# THE DENSO HP2 FUEL SYSTEM EXPLAINED...

**This particular system was fitted to Toyotas, Nissans, and Renault vehicles from around 1999 to 2007 but may vary from model to model. The HP2 system is easily identifiable because it is unique in the fact that it uses two Suction Control Valves. Looking on the back of the pump you will see there are two electrically operated solenoids – one red and one green.**

**Why two? Well the system is not like any other. The job of the SCV is to control the flow of fuel oil to the pumping chamber of the high pressure pump, as a means of controlling the pressure in the common rail. The pumping chamber in other systems (including Bosch, Siemens and Denso HP3), consists of a cam, piston and powerful spring. The spring provides the inlet stroke and the cam provides the outlet stroke; this means that the engine has to provide a large amount of power to operate the pump. The Denso HP2 system uses a single internal eccentric cam and two pumping chambers.**

Figure 1

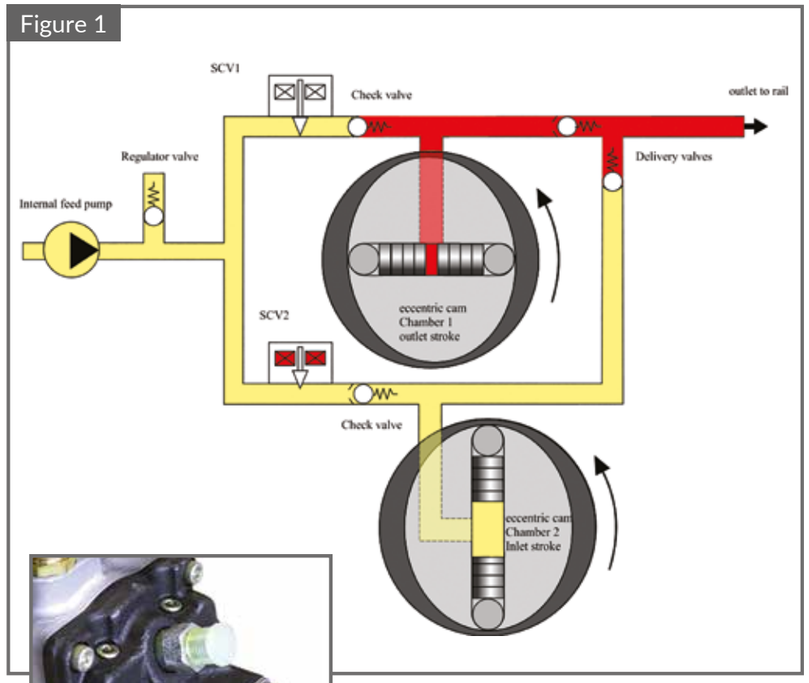



**Figure 1** shows a schematic of the system.

The two pumping chamber's pistons are set at 90° to each other so that they are on opposite strokes but are operated by the same cam. In Figure 1 Chamber 2 is on the intake stroke; fuel from the internal feed pump enters the chamber via the check valve when the SCV is open and forces the pistons apart. The amount of fuel entering the chamber is controlled by how long the SCV is open during the intake stroke. A short opening time will only partially fill the chamber, by moving the pistons out a reduced amount so that the rollers do not touch the cam. This means the cam has to turn until the rollers touch the cam and start the outlet stroke.

The amount of fuel delivered to the common rail is controlled by the angle through which the rollers are in contact with the cam. Both the contact angle and the common rail pressure are parameters on your scan tool; the relationship between engine speed, contact angle, injection quantity and common rail pressure are monitored for plausibility.

Figure 2

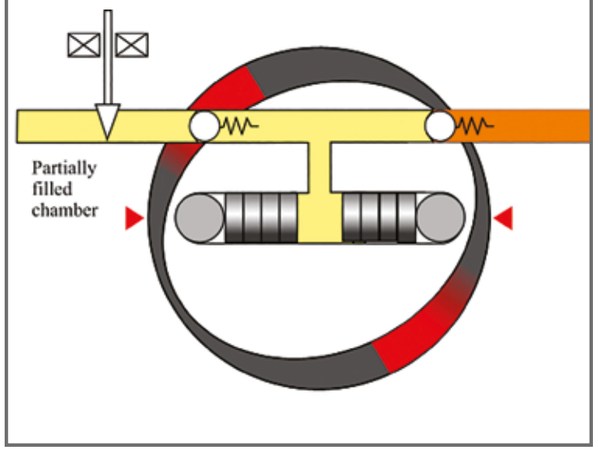



**Figure 2** shows the single pumping chamber.

## Pump Timing...

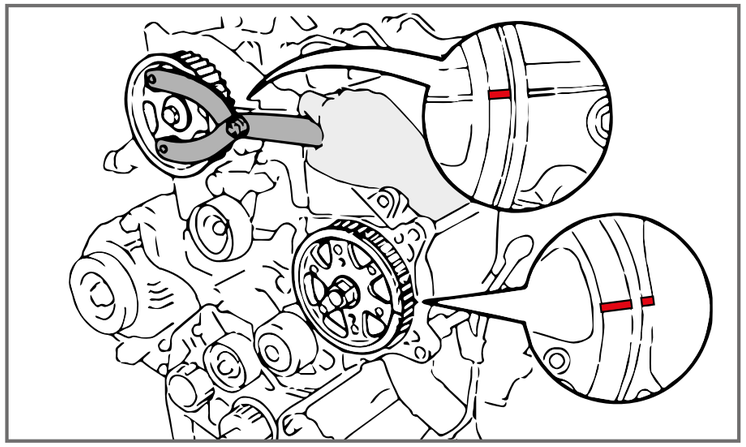
Unlike the SCVs in other systems (where the opening of the valve is controlled in degrees by using Pulse Width Modulation), the Denso HP2 system uses a timed open period. The result of this, is that less effort is required to operate the pump.

As a result of this method of control, the opening of the SCV has to be timed to allow the flow of fuel into the chamber when the internal cam is at its maximum stroke. This means that the pump drive pulley has to be timed to the engine.

## What goes wrong?

The SCV fails to respond to the control signal correctly; this can be caused by various reasons but essentially, they stick. There has been some speculation about the reduction of the lubricating properties in modern diesel fuel due to the reduction of sulphur. Sulphur is not a lubricant but it can combine with the nickel content in many metal alloys to form an alloy that can increase lubrication. Also the process used to reduce the sulphur content in fuel, reduces the fuel's lubricating properties.

Over the years of production small modifications have been made to the design of the SCVs to overcome the problem, but there are still plenty of older vehicles out there that have the potential to fail.



## Symptoms of SCV failure...

The most common symptoms are a lack of power or rough idling; both these faults may be intermittent. DTCs P1229 and P0093 relate to excessive pressure in the system caused by the SCV sticking open longer than it should and will cause the engine to go into failsafe mode where the engine power is restricted. DTC P0627 relates to the SCV circuit, this could be caused by an open or short circuit in the SCV field coil or in the wiring.

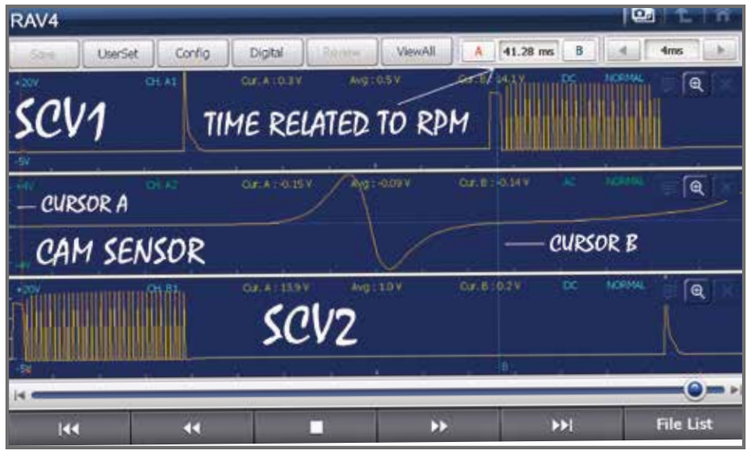
## Checks...

If DTC P0627 is recorded the SCVs should be checked for resistance and insulation. The wiring from the Engine ECU to the valves should also be checked for continuity; for this you will need a wiring diagram. A quicker test can be carried out using an oscilloscope.

## What's going on?

The oscilloscope was switched to show 3 of the 4 possible channels; channels A1 and B1 are connected to the PCV 1 and 2 terminals and a common ground, then cursors A and B were set to the start of the SCV 'on' time. The oscilloscope pattern shows the individual switching of the two SCVs 180° apart. The rapid switching effect is used to limit the current through the SCV winding and prevent overheating. The clean scope pattern shows that the wiring is intact.

Channel A2 shows the camshaft sensor indicating the need for timing; if the control circuit checks out, then the likely cause is that the SCVs are sticking.




## Replacing the SCVs:

Cleanliness is of paramount importance; the ingress of the smallest particle could cause the valves to malfunction. Clean around the area with brake cleaner and use compressed air to remove any small particles.

Depending on the vehicle application, certain components may need to be removed to gain access to the valves; removal and fitting procedure for Suction Control Valves **(ADT36846C)** are highlighted in our technical bulletin INF156. After replacement, reset any engine diagnostic trouble codes using a suitable diagnostics tool, before road testing the vehicle.