August 2009
Technical Newsletter

Automotive Electronic Control Systems

AECS
Training, Equipment and Data for Automotive Diagnostic Specialists

No go Nissan

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

Vehicle: Nissan Terrano R50 ZD30 DDTI 1999 Direct injected Diesel engine.

Problem presented to the help desk
This vehicle only came to our attention when the problem was solved. Yet it is still a nice case to get the teeth into, and such a likely fault to come your way!

Background
The workshop wasn't sure why the VP 44 injector pump was overhauled several months before they got involved. The EDU (ECU which is part of the pump) was replaced or reprogrammed as part of the pump overhaul and its re-calibration.

As a result of compatibility issues between the EDU software and the vehicle's own ECU it required the vehicle's ECU to be replaced as a result of the pump EDU upgrade. This seems normal for some of those Terrano models, yet it makes the job very expensive.

Maybe as a result of the pump job, we do not know, the vehicle intermittently wouldn't start, and when it would start it was logging a code and was very sluggish to respond to the throttle.

Codes
The code logged in the EDU (pump) was code 5 which according to the scan tool meant that communication was lost with the ECU.
The code logged in the ECU was 31 (ECU faulty - replace). Please note the ECU was brand new.
So replace the ECU again???
The previous garage had the starter motor overhauled, the battery and glow plugs replaced and the alternator overhauled, to try to combat the starting issue.

Where do we start?
It is best to start with a dual channel measurement with the ATS 5000 scope connected to the spill valve and the timing control valve, both on the pump. This measurement is easy, quick and definite. It is a little hard to get to the wires between the EDU on the pump and the Spill valve/timing valve also on the pump, but it can be done.

With the timing massively out the car will be very hard to start, or even refuses to start. With no or incorrect spill valve activity, no fuel or the incorrect amount of fuel gets injected. During starting the amount of injected fuel needs to be pretty much correct and on time on these low compression direct injected NEO Diesel engines.

No Spill valve

This first recording had been done but unfortunately it was not saved. The pattern showed during winding over, with no fire up, no spill valve activity.

No spill valve activity means that no Diesel gets injected, which of course means no firing up of the engine.

Combined with the fault codes the technician decided to scope the CAN bus. Incorrect CAN bus communication, or no communication will certainly result in no spill valve activity.

The Technician had completed the ***AECS*** **DMS1-2** VP 44 training seminar and therefore knew how to diagnose CAN communication on these systems.

Creek no paddle

The scope pattern on the CAN bus showed proper communication, with questions and answers. This can only mean that

a) the ECU is correct and

b) the CAN system is working correct.

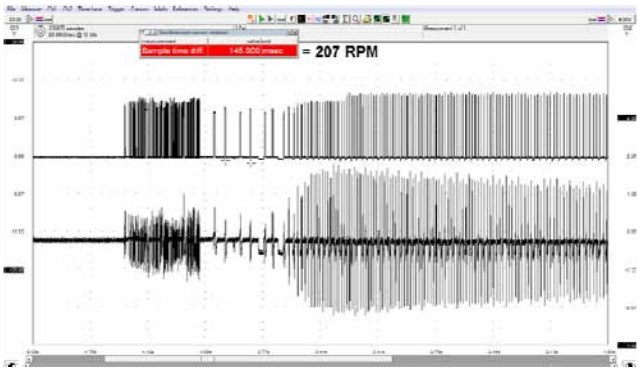
So where does that leave us with the fault codes?

Evaluate

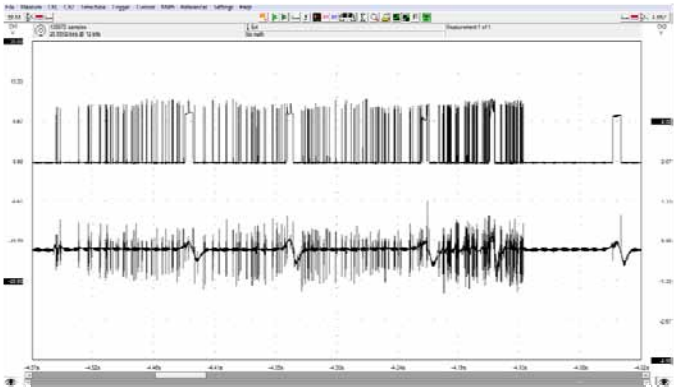
Okay what <u>do</u> we need to get spill valve activity? Instructions to the EDU, and EDU input signals. The A.R.S. inside the pump is a bit hard to measure, yet it is often faulty. Leave it for now, we have considered it as a possibility and will get to it if all else is correct.

The EDU needs communication (checked), it needs to have a crank speed signal from the ECU and it must NOT have the fuel kill signal.

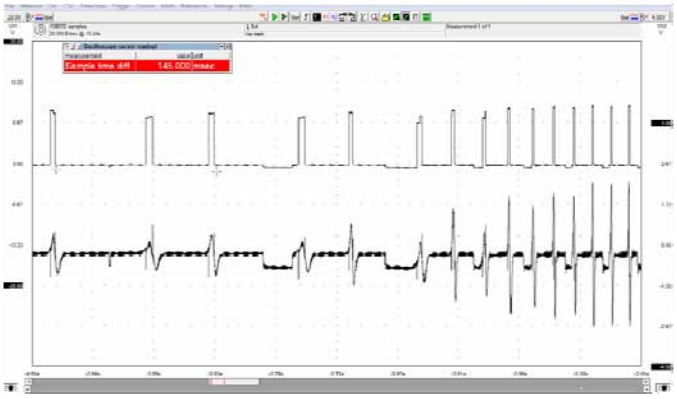
The technician decided to measure the crankshaft signal at the sensor vs the converted crank signal from the ECU to the EDU while starting.



Dual channel ATS 5000 scope recording of the crank shaft sensor and its converted signal when the engine decided to fire up. Look at the mess during winding over!



Zoomed in recording of the crank shaft sensor and RPM signal to the EDU during winding over.



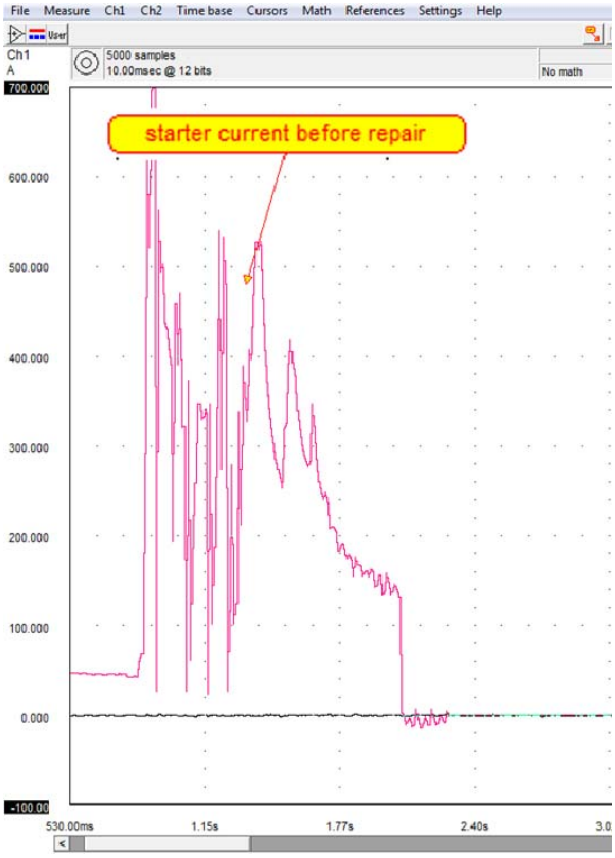
Zoomed in recording of the same crank shaft sensor and RPM signal to the EDU when the engine just fires up. The dips in the signals are where the spill valve loads up the circuit with 17 Amps (!)

Electronics (boring)

The signal of the inductive crank shaft sensor (CH2) gets converted in the ECU by a comparator circuit into a square wave. The comparator will switch the output voltage to high when the input moves over an 'arm' voltage level. It will switch its output voltage down to low again when the input

drops below a ‘fire’ voltage.
The ECU output signal is used by the EDU to see if the crankshaft and pump shaft are in phase (injection timing control).
The ‘noise’ during start up causes the EDU to receive information that the crankshaft is turning way too fast!
As a result it will hold back Diesel and throws several fault codes, one of them being an ECU error as the CAN bus data reports a different engine speed as the direct RPM signal.

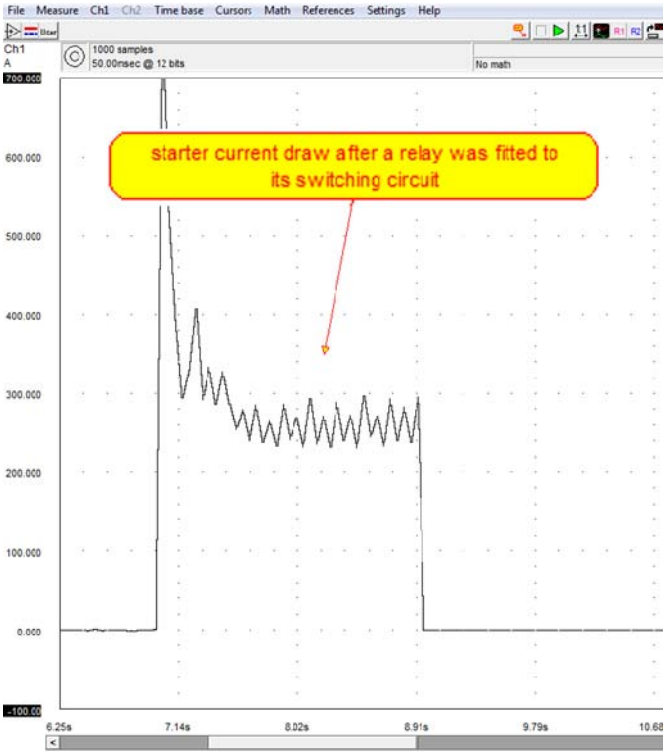
Where is the noise coming from?
Well it’s easy from here! Where is the noise coming from? It is only present during winding the engine over; guess…



Starter current measurement before the repair. Pls note that the current drops down to almost zero amps about 4 times before it starts to wind over properly.

Sudden current changes create massive changing magnetic fields, which induce voltages into any circuit close by. The greater the current changes, the stronger the induced magnetic fields.

Found it.
The starter motor current dropped in the above sample 4 times from about 400 Amps to zero amps and up again! That is massive current changes, the technician had found the problem alright!
The power to the starter solenoid was found to be low, causing the solenoid to cut in and out a few times under high current draw conditions (lower battery voltage). The bad connection in this circuit was by-passed with a relay feeding the starter solenoid directly from the battery positive. This fixed the problem.



Starter current after the repair.

The start current looks normal after the repair, a high ‘short circuit’ current (700+ amps) and after the engine starts to turn the starter motor settles on around 250 amps, till the engine fires up.

The technician had the courtesy to also record the crank vs RPM signals after the repair.

ATS 5000 recording of the RPM signal and the crank shaft sensor after the repair

Please note in both patterns that the cranking speed is almost the same as on the previous recording. This explains why the technicians involved in this job never heard anything wrong with the starter motor or its circuit.
Nice job!

Review

I suspect that the injector pump was overhauled to try to repair the starting problem, although we could not be sure. This would have set the owner back a cool $4000+ (including the new ECU). I wonder how much the starter motor, alternator and glow plugs have cost. Never mind the labour content of the bill, the job spanned across about 6 months….
Just a simple 12V relay fixed it.
I am sure that a simple wiring or connection fault like this will never come your way…!?
How are you going to repair and charge this job without the ATS scope?

Conclusion

This diagnostic shop obviously owns the ATS 2 channel automotive scope. This scope is earning its keep in hundreds of workshops around NZ and Australia, ranging from franchise workshops through universal garages, technical training institutes, mobile technicians, auto electricians to Diesel specialists. The amount of work these machines are doing is phenomenal, increasing the payback for the investment made.
There are many more brands of scopes available out there, but combined with the sample patterns, presets, AECS training and back up none of the other scopes makes fault finding this professional, quick and profitable.

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***AECS* Training coming up:**

DMS1-3	11th & 12th August	Rotorua
AED	15th & 16th September	Tauranga
ABS	17th & 18th September	Hamilton
AED	12th & 13th October	Christchurch

See our website for more details www.aecs.net