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Technical Newsletter

Automotive Electronic Control Systems

AECS
Training, Equipment and Data for Automotive Diagnostic Specialists

Rumbling Rotary

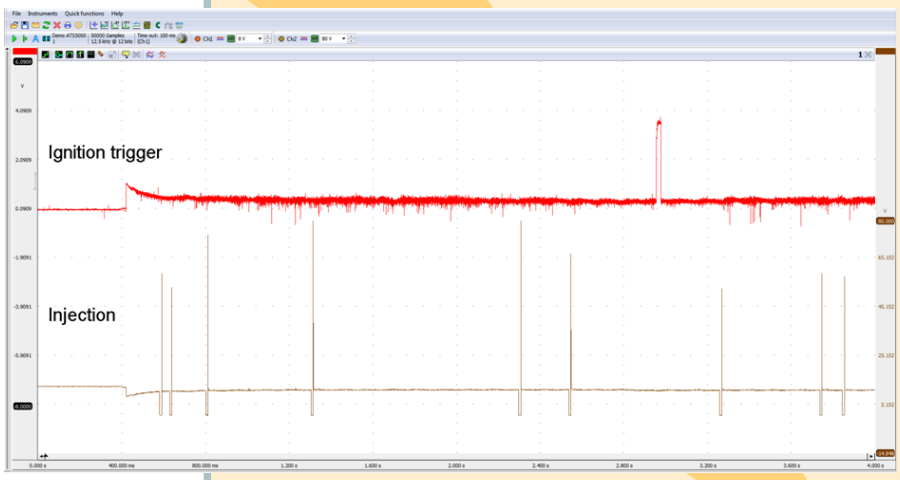
This article is a true description of an AECS technical help desk problem and how it was solved.

Vehicle
2005 Mazda RX8 13B engine.

Problem presented to the Helpdesk
This vehicle is every so "now and then" very hard to start. It winds over but does not fire, then on a second or third attempt it will fire up. When it fires up after a few attempts it sounds flooded. It drives fine and runs good in every other way.
There are no fault codes stored.
These cars with rotary engines are notorious for hard starting especially when they have a few k's on the clock.

Where do you start?
As with most cases the diagnostician wants to know why the engine does not start (no ignition, no injection or both) so we can then focus on what the problem really is.

The ATS scope was connected to the ignition trigger and the injector during a number of times of good starting.
When the engine finally refused to fire up the diagnostician captured the pattern below. That moment is something to be grateful about or else you end up giving the car back to the customer with a lot of time spent and no fix.



Picture 1: ATS 5000 scope recording of ignition vs injection

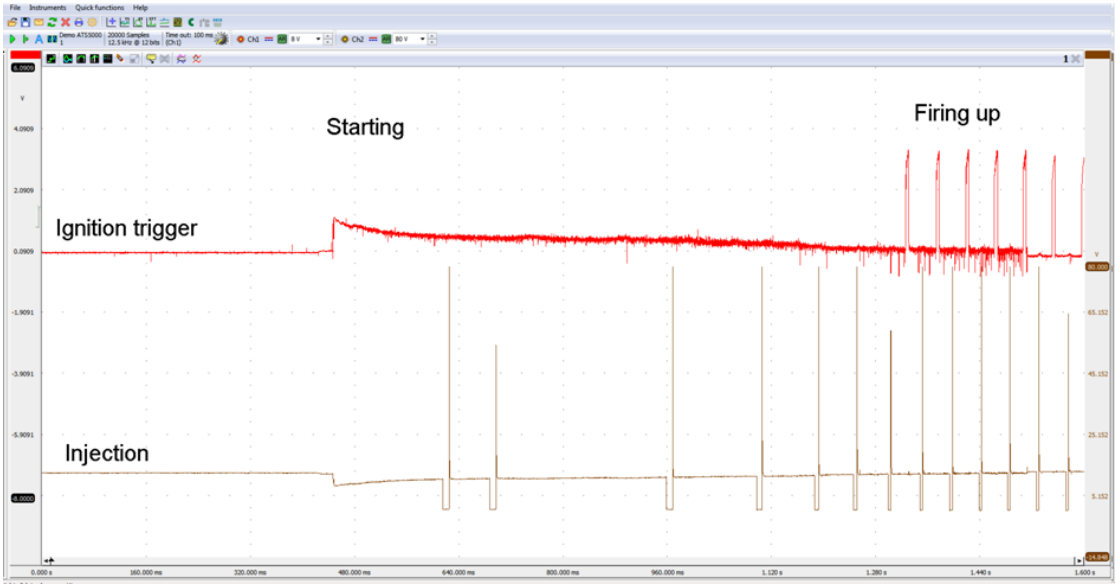
The recording in Picture 1 showed clearly that the problem was on both the ignition trigger and on the injection patterns.

System description

First you need to understand the system. This rotary engine has only one inductive crankshaft sensor, and of course no camshaft sensor. It has 4 spark plugs with 4 coils, for the two rotors.

What are the critical inputs the ECU needs? Let's list them.

1. It needs to be powered up, best is to check the 5 volt supply and ref earth as discussed in the AED training. Both were present, but that could also be seen on the recording as the ECU was doing at least something.
2. It needs to have the okay from the immobiliser. The immobiliser will never stop ignition yet allow injection (as discussed in the EMS 1-2 training), so this was also not our problem.
3. The ECU needs as core input a crank shaft sensor signal, so it knows when and where to inject and ignite. This was clearly our problem so we can focus on the crank shaft input.



Picture 2: Recording of the hard starting rotary

The crankshaft sensor signal was measured while the vehicle refused to start, the pattern was very hashy. Yet when the car was running it was nice and clean. Unfortunately there is no saved recording of this pattern. Yet the recording in Picture 2 is clearly showing an enormous amount of hash during winding over.

It also shows that injection takes place well before the ignition starts. It's only after the voltage loss in the earth drops below approx. 180 mV that ignition begins.

Noise like the pattern recorded above and on the crank shaft sensor signal is often induced by a worn starter motor.

The technician decided to take the starter motor apart and look for worn brushes or damaged collector.

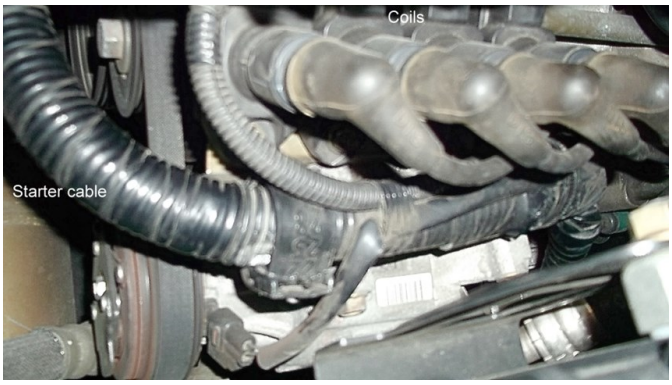
Picture 3: Starter motor was in relative good nick but got rebuilt to be sure.

No luck

After cleaning up the starter motor the starting had improved marginally but it was still not normal.

When putting a starter pack on the starter motor and completely circumventing the vehicles own wiring to the rebuilt starter motor; the car started beautifully.

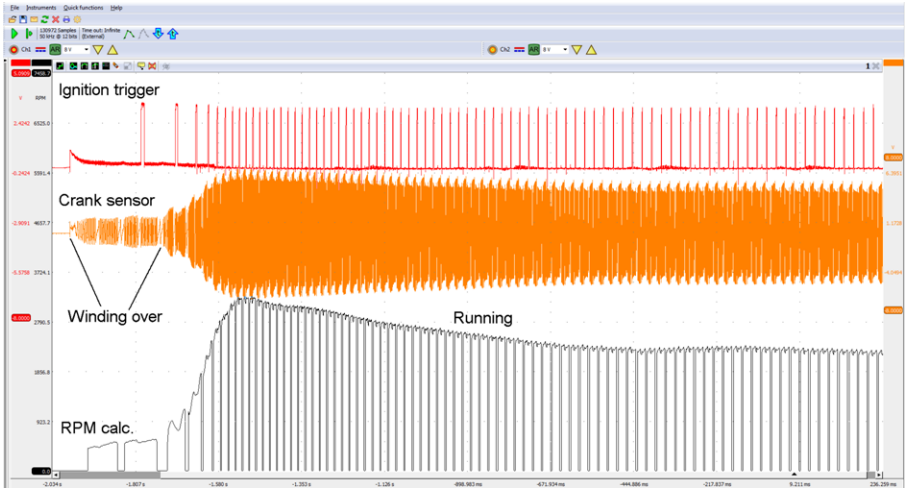
The diagnostician had decided to route the starter motor cable away from the coil pack and wiring loom, to see if the magnetic field induced by such a high current source could upset the ECU control.



Picture 4:

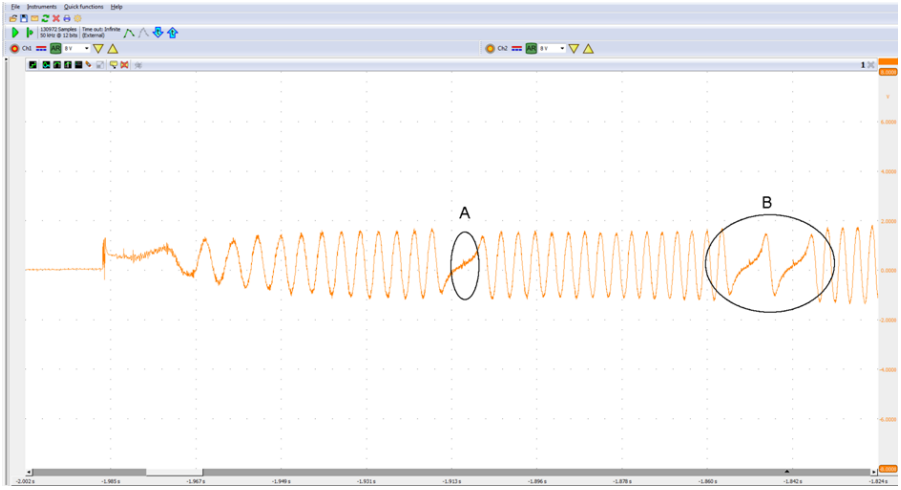
The starter motor cables moved away from the coil pack and its low voltage wires, cured the problem.

The car starts now every time after only a few revolutions, just like a normal engine. In the recording in Picture 5 the engine fires up after just 2 revolutions.



Picture 5: ATS scope recording of crank shaft sensor vs Ignition trigger. Added is a calculated RPM line.

Zooming in on the crankshaft sensor pattern, in Picture 6 there is still a bit of hash visible during winding over.



Picture 6: Zoomed in on crank shaft pattern.

At the reference mark "A" a tiny hump can be seen, just like at reference mark "B". If this hump is any bigger, and passes the 'arm' and 'fire' points in the ECU they will be seen by the ECU as teeth (the arm and fire points are discussed in the AED training seminar).

The extra teeth at the reference points will cause crankshaft position miscalculations in the ECU causing it to wait with firing or causing firing on random positions, just like what is visible in the first recording.

Conclusion

I always wonder how you would solve problems like these without a decent scope. I think that this car would have been dismissed as "they are all a bit hard to start when the rotary seals are getting worn a bit". If it was not for this diagnostician using his learned skills and ATS scope to his advantage the car (and customer) would be no better off.

There are many tools out there and also many training seminars available. Choose the ones that suit your workshop wisely. Just swapping parts would not have solved this problem.

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