

## Rover SD1 Efi Injector (Including Injector Resistor Pack)

### Introduction

- According to their service manuals Rover would have us believe that the Fuel Injectors fitted to the Rover SD1 Efi cars are not a serviceable item. However, most people are aware that they can be ultrasonically cleaned which is an expensive process and a neat way for service outlets to make loads of money (up to £150 per set of 8) for just a few minutes work on each injector.
- What isn't so readily known is that the Rover SD1 Efi Injectors are very hardy indeed and can be flushed out and cleaned in the home workshop and that the service parts are not at all expensive.
- First off, however, to best understand these bulletproof items it is useful to have some knowledge of how they operate for diagnostic purposes.

### Operation

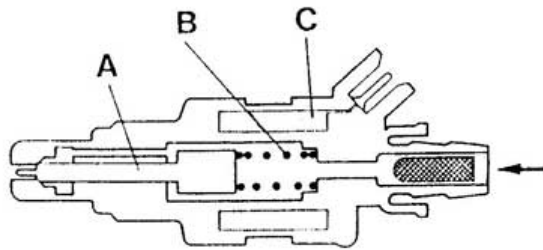


Fig.1 Injector

- A Needle valve
- B Coil spring
- C Electrical solenoid

- Each injector contains a needle valve (A) as seen in Fig.1 which is held closed in the rest position by a coil spring (B). When the electrical solenoid (C) is energized, it lifts the needle valve to allow the fuel to pass; and when the solenoid is de-energized, the spring snaps the needle valve closed to cut off the fuel flow.
- The tip of the needle is ground to a pintle shape to ensure efficient atomization of the fuel spray into the inlet manifold.

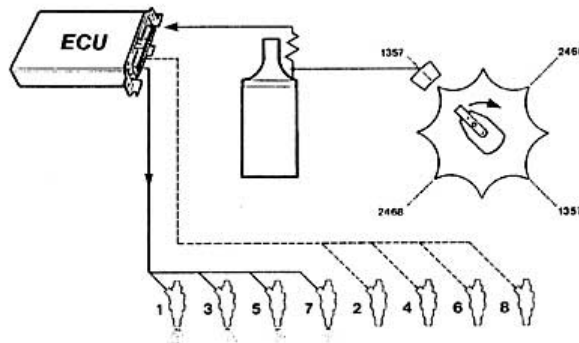


Fig.2 Injector Signal

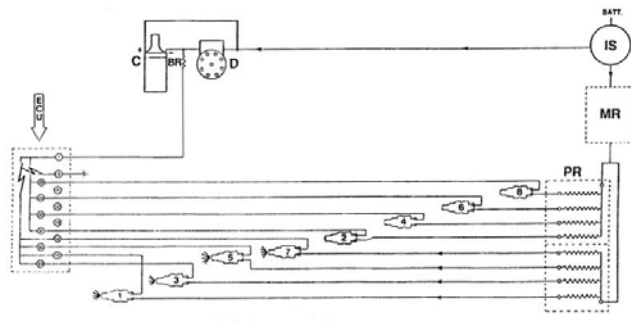
- The injector is opened when signaled by the ignition system via the ECU.
- The signal to inject originates at the ignition distributor reluctor as shown in Fig.2
- Only four of the reluctor gaps are used to signal 'inject'; the ECU ignores every other signal. It is the ECU, which dictates the injector 'open time' and therefore the amount of fuel that is injected.
- A separate resistor pack is fitted in the circuit to reduce the 12 volt supply down to 3 volts at the injector.
- Obviously if the incorrect quantity of fuel is injected, emissions, performance and economy soon become upset.

### **Injector Circuit**

- The injectors that inject fuel into the engine are opened by internal solenoids. Current comes from the ignition switch and Main Relay (MR) terminal 87 via two resistor modules inside the Power Resistor pack (PR) (Fig.3). Current is available immediately the ignition is turned on.
- However the circuit is not complete until the injectors are earthed by the ECU. To achieve this, the engine must be either cranking or running and the engine speed signaled via the trigger resistor (BR) to Pin 1 of the ECU, which is programmed to operate each cylinder bank of injectors twice per complete engine cycle.
- The circuits for injectors 1, 3, 5 & 7 are earthed by the ECU via pins 15, 33, 32 & 14, whilst the circuits for injectors 2, 4, 6 & 8 are earthed via pins 31, 30, 29 & 28

**Fig.3 Injector circuit**

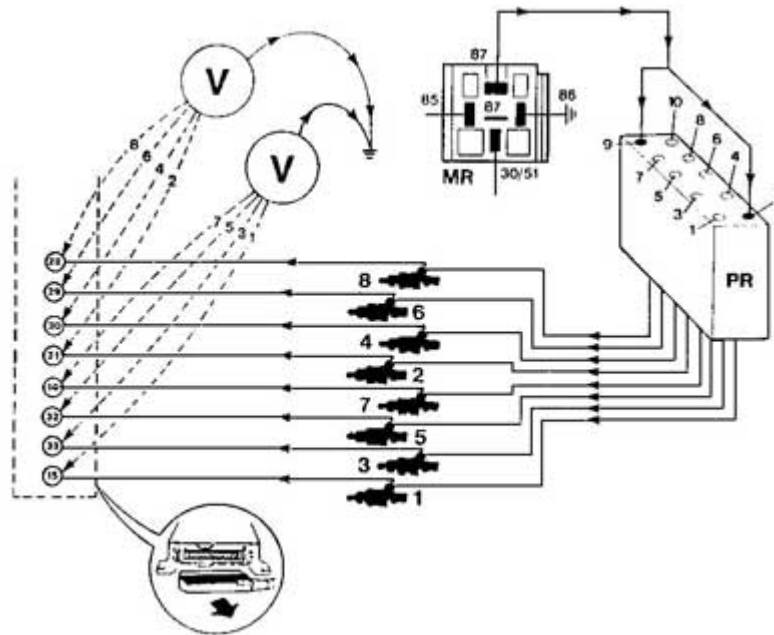
- IS Ignition switch
- D Distributor
- C Coil
- MR Main relay
- PR Power resistor packs
- BR Trigger Resistor
- 1- 8 Injectors 1- 8



### **Testing Injectors and Associated Circuits**

- The following tests are designed to establish the integrity of the injectors, their associated resistor pack and circuits, the latter being more prone to faults.
- If appropriate, skip to the last test to carry out just the injector test process.

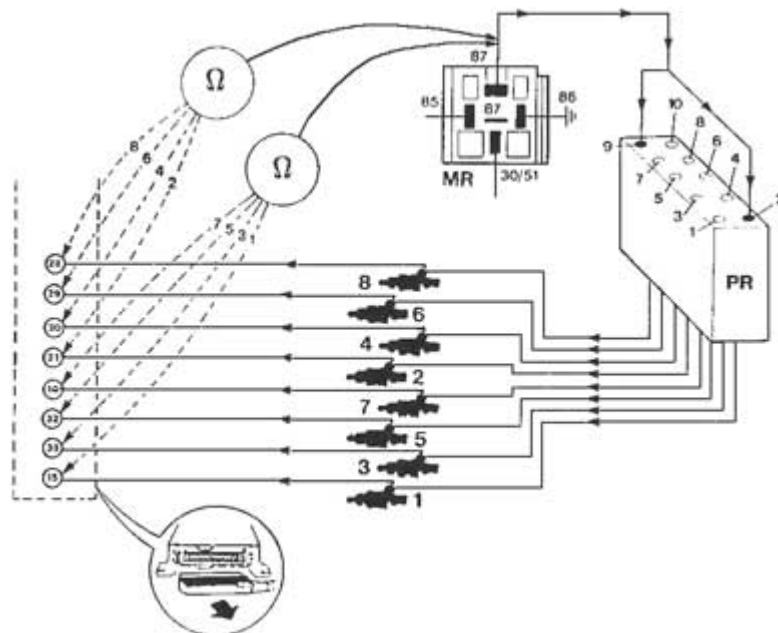
**Check the integrity of injector solenoids, resistor pack, wiring and ECU connections**



**Conditions**

- ECU multiplug disconnected
- Ignition ON
- Connect voltmeter between engine earth and each injector multiplug connector
- Readings should be within 0.5 volts of battery voltage
- If variation is in excess of 0.5 volt carry out the next test

**Check the continuity and resistance of each injector and its resistor**



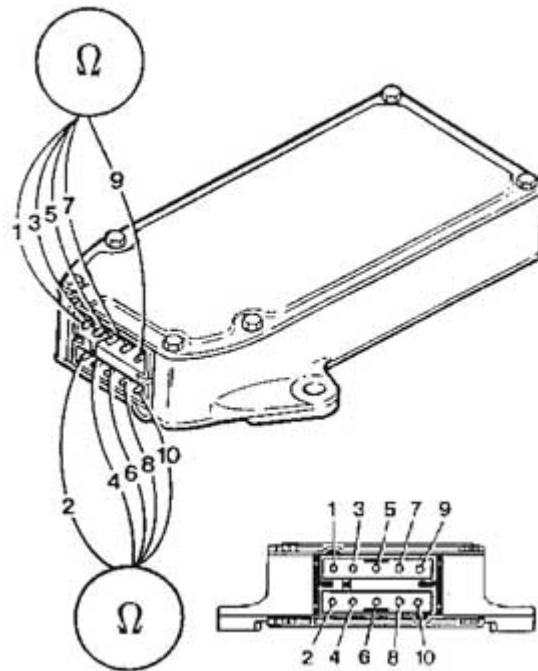
### Conditions

- ECU multiplug disconnected
- Ignition OFF
- Connect the ohmmeter between terminal 87 or 87A on the main relay and each injector multiplug terminal in turn
- Reading of 7 to 10 ohms indicates no fault
- Reading of infinity indicates a broken connection or component
- Reading of high resistance indicates a poor connection, faulty wiring or a faulty injector or resistor
- If a faulty injector or resistor is suspected continue with next test.

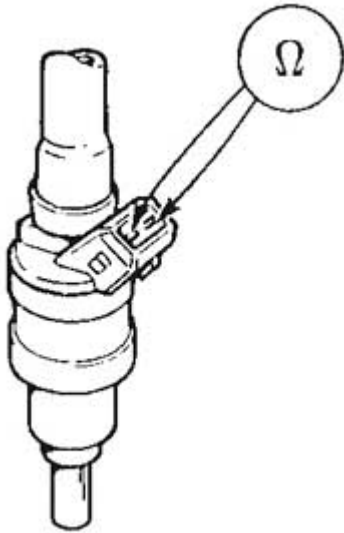
### **Check resistance of power resistor pack**

#### Conditions

- Disconnect harness multiplug from resistor pack
- In turn, connect an ohmmeter between terminal 9 and terminals 1, 3, 5 & 7 to check the resistor values for injectors 1, 3, 5 & 7
- Similarly connect the ohmmeter between terminal 2 and terminals 4, 6, 8 & 10 to check the resistor values for injectors 2, 4, 6, & 8
- Reading should be 6 ohms  $\pm$  1 ohm for each resistor
- If any value is incorrect renew the complete resistor pack



### Check resistance of injectors



#### Conditions

- ECU multiplug disconnected
- Ignition OFF
- Disconnect the wiring from each injector, and check its resistance value by connecting the ohmmeter to both terminals of the injector
- Reading should be  $2.4 \text{ ohms at } 20^{\circ}\text{C} \pm 0.5 \text{ ohm}$
- Renew any injector outside this resistance value

### Interpreting the Results

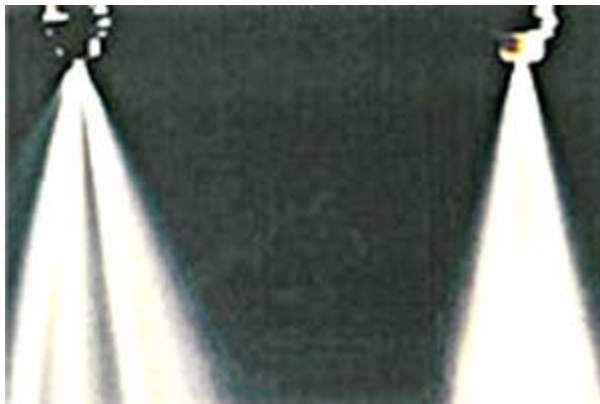
- Basically the above tests should show that the injectors are operating electrically within specification and the associated circuits are sound and in good condition.
- As already mentioned the injectors are practically bullet-proof but the same cannot be said for the resistor pack or the injector wiring.
- The former is subject to long term vibration damage because the resistors are actually formed onto a circuit board.
- The latter is operating in the harshest environment on the engine, subject to extreme heat and temperature change. Sadly, the original choice of wire and connectors left something to be desired so they are quite prone to failure.
- This often fools the “home mechanic” owner into thinking that an injector may be faulty when in fact, they rarely fail electrically. For these reasons it is better to perform the full range of tests to establish the real cause of a suspected problem.
- Furthermore, even if all the above tests are satisfactory, they do not demonstrate that an injector is actually squirting petrol properly or perhaps even squirting continuously. Problems here can be due to a number of issues.
- Internal solenoid and/or pintle jammed open or shut.
- Pintle or pintle cap damaged
- Internal injector filter blocked

- Tell tale signs of the above might be, very lumpy running and heavy fuel odor due to injector stuck open, fouled spark plug, or definitely misfiring on one cylinder, usually discovered by removal of the matching high tension lead making no difference to the misfire.
- At this point the usual route would be to replace a suspected injector with a new or secondhand spare and indeed, this is the fastest solution.
- However, if the problem with the injector is age/mileage related then in all probability all the injectors will be in the same “mean-time-between failure” time frame, so it may be appropriate to contemplate some preventive maintenance.
- The following home brew solution can save loads of money and actually works.

### **Home Workshop Injector Maintenance**

- I devised this process following Rover SD1 Club local meeting discussions with Dave Horne and have done all injectors on two different cars including my current Twin Plenum Vitesse. The injectors are still going strong since 1998.
  - All the components needed for injector overhaul can be sourced from a local injection specialist or from Burlen Fuel Systems (Tel: 01722 412500) under the following Burlen part numbers and description (1998 prices).
- |             |                                      |                 |
|-------------|--------------------------------------|-----------------|
| • BFB103Q10 | Filter Baskets 10 off                | £5.00           |
| • BPC13Q10  | Pintle Caps 10 off                   | £2.50           |
| • ABF407    | Fuel Injection Hose 2.0 mtr X 7.6 mm | £13.40          |
| • BHC1214   | Hose Clamps 12-14mm 100 off          | £14.50          |
|             | Packing and First Class Post         | £1.95 all + vat |
- Cleanliness is a key factor particularly as there is the possibility of metal debris whilst removing the old hoses.
  - Cut off the swaged hose collar at a sharp angle using suitable snips or a very fine junior hacksaw blade and discard the old fuel hose
  - Cut off the old pintle caps with a sharp blade being careful not to mark the body of the filter.
  - Clean all around the area where the pintle cap fits with fine wire wool and metal polish.
  - Clean up the body of the injector and the area where the manifold rubber seals fit with a wire brush, wire wool and polish.
  - Blow off any debris and wash the injector in a container of clean “Panel Wipe”.

- ast in this sequence, pull out the old injector filter using a wood screw or small "easy-out" gently screwed into the open end of the filter, bathe the injector again and blow away any more debris with a 100 psi airline.
- Access to an ultrasonic cleaner may significantly improve the cleaning process and if thought necessary such equipment is readily available at low cost on popular auction sites.
- Press a new filter into place using a drill press or vice, protecting the pintle end of the injector with suitable hole in a hardwood block.
- Press on a new pintle cap using a small hardwood block with another small hole to protect the pintle end, ensuring the cap starts off upright to prevent uneven fit.
- It's probably best to think this next part through and make up a rig meeting the following requirements.
- Temporarily connect a 6" length of hose to the input end of the injector with a hose clip, and connect a 3 volt supply to the injector connector using a switch to pulse the injector on and off.
- Note: It's possible to use a 12 volt supply but the injector must be protected by a 6 ohm resistor wired in series with the supply and switch.
- Pour a small quantity (about one fluid ounce) of Panel Wipe into the open end of the hose and connect a 30 psi compressed air source securely to the hose sufficient to withstand the pressure.
- Ensure there is suitable lighting to the rig so that one may clearly see the resulting spray pattern.



- Pulse the injector coil briefly with the switch and observe an orderly conical spray pattern with no dribbling. R/H pattern.
- Pulse the injector several times and see that the above is repeatable with a clean start and finish to each pulse.
- If the spray pattern is disorderly or dribbles then the injector is probably still contaminated, damaged (or blocked) and should be replaced. L/H pattern.

- Complete the above for all the injectors.
- Cut new hose lengths for each injector and ensure there is no rubber debris contaminating the hose interior.
- Couple the new hose to each injector using the appropriate hose clips.
- Assemble the injector hoses to the fuel rail using similar clips.
- Ensure that the hose clip screws are facing in a convenient direction to provide easy access for screwdriver tightening in their final position.
- Fit the other various hose lengths to the fuel rail and the job is complete.

### **Conclusions**

If the ECU can be described as the heart of the Rover SD1 Efi System then the eight fuel injectors can be described as the being at the sharp end.

No matter how well the rest of the system and its associated sensors are set up, if the injectors don't deliver the fuel effectively, in an orderly spray pattern and correctly atomized then there will be a loss in efficiency.

Even though the injectors are virtually bullet-proof they will obviously have a finite lifetime, variously estimated by the manufacturers to be over 200k miles.

Even so, the supporting components such as the resistor pack and local wiring/connectors are more likely to fail within that time frame.

When the injectors are ready for professional cleaning or replacement then expect the cost to be anything from £150 for cleaning to £500 for new injectors.

Alternatively there are many opportunities to purchase S/H sets complete with fuel rail on popular auction sites that will serve to provide additional units which could then be cleaned as described and the best ones retained for spares.

When I devised the above home-brew process the cost per car was less than £50 and all the bits needed for the rig were found in my workshop. Plus it was good fun.

Ramon

Website: <http://www.vintagemodelairplane.com>

Blog: <http://uk.blog.360.yahoo.com/maureen9235>