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2008
Technical Newsletter

Automotive Electronic Control Systems

AECS
Training, Equipment and Data for Automotive Diagnostic Specialists

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This article is a true description of an AECS technical help desk problem and how it was solved.

Vehicle:
1997 Mitsubishi Legnum VR4 6A13 (V6 Turbo).

Problem presented to the help desk.
Before starting I need to say that this really simple problem was found and rectified without the help of AECS. This YES inc. member has been kind enough to share his findings and measurements of this 'nice and easy' case with me.

Customer complaint:
Engine runs perfectly OK until.....when cruising along at 70 to 90 Kph in 5th, and flooring the throttle, the transmission will kick down to 2nd (as normal) and suddenly engine will lack power and vehicle will get slower and slower. It will eventually pick up and go again.
The engine check light operates normally. What had been done to this vehicle before this YES inc. member was asked by an other garage to look at it?

Vehicle history:
1) Car had just changed hands (did it have too many problems for the previous owner perhaps?).
2) A fault in with the SRS system hand meant the Air Bag module and a few sensors had been replaced.
3) The small electronic module that drives the tacho was replaced to make the tacho work.
4) Two new coils had been fitted I assume as a result of them testing faulty.
5) The vehicle was scanned for codes, no codes where stored and in live data the mixture showed lean when problem occurred.

The garage (our customer) asked if I could scope the crank angle sensor and other ECU inputs to confirm if they were all good before a new ECU was ordered as it was thought that it might have suffered damage from the other electronic parts that where replaced, causing the drivability problems (??).
Test driving the car confirmed the fault with the addition that I could detect a surge at full throttle acceleration when held in tiptronic 2nd or 3rd. I could also get the lack of power/dying condition to occur after kick down from 4th gear.

So where do we start then?
As in almost all cases you start with a scope measurement of ignition over injection, that is easy and in almost all cases quicker than plugging in a scantool. Lets face it if something is wrong with either of those the driver is going to notice it.
The recording is most certainly going to tell us in which area to look further. This YES inc. member has an ATS 5000 recording scope.

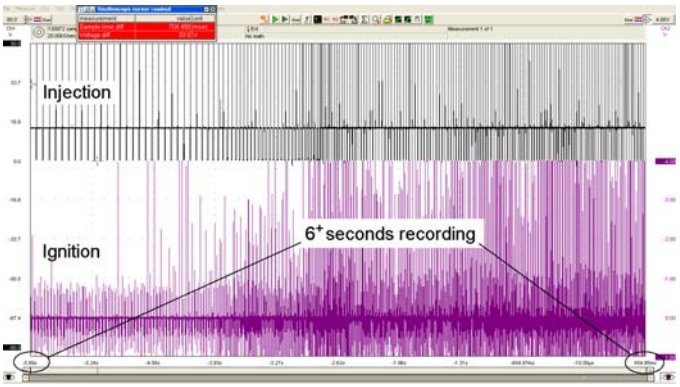

Figure 1: *ATS 5000 dual channel scope recording of Injection over ignition. The remote 'store' button was pressed around 2 seconds after the fault occurred, giving the diagnostician a view of what happened before the fault, during the fault and after.*

Under hard acceleration it felt like it was not getting any fuel, with the odd backfire, but eventually it would catch up and the revs would slowly climb.
The check engine light was not on and the scan tool present in that workshop would not communicate with the vehicle.

Where would you start?

I personally would start with a measurement of the ignition over injection, dual channel, as it is very likely that something is wrong with either the ignition quality or the injection duration.

The vehicle has 3 COP coils with internal ignitors. This eliminates the possibility to measure primary vs injection. The next best thing is to measure secondary vs injection. The secondary pattern will at least show us the spark duration, not the spark quality. Instead of using secondary pickups, we measured the change in magnetic field around the coils, which is similar to a secondary measurement.

This screen full of hundreds of patterns needs to be examined carefully, so it needs to be zoomed in. Following are a few screen shots indicating the method of working.

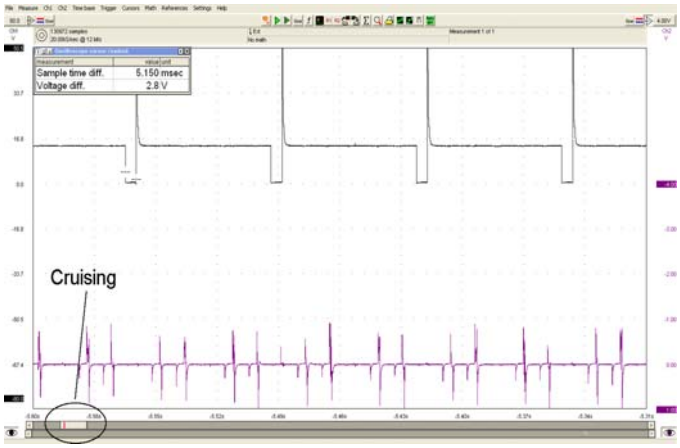

Figure 2: *Scope recording zoomed in on phase where everything is 'normal'. Please note the 5.1 msec injection duration. The 0.9 msec ignition duration is short and deserves attention, but lets first examine the whole recording.*

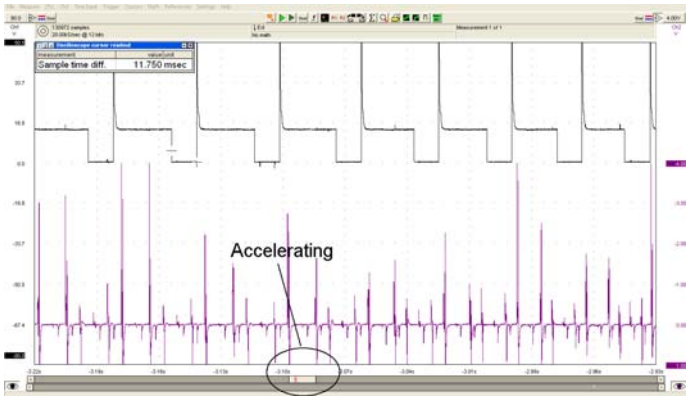

Figure 3: *The same scope recording, scrolled to the point where it is clear that acceleration takes place. Please take note of the 11.7 msec injection duration.*

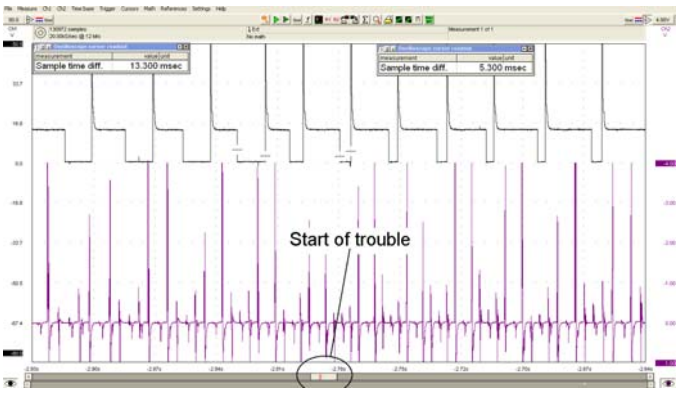

Figure 4: *Bingo! the same first scope recording, scrolled to the point where the problem starts. Please note the sudden change in injection pulse width, in two beats it moves from 13.3 msec down to 5.3 msec.*

It needs to be noted that the driver was not moving his foot when this happened, He was accelerating firmly but steady.

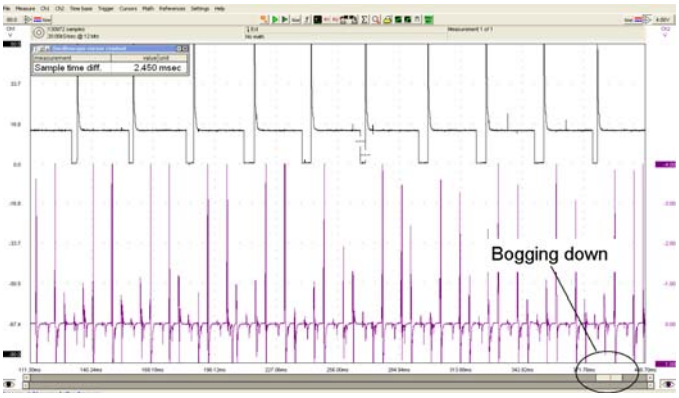

Figure 5: *Same recording, and still with the foot firmly on the accelerator. Please note the VERY narrow (2.4 msec) and variable injection pulse width.*

Systems knowledge through training

This diagnostician knew his stuff, on top of his own experience as an auto electrician he attended almost all of our AECS diagnostic training seminars. The injection pulse width was clearly the problem, the narrow pulse almost stopped fuel from entering into the combustion chamber. He knew that the injection pulse width calculation is only grossly affected by Air mass, TPS and ECT. So let's measure the most important one first, airmass over injection and see if it will happen again.

AECS requests your help for calendar assistance to arrange the 2009 AECS training.
See Page 5 & 6 for more details

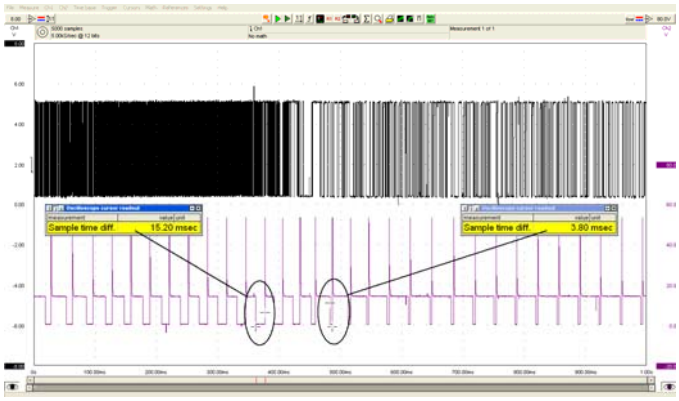

Figure 6: *Scope recording of the Karman vortex air-mass sensor signal vs injection.*

There it was again, a sudden transition from 15.2 msec to 3.8 msec. Lets zoom in on the pattern and look at the air mass sensor's frequency.

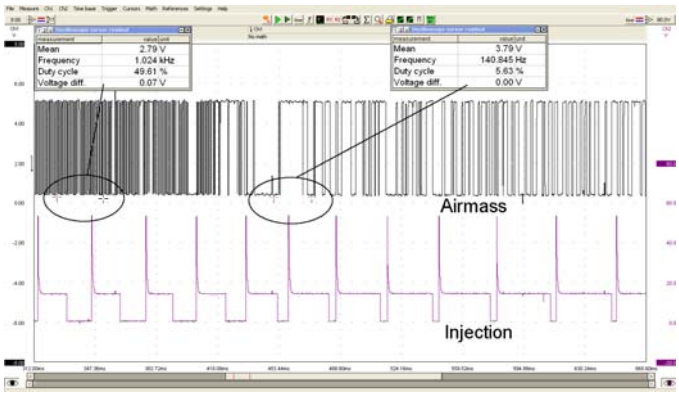

Figure 7: *Same ATS scope recording of the airmass sensor signal vs the injector pulse width, focussed on the frequency of the air mass sensor*

Wow!

That is a massive change of air! The frequency indicates to the ECU the quantity of air entering the engine. The frequency dropping from 1024 Hz to 140 Hz will have a massive effect on the injection quantity, as can be seen in the injection pattern.

We now had the cause for the bogging down of the engine.

Lets inspect the air mass sensor, it is probably faulty (unusual).

Found it!

Figure 8: *Overview picture;* What stands out?

The 'pod' filter! A pod filter DOES disturb the air-flow! It needs to be noted that a carman vortex airmass sensor has to have a very stable airflow into the grating upstream of the measuring element. This measuring element measures the vortexes (controlled disturbance of airflow). By fitting a 'pod' filter you disturb the airflow uncontrolled, decreasing the vehicle's performance. But not as much as what we measured, there had to be more.

Figure 9: *When taking the filter off a shiny disc fell out....*

Figure 10: *The shiny disc has damaged the grate, destroying the airmass sensor.*

It was not the filter which disturbed the airflow, the filter was not even being used!
The end cap had come off this filter letting unfiltered air into the engine for who knows how long.

Good isn't it? Now we had a need for a new airmass sensor, a new filter and its (original) housing and still maybe a premature worn engine / turbo. And the customer only just bought the vehicle.

Now just think about the path this vehicle has trodden, from repair to repair, ready to replace the ECU because of the mysterious drivability problems.

Conclusion

The YES member kindly told me that for this we didn't really need a scope to diagnose, as just an old fashioned visual inspection would have found it.

My reply was that it did not take long to find the fault and that it was conclusive.

The job was quick and profitable for this well trained YES inc. member. The diagnostician obviously owns the ATS two channel scope and has technical back up from their equipment provider (AECS).