Chapter Four
ABS Training

4.1 What is ABS?

Anti-Lock Brake System (ABS) is a combination of vehicle hardware and software that work together to maintain steering control and vehicle stability during hard braking.

Initially developed as a special option for top-of-the-line models, today's ABS units are compact, easy to service, inexpensive and widely available. Now every major automotive manufacturer offers some form of ABS vehicle control that provides safe, maximum braking under all weather conditions and road surfaces.

INTEGRAL AND NON-INTEGRAL

There are basically two types of Anti-Lock (or AntiSkid) Brake Systems–Integral and Non-Integral. **INTEGRAL** systems incorporate the power unit (pump and accumulator), master cylinder, and control valve mechanism into one hydraulic unit. An external microprocessor and individual wheel sensors complete the system. The Teves Mark II system (Fig. 1) is an example of an integral unit.

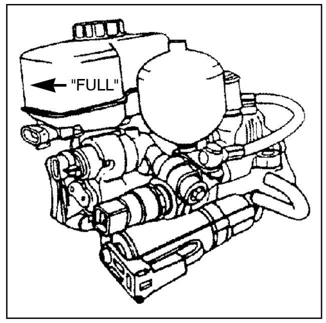


Fig. 1

The other type of ABS is referred to as **NON-INTEGRAL** or **ADD-ON.** The non-integral system incorporates ABS components into the standard brake system. Added to the power brake unit, master cylinder, and calipers are a microprocessor (computer module), modulator valve, and speed sensor(s). A lateral accelerator

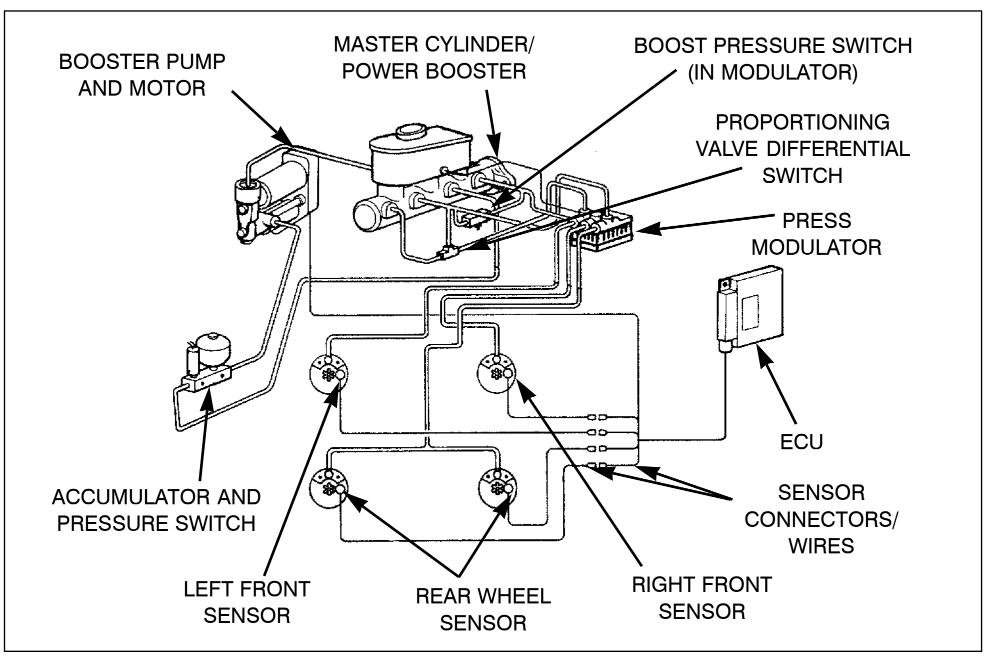


Fig. 2

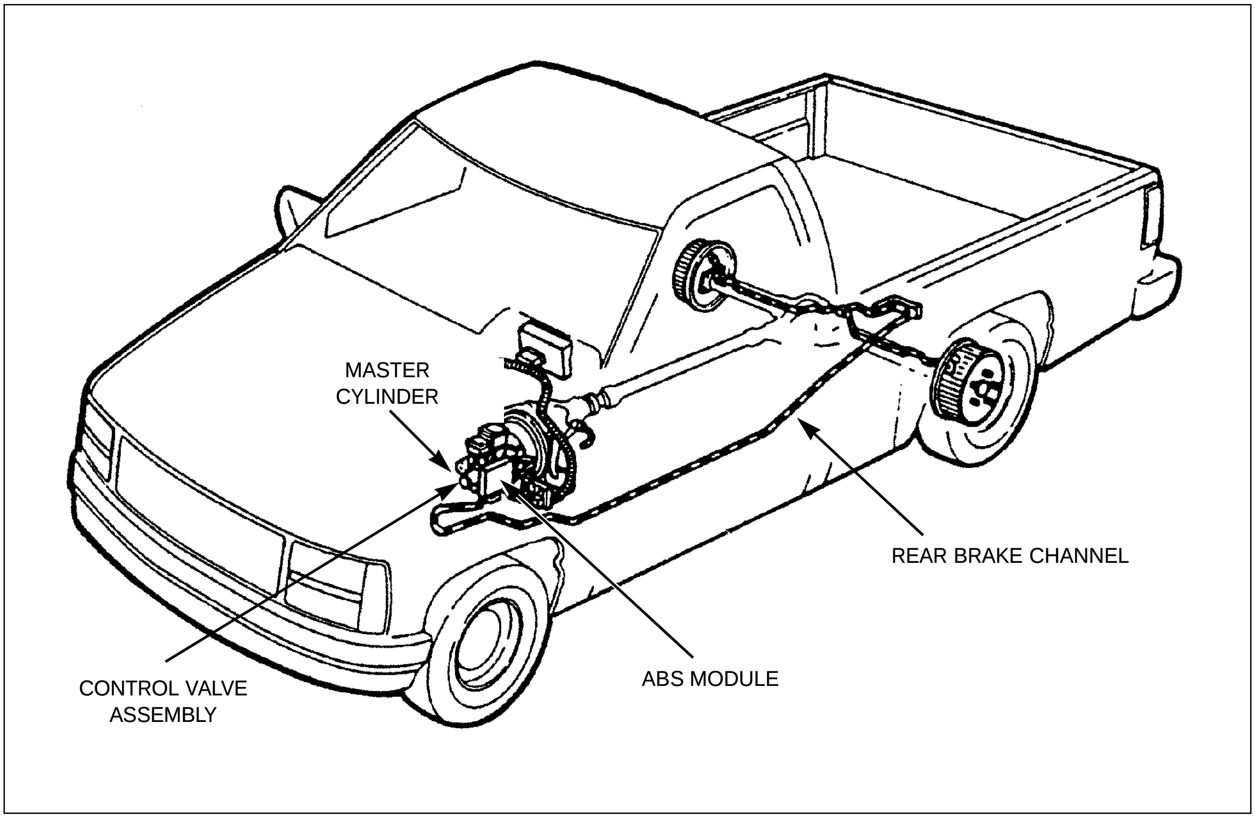


Fig. 3

switch, measuring side “G” forces, can also be a part of this system. Because of its lower cost, vehicle manufacturers are designing add-on systems for the majority of the future vehicle population. The typical components used in a non-integral system are shown in Fig. 2.

FOUR, THREE, OR SINGLE CHANNEL

Non-integral ABS systems are grouped by the number of wheel sensors used in the system. On some applications, each wheel is equipped with its own speed sensor. This type of system is referred to as a four wheel or four channel system. A variation of this system has a separate wheel speed sensor for each front wheel but uses a common speed sensor for both rear wheels. Known as a three channel system, the rear axle speed sensor is mounted in the differential or transmission and reads the combined or average speed of both rear wheels. This type of setup saves the cost of an additional sensor and reduces the complexity of the system by allowing both rear wheels to be controlled simultaneously.

The last non-integral variation is the single channel or rear-wheel only ABS system. Used on many rear-wheel drive pickups and vans, Ford’s version is called Rear Anti-Lock Brakes (RABS) while GM and Chrysler call theirs Rear Wheel Anti-Lock (RWAL). A typical installation of a single channel system is shown in Fig. 3.

In this system the front wheels have no speed sensors. Only a single speed sensor, mounted in the differential or transmission, monitors both rear wheels. Rear-wheel anti-lock systems are typically used on applications where vehicle loading can affect rear wheel traction, which is why it’s used on pickup trucks and vans.

4.2 How ABS Works

ABS improves vehicle control through a blending of computer technology, modern electronics and standard brake components. Sensors constantly monitor the rotating speed of each wheel or the rear axle. These sensors are connected to the ABS control module. The signals sent from each sensor are constantly compared to stored parameters by the control module.

In a hard braking situation, the control module can detect a slowing or lock-up of each sensor equipped wheel or axle and instantly pulse the braking force up to 15 times a second. This process "pumps" the brakes, avoiding wheel lock-up while allowing the wheels to continue to turn. All the driver does is keep his foot on the pedal and continue to steer. After the need for ABS control passes, the system returns to normal braking.

YOU CAN DO IT!

Many repair technicians are turning away ABS equipped vehicles because they perceive these systems as too complex, too tough to diagnose, or requiring special tools and repair skills. What these technicians don't realize is that the same brake components they've worked on for years still do the job of stopping the vehicle. It's simply the addition of the ABS unit and its components that make the system special.

Service technicians had the same reaction when ECM controlled vehicles first appeared. What we quickly learned was that 80% of the driveability problems were still engine related. The same will hold true for ABS systems. Proper training to recognize and understand the differences between ABS systems and how they function will be necessary, and some special test equipment and reference material will be needed. But experienced technicians knowledgeable in brake systems, will have little difficulty diagnosing and repairing ABS.

ABS COMPONENTS AND OPERATION

Basic brake components such as calipers, pads, rotors, wheel cylinders, and drums are still there. The ABS components include wheel speed sensors, an electronic control module, and a hydraulic modulator assembly that includes electrically-operated solenoid valves.

THE HEART OF THE SYSTEM

Everything starts with the wheel speed sensors. Wheel sensors consist of a magnetic pickup and a toothed sensor ring or a slotted collar. In some applications, the sensor is an integral part of the wheel bearing and hub assembly. In others, the sensor ring(s) may be mounted on the axle hub behind the brake rotor, on the brake rotor itself, inside the brake drum, on the transmission

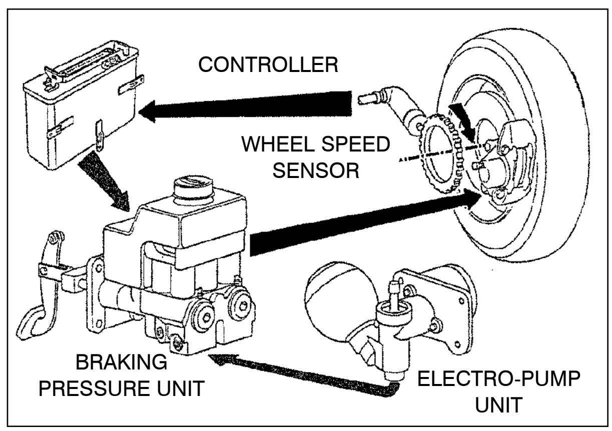


Fig. 4

tailshaft or inside of the differential on the pinion shaft. As the wheel turns, teeth on the sensor ring move through the pickup's magnetic field inducing voltage in the pickup's windings. The number of voltage pulses generated indicate the speed of the wheel or vehicle. The frequency of these pulses are converted into a digital signal by the ABS control module. Some typical wheel speed sensors are shown in Fig. 5.

THE BRAINS OF THE SYSTEM

The ABS control module is the nerve center of the ABS system. Usually a separate unit located under the hood, some older systems integrated ABS control information into other electronics such as the body control or suspension computer. Today's modern ABS control module receives inputs from the wheel speed sensors and a brake pedal switch. When it detects a difference in the deceleration rate between one or more wheels while braking, it cycles the ABS solenoid valves in the hydraulic modulator assembly to prevent wheel lockup. Like any other electronic module, the ABS module is vulnerable to damage caused by electrical overloads, static electricity, impacts and extreme temperatures. This block diagram (Fig. 6) shows how ABS system components interface with the internal components of the control module.

TYPICAL WHEEL SPEED

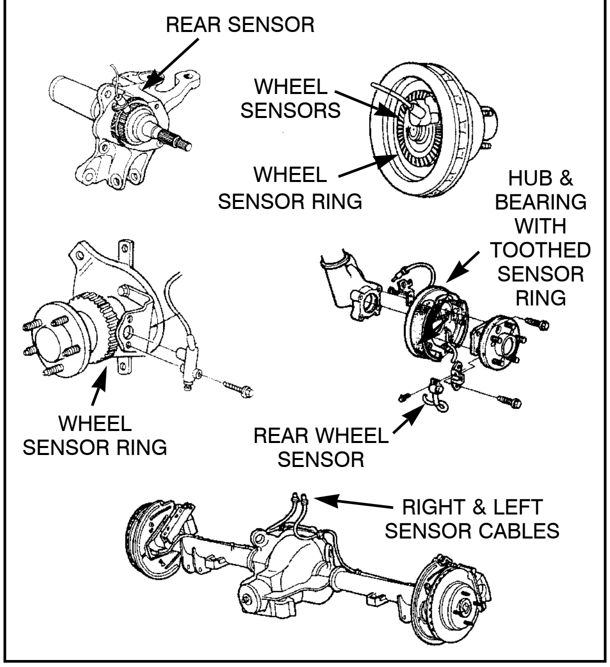


Fig. 5

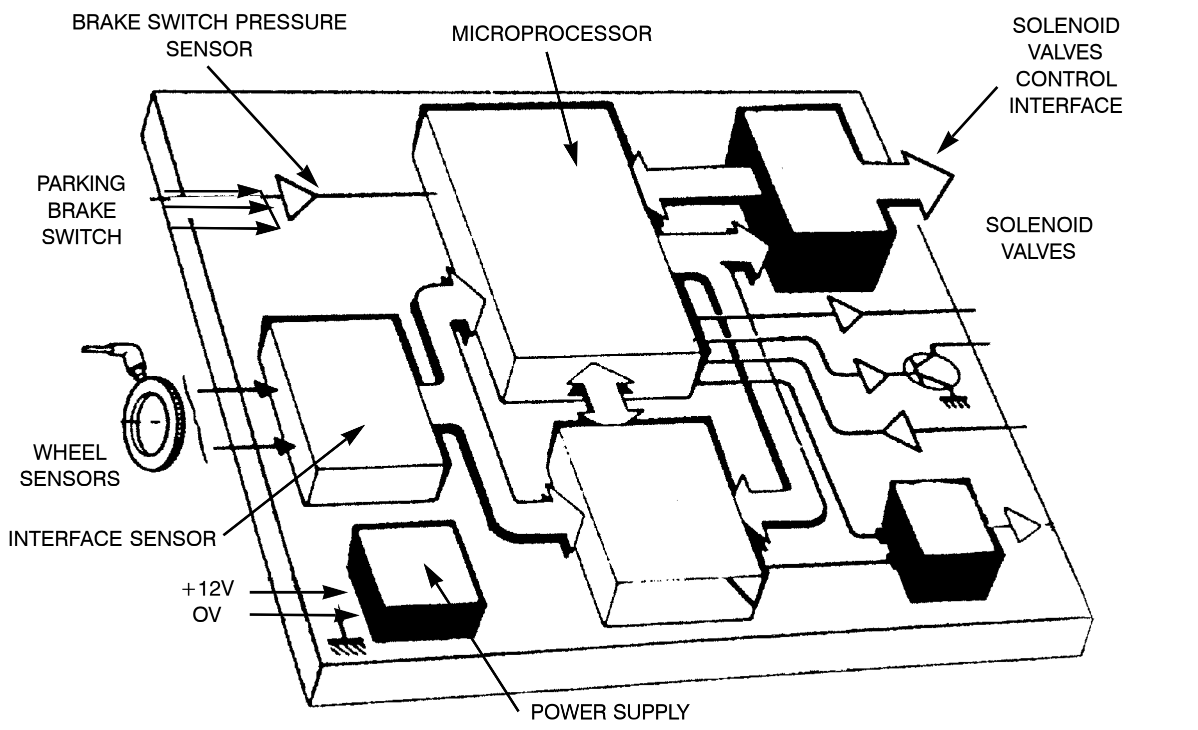


Fig. 6

THE MUSCLE IN THE SYSTEM

The hydraulic modulator contains a valve block and ABS solenoid valve for each brake circuit. The exact number of valves per circuit and their configuration depend on the application. Some use a pair of on-off solenoid valves for each brake circuit while others use a single valve that can operate in more than one position.

A typical ABS solenoid consists of a wire coil with a movable core and a return spring. When current from the ABS control module energizes the coil, it pulls on the movable core. Depending on how the solenoid is constructed, it either opens or closes the valve. When the control current is shut off, the solenoid snaps back to its normal or rest position.

Some solenoids are “multi-position” valves that open to an intermediate position when a certain level of current is applied, then fully open or close when additional current is applied. This design (Fig. 7) found in Bosch units, allows a single solenoid to perform the same functions as two or even three open and shut solenoids. ABS solenoids in the modulator are used to open and close passageways between the master cylinder and the individual brake circuits. This allows brake pressure to be held, released and reapplied

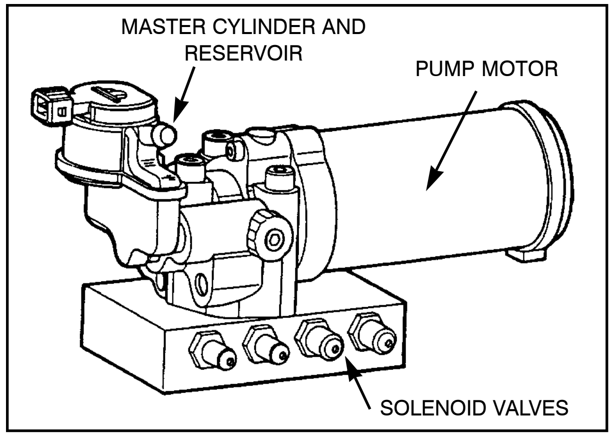


Fig. 7

to prevent wheel lockup during hard braking. The diagram below (Fig. 8) represents control valves used on the Kelsey-Hayes RWAL system and the Delco VI system.

ELECTRONIC CO-PILOT ON BOARD

From a safety perspective, perhaps the greatest benefit of most ABS systems is their fail-safe nature. In the event of failure of any ABS component, the main braking system continues to function. Anti-Lock capability is lost, but the

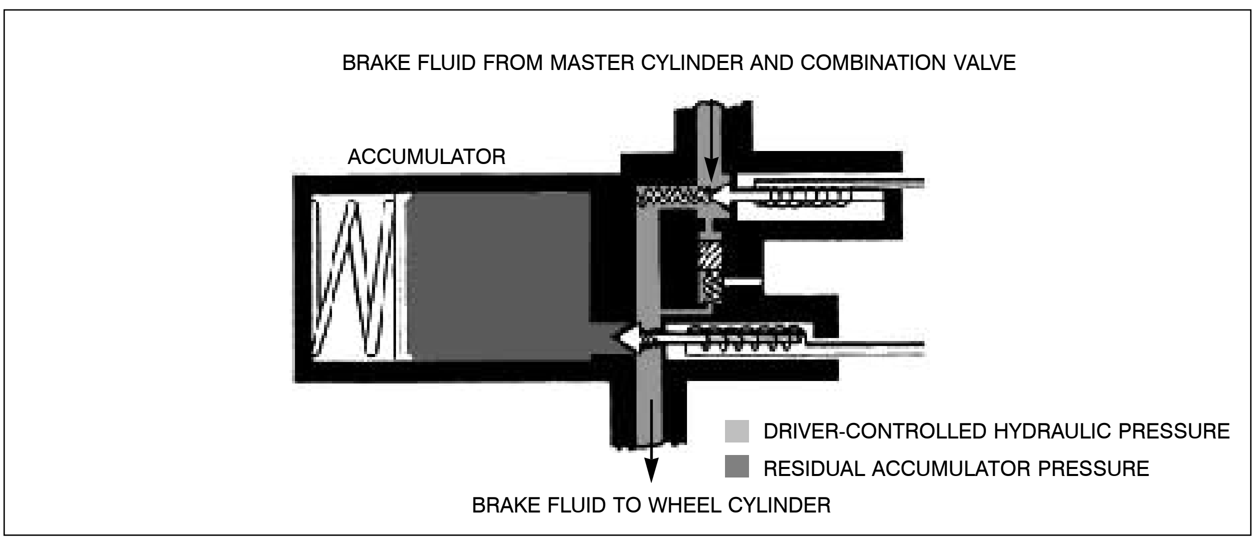
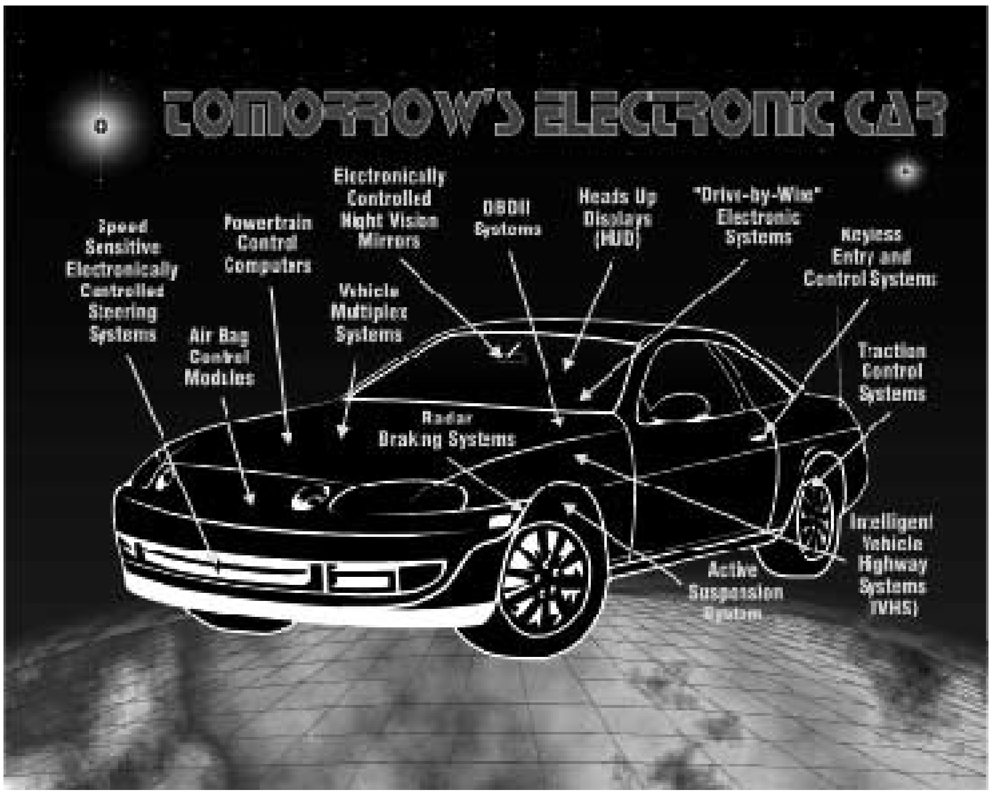


Fig. 8

driver will still be able to stop the vehicle in a normal manner.

The safety and control ABS provides is being extended to other areas of vehicle control. Traction control is becoming a common option on today's vehicles. Future vehicles will increase this safety envelope by providing electronic control over every area of vehicle performance and handling. Today we have Anti-Lock brakes, tomorrow the total package of vehicle control and stability dynamics will be combined into a single system. No matter what the electronic co-pilot is, you can do the job now.



4.3 System Groups

The major groups or suppliers of ABS units on the market today are AC-Delco, Allied Signal Automotive, Robert Bosch, Kelsey-Hayes and Teves.

AC-DELCO

ABSVI - The Delco Moraine ABS VI is one of the newest designs and is rapidly expanding to all GM vehicles. The reason for this is that ABS VI was designed with low cost and serviceability in mind from the beginning. Setting the standard for self-diagnosis, this unit keeps track of which of the 60 possible codes are set and how often. Serviceability and readily available parts will make it a hit with the aftermarket and repair shops.

TEVES

MKII - The Teves MKII integral ABS system was used in different forms by Ford, GM and some imports. One of the first units on the market, the system was complex, needed special test equipment and required a technician that understood the variations between different applications.

MKIV - The Teves MKIV is the non-integral replacement for the Teves II system. Using this design is a big advantage for manufacturers because it allows the use of standard vacuum boosters and a conventional master cylinder. It can also be upgraded to include traction control. The combination of simplicity and low-cost provide manufacturers an ABS system for all production lines.

KELSEY-HAYES

Kelsey-Hayes offers a number of units that cover passenger and light truck applications. RWAL provides rear wheel ABS for 2 and 4 wheel drive vehicles, and 4WAL provides four wheel ABS for vans and light trucks. Both units are non-integral designs that utilize conventional brake boosters and master cylinders.

RWAL - The RWAL unit (RABS is the Ford version) was designed specifically for applications where rear wheel traction varies with vehicle loading. This ABS system uses a single sensor located in the differential or transmission for both rear wheels. A new variation of RWAL used on Dodge trucks is FWAL.

4WAL - The 4WAL system is designed to provide ABS control over all four wheels. 4WAL relies on wheel sensors at each wheel or separate sensors for each front wheel and one common sensor for both rear wheels, depending on the application.

ALLIED SIGNAL AUTOMOTIVE

Allied Signal has been a supplier of ABS systems to the industry for many years. Its early models were both integral and non-integral designs that shared the same basic technology. However, its three newest systems are all lighter and less complicated than their predecessors.

BENDIX III - The first of these designs is the Bendix III unit. This non-integral, four channel, four solenoid system is 30 percent lighter than the Bendix 6 and 10 it replaces. It also uses far less and simpler components. This unit is currently available on Chrysler, Dodge and Plymouth passenger cars.

ABX-4 - The ABX-4 was introduced on the Chrysler Neon. This non-integral system is the simplest, least expensive and most compact ABS unit Bendix has yet designed. Like all non-integral systems, the ABX-4 consists of an electronic control module, a hydraulic control unit, an ABS relay box and four independent wheel sensors. One of this system’s unique features is that it provides system messages instead of numeric codes. Retrieving these messages require Chrysler’s DRB or similar scan tool.

MECA II - The third system, Mecatronic II, is currently used in Europe on the Ford Mondeo and domestically on the Ford Contour and Mercury Mystique. The Mecatronic II is a four channel, non-integral add-on ABS system, however, the control module is mounted on the HCV. An added feature is a unique traction control that uses braking to control wheel spin below 31 MPH and throttle control above 31 MPH.

ROBERT BOSCH

BOSCH 2S, 2U - The BOSCH 2 system in different forms has been used on a variety of domestic and import vehicles. The Bosch 2 system was used on Corvettes from 1986 to 1989. The 2U unit was used by GM on their full-sized passenger vehicles starting in 1991. The 2S MICRO was used on 90 and 91 Corvettes and other GM vehicles, and since 1992 has incorporated traction control, which they market as Acceleration Slip Regulation. All of the Bosch 2 variations are non-integral designs.

BOSCH III - The Bosch III unit was used by both GM and Chrysler on their luxury vehicles and is their only integral ABS design.

BOSCH 5 - This system is standard equipment on 1995 Corvettes and Porsche 911, Carrerra 4, and an option on two-wheel drive Carrerras equipped with Automotive Brake Differential. The Bosch 5 system is a non-integral, four-channel unit using separate solenoid valves for each brake circuit. The unit also provides traction control for both vehicles although by different techniques.