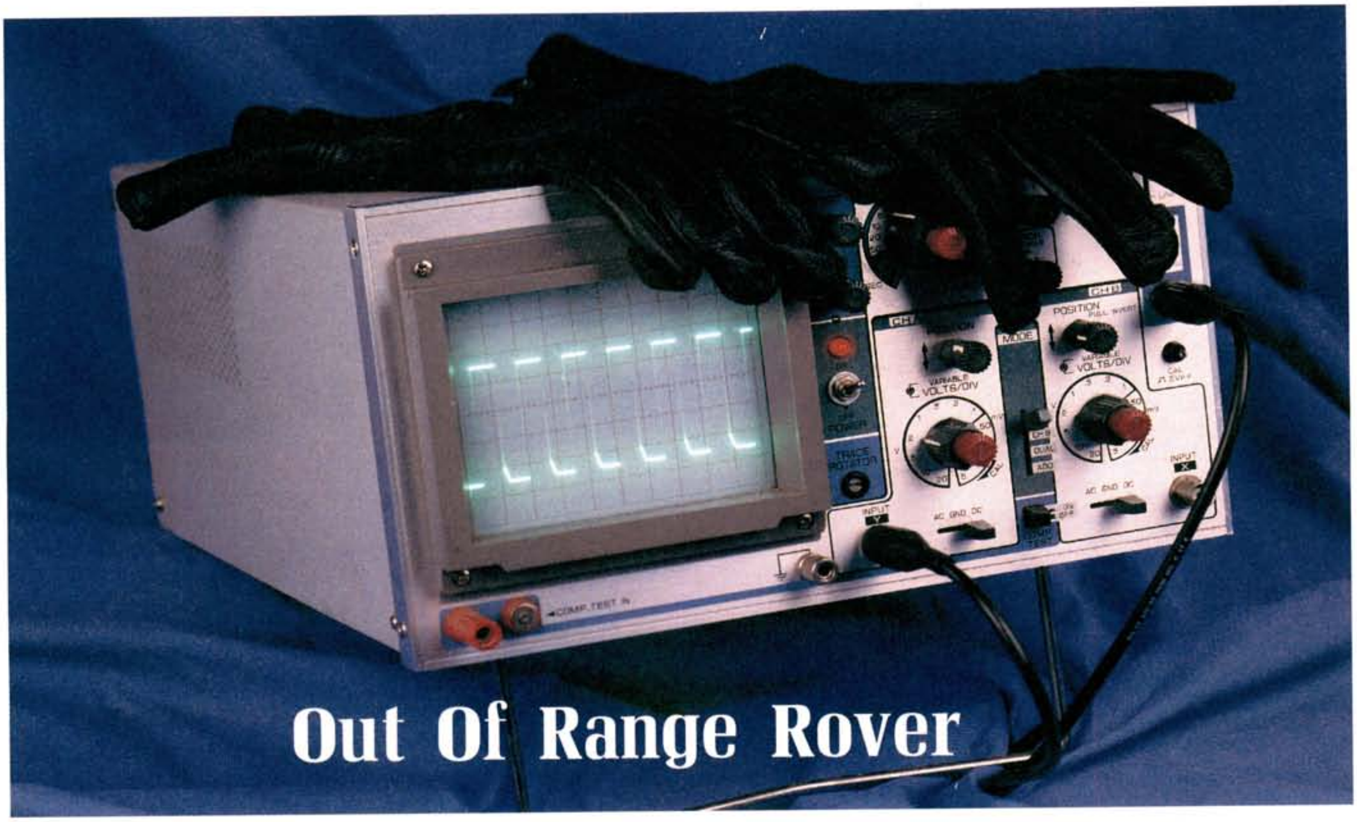


Out Of Range Rover

I received a call the other day from a shop owner who wanted to inquire about some fuel injector connectors. As we were talking, the shop owner said "Oh by the way, can you help me with a 1987 Range Rover that intermittently runs very rough, floods, and won't restart?" I told him I'd be glad to try, and so the story begins.

The vehicle in question is a 1987 Range Rover, which uses a Lucas fuel injection system. This system has a 40 pin ECU connector, similar to the Bosch 25 and 35 pin connector family. The Lucas system is also similar to the Bosch L-Jetronic engine management system, because it does not control ignition timing. However it does receive a coil negative signal (after a 6.8 K ohm dropping resistor) from the negative side of the ignition coil. This gives the ECU RPM-based ignition reference pulses. The air mass meter provides an accurate A/F ratio, which allows tighter emissions control versus the vane air flow meter used in an L-Jetronic system.

The Lucas system also includes one unusual component—a fuel temperature sensor mounted in the fuel rail housing toward the front of the engine. The sensor produces a 2.5V output with an ambient temperature of 70 degrees F.

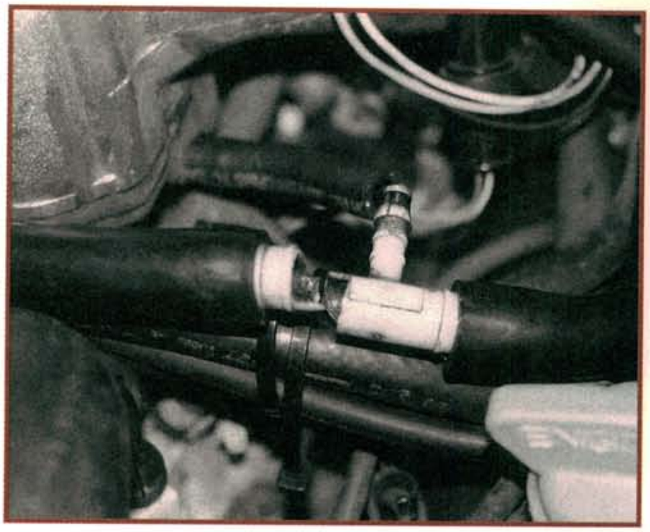
The Rover's 3.5 liter V8 engine places dual heated oxygen sensors (HO_2S) in the exhaust stream. Banked injection is used, with the even cylinders controlled by one pin of the ECU and the odd cylinder injectors controlled by another. The injectors are a high resistance type (14 ohms) and the ECU uses saturation drive to control injector "on time."

There is a main relay and a fuel pump relay. The fuel pump relay supplies power to the pump via an inertia switch. The idle speed is controlled by a four pole GM style ISC motor. This system also uses a TPS input, Park/Neutral switch, road speed sensor input and EVAP control to round out the main system components.

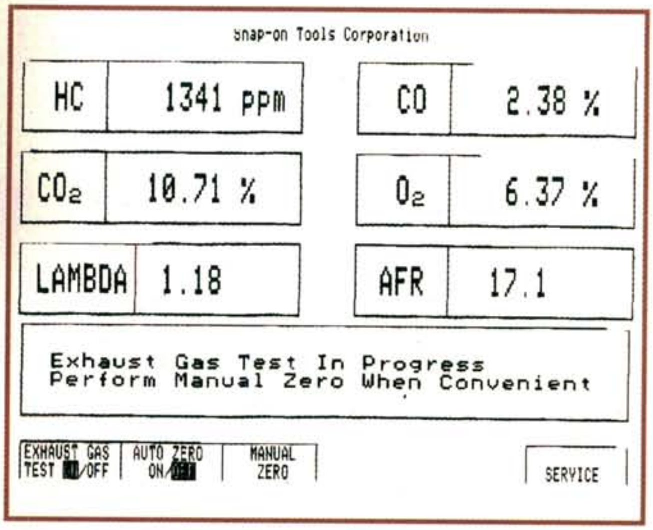
Besides the odd fuel temperature sensor input found on this system, there is one other unusual feature—the ECU controls A/C compressor ON output. Most European systems have an A/C compressor ON input that is used as an idle-up signal to the ECU. The Lucas system has an A/C request input which the ECU then uses to control A/C compressor ON output. This is worth knowing if you are doing an A/C service on this vehicle, since this style of A/C control is not generally found on 1980s-vintage European engine management systems.

At no point during our diagnosis did the MIL light come on. (Surprising, considering the vehicle's problems.) Given my lack of confidence in the fault code diagnostics available in most 1980s-vintage European engine management systems, I diagnosed the system by checking inputs and outputs. If a method for pulling fault codes were available to you, I would suggest it as a good place to start. At the time of diagnosis, I did not have this information available, so no fault codes were pulled.

—By Lester Bravek

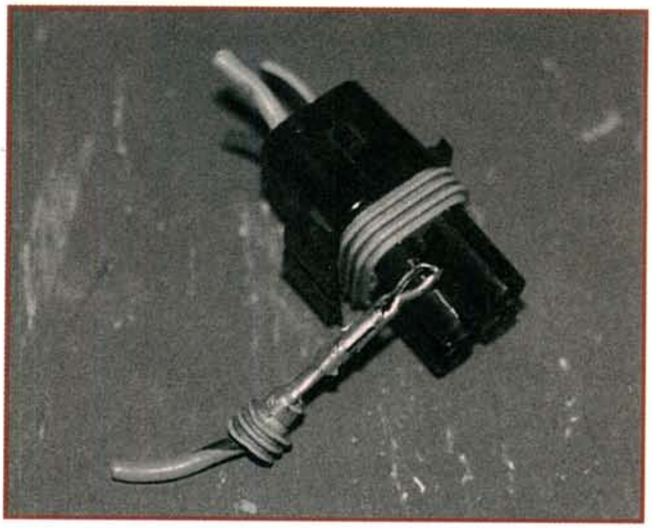


1 We're just getting started, so a visual inspection should take first priority. This will often allow you to quickly solve a problem. In this case, we spotted several little problems and improved the engine's idle quality, but the original symptoms still returned. At idle, the engine sounded anemic and a vacuum leak was evident (this broken vacuum connector was to blame). The last person to work on the Rover attempted to adjust the system without diagnosing the underlying problems.



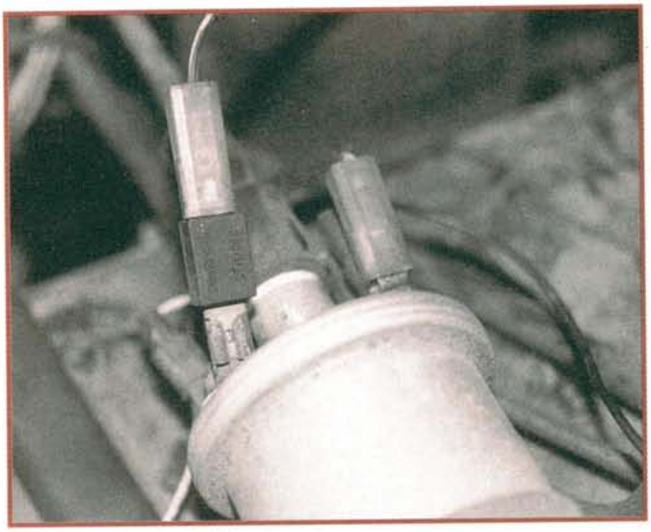
2 The vacuum leak and several other problems we'll describe as we go along all contributed to the miserable "before" four gas readings shown above. The Rover has no upstream test port, so the readings were taken after the catalytic converter. The engine was not misfiring, but it was running extra rich and the converter was getting more than it could handle in the unburned hydrocarbon department. The low CO_2 reading also indicated that the engine was running well below peak efficiency.

3 It appeared that the TPS sensor had been adjusted to 2.2 volts in an effort to compensate for the Rover's running problems. The high TPS voltage would explain why the vehicle was running rich with a high idle speed. Also, the high TPS setting was covering up the vacuum leak we discovered earlier. I initially adjusted the TPS to 0.5 volt and proceeded with our diagnosis. We later learned that the correct TPS voltage value should be 0.325 volt with the throttle fully closed.

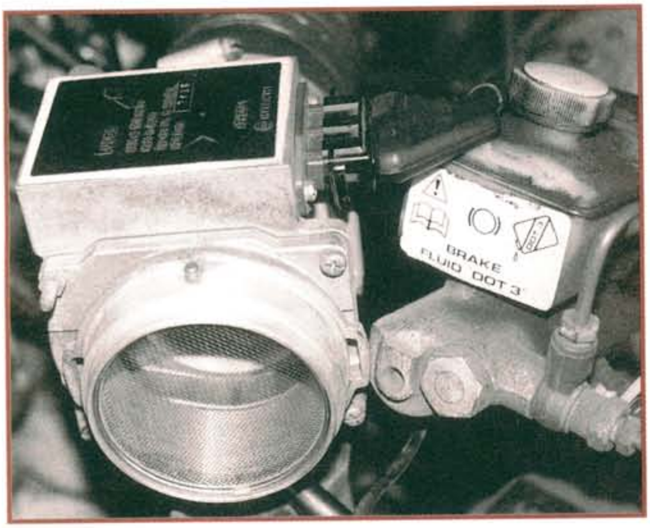


4 Here's another cause for our high idle. The engine was idling at 1500 RPM with the idle screw turned all the way into the throttle housing. We found a bent and recessed terminal inside the idle speed control motor harness connector. This four terminal Weatherpack connector may be familiar if you work on GM vehicles. We replaced it with a new connector and terminals. Without a properly functioning ISC, the vehicle had no cold engine idle compensation, and ran at 700 RPM.

5 While driving the vehicle, we noticed that the instrument cluster temperature gauge never registered a warm engine. This looked like another potential cause for our rich running condition. The thermostat was stuck open, which kept the engine from reaching operating temperature. The coolant temperature sensor's output voltage never dropped low enough to signal the ECU of a warm engine condition, which also contributed to the rich running condition.



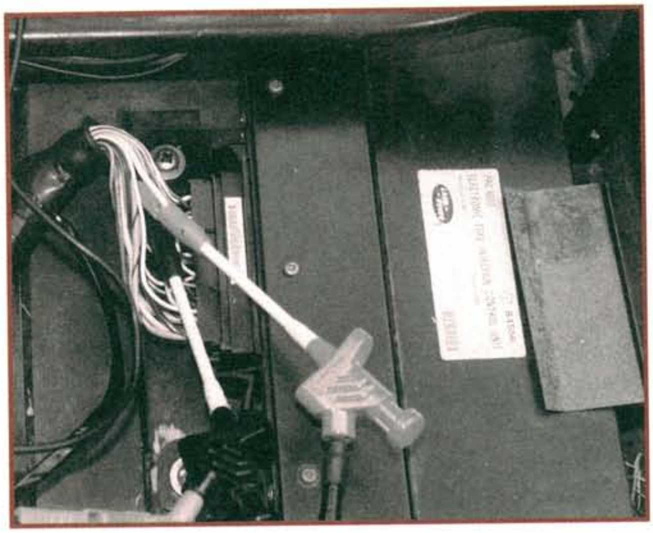
6 Ignition timing is not controlled by the ECU, but the ECU does receives RPM-based information via the minus side of the ignition coil. The black spacer pictured above is a 6.8 K ohm dropping resistor which is connected in series with pin 39 of the ECU. This resistor was inspected for any visual signs of cracking. An open in this resistor could contribute to a no-start condition. This input brings the ECU to life and tells it to start processing sensor data and compute injector ON time.



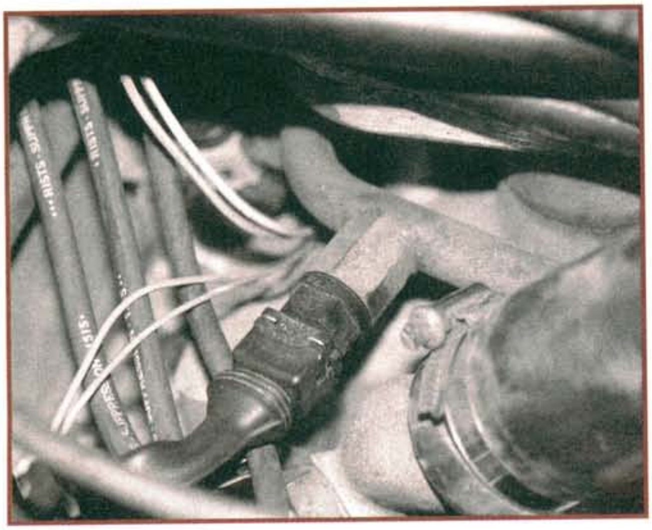
7 Although my experience with AMM (air mass meters) has shown that they rarely contribute to a rich running condition, we gave the meter a visual inspection. We pulled off the connector and inspected the terminals for any signs of corrosion or damage. A look inside showed an open bore with a mesh screen covering the opening. The sensing element is hidden out of harm's way inside a sampling port, which runs parallel to the incoming air flow in the main air passage.

8 While the engine was cold, we measured a coolant sensor reading of 3.5 K ohms resistance, and a 3.2 volt output with the sensor connected. We set the DMM on MIN/MAX voltage, then started the engine. As the engine warmed, the voltage slowly dropped to 1.1 volt, then started to climb. The vehicle started to stumble and a check of my MAX reading showed the sensor output had reached 3.9 volts! Now we had an answer to the intermittent stumbling and flooding during hot restarts.

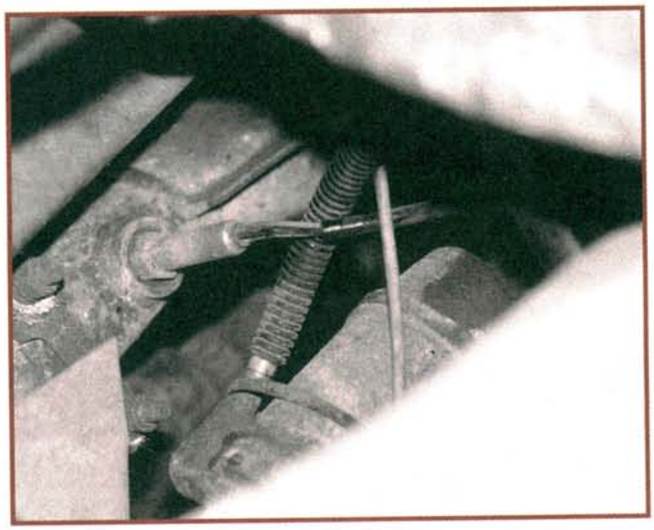
9 Next we shut the engine off and measured the resistance at the temperature sensor to make sure the voltage fluctuation wasn't coming from a bad electrical connection between the sensor and the ECU. As this photo shows, the resistance at the sensor had climbed to 33.26 K ohms, indicating that the engine temperature was below zero. It was clear at this point that we had found the main cause of the driveability problem, and discovered a bunch of other problems as well.



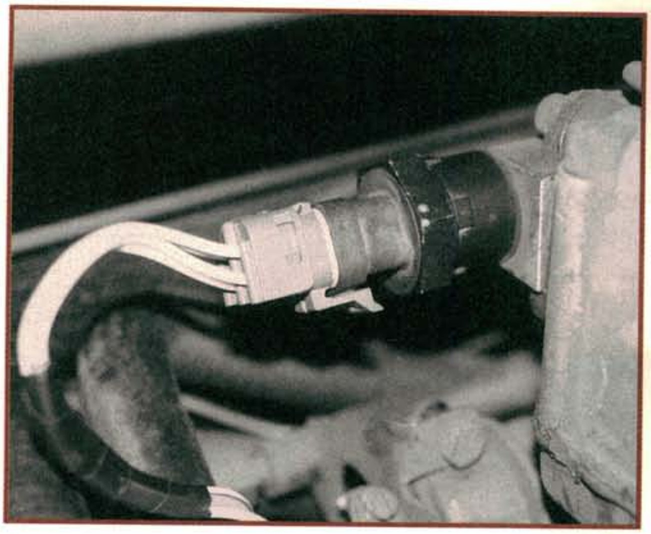
10 The ECU is located under the front seat, which required removal in order to gain access to the 40-way connector. This allowed us to check all the inputs and outputs right at the ECU, and inspect the condition of the connectors inside the plug for any signs of damage. We also checked for any bad power or ground connection problems. While test driving the vehicle, we were able to measure coolant temperature, AMM, and injector ON-time, all while seated inside the vehicle.



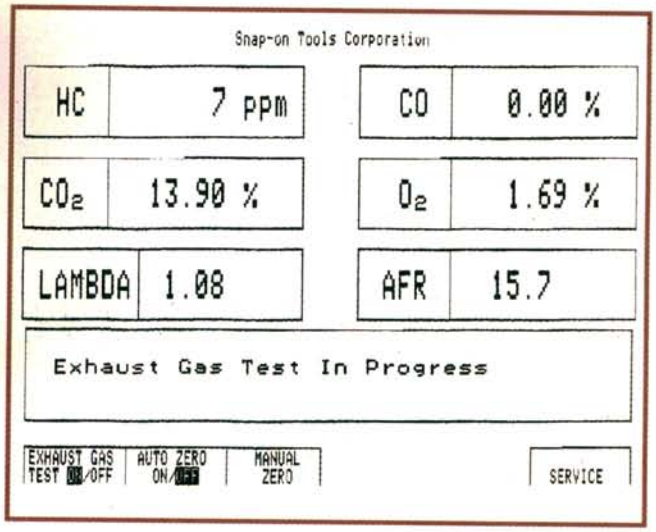
11 The system has a fuel temperature sensor housed inside the fuel rail at the front of the engine, near the thermostat housing. The sensor produced a 2.5 volt output with an ambient temperature of 70 degrees F. Disconnecting the sensor did not seem to affect engine idle quality or running condition. Don't confuse this sensor with the engine coolant temperature sensor, which uses the same style connector and is located behind the thermostat housing to the right of the fuel temperature sensor.



12 The Rover's V8 engine has a pair of three wire heated 0_2 sensors, one for each side of the engine. The harness connectors for the 0_2 sensors are located behind the engine along the firewall and are not easily accessible. Always check the internal resistance of the O_2 sensor heater elements, and make sure they are getting power and ground. This will ensure proper $H0_2S$ operation and will allow the system to enter closed loop, once all the other sensor input conditions have been meet.



13 1987-89 Range Rovers equipped with 3.5 liter V8 engines and LH 40 engine management systems have no fault codes that are accessible without specialized equipment. If the Check Engine light is illuminated, any of four engine management sub-systems may be out of parameters. They are: TPS, idle speed stepper motor (ISC), AMM, or coolant temperature. The factory hand-held diagnostic tool plugs into the four wire diagnostic socket located inside the engine compartment to read these faults.



14 To set the base idle speed, perform these steps in the following order: close the throttle; adjust the TPS to 0.325 volts; use a hose clamp to close off the hose in back of the plenum that leads to the ISC motor; adjust the throttle bypass screw until the engine is at 525 RPM; release the hose clamp; let the ISC stepper motor stabilize the idle speed. This last adjustment finished off the job and fixed our fluctuating idle speed problem. The "after" four gas readings show the results.