



# No Magic

After spending time on the phone talking to folks in the automotive industry, we've come to the opinion that the greatest enemy of ABS braking systems may be our old friend—the wild hare who owns the vehicle.

Some customers seem to view an ABS system as some sort of mystical, magical device. And many of them firmly believe that no amount of brake system maintenance should ever be needed as a result. It's magic, right?

So when the vehicle owner does experience a braking problem, the first thing he's apt to blame is the thing he understands the least—the ABS system. It's not too surprising that he also expects a magical cure for the results of long-term vehicle neglect.

Fixing the basics may seem boring to him. Let's face it, there's precious little hocus pocus in brake fluid changes. And it doesn't require any sleight of hand to diagnose a weak battery or loose fan belt.

## Those ARE the Brakes

Don't get caught in the customer's trap. Forget about the electrical wizardry of the ABS system for a moment. The braking system on an ABS-equipped car needs all the things a non-ABS braking system needs before it can do its job.

It needs non-magical things like these:

- Clean brake fluid. We're going to start with this, just for emphasis. Brake fluid may be the most neglected part of any brake system. Old, water-soaked, corrosive brake fluid will ruin any brake system. No magic here.
- Regular inspection of brake pads, rotors, wheel bearings, and other suspension parts. If the pads are worn out, the brake hardware has dissolved into a pile of salt-soaked powder, and the rotors resemble the surface of the moon, ABS doesn't have a prayer.

Let's toss in loose wheel bearings and bald or

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mismatched tires, just for good measure. A car that won't steer straight or stop under normal conditions won't be miraculously transformed into a super-stopper by ABS.

## Basic Electricity

An ABS system does use electrical and electronic components. That means it needs a good, steady supply of voltage. This makes it no different from other electrically operated systems in the car. Regular inspection and maintenance of the car's battery and charging system should be considered an integral part of ABS service.

Something as simple as low battery voltage can cause ABS problems. So don't get exotic until you check battery post voltage and charging rates.

A good, old-fashioned test drive is a great place to start when you're diagnosing an ABS problem. If

the car stops poorly during normal braking, the odds are that you have a normal brake problem.

Be on the lookout for a low or spongy brake pedal, a pull to one side when braking, or other indications that a parking brake cable or brake caliper may be sticking.

The ABS system supplements the normal braking system. It isn't a substitute for it. If the car doesn't brake well under normal conditions, the ABS system becomes about as useful as a pearl necklace on a hog.

Let's roam around a typical ABS-equipped car. The car is a 5-series BMW, and does have a braking problem. We'll show you the non-ABS fix. Then we'll show you good places to start your search in the event that a real ABS problem occurs.

— By Ralph Birnbaum



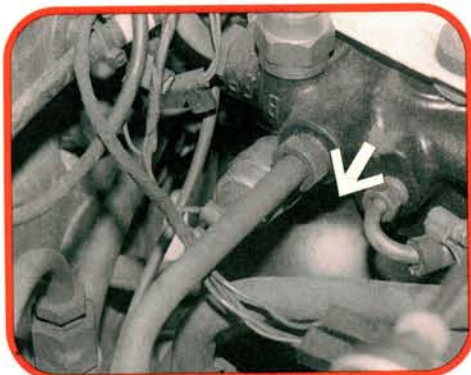
1

The BMW's owner has complained of some weird goings-on with the brakes. There are times when the brake pedal is high and hard as a brick. Placing a size 12 foot on the pedal, and standing upright in the driver's seat produces little or no reduction in vehicle speed when this occurs.



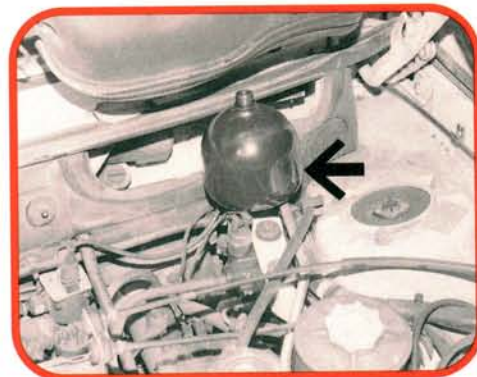
2

Brake assist on our Bimmer is hydraulic. Pressure for the power steering and brake assist are provided by this pump. But the belt is tight, and the hydraulic fluid level is correct. A test drive shows that the power steering is working, but that brake assist all but disappears at low engine speed.



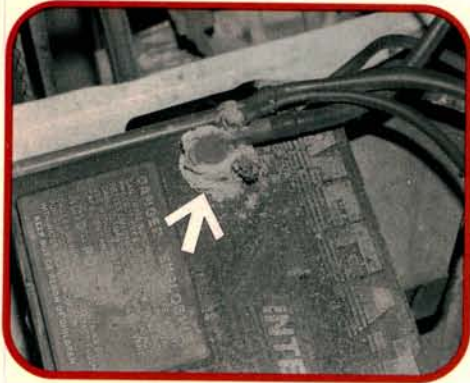
3

The hydraulic system in the car uses an accumulator to maintain hydraulic pressure when the power steering pump pressure drops off at low engine speeds. The accumulator screws into the underside of the power flow regulator (arrow). You might not even notice it from above.



4

This photo shows the new accumulator (arrow), ready for installation. Since the accumulator is connected to the hydraulic assist circuit, not the braking system, we don't need to bleed the brakes for this repair. Contrary to what the customer first thought, this was not an ABS problem.



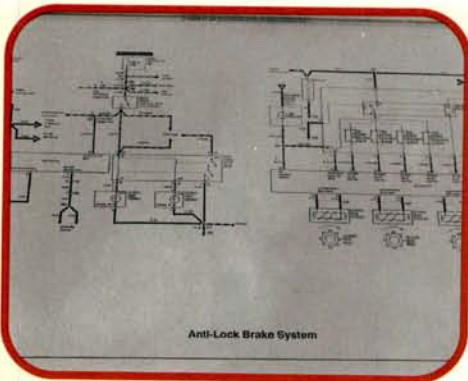
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If the ABS warning light had stayed ON, we'd have checked the battery post voltage and charging voltage before doing anything else. Low voltage can cause an ABS warning light to come on and stay on. This snow covered battery terminal connection is an open invitation to a low voltage condition.



6

The ABS dash light should cycle through a normal bulb check sequence, and go out within a few seconds after starting the engine. If the bulb does not come on with the Key ON/Engine OFF, find out why. Some bulbs have been removed when other repair attempts failed. This deactivates the ABS.



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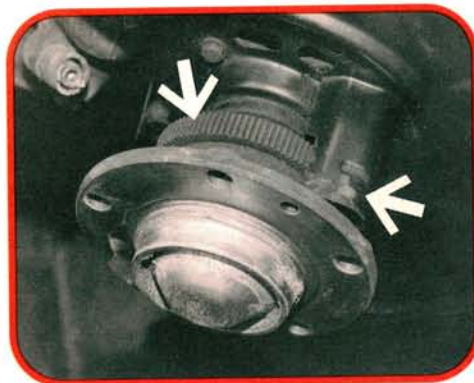
If you don't have a breakout box or ABS tester, the next thing you'll need is an accurate wiring diagram and a DVOM. If you're not sure where the ABS control unit is located, a component locator is also a big plus. Backprobing individual pins at the control box can be tedious, however.

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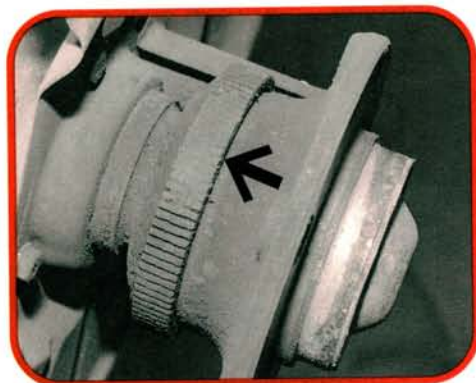
8

This breakout adapter from Thexton is one way to speed your tests. It provides an interface between many import and domestic ABS harnesses and a Ford 60 pin breakout box. Then use your Mitchell manual or comparable reference guide to determine correct pin numbers. **Thexton, Circle No. 140.**



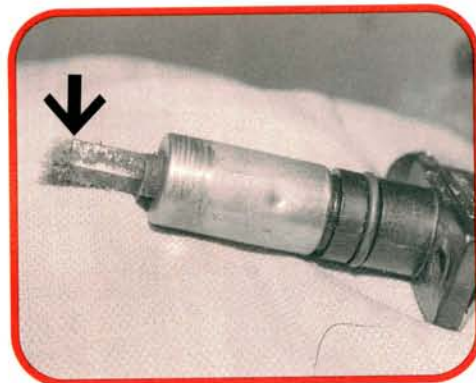
9

The most important inputs to the control unit are the speed sensor signals. The BMW's front sensors are mounted near a toothed ring on the wheel hub (left arrow), and are protected by a metal cover (right arrow). They transmit an A/C voltage signal to the control unit proportional to vehicle speed.



10

A weak or missing signal from a sensor may fool the control unit into thinking that the wheel has stopped. In addition to the sensor problems already listed, add bogus inputs from sensor rings which have clogged (arrow) or missing teeth, or excessive clearance between the sensor tip and wheel.



11

Of all the ABS components, the toothed wheel/magnetic speed sensor assemblies are exposed to the most abuse. In addition to the presence of our old friends rust and corrosion, the sensors are also exposed to metallic debris which can be attracted to the magnetic sensor tips.



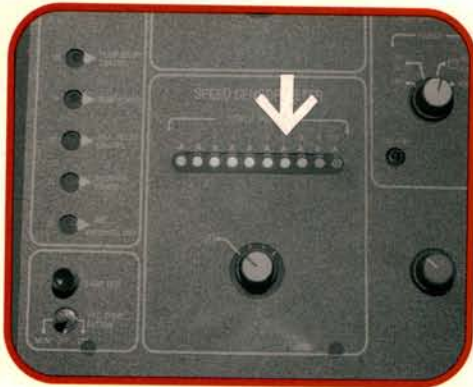
12

Even good sensor signals may not make it all the way to the ABS control unit. The wiring and connections from the sensors to the control unit are also exposed to a lot of physical abuse and moisture. In some cases, the only way to check for a bad connection will be to test the inputs right at the control unit.



13

At a given vehicle speed, all wheel sensor inputs should be the same. A weak or missing signal can muddle the ABS control unit's mind. Today we're using the **AutoForce 8400 ABS tester (Circle No. 141)** to speed our tests, and also to give you a better mental image of common test procedures.



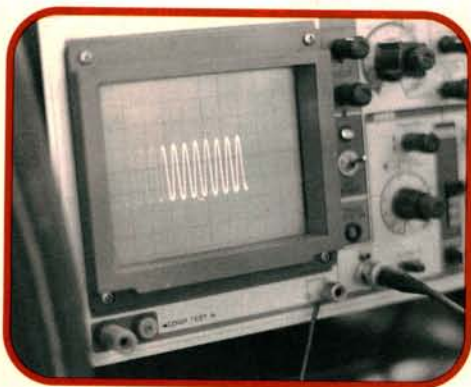
# 14

A string of quick check LEDs illuminate to verify power supplies and grounds at the control unit. We can also select individual speed sensors and watch another string of LEDs (arrow) to check each sensor's output. Then we can compare the readings, which should be the same at a given vehicle speed.



# 15

Erratic signals from any one sensor can indicate a problem. Maybe the sensor wheel is partially plugged with rust or debris, or has more teeth missing than an NHL goalie. We can measure peak voltage levels of each sensor by plugging a DVOM into the tester's breakout pins.



# 16

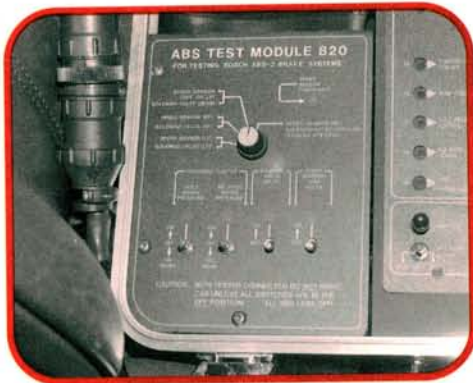
We can also watch the signal from each sensor with our lab scope. This is a clean, crisp display from a good sensor. Missing or plugged teeth will show up in a hurry as a ragged, uneven pattern. This sure beats tearing the car apart and visually inspecting each sensor to find the bad one!



# 17

From all reports, ABS hydraulic modulators (arrow) are very reliable. Blame them only as a last resort. Any thoughts about servicing them in the field should be freely sprinkled with the word "liability" and permanently placed on the proverbial back burner. Replace a bad modulator with a new one.

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So how do you know when an ABS modulator is bad? We're about to use the 8400 tester to send a few signals of our own. We'll activate the control solenoids in each circuit to check proper operation of the modulator control valves in each of their three modes: Apply, Hold, and Release.



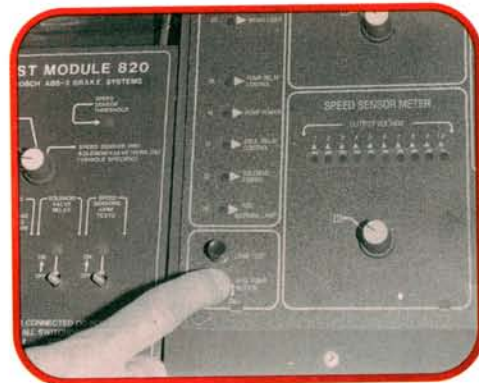
# 19

We're going to raise the vehicle, apply the brakes, and press the HOLD button after selecting a wheel. If the wiring to the actuator and the solenoids inside it are good, the brake should stay applied until we press the Release button. Do not perform these tests out on the road, for safety's sake.



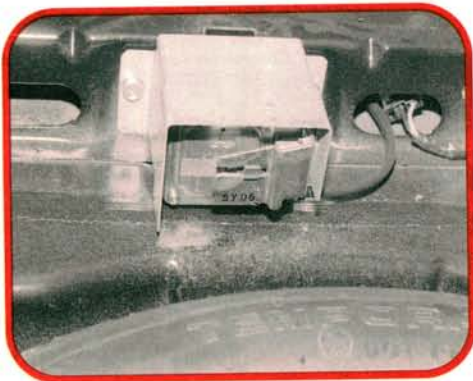
# 20

This is a four channel system, and has four solenoids to test—one for each wheel. By switching to each solenoid, we alternately test all of the valves by applying, releasing, and holding brake pressure. If any valve fails, either mechanically or electricaly, the modulator fails.



# 21

We can also test the pump inside the modulator. When powered up, it should make an audible humming noise. If it doesn't, check the power supplies and grounds before condemning it. The pump isn't serviceable, so you'd better be sure it's bad before replacing the modulator body.



# 22

Here's a final note about a component used by some manufacturers. The G (inertia) sensor is located in the trunk of this Mitsubishi, just ahead of the spare tire. Not normally a problem, it can cause abnormal ABS application when knocked off-level, or improperly installed during a collision repair.

## The ABCs of ABS

### ABS Inputs

Inputs to the ABS control unit are few and fairly simple compared to the number of inputs required by an electronic fuel system.

After verifying normal voltage and ground connections, the most important inputs come from the speed sensors. Some systems (Mitsubishi and some Toyota cars, for example) also use an inertia switch to limit ABS operation at very low speeds. But, the speed sensors are the critical inputs for proper ABS operation.

This reinforces the importance of the speed sensors and anything which can affect their signals to the control unit.

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## ...and Outputs

Outputs from the ABS system are the responsibility of the control unit and the ABS hydraulic actuator.

There are three basic modes of ABS operation:

- **Apply.** Electrical signals from the control unit move a valve in the actuator assembly to allow normal braking pressure to reach a brake or brakes. This applies the brake as it would under normal braking conditions.
- **Release.** If the control unit senses that a wheel (or wheels) has stopped turning because it's in a skid, it will release braking pressure at the brake on that wheel so the wheel can turn. The internal pump in the modulator body starts pumping the pressure away from the calipers and returns it to the master cylinder.
- **Hold.** Under some conditions, the control unit decides that the amount of braking at a wheel is just right, and moves the valve until it traps the pressure in the brake circuit. Apply pressure at the brake remains constant in the Hold mode.

The control unit's hand is quicker than the eye, and can switch back and forth between different modes several times a second. The rapid transitions between Apply, Release, and Hold are the cause for a pulsating brake pedal when ABS is working.

## You Can't Get MTV

The number of sensors used on an ABS system determine how many channels you get on a given system type.

There are only three channel types:

- **Four Channel.** In this type, each wheel has its own sensor, so the rotational speed of each wheel is monitored and controlled separately.
- **Three Channel.** Three channel systems are used on both front and rear-wheel drive vehicles.

On rear wheel drive vehicles, there are three sensors: one at each front wheel, and a third which monitors both rear wheels at the same time. It's common to mount the third sensor on the driveshaft, at the ring gear, or in the transmission on three channel systems.

Front wheel drive, three channel systems work a little differently. While they use a sensor at each wheel, they control ABS braking to the rear brakes as a pair.

- **Single Channel.** You might want to think of single channel systems as a proportioning valve with a brain. Rear wheel lockup is a common problem on small trucks (especially when they aren't carrying a load in the bed). Single channel ABS goes one-up on traditional proportioning valves by modulating brake apply pressure to the rear wheels, instead of simply reducing rear brake apply pressure.