

Done Dyna

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

Vehicle

2000 Toyota Dyna, S05D 4.9 Ltr 4cyl. engine



Problem presented to the Helpdesk

The truck was referred to the workshop (who owns AECS diagnostic equipment) by another garage, as they were at the end of their diagnostic ability. The truck has this complaint, that when the engine was warm; you could not rev it over around 2500 RPM as it would start to misfire and smoke really bad.

The garage who first worked on the truck had replaced the air cleaner, injectors, injection pump, cleaned the intake manifold and blanked off the EGR channel. Because there were no fault codes, they even tried another ECU.

All to no avail! I am unsure what the total costs were but the replacement (new) injection pump by itself was around \$4500.

What would you do next?

Diagnose

After having the vehicle in their workshop for months the shop passed the vehicle on to a

LAUNCH

PRO2

SCAN Tool



**Not many left at this
crazy price of
\$2,250 + gst !**

Set up to work with
GoLo Car Care

Note:
Comes as an
optional extra

Features

- Modern Android 7" Touch Screen operating system.
- Wireless Bluetooth communication and diagnostics **with over 74 vehicle brands.**
- 12 months of Software Updates included
- One Touch software upgrades via WiFi. Continuously evolving software with regular updates!
- Take screen shots and print live data.
- Individual or Multiple Combined Sensor Graphing.
- Auto vehicle recognition.
- Special Functions including Injector re-coding, throttle re-learn, remote key reprogramming + re-pairing, battery replacement, G-Sensor Zero point calibration, many more.
- Database for wiring diagrams and special diagnostic procedures specific to certain manufacturers.
- **AECS** Technical support available directly through the tool via your wireless network.



Call **AECS** today:

Ph: 06-874-9077

Authorised Launch distributor

workshop who has invested in decent diagnostic equipment.

We started by measuring the Spill valve vs the Timing control valve (TCV) on the pump. Bad running could be caused by incorrect quantity (spill valve) or incorrect timing (TCV). It was immediately evident that the TCV signal was erratic when the truck misfired.

The misfiring only happened when the engine was hot, so not to have to wait till the engine was warm all the time we fitted a variable resistor in place of the coolant temp sensor. We could 'turn the bad running on/off' by changing the temperature signal.

At this stage most technicians would call it a day and fit a resistor in the coolant temp circuit. In our feeling there was more to this story so it is better to investigate properly.

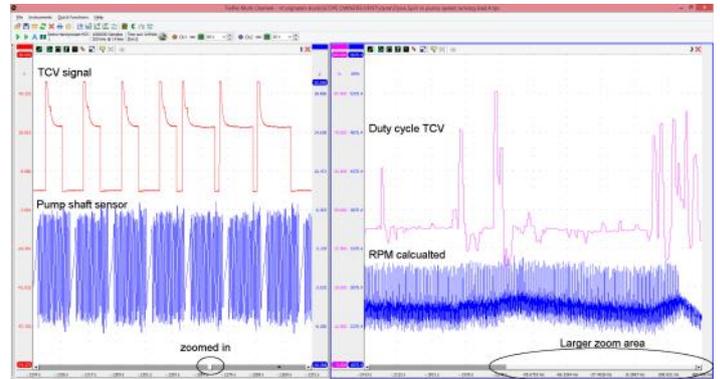


Picture 1: ATS 500XM 2 channel scope recording of Spill valve vs pump shaft sensor

The long recording of the spill valve vs pump shaft sensor signals (in picture 1) showed erratic running but no real changes in spill valve actuation. This ruled out that quantity changes were the cause of the erratic running.

TCV

The same recording was done with the TCV in picture 2.



Picture 2: Zoomed in on ATS 500XM scope recording of TCV vs Pump shaft sensor when the engine is misfiring badly.

The recording was made using split screen, so we could investigate the raw signal and the calculated signals in separate screens.

The first screen shows the simple recorded patterns of the TCV and the pump shaft, zoomed in on one area of interest.

The second screen shows the TCV's duty cycle and the pump shaft sensor's calculated speed transformed into two analogue patterns. It is clearly visible that the RPM is not steady (misfiring) and that the timing control valve makes very big changes to correct the injection timing. To me this looks like the problem!

Investigate why

To find why the engine is running bad is one thing but now we had to find out why the ECU was correcting the timing so violently, causing misfires on the way.

Firstly see what the pattern looks like when the engine is running fine, by dialling up a cold engine temperature (Picture 3). The setup was TCV vs TCV current, so we could in the same measurement eliminate any bad connections in the TCV circuit.



LAUNCH

Scan tool

PRO3

\$4,099 +gst

AECS technical support included

Authorized Launch distributor

★ Trade in your old Scan tool.
(any brand accepted, terms & conditions apply)

- * Modern Android OS, 10.1" Touch Screen
- * Wireless Bluetooth communication and diagnostics with over 74 vehicle brands
- * 12 months of Software Updates included
- * One Touch software upgrades via WiFi. Continuously evolving software with daily updates
- * Take screen shots and print live data
- * Individual or Multiple Combined Sensor Graphing
- * Automatic vehicle recognition
- * Up to 15 life data graphs.
- * Full day's work worth of battery life
- * Special Functions including Injector re-coding, throttle re-learn, remote key reprogramming plus re-pairing, 12v battery coding, G-Sensor Zero point calibration, & many more functions

Ask for our scan tool comparison chart



PLUS

AECS Online technical support available directly through the tool!



INNOVATION & TECHNOLOGY

**Diagnostics
and very complete
database for**

*Truck, Trailer, bus,
light commercial
and agricultural
vehicles*

**Complete Kit
\$12,000+gst**

Note: pricing depends on options and extras



Ring 06-874-9077
for more information

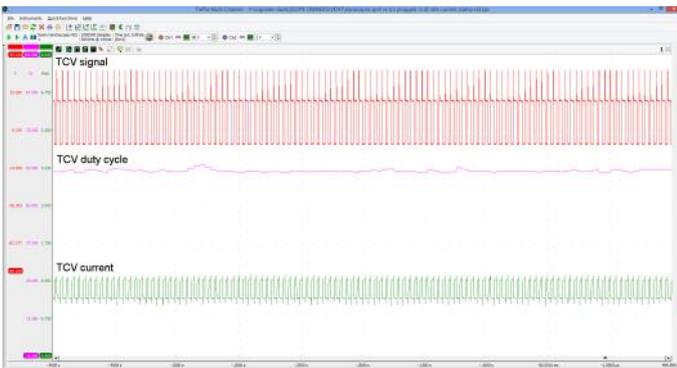
Automotive
Electronic
Control
Systems



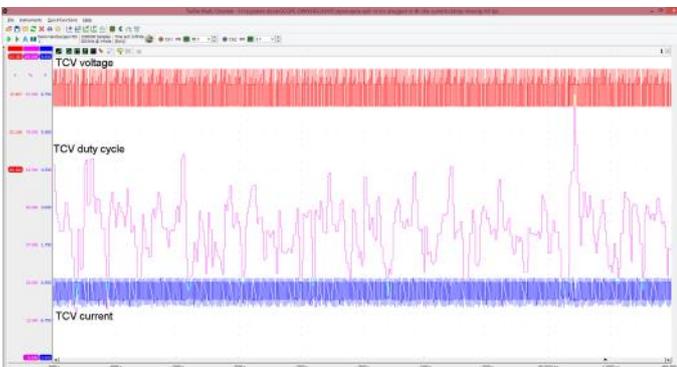
AECS

Training, Equipment and
Data for Automotive
Diagnostic Specialists

www.aecs.net



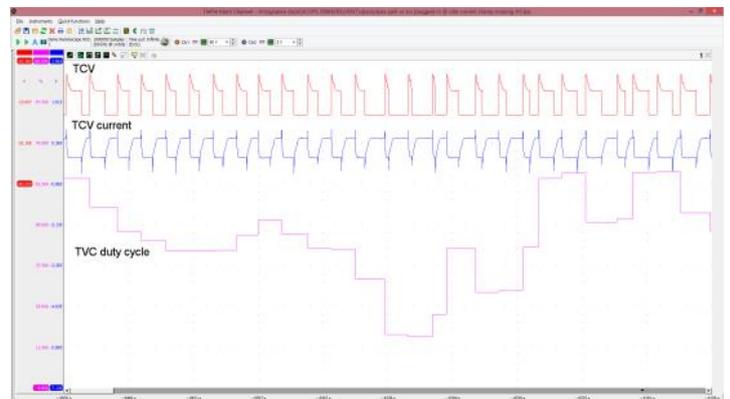
Picture 3: ATS scope recording of TCV voltage over current, running good (cold engine).



Picture 4: TCV voltage over current, running really bad (warm engine).

Zoomed in we could see if the current was as expected or perhaps the cause of the erratic running. What was in our minds was for example a broken pin in the TCV connector making and breaking a

connection in the TCV circuit. One moment it is working properly, then the next moment it lets go. When the connection is lost the valve will close, advancing the timing, even though the ECU is trying to retard, by increasing the duty cycle. The next moment the connection is 'made' and a far too large duty cycle opening the TCV fully retarding the injection timing too much. We have dealt with a number of cases doing just that at the AECS help desk.



Picture 5: Zoomed in portion of TCV recording.

By zooming in on a portion of the pattern (Picture 5) where the duty cycle changes are 'violent', we saw no changes in current. We expected to see a sudden drop to zero amps, just before the duty cycle went up.

We were wrong.

AECS 2015 training:

Enclosed is a quick view of our 2 Day training courses for 2015. Enrolling early ensures you secure your place on our popular training courses.

ECAC1 - Air-conditioning

8 - 9 June 2015 - Christchurch
2 - 3 July 2015 - Hamilton
8 - 9 September 2015 - Whangarei
19 - 20 October 2015 - Auckland

AED - Automotive Electronic Diagnostics

~~5 - 6 May 2015 - Auckland~~ **FULL**
8 - 9 June 2015 - Christchurch 1 Spot left !
23 - 24 June 2015 - Rotorua
13 - 14 July 2015 - New Plymouth
7 - 8 September 2015 - Hamilton

EMS1-1 Engine Management Systems

15 - 16 October 2015 - Auckland

EMS1-3 Engine Management Systems

23 - 24 July 2015 - Auckland

EMS1-5 Immobiliser & Anti theft devices

10 - 11 June 2015 - Christchurch ****New Training****

SCAN1 - Scan tool Diagnostics

25 - 26 June 2015 - Hamilton
13 - 14 October 2015 - Auckland

DMS1-3 Common Rail Diesel Systems

~~5 - 6 May 2015 - Auckland~~ **FULL**

****New Training****

CANBus 1 4 hrs (\$155+gst)

6 June 2015 - Christchurch 1 Spot left !
18 June 2015 - Hastings
17 July 2015 - Palmerston North
11 September 2015 - Taupo
3 October 2015 - Auckland

Ph:06-874 9077

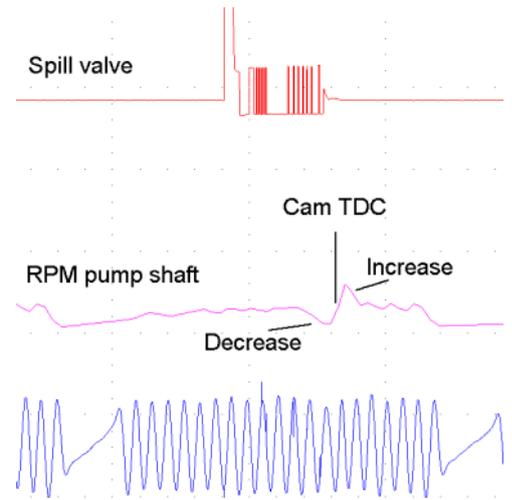
www.aecs.net

NB: Course dates subject to change, please check our website for current course dates.

What's next?

We started to doubt, the TCV duty cycle fluctuations might have been normal, we had no vehicle to compare. We looked in more detail at the spill valve vs pump shaft to see if there were any minor changes in injection volume or Spill valve timing, no changes.

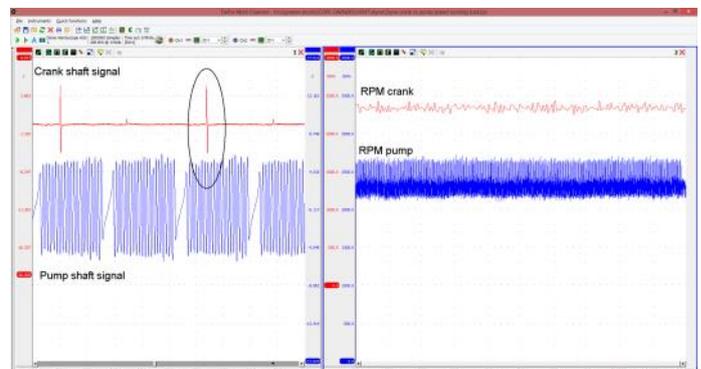
What was evident from the spill valve/ pump shaft speed sensor recording was that every beat there were large speed fluctuations. We explained that as the cam in the pump 'flicking' past the top dead centre (climbing the cam vs falling).



Picture 6: Detail of spill vs pump shaft recording

Could there be mechanical damage inside the new pump, that free play allowed the pump shaft to speed up/slow down out of synch with the crank shaft?

It was a long shot but a simple pump vs crankshaft sensor recording was made to confirm:



Picture 7: Split screen recording ATS 500XM of Pump shaft vs crank shaft sensor, when running bad.

The relation between the pump and crank shaft signals showed hardly any movement (maximum of 0.5 pump shaft teeth) when the vehicle was running bad! Again the doubt set in. Was this a timing issue?

Yes the ECU could perhaps keep the timing virtually correct by its violent duty cycle swings, but then you have to consider that the crank/pump shaft recording showed the outcome of the timing corrections, so the engine should be running correct..... That is a brain teaser aye?

Consider that the crank shaft has got only one lobe (pulse) per revolution, how precise can the timing be corrected when you only once per revolution check the pump position, while correction takes place continuously?

To make sure that our forming thoughts were correct, we checked the ECT, MAP and APS sensor when it was running badly, to see if those signals were perhaps erratic causing the timing changes, all measured stable.

Timing corrections

Pump timing correction is a function of pump sensor speed changes (time) and phase difference between the pump and crank shaft signals.

Now put that into perspective with the speed fluctuations every time the cam lobe in the pump 'flicks' past TDC.

Free play

After this conclusion the diagnostician decided that it was time to see if there was any free play in the pump drive train or in the pump itself.

Lifting the rocker cover revealed a badly worn cam gear. Removing the gearbox and cam drive gear cover, revealed a mess.



Picture 9: Badly worn idler gear, from the pump and camshaft drive train

AECS Equipment



Professional 500 MS/s 14-bit dual channel High Resolution Oscilloscope with signal generator.



Scope

Full kit:

\$7,700+gst

Scope Only:

\$3,840+gst

This powerful high speed USB oscilloscope features:

- fast sampling up to **500 Million Samples/sec**
- high resolutions of 12, 14 and 16 bit,
- a large memory (buffer) of **64 Million Samples**.
- an extremely accurate built-in 30 MHz 14 bit arbitrary waveform generator (signal generator).

The oscilloscope supports continuous streaming measurements up to 20 MS/s and can be synchronized with other oscilloscopes to form a multi channel combined instrument with synchronized time-base.

The flexibility and quality that the ATS 500XM offers is unparalleled by any other oscilloscope in its class.



Picture 8: Denso pump (picture from internet)

Metal filings were found in the oil filter indicating that not just the drive train was worn but that most likely oil galleries, oil filter bypass valve, piston cooler pipes, etc. were all full of filings as well. The engine was done!

The brand new pump was left alone, as that would be the least likely have internal free play.

A decision was made to replace the engine for a second hand unit.

Right from the first beat the replacement engine was running perfect.

Conclusion

Imagine that the diagnostician put a resistor in the coolant temperature circuit? Who would have gotten the blame for this engine blowing up. I can see the customer relating the colder temperature setting (as a result of the resistor) to advanced timing, knock and engine damage.

Also the cooling fan would not have come on or too late, resulting in engine damage in the mind of the customer.

Who would they have blamed for breaking this already 'broken' engine??

This problem was not easy to find, simply because it is hard to find a mechanical fault with a scope. Also the judgement call to go after the free play (cam flicking), was not easy to make. Yet I can say that I have never seen speed changes as bad as in the recordings made in this article.

How would you have solved this issue?

After having replaced everything including the engine you would have gotten there! Is that realistic?

Please consider quality equipment which has the abilities needed out there!

I see too many times that scopes are sold into workshops with the following line: "a scope is a scope".

That is not true! That is only people speaking without technical knowledge, pushing a sale.



For **AECS** Ltd
Herbert Leijen
06 8749 077
www.aecs.net

BRAKE TESTERS for Light

& Heavy

Vehicles

VTEQ



From \$22,500

+ gst

VTEQ 3080 HD

COF-B certified (limited)

12kn per wheel, 4x4 brake tester with digital display cabinet. Includes printer, remote control, weight cells, cover plates, Wi-Fi & networking.

AECS is accredited by the NZ Transport Agency to deliver certified roller brake machine training for COF - B Vehicle Inspectors.

Call us for training dates

AECS Equipment

www.aecs.net

PH:06-874 9077

"Calling all ATIS scope users !"

This course is specifically designed for the scope you have and will train you and your staff up in how to get the most out of this nice piece of equipment, along with learning new diagnostic methods.

It also covers the specific features of the ATIS v5 software in depth, for example RPM, Duty cycle, injection volume and signal generator.

11th & 12th May 2015 - AUCKLAND

4th & 5th June 2015 - CHRISTCHURCH

15th & 16th July 2015 NEW PLYMOUTH

Ph:06-874 9077

or email

Training@aecs.net



AECS training relevant to your workshop.