User's Manual

ISL81601-US011REFZ

User's Manual: Reference Board

Solar Battery Charger with MPPT

Renesas Electronics Corporation
www.renesas.com

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For Your Safety

Do not fail to read this manual before using the board

- Follow the indications in this manual when using the board
- Keep this manual near the board so you can refer to it whenever necessary.
- Transfer or sale of the board to third parties is prohibited without written approval.
- The purchaser or importer of the board is responsible for ensuring compliance with local regulations. In addition, the customer is responsible for ensuring that the board is handled correctly and safely, in accordance with the laws of the customer's country (region).
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■ Danger Items

Warning	
	Always insert plugs, connectors, and cables securely, and confirm that they are fully inserted. • Incomplete connections could cause fire, burns, electric shock, or injury.
	Use the power supply apparatus specified in the manual. • Failure to do so could cause fire, burns, electric shock, injury, or malfunction.
	Disconnect the power supply and unplug all cables when the system will not be used for a period of time or when moving the system. • Failure to do so could cause fire, burns, electric shock, or malfunction. • This will protect the system against damage due to lightning.
	Use a mechanism (switch, outlet, etc.) located within reach to turn off (disconnect) the power supply. • In case of emergency, it may be necessary to cut off the power supply quickly.
	Turn off the power supply immediately if you notice abnormal odor, smoke, abnormal sound, or overheating. • Continuing to use the system in an abnormal condition could cause fire, burns, or electric shock.
	Do not integrate the product or any part of it into other equipment. Do not insert or remove cables or connectors when the product is powered on. • The product has no safety case. • Failure to observe the above could cause fire, electric shock, burns, or malfunction. • The product may not perform as expected if used for other than its intended purpose.

■ Caution Items

Caution	
	Before modifying any part of this product, carefully check the manual. • Incorrect modification or retrofitting may cause heat generation and device failures.
	Follow the procedure specified in the manual when powering the system on or off. • Failure to do so could cause overheating or malfunction.
	Use the cable that is less than 3m in length to be connected to the product. • Failure to do so could cause device failures or malfunction by external noise.
	Caution – Static Electricity • Use the antistatic band. Failure to do so could cause malfunction or unstable motion.

ISL81601-US011REFZ

Solar Battery Charger with Maximum Power Point Tracking (MPPT) Reference Board

The Renesas ISL81601-US011REFZ solar battery charger board with MPPT uses energy from a solar panel (user provided) to charge a standard 12V lead acid battery. The MPPT software maximizes the power drawn from the solar panel, and the RL78/G14 microcontroller (MCU) controls the output voltage to follow a safe charging profile for the lead acid battery.

The ISL81601-US011REFZ reference boards are designed to provide a quick and easy method for creating a solar battery charger using the ISL81601 buck-boost controller, RL78/G14 MCU, ISL80410 linear regulator, and ISL28413 quad op-amp.

Key Features

- Up to 40V_{IN} and 60V_{OUT}
- Capable of 10A+ output
- Programmable output to match battery requirements up to 60V
  - Currently optimized for 12V, 8Ah lead acid battery
  - Automatically goes to float mode to maintain battery after a full charge
- Maximum power point tracking in software optimizes the power from the solar panel
- Integrated protection features include overcurrent, overtemperature, over/undervoltage, and reverse polarity protection

Board Specifications

- V_{IN}: 8V to 40V
- V_{OUT}: Bulk Charge = 14.5V @ up to 7A, Float Mode = 13.6V @ <= 0.7A

Ordering Information

Part Number	Description
ISL81601-US011REFZ	Solar Battery Charger with MPPT

Related Literature

For a full list of related documents, visit our website:

- US011 Solar Battery Charger Winning Combination
- ISL81601 device page
- RL78/G14 device page
- ISL80410 device page
- ISL28413 device page
- ISL28022 device page

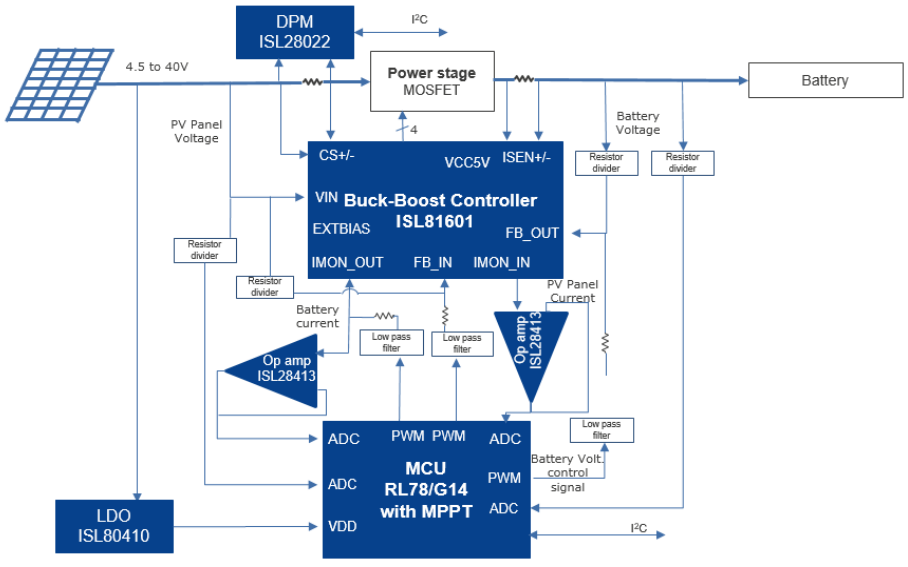


Figure 1. ISL81601-REFZ Block Diagram

1. Functional Description

The ISL81601_US011REFZ utilizes the ISL81601 buck-boost controller to convert the voltage from an external solar panel into the appropriate voltage to charge a 12V lead acid battery. RL78/G14 MCU gathers telemetry data and uses it to manage the controller and follow the battery charging algorithm. The MCU is powered by the ISL80410 linear low dropout regulator (LDO), and the ISL28413 quad op-amp buffers and amplifies signals between the buck-boost controller and the MCU. The ISL28022 digital power monitor is an optional addition for systems that require higher precision current measurements.

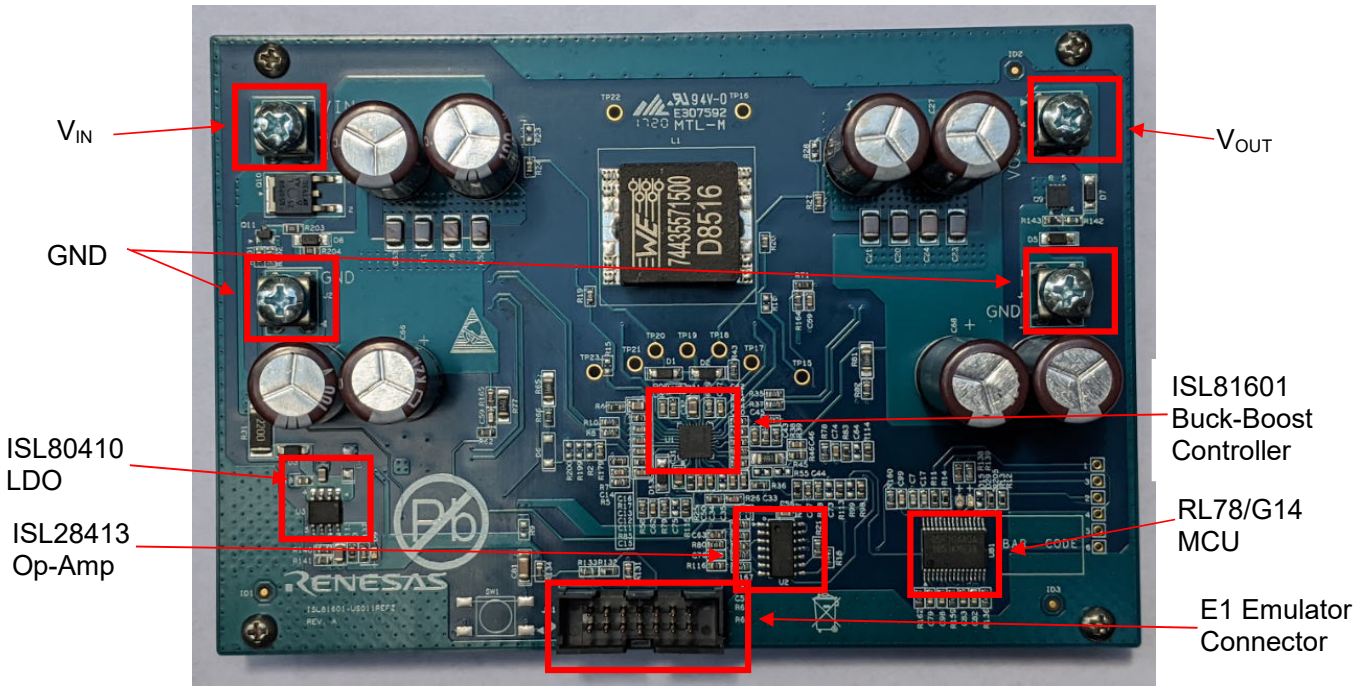


Figure 3. Board Devices and Connections

1.1 Operating Range

The ISL81601-US011REFZ board will operate with an input voltage between 8V to 40V. This voltage range is set to accommodate most standard solar panels. The 8V and 40V limits are set for undervoltage lockout protection and maximum voltage on the linear regulator.

1.2 Quick Start Guide

Using the board:

1) Start by connecting the wires from the solar panel to the screw down terminals on the input of the board. The J1 connector is V_{IN} and J2 is GND. The D9 red LED will light up indicating the MCU is receiving power.

Figure 3. Input Connections

2) The RL78/G14 turns on the D29 green LED to show it is active and initializes the board. Once all systems are nominal, the D15 yellow LED begins to blink.

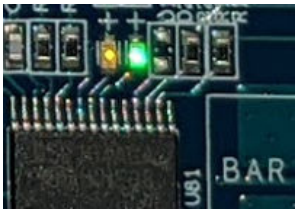
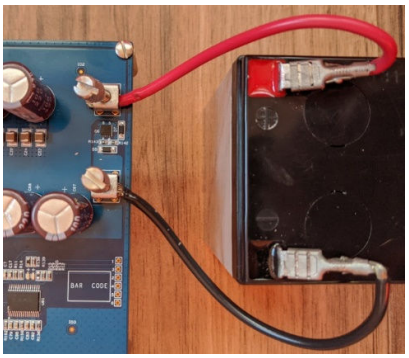


Figure 4. LED Active Status Indication

3) Connect the battery to the output of the board via the J4 (V_{OUT}) and J5 (GND) screw down terminals. The output voltage is monitored by the MCU and the controller is enabled when the voltage is above 8V. Once operational, the output voltage and current are measured to determine the appropriate charging stage and battery charging proceeds accordingly.



NOTE: please ensure the battery is a standard 12V lead acid battery in good operating condition.

Figure 5. Battery Connections

4) Battery charging goes through three different stages depending on the battery power level.

a) In the bulk stage, the output of the ISL81601 is set to 14.5V and the battery pulls this voltage lower as it charges with a fixed 7A max current. The yellow LED is constantly on. In this stage, MPPT is running to maximize the power from the solar panel. Once the battery stops pulling V_{OUT} down, the current starts to decrease and the system enters the absorption stage. MPPT is turned off for this stage. The third stage activates when the output current drops below 700mA, and is the float stage. MPPT remains off and the output voltage is decreased to 13.6V. The battery is fully charged once it hits float stage and can remain on the charger in float stage indefinitely or be removed from the system as desired. The yellow LED once again blinks slowly to indicate the system is in float mode.

Note: if the solar panel is incapable of delivering 0.7A due to weather conditions, the system will measure the voltage on Vout to determine if it should enter float stage or stay in bulk mode. If the battery voltage stays near 13.6V (Vout for float stage) while pulling less than 0.7A, it is assumed the battery is fully charged.

CAUTION: Do not interrupt the MCU during operation (i.e. reset or stop using E1 emulator) as this can lead to board damage.

2. Default Configuration Settings

The ISL81601-US011REFZ is set to charge a 12V, 8Ah lead acid battery.

Table 1 shows the default configurations in software.

Table 1. Default Configurations

Spec.	Value	Comments
Input Overvoltage	42V	Output disabled if exceeded
Input Undervoltage	7.5V	Output disabled is lower than this value
Over Temperature	100 C	Output disabled if exceeded
Output Overvoltage	15V	Output disabled if exceeded
Output Undervoltage	7.5V	Output disabled is lower than this value
Bulk Stage Voltage	14.5V	V_{OUT}
Bulk Stage Current	7A	Maximum current limit, set to constant current
Absorption Stage Voltage	14.5V	V_{OUT}
Float Stage Voltage	13.5V	V_{OUT}
Float Stage Current	0.7A	Threshold to enter float state

3. Revision History

Rev.	Date	Description
0.00	TDB	Initial release

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