

Low-Side Low Cost Current Sense Amplifier

Introduction

The ISL28130ISENSEV1Z evaluation board is designed specifically for low-side current sensing up to 10A of current. The evaluation board uses a 1mΩ current sense resistor that is capable of handling 4W of power dissipation. The ISL28130 low cost micro-power amplifier gains the current sensing input signal and can be used to directly drive ADC inputs.

The ISL28130ISENSEV1Z evaluation board is optimized to operate at +5V. An ISL21010 micro-power 2.5V voltage reference sets a zero current reading of 2.5V at the amplifier output to interface with ADCs operating at 5V. The voltage reference raises the common mode input by approximately 40mV above GND at zero current flow. This connection enables bi-directional current sensing, allowing the sense voltage to be positive or negative relative to the common mode voltage. This is helpful for applications such as the charging/discharging current from an Electric Vehicle battery or motors that switch polarity.

With the input common mode at 40mV above ground and a 1mΩ sense resistor, this allows ±40A current sensing before amplifier saturation. However, due to PCB copper resistance causing error at high currents, the recommended current sense is ±10A.

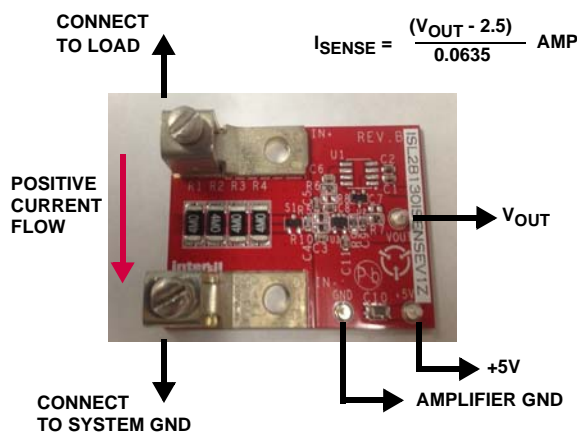


FIGURE 1. ISL28130ISENSEV1Z EVALUATION BOARD

Board Layout

The evaluation board is laid out with heavy duty screw lug terminals that allow connections of wires up to 6 AWG. The 1mΩ sense resistance is formed from four 4mΩ 2512 style resistors to increase power dissipation capacity of the sense circuitry. The total power dissipation critically allowed is 4W. The PCB board is made using 2oz copper PCB with the current path routed on the top and bottom layer, minimizing trace resistance to maintain accurate current sense resistance. To further reduce sense errors, the current sensing uses a Kelvin connection with the sense voltage pick up points at the center of the current density distribution.

Amplifier U3 gains up the voltage drop developed across the sense resistor from the current flow. The voltage Reference U2 sets the zero current reading output of the amplifier at 2.5V.

Quick Setup Guide

1. Connect single supply +5VDC to +5V and GND terminals.
2. Connect low-side load to terminal lugs. Current flow from top to bottom of board.
3. At no load, V_{OUT} is 2.5V.
4. With 1mΩ sense resistance and amplifier gain of 63.5V/V, the sense current reading is: $(V_{OUT} - 2.5V) / 0.0635$ in Amps.

REF	PART NUMBER	COMMENTS
U1	DNP	Not Populated On Board
U2	ISL21010	Micropower 2.5V Voltage Reference
U3	ISL28130	Micropower Low Cost Amplifier

CURRENT SENSE SPECIFICATIONS	
Supply Voltage Range	3.0V to 5.0V Optimized for 5V Operation
Max Sense Current	±10A recommended ±40A Before Amplifier Saturation
Abs Max Sense Current	60 Amps Thermally Limited by Sense Resistor
Current Sense Resolution	±10mA
Current Sense Accuracy	2%
Voltage to Current Conversion	$I_{SENSE} = (V_{OUT} - 2.5V) / 0.0635$ Amps
Amplifier Bandwidth	5kHz

Measuring Very High Current

The reference design is capable of sensing currents greater than ±40A, however, it is limited mechanically from the temperature rise of the copper PCB layout and current sense resistor and limited electrically by amplifier saturation. One must consider the temperature rise of the PCB trace from the power dissipated under high currents, which may cause the copper trace to delaminate. The high current carrying PCB trace is made with 2oz copper on FR4 board both top and bottom layers. The trace dimension is approximately 25mm width and 40mm length. Substantial vias are used to connect the planes for lower thermal impedance. The current sense resistance is capable of 4W dissipation maximum.

Bill of Materials

PART NUMBER	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
DNP	U1	DO NOT POPULATE OR PURCHASE		
ISL21010CFH325Z	U2	Low Power 2.5V Voltage Reference, SOT23	INTERSIL	ISL21070CFH325Z
ISL28130FHZ	U3	Low Power Low Cost Amplifier, SOT23	INTERSIL	ISL28130FHZ
H1045-00101-50V5-T	C8, C9	CAP, SMD, 0603, 100pF, 50V, 5%, COG, ROHS	GENERIC	
H1045-00102-50V5-T	C4	CAP, SMD, 0603, 1000pF, 50V, 5%, COG, ROHS	GENERIC	
H1045-00103-50V10-T	C1, C3, C5, C6, C11	CAP, SMD, 0603, 0.01μF, 50V, 10%, X7R, ROHS	GENERIC	
H1045-00104-50V10-T	C2	CAP, SMD, 0603, 0.1μF, 50V, 10%, X7R, ROHS	GENERIC	
H1045-DNP	C7	CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS		
H1065-00475-50V10-T	C10	CAP, SMD, 1206, 4.7μF, 50V, 10%, X5R, ROHS	GENERIC	
BAV99LT1G-T	S1	DIODE-SWITCHING, SMD, SOT23, 70V, 0.2A, ROHS	ON SEMICONDUCTOR	BAV99LT1G
H2511-00R00-1/10W-T	R7	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	GENERIC	
H2511-01623-1/10W1-T	R6, R9	RES, SMD, 0603, 162k, 1/10W, 1%, TF, ROHS	GENERIC	
H2511-02551-1/10W1-T	R5, R10	RES, SMD, 0603, 2.55k, 1/10W, 1%, TF, ROHS	GENERIC	
H2511-DNP	R8	RES, SMD, 0603, DNP-PLACE HOLDER, ROHS		
H2515-0R004-1W1-T	R1-R4	RES, SMD, 2512, 0.004Ω, 1W, 1%, TF, ROHS	GENERIC	

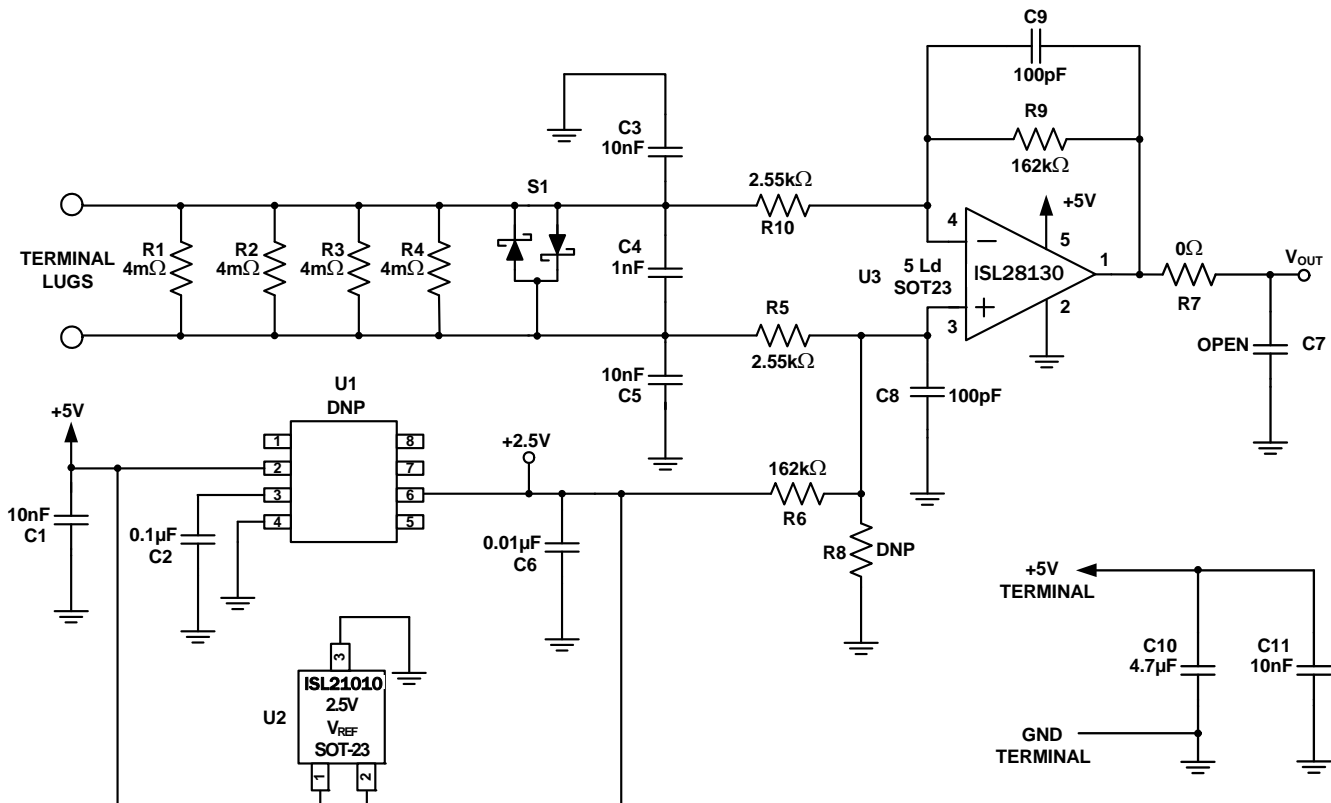


FIGURE 2. CURRENT SENSE AMPLIFIER SCHEMATIC

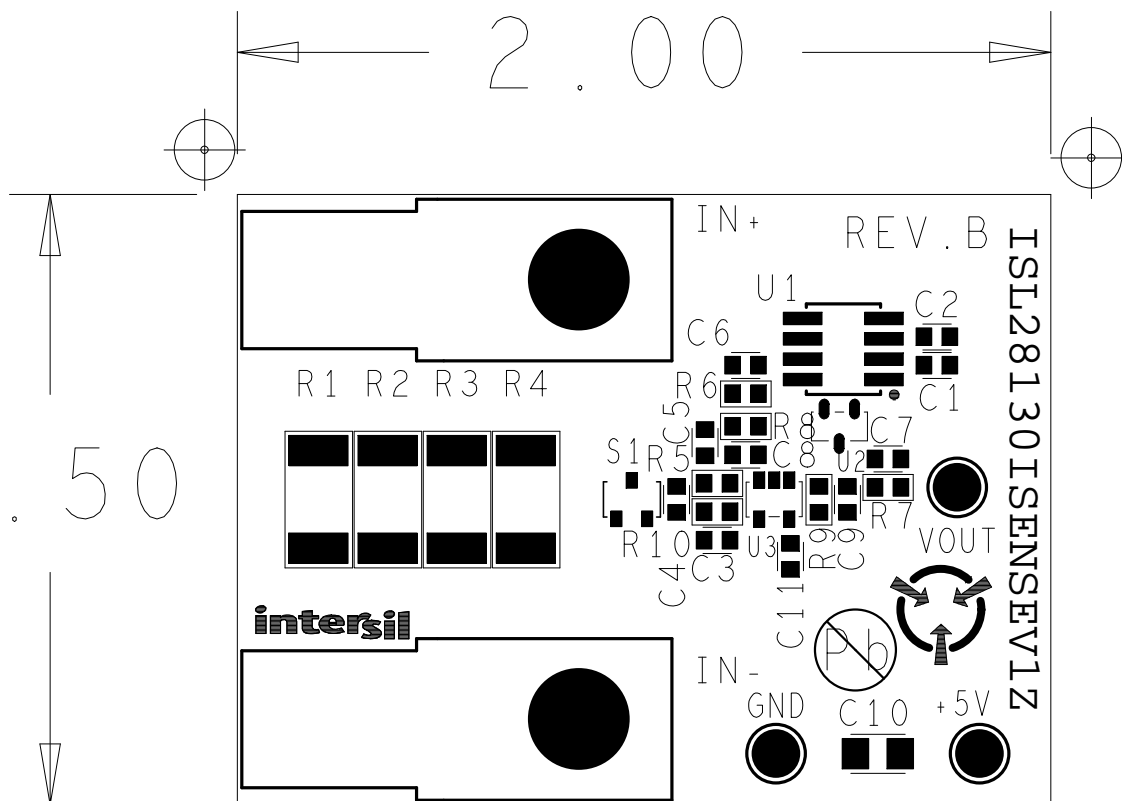


FIGURE 3. CURRENT SENSE AMPLIFIER ASSEMBLY DRAWING

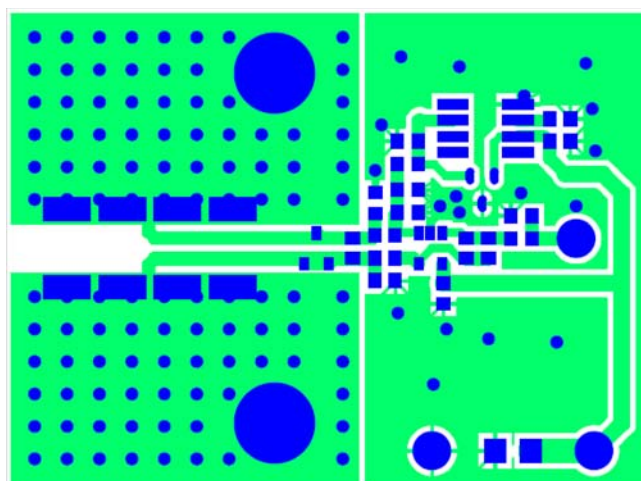


FIGURE 4. PCB TOP LAYER

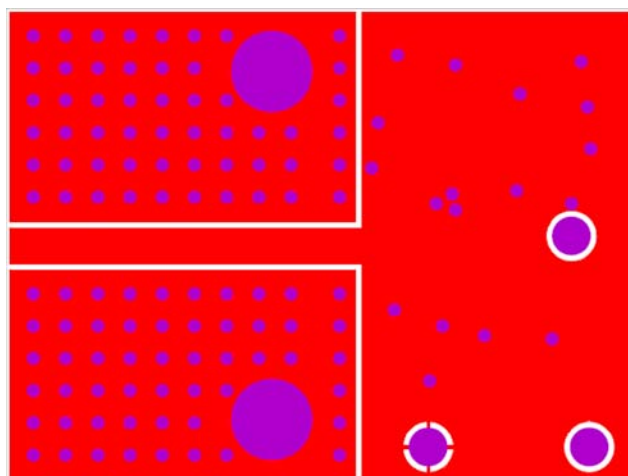


FIGURE 5. PCB BOTTOM LAYER

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