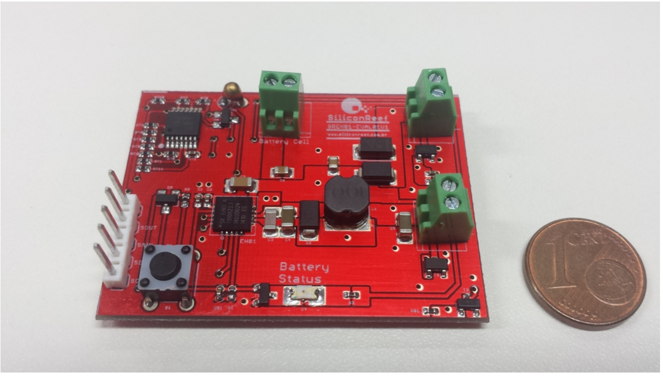
SREH01-EVAL01

2.5 W wide input range solar charger using EH01



Features

- Input voltage from 4.0V to 7V
- Input current up to 1.5A
- Output voltage 5V@500mA
- Complete all-in-one management of energy-harvesting process
- Works with both solar or conventional wall adapters
- Battery cell temperature monitor
- Regulated USB output, compliant with ITU – L.1000 standard for universal charger solution
- Serial Communication Interface
- Operation mode consumption less than 5mW
- Total conversion efficiency greater than 90%
- Stand-by consumption less than 500µW
- PCB: 49mm x 36mm double side PCB

Description

The SREH01-EVAL01 is design to provide the best tradeoff between size, cost and performance for solar charger devices. The small board and low component count are achieved thanks to the use of EH01's features, that already include complete Li-Ion battery power management, output voltage regulation and status interface.

Among the basic elements within the SREH01-EVAL01, the Battery Status LED and push-button are the ones that actually interact with the user. The LED indicates the amount of charge stored at the battery. The number of times the LED blinks represents the percentage of the charge level stored in the battery. Thus, 1 blink indicates up to 20%, 2 blinks up to 40%, and so on. Once the push-button is pressed the LED becomes active. Furthermore, the board contains a serial communication interface that allows the user to check battery voltage level and battery charging/discharging state (refer to datasheet).

The board allows for higher input voltage (up to 7V) than the specified for the EH01 chip (5.6V) due to the presence of a zener diode. Furthermore, the system is able to withstand higher input currents (1.5A) than the IC specified (1.2A) due to proper routing and pin distribution. Both of these features allow for higher versatility and flexibility regarding the input photovoltaic cell selection and target application.

For proper operation, the interconnection wires for both the battery and the application load should be kept as short and as wide as possible in order to guarantee minimum losses in the transmission of the power harvested by the EH01 IC. Thus, the output pins of the SREH01-EVAL01 board have been place at the border to facilitate the interconnection.

Board Description

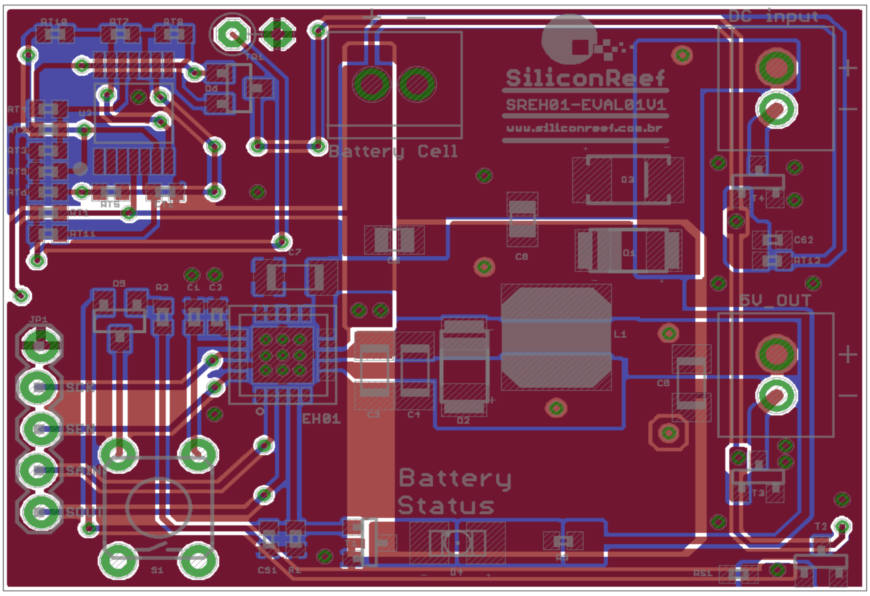


Figure 1: SREH01-EVAL01 evaluation board layout.

Table 1 Connector DC Input

Name	Type	Function
"+"	Power	Positive input connection
"-"	Power	Negative input connection

Table 2 Connector 5V Output

Name	Type	Function
"+"	Power	Positive output connection
"-"	Power	Negative output connection

Table 3 Connector Battery Cell

Name	Type	Function
"+"	Power	Positive battery connection
"-"	Power	Negative battery connection

Table 4 Connector JP4

Name	Type	Function
SCK	Digital Serial Interface	Clock signal
SEN	Digital Serial Interface	Enable signal
SAIN	Digital Serial Interface	Input signal
SOUT	Digital Serial Interface	Output Signal
GND	Ground reference	Ground

Schematic Diagrams

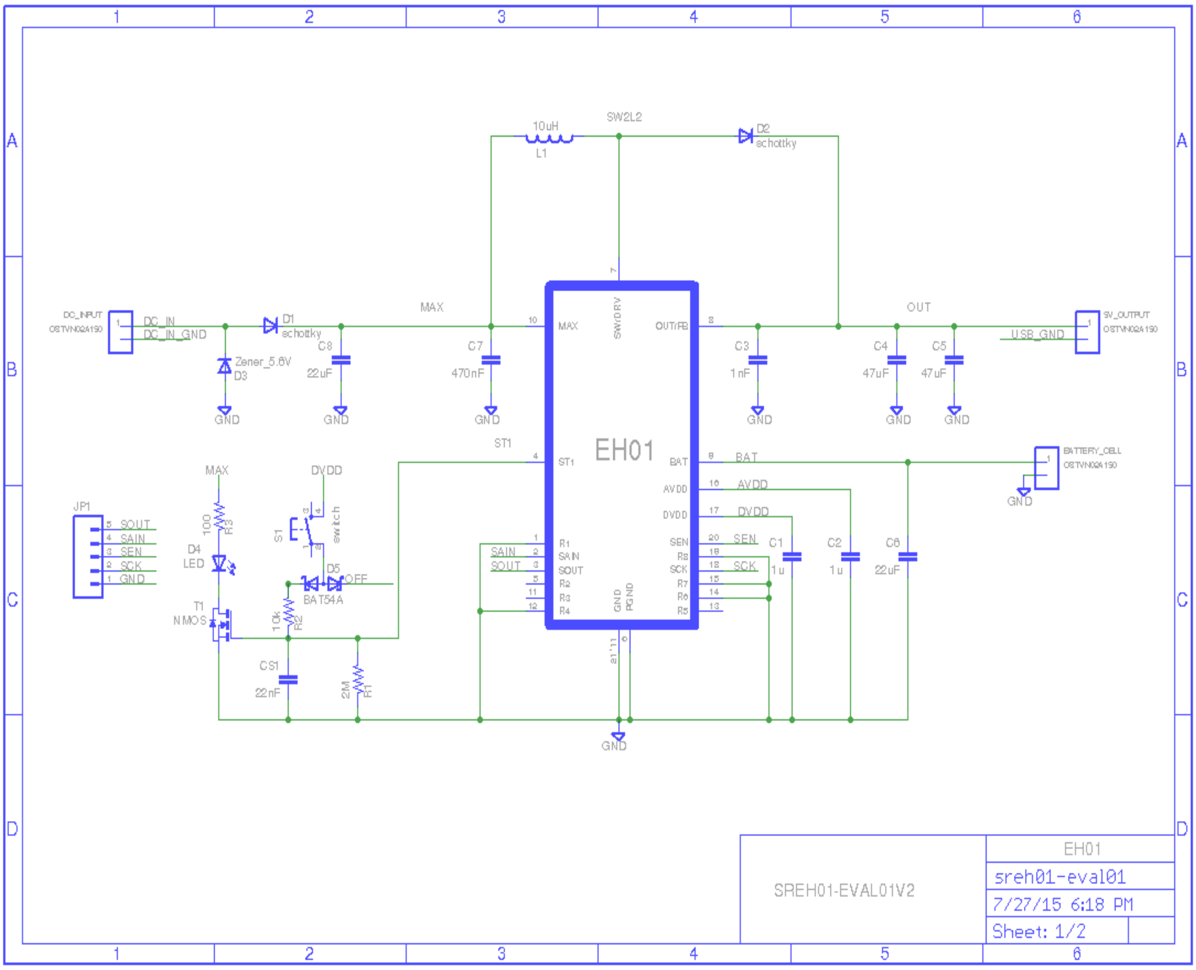


Figure 2: SREH01-EVAL01 evaluation board schematic.

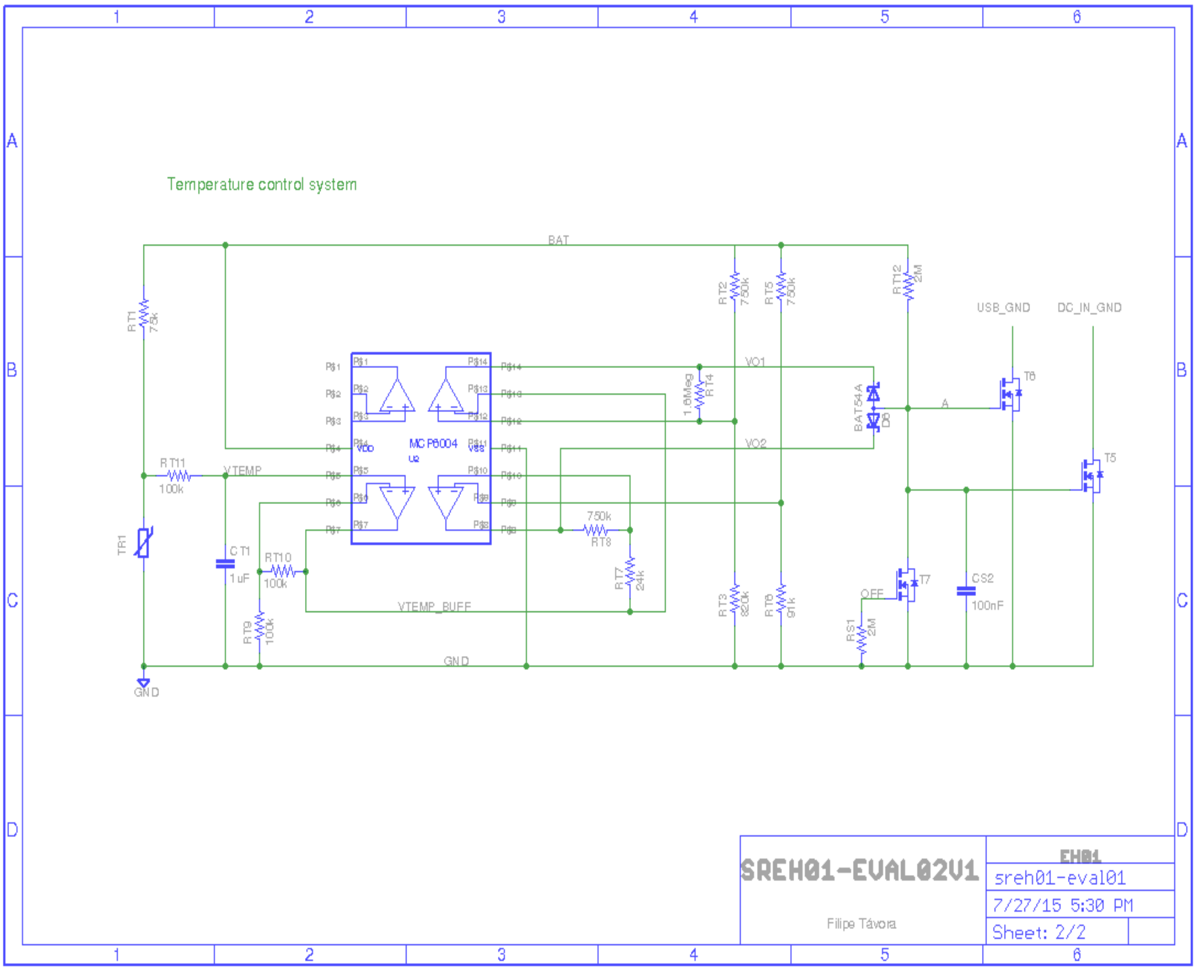


Figure 3: SREH01-EVAL01 evaluation board schematic.

Absolute Maximum Ratings

Parameter	Range
DC Input connector voltage[1]	7V
DC Input connector current[2]	1.5A
5V Output connector voltage	5.6V
5V Output connector current	1A
Battery Cell connector voltage	5.5V
Battery Cell connector current	1.2A

1. The maximum input voltage has a direct impact on the solar panel selection. Please refer to the Special Considerations section for further details.
2. The maximum input current has a direct impact on the solar panel selection. Please refer to the Special Considerations section for further details.

Electrical Characteristics

Parameter	Min	Typ	Max	Units
DC Input connector voltage[3]	4.0		7.0	V
Input current			2	A
Battery Cell connector regulated voltage	4.1	4.2	4.25	V
Fast Charge Current Limit	400	500	800	mA
Slow Charge Current Limit	100	150	200	mA
Slow/Fast charge Threshold	3.4	3.5	3.6	V
End of Charge Trigger	4.05	4.1	4.15	V
End of Charge Current	10	50	100	mA
End of charge Timeout	100	120	140	min
End of Discharge Trigger	2.9	3.0	3.15	V
Discharge current			1.2	A
5V DC Output connector regulated voltage	4.75	5	5.25	V
Ripple Voltage		2		%
Output Current			500	mA
Output Enable Trigger[4]	3.4	3.5	3.6	V
Inductor peak current			1.2	A
Switching frequency	0.8	1	1.1	MHz
Battery temperature upper threshold	53	55	57	°C
Battery temperature lower threshold	-2	0	2	°C
Temperature hysteresis		10		°C

Component Suggestions

The following table summarizes the external components that should be used to achieve the best performance for efficiency and output currents specified.

#	Part	Manufacturer Part Number	Description	Vendor
1	L1	SRN6045-100M	10μH inductor 2.5A 58 mΩ smd	Bourns
2	C1 and C2	GRM155R61A105KE15D	1μF ceramic capacitor 10V X5R 0402	Murata
3	C3	CL31C102JBCNNNC	1nF ceramic cap 50V NPO 1206	Samsung Electro-Mechanics
3	C4 and C5	C1206C476M8PACTU	47μF ceramic capacitor 10V X5R 1206	Kemet
4	C6 and C8	GRM219R61A226MEA0D	22μF ceramic capacitor 10V X5R 0805	Murata
5	C7	CL31B474KAFNNNE	0,47μF ceramic capacitor 25V X7R 1206	Samsung Electro-Mechanics
6	R1	MCR01MRTF2004	2MΩ resistor, 1%, 1/16W 0402	Rohm Semiconductor
7	R2	RC0402JR-0710KL	10kΩ resistor, 5%, 1/16W 0402	Yageo
8	R3	RC0402JR-07100RL	100Ω resistor, 5%, 1/16W 0402	Yageo
9	D1 and D2	B340A-13-F	Diode schottky 40V 3A DO214-AC	Diodes Inc.
10	D3	3SMAJ5919B-TP	5.6V zener diode 3W DO214AC	Micro Commercial
11	D4	SML-LX1206GC-TR	Led 565nm WTR GREEN 1206 SMD	Lumex-Opto
12	D5, D6	BAT54A-7-F	Diode Array Schottky 30V sot23-3	Diodes Incorporated
13	S1	MJTP1230	SWITCH TACTILE SPST-NO 0.05A 12V	Apem

3. The main features of the system, such as battery charging and output regulation, are available and operational for a more specific input voltage range. For a more detailed explanation of the operation limits of this evaluation board please refer to the Special Considerations section.
4. The Output Enable Trigger activates the output regulation feature of the system. However, it does not monitor the 5V DC Output Connector, but the Battery Cell Connector instead. For a more detailed explanation of the operation of this evaluation board please refer to the Special Considerations section.

#	Part	Manufacturer Part Number	Description	Vendor
14	RT1	RMCF0402FT75K0	75KΩ resistor, 1% 1/16W 0402	Stackpole Electronics Inc
15	RT11	RC0402FR-07100KL	100KΩ resistor, 1% 1/16W 0402	Yageo
16	RT12	RC0402FR-071ML	1MΩ resistor, 1% 1/16W 0402	Yageo
17	RT2, RT5, RT8	CRCW0402750KFKED	750KΩ resistor, 1% 1/16W 0402	Vishay Dale
18	RT3	CRCW0402820KFKED	820KΩ resistor, 1% 1/16W 0402	Vishay Dale
19	RT4	CRCW04021M60FKED	1.6MΩ resistor, 1% 1/16W 0402	Vishay Dale
20	RT6	RC0402FR-0791KL	91KΩ resistor, 1% 1/16W 0402	Yageo
21	RT7	RC0402FR-0724KL	24KΩ resistor, 1% 1/16W 0402	Yageo
22	RT9, RT10	RC0402FR-07100KL	100KΩ resistor, 1% 1/16W 0402	Yageo
23	TR1	NTCLE100E3103JT2	Thermistor NTC 10K 5% RADIAL	Vishay BC Components
24	T1, T2	NTR4003NT1G	MOSFET N-CH 30V 500mA SOT-23	ON Semiconductor
25	T3, T4	AO3400A	MOSFET N-CH 30V 5.7A sot-23	Alpha & Omega Semiconductor Inc
26	U2	MCP6004T-I/ST	IC OPamp gp 1MHz rro 14tssop	Microchip Technology

Special Considerations

Though the nominal performance is thoroughly detailed in the Electrical Characteristic section, there are some particular conditions to consider when using the SREH01-EVAL01 development board.

The DC Input Connector voltage range, for instance, states that the system is able to withstand voltages as low as 4.0V and as high as 7.0V. If a voltage below 4.5V were to be applied at the DC Input Connector, the system would be able to regulate the 5V DC Output Connector at the proper level once the voltage at the Battery Cell Connector reaches the Output Enable Trigger value (3.5V). Nevertheless, the Battery Cell Connector would never rise to 4.2V, which in turn implies that the battery cell attached to it would never fully charge due to the voltage drop present in the schottky diode D1 (around 400mV). Furthermore, if a 400mV difference between the MAX and BAT pin of the EH01 IC is not guaranteed, the risk of battery charging currents surpassing the specified range exists and will be defined by the selected source current capability. Therefore, a voltage equal or higher than 4.9V must be supplied at the DC Input Connector if the user seeks both a regulated output and a fully-charged battery cell. Likewise, if a voltage higher than 5.4V is applied at the DC Input Connector, the DC-DC converter in the EH01 IC will cease to operate and the input voltage will simply be transferred to the 5V DC Output Connector. Hence, if the input voltage continues to increase the output voltage will follow the same behavior and no regulation will take place. However, once the DC Input Connector reaches 5.6V, the zener diode in the board (D3) will clamp the voltage at this value and, in doing so, protecting the EH01 IC. Consequently, only the battery charging feature of the system will be operational in this scenario.

Regarding the solar panel selection, the ideal scenario would be 6W photovoltaic cell with 6.5V of open circuit voltage (around 4.9V at maximum power point). Nevertheless, the maximum input voltage specified in Absolute Maximum Ratings section indicates that the SREH01-EVAL01 is compliant with solar panels with open circuit voltages up to 7.0V. Moreover, if a photovoltaic cell with power delivery greater than 6W is chosen, some precautions must be taken. The zener diode present in the board has the responsibility to protect the system against overvoltages at the input (>5.6V). Therefore, when this scenario arises the zener diode will drain all the current from the input source and, consequently, must be able to withstand the input source payload. Thus, the zener diode must be chosen accordingly. The one specified in the Component Suggestions section was chosen for the ideal solar panel scenario. Another important aspect is the amount of input power that the system is able to actually use. The maximum output power, driving both the maximum output load and a battery cell at the fast charge stage, does not surpass 5W due to the limitations that EH01 IC establishes. The efficiency of the system at this scenario gives approximately 6W of required input power, which, in turn, means that any extra power will be basically wasted. Hence, despite the fact that the system is able to withstand input currents higher than 1.5A at the maximum power point of the ideal solar panel, the excess of current will not be seized and transferred to the output.