

ISL28130ISENSEV1Z

Low-Side Low Cost Current Sense Amplifier

AN1883

Rev 0.00

September 24, 2013

**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.

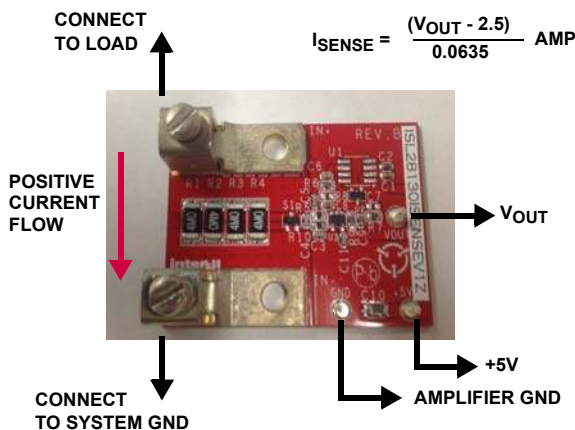


FIGURE 1. ISL28130ISENSEV1Z EVALUATION BOARD

**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<sub>OUT</sub> is 2.5V.
4. With 1mΩ sense resistance and amplifier gain of 63.5V/V, the sense current reading is: (V<sub>OUT</sub> - 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	$I_{SENSE} = (V_{OUT} - 2.5V) / 0.0635 \text{ Amps}$
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	

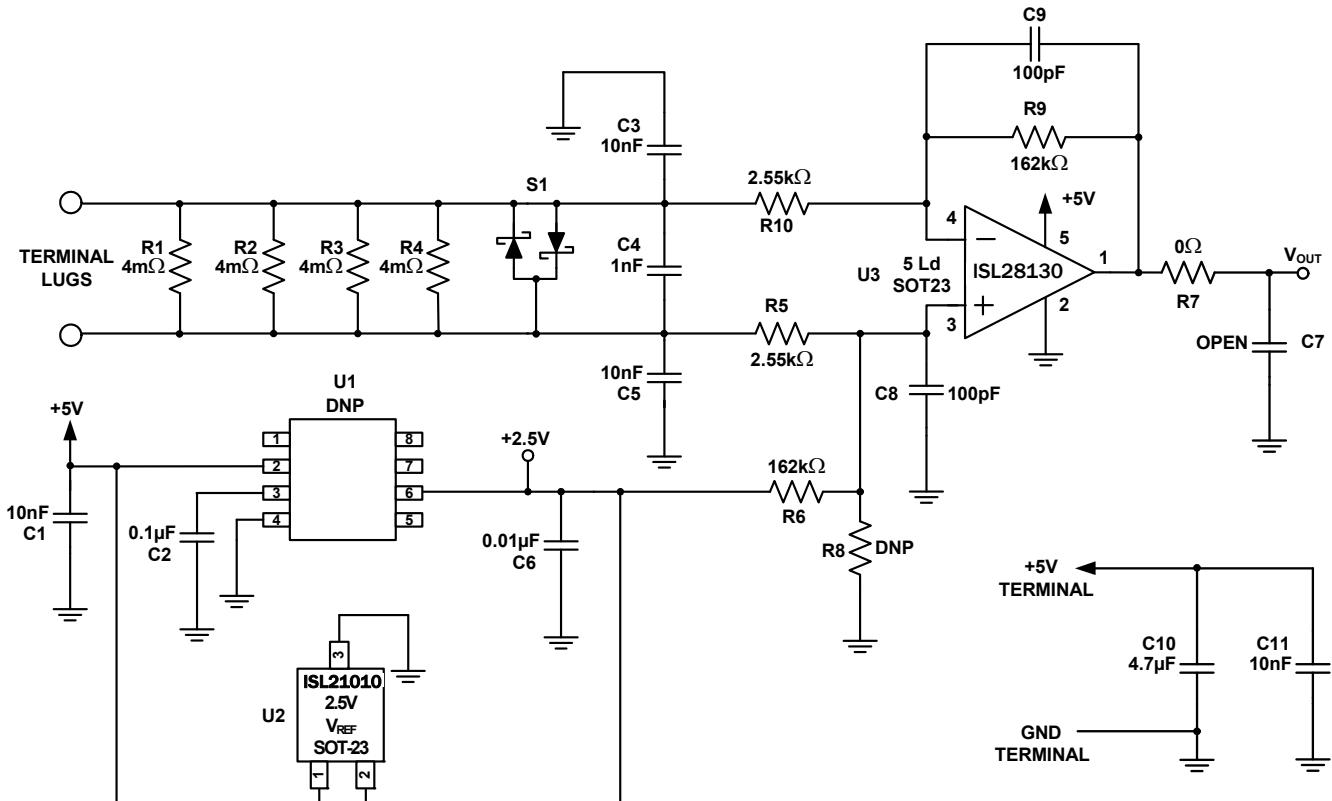


FIGURE 2. CURRENT SENSE AMPLIFIER SCHEMATIC

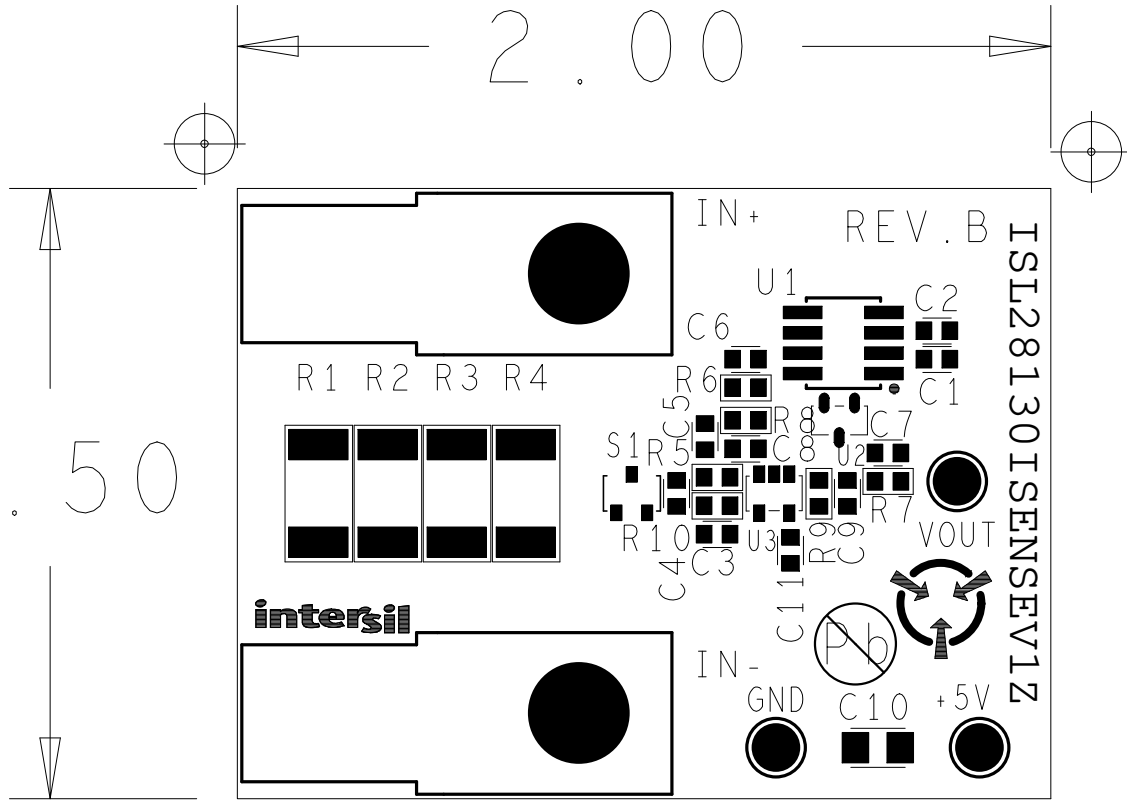


FIGURE 3. CURRENT SENSE AMPLIFIER ASSEMBLY DRAWING

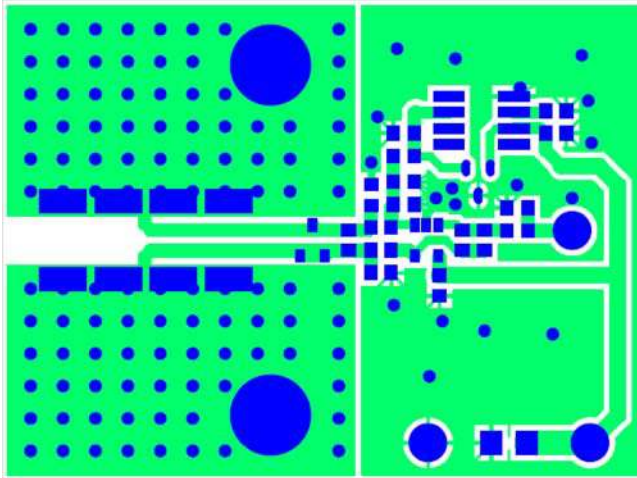


FIGURE 4. PCB TOP LAYER

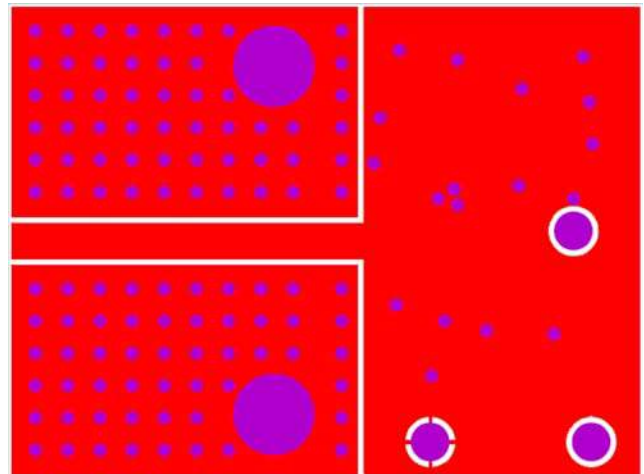


FIGURE 5. PCB BOTTOM LAYER

## Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.  
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.  
Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.  
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.  
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)



### SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

**Renesas Electronics America Inc.**  
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.  
Tel: +1-408-432-8888, Fax: +1-408-434-5351

**Renesas Electronics Canada Limited**  
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3  
Tel: +1-905-237-2004

**Renesas Electronics Europe Limited**  
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K  
Tel: +44-1628-651-700, Fax: +44-1628-651-804

**Renesas Electronics Europe GmbH**  
Arcadiastrasse 10, 40472 Düsseldorf, Germany  
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

**Renesas Electronics (China) Co., Ltd.**  
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

**Renesas Electronics (Shanghai) Co., Ltd.**  
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China  
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

**Renesas Electronics Hong Kong Limited**  
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
Tel: +852-2265-6688, Fax: +852-2886-9022

**Renesas Electronics Taiwan Co., Ltd.**  
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan  
Tel: +886-2-8175-9600, Fax: +886-2-8175-9670

**Renesas Electronics Singapore Pte. Ltd.**  
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949  
Tel: +65-6213-0200, Fax: +65-6213-0300

**Renesas Electronics Malaysia Sdn.Bhd.**  
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

**Renesas Electronics India Pvt. Ltd.**  
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India  
Tel: +91-80-67208700, Fax: +91-80-67208777

**Renesas Electronics Korea Co., Ltd.**  
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5338