Supercharge! Chapter 7

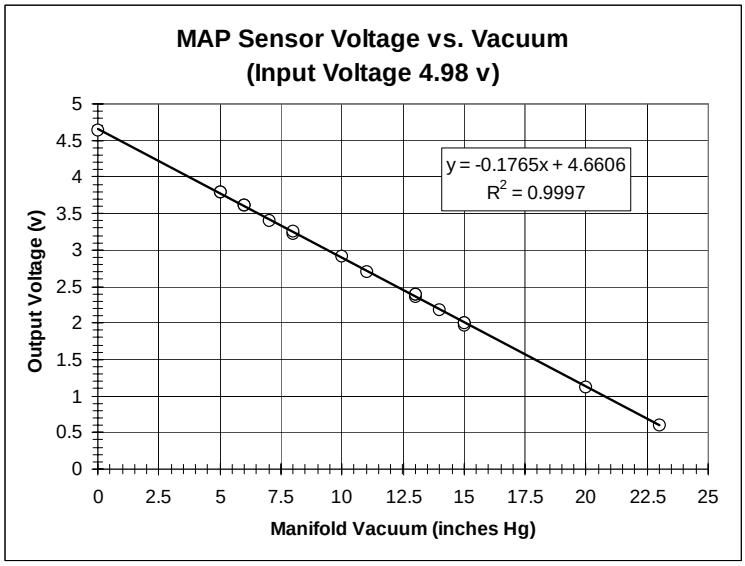
Supercharging Your Volvo Chapter Seven: "Control!" by Greg Sievert

Hi All. It's been ages since my last instalment of the supercharger project. There are probably many of you reading this now and saying "what supercharger project?" If you just joined the club, you missed out on Chapters 1-6 of the saga. I need to work with our web master to get the earlier chapters put online on our web site, but until then, I'll give a very brief background. Before I forget, I might mention that other than one of my bargain used Saab turbo hoses developing a small split, the supercharger system has performed flawlessly for over a year of driving.

It all started a couple years ago when I decided I wanted to do something a little different to extract a bit more power out of our 1988 240 GL sedan. At that point, the car had roughly 240,000 km, and was still going fine. I decided to explore supercharging, and after doing some internet research and reading, I purchased a small belt-driven supercharger from a Japanese Toyota Supra 2-litre L6 engine. The supercharger is called "SC-14" in Toyota-speak, and is the larger of the two they used in their cars. One unique aspect of the Toyota superchargers is that they have a magnetic clutch, just like your AC compressor. This allows the SC to be turned on and off with a switch, depending on whether you want maximum power or maximum economy.

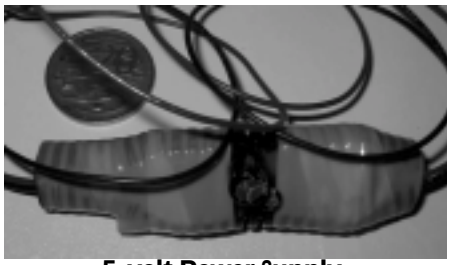
MAP Sensor (20-cent coin for size reference)

Over a period of what seemed like years (probably actually 6 months), I made up custom bracketry, hoses, belt tensioners, etc, and successfully fitted the supercharger to the 240. Additional work was done to improve fuel flow to the engine (larger fuel pump and rising rate fuel pressure regulator), but no modifications were made to the engine management system (LH 2.2, which includes knock sensing ignition retard).



Until recently, we had been happily operating the supercharger with the flick of a rocker switch in the centre console, but the plan had always been for Wayne (with his electronics background) to help me develop an "automatic" mode to switch the unit on and off. After procuring most of the parts over a period of a year or more, we finally got motivated to complete this phase of the project. The result is a very simple circuit that engages and disengages a control relay based on engine inlet manifold vacuum. Here's how it works.

The inlet manifold vacuum is measured by a MAP sensor. This is a relatively inexpensive component, about the size of a matchbox, that converts the manifold vacuum to an electronic signal that can be read by a small control box (the "black box" that Wayne built up). MAP sensors are used in many cars to provide valuable information to the engine computer, but the 240's don't use a MAP sensor, instead using a mass-airflow sensor in the inlet duct. I think I paid about $25US for the MAP sensor, but you could probably find them just as cheap in Australia as they are used on Commodores etc. The first thing we had to do was measure the MAP sensor with various vacuum levels and read the output voltage. I have a hand-held vacuum pump used for engine testing, and hooked that to the MAP sensor with an in-line calibrated vacuum gauge. The MAP sensor gets a constant 5 volt supply (more on that later) and depending on the vacuum level, it outputs a voltage between 0-5 volts. Once we figured out the calibration



5-volt Power Supply

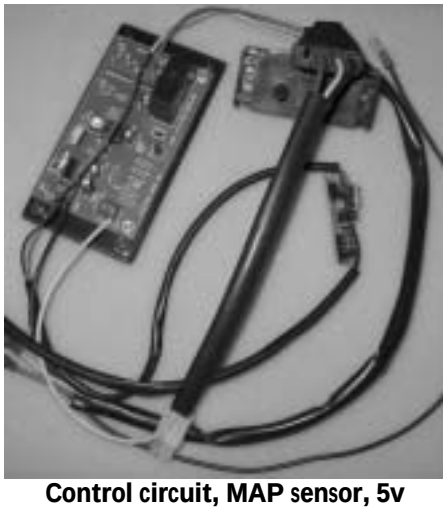
curve (just took some readings and input this into a simple Excel spreadsheet), we knew what voltage we'd want to look for when switching the supercharger on and off.

Wayne then built a small black box from a kit that was designed to switch a relay on and off, based on what voltage it sees coming in from the MAP sensor. It basically looks at the voltage and has 2 switching points, high and low, and when the voltage gets to the high or low point, it switches the relay on or off. The relay powers the electromagnetic clutch on the supercharger, consequently engaging and disengaging the supercharger drive.

To determine the cut-in point, we did a bit of experimenting in the car, and we determined that when the inlet manifold vacuum dropped to about 10

The "Black Box"

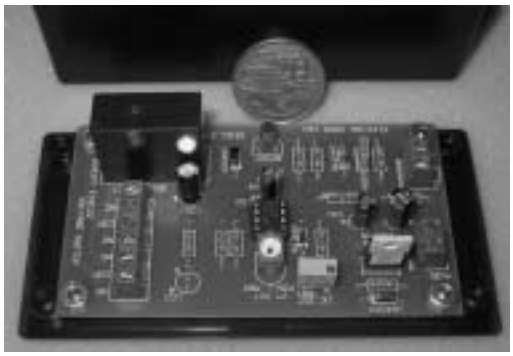
inches of mercury ("in-hg" - sorry, my gauge is imperial!) that was when we wanted to switch on the supercharger. Basically, when you put your foot down, the inlet manifold vacuum drops, so manifold vacuum is more or less a measure of how far you have the throttle open. I considered just having a micro-switch on the throttle linkage to operate the supercharger relay, but we decided that another important feature was to have the supercharger stay engaged a bit longer, even when you start to reduce the throttle opening. With the MAP sensor and black box, we were able to tell the supercharger to stay "on" until the vacuum level increased back up to about 14 in-hg. This prevents it from switching on and off rapidly at one given vacuum setting. If you just used a simple micro-switch on the throttle, you might get some unwanted switching if, for example, you had the throttle open to a point just where the micro-switch was engaged. Imagine going over a bit of a rough spot in the road, and your foot isn't 10% steady - you get the picture - supercharger switches on-off-on-off-on - not ideal. You probably could



Control circuit, MAP sensor, 5v supply and wiring. Fits easily under glove box.

prevent this by using 2 micro-switches, but it seemed like a rather unsophisticated way to do the job.

I mentioned before that the MAP sensor operates on a 5 volt input. To cope with this, Wayne built up another small circuit that converts the Volvo's 12 volts down to 5 volts for the MAP sensor. It works great when you hook it up properly - ask me how I know (hmm, why are all the wires black? Which one is which? Gee, this thing is getting hot, and no volts are coming out of it....they must all be building up inside!!) Once we got it all wired up (properly), we calibrated everything on the bench using the vacuum pump, gauge, and 5 volt power supply, and made sure the relay engaged at 10 in-hg and closed at 14 in-hg. Time to put it in the car and



Mysterious things inside Black Box

hook it up!

In addition to the automatic mode, I wanted to retain a manual mode as well, so I wired everything up to a 3-position toggle switch (no, not a rocket launcher switch!) This way we can run in economy mode (off), automatic mode or "on all the time" mode. Now for the test drive. Wow, what a transformation! It's amazing how much different the car feels when you don't have to fumble around for the "on" switch when you want a bit more oomph. Now, it's a seamless engagement of the supercharger as soon as you put your foot down, and for economy and between shifts, the magnetic clutch is disengaged automatically. Works like a dream, and we haven't even had to reconsider the on/off points. Our initial guess was spot on.

While the black box, power supply and MAP sensor are quite small, it still adds to the spaghetti of wiring under the glove box. Some day I'll have to rip out all the wiring and do it all again, putting everything in nice black sheathing and getting rid of any excess wire. I did take the opportunity to tidy up the relay "centre" near the battery.

Relay Cover

With the addition of driving lights, air horns and the supercharger, I had 3 relays mounted on what used to be the power steering reservoir bracket. Using one of the readily-available electronics project boxes from Dick Smith, I made up a cover for the relays that hides them neatly out of view, and prevents them getting wet or having the wires get knocked loose.

The next project will be finally installing that electric engine cooling fan (and removal of the belt-driven fan). Once I do that, I think I'll be able to come up with some real estate for the cold-air inlet duct. Currently, with the large fan shroud taking up half the engine bay, I'm scratching my head as to how to run the ducts without cutting a hole in the battery! Don't try that at home! For more info or questions, feel free to email me on gsievert@tpg.com.au

Regards,
Greg

PS: See the Victorian club events pages for coverage of our recent Dyno Day - I was happy with the results of the supercharger project, as I think it provided a respectable ratio of power gain-per-dollar.

Still working on that elusive Cold Air Induction!