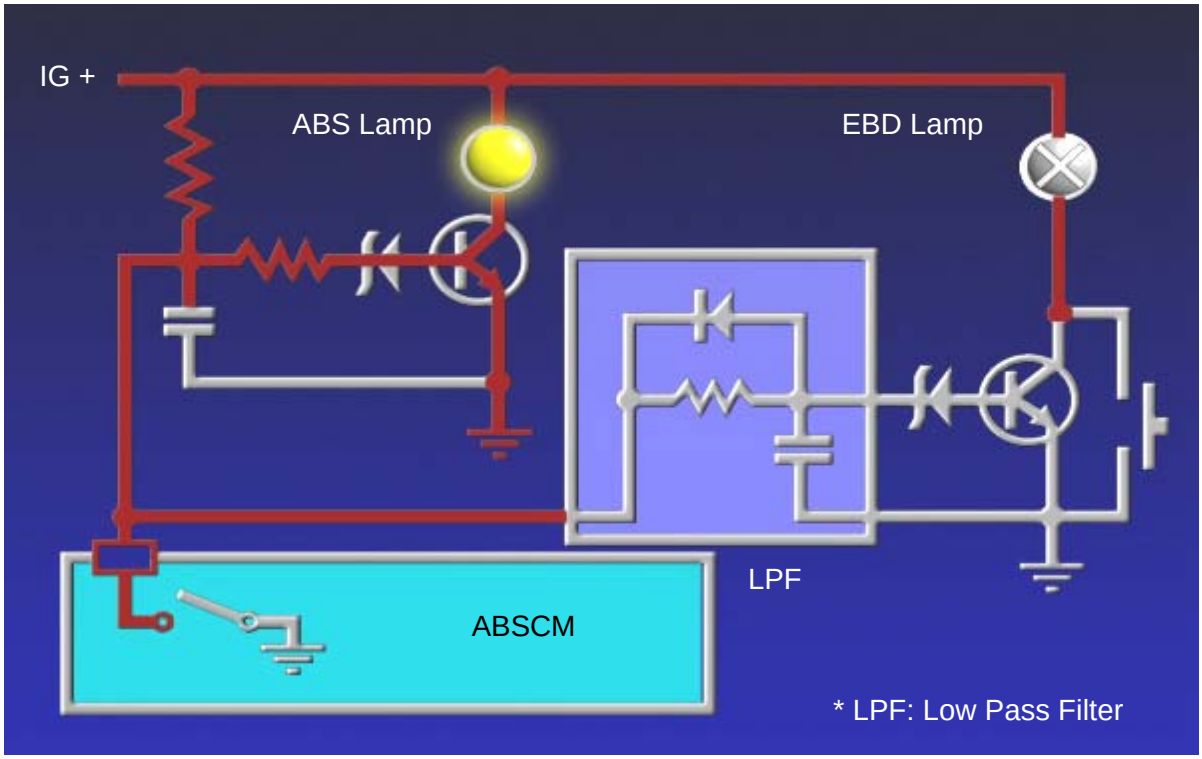
1. ABS & EBD warning lamp “OFF”



2. ABS & EBD warning lamp “ON”

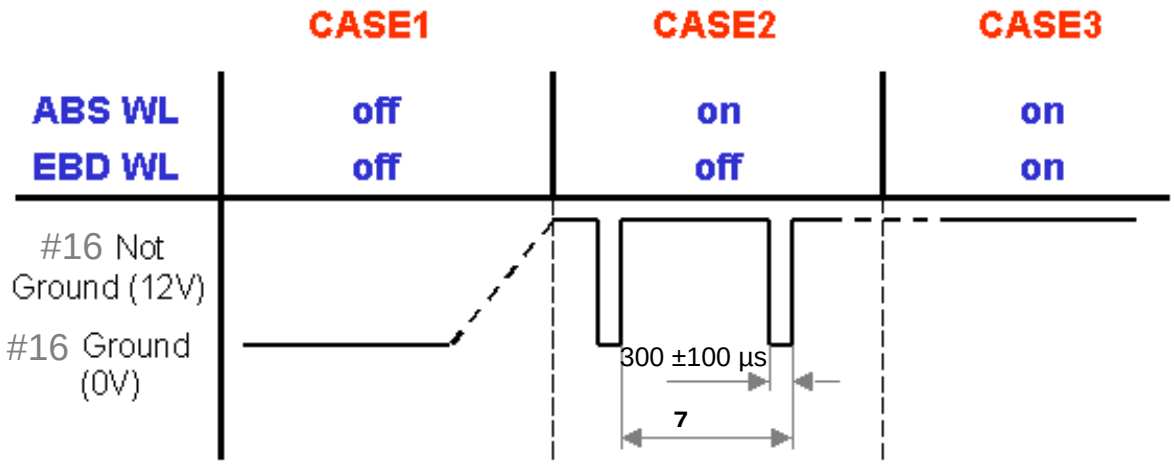


3. ABS warning lamp “ON”, EBD warning lamp “OFF”



LOW PASS FILTER

Low Pass Filter is located on the EBD Warning Lamp circuit. If the frequency of the signals from ABSCM is high, ABSCM can only turn ABS WL on, remaining EBD WL off. Because Only low frequency signals are allowed to pass the Low Pass Filter. ABS Warning Lamp is continuously on because it is off only for 300±100 μs.



CASE 1)

ABSCM(#16 terminal) is grounded, and both lamps are off.

: When the terminal #16 of the ABSCM is grounded, current flows from the IG switch to the #16 terminal. So, voltage to operate the transistor of the each warning lamp is 0 volt. Therefore, both lamps are off.

CASE 2)

ABSCM(#16 terminal) sends signals to the both lamps, and ABS WL is on but EBD WL is off.

CASE 3)

ABSCM(#16 terminal) is not grounded, and both lamps are on.

(In case that the terminal #16 is not grounded, voltage from the IG switch operates transistor and both lamps are on.)

2. TRACTION CONTROL SYSTEM (BTCS/FTCS)

There are two kinds of the MGH-20 TCS applied to the CERATO according to the engine. The 1.6 Alpha engine and the 2.0 Diesel engine are installed with the BTCS(Brake Traction Control System) optionally, the 2.0 Beta engine using CAN communication are installed with the FTCS(Full Traction Control System) optionally.

2.1. TCS PRINCIPLE

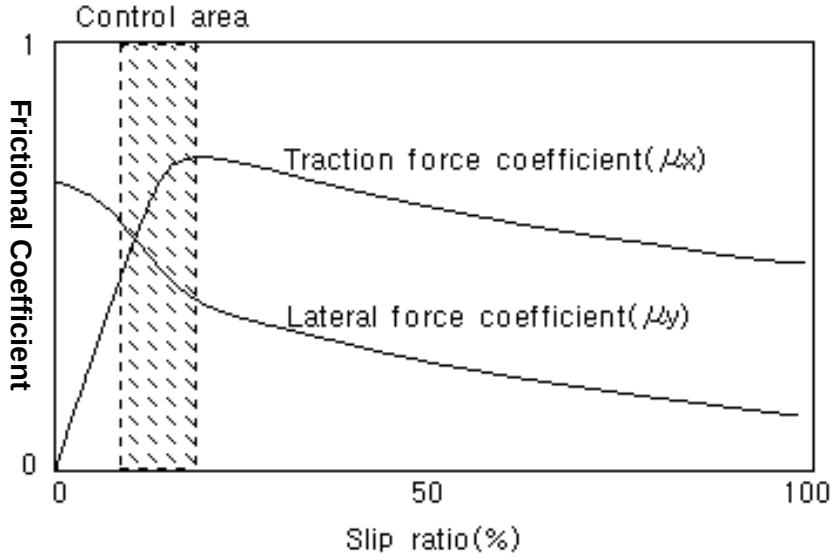
Vehicle acceleration on the low frictional road surface such as snow or ice depends on the friction force between the road surface and the tyres. And that amount of engine torque is used for traction and the rest torque generates unnecessary slip of the driving wheels.

As shown in the picture below, excessive slip of the driving wheels results in the decrease of traction force coefficient and worsens the driving force as well as vehicle stability caused by lateral force coefficient decrease.

Therefore, to get an enhanced vehicle traction and stability by controlling the slip ratio of the driving wheels is the purpose of TCS control.

Slip ratio is,

$(Vw - Vv)/Vw \times 100\ (\%)$ (Vw : Wheel speed, Vv : Vehicle speed)



[Traction and lateral force Characteristic according to the slip ratio]

If during acceleration one of the driven wheels has the tendency to spin caused by excessive engine torque, pressure in the wheel cylinder will be increased to prevent spinning. Spinning tendency will be detected by the wheel speed sensors.

To increase pressure, the TC solenoid valve will be closed and the pump starts to run. It sucks volume out of the accumulator and pumps it via the solenoid valve to the caliper. The caliper of the spinning wheel will be pressurized.

As in the ABS pressure modulation concept, the caliper pressure is controlled to prevent spinning wheels and achieve maximum traction and stable vehicle behavior.

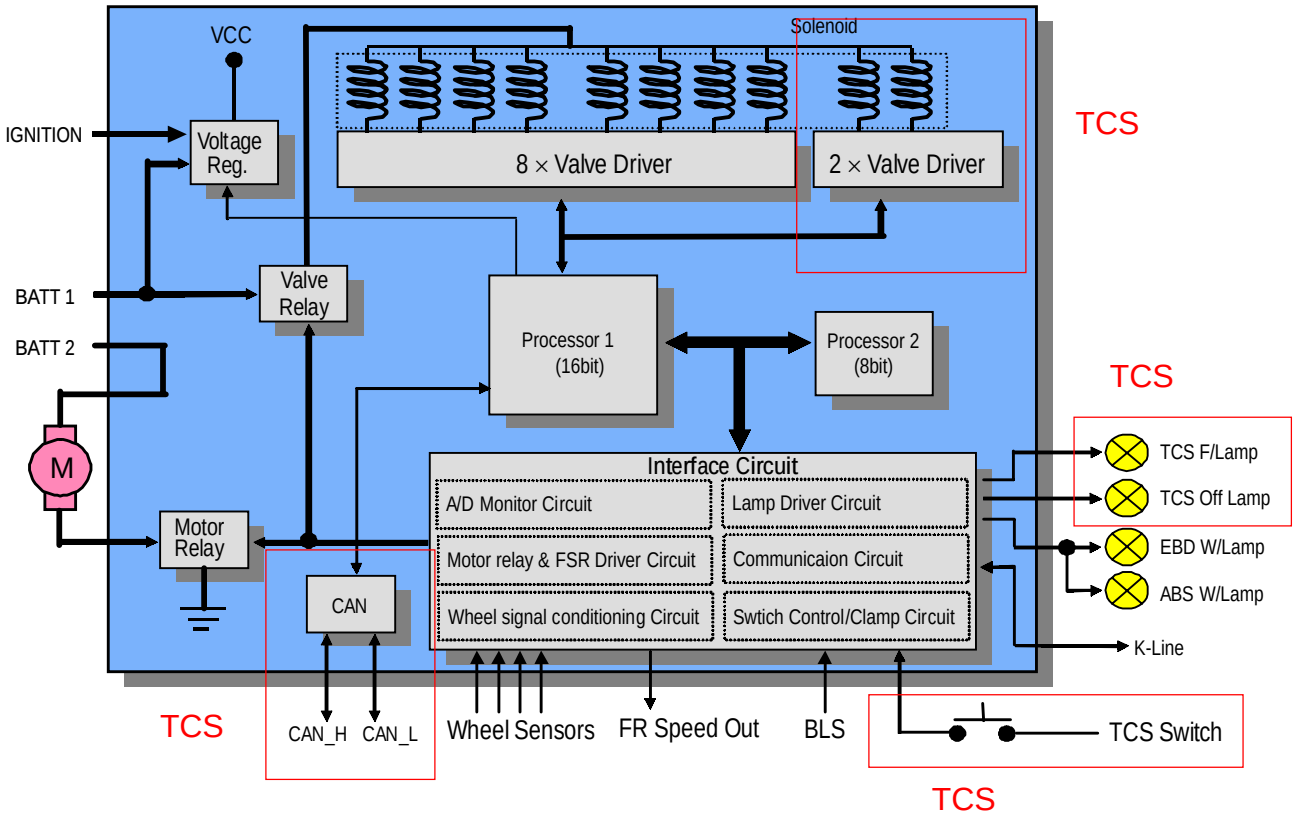
2.2. SAFETY CONCEPT

TCS components as well as the ABS components are continuously monitored by the control module.

The safety concept always has priority to brake function. TCS valves are incorporated in the hydraulic circuit in such a way that braking of non-driven wheels is always possible.

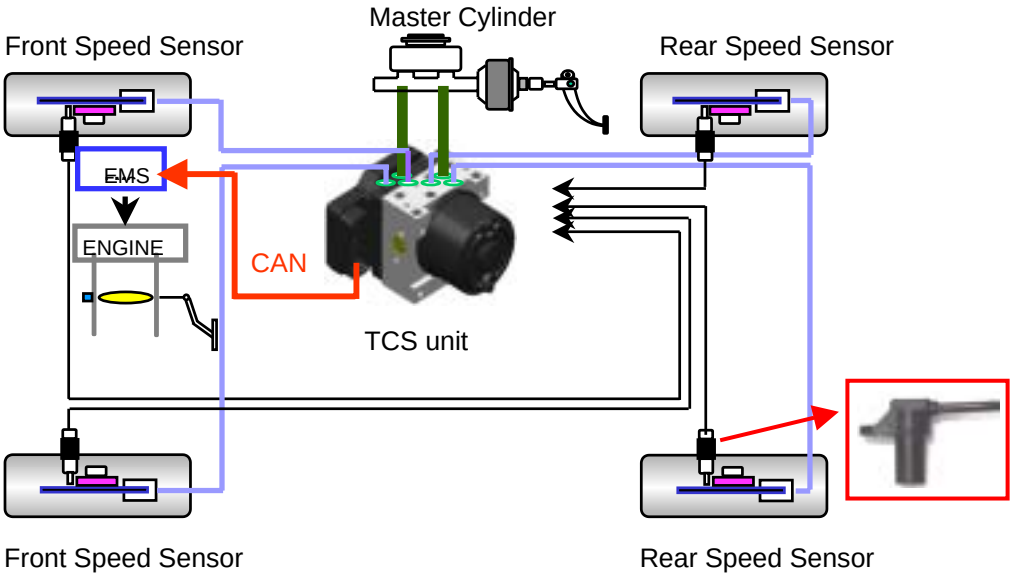
For prevention of excessive brake temperature caused by TCS function, the temperature of the brakes is calculated at any time when the vehicle is being driven. TCS function will be switched off when brake temperature exceeds a certain limit.

2.3. TCSCM BLOCK DIAGRAM



2.4. TCS CONSTRUCTION

System Construction : TCS unit + Wheel Speed Sensors +CAN



2.5. TCS CONTROL TYPE

To reduce an excessive moving slip when a vehicle starts and accelerates on the low frictional road, ETCS that controls engine torque and BTCS that controls brake pressure are available. An recently FTCS, the combination of ETCS and BTCS, is increasing its share.

1) ETCS: Engine torque control

- ▶ Direct control type: Throttle valve control
- ▶ Indirect control type: Ignition timing control, Fuel injection control

  : Incorporated in the most vehicle owing to cost reduction

2) BTCS: Brake pressure control:

: Independent control of each driving wheel

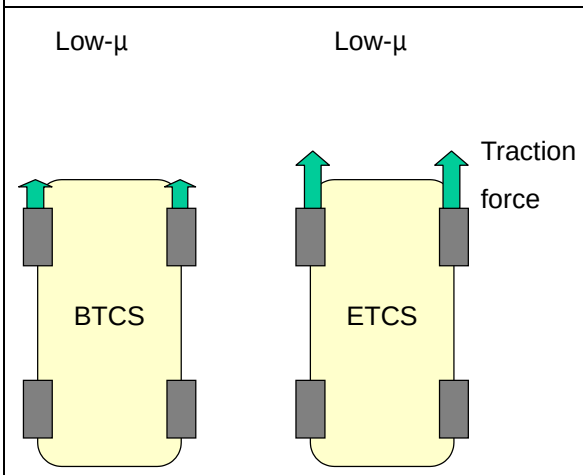
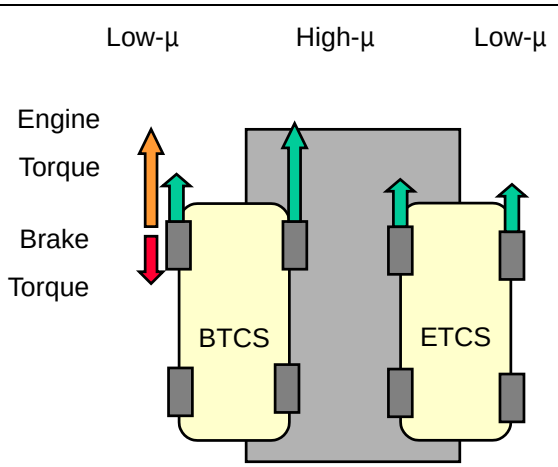
3) FTCS: ETCS + BTCS

2.6. COMPARISON

BTCS restricts the driving force by the brake application. Independent control for a slipping wheel is available. BTCS control has a speed limitation. It is available until around 50km/h.

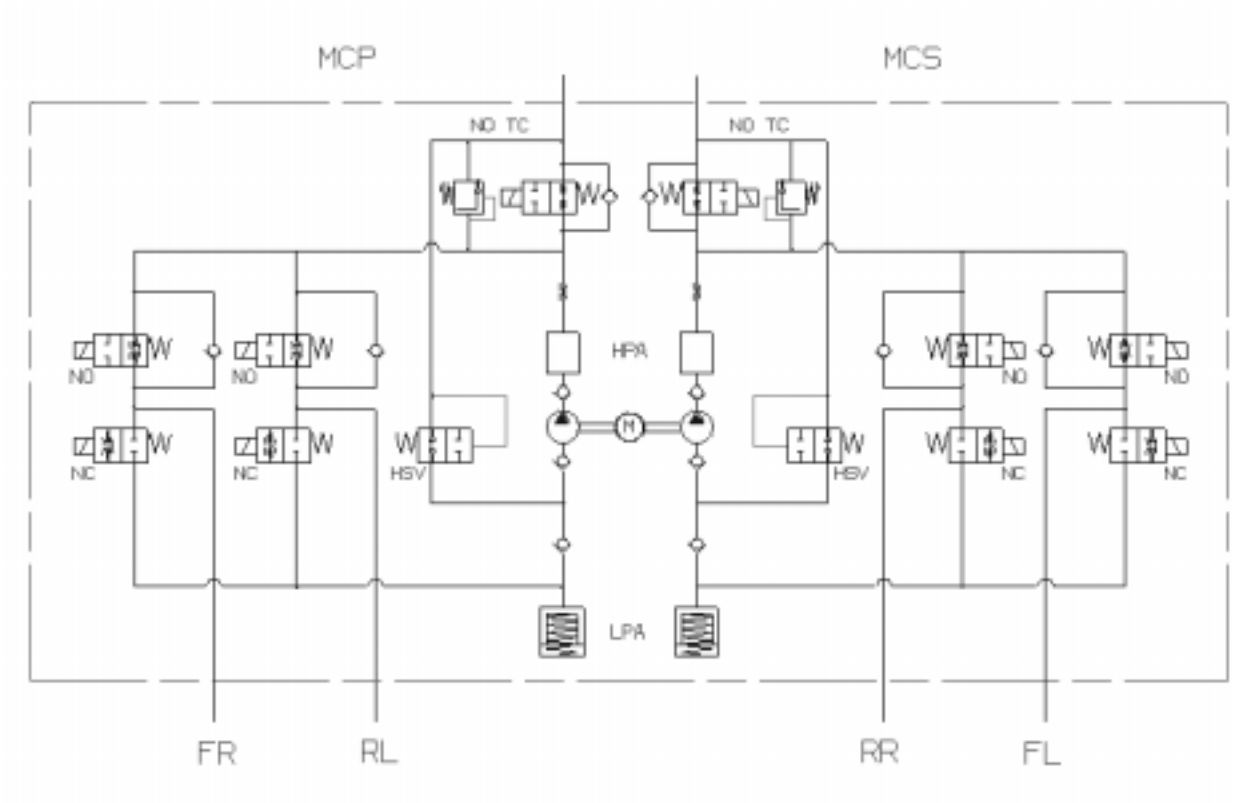
FTCS performs a brake control as well as the engine torque control through the CAN communication. Once wheel slip from one or both of the wheels is detected by the control module, torque reduction for the both driving wheels is performed.

BTCS vs. ETCS

Homo-μ	**Split-μ**
	
- Better traction force (ETCS) - Trace control at high speed - Comfortable (No vibration & noise)	- Better traction force (BTCS) - Speed limitation(BTCS) - Not comfortable (vibration & noise)

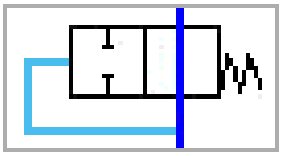
2.7. TCS HYDRAULIC CIRCUIT

It includes the ABS function and comprises of the eight solenoids for the ABS control as well as the two more solenoid valves for TCS and the two Hydraulic Shuttle Valves (HSV).



2.8. TCS HYDRAULIC UNIT

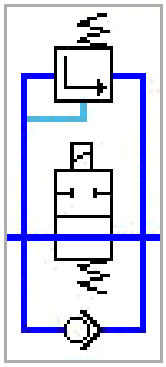
1) HS (Hydraulic Shuttle) Valve



When the TCS operates, the brake fluid is supplied to the motor pump from the M/C via HSV.

This valve is closed and blocks the passage when a brake pedal is applied.

2) TC (Traction Control) Valve



TC valve is only for the front wheels One side of this valve is connected with the master cylinder and the other side is connected with the HPA.

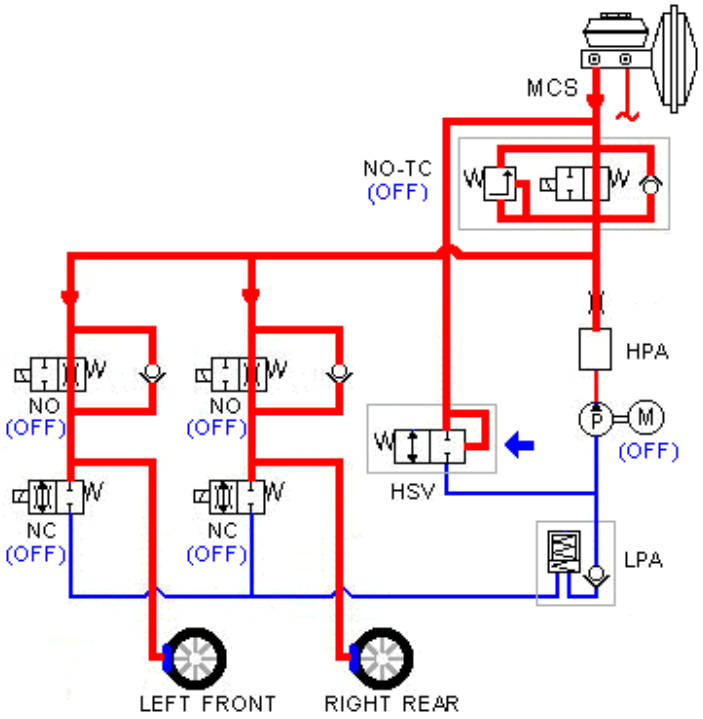
In case of a normal condition, this valve remains open and the brake pressure from the M/C can be applied to the front wheel via TC valve

When a front wheel spin occurs, TC valve is closed and the brake pressure is applied to the front wheel by the motor actuation.

TC valve includes a relief valve and a check valve. When excessive pressure is supplied from the motor, relief valve is opened and the pressure is relieved.

2.9. TCS OPERATAION

▶ NORMAL MODE



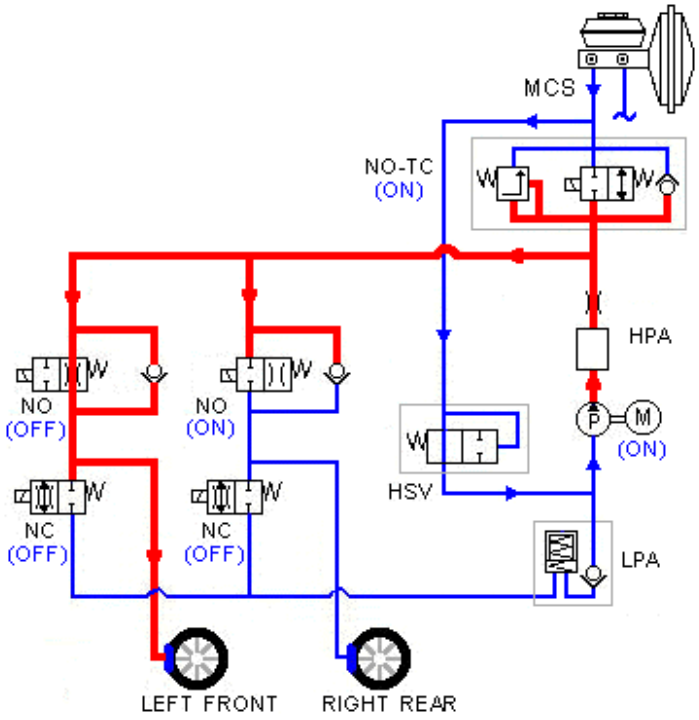
SOLENOID VALVE	N.O	OFF
	N.C	OFF
MOTOR		OFF
TC VALVE		OFF

In the normal driving condition, TC valve (normally open) is the passage between the master cylinder and the each wheel cylinder.

When brake pedal is applied, brake pressure is delivered to the wheel cylinders via NO-TC valve and all solenoid valves inside the hydraulic unit are deactivated.

In case of TCS malfunction it does not affect brake operation.

▶ PRESSURE INCREASE MODE



SOLENOID VALVE	FRT	N.O	OFF
		N.C	OFF
	RR	N.O	ON
		N.C	OFF
MOTOR			ON
TC VALVE			ON

If a front wheel spin is detected, TCS begins a brake control to decrease a wheel spin.

HSV is opened.

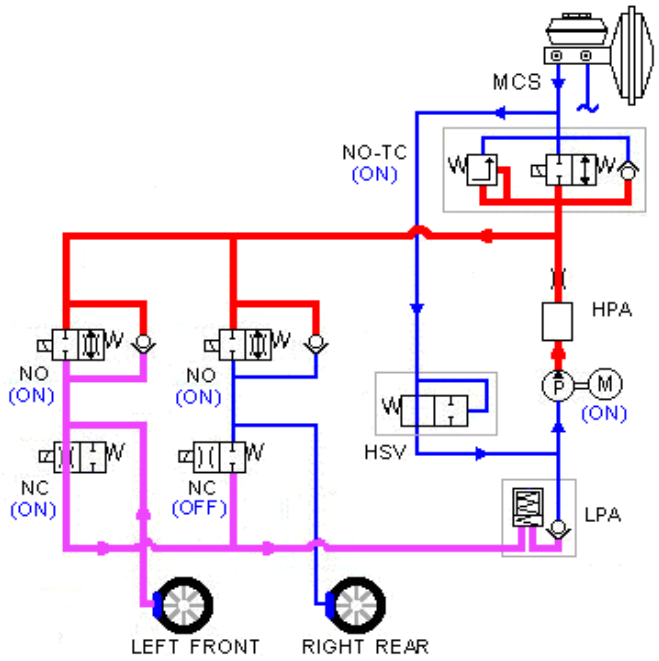
Brake fluid is supplied from the master cylinder by motor operation to the spin wheel via HSV.

TC valve is closed (ON).

Brake pressure generated from motor pump is delivered only to the front wheel.

Inlet valve remains open to deliver the brake pressure generated from motor pump to the spinning wheels

▶ PRESSURE DUMP MODE



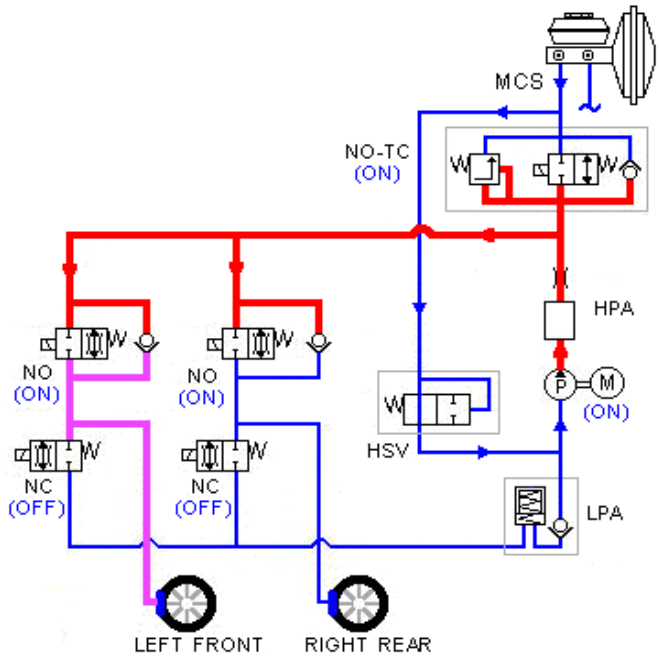
SOLENOID VALVE	FRT	N.O	ON
		N.C	ON
	RR	N.O	ON
		N.C	OFF
MOTOR			ON
TC VALVE			ON

When the wheel deceleration is under the threshold and the wheel spin is reduced under a slip threshold, applied brake pressure is reduced to get a optimum traction force.

Outlet valve is open to release the brake pressure and inlet valve is closed to block the pressure increase from the motor pump. HSV remains opened, TC valve is ON.

Motor is ON, to dump the brake fluid being released from the lock-up wheel.

▶ PRESSURE HOLD MODE



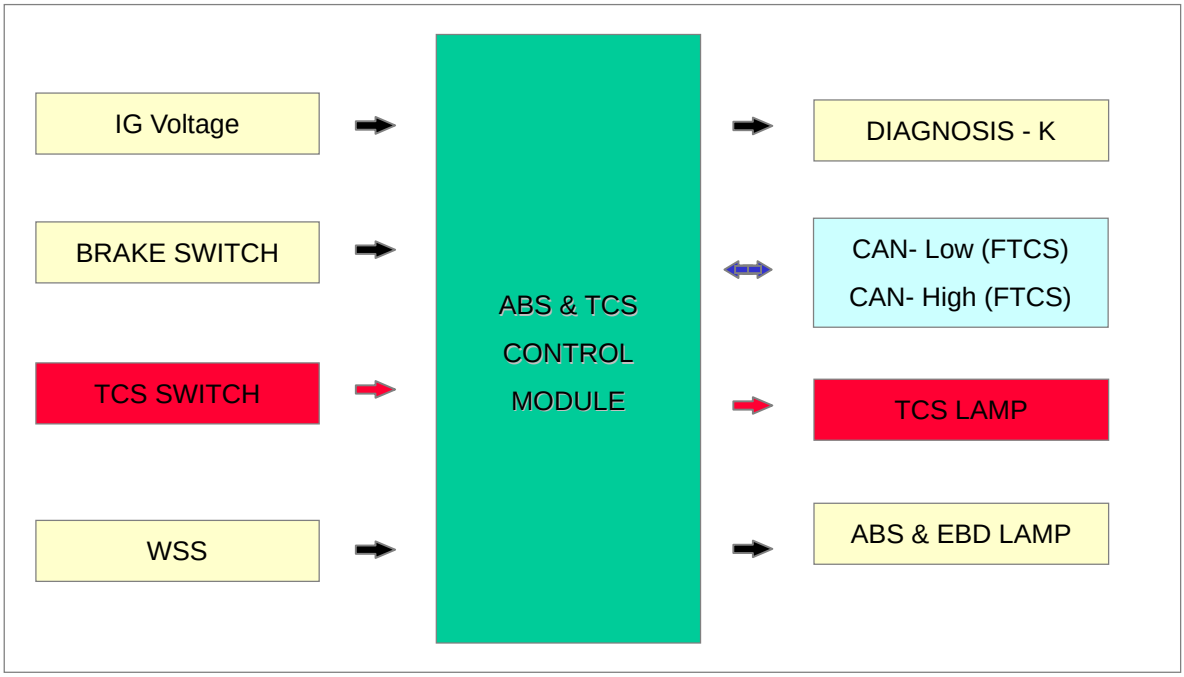
SOLENOID VALVE	FRT	N.O	ON
		N.C	OFF
	RR	N.O	ON
		N.C	OFF
MOTOR			ON
TC VALVE			ON

2.10. TCS WARNING LAMP

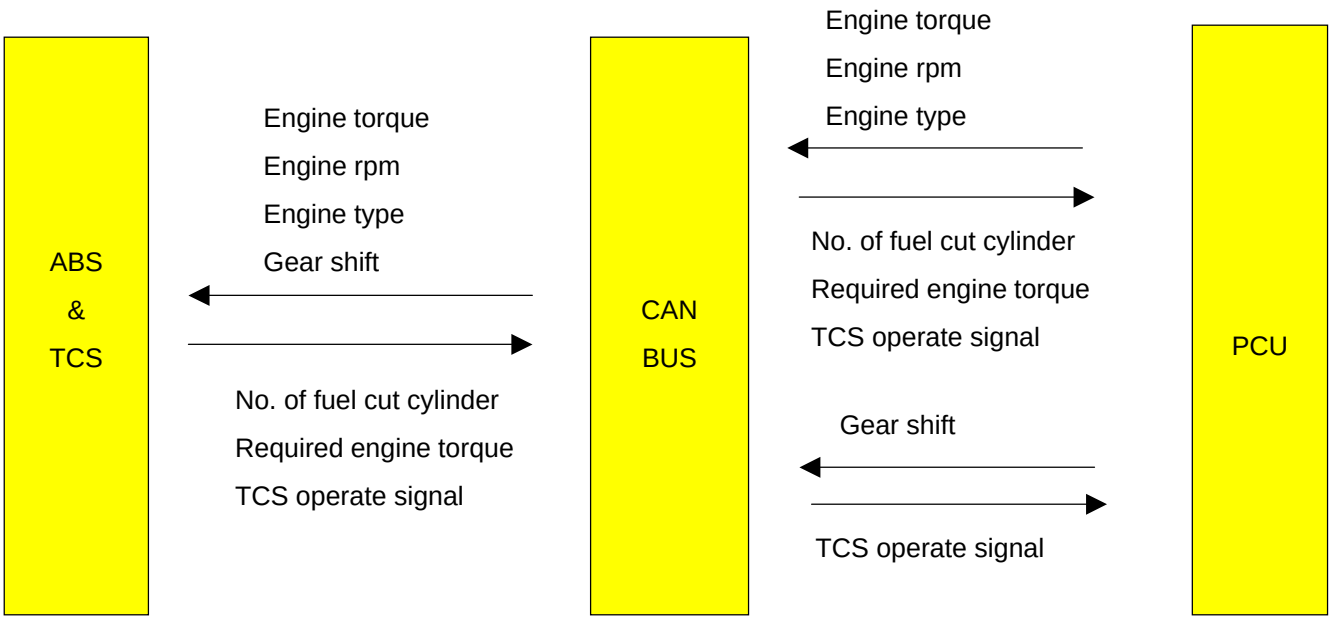
'TCS OFF' lamp is a TCS warning lamp. When the TCS system fails, TCS OFF lamp remains on.

'TCS' lamp is a TCS function lamp. This lamp flashes while TCS operation.

2.11. SYSTEM INPUT & OUTPUT



2.12. CAN (Control Area Network)



2.13. TROUBLESHOOTING

DTC LIST

C1101	OVER VOLTAGE	C1211	RR SENSOR - AIR GAP ERROR
C1102	LOW VOLTAGE	C1604	ECU SOFTWARE ERROR
C1200	LF SENSOR - OPEN OR SHORT	C2112	VALVE RELAY OR FUSE FAIL
C1201	LF SENSOR - SPEED JUMP	C2380	SOLENOID VALVE FAIL
C1202	LF SENSOR - AIR GAP ERROR	C2402	PUMP-MOTOR
C1203	RF SENSOR - OPEN OR SHORT	C2227	DISC OVERHEAT
C1204	RF SENSOR - SPEED JUMP	C1503	TCS SWITCH ERROR
C1205	RF SENSOR - AIR GAP ERROR	C1604	ECU SOFTWARE ERROR
C1206	LR SENSOR - OPEN OR SHORT	C1605	CAN HARDWARE ERROR
C1207	LR SENSOR - SPEED JUMP	C1616	CAN BUS OFF ERROR
C1208	LR SENSOR - AIR GAP ERROR	C1611	CAN TIME OUT EMS
C1209	RR SENSOR - OPEN OR SHORT	C1612	CAN TIME OUT TCM
C1210	RR SENSOR - SPEED JUMP	C1613	CAN TRANSMISSION UNMATCH

CAN COMMUNICATION ERROR

NO	ITEMS	DETECTED CONDITIONS	ERROR CODE	ABS W/LAMP	EBD W/LAMP	TCS W/LAMP
1	CAN L SHORT TO CAN H CAN H SHORT TO CAN GND CAN L SHORT TO CAN BAT	BUS OFF for 100ms	C1616	×	×	○
2	CAN L SHORT TO OPEN CAN H SHORT TO CAN GND CAN L SHORT TO CAN BAT	EMS Message missing for 500ms	C1611	×	×	○
3	TCU TIME OUT ERROR	TCU Message missing for 500ms (EMS=AUTO T/M)	C1612	×	×	○
4	TCU DATA UNMATCHING ERROR	TCU Message transmission for 500ms (EMS=MANUAL T/M)	C1613	×	×	○
5	CAN H/WARE ERROR	CAN H/WARE failure	C1605	×	×	○

C1605 CAN HARDWARE ERROR
: when CAN IC in the TCSCM malfunctions.

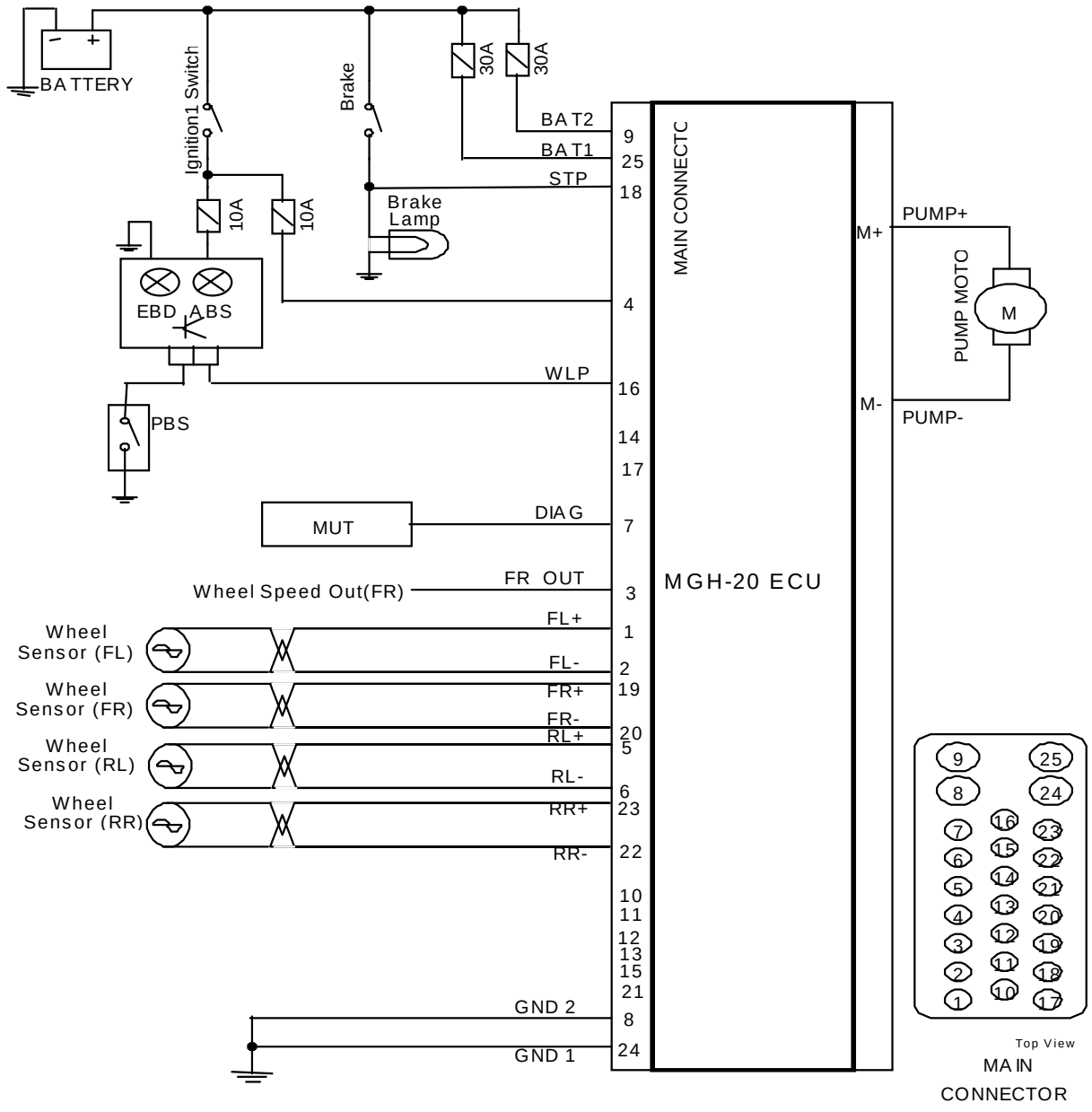
C1616 CAN BUS OFF ERROR
: When CAN communication line is open.

C1611 CAN TIME OUT EMS

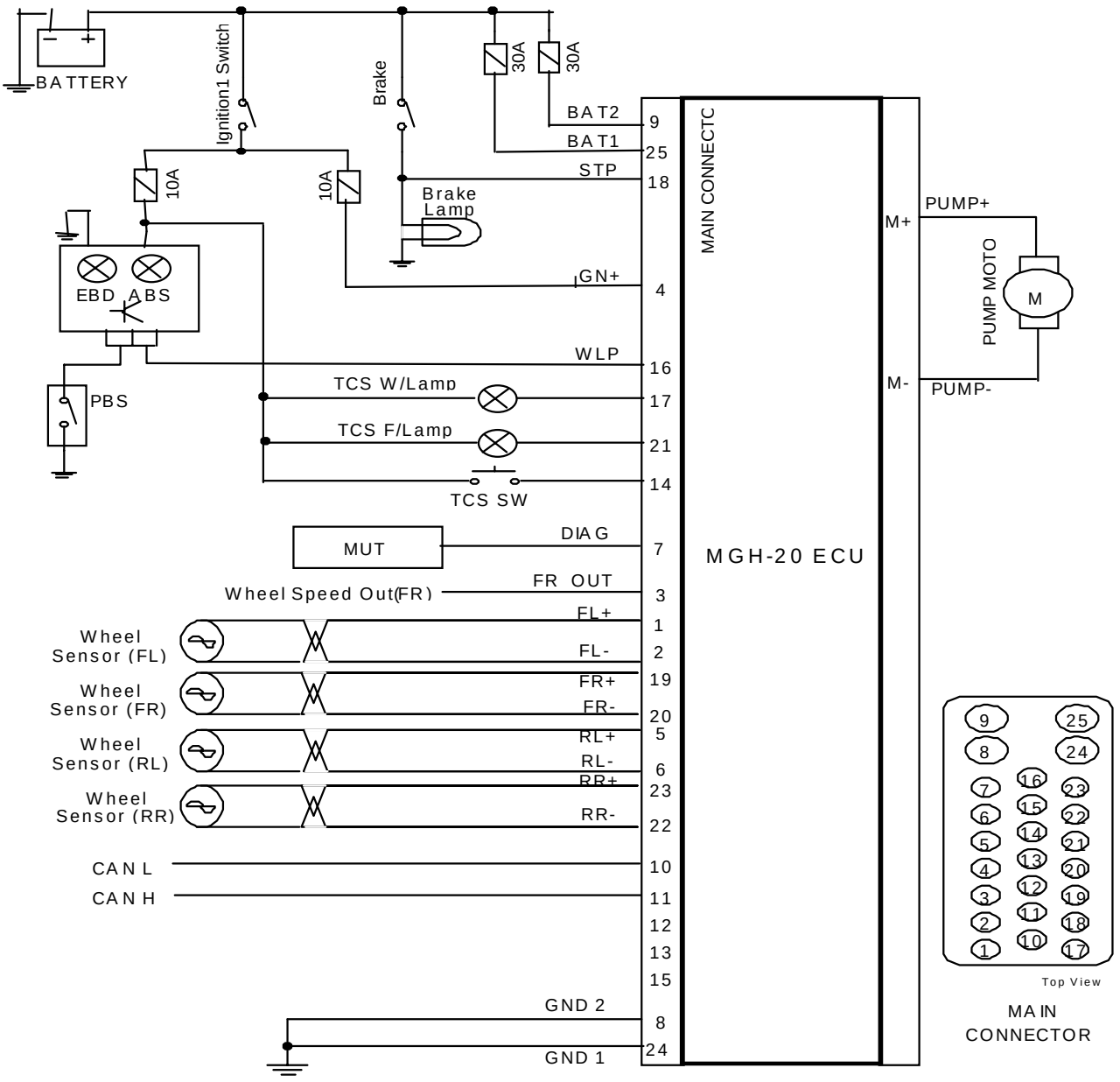
C1612 CAN TIME OUT TCM
: TCSCM, ECM, TCM sends its own conditions through CAN bus line.
If the signal from the ECM or TCM is not received for 500msec, then the corresponding trouble code is read and TCS warning lamp comes on.

C1613 CAN TRANSMISSION UNMATCH
: TCSCM is informed of transmission type from ECM.
If TCSCM receives manual transmission information from the ECM and at the same time it gets TCM data through CAN line, the trouble code above is read.

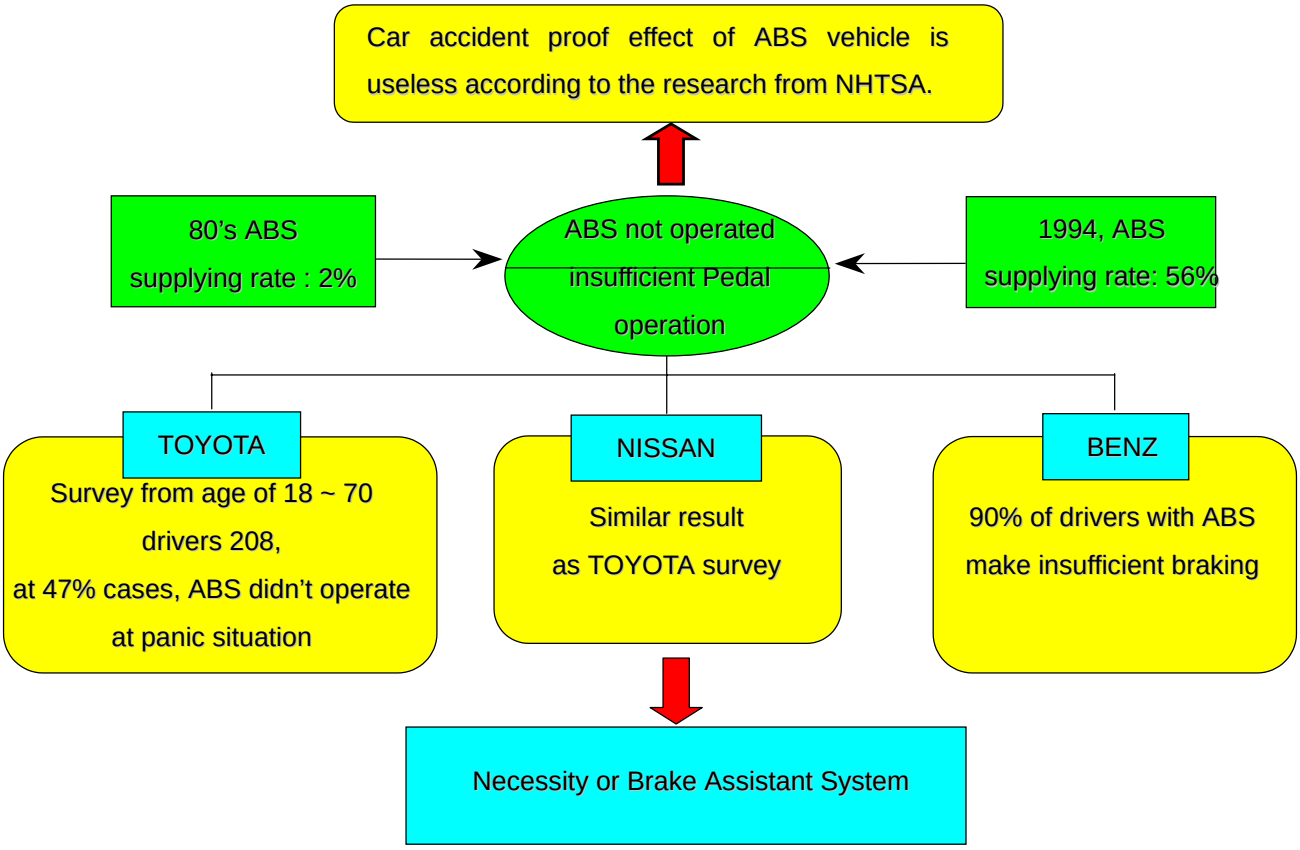
2.14. ABS EXTERNAL DIAGRAM



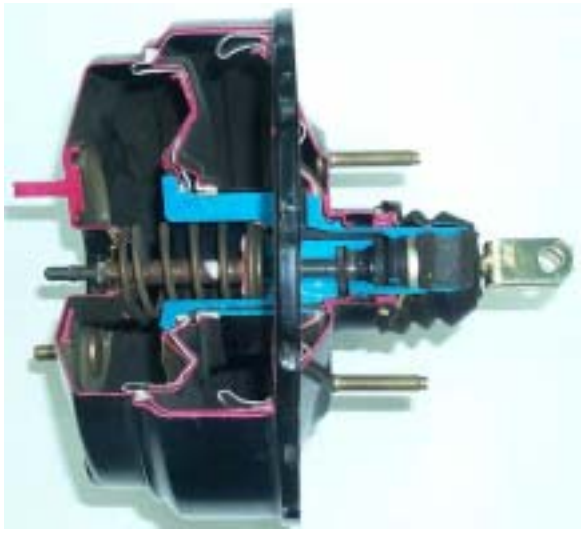
2.15. FTCS EXTERNAL DIAGRAM



3. BAS (Brake Assistant System)



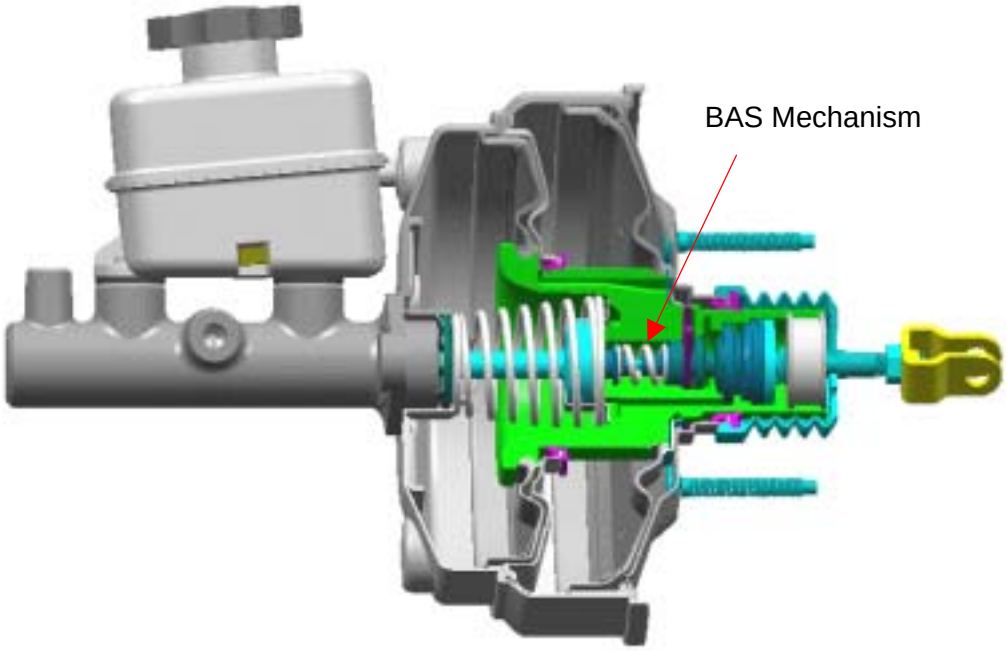
3.1. BOOSTER



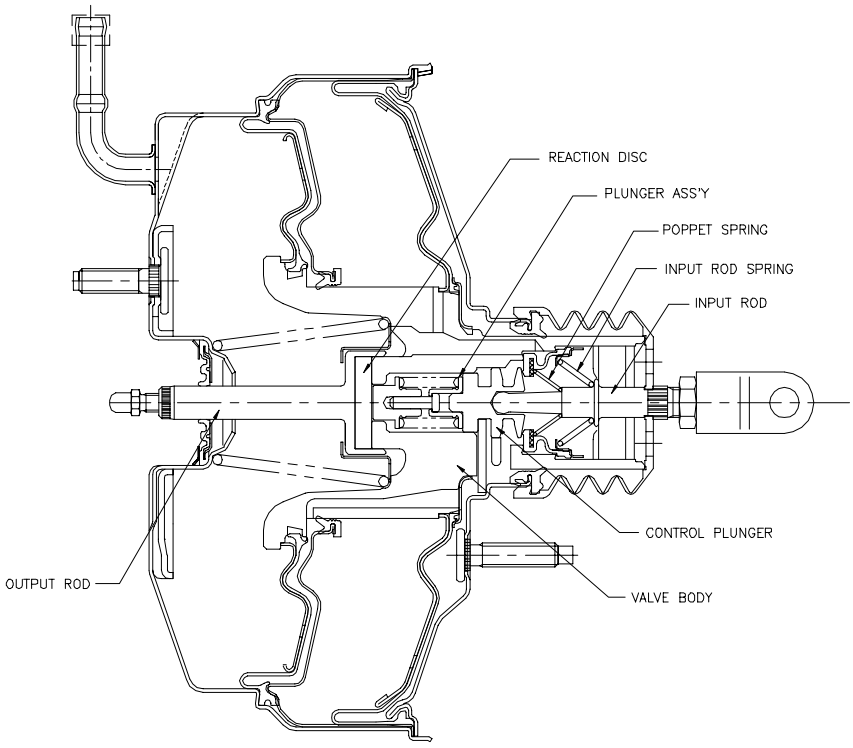
[Conventional Booster]

[2-Ratio Booster]

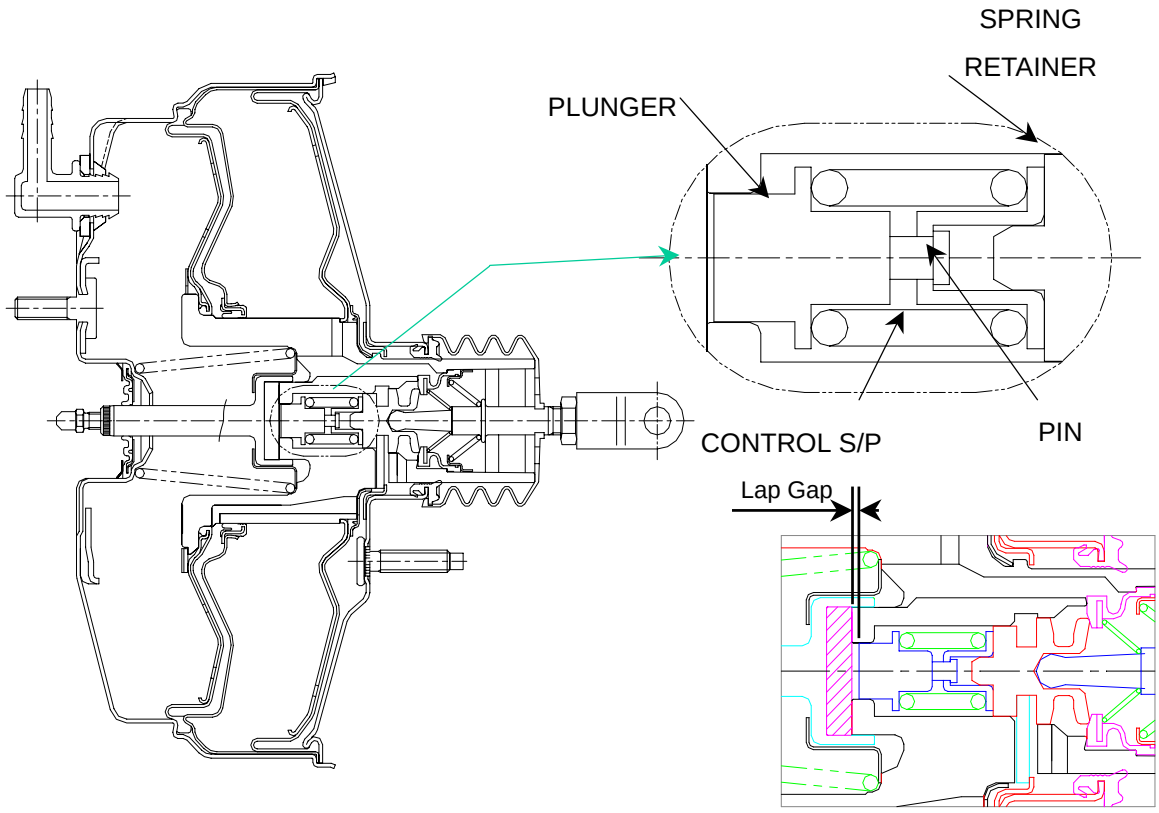
2-RATIO BOOSTER



* 1. 2-Ratio Booster Unique Parts: Control spring, Plunger, Spring Retainer, Pin



1) PLUNGE ASSEMBLY

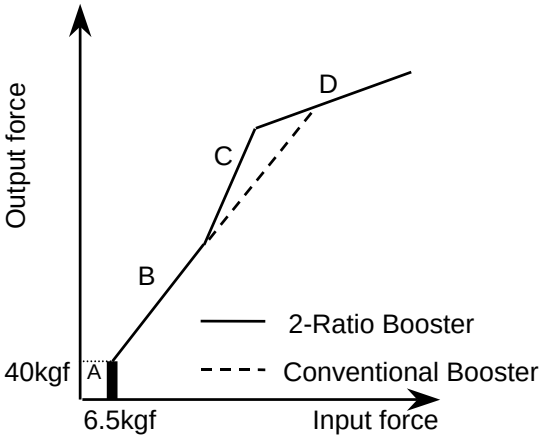


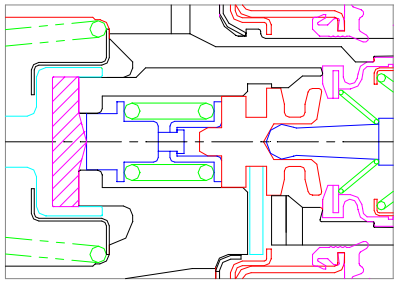
2) COMPONENTS

COMPONENTS	FUNCTIONS
CONTROL SPRING	Deliverers input force to plunger Spring deforms when the input force over its setting value 2-RATIO function can be available
SPRING RETAINER	Support a control spring Delivers input force to a control spring
PLUNGER	Delivers the input force to a reaction disc
PIN	Hold a plunger and spring retainer

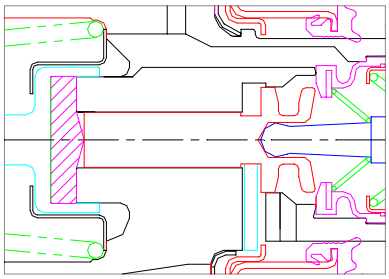
3) OPERATING PRINCIPLE

<Jump In Stage: 40kgf>





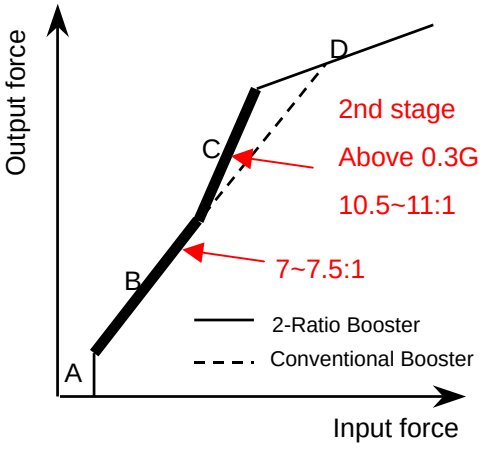
2-Ratio Booster

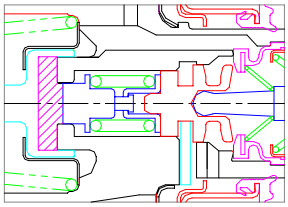


Conventional Booster

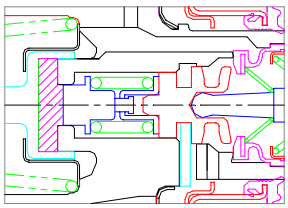
- Jump in stage continues until a reaction disc fills in the Lap Gap

<Boosting Stage>





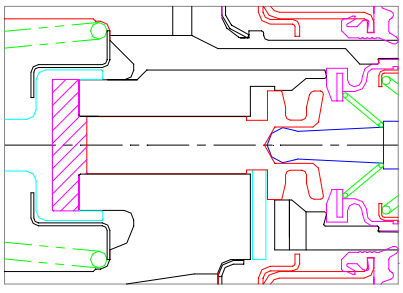
B : 1st Boost Ratio Stage



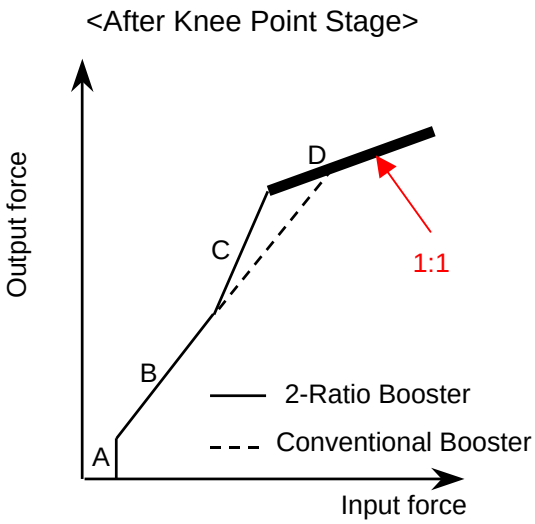
C : 2nd Boost Ratio Stage

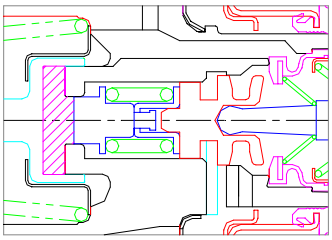
- Control spring is not compressed and moves together at Normal range (B)
- Increase pedal force → Control spring is compressed → Air valve opens more→ Boost ratio increase

2-Ratio Booster

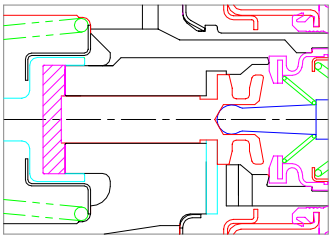


Conventional Booster





2-Ratio Booster



Conventional Booster

- Control spring adheres to a retainer, 1:1 ratio

4) PURPOSEOF 2-RATIO BOOSTER

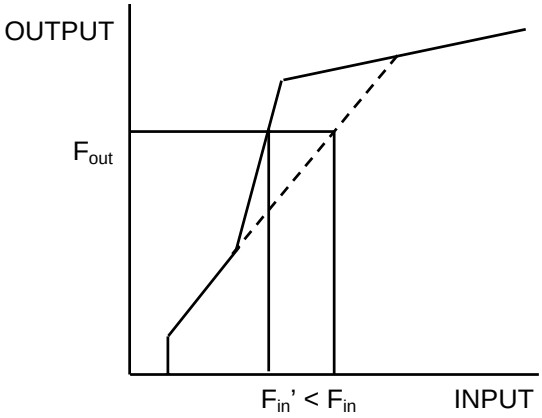
- To reduce input force at high pressure range by increasing a booster ratio
- Increase the braking response while sudden braking

*** ADVANTAGE**

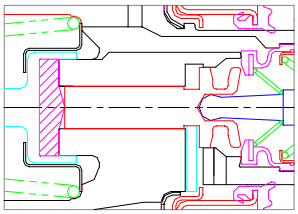
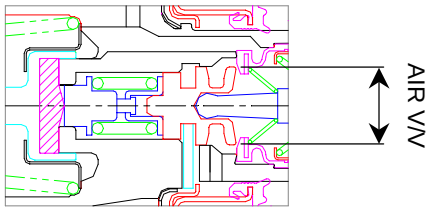
- Reduction of stopping distance while heavy braking (10~15%)
- Less input effort at high pressure applying range while heavy braking

*** DISADVANTAGE**

- Less knee point



5) COMPARISON OF CONSTRUCTION

ITEM	CONVENTIONAL	2-RATIO
PLUNGER		
AIR V/V AREA	77㎟	102㎟ (32% UP)
FEATURES		1. AIR V/V AREA UP (32% UP) 2. ROOM FOR CONTROL ASS'Y 3. 2-RATIO FUNCTION