Compact DC Voltage and Current Sense PCB with Analog Output

Features

- New! Three Ideals ranges for small robotics applications:
  - New 50 V / 180 Amps
  - 50 V / 90 Amps[1]
  - New 13.6 V / 45 Amps
- Low zero current offset and high sensitivity
- Analog output scaled for 3.3V ADC
- Self powered
- Compact thin design (4 x 15 x 19mm)
- Analog Voltage Outputs for Sensed Parameters:
  - 50V/180A = 63.69mV / Volt 18.30mV / Amp
  - 50V/90A = 63.69mV / Volt 36.60mV / Amp
  - 13.6V/45A = 242.3mV / Volt 73.20mV / Amp
- New! Re-designed to accept direct solder connection with Deans Ultra™ connectors

Description

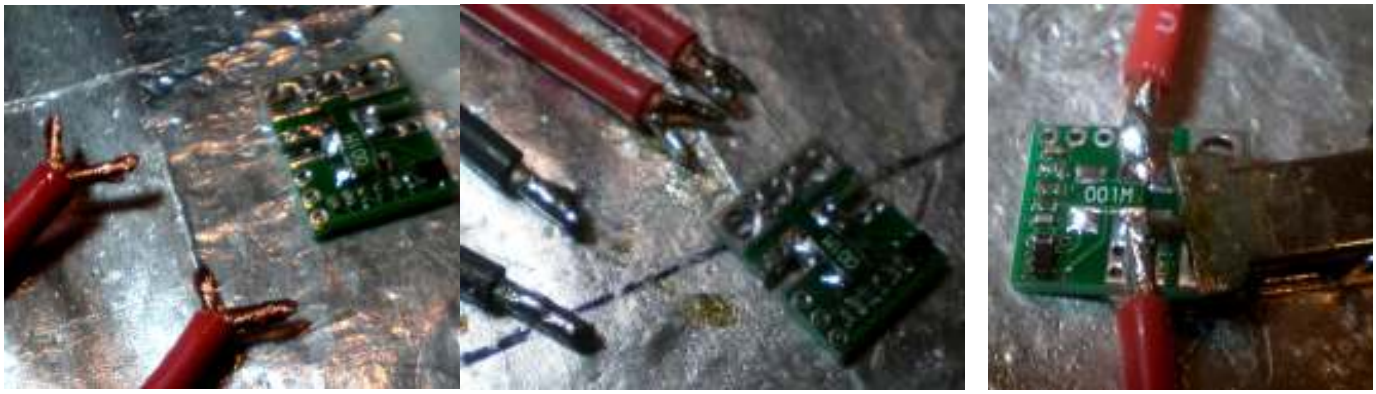
A small voltage and current sense PCB. DC current is determined by measuring voltage drop across a shunt resistors then converted to analog voltage output by the Texas Instruments INA-169. Voltage sense is accomplished by scaling to 3.3V ADC range by a precision resistor divider.

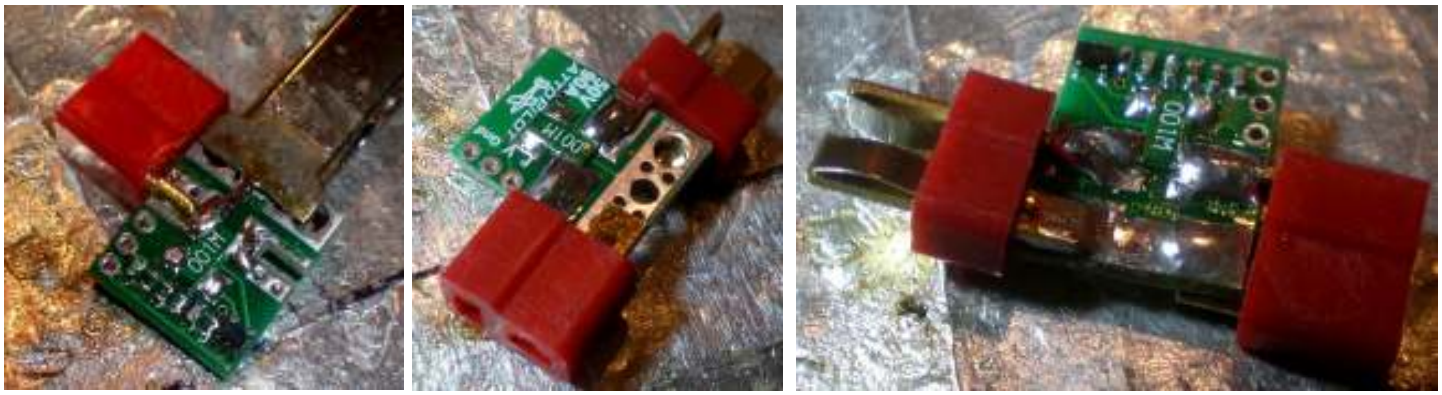
The current limit coincides with maximum power rating of the shunt resistors.

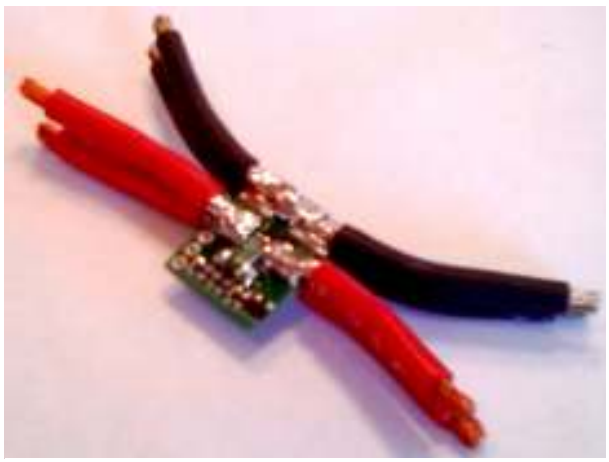
Assembly

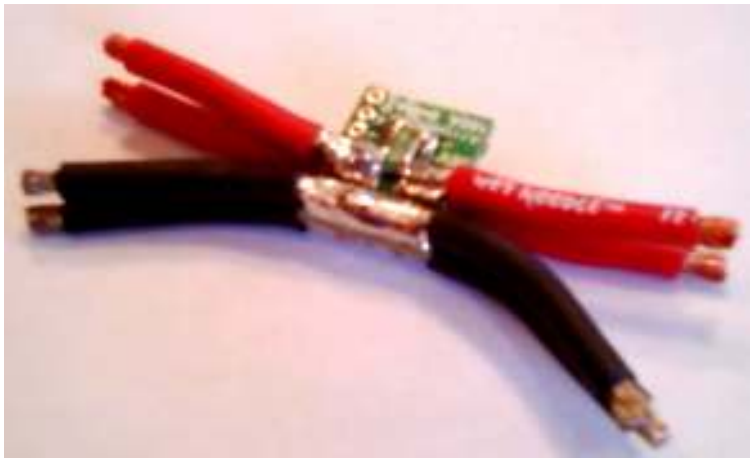
The PCB is supplied without leads or connectors. Care must be exercised in soldering, though the pad sizes are large enough to accommodate 12 gauge heavy duty leads (see photograph below). Smaller gauge leads may be easier to solder without creating shorts.
The sensed current path is from "In+" to "Out+". It is important to completely flood this connection path through shunt resistors with solder, *on both sides* of the PCB. As-supplied, the PCB has some solder flooding in this area, but it is up to you to ensure this is maintained after attachment 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.

It is important that both shunt resistors carry equal current load for sensor accuracy. To ensure equal current load, the solder pads have a large via holes through which the leads must pass through then be flooded with solder. Pass the "In+" and "Out+" leads through the large via holes and solder flooded on top and bottom of the PCB. The "GND" pads also have a large via hole however large current does not flow through the PCB from the GND leads; the PCB "GND" pad is merely a small current common GND connection. The large current flow in GND is from one lead to the other through the pad and solder-flooded via hole itself.









180 Amp Sensor – Recommended Lead Arrangement

For the 180 Amp sensor, it is recommended to use doubled pairs of 12 gauge wire, as shown above.

Figure 1 Schematic

Connection to ADC and Use

There are three 0.1” spaced plated through holes labeled “**GND**”, “**V**” and “**I**”. **V** is the analog output for voltage sensing, and **I** is analog output for current sensing. **V** and **I** are both relative to **GND**. 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 **I** analog output contains a 0.1uF bypass capacitor, but no series resistor. To complete an RC filter into the ADC inputs, you may place a low value resistor between the ADC inputs and **I** output. The **V** output has a resistance of 14.7kΩ between the sensed drain and analog output with 0.1 uF bypass capacitor for an approximate bandwidth of 108 Hz, via the equation $1/(2\pi RC)$

The shunt resistors typically need no cooling airflow as the copper leads provide a facile pathway for heat loss. Power dissipation by the shunt resistors is:

$$\text{Dissipated Power} = I^2 \times R$$

For the “90A” device R = 5×10^{-4} Ohms, power 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 Power = 4 Watts. I = $(4 \text{ Watts} / 0.0005 \text{ Ohms})^{0.5}$ = 89.44 Amps. Max amps for “45A” “180A” parts below.

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…….….44.7 / 89.4 / 178.8 Amps (upper limit set by shunt resistor)