November 2014

Technical Newsletter

Automotive Electronic Control Systems

AECS

Training, Equipment and Data for Automotive Diagnostic Specialists

Exhausted E-class

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

Vehicle

2003 Mercedes Benz E-class 3.2Ltr Bosch CP3 CR diesel.

Problem presented to the Helpdesk

The vehicle became slower and slower to start and destroyed a battery. It was manageable by jump starting the vehicle off a spare battery kept in the boot. Eventually the owner of the vehicle got fed up with this situation and purchased a new big starter battery for the vehicle. The vehicle was still slow to start and again it left the owner of the vehicle stranded. At this point, it was decided to tow the vehicle to a local garage who had the car for a week without any starting difficulties. Meanwhile number 6 injector had started chuffing (blow by) so this was removed and sent away for testing. During this time, the battery was left disconnected. The injector tested fine and was refitted with a new copper washer. After that, the vehicle did not want to start at all. It cranks, but did not fire up.

The local workshop diagnosed it as a "computer" fault after having the vehicle scanned by a colleague. The used scanner showed a few codes in total, of which some were "unknown" and "hidden" codes. He told us that he thought that having the battery disconnected for a week could have cleared the ECU/immobiliser key memory!?!

He then sent the car to a customer of ***AECS*** who has an ATS scope, Launch Scan tool and AECS technical support.

Initial Scan

With a recently updated Launch Scan tool, the workshop was able to scan the vehicle correctly and have full communication with all 28 control units on board of this highly spec'd vehicle. A full system scan revealed that 26 out of 28 ECUs had registered one or more fault codes. Enough to scare away any technician…correct?

Diving deeper into each system showed that there were in fact no “unknown” or “hidden” fault codes. This was simply the result of the scan tool reading a fault-code that hasn’t been programmed into the tools fault-code database and is a classic sign of an under developed tool. The first system that needed attention was the diesel injection ECU. The vehicle does not fire up so this must be where there are some issues? 15 stored fault codes were found with no active codes in just the engine ECU alone.

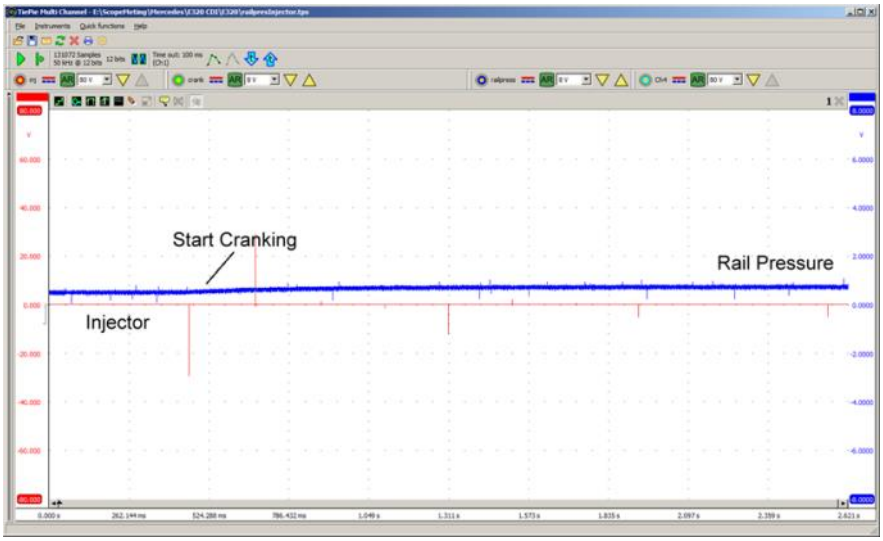

Figure 1: Injection vs Rail Pressure during cranking

Back to basics

AECS recommends that a printout of all the fault codes needs to be done before clearing them as stored or history codes can hold valuable clues to where the fault may be. Printing can be easily done through your workshops Wi-Fi system from the new Launch Pro range of scan tools. The technician did this and after refilling the printer with paper, he had a full printout of all the codes in all the ECUs. The most prominent codes throughout all the systems were “supply voltage low” and “CAN bus error”. Given the history of the vehicle (battery started till flat many times), it was no surprise that these codes were stored, the technician proceeded to clear all codes.

Amazingly, after redoing the full system scan, only four modules still had fault-codes, all unrelated to starting issues, yet no firing up of the engine was possible. This is where the technician phoned AECS for support as also in his mind none of the remaining fault codes was preventing the engine from starting. He proved absolutely correct!

No electronic faults?

After running through all the fault-codes with AECS technical support helpdesk it was decided to check all the earth circuits to at least the engine ECU as one broken sensor earth can cause multiple sensor voltages to go outside of fault-code parameters. Furthermore, one ECU losing power supply can cause CAN bus communication errors in multiple ECUs. With the battery in the boot, many junction points, spot-welds and earth straps could be faulty throughout the system. Hoping for the “quick-fix” the technician sanded, copper pasted and retightened the main earth points in the boot and the main earth points he could find under the bonnet. Again winding over but no fire up….

Scope time

There is no avoiding it now, and only by a stroke of

luck would you be able to solve a problem like this efficiently without an oscilloscope. The workshop was well equipped with an ATS5000, ATS5004 and an RFS-400 (Return Flow Sensor). The first measurement to be done in a situation like this is injection over rail-pressure, a simple two channel measurement that will tell you most of what you need to know on almost all common rail Diesel engines with a no fire up problem.
In Figure 1, we can see that there is no injection occurring while cranking. What are the possible causes?

#1 Missing crank shaft sensor input?
The ATS5004D is the first scope the diagnostician uses because with four channels he can see more. The recording in figure 2 shows injection with rail pressure and crankshaft sensor output measured at the ECU. We can see from the crank shaft sensor output voltage height, that it easily exceeds the ARM and FIRE points inside the ECU (as discussed in the AED training). Therefore, our issue is not with the crankshaft sensor.

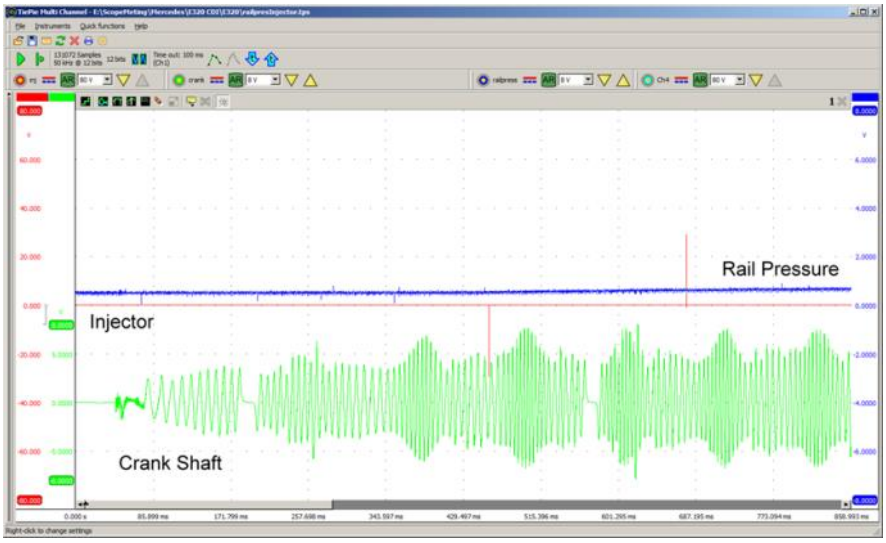

Figure 2: Injector, Rail Pressure and Crankshaft sensor

#2 Low fuel pressure?
This question we answer by thinking as a designer. Would you open the injectors, draining fuel from the fuel rail, if the desired fuel rail pressure has not been achieved?

To check this logic, a higher voltage was generated on the rail pressure sensor with his ATS5000 (two channel oscilloscope with signal generator) while measuring injector activity during cranking: this made the engine run!

Of course, when the rail pressure sensor voltage is simulated higher, the actual rail pressure is lower when the system enters closed loop pressure control (DMS 1-3 training), so the simulated extra voltage is quickly dialled back to 0 once the engine is running. After a test drive, fault-codes in engine management system were checked but no fault codes were present, indicating no major electronic issues.

*To view the pattern pictures in **High Definition - click on the pictures***

Did you Know?

Many seminars are already full (closed) for courses in 2015, and we have decided to add on extra trainings now, with our team of three tutors (Paul, Peter and Herbert).
On our calendar (www.aecs.net) you can see exactly which seminars we have already planned. We will continue to add more training courses through-out the year, like for example Gisborne and New Plymouth (to name a few), but this will depend on the demand.

AECS Training

Taking enrolments for:

BOOK NOW

ECAC-1
Air–conditioning training
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CHRISTCHURCH
and complete your Handlers and Fillers certificate on the 5th March 2015 —**Ring now!**

AED
Automotive Electronic Diagnostics
24 & 25 March 2015
AUCKLAND

EMS1-5
Immobiliser & Anti theft devices
26 & 27 March 2015
AUCKLAND

We have added more training to the AECS 2015 calendar - Check it out here.. www.aecs.net

Ring us for more information or visit us at www.aecs.net

Ph:06–874 9077 to Enrol

With the engine now running, a high pressure leakage test of the whole system was done by simply measuring the drop in rail-pressure voltage during fuel cut.

Figure 3 shows a drop in rail pressure of 0.459 V in 0.5 seconds during deceleration fuel cut. DMS1-3 training seminar knowledge tells us that this is approximately 2.5 times an acceptable level of leakage on a Denso common rail system.

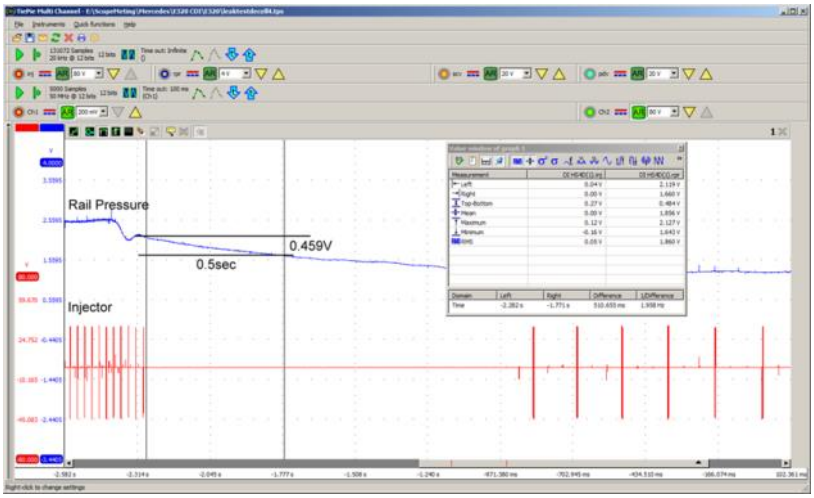

Figure 3: Rail Pressure Leakage measured under deceleration fuel cut

Where is the leak?

At this stage, it was end of day and the vehicle was left overnight. The following day the vehicle would not start again. Great! A quick confirmation measurement of rail pressure over injector was performed with the same result. It could be air in the lines with a slow leak into the fuel supply to the high pressure pump, but this system runs an electric lift pump in the tank which automatically bleeds the low pressure system. The lift pump pressurises the LP system to approx. 5bar which would have shown up a leak. Therefore, the problem is not with air entering the supply side. After starting the car with the signal generator attached to the rail pressure sensor, another test drive was carried out to see if we had full power, reducing a possible pressure discharge valve and SCV issues (the high pressure control valves). This only left a high pressure fuel leak from the injectors. The 4 channel return flow sensor was connected to the first four injector return lines to check injector leak back as in Figure 4. We know that during winding over and not firing up, there is no injector activation.

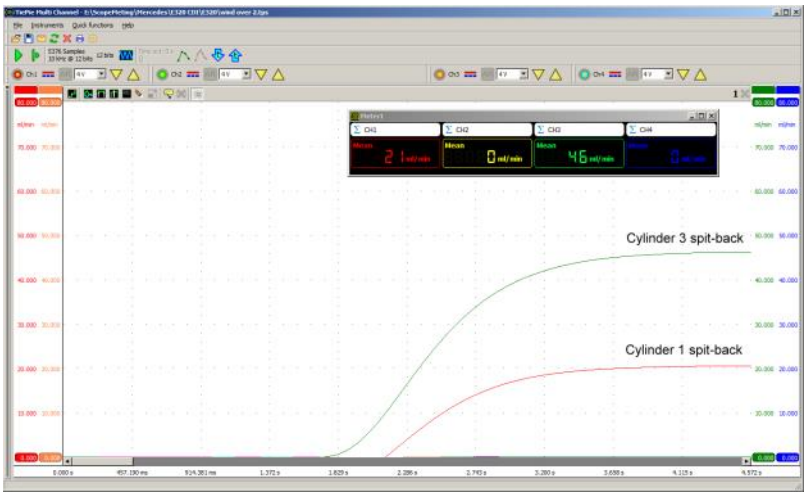

Figure 5: return flow on first four injectors showing high spit-back on injectors 1 and 3

RFS 400 connected to first four injectors with 4 channel measurement leads connected

Figure 5 shows the return flow measurement during cranking (not firing up).

Bingo, found it!

We have found out why the high pressure rail pressure remains too low for injector activity. When the injectors do not get activated, the return flow should be zero. Two injectors show 21 and 46 ml/min return flow during cranking! That fuel does not stay in the rail…

Fix.

Due to the high mileage of the vehicle and previously unknown service history, it was decided to fit 6 remanufactured injectors. Winding over (after bleeding the system and letting the vehicle glow) it started within a few beats. This is the point at which most workshops wrap up the job and send it out the door. Luckily, the technician was convinced to recheck one measurement. Remember Figure 3 shows the deceleration rail leakage

with the "bad" injectors. Figure 6 shows the same measurement with the remanufactured injectors. Also in Figure 6, it still shows that we have a high leak rate compared to the Denso reference. Mmm… It turns out that this CP3 system has got closed loop pressure control under deceleration and that there is a difference in the duty-cycle control of the pressure dump valve during deceleration, which is covered in detailed in our DMS1-3 training.

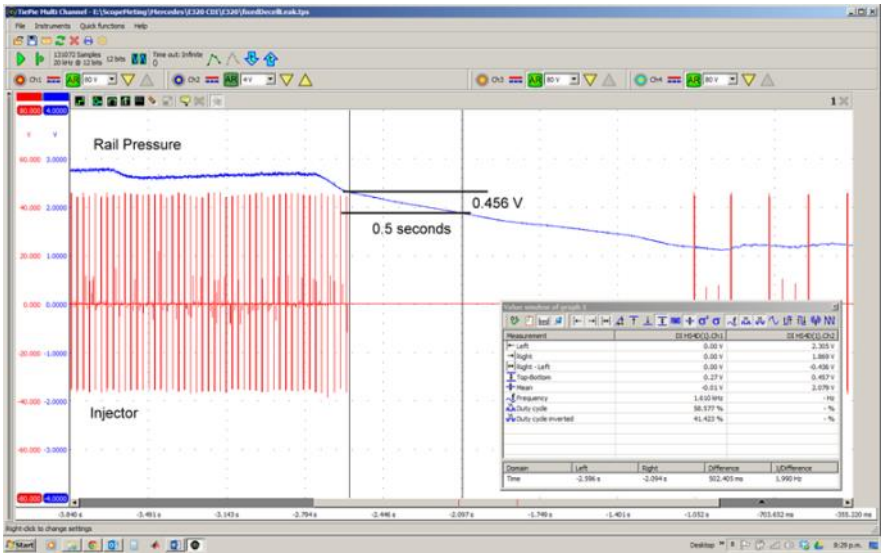

Figure 6: Deceleration leakage with 6 re-manufactured injectors.

Conclusion

Knowing the system in detail (training) and having the correct tools (ATS scope) and skills for the job made this a very quick diagnosis. Do not let stories like "ECUs loosing memory", "unknown or hidden/secret fault codes" or "Googling" common faults put you off during your diagnosis. Those stories just suck the confidence and money out of any technician. Unnecessarily replacing an ECU is an expensive exercise and is something AECS encounters more and more. The technology in this vehicle is now main-stream, make sure you can rely on your knowledge, tools and support network (like AECS tech support).

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