

Injection Rejection

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

Vehicle

2007 VW Golf 1.4 BLG 4cyl TSI petrol engine direct injection.

Picture sourced from internet



Problem presented to the Helpdesk

There is a misfire on Cylinder 3. A **P0303** fault code is stored and wont erase.

This car has been of the road for about 6 months now, it has been to several workshops who done all sorts work. One work shop removed the ECU after trying everything else and send it to an ECU expert in NZ. They found some faults and repaired that. Another workshop sent the ECU to an ECU repair specialist in the UK, who returned it after they had found no faults. They updated the software. All to no avail. The car still has the same fault code and cuts out after a few seconds running.

This AECS customer could not fault anything and was close to making a decision that the ECU needed to be replaced for a brand new one.

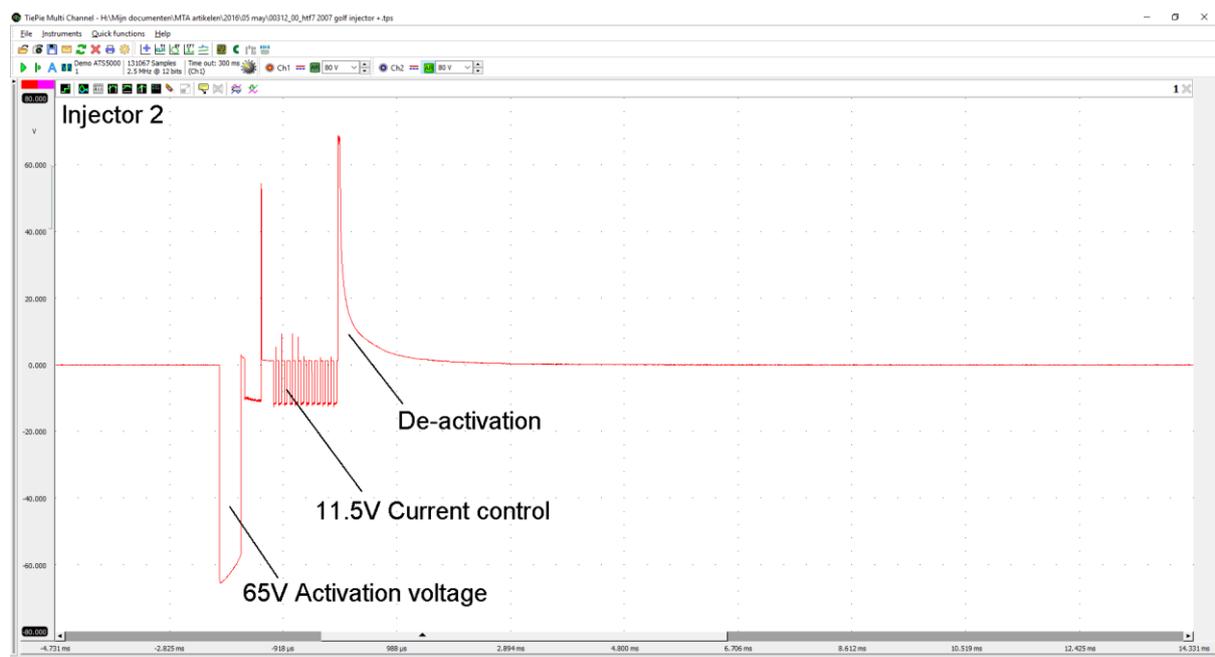
He asked us to look over this case to see what we at the help desk could find.

Injection on Cyl 3

The diagnostician is a proficient scope user and told me that there was ignition on Cyl 3 but that the injection pattern was all wrong. The injector pattern needs to be viewed differently as what needs to be done on 'normal' fuel injected cars, as this engine is direct injected.

The Injector has on one side a power supply/current control mechanism and on the other side it is switched on and off to earth. In the 'EMS1-3 technology seminar' we go really deep into the direct injection driver control and its diagnostics.

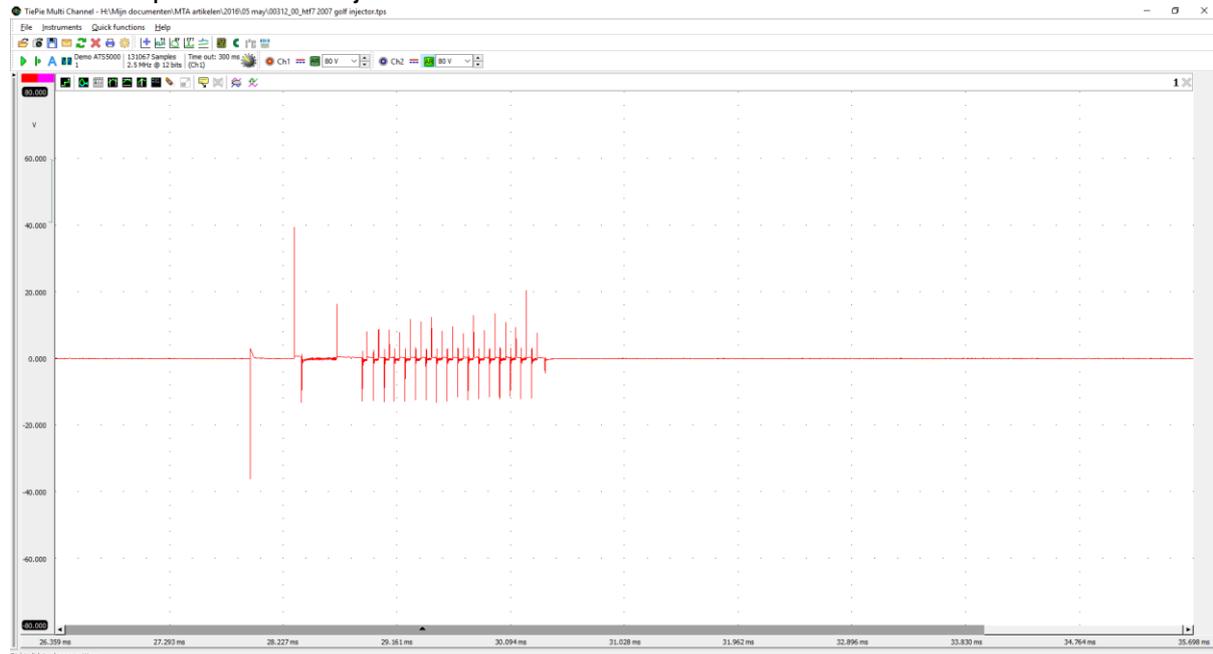
The measurements he sent were of injector 2 (no code) and 3 (fault code).



ATS 5004 differential measurement of injector 2.

On injector 2 it is clear to see that the ECU opens the injector with 65V, and then enters injector hold by switching between 11.5V and earth.

Below is a picture of the injector 3.



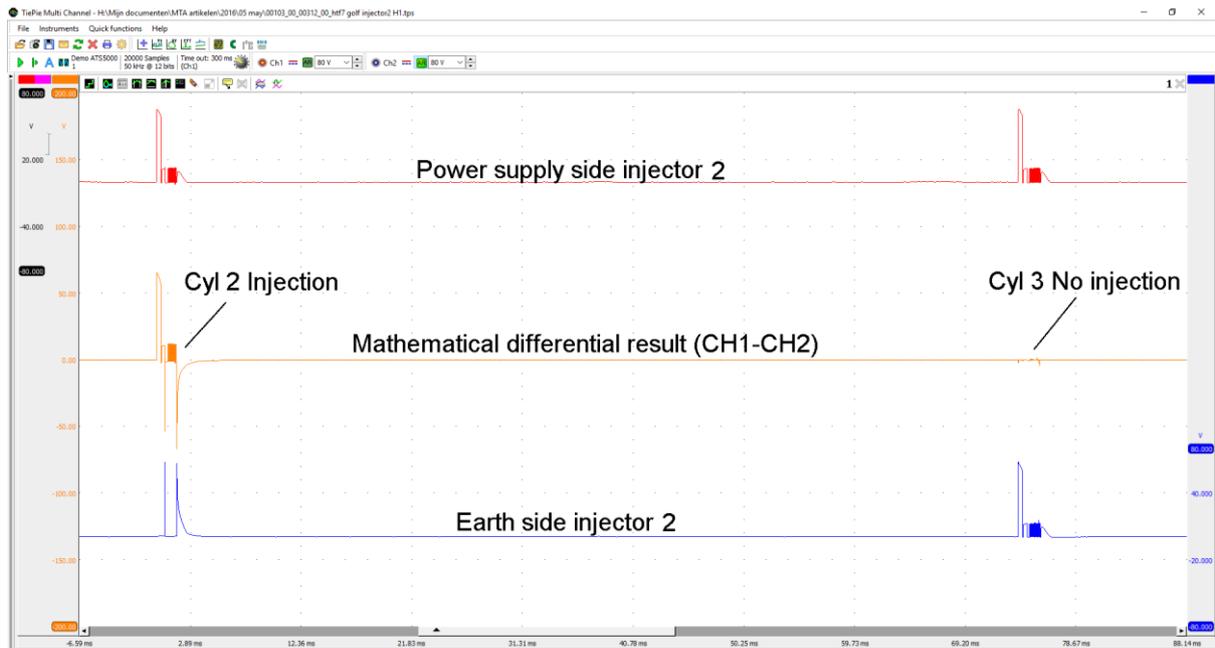
ATS 5004 differential recording of injector 3.

There is no voltage difference across the injector 3, indicating that the ECU does not switch the injector on the earth side, but that it does switch it on the power supply/ current control side. That surely indicates an ECU fault correct?

Well in our view it could also be an open loop inside the injector or between the injector and the ECU on the earth side. We advised not to replace the ECU just yet.

We asked him to swap the injectors from cylinder 2 and 3. Swapping injectors on this TSI engine is a lot of work, so we asked him to swap just the connectors from injector 2 to 3 and vice versa. Since this direct injected engine has to have the injection at the correct time, a 2 cylinder misfire (injection 360 degree out) will be created with a lot of raw fuel entering the Catalyst. We advised to only run the engine for a few seconds at the time, only to see if the ECU was able to drive injector 3.

We also asked him to record off set, with 1 channel on each side of the injector. In the below recorded pattern you can see a recording done on injector 3, the pattern recorded on injector 2 was identical!!!



ATS scope recording on both wires of injector 2. The differential line is a product of the live math function of the scope and shows if the injector is activated or not (live).

Number 3 back on deck

We had injection on all injectors (including 2 and 3) for the first time, what happened?

The diagnostician had to remove intake manifold to fit the jumper leads from connector #2 to injector #3 and vice versa.

This left a number of sensors, including the airmass sensor, disconnected putting the engine in limp home mode. At this stage the ECU 'does not care about misfiring'.

This proved a number of things:

- The ECU was fully able to 'drive' the injector at cylinder 3, concluding that the injector driver inside the ECU was not broken. Confirming that ECU replacement was not necessary!
- The ECU deliberately did not activate the injector, as a direct result of the misfire detected (P0303) fault code, to protect the catalytic converter.

Misfire cause

The first thing we had to do was to determine the cause of the misfire, that was very obvious. "The misfire was the cause of the injection being switched off, the misfire was not the result of no injection!"

Please think about this statement.

We asked the diagnostician to record ignition vs injection on cyl 3. With the intake manifold sensors disconnected he had plenty of time (engine revolutions) to make these measurements as the engine was in limp home mode. As long as it stayed in limp home mode it would keep activating injector 3, and not even look at the misfire problem. The only real concern at this stage was the catalytic converter, that would be filling up with fuel and air during the running of the engine while it was misfiring on cylinder 3.

Misfiring can be caused by the following:

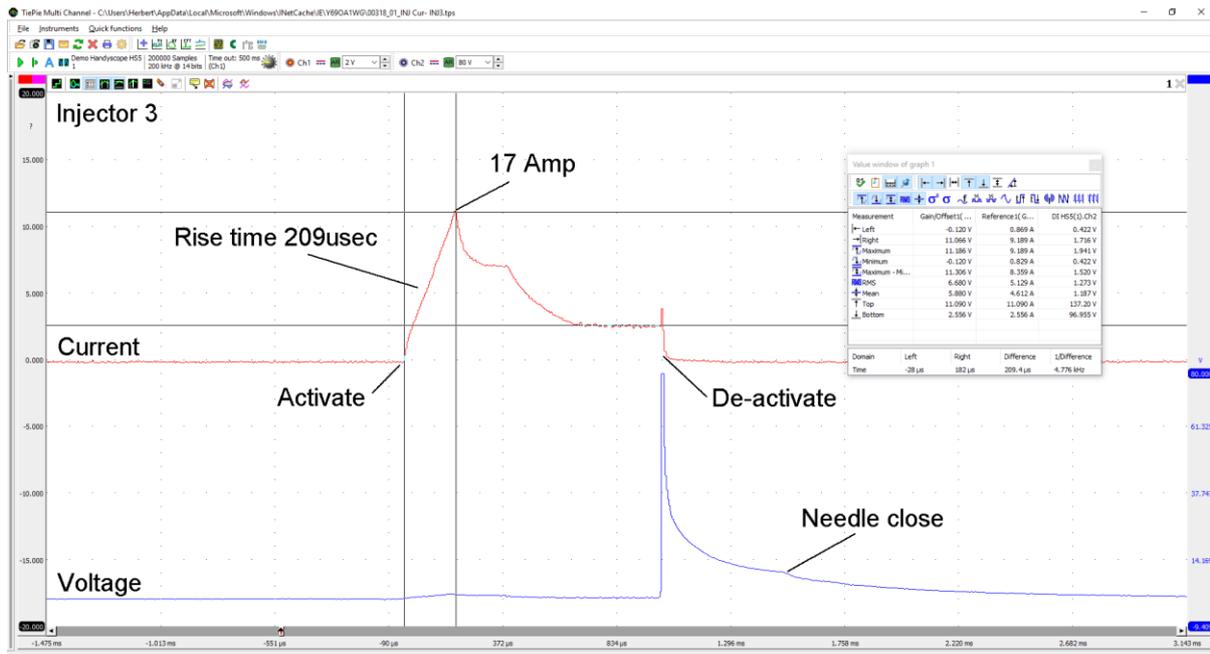
- Ignition problems
- Injection problems
- Compression (breathing) problems.

We had to investigate all 3 in the above sequence of likely faults.

However the diagnostician had the scope connected to injector 3 and it was a small extra job to measure the current to the injector, to make sure we did not have a short circuit or open loop in the injector circuit.

In the pattern below we measured the peak current after activation and the rise time for the current to reach the peak. If a short or bad connection was present, this rise time would be affected.

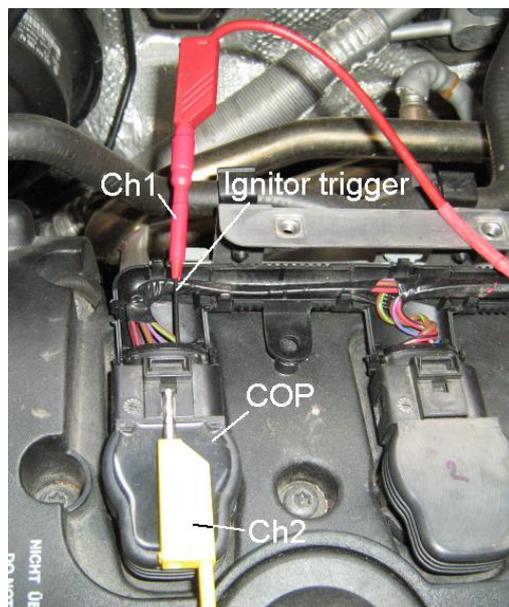
The peak current and rise time of all injectors was identical. That sorted the injector circuit. Our comment was that the ECU was most likely good and that the injector was most likely good, and that the problem might simply be an ignition problem. We needed to see the ignition pattern!



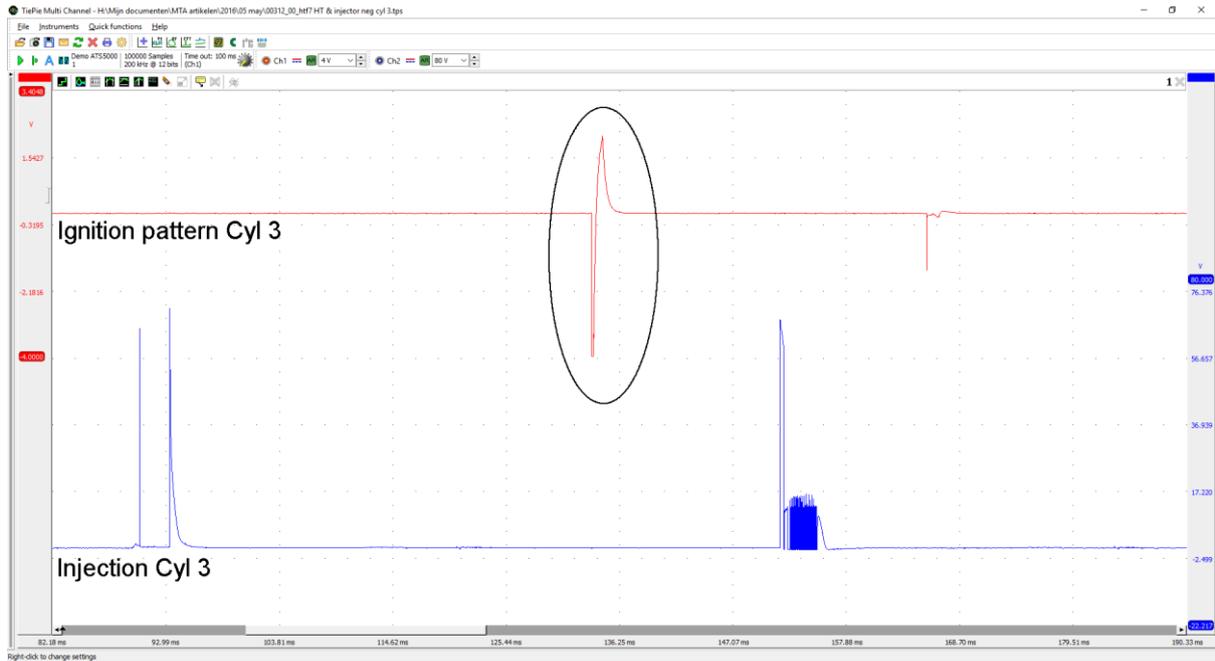
ATS recording of voltage vs current measurement injector 3

Ignition vs injection

The coil on plug does not allow for a primary measurement, but with the sensitive ATS scope, an ignition pattern can be measured by simply holding a probe above the coil.

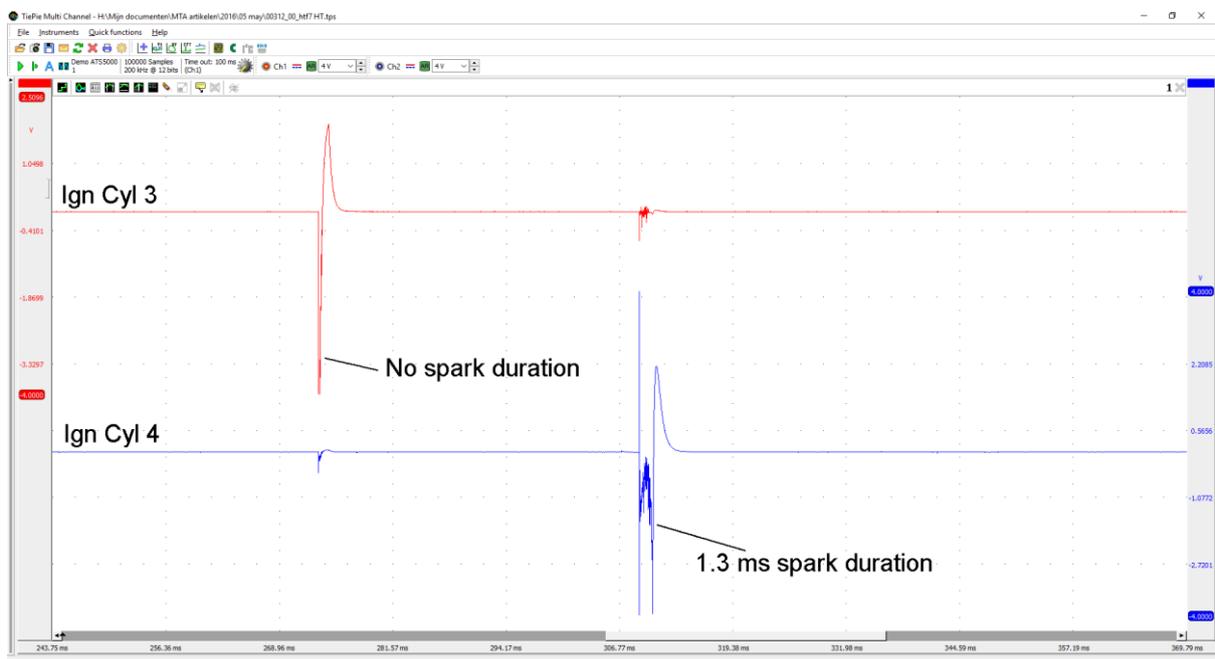


VW FSI ignition recording picture from the EMS 1-1 training seminar. CH2 will pick up the ignition pattern just fine.



ATS scope recording induced ignition and injection on cylinder 3.

The ignition and injection pattern revealed a very strange ignition pattern, we might be onto it but had to check the pattern with a good cylinder's coil.



ATS scope recording of 2 induced ignition patterns.

Bingo?

Yes that IS the problem! No ignition (no spark duration) on cylinder 3, that is surely why the cylinder misfire detected fault code comes from and why the injector was shut down!

We need to find the reason for the spark duration being zero.

At least we were getting some were!

Spark duration not present can be caused by for example:

Bad power supply, bad earth to the coil, very short charge duration (ignition trigger duration), bad spark plug (large gap), flooded plug (spark drains to earth), water in the spark plug tube, etc.

The diagnostician mentioned that the spark plug on cyl 3 looked very clean compared to the other spark plugs. This was attributed to the injection shutting down keeping that spark plug cleaner than the others... How wrong could he be!

When the diagnostician took the spark plug out he noticed 'a bit of a wiff of petrol', and thought it was a good idea to wind the engine over to perhaps clean out possible fuel droplets from the combustion chamber.



Screen shot of the movie sent to us.

He took the effort of recording what happened next on his phone and emailed us the movie.... I have never seen so much fuel coming out of a combustion chamber!! Nice little detail on the video is the connected and arcing sparkplug ☺.

Found it

Okay that was a perfect indication why the spark duration on cylinder #3 was 0 msec. The flood of petrol pouring in from the crook injector number 3 drowned the plug, causing the high tension to track straight to earth, causing a misfire logging code P0303.

All this fuel would have been collected in the catalytic converter and posed a serious danger of a meltdown causing rear Oxygen sensor fault. The workshop who delivered this car to the diagnostician who got to the bottom of it, took the exhaust off and poured the petrol out from the mufflers and catalyst.

Conclusion

So we at the help desk were wrong, I told the diagnostician that the injector was most likely okay, just like the ECU. The Injector was at fault, but certainly not the ECU!

The injector was electronically okay but mechanically it stayed open.

On direct injection systems with high pressure in the rail a lot of fuel will be pushed through an even slightly open injector.

We show the inside of direct injectors and the problems these injectors face in the EMS 1-3 training seminar.

I still dare to say that the AECS help desk was helpful in getting a resolution!

There was most certainly no need for this car to be off the road for months and there was also no need to send the ECU away, certainly not to the UK!

How could the ECU ever have been condemned? I feel that the customer has had the car off the road for too long (costs?), only this last diagnostician was worth every minute of labour he worked on the job.

The ATS scope with a highly experienced scope user, made this job efficient and effective with only with a little help from the AECS back up team.

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