Every so often, a vehicle shows up with an electrical problem that’s tough to pinpoint. You test the battery, starting, and charging systems. You install redundant power and ground jumpers to the computer and the circuit in question. You reprogram the computer or replace the PROM, and check service bulletins for any possible related problems. You may even wire solenoids or sensors directly to the computer, but the system still keeps setting a DTC or goes into failsafe.

So you turn your suspicions toward the computer. Replacing a computer can be an expensive proposition. And, if it’s an older vehicle, it may be difficult to locate a replacement.

Electronic Control Units (ECUs) have many names: Powertrain Control Module (PCM), Engine Control Module (ECM), Transmission Control Unit (TCU), and the list goes on and on. They all refer to the same type of component: a computer-based controller that receives input information, analyzes it, and creates output signals based on its processor and programming. We’ll refer to this type of device as an ECU in this article, regardless of the specific application.

We’ll start with a basic visual...
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inspection, and then move on to some advanced ECU diagnosis and repair. The basic inspection information will help you identify internal problems, which can help you determine whether an ECU is damaged or faulty. The advanced diagnosis and repair information will guide you through functional tests to determine whether an ECU is repairable by identifying, removing, testing, and sourcing components.

Static Electricity
Static electricity can damage an ECU’s non-serviceable components beyond repair. The damage won’t be visible, and you may not even feel a shock. Never touch the ECU’s harness connector terminals after removing it from the vehicle. And always disassemble, inspect or repair an ECU on a static mat, while wearing a wrist strap. You can purchase a basic mat kit with a wrist strap from Radio Shack (P/N 276-2370) or any electronics supply store.

Basic Visual Inspection: Inside the ECU
Listen to the ECU while you give it a gentle shake: If you hear anything rattling or bouncing around, expect to find loose parts inside. Remove the cover. Most covers are held in place with screws; some are held in place with bent metal tabs that you’ll have to straighten. It’s a good idea to have a magnifying glass and a strong light available, to help you take a closer look.

Once inside, look for signs of rust or corrosion (green or white crusty deposits). Pay close attention to the harness connector terminals, both inside the connector and where they’re soldered onto the circuit board. Inspect around the metal leads where the components are soldered to the circuit board. Figures 1 and 1a show a Mitsubishi transmission control unit with green corrosion around component leads and connector terminals. This indicates water intrusion.

Some ECUs, notably late model Chrysler units, are “potted”; that is, liquid resin is poured and molded over the circuit board and its components during manufacture. The resin hardens and — you have a magic electronic brick. In that case, you can forget about taking a peek at any internal components. The only checking you can do is sniffing the harness connector, and visually inspecting it for corrosion and burnt or overheated terminals.

Smell the ECU: A strong, burnt odor means something recently went nuclear.

Smell the ECU: A strong, burnt odor means something recently went nuclear. Check the harness connector terminals for signs of overheating or burning. This can be caused by the heat generated from a poor connection on that terminal, or a circuit that’s drawing too much current. Look carefully at the components on the circuit board.

If you see a component that looks burnt, cracked, blistered, or is black or chalky-gray, it may have overheated. If you suspect a component has gotten too hot, look at the circuit board around the connector terminals and see if it shows signs of heat. Check the back of the circuit board, around the component leads: If the board is brown, black, or the solder or traces are melted away, a component may have overheated or failed.

Figure 2 shows an overheated resistor on a Honda Accord transmission control unit. This failure is often found together with leaking electrolytic capacitors; more about them in a minute.

Figure 3 shows a Mazda transmission control unit with a burned out solenoid driver transistor. The back of the circuit board also shows heat damage. Some transistors and components may be attached to a heat sink by a clip or screw. You may have to remove them from the heat sink to examine them thoroughly.

Some overheated components are not so obvious. The component may look okay, but careful inspection of the circuit board shows signs of overheating, such as this damper clutch solenoid...
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driver transistor in a Mitsubishi transmission control module (figure 4). The transistor is actually shorted, keeping the solenoid energized all the time. This is a common failure on Mitsubishi KM transmission controllers and is caused by using a 3-ohm damper clutch solenoid with a transmission controller designed for a 13-ohm solenoid.

Integrated circuits, or “chips” as they are sometimes called, are square or rectangular plastic components, usually with many leads or connections. Figure 5 shows an integrated circuit on a circuit board. Inspect these carefully: If you see cracks, bubbling, or a hole in the chip, it’s a sure sign of failure.

Circuit traces on the circuit board can also be overheated or burned by excess current. The traces are copper foil bonded to the fiberglass board surface. Figure 6 shows a burned and lifted trace on a Lucas/Bosch L-Jetronic engine control module from a Rover.

Most automotive ECU circuit boards have a thin, clear plastic coating applied to the board and all its components. This coating can be cloudy in some areas, and will normally have some bubbles and runs in it. Keep this in mind when inspecting the circuit board and its components.

Leaking Capacitors

Figure 7 shows an electrolytic capacitor. You can usually identify them by their aluminum top. Electrolytic capacitors contain a corrosive electrolyte. The seal can fail on these capacitors and allow the electrolyte to leak onto the circuit board, damaging and shorting circuits on the board. Look closely at the circuit board around these capacitors. Figure 8 shows the staining and corrosion on the board around a leaking electrolytic capacitor. This is a common failure on 1990 to 1994 Honda Accord transmission control units, as well as Mitsubishi ECUs.

Cracked or Cold Solder Joints

Solder joints will sometimes crack right where the component lead is soldered to the circuit board. These cracks
Diagnosing ECUs, Part I: Visual Inspection and Common Failures

can be difficult to see. A powerful magnifying glass and a strong light can help you inspect a circuit board for cracked solder joints. Cracks will usually look like a fine circle in the solder, going around the component lead. Figure 9 shows a magnified view of some ring cracked solder joints.

Although sometimes difficult to find, this is probably one of the easiest problems to fix, if you feel confident about soldering circuit boards. Carefully scrape the plastic coating away from the solder joint, heat the joint with a soldering pencil, and melt a little fresh solder and flux into the joint. Even if you’re not sure if it’s cracked, it doesn’t hurt to re-solder a joint. This is always worth a shot.

**Cracked or Broken Circuit Board**

Carefully inspect the printed circuit board for cracks, especially around the mounting screws, clips, and the larger, heavier components mounted on the board. These are the most common areas for cracking, particularly if the car has been in an accident, or is driven over rough roads. If you see any cracks — particularly ones that run through any circuit traces on the board — you have pretty clear evidence that the ECU is damaged.

**Missing Components**
*(Not really missing, just not installed on that particular ECU)*

Sometimes you will see a blank space on the circuit board that’s all marked out for a component. Circuit traces, solder pads… everything is there, except the component itself. This is usually because the component wasn’t needed for that particular application. Figure 10 shows a Honda transmission control unit with a couple of blank spaces on the circuit board.

Sometimes a component can get so hot that it melts its own solder connections and falls off the board. You will usually have the loose component jingling around inside the ECU before you remove the cover, and you’ll see evidence of heat damage where it came from.

This pretty much covers the basics of visual diagnosis and common ECU failures. In the next issue of *GEARS*, we’ll talk about what equipment you need to perform quick tests and diagnosis on an ECU, as well as diagnostic procedures to determine if an ECU is showing any signs of life.