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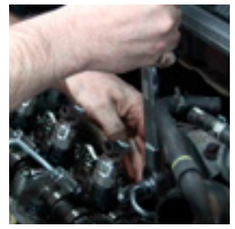
DIESEL TORQUE

OFFICIAL MAGAZINE OF THE ASSOCIATION OF AUSTRALASIAN DIESEL SPECIALISTS INC. (AADS)

Inside this issue

Registered Office

AADS Inc
Level 3, 33-35 Atchison Street
St Leonards NSW 2065
Tel: +61 2 9431 8685
Fax: +61 2 9431 8677
Email: aads@aads.com.au
Web: www.aads.com.au



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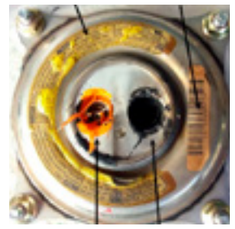


President's Report

by Merv Bryant, President

aads@aads.com.au www.facebook.com/NZADS www.twitter.com – @DieselAADS

Thank you to all who attended the 2017 conference held at Novotel Melbourne St. Kilda. It was a very successful and well run conference, which I am sure members that were in attendance will agree; and that they gained helpful knowledge for the future years within the diesel industry keeping up with the latest trends and equipment.

I thank the Committee who have put their trust in me as the new President of the association. I intend to contact all members new and old within the next few months to try and have all pump rooms on board for this valuable association. I will be attending the state committee meetings at least once during the year.

Don't forget about AADS Facebook page (https://www.facebook.com/NZADS) which provides you with an excellent online platform for networking, job referrals, and seeing the latest event invitations, as well as a bank of knowledge where members share tips of the trade and advice on how to combat on-the-job problems.

To renew your membership please follow either of the below links:

- **AUSTRALIAN members:** https://tas.currinda.com/register/organisation/108
- **NEW ZEALAND members:** https://tas.currinda.com/register/organisation/109

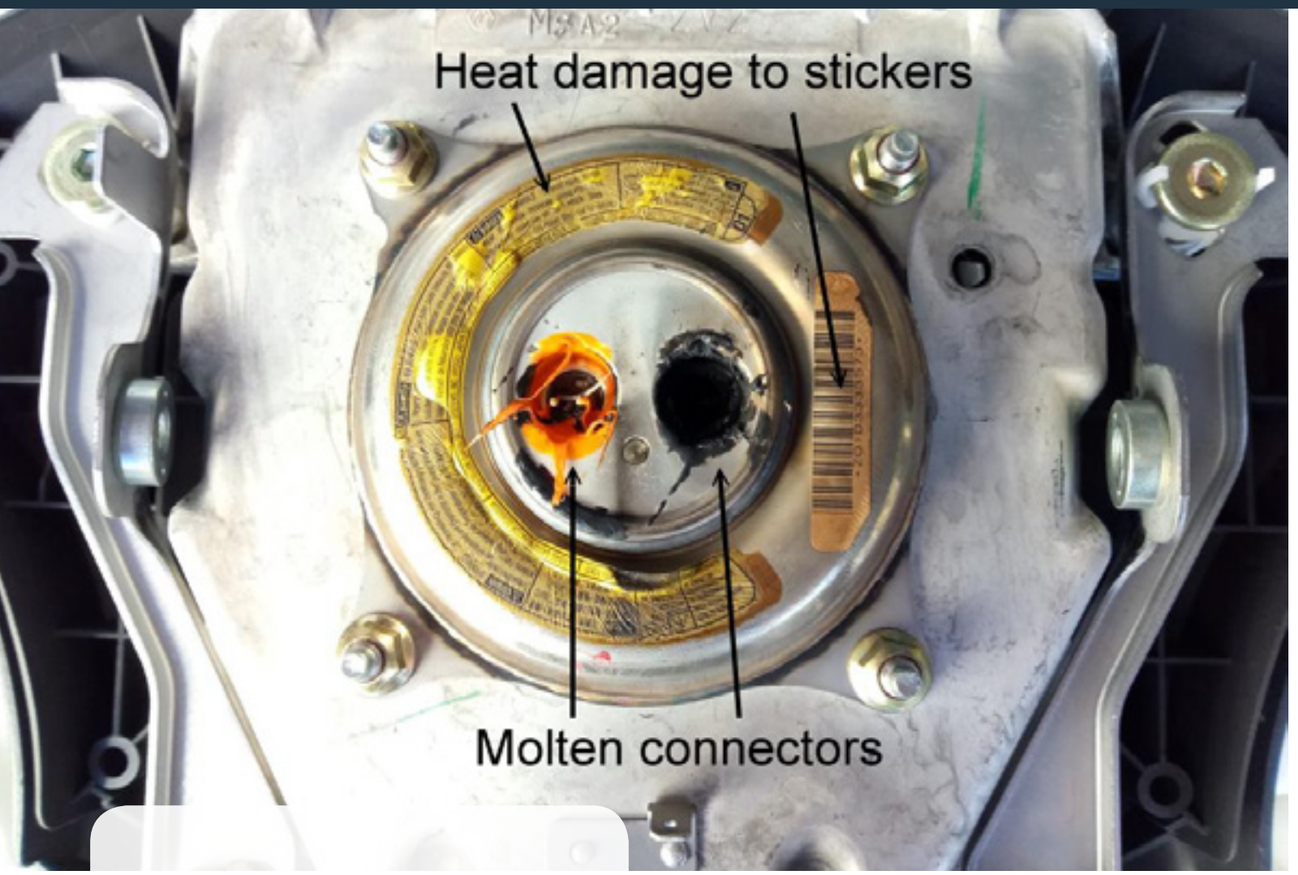
Enter your email address and password to access your AADS membership 'dashboard'. If you have forgotten your password, click on the 'forgotten password' link underneath the log-in section. Once in your AADS membership dashboard you can pay via credit card online, elect to pay via cheque or EFT, update your details and print off your invoice and statement online.

Please find enclosed a Tax Invoice for your financial records and payment. Payment options are listed at the bottom of the invoice for your convenience. If you have any questions, please do not hesitate to contact the Secretariat via email **aads@aads.com.au** or via phone on **+61 2 9431 8685**.

We look forward to having you on board for 2017-2018 and importantly rewarding you with more value from your AADS membership.

ECU re-flash crash

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



Damage to airbag connectors because of the heat of the ignitor

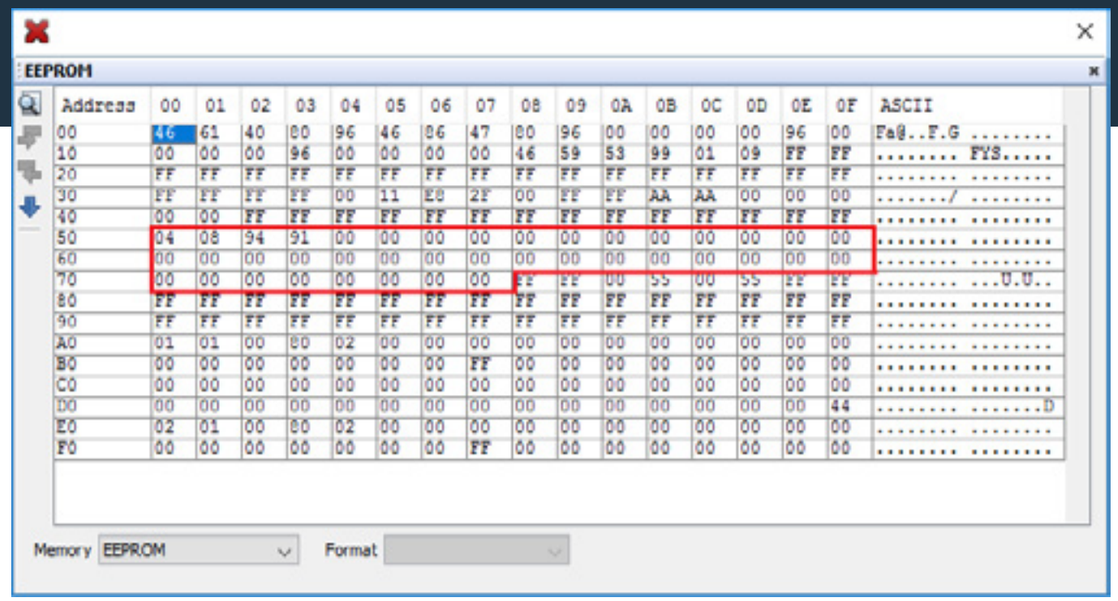
Background

In this article I need to start with a bit of background. At AECS we have been asked to develop a new training seminar. The new training seminar is about airbag safety and diagnostics. This group which requested the training has specifically asked that an airbag be deployed during the training seminar so that the technicians get to see first-hand just how violent and potentially damaging such an explosion can be. To deploy an airbag you can simply apply a voltage across the ignitor circuit as you would have seen happen in may "funny" you tube videos. This however isn't realistic and doesn't allow the technicians to diagnose what actually happens inside the SRS ECU when all conditions are met for it to deploy the airbags.

For example, during the training course we discuss the actual crash sensor's technology and why many manufacturers now specify that when an airbag is deployed the whole system from ECU, wiring harness and obviously airbags need to be replaced in order to get the system back up and running.

If a vehicle has been in an accident and the airbags haven't been deployed (e.g. key off, parked car) it is still strongly recommended that these components are replaced as irreversible damage can be caused to the G force sensors.

Some SRS ecu manufacturers set an SRS fault code after a crash, which cannot be erased meaning that the ECU needs to be replaced in order to "clear" the code. To save costs it



Section of EEPROM showing where the codes are being stored showing the Lateral deceleration exceeded fault code and crash data (address A0 onwards)

is therefore also no secret that people have found a way around this un-erasable code by clearing certain sections in the ECU memory which store this code along with the associated crash data.

The ECU that we have used during training development is such an ECU and I have been able to clear this un-erasable code by clearing certain sections in the ECU's EEPROM to make the ECU think that it hasn't been crashed. No we did not replace the G force sensor!!

However, while reading and writing to the EEPROM inside this ECU I eventually had a situation where I'd not only cleared the un-erasable code but the ECU also didn't set any other fault codes! With no airbags (or airbag simulation resistances) connected the SRS ECU had still no fault codes. How safe is that!

ECU reflashing

Having programmed a fair number of microcontrollers I'm not afraid to share this information with you. A standard off the shelf micro-controller as used in all sorts of ECUs, consists of three different memory sections, the registry, program memory and EEPROM. If you have the correct tool they can all be edited and reprogrammed.

The registry is a small section of the micro-controller memory which contains all the pin assignments. Each pin on the micro-controller can be programmed for different functions.

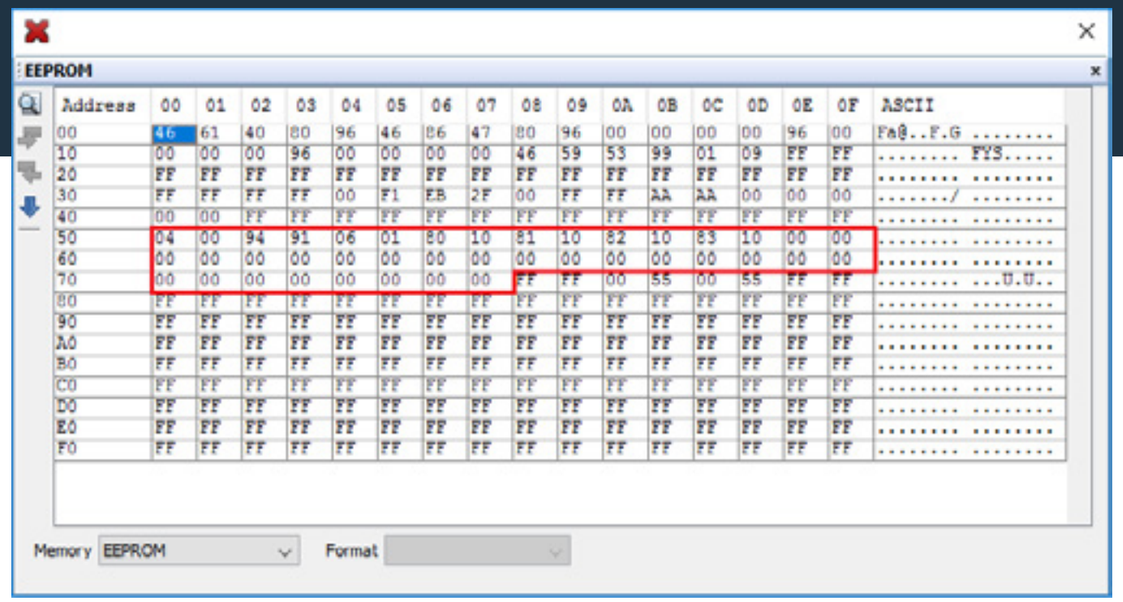
In an Engine control unit, for example pin one can either be

a) a digital output (activate or deactivate the transistor which switches the injectors to ground),
b) a digital input (hall effect crank angle sensor or converted inductive sensor input),
c) an analogue input (APS sensor voltage input) or
d) a communication pin.

I will leave it up to your imagination what a simple mistake in programming this section of the CPU memory can cause.

The program memory, as its name suggests is where the ECU program lives. In this section all the decisions get made i.e. if the analogue input for the throttle position sensor drops below the soft idle switch then the ECU will attempt to match engine speed to target idle speed by adjusting ignition timing and opening or closing the throttle (drive by wire), those of you that have done the AED will know what I'm talking about.

Or if the analogue input for differential pressure across the DPF exceeds a pre-determined value the ECU needs to start a regeneration process or activate the digital output which sets the check engine light and write to EEPROM the corresponding fault-code.



Section of EEPROM showing multiple codes with crash data cleared (FF)

The "program" in the program memory needs a certain amount of headroom to grow (storage space). The program does all its complicated calculations with for example variable inputs and 'write to the side' variables. These variables take up program memory. If there isn't enough program memory left over for the variables to "grow" into, because somebody has incorrected reflashed the ECU, then then software will produce completely unexpected results or just crash. Needless to say that if changes are made to the program memory you can also produce unexpected results in areas of the software where you haven't even made changes (sector overflow).

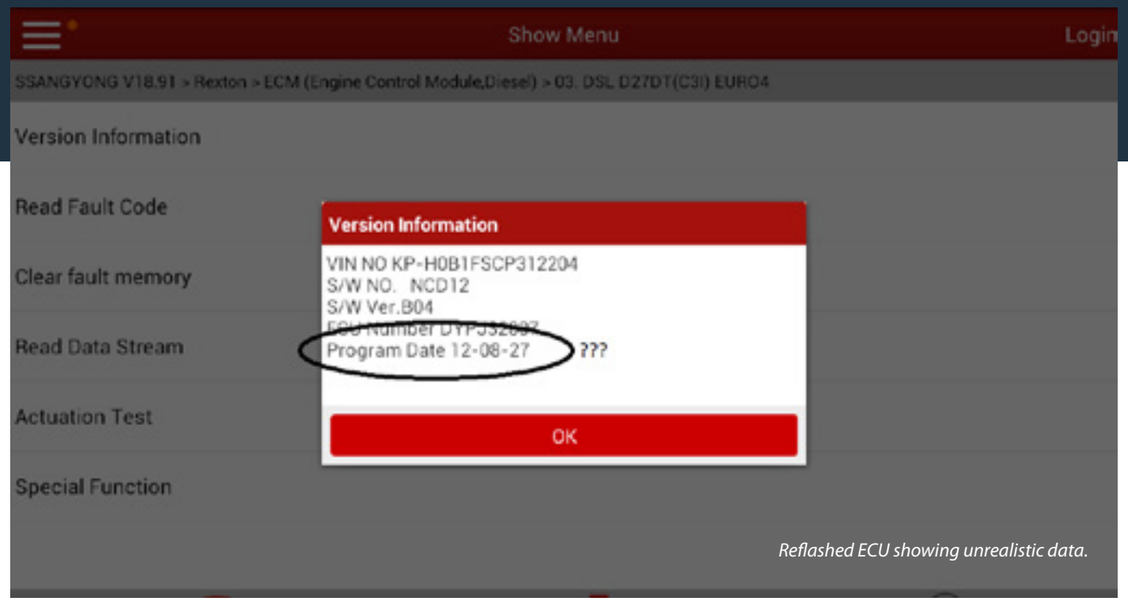
The last memory section is the EEPROM this is where the ECU stores all its permanent variables, injector calibration codes, maps (e.g. fuelling, timing etc.), vin information etc. In many cases the information that needs to be stored within the EEPROM is too great to be stored in the microcontrollers on-board EEPROM (memory) so often a separate EEPROM chip is fitted in the ECU which the CPU communicates with to read the relevant data.

Re write EEPROM

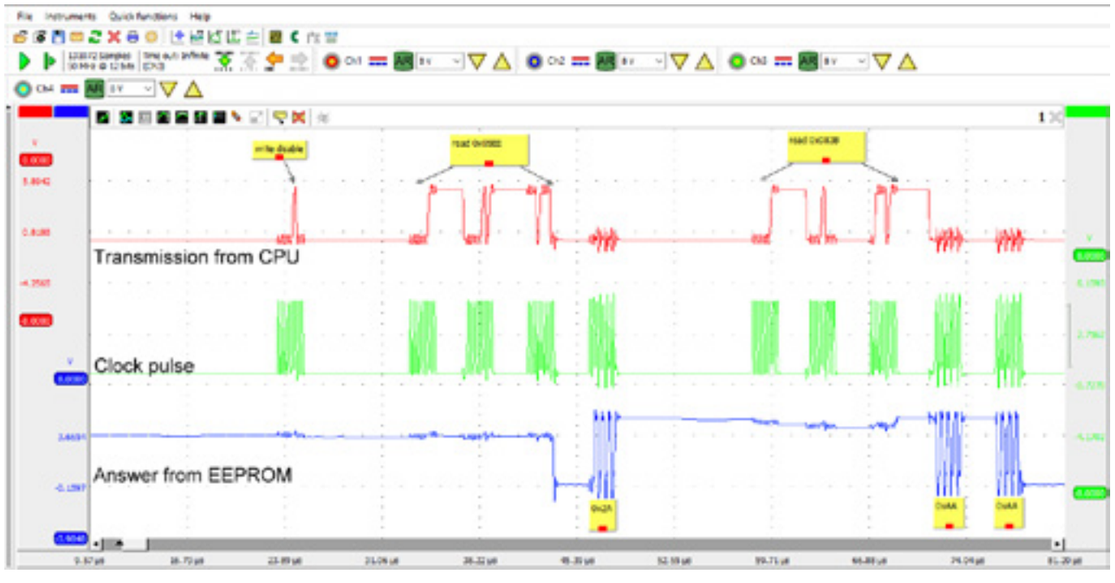
Information about these separate EEPROM chips is often readily available with instructions on how to read and write the information within this chip. Either a programmer for the EEPROM can be purchased or a microcontroller similar to the CPU can be programmed to read and write the information within the EERPOM.

Don't get me wrong this is NOT like browsing a folder on your PC, opening a word document and reading its contents. The data within the EEPROM is binary (1's and 0's) and can be encoded in hexadecimal format (bytes). Each byte has a memory location, the value of each byte in each memory location has a specific meaning. For example, the 30bytes stored in location 0x300 to 0x31E could be the calibration code for injector #1. This means that when an EEPROM is read only, the designers know exactly what is stored in each memory location and exactly what each byte value means. Switching DPF and SCR on or off could be just one 1 or 0 out of a possible 32,000 (32kbit EEPROM) 1's and 0's. Getting the right one(s) can be tricky but is not impossible. Usually does the removal of emission treatment require a complete rewrite of the file to take all references to the expected values out and to stop the driver pins from being activated. You can remove it in one area of the chip but then have to test in other areas of the software if it still is not activated. Besides that the removal of emission treatment systems is illegal, and can be tested with a simple 5 gas analyser, it can be costly and tricky.

There are tools available for tuning factory ECUs, these tools rely largely on recognising certain patterns within the MAPs stored in the EEPROM. One of our suppliers calls these EEPROM decoders (for lack of a better description) a driver. The driver tells the user which memory locations store the ignition timing maps, fueling maps, torque limiting maps and many more. Drivers are also readily available for many SRS ECUs to clear crash data and reset the ECU. I must stress that this is not a recommended repair method as g-force sensors outputs are no longer reliable after being exposed to shock, this is covered in depth in the airbag training course.



Reflashed ECU showing unrealistic data.



Scope recording showing the communication between CPU and EEPROM within the ECU.

Conclusion

After clearing the relevant sections of EEPROM in the SRS ECU the ECU's full functionality has returned, as far as a bench test would allow me to test. After "crashing" the ECU again a current pulse was sent through the airbag ignitors which again stored the lateral deceleration exceeded fault code which could not be erased. Clearing the EEPROM again has now resulted in an "airbag deployment blocked for manufacturing" fault code. More research is required to find out what needs to be done now.

AECS is now by no means in the business of reviving crashed airbag ECUs you should always follow the manufacturers recommendations for repairing these safety critical systems. Look out for the 1 day SRS1-1 course on the training calendar for 2018!

Focus on scopes

In the advert below the focus is on scopes. The software for the ATS scopes is continuously evolving. There are still technicians out there who believe that there are other scopes out there with the same ability, or even with better ability! Is this because other scopes are more expensive or because the 'sales talk' for that tool is better?

I don't know. We are engineers.

The sample in the advert below spotlights how we check cam timing with the 2 channels of the ATS 500XM connected to only the crank and cam shaft sensors.

Branch Updates

AADS QLD BRANCH MEETING

Saturday 18 November, 2017

Mantra Hervey Bay, Buccaneer Drive

The next meeting of the QLD branch will be held in Hervey Bay! This will be an AGM as well as normal meeting, which means all positions are available for Election.

DATE: Saturday 18 November 2017

COST: $65 per person incl morning tea & lunch
Family $40.00 Adult / $20 Kids

CRUISE: A sunset Dinner cruise with Champagne and Dolphin spotting with a Seafood Buffet Dinner. Departs 5pm returns 7.30pm. Cost $55.00 per person.

ACCOMMODATION:
Accommodation is from $135.00 Inc Breakfast.
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Please contact resort on **07 4197 8200**
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(Can request a swim up pool, but no guarantee)

RSVP

Friday 20 October ??
Email Nichole at dieselit@bigpond.com

Looking forward to seeing you all!

Lance Anderson *NZ*

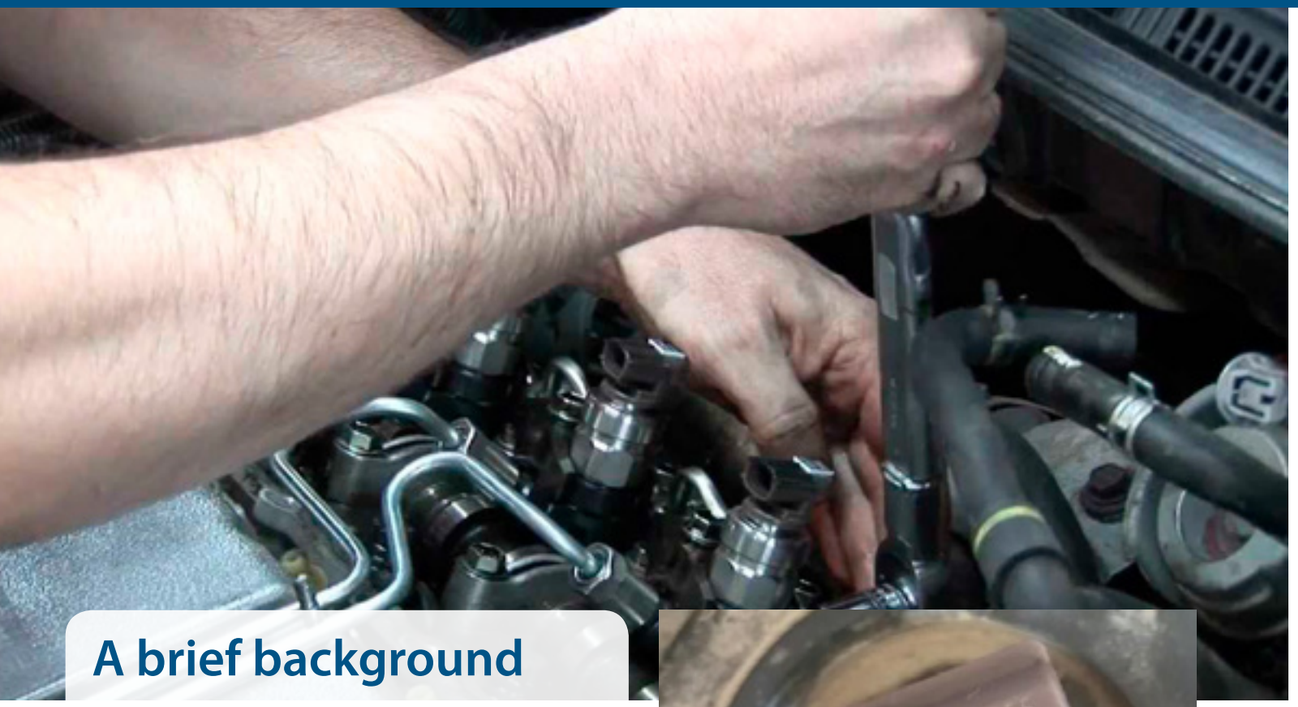
Well things are going very well here in New Zealand. All shops I have talked to lately are very busy, and the continued growth in New Zealand seems to be having a positive flow on effect into on our industry. We have had a few Diesel Shops change ownership lately so we lose a couple of long time members and gain a few new people into the Industry. I wish all those that have decided to move on all the best and welcome the new comers.

We are holding our annual conference on the 18th & 19th August 2017, on Auckland's North Shore. This year's theme is "At the Bottom of the Wave". We chose this to illustrate where we feel we are in the Diesel Industry. At the bottom of the wave, ready to roll in on a wave of new work sales and opportunities. With the ever-increasing number of Diesel Utes, Cars and Commercials on the road. This year in New Zealand we are encouraging all shops to bring along their workshop staff to the conference, so far we have had an exceptional uptake and this looks to be a very well attended conference.

If any of you want to attend drop us a line and we can send you a registration.

Automotive and Commercial Vehicle Common Rail Diesel Injectors

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



A brief background

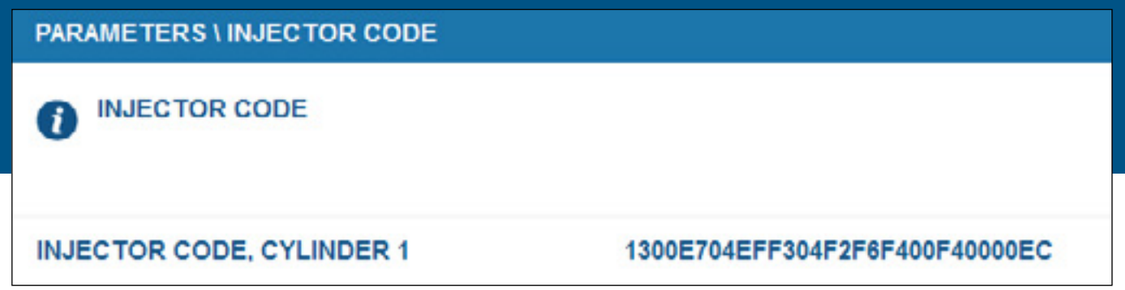
One of the most overlooked procedures on a modern diesel vehicle, car or commercial vehicle is the coding of the common rail injectors.

This is sometimes overlooked as simply not necessary or too complex but its importance and the logic behind it must never be overlooked or taken likely.

Each injector when it is manufactured is made to incredibly tight tolerances, sometimes as small as 1 to 3 microns (a human hair is typically 70 to 100 microns thick). Any machining process will produce parts within a certain bandwidth or tolerance level. However, manufacturing and machining differences will inevitably remain. As a simple example take the holes in the nozzles of the injectors, they need to be of a very precise diameter and finish. To make up for variations in the injector's parts, an injector needs to be individually tested to establish the flow rate, spray pattern and response time. This is carried out and monitored under strict quality control by the manufacturer and under laboratory type conditions. This

Denso CR injector and its 30-digit code.

data is then matched to a code, the code is then printed on the top or side of the injector. This is not just for decoration! Rarely are 2 injectors ever exactly the same and this must never be assumed or even considered. As you would expect the OE part is likely to be of a higher quality and subsequently built to tighter tolerances than one from an aftermarket manufacturer.



Toyota Hilux Injector code for Cyl.1 read with a Jaltest Diagnostic tool.

The same Toyota Hilux Injector code for Cyl.1 read this time using a Launch Diagnostic tool.

For example, some Denso injectors use 30-digit Hex codes. When replacing the injector, this code MUST be entered into the vehicles ECU so that the necessary adjustments to activation timing, duration of injection and rail pressure can be made by the vehicles' ECU during operation and remember, the vehicle has to be able to do this under a multitude of circumstances and driving conditions.

Swapping or replacing injectors without entering the correct code will almost certainly create trouble and in extreme circumstances may lead to engine failure (e.g. holes in pistons). Aside from the rough running an injector delivering too much fuel too late may lead to a prematurely blocked DPF.

An injector delivering fuel too early will increase the amount of engine knock which in itself is not good however, on a late model vehicle with an SCR systems on-board in a quest to reduce Nitrous Oxides in the exhaust caused by this knock the Adblue system goes into overdrive delivering way too much Adblue in an attempt to reduce the excessive NOX.

AECS Nov 2017 Newsletter

Does any of this sound familiar? Many commercial vehicle owners respond to the increase fuel costs (regenerating DPF's) and excessive Adblue costs (too much NOx produced as a result of knock), by asking technicians to cancel or remove the emission treatment systems. Removing or deleting emission treatment systems is illegal in NZ, especially for commercial enterprises (as far as we are aware).

Coding – it's so easy!

As long as you stick to some simple rules, entering the injector codes is an easy procedure to carry out and can ONLY be done with a scantool equipped with this function. Please be aware that not all scantools have this ability so it pays to check this with your supplier before selecting as scantool and committing to this kind of work. The coding procedure itself is usually a short and simple affair with a typical 4 or 6 cylinder vehicle being done in around 10 minutes.

So how do we do it? In our experience, we find it pays to first read the original codes that are stored in the ECU, save them, note them down or print them off if your tool has this ability. Follow precisely the instructions given through the software of the tool, enter in the new codes for each cylinder in turn or for each injector changed until all the codes match what is fitted to the engine.

NOTE, You must enter the codes in the way that your tool had previously read the codes. For example, if it reads the original codes in numbers and lower case letters, than this is how you must enter the code in regardless of how it might be printed on the injector itself. In the example below 2 different tools were used on the same vehicle. The results are clearly quite different and can be confusing if not explained. Using the Launch tool the letters must be entered as lower case and on the Jaltest as capital letters.

Once the code/s have been entered it is always prudent to re-read the codes to make sure they have been written correctly to the ECU. For added safety we also recommend coding of injectors and making adjustments and parameter

An injector clearly showing the wrong code but supplied as part of a "Set".

changes, with the battery of the vehicle fully charged and the voltage being held stable at 13.8v on a standard 12v vehicle or 27v on a commercial 24v system with a ripple free power supply.

Right or Wrong

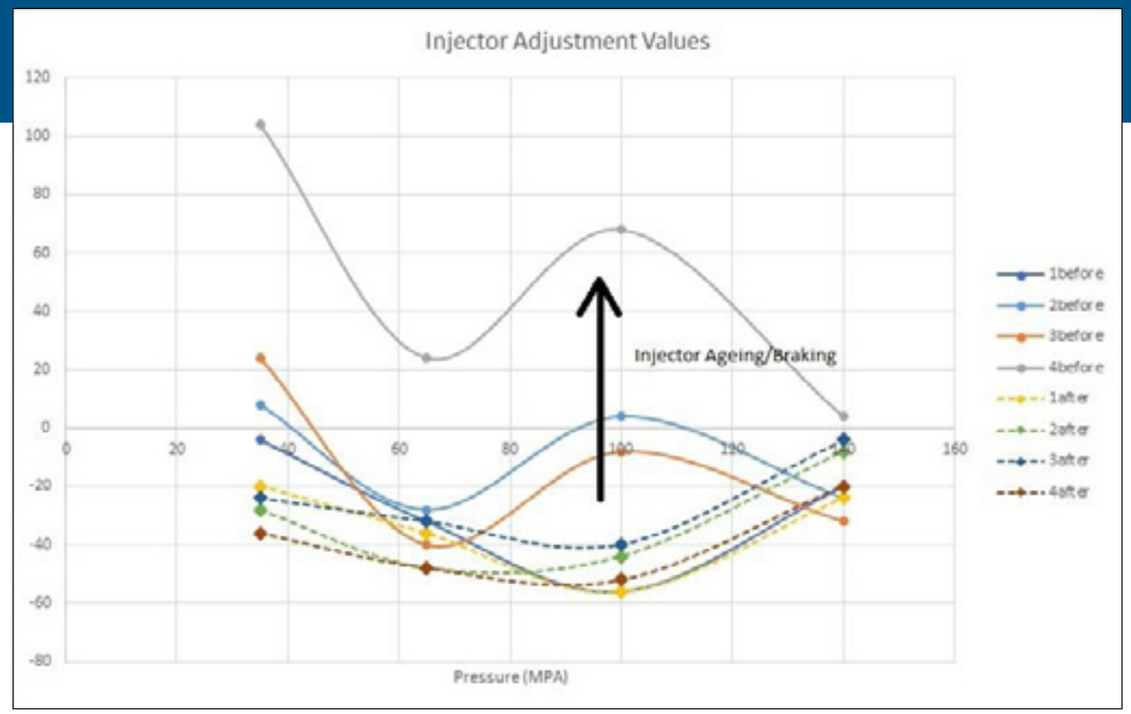
Another issue we have been hearing more about recently are suppliers sending out injectors which are simply not for the intended vehicle and in one instance a customer was told "if it looks the same it is the same"! Diesel shops all over the country I'm sure may laugh at this approach as you appreciate how very different 2 injectors can be internally and in the detailing of the nozzle while being physically the same on the outside. If you consider an example of two injectors that look identical but can be fitted vertically into the top of the cylinder head on one manufacturer while on another vehicle its fitted at 15 degrees into the cylinder head.

Consider in what area in the cylinder the fuel is being injected into. The nozzles are obviously not going to be the same. This is not visible to the naked eye but is evident in the injectors' code. If you want to be sure an injector is correct for the vehicle you are working on, simply request the codes from a new set of injectors before they are even sent to you by a supplier. You can then at least try the code in the actual vehicle. This way you can see if the ECU will accept that injector and maybe save yourself some wasted time and postage. As a rule if the code is not accepted by the ECU it is simply not the right injector for that vehicle. There have been several cases recently where random sets of similar looking injectors have been sent to a workshop only for them to then discover they won't code in to the vehicle. For those that chose to "try it and see" they quickly realise that they are left holding an injector/s that cannot be returned as they are now deemed to be second hand by the supplier. They suffer further delays in returning a customer's vehicle while the correct injectors are sourced and correctly coded. Not an ideal scenario.

Compensation Values "They sort themselves out"

This is one of the most common misunderstandings we hear about and alarmingly we hear it all too often, especially in the commercial sector. It should be understood that each injector and cylinder is subject to wear. Over and above the injector code the ECU is able to learn (adapt or compensate) to the new conditions. This also means that an incorrectly or un-coded injector will be compensated for to some degree, this will mainly be through injection quantity adaption, to a lesser degree timing but no adaption for pre- and after injection will take place.

Yes, the ECU does have the ability to make adjustments for some changes but if the initial base setting for any given injector is not entered into the ECU it will be trying to adjust the new injector based upon the data and information that is stored in its memory from the previously installed and coded injector. This will have an effect on engine balance (vibrations) and emissions and ultimately lead to the ECU trying to adjust the injector beyond its capable range in an attempt to achieve the ideal engine balance. Once the limits have been reached the engine light will illuminate and in some cases the engine will simply shut down with an 'injector compensation value out of range' fault code. All manufacturers have different limits for this so some are able to compensate far more than others.



We are also aware that some workshops have run into trouble coding an injector that is specified for a vehicle for the Oceania market which is put into an imported vehicle from Europe. The codes that are accepted in a NZ new vehicle's ECU will often not be accepted by an ECU from another area. Much research then needs to go on to discover what the equivalent and correct injector should be which will inevitably leave you with unrecoverable costs.

Conclusion

What you must do as technicians and workshop owners is to realise the importance of injector coding and not be swayed by those within our industry that serve us only to supply as many parts as possible through special offers and promotions without considering how accurate they are being and then not being there to pick up the pieces when it all goes wrong.

Demand high standards from your support network, that ALWAYS pays in the end! Skill up and choose top level equipment. Our training is available throughout NZ and is accessible for everyone. Besides being very good value and high on technical content, it is also FUN!

When choosing equipment, support and training be sure you pick a supplier who not only thoroughly understands the equipment they are supplying but can train you correctly and support you into the future with a quality service you can rely on.

AADS Conference 2017

Thank you to all the members who attended the 2017 conference held at Novotel Melbourne St. Kilda. It was a very successful and well run conference, which we are sure members that were in attendance will agree; and that they gained helpful knowledge for the future years within the diesel industry keeping up with the latest trends and equipment. Stay tuned for more information about our 2018 event!

AADS Conference 2017

DIESEL TORQUE

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Hay on High

2008 Toyota Prado 3.0L CR Turbo Diesel 1KD-FTE

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

Problem presented to the Helpdesk

We received a common rail Diesel Prado in our workshop with an intermittent surge on light throttle and no fault codes. I have replaced a sludged up suction control valve (SCV) on the Injection pump. I fitted a new genuine fuel filter, as the aftermarket filter must have allowed the drab to pass through and partial block (sludge up) the SCV.

I have cleaned the EGR valve from carbon deposits. We have a scope pattern of SCV vs Rail Pressure vs Air Mass and Turbo actuator position. Any tips on what I`m missing would be great?

Measurements

Let's look at the recording opposite made while the vehicle was surging with steady accelerator position.

We at the AECS help desk could see that the rail pressure was responding beautiful to the SCV commands. Clearly, the most common reason for surging of those vehicles was eliminated by replacing the SCV and the aftermarket fuel filter.

We teach in the DMS 1-3 common rail training the absolute relation between the SCV analogue duty cycle and the rail pressure. Being able to read those two patterns is a critical time saver, ask anyone with an ATS scope.

We can drop focus from the rail pressure/SCV for the most part now. We still need to see the rail pressure as it will tell us what the ECU is doing as a response of maybe something else.

Not sure

What did confuse me in the recording was the Variable Nozzle Turbo (VNT) position sensor signal. Why was that moving up and down during the surging?

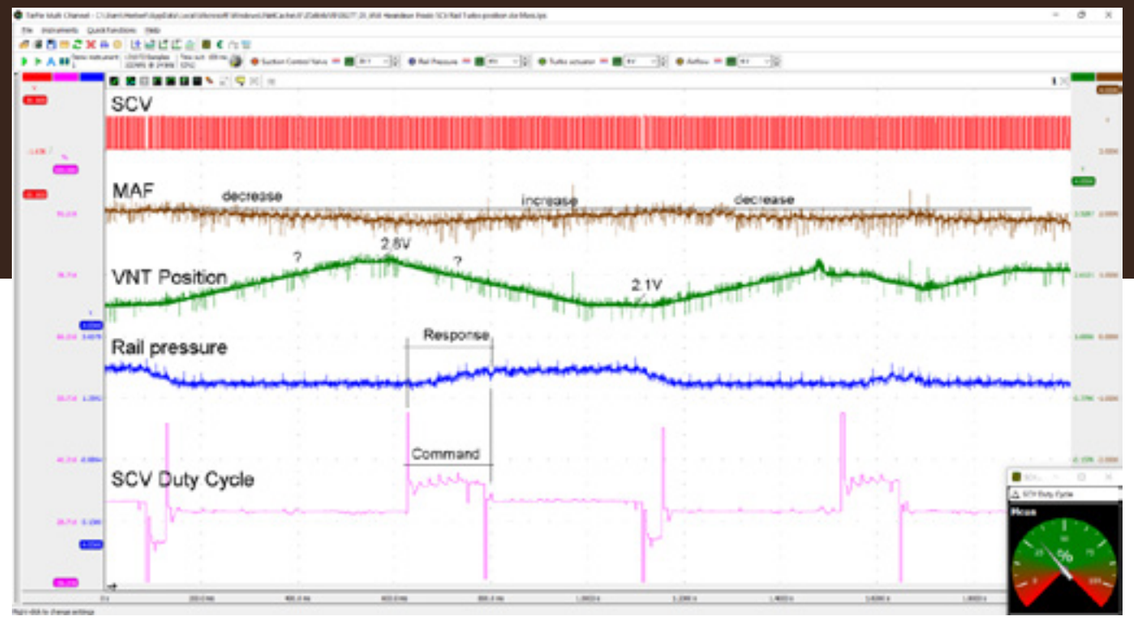
To make any sense of it I had to know what the sensor's voltage was in the ideal approach angle (also this is taught during the DMS1-3). I asked the diagnostician to make a recording of the SCV, VNT, MAF and rail pressure during idle.

He send us that pattern with the transition from idle to high load with no surge in the engine.

In the VNT position trace it is clearly visible that the idle position is 2.08V. On most VNT turbo systems, is the idle position the ideal approach angle. At Idle there is little gas flow and in that position is the turbo ready to boost as soon as the demand is there.

On this Turbo is the idle position slightly off 'ideal', as during acceleration it drops to 1.7V (max boost). As soon as the amount of air entering the engine is getting past a predetermined value (for those revs), the boost needs to be backed off (rising voltage of the position sensor).

We can see that the low voltage is the 'increase boost' position.



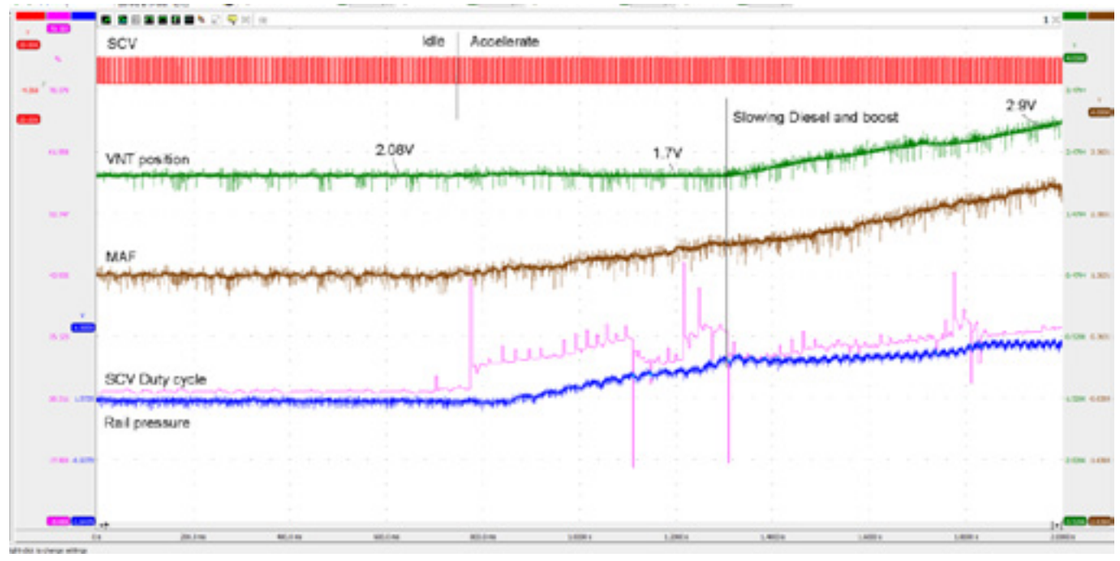
1) ATS 4 channel scope recording with math line (SCV duty cycle) added.

Looking back

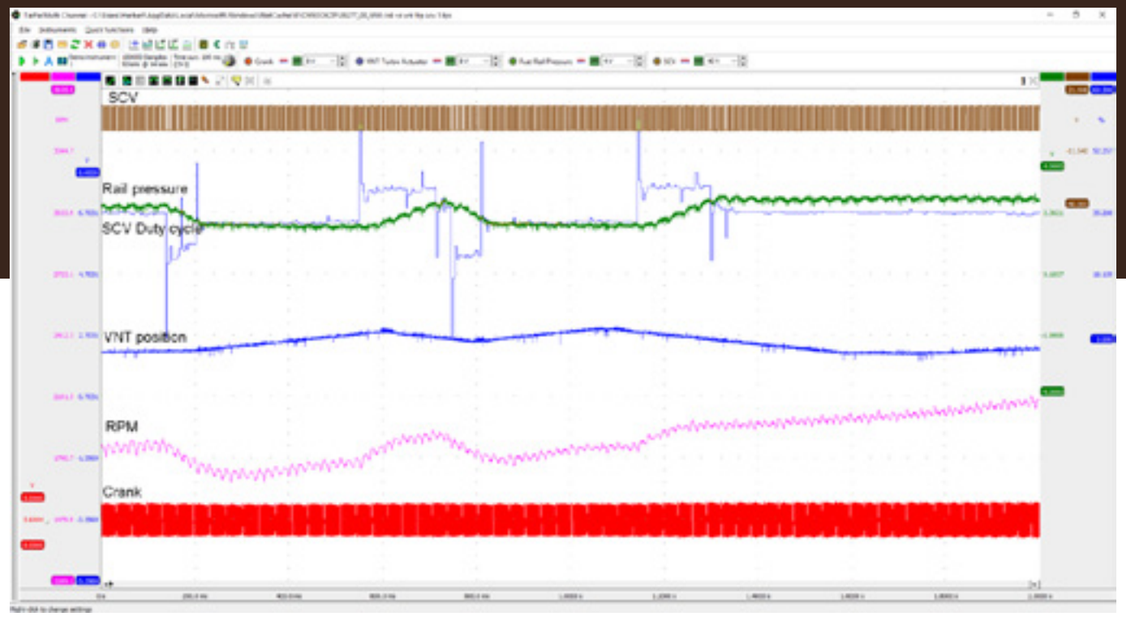
If you now look back at the first recording, you can see that the relation between the VNT position sensor and the MAF does leave question marks. When you look at the relation, at first glance the relation is okay, when the position is going down, the air flow increases, and when the position goes up the airflow decreases. However in detail, when the VNT plateaus at 2.1V the MAF signal keeps creeping up, and the same when the VNT plateaus at 2.8V (MAF keeps going down).

The MAF is on this vehicle is the Diesel quantity limiting input of the ECU. When the airflow is not high enough the Diesel quantity will be held back (lack of power). When the airflow is high the ECU will release the Diesel (increase of power). The varying amount of Diesel will cause the vehicle to surge and is evident in the rail pressure variations in the first recording.

Are you learning a bit from reading this in detail? These are not uncommon vehicles in NZ! We go much deeper into this type of diagnostics during our DMS 1-3 seminars.



2) 2 x ATS 500 XM's scopes joined together recording the transition from Idle to high load.



3) ATS XM combination recording.

Surge

To make the severity of the surge visible and to see if the changes in Diesel were cause or effect, the diagnostician moved one of the scope probes from the MAF to the crank shaft sensor, and made the above 4 channel recording:

Look first at the RPM line, it shows small fluctuations which are DeltaN (compression of each cylinder and ignition in each cylinder). It also shows large fluctuations from 1670 RPM to 1924 RPM within 400 ms (milli seconds), that is a Surge alright!

The VNT position seems to be related to the RPM surge, as soon as the VNT lowers the RPM picks up. But the relation rail pressure vs VNT made no sense at all.

A shame that the Airmass was not in the recording.

He did a recording of a full acceleration with airmass, the MAF signal only going up to 2.8V at 3800 RPM, which seemed low to us. Again was this the result or the cause of the VNT control.

Look at other inputs

At this stage it was very busy at the help desk and frankly we could not see a direct fault, other than that the VNT was moving way too much with as result or as cause the MAF and Diesel quantity fluctuating.

We asked the diagnostician to measure a few sensors which have given us grieve in the past, just to be sure (this is offering the sad solution "they all do that"). Please check:

The ESP when it detects slip it will pull back power, please check wheel speed sensors on Launch scanner first when it is surging.

The inhibitor switch, we have had issues with an ECU intermittently measuring Neutral while accelerating with another car brand, which instantly cuts fuel intermittently (surging). The APS. When the Accelerator Pedal Sensor's signal is not stable the engine torque is not stable.

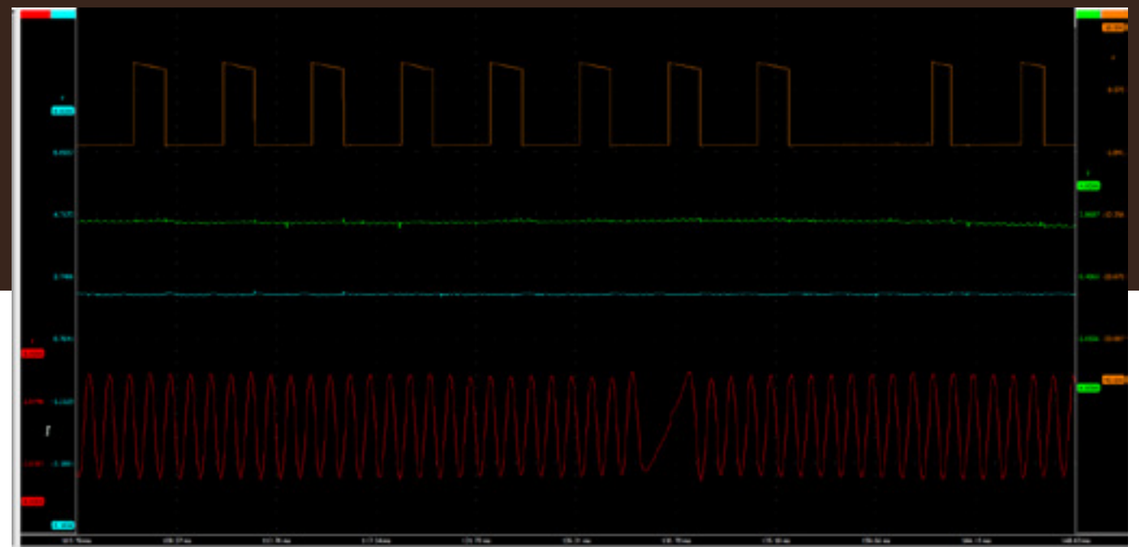
The boost sensor, just in case the boost sensor is responsible for the max Diesel quantity, we did not think so but in the end you never know for sure.

All the above measured fine, except the throttle on the intake manifold, which seemed to respond rather than cause the surge.

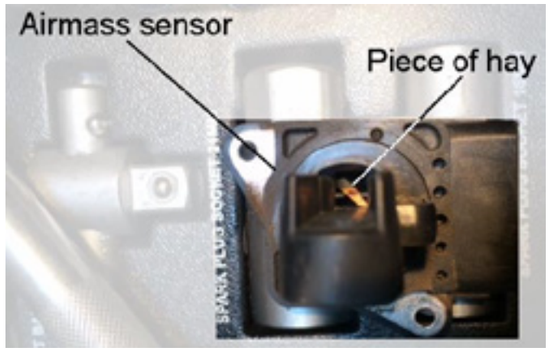
Found it!

Aftermarket airfilter

While the diagnostician was checking the MAP and MAF he removed the air cleaner top, and found an aftermarket air filter.



4) The data from "3) ATS XM combination recording" transferred to a normal scope's view, from top to bottom: SCV signal, Fuel rail pressure, VNT position, crank shaft.



Airmass sensor on socket set tool tray.

Since there have been of late many problems with aftermarket filters (mainly common rail fuel filters), he decided to check a bit harder in the MAF.

He sent the following pictures:

Inside the airmass sensor he found a piece of hay stuck on the hot wire element! This could only have gotten there through the filter as the car had not been serviced recently.

He bought a genuine filter for the car (double the thickness of the aftermarket filter and has a pre-foam pad) and cleaned the airmass sensor. The car drove excellent and had full power. As a courtesy he measured the airmass at full acceleration. The airmass voltage quickly went over 4V (at around 3000 RPM).

Conclusion

We at AECS are certainly not on a mission to prove that aftermarket filters are substandard, as we have been accused of after an article we published 6 months ago.

We have nothing to gain with such an attitude. However there seems to be no let-up in problems we run into caused by a number of filters. I am sure that the production of aftermarket filters will soon increase in quality and that all these problems will be behind us very soon. Until such time please be open minded when there is trouble!

The straw was intermittently upsetting the airmass sensor (MAF) reading, and the VNT was trying to correct the obvious incorrect air quantity. Think about the piece of straw moving around on the hot wire element. The MAF was holding back the Diesel affecting the power of the engine intermittently. Very hard to diagnose when at times the engine was running fine!

How would you have found the relations between the signals without measuring the signals, to give you a sense of direction as to where to look?

To give you an impression what the signals would look like on a normal scope without the ability of the ATS scope I have transferred the data from the third scope recording (3) ATS XM combination recording) to a standard scope's settings.

I just wonder how you would diagnose trouble like in this case with a scope of lesser ability than the ATS scope. The statement "a scope is just a scope" is not true, no matter what some sales people say!

The ATS scopes and the back up from AECS helped the diagnostician making a sound conclusion with all spend time fully chargeable.

for AECS Ltd:
H.P. Leijen
Web: www.aecs.net
Email: info@aecs.net

TURBOCHARGER
Wastegates 101

Figure 1

Figure 2.

Figure 3

Figure 4

Figure 5

Figure 6

A Turbocharger Wastegate is simply an exhaust gas bypass valve, found on the exhaust side of a turbocharger installation. It works by diverting some portion of the exhaust gas around and out the exhaust path, instead of through the exhaust turbine. This governs the turbo speed, in turn determining the given boost output of the compressor wheel, as the turbine and compressor wheel are connected and spin at a 1:1 ratio. The Turbocharger Wastegate is designed to limit the boost and hence power output to protect the engine and turbocharger, to meet emission regulation, to control exhaust gas temperatures and to improve turbocharger transient response (spool time).

The Turbocharger Wastegate valve can be either"internal" or "external" to the turbocharger in design and functionality.

For internal Wastegates, the valve itself is integrated into the turbine housing (see figure 3) and is opened by a turbo-mounted boost-referenced actuator (see figure 1) This turbo-mounted boost-referenced actuator can be pressure only operated or pressure over electric operation, as commonly found in Euro 4 onwards turbochargers. This type of installation is most common due to the ability to make the turbocharger compact in design and all-encompassing in operation.

An external Wastegate (see figure 2) is a self-contained valve and actuator unit that is completely separate from the turbocharger, and typically mounts directly into the exhaust manifold, close to the turbocharger attachment point. This type of installation is less common in original equipment applications, but can be found being used by manufacturers such as Deutz, Detroit Diesel, IVECO, MAN, MTU and Volvo Penta.

Both Wastegates types use boost pressure directly from the charge air side, typically via a small hose connection to the compressor housing or intake manifold, this pressurised gas is applied against sealed diaphragm fixed atop of a control spring and the force then regulates the opening of the wastegate valve until equilibrium is obtained and thus flow bypassing the turbine. The spring pressures can vary from application to application, hence allowing different maximum boost pressures to be achieved.

The Electric actuator (see figure 5) enables a more accurate control of the air flow through the wastegate valve than the pneumatically controlled wastegate. It allows full control over the entire load/speed range enabling fine tuning of air fuel ratio and turbine outlet temperature. This allows optimisation of emissions and fuel consumption in conjunction with after treatment management. At altitude Electric Wastegating in conjunction with appropriate sensors enables the Electronic Control Unit (ECU) to control the turbocharger speed, maximising the torque and hence vehicle performance at altitude. Due the nature of an electrical device it is recommend that it be check and calibrated at regular intervals, to optimise performance and avoid any potential turbocharger failure.

There are still a number of engine configurations that operate with no wastegate at all (known as a "Free-Floating Turbocharger"), in this case the turbocharger sizing is very specific as its speed is self-governing, typically by the aero design of the turbine and compressor wheels and the air ratio (a/r) of the turbine and compressor housings. This is typically found in larger displacement engine packages.

Turbocharger manufacturers determine which method of boost control is best for the application by using extensive data provided by engine manufacturers, which encompasses required boost pressure output, packaging (size and space to fit the turbocharger), emission regulation and cost factors for the application.

The efficiency of modern engines and improvement in turbocharger designs means that the turbochargers fitted can run quite high boost pressures. This in turn adds to the reliability of both styles of wastegate systems, as there is a reduced amount of exhaust gas that requires diversion, hence less demand on the actuation of the wastegate and controlling valve. It also can lead to inherent over boost and turbocharger overspeed issues if the wastegate and/or controlling valve were to fail, in this situation the turbocharger would be ungoverned and potentially would spin and boost to destruction. Hence maintenance or regular checking of your actuator is recommended.

GCG Turbochargers Australia Pty Ltd, are equipped with OE equipment to test, calibrate and set most types of Internal, External and Electrically operated wastegates, and sell replacement parts or service where possible.