

## CIRCUIT OPERATION

The Anti-lock Braking System (ABS) prevents wheel lock-up during braking. This enables the driver to maintain vehicle stability and steering control while braking.

The Electronic Traction Control (ETC) system prevents wheel slip to maintain optimum traction on slippery surfaces. Up to 99 Model Year, ETC operates only on the rear wheels at vehicle speeds below 50 km/h (30 mph). From 99 Model Year, ETC operates on all four wheels at vehicle speeds below 100 km/h (62.5 mph).

### Anti-lock Braking System Electronic Control Unit (ECU) (Z108)

The ABS ECU (Z108) is a computer that controls ABS operation by permanently monitoring the vehicle's four wheel speeds when the ignition switch is in position II. If an impending wheel lock-up is detected during this monitoring, the ABS ECU will apply voltage to the applicable inlet and outlet valve solenoids contained in the ABS Booster Unit (Z103). Operation of the solenoid valves regulates the pressure applied to the brake caliper and prevents wheel lock-up.

ETC is an extension to the ABS ECU. In addition to monitoring the wheel speeds for lock-up, the ABS ECU also monitors wheel speeds for wheel slip (i.e. wheel speed faster than vehicle speed). When wheel slip is detected, the ABS ECU will apply braking pressure to the slipping wheel(s), causing the wheel speed to slow to vehicle speed and torque to be transferred to the non-slipping wheel(s). The ABS ECU applies the brake by operating the applicable inlet and outlet solenoid valves in the ABS Booster Unit.

The ABS ECU has diagnostic capabilities that allow it to detect faults that may impair the system's efficiency. If a fault occurs, the ECU adopts a default strategy which illuminates the ABS or the TC warning light in the instrument cluster (Z142) and stores a fault code in its memory to aid system troubleshooting. When an ABS fault has been detected, the message ABS FAULT may also be displayed in the instrument cluster message centre. When an ETC fault has been detected, the message TRACTION FAILURE is displayed and on the first detected fault a single audible chime sounds. Fault codes stored in the ECU memory can be retrieved using Testbook or a universal scan tool.

The ABS ECU also performs a bulb check of the warning lights when the ignition switch is first turned to position II. The ABS warning light is illuminated for 1 second, extinguished for 0.5 seconds and illuminated again until the ECU receives an input speed of 7 km/h (5 mph) from all four wheel speed sensors (X137, X140, X1158, X161) and is then extinguished. The TC warning light is illuminated for 3 seconds and then extinguished. If a system fault is detected during the bulb check the ABS or the TC warning light remain illuminated.

When ETC is activated, the TC warning light illuminates, a single audible chime sounds and on earlier models, the message TRACTION is displayed. The message and warning light extinguish after 2 seconds minimum or when ETC is de-activated. If ETC is continuously or repeatedly active and there is a risk of the brakes overheating the ABS ECU disables the ETC. To advise the driver of the disablement, the ETC warning light flashes for 10 seconds minimum, a single audible chime sounds and the message TRACTION OVERHEAT is displayed. The ABS ECU restores ETC availability after allowing time for the brakes to cool.

### **ABS Booster Unit (Z103)**

The ABS Booster Unit (Z103) contains 2 isolation solenoid valves and 4 pairs of solenoid control valves which are grounded through the harness. When the ETC is fitted, the booster unit also contains an additional 2 solenoid valves. The pairs of solenoid control valves each include a fluid pressure inlet and outlet valves that control ABS braking to one wheel.

The Anti-Lock Brake System ECU (Z108) operates these valves by applying battery voltage to them. The valves are designed to decrease, hold or increase pressure to retain wheel rotation and optimum braking.

The 2 isolation valves consist of 2 solenoid valves that control fluid inlet and outlet. Their function is to disconnect or isolate the master cylinder from the servo cylinder and to connect the servo cylinder to the reservoir return during ABS functions.

### **Wheel Speed Sensors (X137, X140, X158, X161)**

A wheel speed sensor is located at each wheel. The speed sensors generate an AC voltage signal as a toothed ring rotates past the stationary sensor pickup. The Anti-Lock Brake System ECU (Z108) calculates the wheel speed by measuring the frequency of the AC voltage signal generated by the sensors.

### **ABS Hydraulic Pump (M102)**

The hydraulic boost for the system is provided by the ABS Hydraulic Pump (M102), which is controlled by the ABS Pump Relay (K102) and the ABS Pressure Switch Unit (Z104).

The Pressure Switch unit incorporates three electro-mechanical switches. The first operates the pump, two more illuminate the low pressure condition and signal that ABS and ETC functions should be curtailed. The Hydraulic Pump includes a hydraulic accumulator and non-return valve, as well as a pressure relief valve to protect the system.

When low pressure occurs in the brake system, a switch in the pressure switch unit closes to ground the coil of the pump relay. The pump relay now energizes and applies battery voltage from the fuse to the hydraulic pump through the closed relay contacts. The hydraulic pump runs to increase pressure in the hydraulic accumulator. When sufficient pressure is developed in the system, the pressure switch opens to de-energize the pump relay and to turn off the hydraulic pump.

### **ABS Warning Lamp**

The Anti-Lock Brake System ECU (Z108) sends signals to the BeCM which then controls the illumination of the ABS warning lamp. The BeCM also controls the display of the system messages.

### **Solenoid Valve Relay**

This is energized by the ABS ECU and sends voltage back to the part of the same ECU which controls the solenoid valves in the booster. When the ABS ECU detects a fault that requires a complete system shutdown, the relay is de-energized.