Features

- Ideal range for small robotics applications:
  - 89.4 Amps
  - 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

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 miliohm shunt resistors (0.5 miliohm 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).

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.

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.
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.

Begin by feeding un-tinned lead through via of “In+” or “Out+”, then solder flood both top and bottom pads of PCB, especially the path to the shunt resistor terminals (next 6 photos).

Next, tin two leads for GND, and fill in the GND via with solder. Solder the GND leads to the pad by application of heat from above the lead. The solder flooded via is the high current path between GND leads:
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:

\[ \text{Power} = I^2R \]

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 \( R = 0.0005 \text{ Ohms} \) and \( \text{Power} = 4 \text{ Watts} \).

\[ I = \left( \frac{4 \text{ Watts}}{0.0005 \text{ Ohms}} \right)^{0.5} = 89.44 \text{ Amps} \]

**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)
2.7-51.8 VDC

Analog V sense out

0.1\mu F

1/15.7 ratio

0-51.8V_in scales to 0-3.3V out

MPMR10011002AT1
10k/1k 0.1%

0.5 mOhm
LVK25R001FER

INA169

Load

Analog I sense out

73.2k

0.1\mu F

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

Voltage and Current Sense
51.8V, 92.6A

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