Enhanced current sensor

4.9.2002/VV

I wasn't happy at all with my power supply, and especially its willingness to produce noise between the floating output and the ground. Well, now the problem is eliminated. The solution also simplifies the structure of the module to be connected to the spark plug.

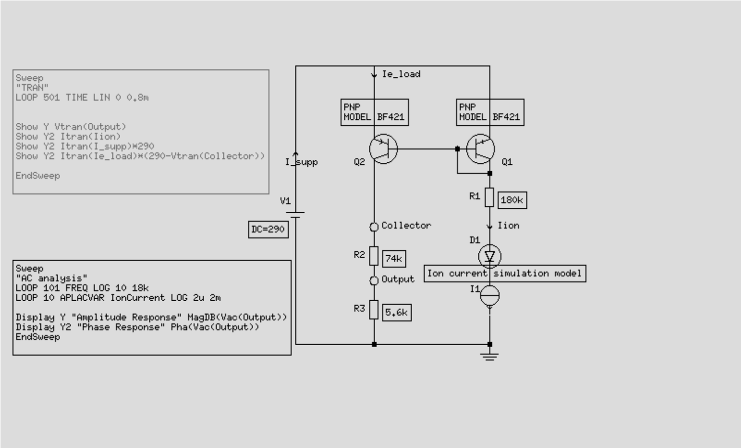

Illustration 1: Sensor, PS and spark plug

In the first pic, there's a schematic of a basic current mirror configuration that is built of two 300V PNP small signal transistors (BF421 because they were the nicest ones easily available). Then there's the good old diode (huge voltage rating, so it's actually a chain of 1000V controlled avalanche ones in a 5mm silicone tube), and a current source to simulate the ion current.

The point of the whole thing is, that no floating-output PS is needed anymore, but a simple one with a big fast cap between output and ground and good EFI shielding. The “drawback” of this solution is that either the sensing voltage is limited to the rating of the PNP, or a bypassing resistor has to be put in parallel with the Q1 to limit Vceo. The latter would cause the output signal to be offset above ground, which is apt to cause headache. So I chose the former version, and noticed, that the 290V allowed by the BF421's is well enough, giving nice current amplitude range (10uA@idle to 1.8mA at full load) when applied via the R1 current limiting resistor. Without this resistor, the module acts as the ones used in CDIs for spark duration lengthening. Well, I got 10ms ones..;) Not good.. So let's keep that resistor there to help extinguish the spark instead of discharging my 22uF capacitor through the plasma and frying Q1 with 400V@100mA rush current (Nice fireworks).

So there's the single-output non-floating PS operating at 290V max few watts, two PNP's, three 1/4W resistors and the diode chain. The diodes cathode is connected to the spark plugs hot electrode. The 'output' node gives signal swinging from ground to few dozen volts, depending on the divider of course, and the load. I've soldered the module together and it works as expected. I use it in the MSP430 system where the microcontrollers integrated ADC gets its input directly from the 'Output' pin of the sensor via a mic coax cable.

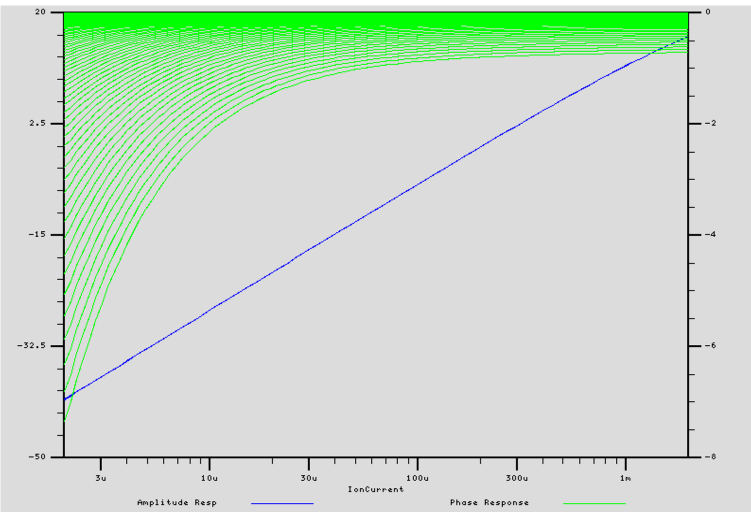

Illustration 2: Simulation results

The latter pic is from an APLAC simulation showing almost linear (u=Ri) amplitude response. The blue lines are all on top of each other, and the lowest of the green ones is at 10Hz, and the highest at 18kHz). The module isn't entirely phase linear in the current/amplitude domain, but this is not a problem, since 8 degs phase shift @ 10Hz (10Hz ion signal corresponds 120RPM..;) means 1,5 crank ° error. At more realistic points (f>100Hz, I>10u) the error is minimal.