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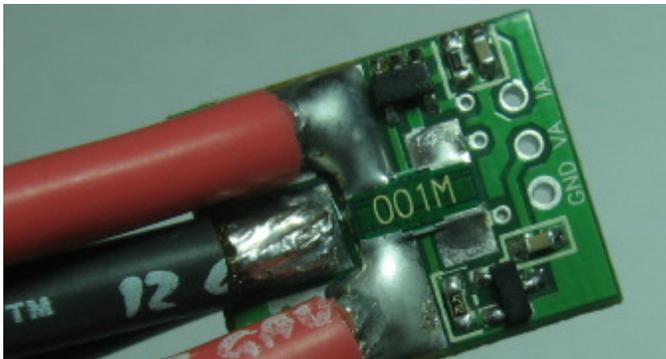
Compact DC Voltage and Current Sense PCB with Analog Output

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## Features

- Ideal range for small robotics applications:
  - 89.4 Amps<sup>1</sup>
  - 51.8 Volts
- Very low zero current offset and high sensitivity
- Analog output scaled for 3.3V ADC
- Self powered
- Compact and thin design (4 x 15 x 19mm)
- Proven in demanding UAV applications
- Measurement resolution with 12 bit 3.3V ADC:
  - 22.01 mA / bit
  - 12.65 mV / bit
- Analog Voltage Outputs / Sensed Parameter:
  - 63.69mV / Volt
  - 36.60mV / Amp



## Assembly

The PCB is supplied without leads or connectors. Care must be exercised in soldering, though the pad sizes are large enough to accommodate 12 gauge heavy duty leads (see photograph above). Smaller gauge leads are considerably easier to solder without creating shorts.

The sensed current path is from “In+” to “Out+”. It is important to completely flood this connection path through shunt resistors with solder. As-supplied, the PCB has some solder flooding in this area, but it is up to you to ensure this is maintained after soldering of leads. The shunt resistors each have four terminals in a Kelvin configuration. Two terminals carry the shunt current load, and the other two terminals are used for the voltage drop monitor INA-169.

## Description

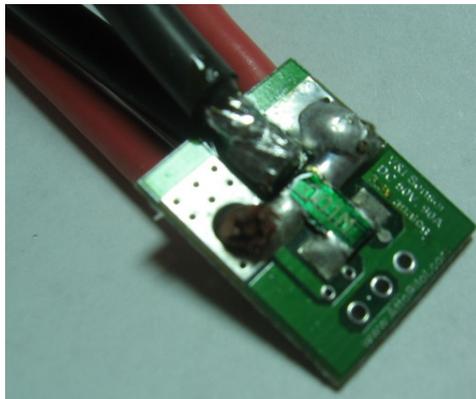
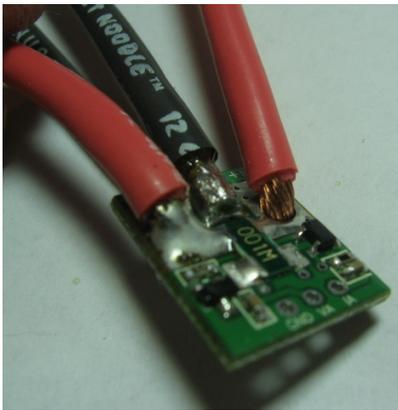
This small voltage and current sense PCB was designed for use in the AttoPilot UAV autopilot system. DC current is determined by measuring voltage drop across a pair of parallel 1 milliohm shunt resistors (0.5 milliohm together) then converted to final analog voltage output by the Texas Instruments INA-169. Voltage sense is accomplished by scaling to 3.3V ADC range by a precision resistor divider.

The current limit coincides with maximum power rating of the shunt resistors, 2 Watts each (4 Watts total).

<sup>1</sup> NOTE: Full scale 3.3V analog output of current sensing corresponds to slightly over-current condition of 90.15 Amps due to discrete nature of scaling resistor choices. Do not exceed 89.4 Amps.



Finally, place the other “+” lead through its via hole, solder flood top and bottom:



## Connection to ADC and Use

There are three 0.1” spaced plated through holes labeled “GND”, “VA” and “IA”. VA is the analog output for voltage sensing, and IA is analog output for current sensing, and both are relative to GND. The scaling was chosen to interface directly with a 3.3V ADC for the AttoPilot (MCP3208 12 bit ADC to be exact). You may use this sensor directly with a 5V ADC, however some resolution will be lost relative to a 3.3V 12 bit ADC unless a higher bit ADC is used. For scaling factors refer to “Features” table at the top of page 1 of this document.

The analog outputs each contain a 0.1uF bypass capacitor, but no series resistor. To complete an RC filter into the ADC inputs, you may wish to place a low value resistor between the ADC inputs and IA/VA outputs. 220 Ohm should suffice though is not necessary.

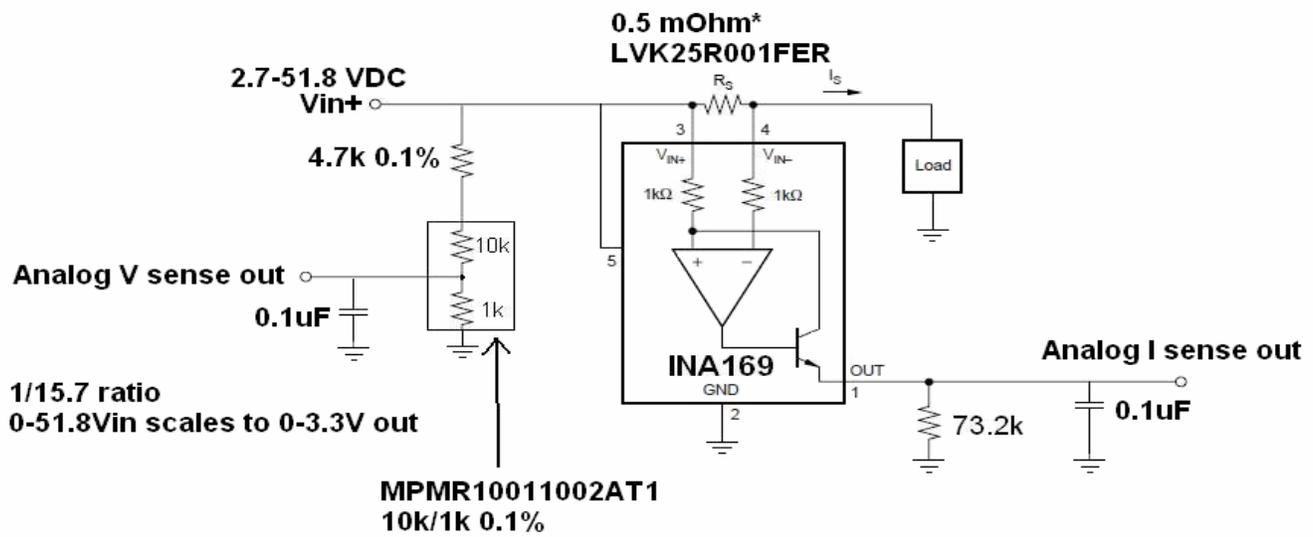
The shunt resistors need adequate cooling airflow above 60 Amps. Power dissipation by the shunt resistors is:

$$\text{Power} = I^2R \quad \text{where } R = 0.0005 \text{ Ohms, power is in Watts, and current in Amperes.}$$

The upper power limit of each shunt is 2 Watts for a total of 4 Watts in their parallel configuration. The upper current limit is computed by solving the equation above for I with  $R = 0.0005$  Ohms and  $\text{Power} = 4$  Watts.  $I = (4 \text{ Watts} / 0.0005 \text{ Ohms})^{0.5} = 89.44$  Amps.

## Absolute Maximum Ratings

Operating Temperature.....	-55 to +125 Centigrade
Voltage with 3.3V ADC.....	-0.3V to 51.8V (upper limit set to not exceed 3.3V output)
Voltage with 5V ADC.....	-0.3V to 60V (upper limit set to not exceed INA169 limit)
Current.....	89.4 Amps (upper limit set by shunt resistor)



\* (2x 1mOhm in parallel, top and bottom of PCB)

**Voltage and Current Sense**  
51.8V, 92.6A

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