KE Jetronic Diagnosis

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Hello all on this forum. I hope to bring to some the benefits of my experience in effecting a remedy to a faulty KE Jetronic system, on a W124 Mercedes 300CE, Australian version. Not that the latter factor makes much difference, seemingly apart from the Aussie version not including a cold air input temperature sensor. It took me a long time to get there and I hope that the following information will be found of help to people with injection system problems.

It can be very daunting coming to terms with a faulty system. You have a great car but it runs disgustingly, if at all. And the solutions are costly and it seems that nobody in the world apart from a few competent service providers knows anything about it. But not only that, it seems that you need special diagnostic tools that cost the earth. When you look through the internet you find dozens of people who have paid large sums to have their systems serviced to no effect.

But here are solutions to several frequent problems that don't involve diagnostic tools much beyond a multimeter.

Before starting anything, please refer to a tutorial about how the system functions, Bosch have an excellent summary readily searched out on the internet. Search for “Bosch KE Jetronic system function” or similar.

It's likely that your symptoms include “won't start when cold or hot; backfiring; cough and splutter on acceleration”.

You will have found from your searching that a most important component is the “Over Voltage Protection Relay” and it is most important!

But there are some tricky things to check out first, before getting into the complicated parts.

First. Note that all the sensors have a return path to ground. Some have the benefit of a wire from the sensor, while others rely on current paths via the engine block and chassis. This latter path can be fraught! The engine block is of course mounted on compound engine mounts which are not electrically conductive. So there is a flexible copper conductor run from the block to the body. On my car this is located between the manifold and a mounting bracket for the ignition coil. It's flexible because there is relative motion between the engine and the body every time the engine speed changes. And because it's not ideally flexible, some reaction occurs on the attachment points at each end and they can become lose. Result? Poor hot or cold starting; coughing and spluttering.... you get the idea. To find these connections you need to take off the air cleaner, find the connecting cable and look. Check each end for tightness, broken cables etc. If they are loose, complete the job by removing the attachment, thoroughly clean the terminals and tighten them up. Then see how your vehicle behaves. In a few cases a miraculous transformation will have occurred. But the probability is not high, especially if the vehicle has a few km or miles on its clock – the electronics do not have an indefinite life!

Now precisely the same effect would occur if at the other end of the chain of supply was affected – that is the battery supply. This goes to the injection control unit, or computer if you like. This is located behind a lovely plastic moulding immediately in front of the battery. Carefully remove it by inserting a finger in between the bodywork and the moulding and you'll work it out from there. Now great care must be used in following the next check. You'll note that there is a large cable entering a plug that in turn is mounted on top of the computer and it's about 150 mm long. To remove the plug it is necessary to deflect the two horns immediately beneath the cable entering the plug towards the computer body. This will release the plug and allow it to be withdrawn. Very carefully lift the plug from its cable end, precisely in line with its attached position. The end of the plug furthest from the cable has a rectangular tongue located in a slot in the computer's body and this is the last part to come free. Of course it is the first part to position when replacing the plug. And it's here that we must observe absolute care. You'll see that the computer has 25 flat pins that each have to enter a connector slot in the plug and these connector slots are fragile. The first connector is say 25 mm from the tongue and as I said above, the plug is about 150 mm long. So in replacing the plug there is a mechanical advantage of about 6 at the point where the first connector pin enters its fragile socket. On my car the first slot had been damaged due to the plug not having been first positioned so the tongue fully engaged its slot and then possibly the plug was pressed into place in such a way that it was not completely parallel with the socket. It took a fair bit of care to realign the connector so that a good contact was effected, using a tiny jewellers screwdriver, but it was done. It did make a difference.

But those things are almost outside the realm of the KE Jetronic system itself and I'll go on to that now.

Fuel Pressures

When the key is turned on, the fuel pump operates for one second, bringing fuel in the system up to operating levels. Upon engine start, the fuel pump is turned on again. Serious running problems can be experienced if fuel pressures are too low. If you are fortunate enough to have access to fuel pressure measuring devices, it's great to prove the pressures right, this can save a lot of time.

If your vehicle will not start at all, a faulty fuel pump or electrical supply can be suspected. It's not much use turning on the key and then crawling under the rear of the vehicle to check whether the pump is operating, because after the first one second, it should have turned off anyway. That is a two person operation, one turning on the key, one listening for pump operation - for one second only!

There's a fuel filter in the line, if it is blocked you'll have poor fuel supply and erratic running, so it will need to be changed. There's another component in the fuel line called the Accumulator. This is just a spring loaded reservoir that maintains fuel pressure during times of low fuel volume requirements, when the pump may be turned off, in the same way as at starting. A symptom of a faulty Accumulator is stalling when idling, say at traffic lights. The acid test for this is to take off the air cleaner to expose the air flow sensor plate. Start the vehicle and run it just for a short time, then shut it down. After about one minute, depress the air flow sensor plate. It should offer resistance to your effort, indicating that residual fuel pressure is being held. If the plate moves downward without resistance, you need a new accumulator.

Diagnosis by Codes

The system is provided with a diagnostic socket from which electrical readings are made that show the condition of the various components. On my car there is an 8 pin socket, concealed by a screw cap, located just above the ignition coil on the inner mudguard. Readings for the injection system are taken from pins 2 and 3 of the socket. Other cars have other styles and sizes of sockets, but there seems to be some commonality in that pins 2 and 3 are used for this purpose. You'll need to determine this from on-line searches, specifically for your model.

But before these codes can be read reliably, the condition of the Over Voltage Protection (OVP) Relay needs to be checked. This relay performs the valuable task of making sure that any short term voltage spikes do not burn out sensitive electronic parts throughout the vehicle, particularly in the computers. Reports abound of OVP relays with failed soldered joint on their printed circuit boards and if these are dodgy, the supply voltage to the injection system components can be intermittently interrupted, producing the same symptoms as the faulty ground or battery connections mentioned above. The OVP relay, while protecting the electronics, turns on the fuel pump relay and other components that prepare the injection system for operation. So a faulty supply from this relay can give symptoms of horrible running, while masking other faults that may be present. You might be able to roughly gauge whether the OVP relay is OK by measuring the voltage at the fuel pump relay while giving the OVP relay a bump. A voltage loss is a sure indication of a problem OVP, but such a method is not reliable. If you don't want to start out with a new or known to be good used unit, you can follow the diagnostic steps, but if you receive variable results, change it out.

These electrical readings are codes, each of which indicates something. There are two forms of these codes. They consist of a set of pulses output by the computer, rising in voltage from zero to the injection system voltage (this can be just a bit less that battery voltage, , depending upon engine operating speed) and the number pulses indicates the nature of the fault. If you don't have access to the proper gizmo to measure these pulses, you can make a pulse counter from a light emitting diode with appropriate resistor and a three connecting leads. Making the test leads is covered in many places on the internet, as is using them to get the computer to output the diagnostic codes. Once connected, you instruct the computer to output one code at a time, then count the number of pulses, then look up a table from Mr Benz to identify the faulty part. My vehicle is a 1988 model and I was not able to find the list, but I reckon that almost everybody else's models are covered by information on many sites. There's some good news though. Alternative checks can be made just using a multimeter on pins 2 and 3 of the diagnostic socket. In one form of multimeter test, the average value of the pulse train voltage is measured and in another form, the on/off ratio of the pulse train is measured. In the following, the average voltage method is described.

Test 1

Average voltage method. Turn on the key, but don't start the engine. Measure the DC voltage between pins 2 and 3. This should be 30% of the injection system voltage as measured usually at pin 6 of the diagnostic socket – it's a little less than battery voltage under the conditions of the test, ie whether the engine is running or not) and correspond to Mercedes' specification of a 70% duty cycle or “on/off ratio”. In fact Mercedes uses the total proportion of its off period as its indicator number, but the multimeter respond to the proportion of time the pulses are on, at injection system voltage. Hence the 30% mention above – 100% minus 70% equals 30%. This initial reading doesn't tell you much, only that the computer is capable of putting out diagnostic codes – but that's something! If you don't receive any readings, maybe your computer is past its prime.

Test 2
Same test conditions
Deflect the air flow sensor plate. The duty cycle should decrease to 10%, that is, the multimeter should read about 11 volts. If no change occurs, that is the reading still is about 3 volts, test the throttle valve switch (Job 07.3-121 in Mercedes shop manuals). Please note that the 10% is nominal, 9% to 11% is seemingly OK.

Test 3
Same test conditions
Deflect the throttle fully, the duty cycle should read 20% or about 10 volts, indicating that the Full Load Contact switch is OK, unless it decreases to only 40% or about 7 volts. In this case test the air flow sensor potentiometer (Job 07.3-121 in the Mercedes shop manual). Again 20% or close to it is OK.

Test 4
Engine operating at 80 degrees C. Check the Lambda Ratio. The Lambda Ratio is the ideal ratio of air/fuel that enables complete combustion of the fuel. It is 14.7/1. The controlling element is the Oxygen sensor in the exhaust gas stream. This sensor operates only at high temperature, so is provided with a heater supplied by the battery, via the fuel pump relay. In operation, it determines the proportion of oxygen present in the exhaust gas and signals the computer to provide more or less fuel to maintain an average value corresponding to the ideal Lambda ratio. Measure the voltage between pins 2 and 3. It should fluctuate, showing that the oxygen sensor is causing the computer to adjust the mixture on a continuous basis. The duty cycle readings should be between 45% and 55 % . Higher than this indicates a lean mixture and lower indicates rich. The voltage levels corresponding to these values are, depending on the battery voltage while running are 7.4 to 6.1. (These values assume a system voltage of 13.5.)

If there is no fluctuation at all, just a steady reading, something is wrong with the oxygen sensor or its supply. It is located not far along the exhaust pipe and replacing it involves a big spanner and a lot of effort. Its wiring is located under the floor mats on the side of the vehicle above the exhaust system.

My vehicle presented readings indicating 55% to 65%, so running was lean. The symptoms were sluggish pickup, coughing and sputtering as well as stalling. The remedy involved adjusting the mixture screw in the injection distributor, but we'll discuss this later.

Air Flow Sensor Potentiometer
This is one of the very important pieces of the system. It is operated by the air flow sensor, the circular metal plate that deflects under the influence of the air flowing into the engine, which in turn is determined by the throttle opening. It is a fair bit more complex than a volume control on

your stereo, but it does the same thing. As the air flow sensor is deflected by the air stream, the shaft upon which it rotates moves sliding contacts over a track of resistive material and this feeds the computer with a voltage reading which allows it to control the precise amount of fuel required by the measured air flow. Now every time the throttle is operated, the air flow sensor deflects and moves the sliding contacts across the resistance material and that can happen a few million times, I guess, in the lifetime of a car. So the track wears and the computer can then be fed with a certain voltage at one throttle opening and with just a very small movement the sliding contacts encounter an area where no resistance material remains, so the voltage indicating air flow drops to zero. The computer doesn't know what to do, so erratic operation is the result.

Testing this component is carried out with ignition on and engine off. The potentiometer is connected by a three pin plug, with locking tags at top and bottom. Ease these out and slightly withdraw the plug, so that the socket pins can be accessed by test leads from your multimeter. The top and bottom pins should have nominally 5 volts across them, as supplied by the computer. The centre pin feeds back to the computer a voltage less than 5 volts for each position of the air flow meter. Connect the multimeter between the centre and the top pin and watch the voltage reading as you very gradually deflect the air flow meter plate. The voltage should increase continually, never dropping out to zero. If it does, you need a new potentiometer. Mercedes only sells these already mounted on a replacement air flow meter and you may think that its cost is comparable to the value of your vehicle. There is information on the web about obtaining a replacement potentiometer at a much lower cost. If you go this way, you'll have to remove the old pot and replace it with a new one, then calibrate it, but that's a simple matter really. One reason for which Mercedes provides an all new solution may be that the sliders that run over the resistance tracks remain in the housing and they may also be worn, so installing a new pot may not produce any improvement. Removing the old potentiometer involves using a very fine screwdriver to insert in the gap between the two roughly circular plastic covers on the front at either end of the potentiometer housing and easing them out, exposing four Torx screws that mount the potentiometer to the air flow sensor body. At this stage it's a really good idea to put a pencil mark around the pot on the air flow sensor body, as an aid in getting the replacement one roughly in the right position. Undo the screws and gently withdraw the pot from its shaft. Look at the tracks and marvel at how the car operated at all! You'll note that the four mounting screws go through slotted holes in the pot housing that allow it to be rotated relative to its operating shaft and this is how the pot is calibrated. Once you have replaced the pot with the screws just loose enough to allow its rotation around the shaft, you reconnect the three pin plug, again with the socket pins exposed for measurement, then measure the voltage at the centre pin. Turn the new pot around the operating shaft until you read about 1 volt. At the 1 volt level the engine will be running rich, but if you try a lower initial setting, you may not be able to start the engine. Now start the engine and get it up to operating temperature, then adjust the pot position until you read 0.7 volts between ground and the centre pin. The pot is now calibrated.

If that was the main problem, your vehicle should now be much improved.

Mixture Adjustment

There's a lot of instruction on the web cautioning any playing around with the mixture control. The screw that allows adjustment is protected by various types of guards against ready access, so Mercedes takes it seriously. But it isn't too much of a problem, the biggest part of the task is removing the guards. Consult the web for details of your particular model. The adjustment consists of using a 3 mm Allen key in a spring loaded coupling to turn an adjustment right inside the injector housing. The screw raises or lowers a plate that changes the aperture through which fuel is dispensed to the injectors. It is essential that you don't leave the Allen key in place after the adjustment is made, because it can cause serious damage to the injector system next time you start.

That having been said, here's how. Bring the engine up to normal operating temperature, about 80 degrees C. Then connect the multimeter to terminals 2 and 3 and adjust the screw until the voltage readings fluctuate between 6 and 7.4. Make adjustments almost microscopically, the tiniest turn will have a significant effect. Allow at least 10 seconds between adjustment and reading, to allow the system to settle into its new operating condition. Those voltage readings correspond to a Lambda ratio of between 45% and 55%, just what you want.

The Cold Start Valve
There is a cold start valve, in the form of another injector that supplies additional fuel when starting from cold. If it or its wiring are faulty, cold starting can be awful. The injector is turned on by a solenoid operated valve that receives its supply from the computer. To check the electrical operation, unclip the stainless steel retainer on the electrical connector and withdraw it. Measure the coil for continuity, you should read about 10 ohms. If that's OK, you need to know if you are receiving an adequate supply to the terminals. The most reliable way of doing that is to measure the current flow through the solenoid, so you have to jury rig a pair of test leads and set your multimeter to read DC amps. Expect 1.2 amps. If all that seems OK but the symptoms persist, you'll need to remove the cold start valve and watch it when simulating a cold start. Put the valve in a jar while connected to its cable and turn on the ignition. If you are not rewarded by a nice spray into the jar, the valve is shot. If you are so rewarded, you'll know why it is necessary to put the valve in a jar. A big one preferably.

Another problem that can arise with these valves is continuous operation, so that the vehicle runs rich, fuel costs rise, spark plugs are sooty and the engine oil is being washed off the bores! Get a new one.

The Coolant Temperature Sensor
The function of the coolant temperature sensor is to tell the controller the current engine temperature. When the engine is cold, the resistance of the sensor is around 2,500 ohms and an appropriate signal is given to the controller to cause mixture enrichment for starting. As the engine warms up to operating temperature, the resistance of this sensor falls to about 350 ohms, telling the controller that no enrichment is necessary. Between cold and hot engine temperatures, the degree of enrichment is progressively reduced.

This component seems fairly forgiving. The main problem for my engine was difficult hot starting. But my coolant temperature sensor was non-functional, so I temporarily wired in a 350 ohm resistor, thus providing advice to the controller that the engine was permanently hot. I had no trouble starting the engine when it was cold in warmer weather, but when ambient temperatures fell to below 15 degrees C, cold starting became a little troublesome. Maybe it would stall immediately upon starting and sometimes it took me three attempts before all was well. But if it does not meet specifications fit a new one.

The Electro-Hydraulic Actuator (EHA)

This is an important (and expensive!) part of the system. It is attached to the rear of the fuel distributor and has the function of opening and closing the fuel metering valves inside the distributor in accordance with the demands of the engine and the instructions from the computer. It is basically an electromagnet and the degree of opening and closing of the fuel metering valves is determined by the strength of the electro-magnetic force it develops, in turn determined by the current flow through its coil.

Consultation of the specifications for current flows through the coil shows that for various models, quite different currents are needed. But commonly, the maximum current flow is 15 milliamps in response to a throttle blip, while at idling, a steady current of about 1 milliamp is normal. It is stressed here that the currents are completely dependent upon which model your are working with, so look carefully at the specifications.

The coil has a resistance of about 20 ohms and you can check this by removing the connector and applying your multimeter. In order to persuade a current of 15 milliamps to flow in the coil, the applied voltage has to be about 0.3 volts. Now if you use a digital type multimeter to measure the voltage output from the computer with the EHA disconnected you may read as much as 4 volts. Ignore that. It's the result of using a very sensitive instrument while the computer is not in its normal operating state. When it is in that state, it will be putting out voltages only up to a maximum of 0.3 volts. What I'm getting at here is that the only valid readings to take relevant to the EHA are those of current. So you need to make up a set of test leads that will let you connect your multimeter in the EHA circuit. Then measure the current flows. No flow at all means that you have an open circuit coil, wiring or connector.

Final Remarks

All the best with your fault finding!