Q about ION Sensing for knock control - and AWD control

danibjor

Q about ION Sensing for knock control - and AWD control

Fri Jul 24, 2015 7:11 pm

I've been tuning Saab's for a long time now. They have a pretty clever system to detect knock and missfire where they use ION sensing to do this.

The Saab 9000 94-98 and 9-5 98-2010 uses a DI cassette witch is hard to fit on other engines - thus I've converted a Volvo B23 to use a Trionic 5 engine management system with the DI cassette mounted on the firewall, and used spark leads from the cassette to the plugs. We also managed to use the built in ION sensing to read knock from the engine.

This is not an optimal setup tough..

Anyhow, the Saab 9-3 2004-2010 uses separate coils on each plug, and this could easily be fitted on other applications. It also has a (denso?) chip hanging on the firewall witch controls/filters the signal from the ION sensing before feeding the ECU with the resulting signal.

(I am a co-developer on the software used to map Saab ECU's so I have a pretty good knowledge on how those works)

Could this somehow be translated over into the Elite ECU?

I'm planning a Skyline GT-R build with an RB26DETT - and as "fragile" as these engines are, i want as good control over knock and missfire as I can get - to really push the limits on the engine, but still have good control and playing safe.

Also, I want the Elite to control the AWD system. With some testing, I found out I could use a generic output to feed the ATTESA controller with a signal for how much torque the AWD system sends to the front. Using a 3D map with lateral G and throttle position on the axis. Ideally you would have a 4D map or something here - where Speed also could be taken into account. Would be nice to add some torque to the front wheels for stability on higher

speeds.

You can also use ION sensing technology to read Cylinder Peak Pressure Point - and use it for ignition optimization/tuning.

Some dokumentation on ION sensing - and why it's a good idea
http://g-homeserver.com/attachments/har ... nities.pdf

Any inputs on these toughts?

Enthalpy

Re: Q about ION Sensing for knock control - and AWD control

Wed Jul 29, 2015 9:01 am

I played with this about 10 years back without much success. Issues I had were the diode in the circuit has to be very high voltage. I wound up stringing 4 avalanche diodes together in series, but this attenuated my signal. As the secondary coil voltage gets higher with aftermarket, powerful ignition systems, this effect gets much worse. This is where I gave up.

The use of a cap charged to 80 volts inside the coil is a great idea. My setup used a power supply that provided several hundred volts for SNR improvement.

I have a question for you. I'm not sure what you mean by "DI cassette". Does this mean the igniter?

If the ion sensing circuitry is placed on the firewall, from your presentation, it looks like the ion sensing circuit needs to be on the coil secondary to be most effective. Doesn't this mean it has to be placed either in the coil or have a special coil setup that exposes the secondary coil like that?

danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 2:06 am

DI (Direct Ignition) cassette is the coil-on-plug solution from Saab fitted on 9000 and 9-5, from 94 to 2010. This fits in the head of the engine and does not look very elegant when retrofitted to other engines.

Anyhow, these contains all the electronics for ION sensing. As far as I can remember, you have inputs 12v, GND and coil 1-4 trigger. For outputs you have combustion cyl 1+3, combustion cyl 2+4 and knock signal output.

I once retrofitted this to a Volvo 242 drift car, having the DI cassette on the firewall with plug wires to the plugs. Not elegant, but the engine ran and we used the knock signals from the ION sensing.

Having both knock signal and combustion signal outputs makes it dead easy to read both knoch and missfire on every single combustion for each cylinder.

-

Looking forward:

The Saab 9-3ss came in 2004 with "regular" coils fitted on the plugs - looking like the one you find on most modern cars today.

In between the coils and the ECU, you have a ION sensing module from Mitsubishi. I guess this does the hard work for us and supply the ECU with knock information.

This is for a 4-cyl engine only. But I guess you could run 2 modules on a 6- or 8-cyl engine, as the Elite 2500 has dual knock inputs.

This could be the key for us to tap into the world of ION sensing.

Attachments

Saab DI Cassette

ION sensing module/electronics
$_35.JPG (20.46 KiB) Viewed 3698 times

Saab 9-3 Coil

Enthalpy

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 2:24 am

This is exciting! What's the nature of the knock signal output to the ECU? Do you think this mitsu module could be used on other coils or does it require specific coil wiring, as I surmised in my original post?

danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 2:56 am

Here are the correct pin out from the old style DI cassette on Saabs.

Code: Select all

```
1 Used for monitoring the charge voltage to the capacitor (T7)
2 Trigger signal cylinder 1
3 Trigger signal cylinder 2
4 Trigger signal cylinder 3
5 Trigger signal cylinder 4
6 Ground
7 Knock sensor function
```

```
8 Combustion signal cylinders 1+2
9 Combustion signal cylinders 3+4
10 Main power from relay
```

I guess we would find something alike on the ION sensing module.

I've found very little information about the Coils and ION sensing module. Guess people haven't been digging into this that much. People don't see the advantaged having in-cylinder monitoring on high performance engines.

I know Saab's with ION sensing have to use NGK resistor spark plugs tough. Failing to use resistor plugs might fry the Coils/ION sensing stuff. It might also play a role in the ION sensing stuff too. Important to remember if you retrofit on another engine.

I have some graphs from the combustions/reading from ION sensing. Can't find it right now, but ill look it up and post back on that.

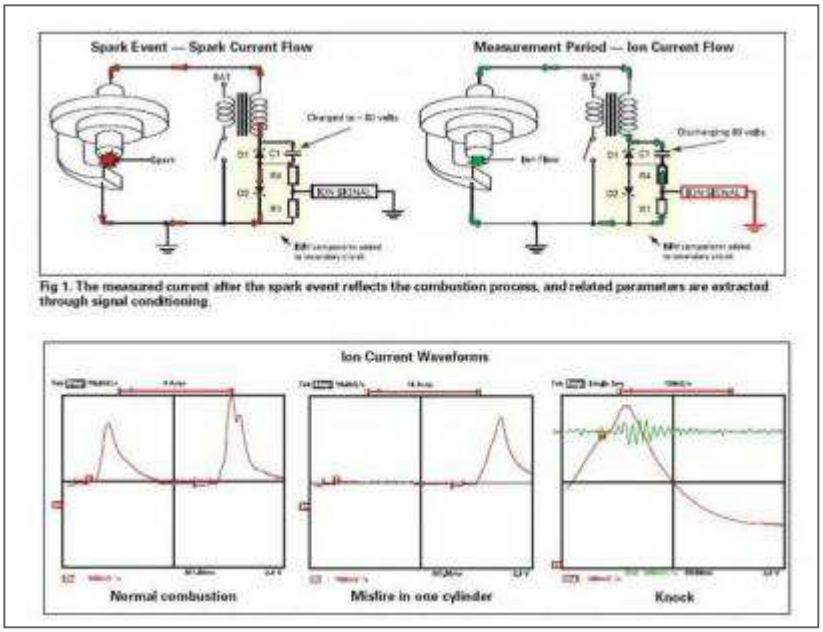
danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 3:42 am

Best I could find as of now.

No signal = missfire. And by the amplitude of the signal, you could detect knock.

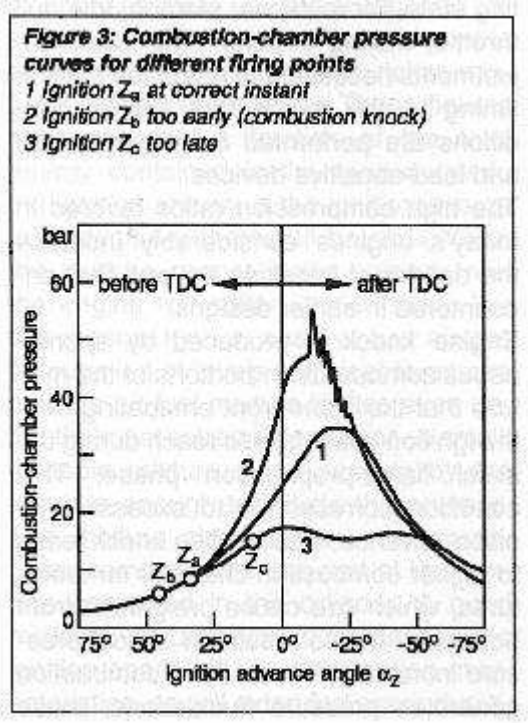


Some in-depth info:

https://dl.dropboxusercontent.com/u/247 ... IA.pdf.pdf
https://dl.dropboxusercontent.com/u/247 ... 580_LE.pdf

-

Same here: Knock generates an higher amplitude signal. Also, a ripple when it fades out, are shown.



advance_vs_pressure1131805767.jpg (32.91 KiB) Viewed 3693 times

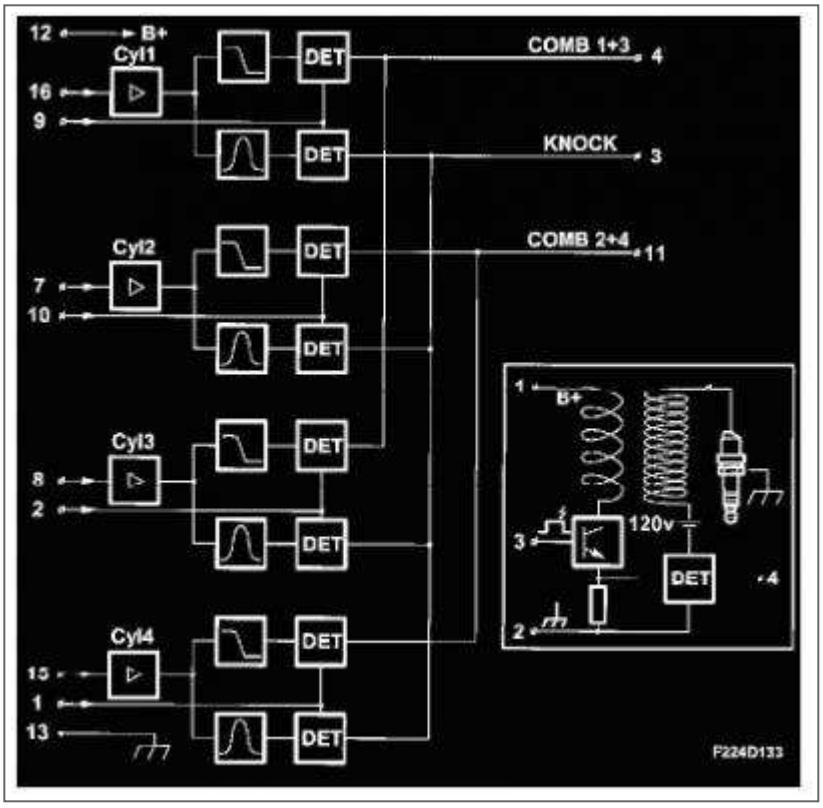
danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 5:18 am

Manage to get the pin-out for the ION sensing module. Looks like its working pretty much as the original DI cassette does, except this one triggers external coils, and thus also does the measurement on the external coil.

I read somewhere that most coils would filter out the signal we want here, so special coils might have to be used.



ION sensing module, pin-out

Enthalpy

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 5:43 am

Yes I too saw that the design of the coil is important. It's acting as an excessively strong low-pass filter.

Most coils don't expose the ground side of the secondary independent from the primary like that. Unless I want to use those specific coils, this is looking very difficult to integrate to really powerful aftermarket coils.

danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 5:51 am

True, but I've been running my older Saab 9000 with 2.2 bar boost on a Garrett GT30 turbo, making over 400hp from a 2-liter engine that originally did 150. Spark was newer an issue.

I've seen applications where they have dyno-sheets showing 700+ whp running Saab coils, so spark should not be an issue - atleast running something like these figures. I figure these would hold 1000hp on a straight six, when an inline four can produce 700+ hp with stock coils.

danibjor

Re: Q about ION Sensing for knock control - and AWD control

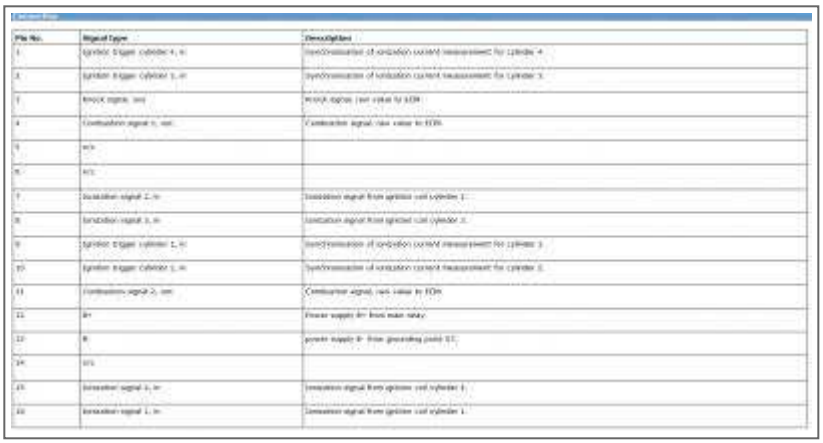
Thu Jul 30, 2015 6:10 am

Got this info from a friend of mine:

> I've seen coils with similar looks and connector on LSJ Chevy Cobalts and Ion Redlines.
> I know zzperformance.com are in the making of new, better, coils with higher power.

Edit: He also provided a screenshot from the Saab Workshop manual, with schematics for the ION module.

This seems to match up with the previous image.



Enthalpy

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 6:12 am

Impressive. I'm not sure I would want to bother with aftermarket coils as they might be changed in a fundamental way.

I might want to rethink the coils I'm using. Do you have the part numbers here?

One other thing - I'm not sure how you would get this without some involved changes to the EMS software, but if you could index the signal against calculated engine position, you could in theory find best timing without a dyno, right? Is this a pipe dream or realistic?

danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 6:22 am

I don't have the part number here.

The knock signal could possibly be plugged into the Elite's knock inputs minor changes to the firmware.

In theory, you could let the ECU do the math. You have the RAW combustion signal, and with some math, you can calculate the peak pressure point. If you know the engines optimal PPP, auto-tuning of ignition is possible. You would need fast hardware and precise measurements, but possible, yes. I can't say if the Elite is capable of this - or not. But people have done auto-ignition with ION sensing in controlled environments before. You might not trust a closed-loop solution running on a daily basis, but while tuning with supervision, yes, it is a good idea.

Enthalpy

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 7:19 am

I actually doubt you can simply plug in an analog output to the knock input. I suspect Haltech is using something like the Intersil HIP9011 or Texas Instruments TPIC8101. These ICs are relatively simple to use. During the "knock window", you latch the chip and it integrates the signal seen from the knock sensor in the designated frequency band. It then outputs an analog signal back to the micro that increases as that integration increases until the latch event lifts. Then the micro samples the output and calls that the "knock volts". Because those chips output an integrated signal and because they likely AC-couple the knock sensor, you couldn't use the knock input for this.

This is a scope trace of those chips. The int/hold signal is coming from the micro and is the "latch" I describe above. The output is the "integrator" I describe. The input is the knock sensor.

http://i163.photobucket.com/albums/t307 ... grator.jpg

If the math isn't too intensive here, an off-the-shelf relatively powerful micro contoller could easily do it. You could feed in the trigger pattern and the output of the ion sensing pin. The micro would have an output to the Haltech to pull timing on detonation detection, but it could also quite easily output the estimated position of the peak pressure point to a little LCD screen in the cabin.

The trick here is the electrical bits and getting the SNR strong enough. That takes experimentation and a budget I just don't have.

danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 7:27 am

I could do a trace of the lines and chips the signal passes trough on the original Saab ECU. Got a few spares here on the desk.. This way we could determine if this is a path worth going down. IF the signal follows a simple path in the stock ECU - and you know the trigger, then you know the window to watch and this could be doable.

danibjor

Re: Q about ION Sensing for knock control - and AWD control

Thu Jul 30, 2015 7:36 am

The knock-signal from engine is passed to the ECU, to a TLC546 8-bit AD converter, then to the main Motorola 68332 micro controller.

http://www.ti.com.cn/cn/lit/ds/symlink/tlc545.pdf

The ECU has a table that sets the window for when to look for knock. It's nothing magic going on here.

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