

# AECS Technical Article ~ Low Tension High Tension

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

**Vehicle:** Subaru Legacy 1997 EJ20, with quad coil ignition system.

**Problem presented to the help desk:** The car offered for repair has a high tension misfire, every time when accelerating it is misfiring, only really gently easing the throttle down increases the revs.

The smell from the exhaust is incredible rich.

No emission tester is present in the workshop, so the emissions were not tested. The workshop replaced the sparkplugs with no effect at all. After trying several things like replacing coils and other vague 'known' solutions found on the internet, the car was brought to a YES! Inc. diagnostic workshop for further investigation. This workshop does have an ATS oscilloscope.

The first measurement made was the ignition primary pattern as taught in the AECS EMS 1-1 training course, as it seemed like a clear ignition problem.

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The ignition primary revealed the following real big concerns.

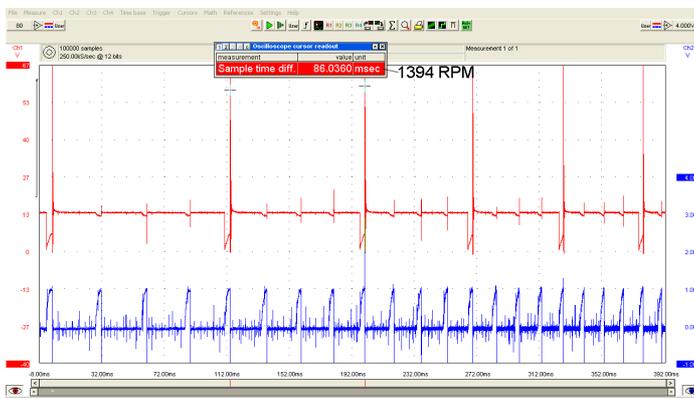
- The spark duration was far too short for an idling engine with no load. The 208 µsec (0.2msec) shows up as a good spark if held on the rocker cover. In the combustion chamber it produces a tiny non sustainable flame, which is 'blown out' when you increase the air in the combustion chamber by opening the throttle.
- The voltage loss on the negative side of the coil was a phenomenal 6 (!) Volts.
- The spark voltage on the primary showed that the sparkplug gap was on the small side, the 33 volt is on the low side.

## Blow out the flame

We must increase the spark duration and sparkplug gap so that a good sustainable flame is being created in the combustion chamber, one which does not get blown during acceleration.

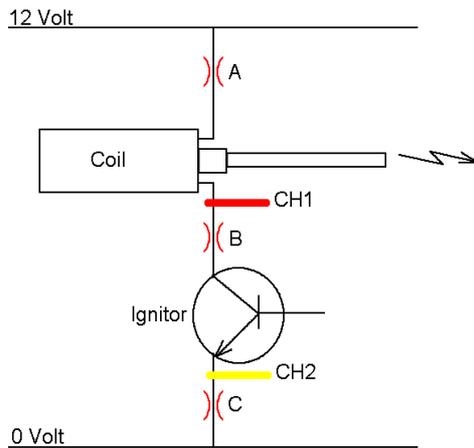
The spark duration can be increased by fixing the primary voltage losses which are restricting the current flow through the coil. The restriction of current in the coil results in a weak magnetic field in the coil. Only a strong magnetic field in the coil's iron core can create a strong spark.

Lets for good measure check the ignitor's earth before we do anything, and since the primary is still connected we might as well make it a dual channel measurement.



ATS 5000 dual channel measurement of coil primary and ignitor earth while accelerating

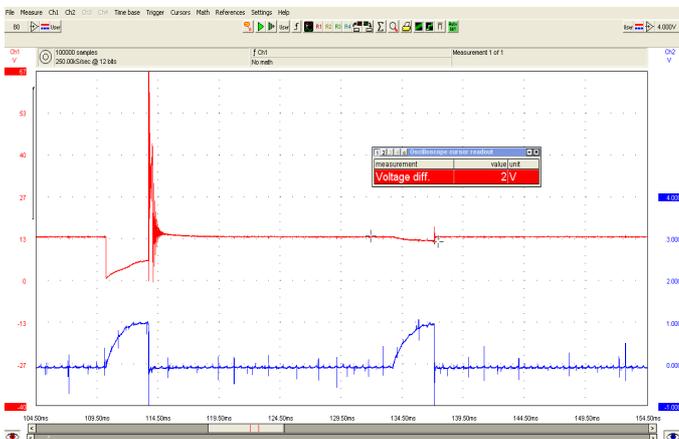
The earth wire of the ignitor should be zero volts, there is at least one volt loss.



Simple depiction of coil and ignitor wiring and where the 2 channels of the scope were connected to

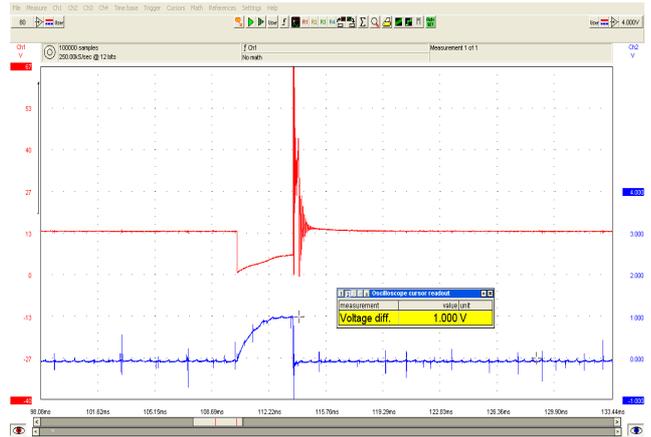
As you can see in the above schematic, the channel 1 lead is connected to the coil's negative side, and channel 2 is connected to the ignitor's 5<sup>th</sup> wire which is its earth connection.

Zoomed in the 2 Channel pattern looks better:

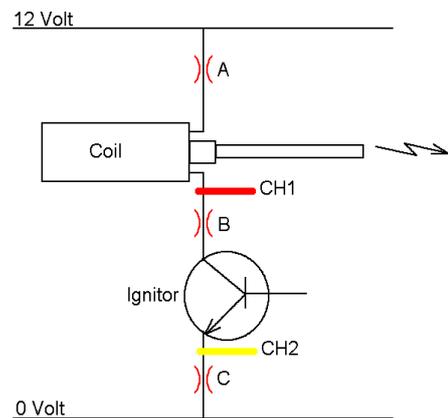


It is clear to see that the other coils during activation 'pull' the power supply an enormous 2 volts down, on the measured coil this is at least the same if not more!

Let's zoom in a bit more on the same pattern:



We are losing 1 volt on the ignitor's earth wire. Let's look at the wiring diagram again and put all the losses into perspective:

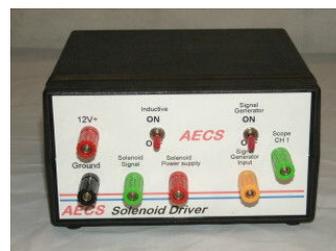


- Bad connection A: 2 Volt
- Bad connection B: 5 Volt\*
- Bad connection C: 1 Volt

This equals a whopping 8 volt loss in the primary circuit!

\*) bad connection B & C plus the loss in the ignitor add up to 6 Volts.

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ATS scope signal solenoid driver

## What do you think?

What do you expect a coil to do? If more than half of the potential difference across the primary coil has gone, the current through the coil is going to be a little less wouldn't you think?

A lower current in the coil results in a lower strength magnetic field, which has a lower secondary output as result (short spark duration).

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## Fix it!

Don't stare at it, just fix it. Pulling new wires and increasing the sparkplug gap made this car run like a beauty again.

So was it a secondary problem now??

Yes it was a secondary problem caused by primary wiring faults.

## Understand it!

In the AECS EMS 1-1 training seminar we spend a lot of time analysing many ignition and oxygen sensor patterns. It's amazing how incredibly quick you can get to the bottom of a problem if you know your business.

Poor ignition results in oxygen in the exhaust, the ECU tries to make up for this by richening up the mixture (the rich smell and high fuel consumption). Please realise that this vehicle had no fault codes, as with many diagnostic problems.

But if any fault code would be logged, it would be an oxygen sensor or mixture adaption fault code as a result of the excess of unused oxygen pumped into the exhaust.

## Conclusion

How can such a simple problem cause anyone in the automotive industry a hard time?

Yet it happens a lot, a lot of costly trial and error 'fixes' will be executed to spend time feeling useful in the garage. This is often a direct result of incapable equipment, or a lack of training.

I stress that it's not a lack of capable thinkers, as I meet in my numerous nation wide training seminars many VERY capable people!

It took for example this ATIS scope owner 2 measurements and less than 3 minutes to find the problem. The fix took a little longer as that was delegated to the junior trainee mechanic.

Again a nice simple and profitable job, good for the bottom line.

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