Fuso Filings

This AECS article takes you through the diagnostic process our technical support team use with problematic vehicles. We look at the issues involved and share how we resolved the problem. This an inside look, from the profound to everyday issues automotive workshops encounter.

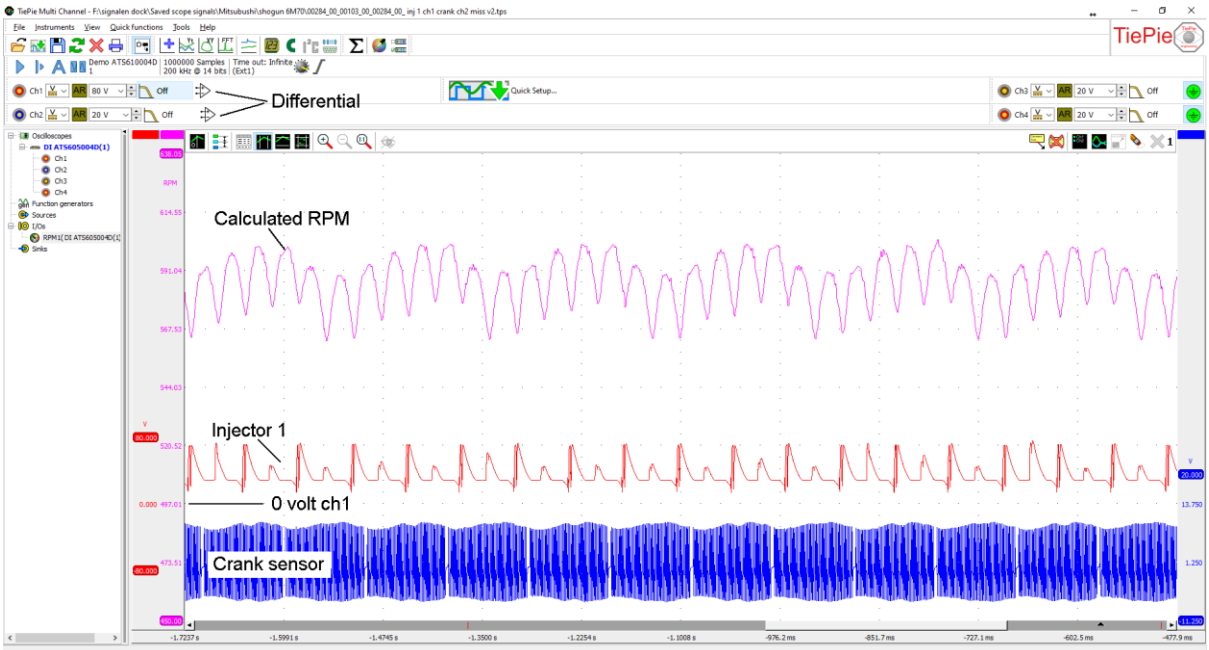
CREDIT: Image sourced online

Vehicle
2007 Fuso Shogun 6M70 6Cyl Turbo Diesel.

Problem presented to the Technical Support Team
The truck was presented with a misfire, to a workshop which has AECS equipment and AECS tech support. The diagnostician suspected that he had to replace an injector. His question was, can you please assist in telling us which injector we need to replace?

Measure
We asked him to measure the number 1 injector differentially and the crankshaft sensor signal offset or differential. The crankshaft sensor signal must be converted into a crankshaft speed signal, so we can look at the compressions and the energy delivery of each cylinder (DeltaN).

The following pattern was posted on the AECS tech support forum.

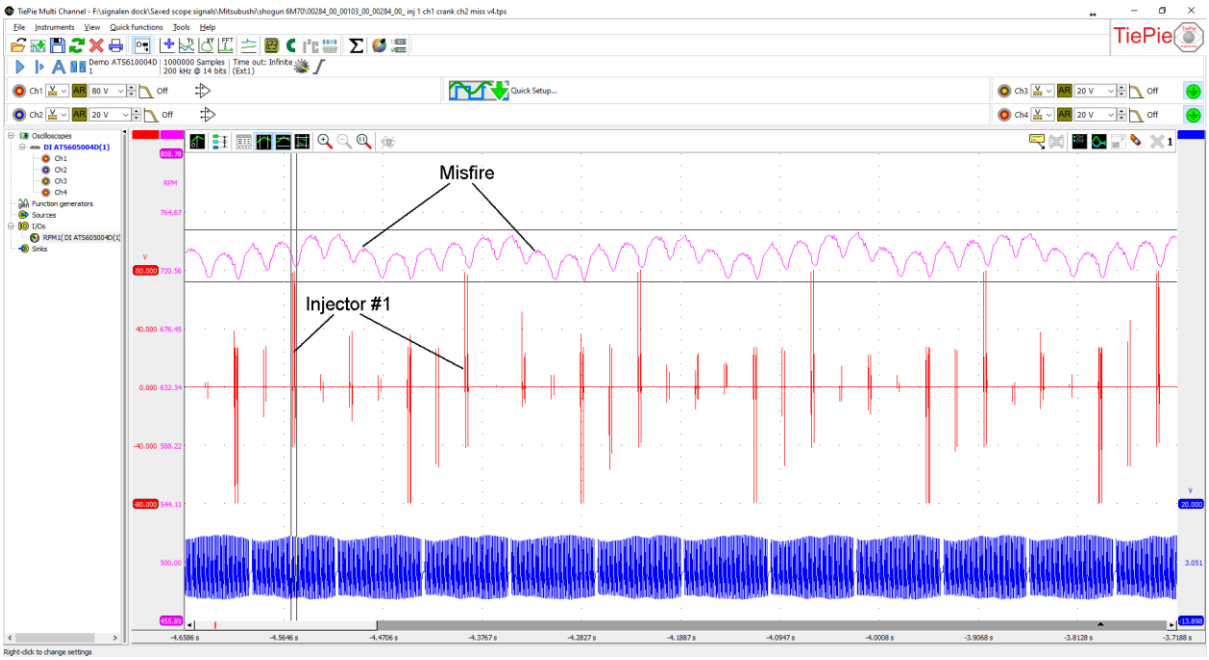


ATS 6004XM Crankshaft and injector signal recording, added is the RPM trace with the math function of the scope.

Incorrectly connected
The injector signal was measured at the multi connector of the loom entering the engine's rocker cover. Even though the scope was set up in differential mode, the signal did not show zero volts when the injector was not activated (AED training), there was clearly a probe hooked up on the wrong wire.

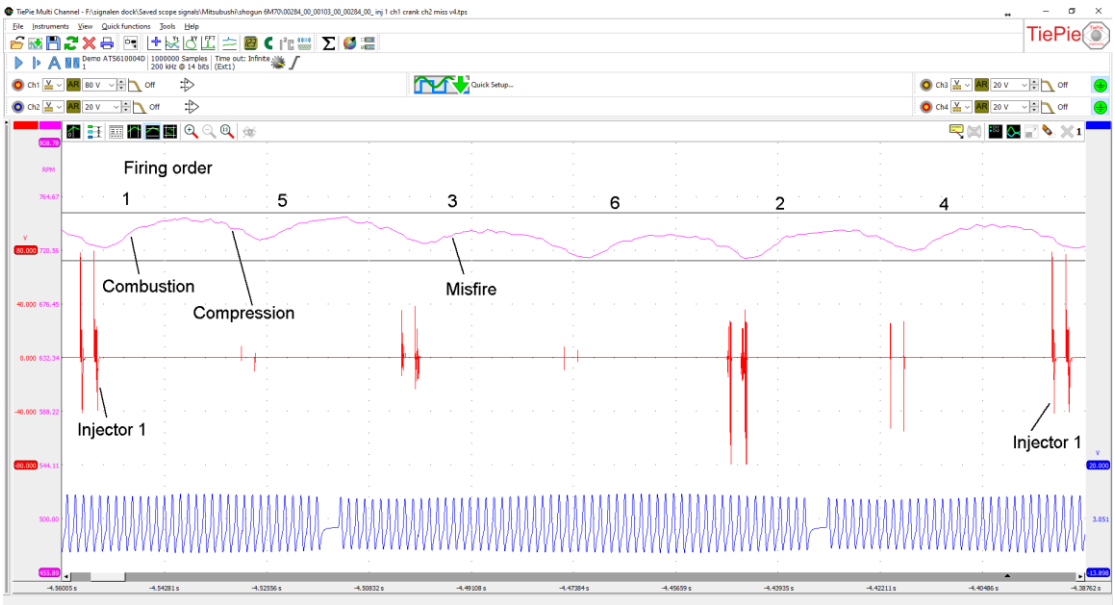
What was very clear that this engine had a misfire! Every 6th RPM rise (combustion) the RPM stayed too low, yet the RPM drop rate was even (compressions).
We were looking at a cylinder specific problem, not at a global (all cylinders) problem.

Remeasure
The rocker cover was taken of the engine to make sure that the CH1 probes where actually connected to the injector of cylinder one.



Partial zoomed in picture of second ATS scope recording

That was a better measurement! Now we can get to work. The misfire is still every sixth cylinder but by looking at the injector pattern and the firing order we can look at which cylinder is the one that does not fire.
Zoom in a bit further:

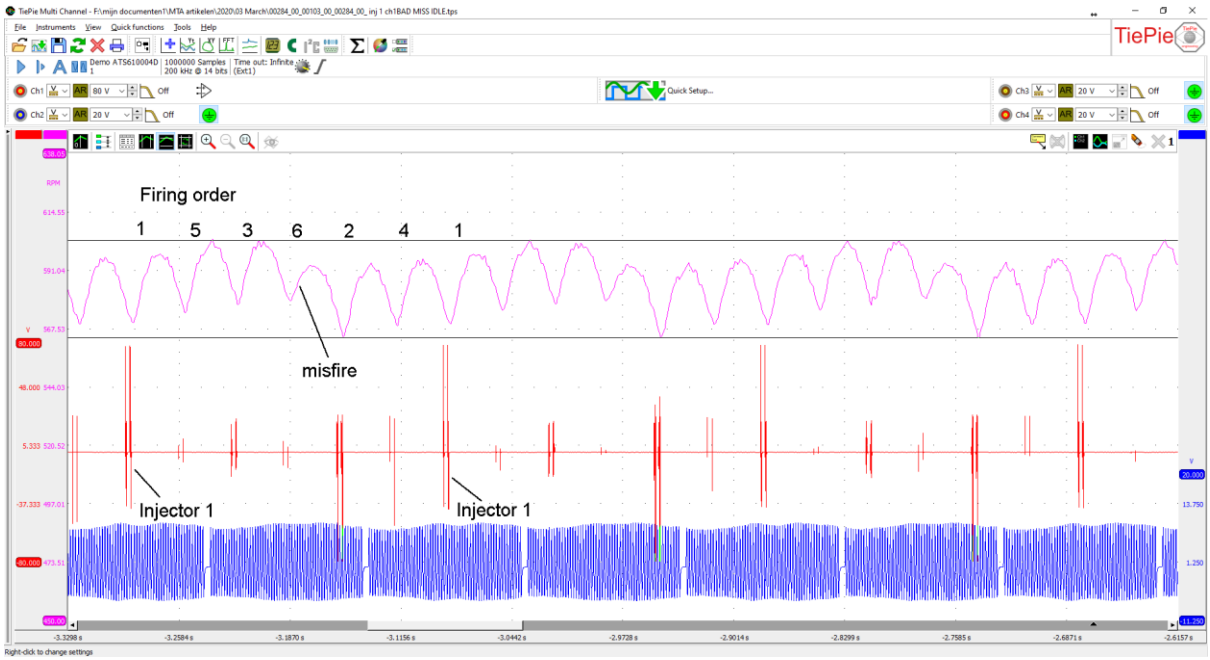


It is clear to see that the voltage of injector number 1 is zero when the injector is not activated, except from noise from all other injectors and when the voltage stacker (buck boost power supply) for injector one is ‘pumped up’ by the inductive force of injector 2.

Firing order
If we look at the firing order of the engine it is clear to see that after injector 3 has fired there is hardly any speed rise of the crank shaft, only that is caused by decompression, not by combustion.

Fixed?
Injector 3 got replaced and the engine ran beautiful. It was given back to the customer whom promptly returned it after his first run with the same misfire!

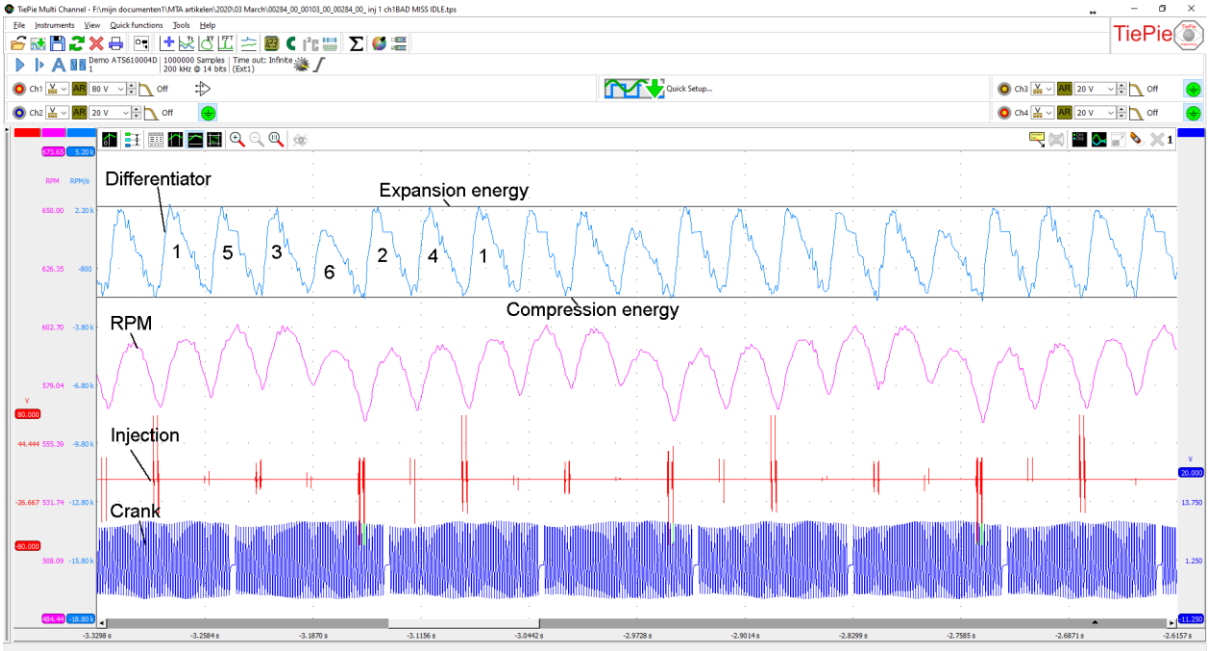
The scope got connected again and guess what?



ATS Scope recording when the truck came back after a few days service

You can clearly see that there is a problem on cylinder 6! Number 3 is fine. Just to make sure that we were not looking at a worn engine with compression problems, EGR problems or intake manifold problems, we added an extra line to gauge the compressions of each cylinder without the rhythm of the misfire affecting the compression speed drop of each cylinder.

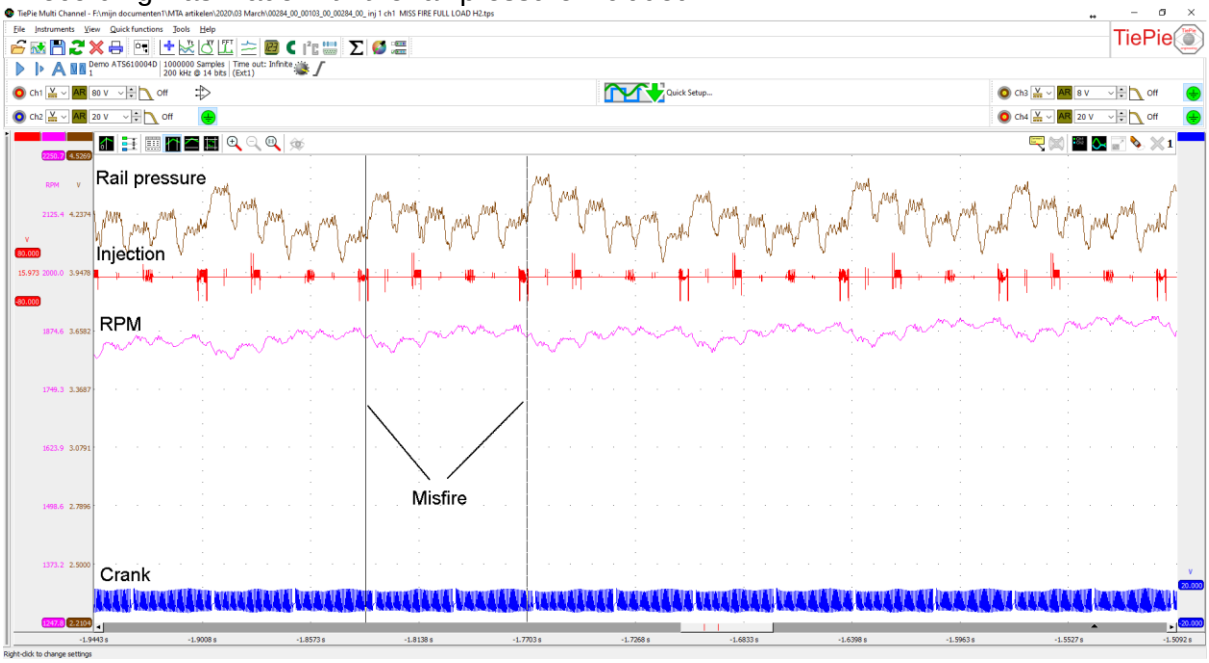
This function is called ‘differentiator’. It calculates the expansion energy and compression energy of each cylinder. All from the crank shaft sensor signal measurement!



ATS 6004XM scope with the differentiator function used.

It could not be any clearer! The compressions of all cylinders are equal, but the energy delivery of this time cylinder 6 is lagging way behind! Is it really the injector that is at fault this time?

A recording was made with the rail pressure included:



ATS 6004XM 4 channel differential/offset scope recording

The cylinder 6 misfire is still clearly visible (drop in RPM at +/- 1800 RPM) but look at what the rail pressure does!

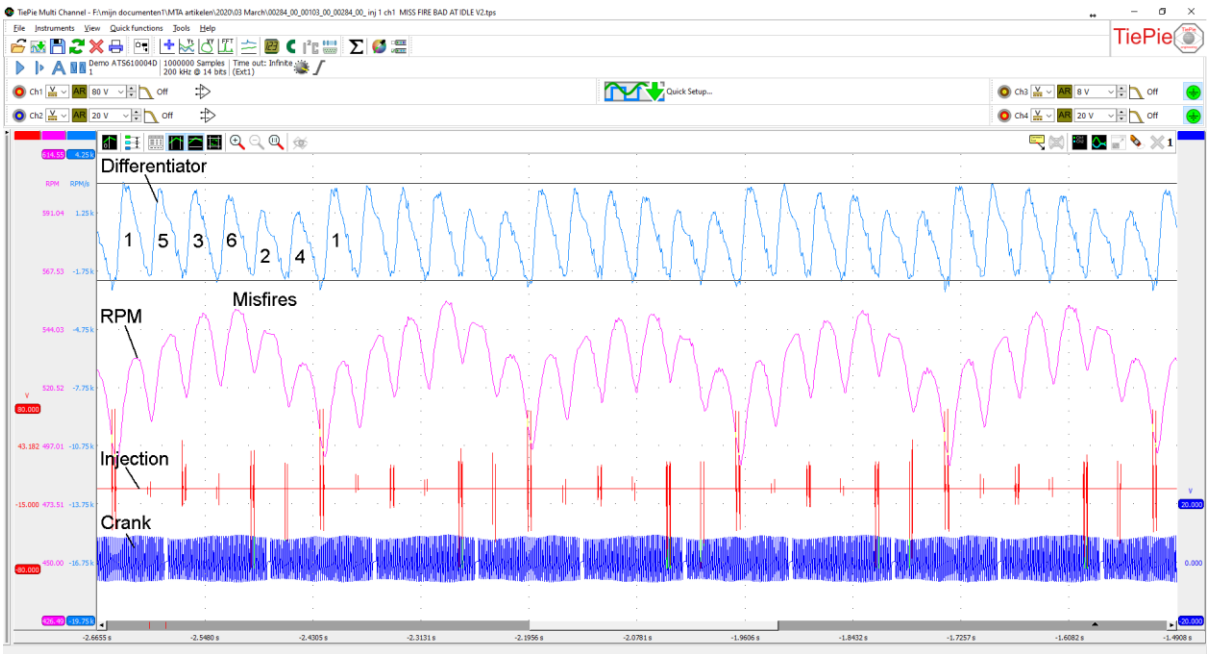
Every time injector 6 needs to take Diesel the rail pressure does not go down; the injector is not taking any Diesel. This can only mean a blocked orifice in the common rail injector (Denso Common Rail Diesel training).

The injector rail was then removed and cleaned. Metal filings were found in the rail.

A decision to replace the fuel pump and put a full set of injectors in, is made. Potentially all injectors could have been blocked or partially blocked by particles left behind in the injector's intake.

Fixed 2?

The truck runs absolutely fine now and is sent on its way, only for it to come back again after a decent trip with another severe misfire! A new measurement gets made and to our frustration the following was found:



2 / 3 injectors faulty???

In the above recording's differentiator, it is clear that there is nothing wrong with the compressions (so the air intake). All cylinders are having even compressions.

Cylinder 6 is holding back a bit; however this can be the result of the revs climbing too high from firm beats at 1, 5, and 3. I am holding injector 6 as likely still okay.
However, the injectors of cylinder 2 and 4 are seriously deficient.
All injectors and the pump are new, the rail has been cleaned out, how is that possible?

Clean again
The rail got taken off the engine and cleaned again but this time much more thoroughly. A small pocket of filings that would not be dislodged with solvent (brake clean), came out when a pipe brush was used.

All components where cleaned and injector 2 and 4 where replaced under warranty.
The truck has been on the road for several weeks now is running fine.

Conclusion
What an utterly frustrating job, and more so, costly for the owner and workshop!
However, the use of the scope and the knowledge gained in the AECS training seminars were put through their paces. Many workshops who are not using AECS equipment and training are often worried about how complex diagnostics is. It is isn't!

In the recordings above you are looking at some of the unique features of ATS scopes, features no other scope on the market can offer. No matter what the equipment salesman tells you.

Is it really that complex, or has the scope and AECS training and support sped the conclusion making process up dramatically?

Agreed, the scope could not point out that there was a pocket of filings still stuck in the rail. However, you really need to think about this case in its wholeness and then take away the scope measurements, or put in place an everyday scope which records just the crank shaft sensor and the injector pattern, without the ability to produce the DeltaN line and the differentiator line.

Please now consider how even you would start doubting about what the hell is going on, three times in a row.

Please consider AECS as your supplier for equipment, training and support.

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Did you know?

Dear AECS customer.
Under the current circumstances (I do not dare to use the C word here), I want to let you know that AECS is "sort of" open for business.
All of the AECS team are working from home. We work with passion, as a team we all WANT to work!
This shows what a great team we have here at AECS, I am very proud of that.

We are not going to be in our headquarters for the next 4 weeks (or more), except for Cunie and I.
What does this mean for you?

General
AECS went into this lockdown in a healthy shape, from the business perspective we should be all right when all of this is over, depending on how long it takes.
From a personal perspective, I really miss the interactions with our customers (you) and staff.
Training I do with a passion and really enjoy the buzz I get from seeing the value training gives to your business.

Technical support
Please call, email and put technical support cases on the forum as per normal.
However the answers you will get from us are not instant and might take sometimes a bit longer than a day.

Training
There will be no training for the next month at least.
I am sorry.
We had to pull out of Christchurch mid training on Monday the 23rd. We had an almost full class, all had to leave the conference centre that Monday afternoon.
I barely made it home as the ferry was a severe bottle neck. Thanks to a bit of perseverance and operator flexibility I got on the 2:30AM sailing, and home at Lunchtime Tuesday, a bit ragged due to lack of sleep and food.

Our training calendar is going to be remade during the next few weeks (?). It is not simply move everything forward a month or so, as customers and conference centres are not always that flexible. We have already numerous prepaid and pre-booked seminars for the period after the lockdown (when that may end), no idea if those seminars are still go-ahead or not.
Too early to tell.
As you can see it is a mess, but we will unmess it again. We will let you know as soon as we can.

Equipment
If you order equipment, great, THANK YOU! That will keep us going in the mean time! We have some really special deals going at the moment.
However the preparation of the equipment might take a little longer, also because we thoroughly clean and disinfect it before it leaves.
I am unsure about the courier services at the moment.

Heads UP and Stay well!

Kindest
Herbert