XM Hydractive system repair

The XM's are fitted with a suspension control system which Citroen called 'Hydractive'. The system has undergone several revisions during its lifetime but during the production run of XM's it went from revision H2 to H4 with several sub-revisions depending on model and year of manufacture. The system works by having 3 spheres in parallel per axle (not the case for earlier versions but the principle described here remains the same). The two wheel spheres are permanently connected to the wheels but the third 'centre' sphere can be switched in and out of circuit with something called an 'electrovalve'. As its name suggests it is a hydraulic valve which is operated by an electrical signal. This electrovalve either connects the centre sphere in parallel with the other two or isolates it from the system and prevents any interaction with the system. When closed, only the two wheel spheres are available to absorb the bumps in the road. When open, all three spheres are able to absorb bumps in the road. Consequently when the valve is open the suspension is in 'soft' mode and when closed the suspension is in 'hard' mode. As the names suggest the least comfortable for the occupants is 'hard' mode which is akin to a car which does not have hydro-pneumatic suspension.

However, a common problem with the XM is its unnerving desire to remain in 'hard' mode. This is caused by the third or centre sphere remaining isolated from the system due to the inactivity of the electrovalve. A picture of the electrovalve is show below:

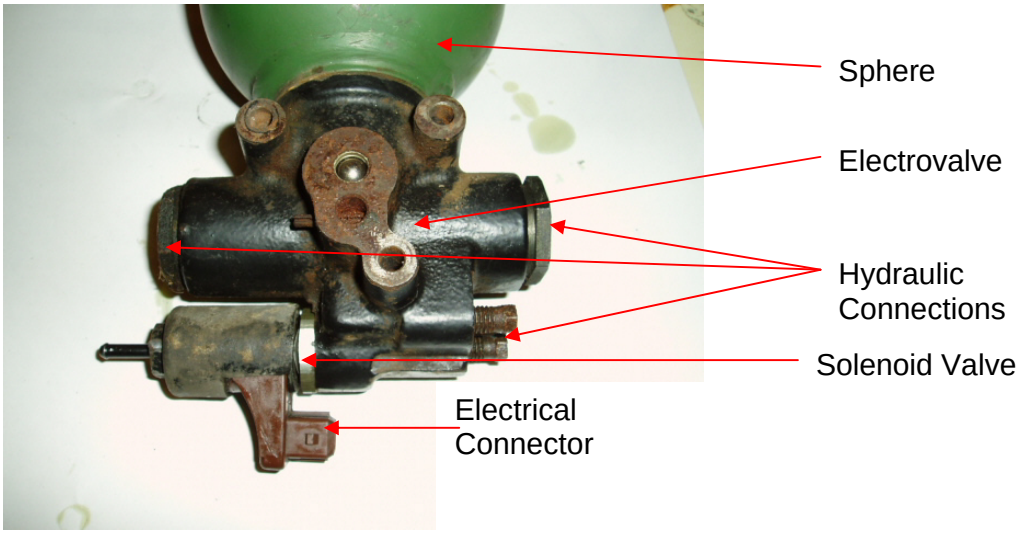

Photo1

The valve is activated by sending an electrical signal to the electrical connector shown above. This connector is part of a solenoid valve which in turn operates the main valve hydraulically. A picture of the solenoid valve coil is shown below:

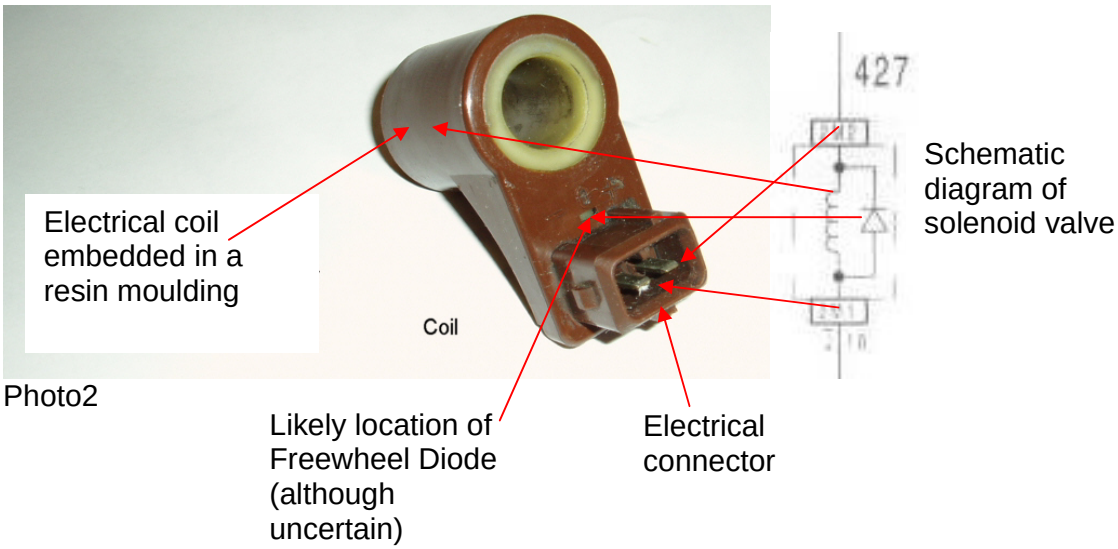

Photo2

The wire-wound coil is cast into a resin moulded casing to afford the electrical components protection from rain and roadsalt. Embedded in the moulding is a device called a ‘Freewheel Diode’. An electrical schematic is shown above. The electrovalve is activated by a signal from the suspension ECU (Electronic Control Unit) which is located under the bonnet on the offside (RHD) inner wing. Within the ECU the device which switches the power off and on to the valve is called a MOSFET (Metal Oxide Semiconductor Field Effect Transistor) the name of which is inconsequential to this document. When the MOSFET switches the power on there is an electro-magnetic field created around the coil inside the solenoid valve. This field opens the solenoid valve which in turn operates the electrovalve. However, when the MOSFET switches the power off the electro-magnetic field surrounding the coil collapses because there is no longer any current to sustain it. As the field collapses it induces an EMF (Electro Magnetic Force) in the windings of the coil which created the field in the first place. The EMF induced attempts to keep the current flowing in the coil in the same direction as it was travelling. This is exactly the same principle as the operation of an HT ignition coil in a petrol engine. Unfortunately the MOSFET doesn’t like the fact that the current tries to keep going because it damages the part of the MOSFET which constitutes the switch. Since this was known at the time of design, a protective device was added to the circuit known as a Freewheel Diode. The purpose of the diode is to provide a path for this unwanted current to flow through which will protect the MOSFET by conducting it out of harms way. The diode (an electrical one-way-valve) creates a short-circuit. The unwanted current leaves the coil heading for the MOSFET but finds it much easier to travel the short way, through the diode, back to the coil again. There is not

much energy left in the collapsing field and it soon dissipates in the resistance of the coil as heat (within milliseconds). For a reason which I do not understand the diode which is embedded in the solenoid valve is prone to failure. When it fails, it fails open circuit ie as if there was no diode there at all. The resulting effect of the diode failure is that the overrun current created by the collapsing field of the solenoid valve is dissipated through the MOSFET. This causes the MOSFET to overheat and eventually fail. For reasons I won't go into here the MOSFET oscillates off and on very quickly when 'on' and switches 'on' and off very often on a normal car journey. Every time it switches off, damage is sustained. Although the lifespan of the MOSFET after diode failure is unknown it would be safe to say it is in the region of weeks to months.

Once the MOSFET fails it can never open the electrovalve and hence the suspension remains in hard mode permanently. The electrovalve emits a distinctive 'hum' or 'buzz' when in operation which is quite audible. With the car on the ramps and the engine and ignition off, open one of the doors. This will cause the ECU to send the signal to the electrovalve for approx 1 minute (after which it will automatically stop - just close and re-open door to re-energise). With your ear in the vicinity of the electrovalve listen for the buzz. The front electrovalve is very easy to access so you can try unplugging the electrical connection and reconnecting it. The buzzing noise should be heard to cease and then restart as the connector is pulled off and put back on again. Try to identify each valve (Front and Rear) independently. They can fail independently to each other.

When the MOSFET overheats the surrounding PCB (Printed Circuit Board) can be seen to be discoloured due to the presence of the high temperatures. A photograph of a replaced MOSFET can be seen here:

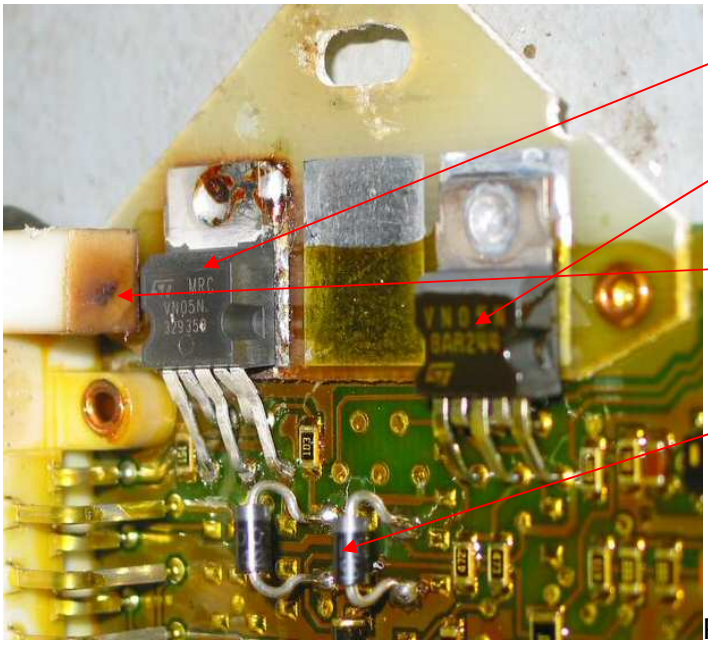

Photo3 (courtesy Jannik Steen)

The MOSFET's fitted to the suspension ECU are VN05N's. They are fairly easily replaced. Just snip the legs of the old one and remove the legs one by one using a soldering iron. To remove the body of the MOSFET from the PCB just heat a large old screwdriver on the gas hob until red hot. Place on the metal part of the MOSFET shown above with the circular depression in the middle. The solder will melt within a second or two and the device will fall off the PCB. Clean out the solder holes with a wick or a 'solder sucker' and re-solder the new MOSFET in place.

The diodes unfortunately cannot be replaced in their original locations due to being embedded in the resin moulding of the coil. However, it is possible (although slightly less efficient) to place them at the opposite end of the connecting wire to the electrovalve ie inside the ECU. The photo above shows two such diodes (IN4007) retrospectively soldered to the PCB inside the ECU as a repair for blown diodes in the electrovalve. The diodes located here will serve the same purpose as the diodes in the solenoid coil. The photograph above is high resolution and can be blown up whilst still retaining the required detail. Alternatively it can be found at the original author's site here: http://kernelpanic.dk/xmhaecu/

I hope this explains the root of the problem associated with the electrovalves on the XM and dispels some of the urban myths surrounding the subject.

I also appreciate that this does not apply to some of the early Hydractive systems where only one hydractive sphere was present and the diodes were built into the ECU. However, the early systems don't seem to suffer from this particular problem, they have their own set of problems which are not discussed here. It is really aimed at the later systems which suffer from this problem.

