TomcoTechtips

TM

ISSUE 29

DIGITAL EGR VALVES

This issue we will study the Digital EGR Valves. These are electronically controlled valves that have no vacuum control at all. This electronic control results in an EGR valve that works faster and more precisely than the vacuum operated styles.

There are two types of Digital EGR valves. There is the Dual-Solenoid Digital EGR valve and the Tri-Solenoid Digital EGR valve. These valves are similar in design and function, with only slight differences in construction.

DUAL-SOLENOID DIGITAL EGR VALVES

The Dual-Solenoid Digital EGR valve has been used as early as 1990 on the GM 2.3L Quad 4 engine, W car lines. The valve consists of two solenoids, two armature assemblies, two shaft and swivel pintle assemblies, an EGR base plate and gasket and the EGR base (Fig.1).

The EGR base contains two orifice holes, through which the EGR gases can flow. These orifice holes are different sizes, one large and one small (Fig. 2). This gives us the ability to have three different EGR flow rates. The small orifice can be opened allowing 1.00 +/- .20 grams per second of EGR flow. The large orifice can be opened allowing 2.00 +/- .20 grams per second of EGR flow. Or both orifices can be opened allowing 3.00 +/- .30 grams per second of EGR flow.

The shaft and swivel pintle assemblies are located above and cover the small and large orifice holes (Fig. 3). The swiveling ability of the pintles insures a good seal of the pintles against the base plate. This helps prevent EGR leakage around the seating areas.

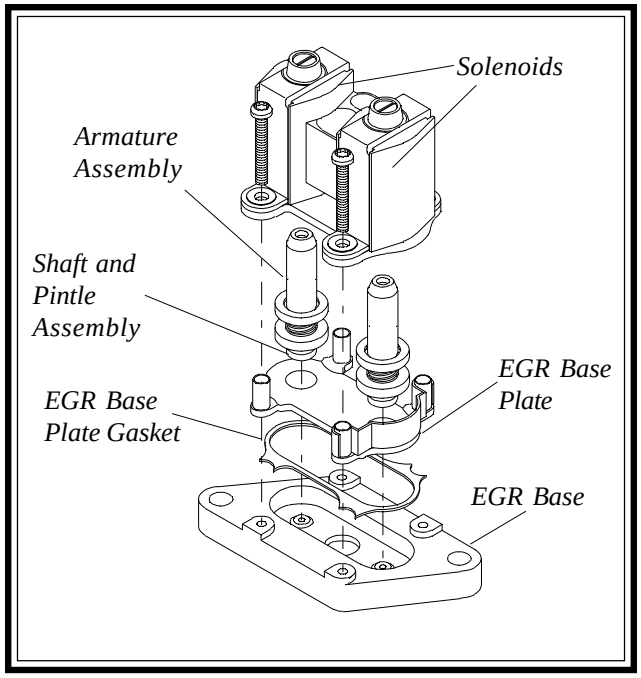

Figure 1

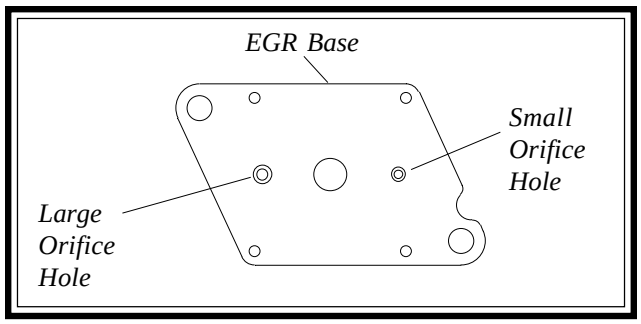

Figure 2

The pintle shafts go through the EGR base plate, through the lower shaft seal, through the spring, and through the upper seal. The lower seal prevents exhaust gas from escaping from the valve. The upper seal seals the armature cavity in the upper portion of the valve. These seals float, allowing a positive seal. The spring holds the upper and lower seals in place.

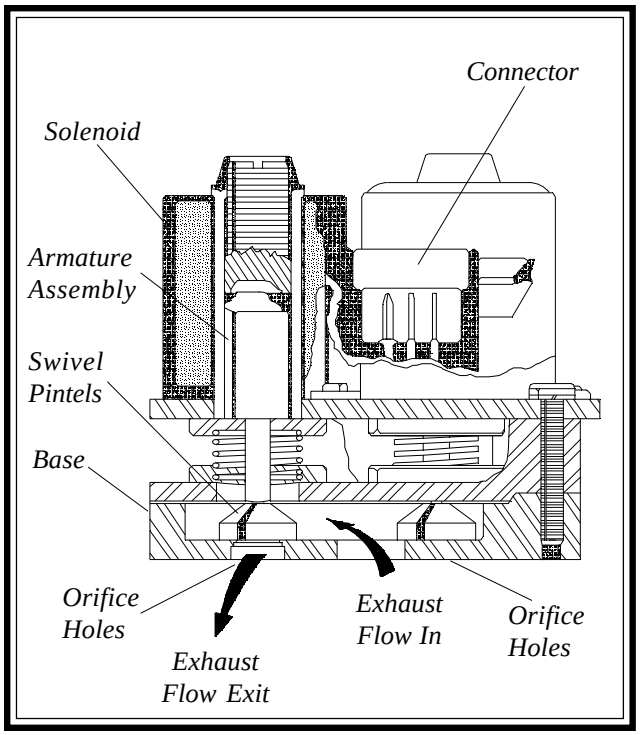

Figure 3

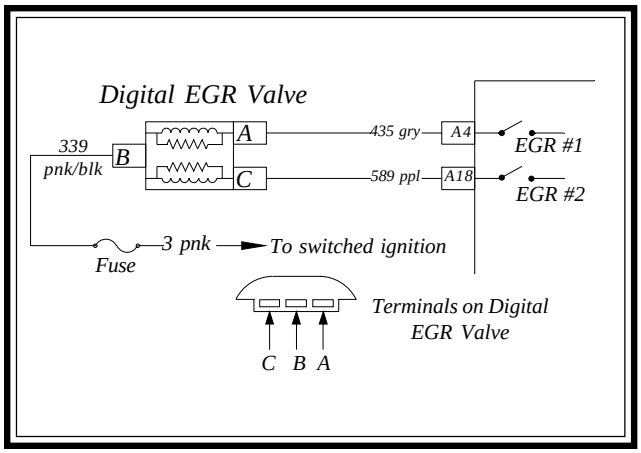

Figure 4

The opening and closing of the pintles is controlled by the solenoids via the Powertrain Control Module (PCM). The solenoids have one common power feed, which comes from the ignition switch. This ignition feed supplies battery voltage to the solenoids (Fig. 4).

The solenoids are grounded separately inside the PCM by Quad drivers. When the PCM senses a need for EGR flow it energizes either one or both of the solenoids through the drivers. This causes an electromagnetic field to be induced, which lifts the shaft(s) and the pintle(s). Exhaust gas then flows through the valve.

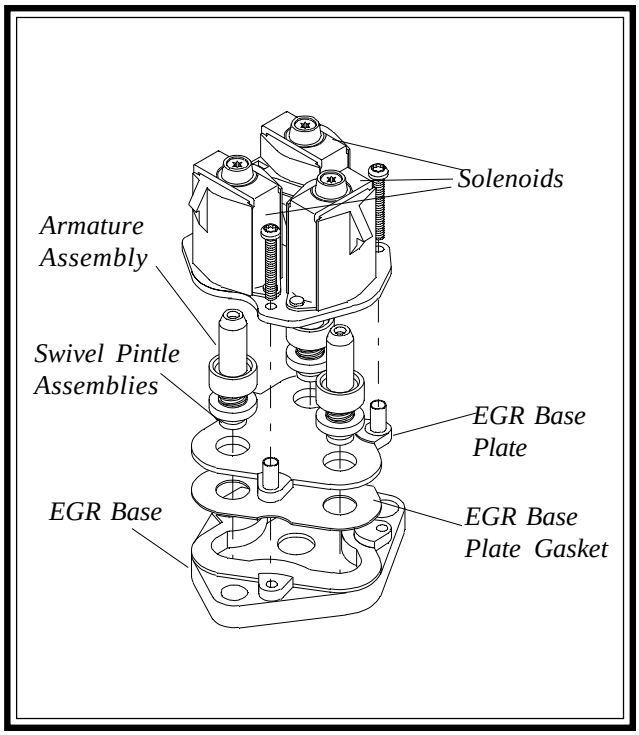

Figure 5

TRI-SOLENOID DIGITAL EGR VALVES

The Tri-Solenoid Digital EGR Valve is the same as the Dual-Solenoid Digital EGR valve except it has three solenoids, three armature assemblies, three shaft and swivel pintle assemblies and three orifice holes (Fig. 5). It has been used on GM vehicles with the 3800 engine car lines C, E, and H as early as 1988.

The three orifice holes are all different sizes. Orifice #1 has a small opening, orifice #2 has a medium size opening and orifice #3 has a large opening (Fig. 6). This provides us with seven different possibilities of EGR flow. Orifice #1 can be open, orifice #2 can be open, orifice #3 can be open, orifices #1 and #2 can be open, orifices #1 and #3 can be open, orifices #2 and #3 can be open or orifices #1, #2, and #3 can be open.

The three solenoids all have a common power feed, which comes from the ignition switch. The solenoids are grounded separately inside the PCM by Quad drivers (Fig. 7). When the PCM senses a need for EGR flow it energizes either one, two, or all of the solenoids through the drivers. This causes an electromagnetic field to be induced, which lifts the shaft(s) and the pintle(s). Exhaust gas then

flows through the valve.

The rest of the valve functions in the same manner as the Dual Solenoid EGR valve.

EGR FLOW AND CONTROL

The EGR flow in the Digital EGR valves is not dependent on the position of the pintle relative to the opening. The EGR flow is only dependent on the orifice size.

The exhaust flow in the digital EGR valves is different from the conventional valves we have studied. In the Digital EGR valve the exhaust gas enters a chamber in the EGR base. When the solenoids are activated, the exhaust gas is allowed to exit the valve. In most other EGR valves, when the pintle opens it allows exhaust gas to enter into the EGR valve (Fig.3).

The PCM monitors the Mass Air Flow (MAF) or the Manifold Absolute Pressure (MAP), the Engine Coolant Temperature (ECT) Sensor and the Throttle Position Sensor (TPS) to determine the correct amount of EGR flow required. The PCM then sends the appropriate signals to the EGR valve so precise control of EGR can occur.

TESTING

A resistance check can be performed on the solenoids. On the Dual-Solenoid Digital EGR valves check the resistance between pins "A" and "B" and pins "B" and "C". Resistance should be between 18 and 30 ohms at both of these points (Fig.8).

On the Tri-Solenoid Digital EGR valves check the resistance between pins "D" and "A" ; pins "D" and "B" and pins "D" and "C". Resistance should be between 20 - 30 ohms; 20 - 30 ohms; and 10 - 17 ohms respectively (Fig.8).

Remember that a resistance test is just a static test. A current draw test would be the best way to find the faults under load. (See "Electronics 101 on page 4).

On some vehicles you can use the scan tool to functionally check these EGR valves. The scan tool will send a command to activate each one of the solenoids grounds. By monitoring the amount of RPM drop you can tell if each solenoid on the valve is opening and allowing EGR flow. It may be easier to disconnect the IAC motor when monitoring the RPM drops.

If your scan tool does not have those capabilities you can backprobe into the ground of each solenoid. Then ground each of the solenoids manually and monitor the RPM drop. Be careful not to backprobe into the power feed. Grounding this wire will short out the fuse.

CODES

The PCM checks the EGR to make sure it is functioning correctly. On a coast down the PCM will cycle the solenoids on and off individually. The PCM then looks for a change in the engine RPM and the O2 sensor activity. If the PCM does not see the change it expects to

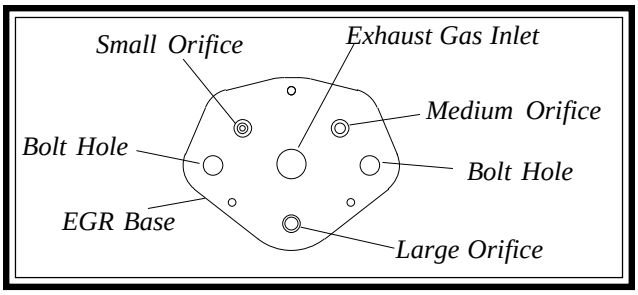

Figure 6

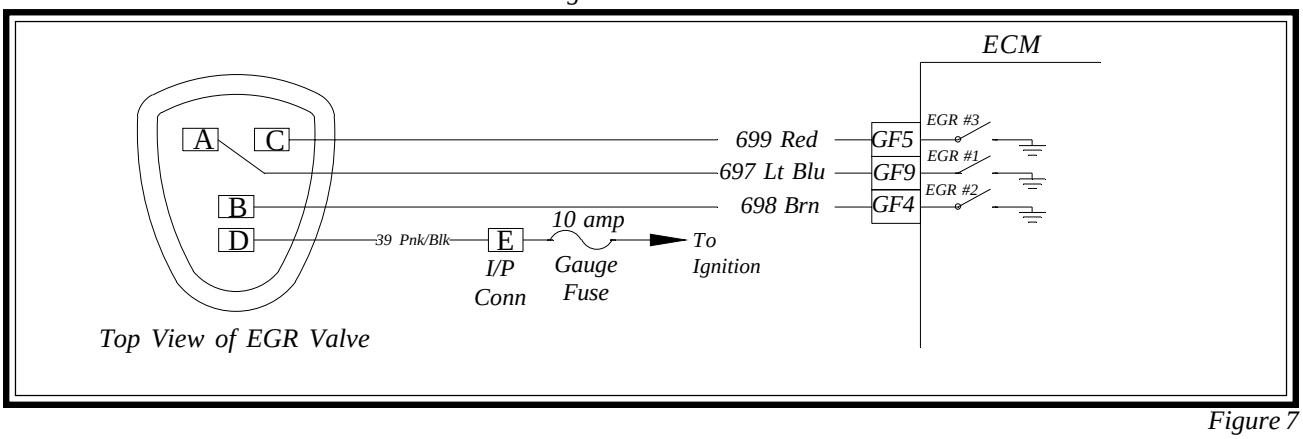

Figure 7

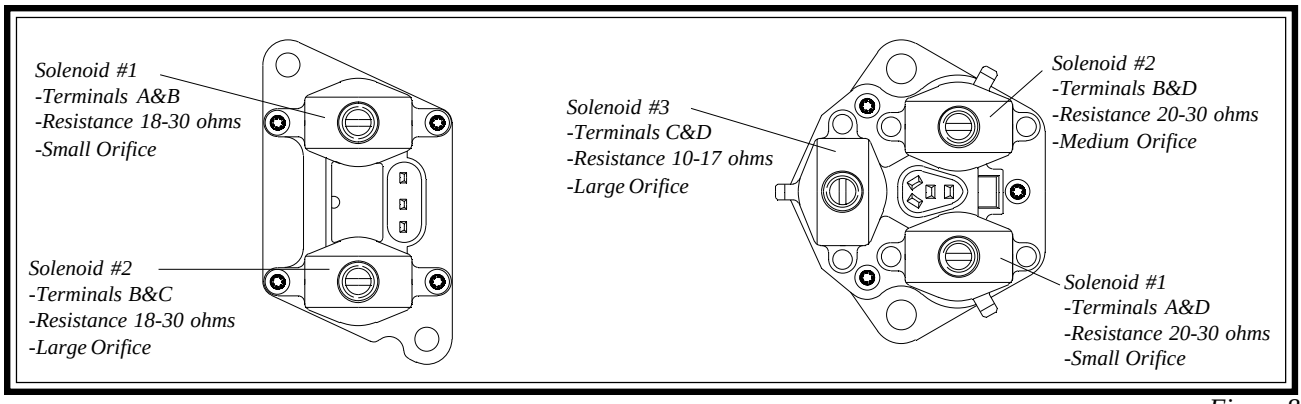

Figure 8

see, it will set a Diagnostic Trouble Code (DTC).

On the Dual Solenoid Digital EGR valve a DTC 63 will be set for the small orifice solenoid and a DTC 65 for the large orifice solenoid. This means that the EGR flow was not sufficient for the orifice that had been opened, therefore the PCM did not see the change in RPM or O2 required.

On the Tri-Solenoid Digital EGR valve a DTC 63 will be set for the small orifice solenoid, DTC 64 for the medium orifice solenoid and a DTC 65 for the large orifice solenoid. This means that the EGR flow was not sufficient for the orifice that had been opened, therefore the PMC did not see the change in RPM or O2 required.

On both style valves if a code 26 is set it means that there is a problem in the circuit or the Quad driver circuit.

HELPFUL TIPS

We have seen a number of Digital EGR valves that have blown the gasket out between the EGR base plate and the EGR base. Since this gasket is not sold separately the whole valve must be replaced. A good service practice is to tighten the screws that hold the EGR base plate and base together. This may prevent premature failure of the gasket.

Electronics 101: Current draw test.

A resistance test is just a static test. A current draw test would be the best way to find the faults under load. This can be done by connecting a 10 megohm DVOM set to the amp scale in series with the ground wires of the solenoids. Typically the solenoids should read less than one amp.

A number of the Tri-Solenoid EGR valves we have tested read approximately 1 amp for solenoid #3 and approximately .52 amps for solenoids #1 and #2. This would make sense since solenoid #3 has approximately 12 ohms of resistance. Using ohms law (Voltage = Current × Resistance), 12 volts divided by 12 ohms would give us 1 amp. The same is true for solenoids #1 and #2 which have approximately 24 ohms of resistance; 12 volts divided by 24 ohms would give us .5 amps.

If the amp reading is excessive this would mean that the solenoid may be shorting under load, even if the static resistance check shows okay. The true test of the solenoid is how it functions under load. If one of the solenoids is shorted the only option is to replace the valve. The solenoids cannot be serviced separately.