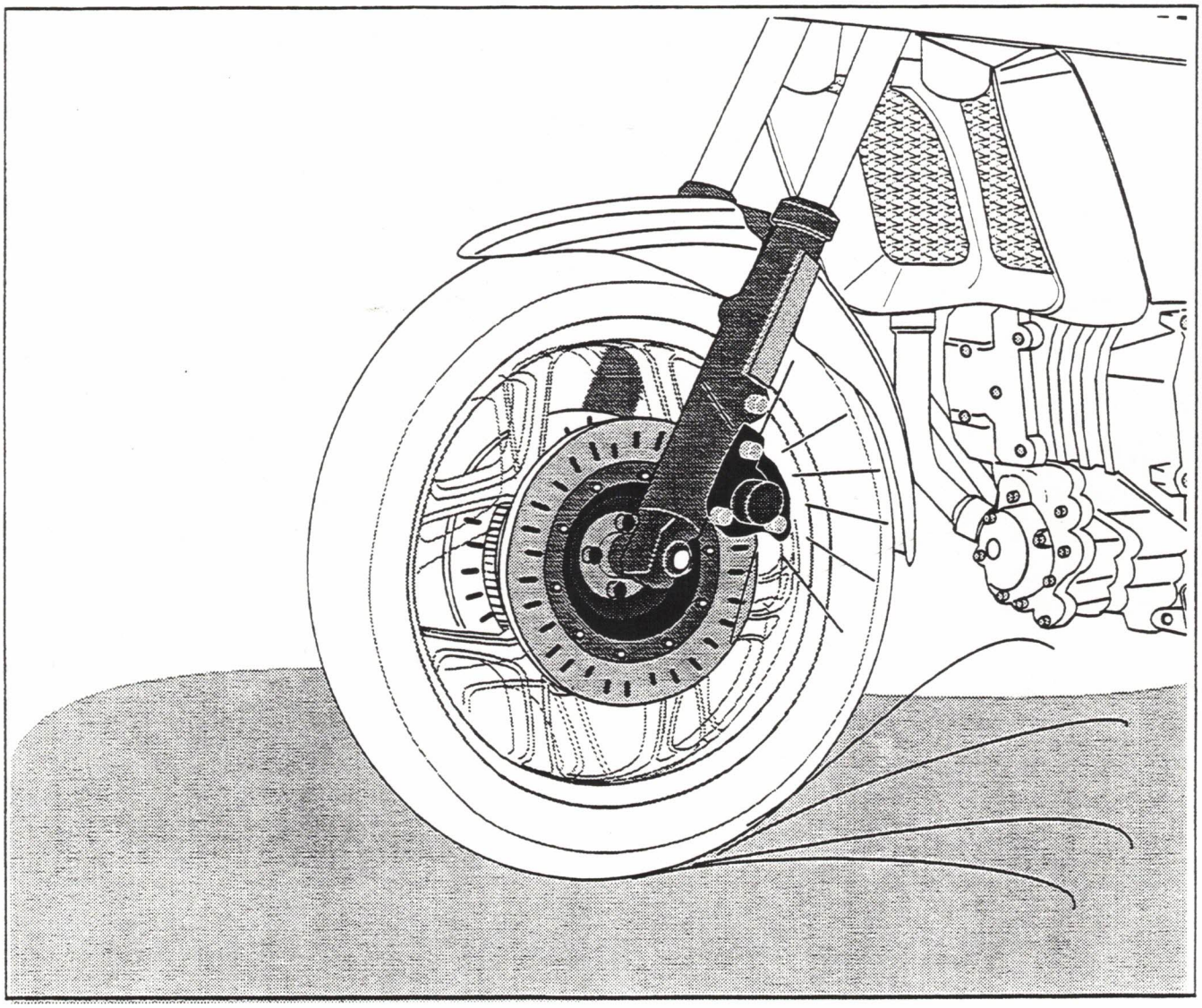
Level 2:

ABS

Training
Reference
Book



BMW of North America, Inc.
Motorcycle Service Department

Disclaimer

This training reference book is not intended to be a complete and all inclusive source for repair and maintenance data. It is only part of a training information system designed to assure that uniform procedures and information are presented to all participants at the BMW Motorcycle Service Training Center.

The technician must always refer to and adhere to the following official BMW service publications:

1. Service Information Bulletins
2. Repair Manuals/Microfiche
3. Specifications Microfiche
4. Electrical Wiring Diagrams

The information contained in the training course material is solely intended for participants in this training course conducted by the BMW Motorcycle Advanced Level Training.

Information Status, October 1993.

For changes/additions to the technical data, please refer to the current information issued by the BMW North America, Inc., Motorcycle Group.

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ABS System Overview

General

BMW, jointly with FAG and Hella, developed the first electronically-controlled Anti-lock Braking System (ABS) for production motorcycles. The ABS system was introduced with the 1988 models as standard equipment on some models and as an option on other models. An improved system, ABS II, was later developed and introduced on 1994 R1100RS models. The two systems operate primarily the same. Differences on the ABS II system are described later in this section.

The ability to slow or stop a motorcycle depends upon the braking force applied to the wheels and the frictional forces that exists between the tires and the road surface. Very low frictional forces exist when a wheel is locked (or skidding).

The ABS system works in addition to the normal brake system and only during hard braking which may result in wheel lock-up. The system is designed to allow maximum braking force to be applied without allowing the wheels to lock.

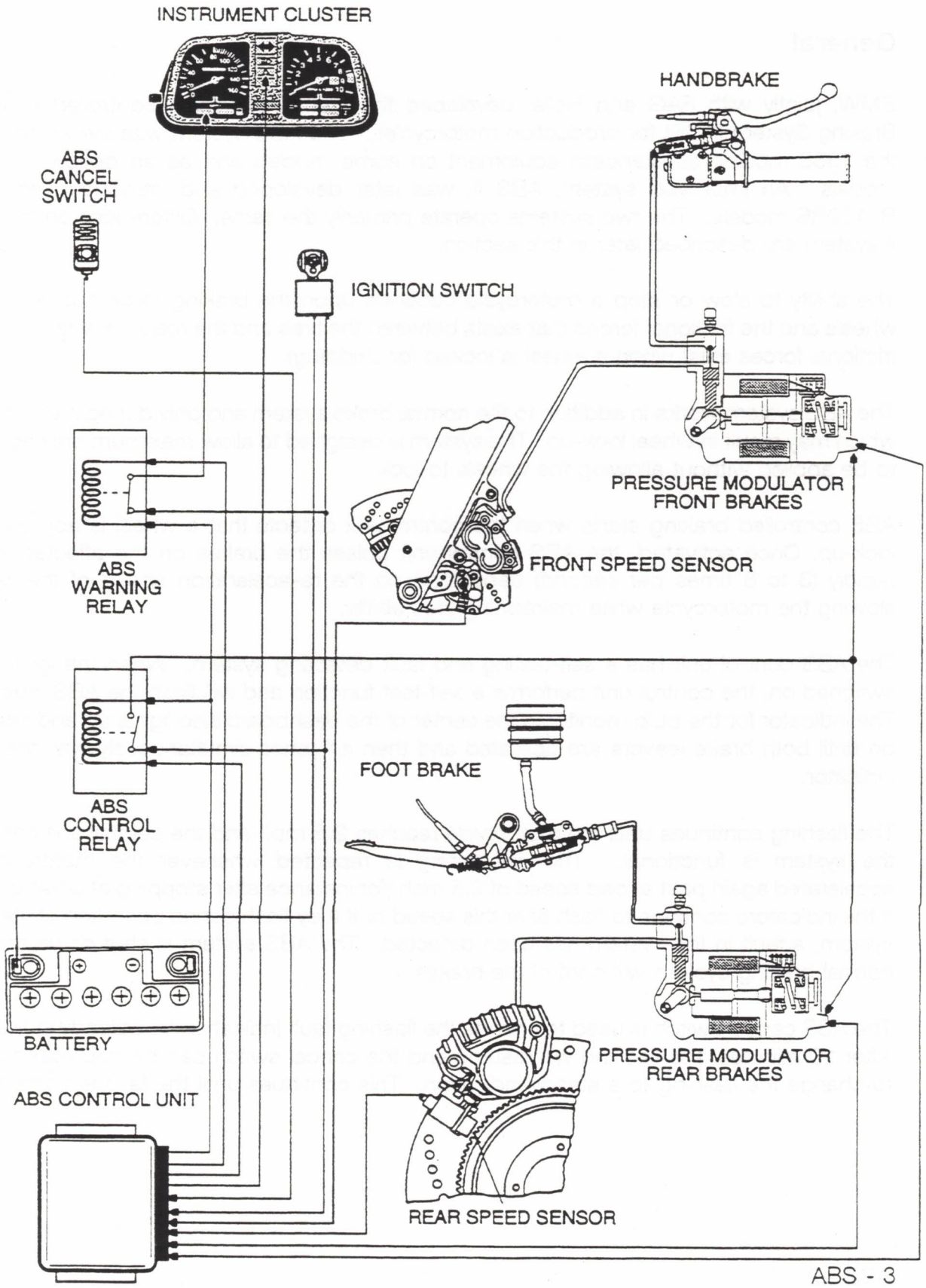
ABS controlled braking starts when the control unit detects that a wheel is approaching lock-up. Once activated, the ABS control unit pulses the brakes on the affected wheel rapidly (3 to 8 times per second) depending on the re-aceleration speed of the wheel, slowing the motorcycle while maintaining steerability.

The ABS control unit has a self-testing and fault detecting system. When the ignition is switched on, the control unit performs a self-test function and will flash the ABS indicator. The indicator for the bulb monitor in the center of the dashboard also lights up and remains on until both brake leavers are operated and then it flashes simultaneously with the ABS indicator.

The flashing continues until the motorcycle reaches 2.5 mph and the control unit confirms the system is functional. The self-testing is repeated whenever the motorcycle is accelerated again past a road speed of 2.5 mph (for instance after stopping at a traffic light). If the indicators continue to flash after this speed or if they flash during operation of the ABS system, a fault in the system has been detected. The ABS system is shut down and the normal braking system will control the brakes.

The ABS cancel switch is used to change the flashing fault indication to a steady indication. After 10 minutes, the flashing will resume and the cancel switch can be depressed again to change the flashing to a steady indication. This continues until the fault is corrected.

Components


INSTRUMENT CLUSTER
HANDBRAKE
ABS CANCEL SWITCH
IGNITION SWITCH
PRESSURE MODULATOR FRONT BRAKES
FRONT SPEED SENSOR
ABS WARNING RELAY
ABS CONTROL RELAY
FOOT BRAKE
BATTERY
PRESSURE MODULATOR REAR BRAKES
ABS CONTROL UNIT
REAR SPEED SENSOR

ABS Control Unit

The ABS control unit is located behind the dual seat. The control unit receives inputs from the following:

- Ignition Switch (power)
- Wheel Speed Sensors
- Pressure Modulators (fault detection)
- ABS Cancel Switch

The control unit controls the following outputs:

- Pressure Modulators
- ABS Relay
- ABS Warning Relay
- ABS Indicators

When the ignition is turned on, power is supplied to the control unit. The control unit performs a self-test of the ABS system and flashes the indicators through the ABS warning relay and the check control. After determining that the system is functional, the control unit operates the ABS relay. The ABS relay contacts close and provide power to the modulators.

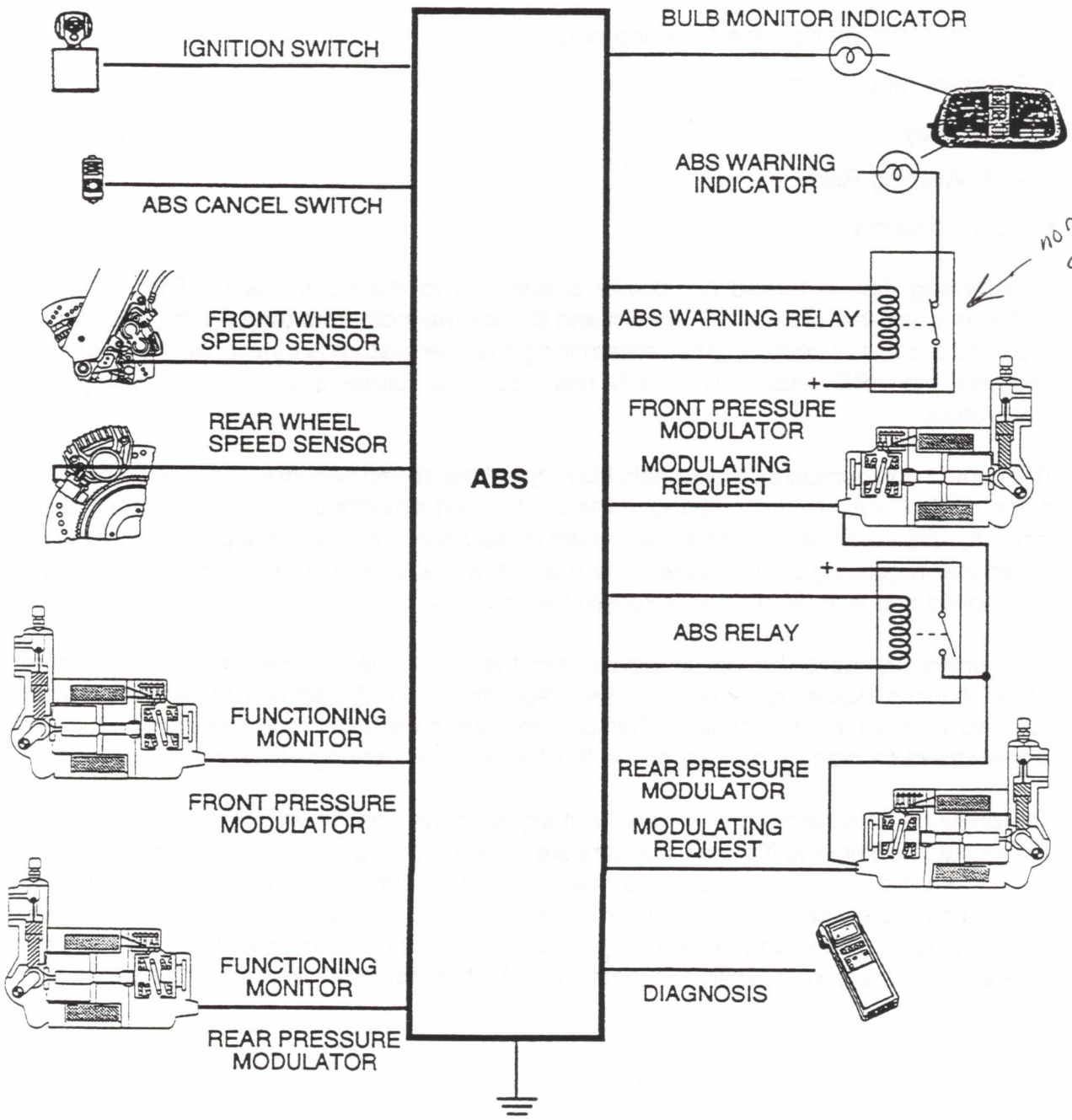
The control unit compares the signals from the wheel speed sensors with a reference curve in the control unit. During braking, if the control unit detects that a wheel is approaching lock-up, ABS controlled braking is activated by applying a signal to the pressure modulator. When the regulating circuits determine that the wheel speed is above lock-up, the signal is removed and normal braking is re-established.

The control unit uses the speed signal from the front wheel to determine when the rear wheel requires regulating. The rear wheel regulation will not start until the wheel is rotating 35% slower than the front wheel. This prevents the control unit from seeing a reduction in wheel speed caused by closure of the throttle or a gear change as a brake application.

The pressure modulators provide an input signal to the control unit. The control unit uses this signal to determine if the modulators are operating properly. If the control unit detects a fault in a modulator, it shuts the system down but only when an ABS-regulated brake application already begun has been completed. During self-testing, the pressure modulators are actuated slightly and a sensor located in the modulator measures the pressure differential of the spring tension to determine if the modulators are operating properly.

The control unit contains a memory for fault retention. When a fault is detected, the control unit stores the fault code until it is erased with the diagnosis tester. There are 8 possible codes. The control unit will shut off the system if any one fault is detected, therefore there can only be one code stored. The fault codes are:

- 1 = Front Pressure Modulator
- 2 = Rear Pressure Modulator
- 3 = Front Sensor
- 4 = Rear Sensor
- 5 = Battery voltage too low
- 6 = ABS Relay
- 7 = ABS Control Unit
- 8 = Fault



Pressure Modulators

The pressure modulators are mounted on the left and right sides of the motorcycle behind the engine. The modulators contain the hydraulic regulating components, final electronic regulating stages and a spring tension pressure differential sensor. There is a separate modulator for the front and rear brakes. During ABS operation, the modulators control the pressure to the brake calipers.

During normal motorcycle operation, the ball valve in the pressure modulator is held open by the piston pressure pin. This keeps the passage from the brake cylinder to the brake caliper open for normal braking.

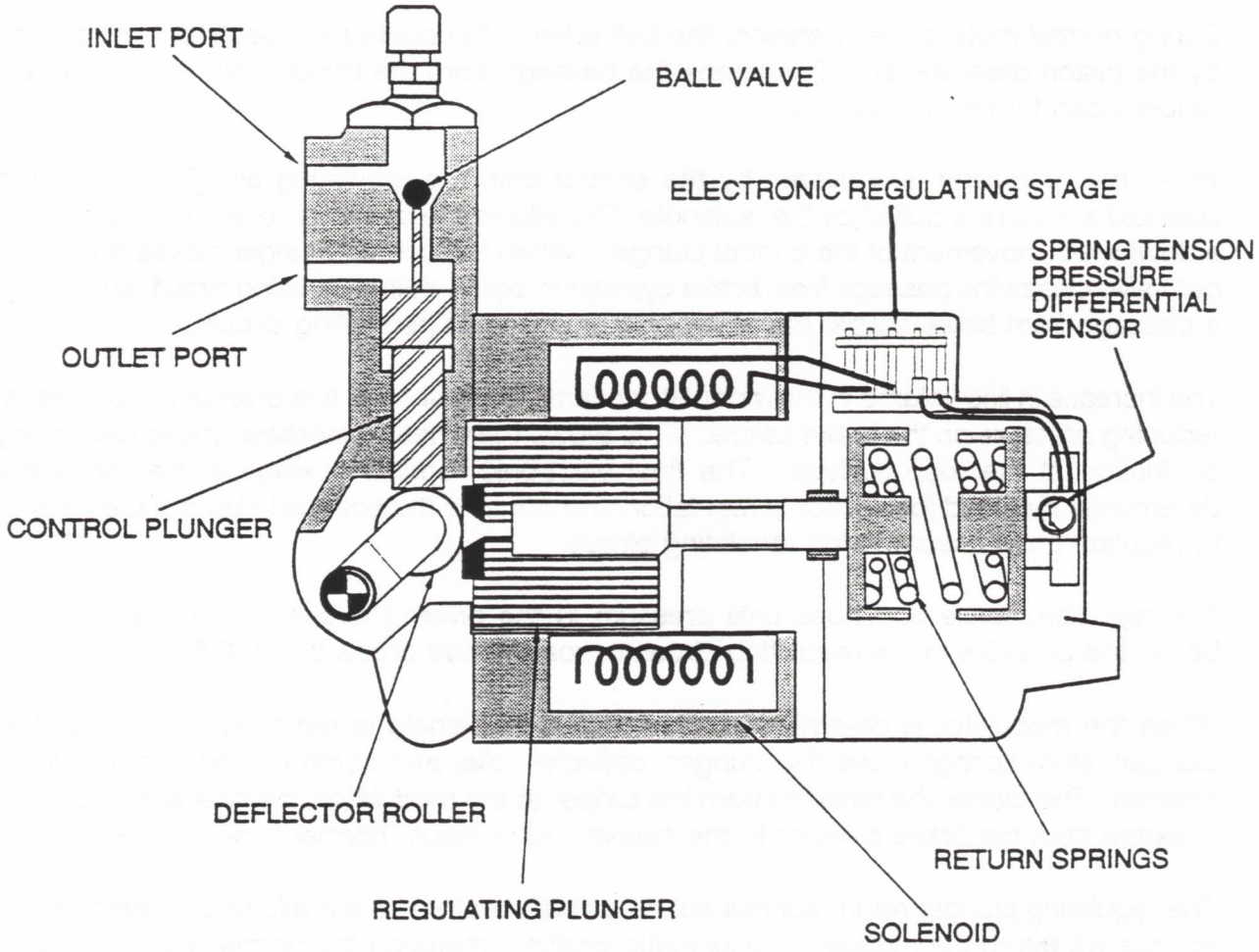
When the modulator is activated by the control unit, the regulating plunger acting as a solenoid armature is pulled by the solenoid. This allows the deflector roller to move causing a downward movement of the control plunger. When the control plunger moves down, the ball valve closes the passage from brake cylinder to brake caliper (braking circuit) and opens a passage from brake caliper to the modulator chamber (regualting circuit).

The increase in line volume in the modulator chamber causes the line pressure to decrease, reducing pressure on the brake caliper. This allows the wheel to increase speed depending on friction at the road surface. The final electronic regulating stage in the modulator determines the need for additonal regulation and controls the solenoid allowing the plunger to regulate the pressure in the regulating circuit.

The regulating cycle continues until pressure in the braking circuit (brake released) falls below the pressure in the regualting circuit or road speed drops below 2.5 mph.

When the modulator is de-activated, power to the solenoid is removed. The regulating plunger return springs move the plunger, deflector roller and control plunger to their initial position. This closes the passage from the caliper to the modulator chamber and opens the passage from the brake cylinder to the caliper. As a result, normal braking is restored.

The regulating plunger return springs act as a safety feature. If a malfunction develops, the springs will return the modulator to its static position, restoring the normal braking system.

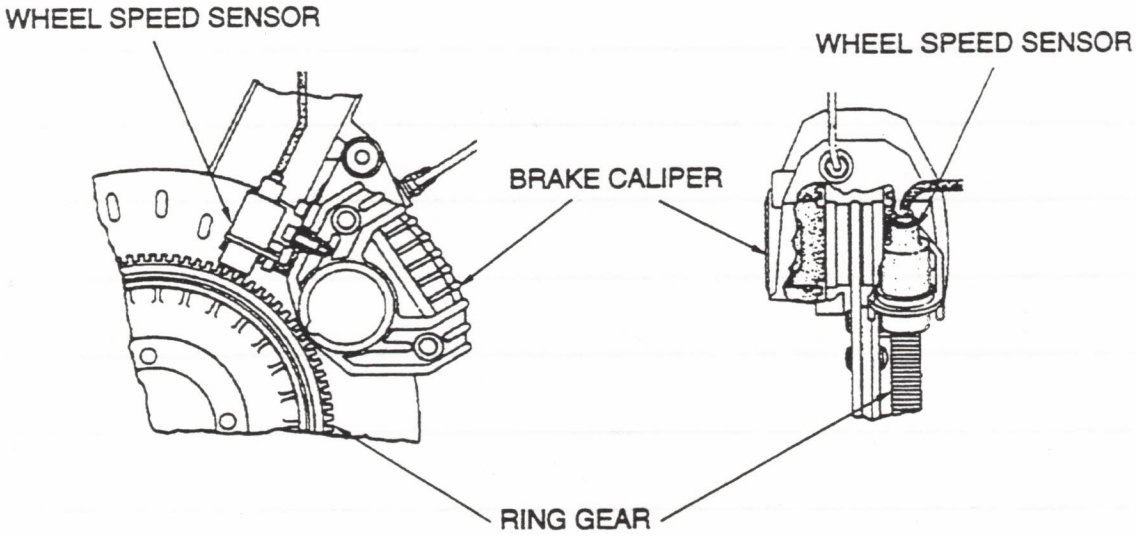

INLET PORT
BALL VALVE
ELECTRONIC REGULATING STAGE
SPRING TENSION
PRESSURE
DIFFERENTIAL
SENSOR
OUTLET PORT
CONTROL PLUNGER
DEFLECTOR ROLLER
RETURN SPRINGS
REGULATING PLUNGER
SOLENOID

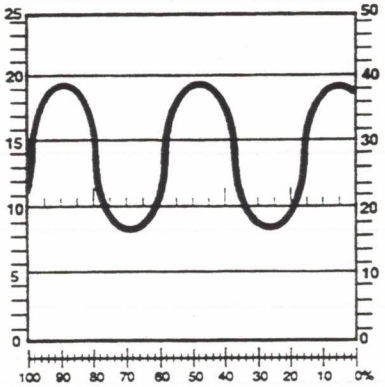
Wheel Speed Sensors

A wheel speed inductive sensor is mounted on both the front and rear brake calipers. The inductive sensors provide A/C wave signals to the control unit proportional to wheel speed.

The signal is generated by a ring gear mounted to the hub of each wheel. As the ring gear turns, each high and low spot on the ring gear changes the inductive potential in the sensor. The control unit "counts" the pulses and interprets the speed of the wheel.

DETAIL OF FRONT WHEEL BRAKE





A/C WAVE FORM REPRESENTING WHEEL SPEED AS SEEN ON A SCOPE

ABS II

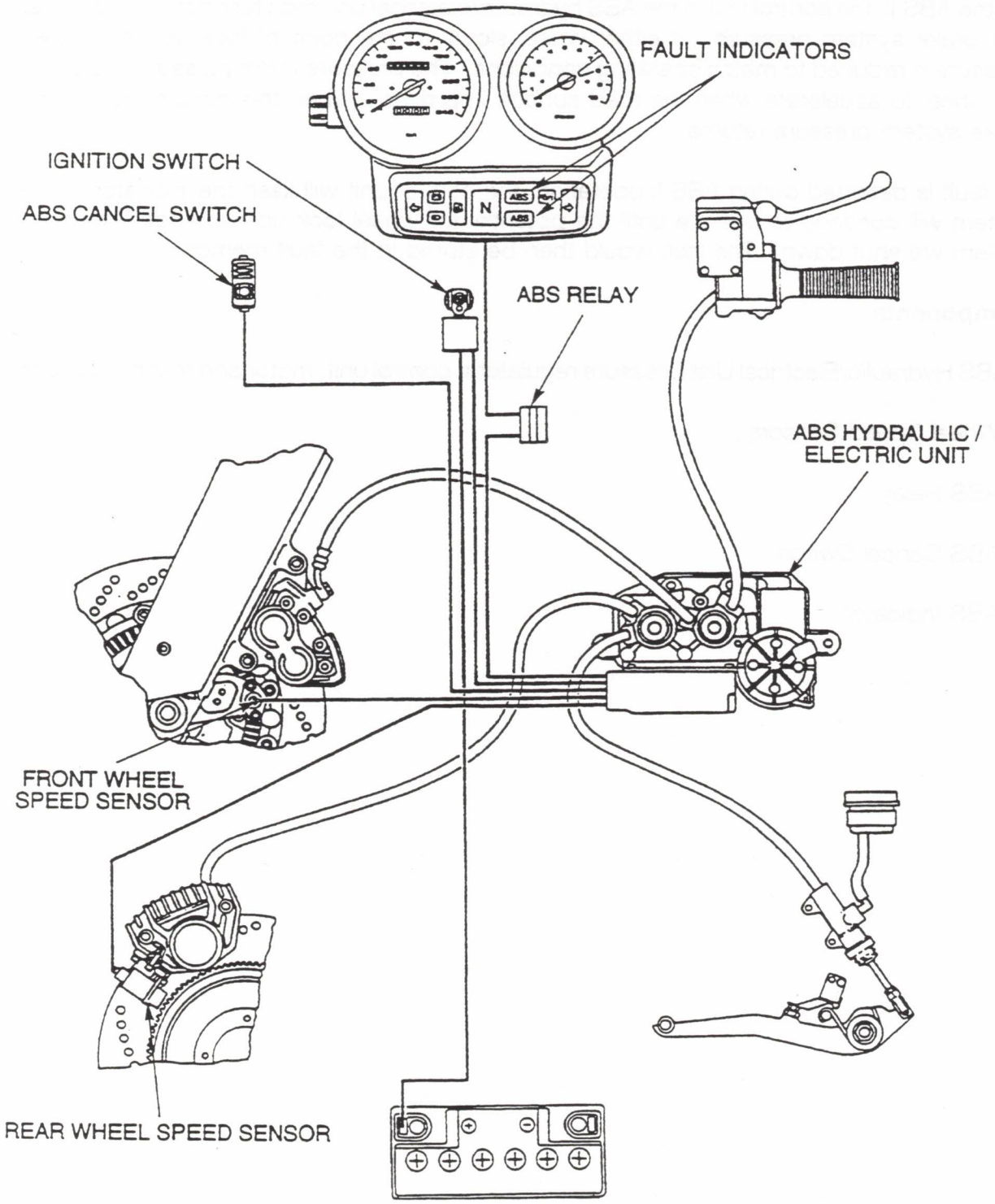
General

On the ABS II, the control unit in the ABS hydraulic/electrical unit monitors both wheel speed and brake system pressure. If either wheel slows to the point of lock-up, the system pressure is reduced to match operating conditions. The pressure is not pulsed. This allows the wheel to accelerate when the road surface improves. When this occurs, the normal brake system pressure returns.

If a fault is detected during ABS II operation, the control unit will flash the indicators. The system will continue to operate until the potential for wheel lock-up has ended, then the system will shut down. The fault would then be stored in the fault memory.

Components

- ABS Hydraulic/Electrical Unit (pressure regulators, control unit, motor and mechanical unit)
- Wheel Speed Sensors
- ABS Relay
- ABS Cancel Switch
- ABS Indicator


FAULT INDICATORS
IGNITION SWITCH
ABS CANCEL SWITCH
ABS RELAY
ABS HYDRAULIC / ELECTRIC UNIT
FRONT WHEEL SPEED SENSOR
REAR WHEEL SPEED SENSOR

ABS Hydraulic / Electrical Unit

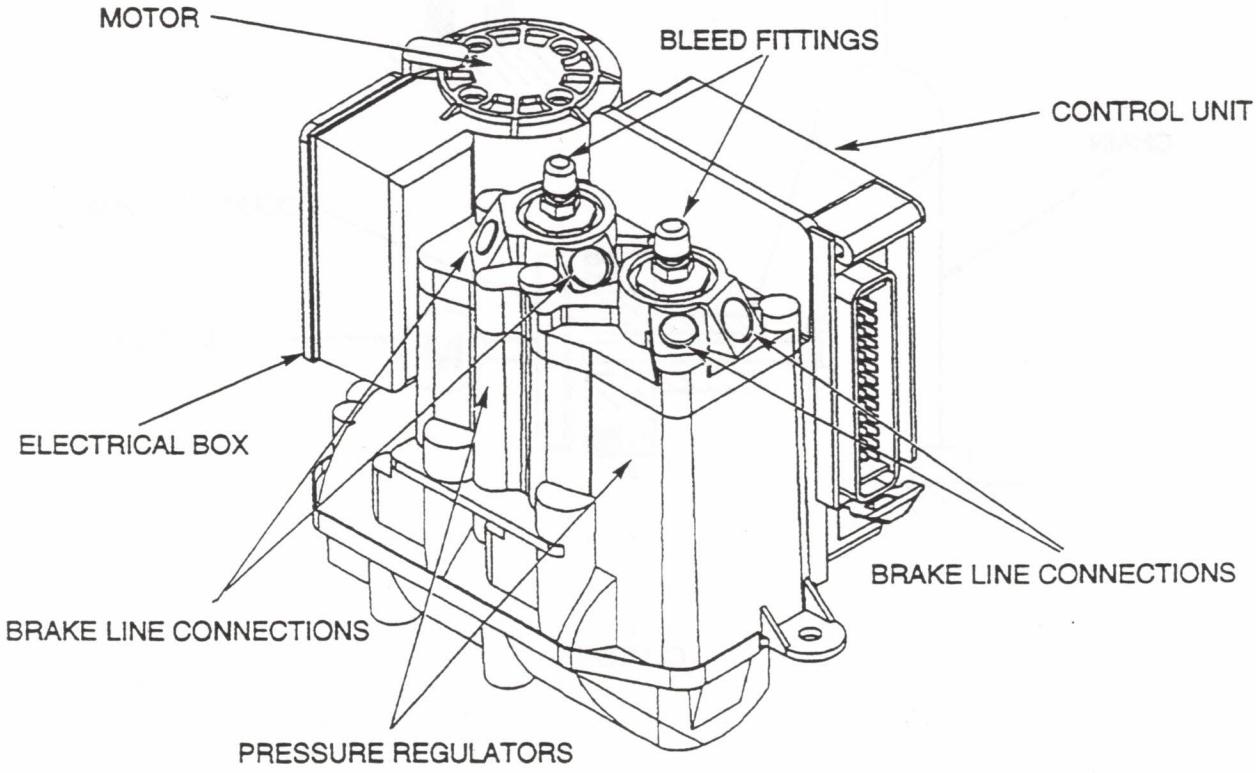
The ABS hydraulic/electrical unit contains the control unit (two process computers and one supervisory computer), pressure regulators mechanical unit and motor in one unit.

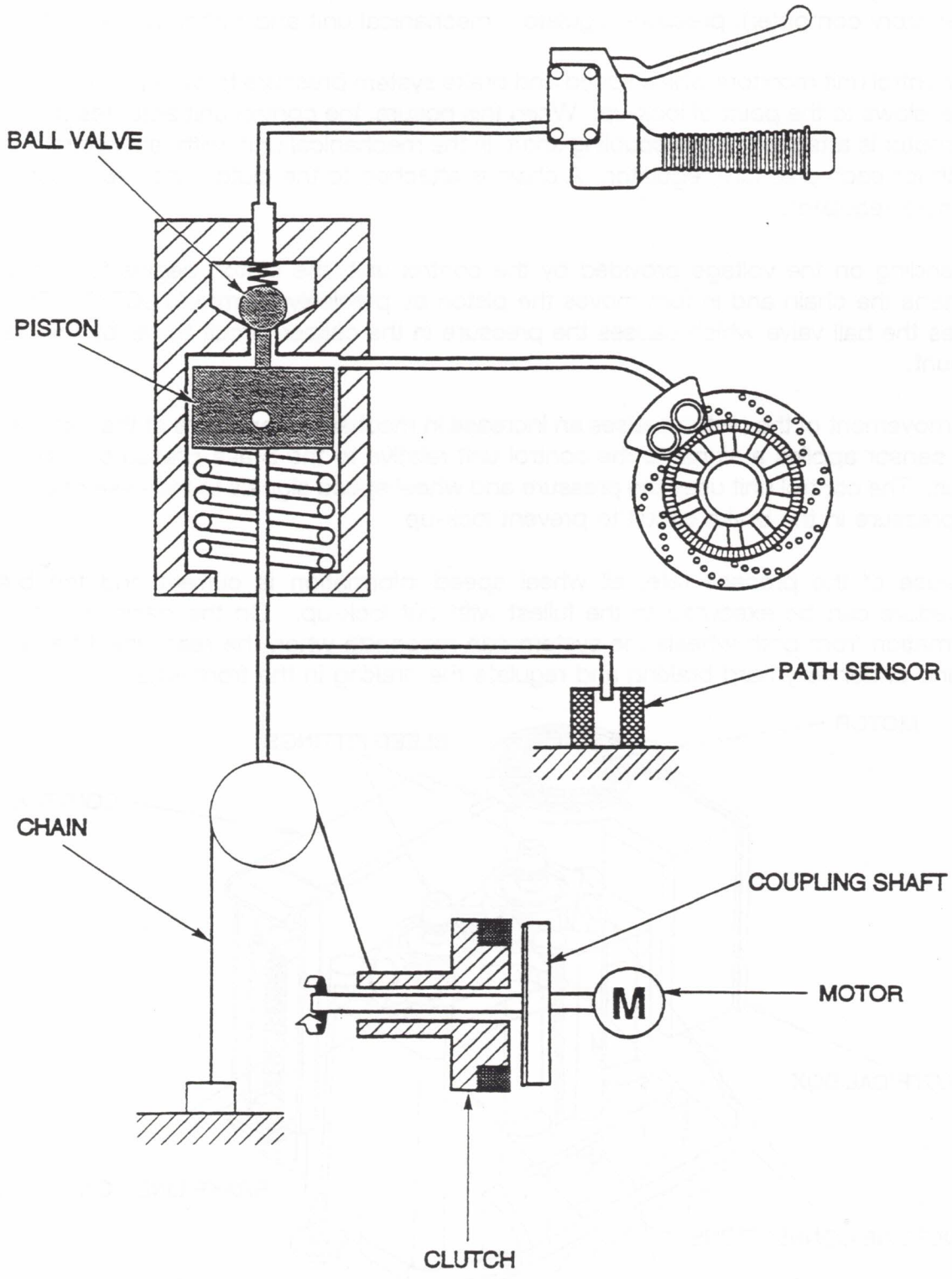
The control unit monitors wheel speed and brake system pressure to determine when either wheel slows to the point of lock-up. When this occurs, the control unit actuates the motor. The motor is attached to the coupling shaft, in the mechanical unit, with an electro-magnet clutch for each pressure regulator. A chain is attached to the clutch and the piston in the pressure regulator.

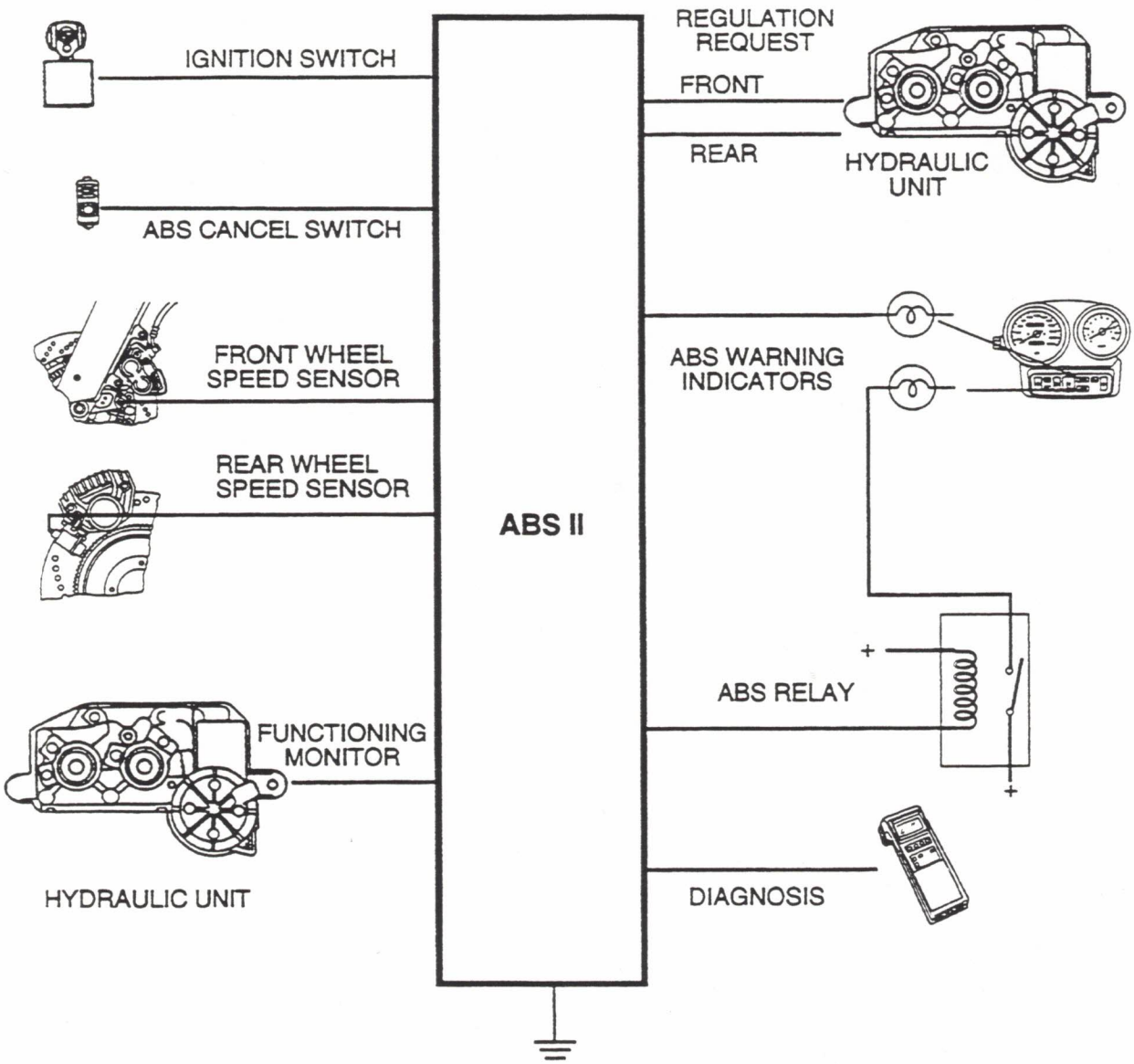
Depending on the voltage provided by the control unit, the clutch begins to turn which shortens the chain and in turn moves the piston by precisely 0.2mm (0.0078"). This also closes the ball valve which causes the pressure in the caliper circuit to fall by the desired amount.

The movement of the piston causes an increase in mechanical pressure at the path sensor. This sensor applies a signal to the control unit relative to the brake pressure in the brake circuit. The control unit uses the pressure and wheel speed signals to increase or decrease the pressure in the brake circuit to prevent lock-up.

Because of the process rate, all wheel speed information is current and the braking procedure can be executed to the fullest with out lock-up. On the basis of the speed information from both wheels the system can recognize when the rear wheel has left the ground under very hard braking and regulate the braking in the front wheel.




BALL VALVE
PISTON
PATH SENSOR
CHAIN
COUPLING SHAFT
M
MOTOR
CLUTCH


IGNITION SWITCH
ABS CANCEL SWITCH
FRONT WHEEL SPEED SENSOR
REAR WHEEL SPEED SENSOR
FUNCTIONING MONITOR
HYDRAULIC UNIT
ABS II
REGULATION REQUEST
FRONT
REAR
HYDRAULIC UNIT
ABS WARNING INDICATORS
ABS RELAY
+
+
DIAGNOSIS