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S6SAE100A00VA1001

# Energy Harvesting PMIC S6AE10xA Evaluation Board Operation Guide

Doc No. 002-08728 Rev.\*C

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# Preface



This manual explains how to use the evaluation board. Be sure to read this manual before using the product. For this product, please consult with sales representatives or support representatives.

## **Handling and Use**

Handling and use of this product and notes regarding its safe use are described in the manuals.

Follow the instructions in the manuals to use this product.

Keep this manual at hand so that you can refer to it anytime during use of this product.


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### Caution of the Products Described in This Document

The following precautions apply to the product described in this manual.

 <b>WARNING</b>	<p>Indicates a potentially hazardous situation which could result in death or serious injury and/or a fault in the user's system if the product is not used correctly.</p>
--	--

<p><b>Electric shock, Damage</b></p>	<p>Before performing any operation described in this manual, turn off all the power supplies to the system.</p> <p>Performing such an operation with the power on may cause an electric shock or device fault.</p>
<p><b>Electric shock, Damage</b></p>	<p>Once the product has been turned on, do not touch any metal part of it.</p> <p>Doing so may cause an electric shock or device fault.</p>

 <b>CAUTION</b>	<p>Indicates the presence of a hazard that may cause a minor or moderate injury, damages to this product or devices connected to it, or may cause to loose software resources and other properties such as data, if the device is not used appropriately.</p>
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<p><b>Cuts, Damage</b></p>	<p>Before moving the product, be sure to turn off all the power supplies and unplug the cables.</p> <p>Watch your step when carrying the product. Do not use the product in an unstable location such as a place exposed to strong vibration or a sloping surface. Doing so may cause the product to fall, resulting in an injury or fault.</p>
<p><b>Cuts</b></p>	<p>The product contains sharp edges that are left unavoidably exposed, such as jumper plugs.</p> <p>Handle the product with due care not to get injured with such pointed parts.</p>
<p><b>Damage</b></p>	<p>Do not place anything on the product or expose the product to physical shocks. Do not carry the product after the power has been turned on.</p> <p>Doing so may cause a malfunction due to overloading or shock.</p>
<p><b>Damage</b></p>	<p>Since the product contains many electronic components, keep it away from direct sunlight, high temperature, and high humidity to prevent condensation. Do not use or store the product where it is exposed to much dust or a strong magnetic or electric field for an extended period of time.</p> <p>Inappropriate operating or storage environments may cause a fault.</p>
<p><b>Damage</b></p>	<p>Use the product within the ranges given in the specifications.</p> <p>Operation over the specified ranges may cause a fault.</p>
<p><b>Damage</b></p>	<p>To prevent electrostatic breakdown, do not let your finger or other object come into contact with the metal parts of any of the connectors. Before handling the product, touch a metal object (such as a door knob) to discharge any static electricity from your body.</p>
<p><b>Damage</b></p>	<p>When turning the power on or off, follow the relevant procedure as described in this document. Before turning the power on, in particular, be sure to finish making all the required connections. Furthermore, be sure to configure and use the product by following the instructions given in this document. Using the product incorrectly or inappropriately may cause a fault.</p>
<p><b>Damage</b></p>	<p>Because the product has no casing, it is recommended that it be stored in the original packaging. Transporting the product may cause a damage or fault. Therefore, keep the packaging materials and use them when re-shipping the product.</p>

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# 1. Description



The S6SAE100A00VA1001 is the tiny evaluation board for the ultra-low-power energy harvesting PMIC for indoor type solar cell, S6AE100A series. This evaluation board consists of three independent boards for S6SAE101A, S6SAE102A and S6SAE103A. This board is capable of supporting life extension of primary battery or becoming battery-less solution, and it is for evaluation of diverse power management functions used for wireless sensor network.

## 2. Evaluation Board Specification



**Table 2-1 Evaluation Board Specification**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage 1(*1)	$V_{VDD}$	VDD1,2,3 pin	3.4(*3)	-	5.5	V
Power supply voltage 2	$V_{VBAT}$	VBAT1 pin (S6AE101A)	3.4(*3)	-	5.5	V
		VBAT2,3 pin (S6AE102A, S6AE103A)	2.0	-	5.5	V
Output voltage 1	$V_{VOUTH}$	Rx1=6.8M $\Omega$ , Rx2=2.7M $\Omega$ , Rx1=9.1M $\Omega$	-	3.29	-	V
Output voltage 2	$V_{VOUTL}$	Rx1=6.8M $\Omega$ , Rx2=2.7M $\Omega$ , Rx1=9.1M $\Omega$	-	2.53	-	V
OVP detection voltage	$V_{OVPH}$	VDD pin(*2)	5.2	5.4	5.5	V
OVP release voltage	$V_{OVPL}$		5.1	5.3	5.4	V
OVP detection hysteresis	$V_{OVPHYS}$		-	0.1	-	V
OVP protection current	$I_{OVP}$	VDD pin(*2) input current	6	-	-	mA

\*1: It is recommended to connect more than six cells in series when solar cells are used.

\*2: IC (U1,U2,U3) pin

\*3: Min. value of power supply voltage depends the output voltage setting.

Please refer the S6AE101A datasheet (002-08493) for more information.

Please refer the S6AE102A and S6AE103A datasheet (002-08501) for more information.

Board size: 19 mm  $\times$  11 mm for S6AE101A, 20.5 mm  $\times$  16 mm for S6AE102A, 23 mm  $\times$  16 mm for S6AE103A.



## 3. Pin and Function Descriptions

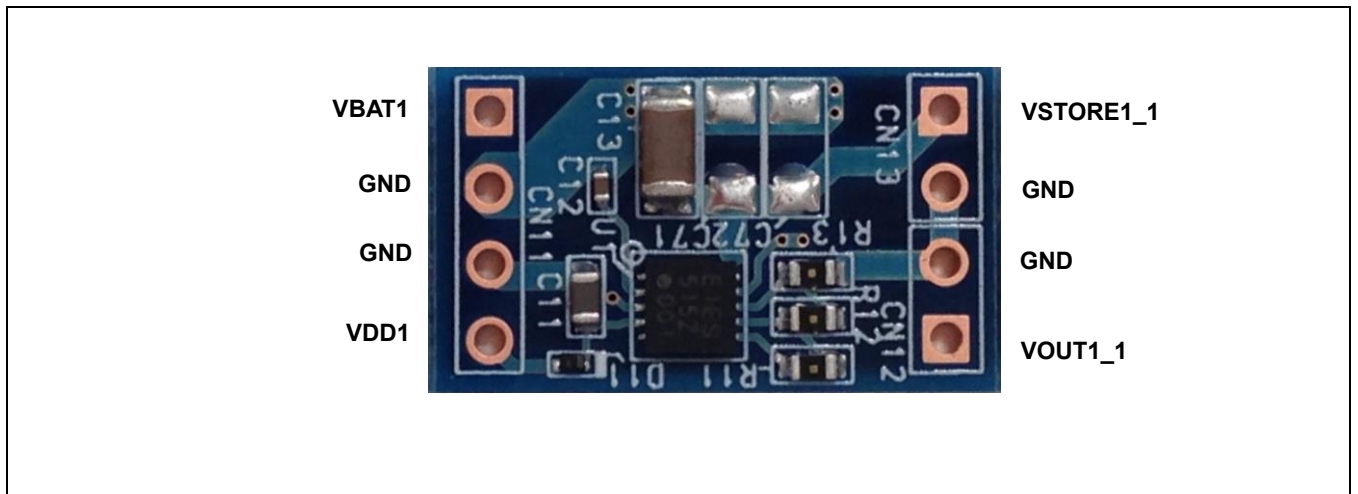


### 3.1. Input/Output Pin Descriptions

Table 3-1 Input/Output Pin Descriptions(S6AE101A)

Pin Symbol	I/O	Function Descriptions
VBAT1	I	Primary battery input pin (when being not used, leave this pin open)
GND	-	Ground pin
GND	-	Ground pin
VDD1	I	Solar cell input pin (when being not used, leave this pin open)
VSTORE1_1	-	Storage output pin
GND	-	Ground pin
GND	-	Ground pin
VOUT1_1	O	Output voltage pin

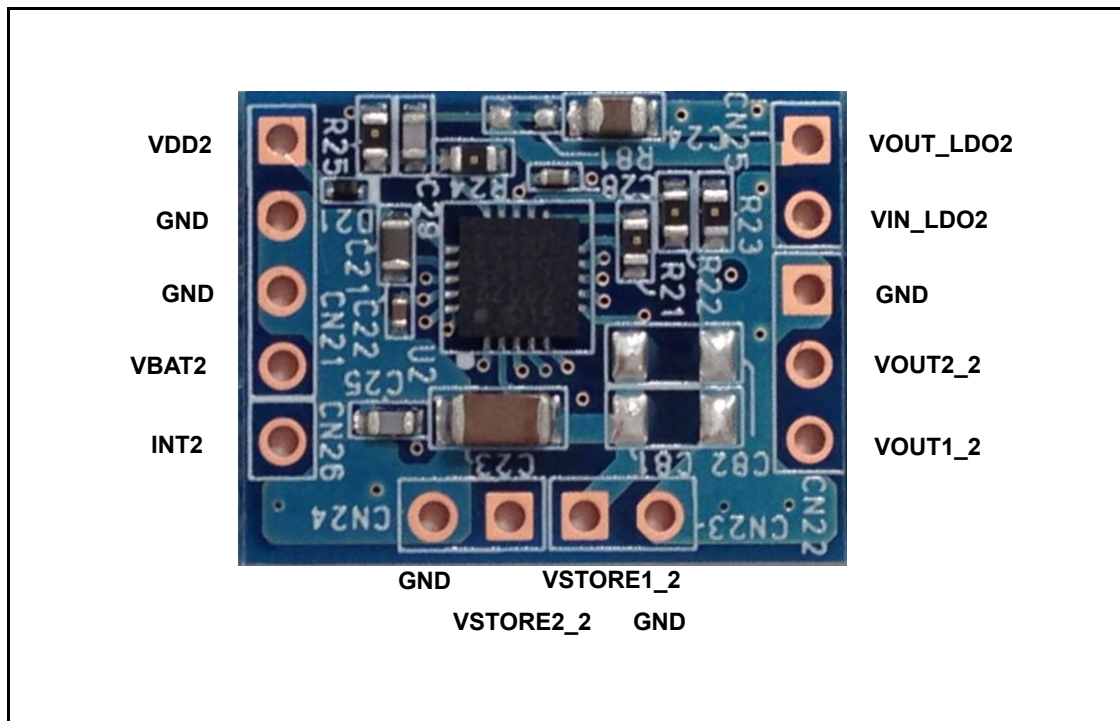
Figure 3-1 Pin Layout(S6AE101A)



**Table 3-2 Input/Output Pin Descriptions(S6AE102A)**

Pin Symbol	I/O	Function Descriptions
VBAT2	I	Primary battery input pin (when being not used, leave this pin open)
GND	-	Ground pin
GND	-	Ground pin
VDD2	I	Solar cell input pin (when being not used, leave this pin open)
VSTORE1_2	-	Storage output pin
GND	-	Ground pin
VSTORE2_2	-	Storage output pin
GND	-	Ground pin
GND	-	Ground pin
VOUT1_2	O	Output voltage pin
VOUT2_2	O	Output voltage pin
VOUT_LDO2	O	LDO output pin
VIN_LDO2	I	LDO input pin
INT2	I	Control signal input for power gating mode

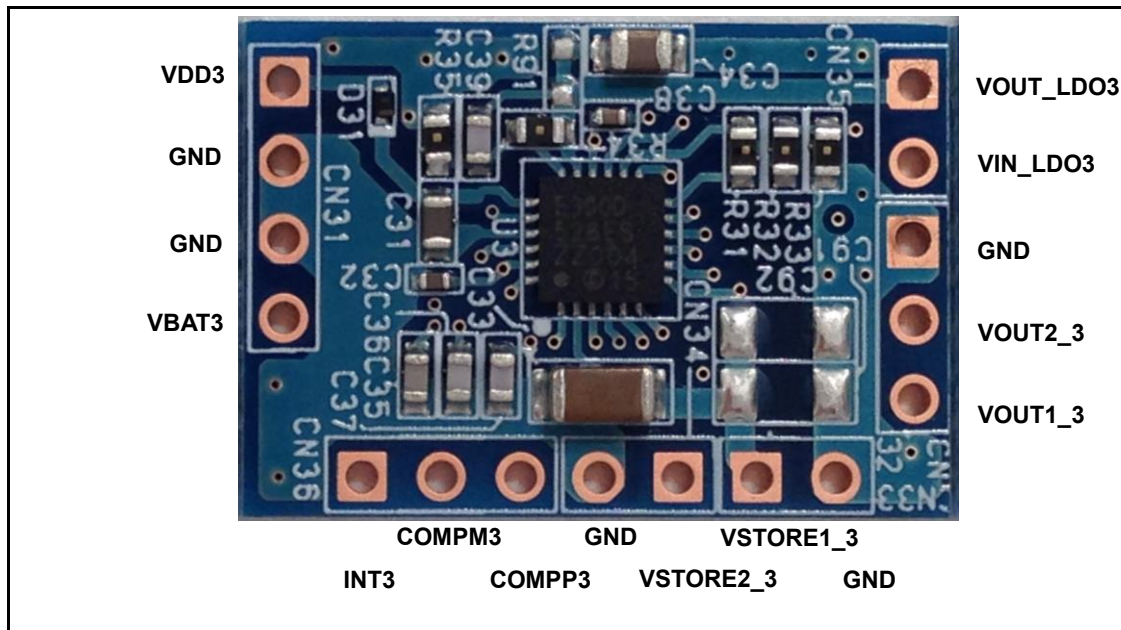
**Figure 3-2 Pin Layout(S6AE102A)**



**Table 3-3 Input/Output Pin Descriptions(S6AE103A)**

Pin Symbol	I/O	Function Descriptions
VBAT3	I	Primary battery input pin (when being not used, leave this pin open)
GND	-	Ground pin
GND	-	Ground pin
VDD3	I	Solar cell input pin (when being not used, leave this pin open)
VSTORE1_3	-	Storage output pin
GND	-	Ground pin
VSTORE2_3	-	Storage output pin
GND	-	Ground pin
GND	-	Ground pin
VOUT1_3	O	Output voltage pin
VOUT2_3	O	Output voltage pin
VOUT_LDO3	O	LDO output pin
VIN_LDO3	I	LDO input pin
INT3	I	Control signal input for power gating mode
COMPM3	I	Comparator input pin
COMPP3	I	Comparator input pin

**Figure 3-3 Pin Layout(S6AE103A)**

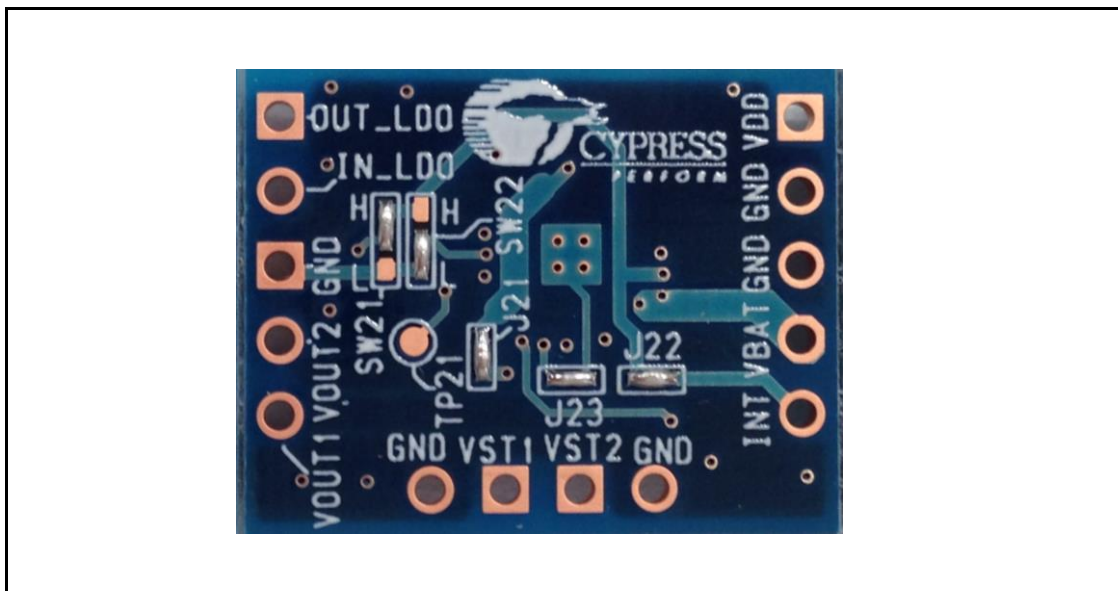


### 3.2. Jumper/Switch Setting

**Table 3-4 Jumper Description for S6AE102A**

Jumper/Switch	Function	Initial Setting
J21	Shorted between VIN_LDO2 pin and VOUT2_2 pin	Short
J22	Shorted between INT2 pin and VINT2 pin	Short
J23	Shorted between CIN2 pin and GND	Short
SW21	Shorted ENA_LDO2 pin to VINT2 pin or GND	Short ENA_LDO2-VINT2(H)
SW22	Shorted STBY_LDO2 pin to VINT2 or GND	Short STBY_LDO2-GND(L)

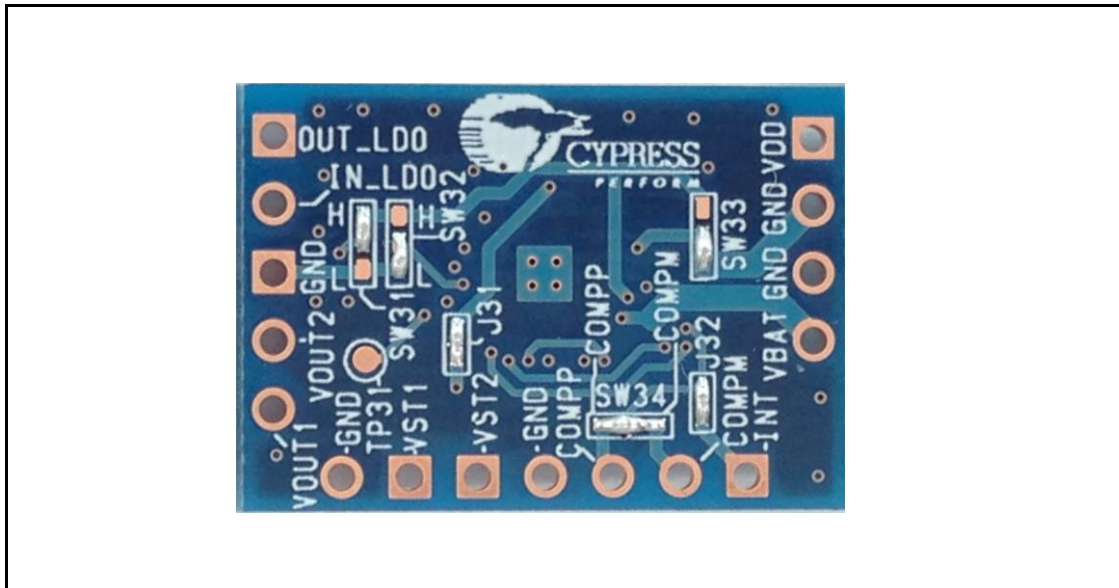
**Figure 3-4 Jumper/Switch Layout(S6AE102A)**



**Table 3-5 Jumper/Switch Description for S6AE103A**

Jumper/Switch	Function	Initial Setting
J31	Shorted between VIN_LDO3 pin and VOUT2_3 pin	Short
J32	Shorted between INT3 pin and VINT3 pin	Short
SW31	Shorted ENA_LDO3 pin to VINT3 pin or GND	Short ENA_LDO3-VINT3(H)
SW32	Shorted STBY_LDO3 pin to VINT3 or GND	Short STBY_LDO3-GND(L)
SW33	Shorted ENA_COMP3 pin to VINT3 pin or GND	Short ENA_COMP3-GND(L)
SW34	Shorted COMPM3 pin or COMPP3 pin to VINT3 pin	Short COMPM3-VINT3(H) Short COMPP3-VINT3(H)

**Figure 3-5 Jumper/Switch Layout(S6AE103A)**



### 3.3. Output Voltage Setting

Output voltage of S6AE100A PMIC is set by changing resistor values of Rx1, Rx2, and Rx3 on the board.

$$Rx1, Rx2, Rx3 = (R11, R12, R13/ R21, R22, R23/ R31, R32, R33)$$

Initial setting value of output voltage of the board is

$$VVOUTH \approx 3.29V, VVOUTL \approx 2.53V$$

To change output voltage, derive Rx1, Rx2, and Rx3 values by using following calculation formulas. Then the sum of Rx1, Rx2, and Rx3 must be set to more than 10 MΩ.

#### ■ VVOUTH

$$VVOUTH = \frac{57.5 \times (Rx2 + Rx3)}{11.1 \times (Rx1 + Rx2 + Rx3)} [V]$$

#### ■ VVOUTL

$$VVOUTL = \frac{57.5 \times Rx3}{11.1 \times (Rx1 + Rx2 + Rx3)} [V]$$

Calculation Example:

#### ■ VVOUTH

$$VVOUTH = \frac{57.5 \times (R12 + R13)}{11.1 \times (R11 + R12 + R13)} = \frac{57.5 \times (2.7M + 9.1M)}{11.1 \times (6.8M + 2.7M + 9.1M)} = 3.29[V]$$

#### ■ VVOUTL

$$VVOUTL = \frac{57.5 \times R13}{11.1 \times (R11 + R12 + R13)} = \frac{57.5 \times 9.1M}{11.1 \times (6.8M + 2.7M + 9.1M)} = 2.53[V]$$

LDO output voltage of S6AE102A and S6AE103A PMIC is set by changing resistor values of Rx4 and Rx5.

$$Rx4, Rx5 = (R24, R25 / R34, R35)$$

Initial setting value of output voltage of the board is

$$VOUT\_LDOx \approx 2.55V$$

To change output voltage, derive Rx4 and Rx5 values by using following calculation formulas

#### ■ VOUT\_LDOx

$$VOUT\_LDOx = \frac{1.15 \times (Rx4 + Rx5)}{Rx5} [V]$$

## 4. Setup and Verification



### 4.1. Contents in a Package

Contents	Description	Quantity	Notes
S6SAE100A00VA1001	Evaluation board of S6AE101A, S6AE102A and S6AE103A	1	-

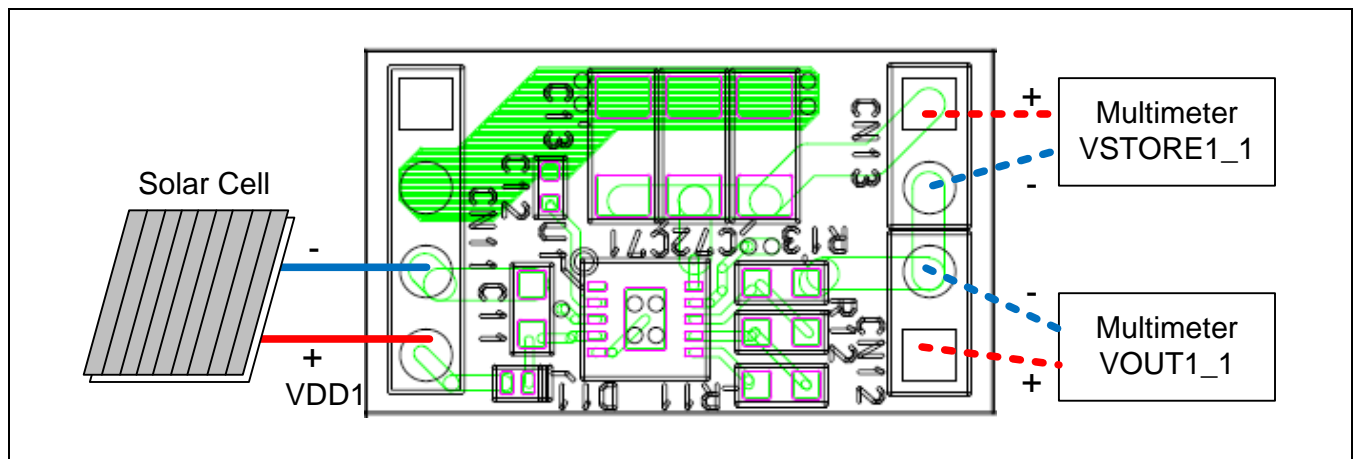
It is recommended to prepare the solar cell (e.g. Panasonic AM-1801 ) and coin battery (or stabilized power supply is available ) by user as input power source for evaluation.

### 4.2. Operation

#### 4.2.1. Connection of Indoor Type Solar Cell

1. To output 3.3V (initial setting value) to VOUT1\_1 pin, input a DC voltage more than 3.4V into VDD1 pin. (It is recommended to connect more than six cells in series if you use solar cells.)
2. Then, confirm that 3.3V is output to VOUT1\_1 pin. When you measure voltage change during charging, monitor the voltage on VSTORE1\_1 pin.
3. To change the output voltage setting, change the resistor value of R11, R12 and R13 with referring section 3.3 Output Voltage Setting.

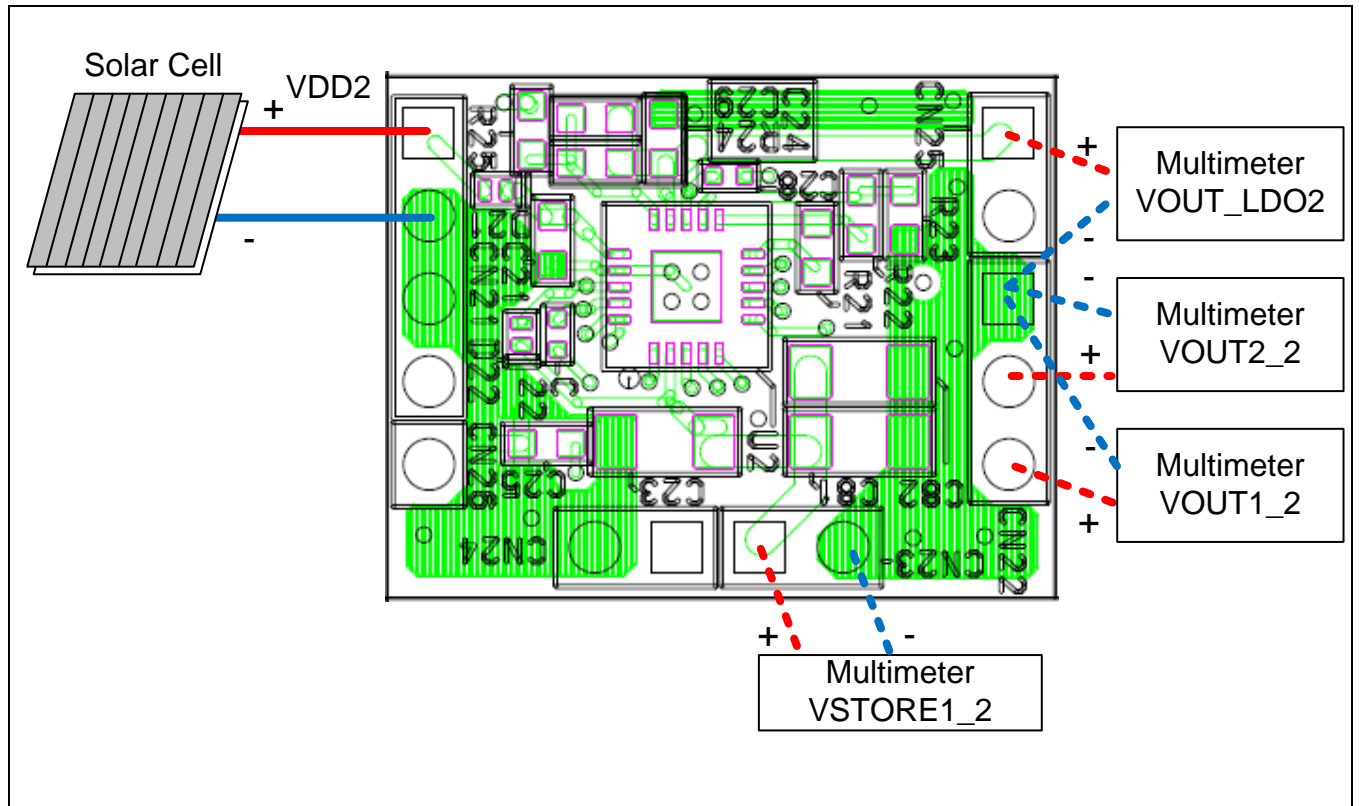
Figure 4-1 Connection of Indoor Type Solar Cell (S6AE101A)





1. To output 3.3V (initial setting value) to VOUT1\_2 pin, input a DC voltage more than 3.4V into VDD2 pin. (It is recommended to connect more than six cells in series if you use solar cells.)
2. Then, confirm that 3.3V is output to VOUT1\_2 pin and VOUT2\_2 pin. When you measure voltage change during charging, monitor the voltage on VSTORE1\_2 pin.
3. Also, confirm that 2.5V is output to VOUT\_LDO2 pin.
4. To change the output voltage setting of VOUT, change the resistor value of R21, R22 and R23 with referring section 3.3 Output Voltage Setting.
5. To change the output voltage setting of LDO, change the resistor value of R24 and R25 with referring section 3.3 Output Voltage Setting.

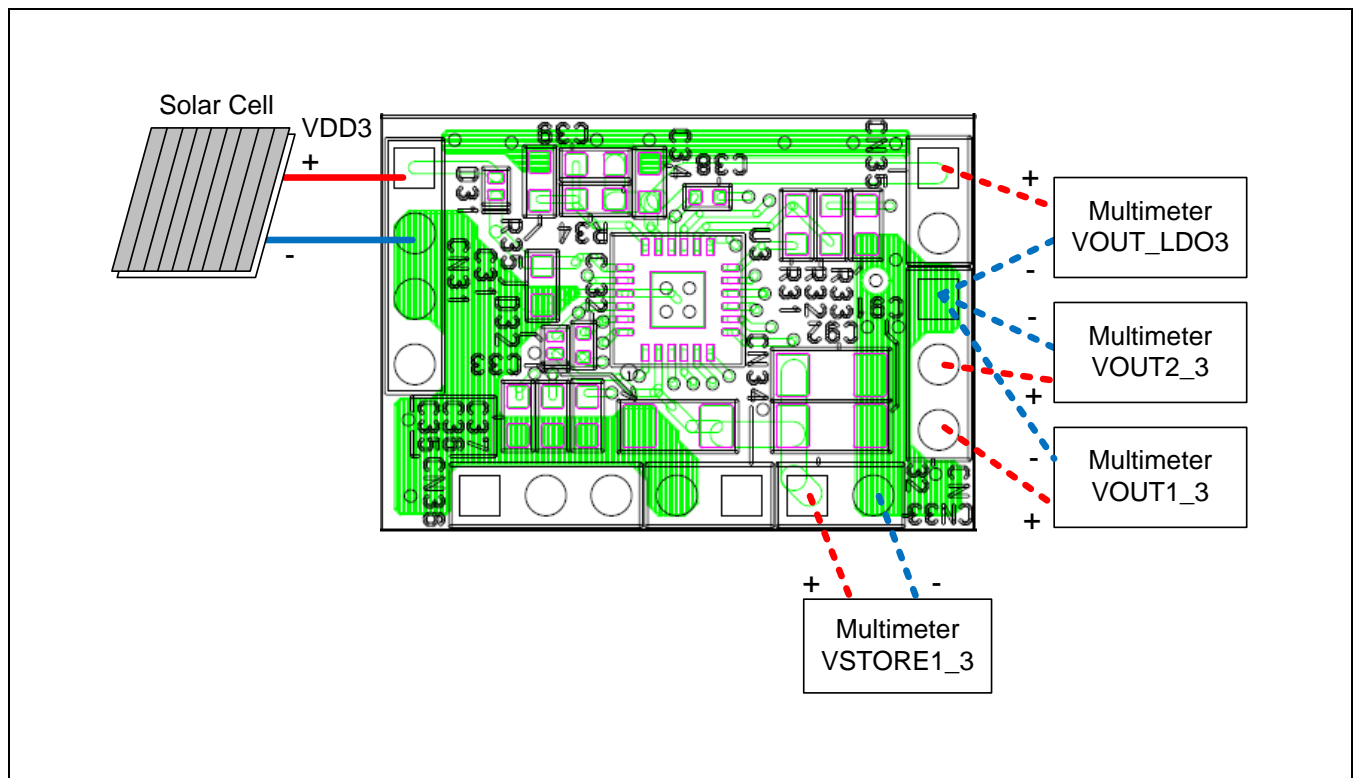
Figure 4-2 Connection of Indoor Type Solar Cell (S6AE102A)





1. To output 3.3V (initial setting value) to VOUT1\_3 pin, input a DC voltage more than 3.4V into VDD3 pin. (It is recommended to connect more than six cells in series if you use solar cells.)
2. Then, confirm that pulsed 3.3V is output to VOUT1\_3 pin and VOUT2\_3 pin by timer control. Please refer the datasheet "Timer Driven Mode in 12.2 Power Gating" for more detailed information about the operation. When you measure voltage change during charging, monitor the voltage on VSTORE1\_3 pin.
3. Also, confirm that pulsed 2.5V is output to VOUT\_LDO3 pin. LDO output is synchronized with the VOUT2\_3, because the LDO is supplied from VOUT2\_3 as input power source at the initial setting.
4. To change the output voltage setting of VOUT, change the resistor value of R31, R32 and R33 with referring section 3.3 Output Voltage Setting.
5. To change the output voltage setting of LDO, change the resistor value of R34 and R35 with referring section 3.3 Output Voltage Setting.

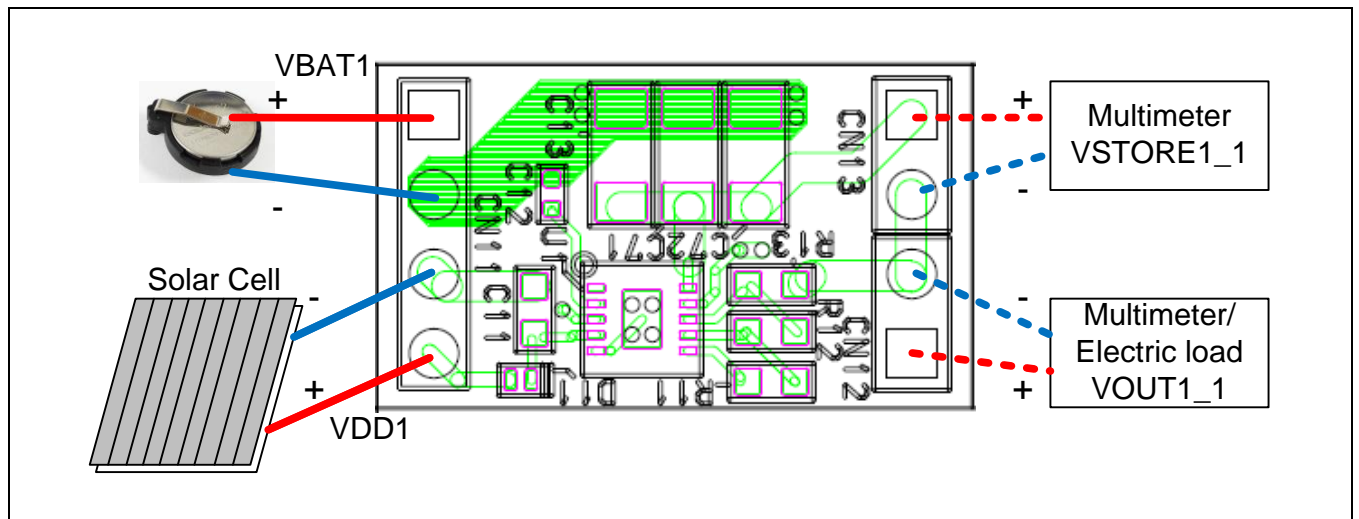
**Figure 4-3 Connection of Indoor Type Solar Cell (S6AE103A)**



### 4.2.2. Hybrid Connection of Indoor Type Solar Cell and Primary Battery

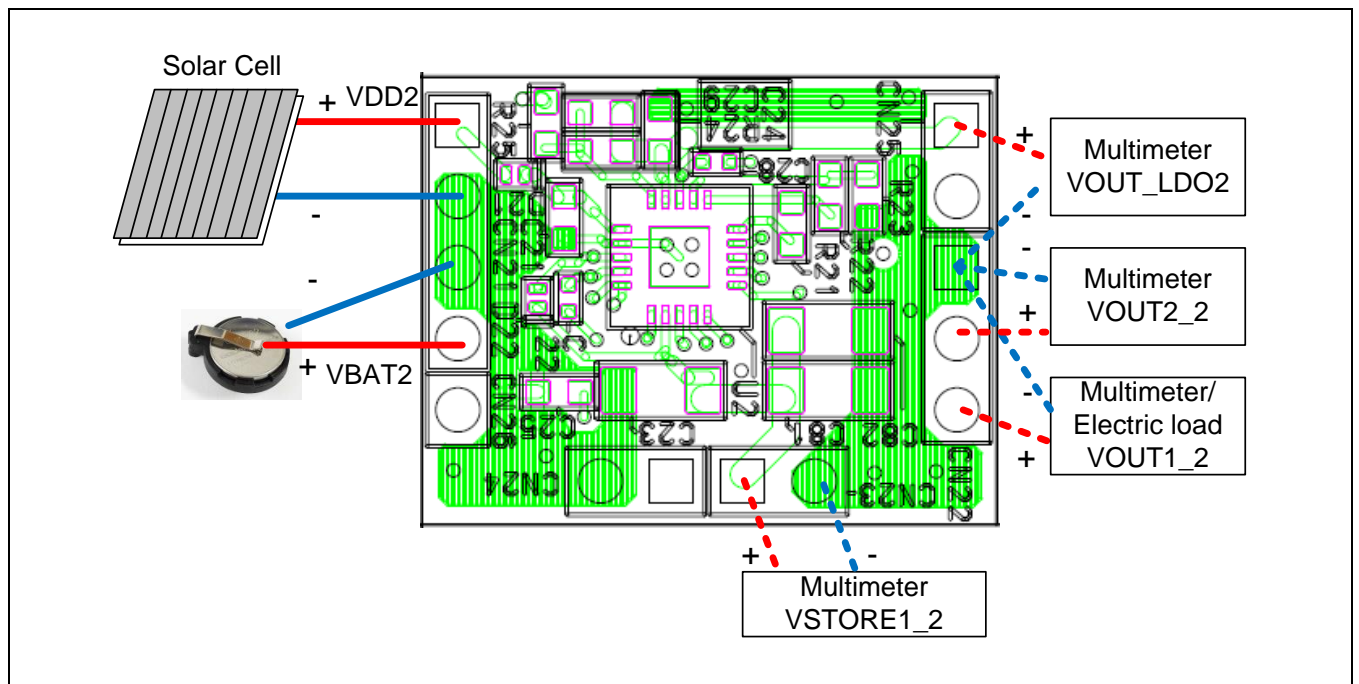
1. To output 3.3V (initial setting value) to VOUT1\_1 pin, input a DC voltage more than 3.4V into VDD1 pin and VBAT1 pin. VDD1 pin is for solar cell and VBAT1 is for 3V coin battery etc.
2. Confirm that 3.3V is output to VOUT1\_1 pin. When you measure voltage change during charging, monitor the voltage on VSTORE1\_1 pin.
3. Connect the load to VOUT1\_1 pin in order to make VDD1 pin voltage dropping under 1.45V. After the VDD1 pin voltage becomes under 1.45V, VBAT1 pin voltage is directly supplied to VOUT1\_1 pin.
4. To change the output voltage setting, change the resistor value of R11, R12 and R13 with referring section 3.3 Output Voltage Setting.

**Figure 4-4 Hybrid Connection of Indoor Type Solar Cell and Primary Battery with Board (S6AE101A)**



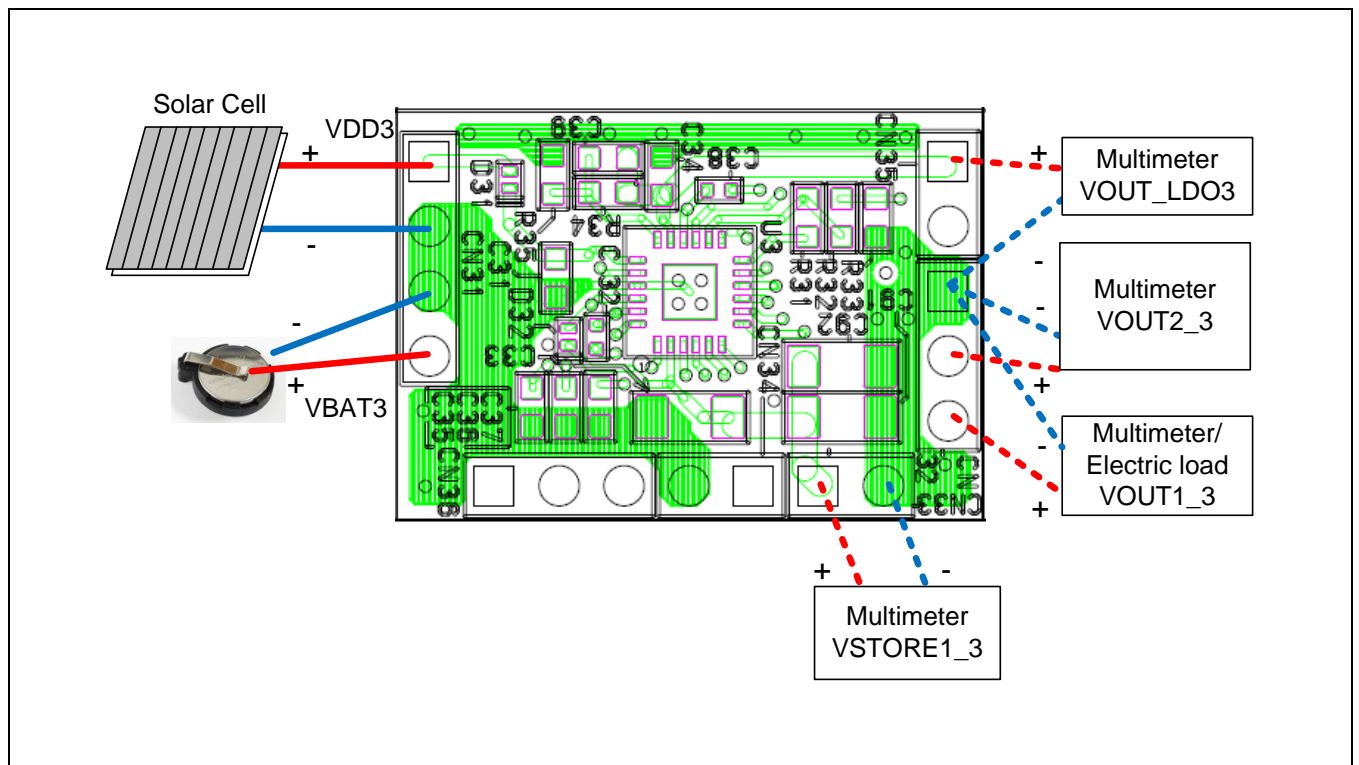
1. To output 3.3V (initial setting value) to VOUT1\_2 pin and VOUT2\_2 pin, input a DC voltage more than 3.4V into VDD2 pin (e.g. solar battery). And input the over 2V into VBAT2 pin (e.g. 3V coin battery). When the VSTORE1\_2 pin voltage drops, VBAT2 pin voltage is directly supplied to VOUT1\_2 pin and VOUT2\_2 pin.
2. Confirm that 3.3V is output to VOUT1\_2 pin and VOUT2\_2 pin. When you measure voltage change during charging, monitor the voltage on VSTORE1\_2 pin.
3. Confirm that 2.5V is output to VOUT\_LDO2 pin.
4. Connect the load to VOUT1\_2 pin in order to make VSTORE1\_2 pin voltage dropping under 2.5V. VBAT2 pin voltage is directly supplied to VOUT1\_2 pin and VOUT2\_2 pin.
5. To change the output voltage setting, change the resistor value of R21, R22 and R23 with referring section 3.3 Output Voltage Setting.
6. To change the output voltage setting of LDO, change the resistor value of R24 and R25 with referring section 3.3 Output Voltage Setting.

**Figure 4-5 Hybrid Connection of Indoor Type Solar Cell and Primary Battery with Board (S6AE102A)**



1. To output 3.3V (initial setting value) to VOUT1\_3 pin and VOUT2\_3 pin, input a DC voltage more than 3.4V into VDD3 pin (e.g. solar battery). And input the over 2V into VBAT3 pin (e.g. 3V coin battery). When the VSTORE1\_3 pin voltage drops, VBAT3 pin voltage is directly supplied to VOUT1\_3 pin and VOUT2\_3 pin.
2. Confirm that pulsed 3.3V is output to VOUT1\_3 pin and VOUT2\_3 pin by timer control. Please refer the datasheet "Timer Driven Mode in 12.2 Power Gating" for more detailed information about the operation. When you measure voltage change during charging, monitor the voltage on VSTORE1\_3 pin.
3. Also confirm that pulsed 2.5V is output to VOUT\_LDO3 pin. LDO output is synchronized with the VOUT2\_3, because the LDO is supplied from VOUT2\_3 as input power source at the initial setting.
4. Connect the load to VOUT1\_3 pin or VOUT2\_3 pin in order to make VSTORE1\_3 pin voltage dropping under 2.5V. VBAT3 pin voltage is directly supplied to VOUT1\_3 pin and VOUT2\_3 pin.
5. To change the output voltage setting, change the resistor value of R31, R32 and R33 with referring section 3.3 Output Voltage Setting.
6. To change the output voltage setting of LDO, change the resistor value of R34 and R35 with referring section 3.3 Output Voltage Setting.

**Figure 4-6 Hybrid Connection of Indoor Type Solar Cell and Primary Battery with Board (S6AE103A)**



# 5. Circuit Schematic



Figure 5-1 Circuit Schematic (1/2)

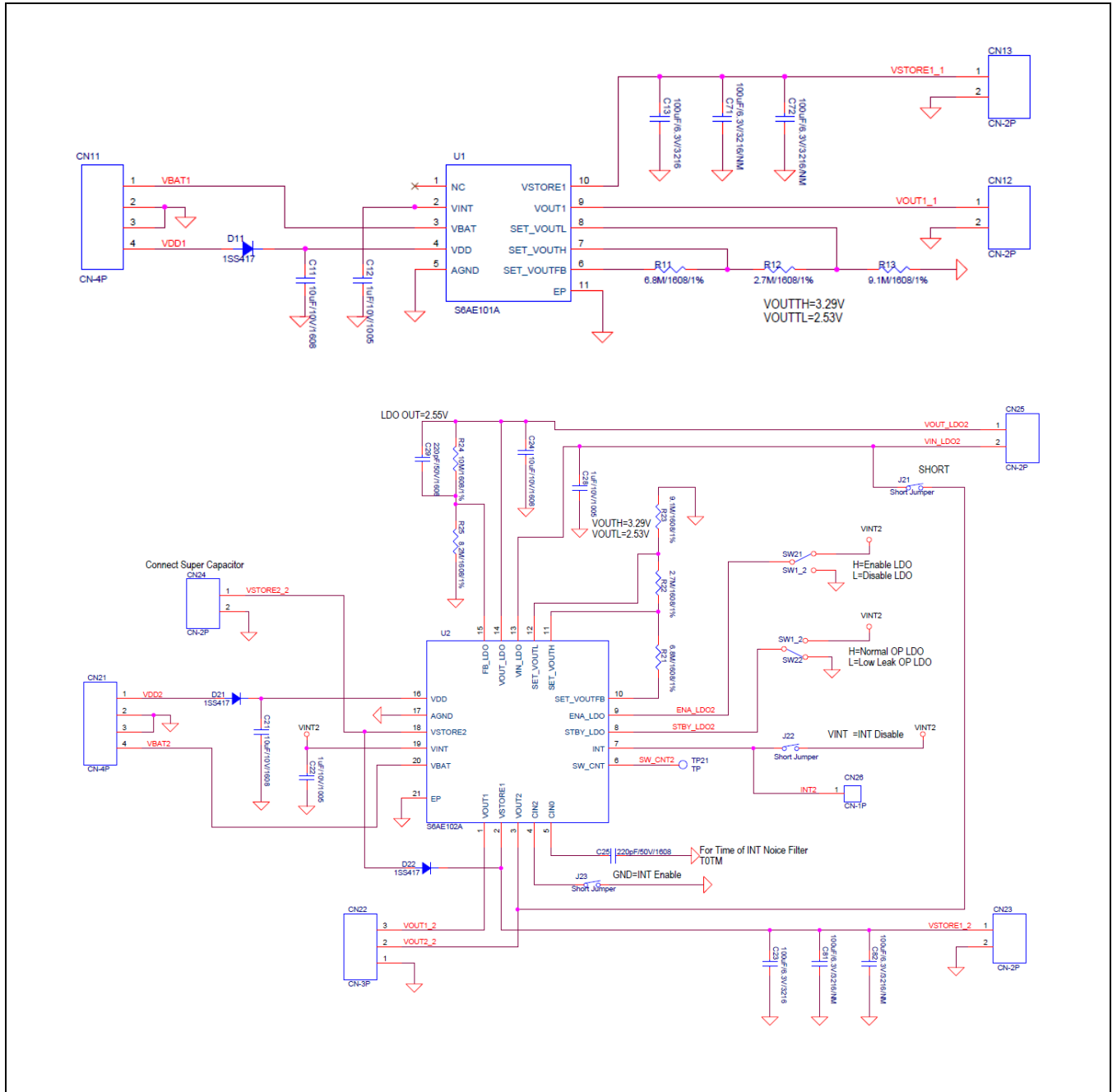
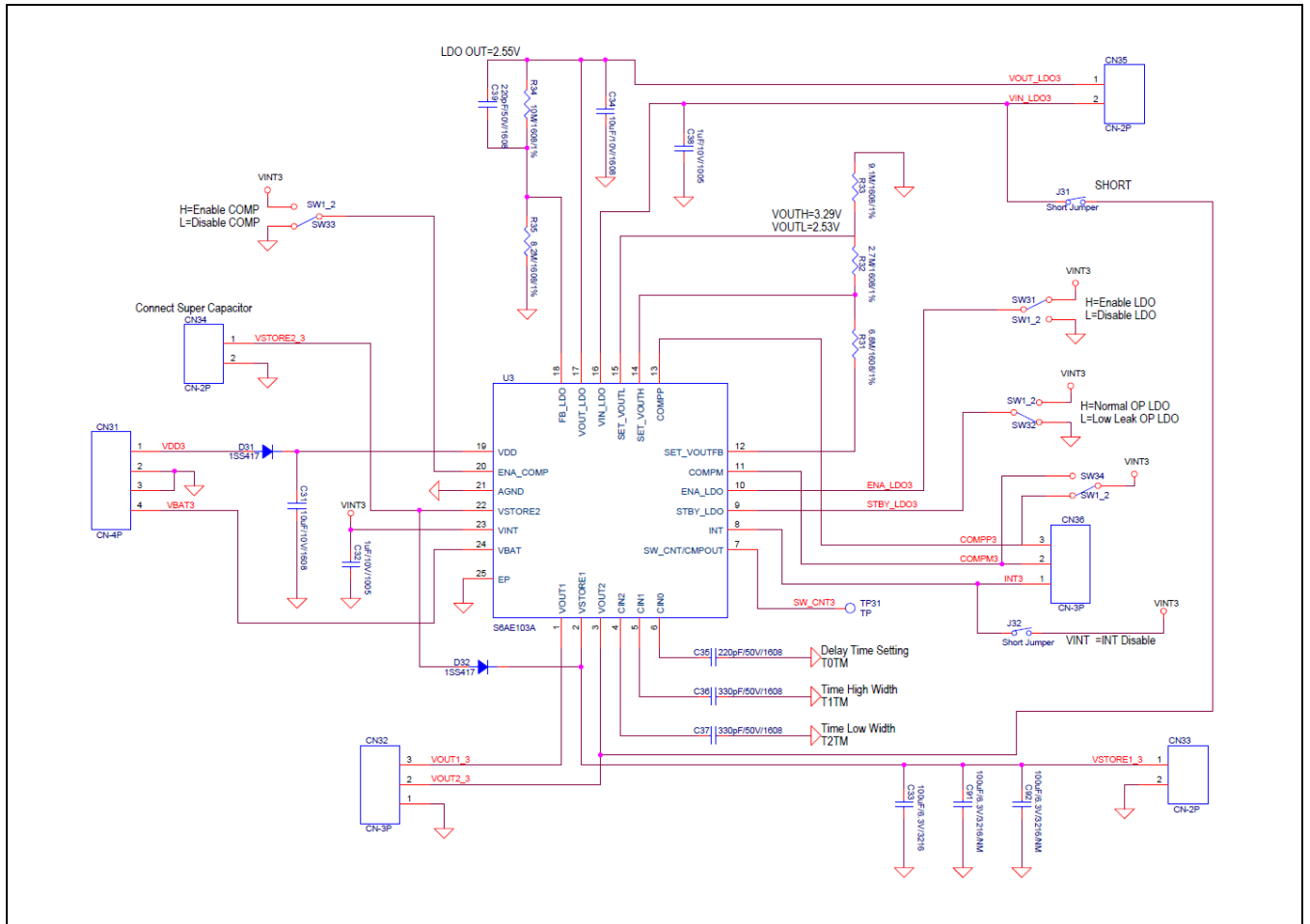


Figure 5-2 Circuit Schematic (2/2)



Notes: This is for S6SAE100A00VA1001 Rev02

## 6. Component List



**Table 6-1 Component List**

No	Reference	Parts Number	Description	Manufacture	Note
1	C11, C21, C31, C24, C34	C1608X6S1A106M080AC	10 $\mu$ F/10V/1608	TDK Corporation	-
2	C12, C22, C32, C28, C38	C1005X7S1A105K050BC	1 $\mu$ F/10V/1005	TDK Corporation	-
3	C13, C23, C33	C3216X5R0J107M160AB	100 $\mu$ F/6.3V/3216	TDK Corporation	-
4	C25, C35	C1608C0G1H151J080AA	150 pF/50V/1608	TDK Corporation	-
5	C36, C37	C1608C0G1H331J080AA	330 pF/50V/1608	TDK Corporation	-
6	C29, C39	C1608C0G1H221J080AA	220 pF/50V/1608	TDK Corporation	-
7	C71, C72, C81, C82, C91, C92	-	100 $\mu$ F/6.3V/3216	-	non mount
8	D11, D21, D31, D22, D32	1SS417CT.L3F	Diode 40V/1006	TOSHIBA Corporation	-
9	U1	S6AE101A0DGNAB000	Energy Harvesting PMIC	Cypress Semiconductor Corporation	-
10	U2	S6AE102A0DGN1B000	Energy Harvesting PMIC	Cypress Semiconductor Corporation	-
11	U3	S6AE103A0DGN1B000	Energy Harvesting PMIC	Cypress Semiconductor Corporation	-
12	R11, R21, R31	ESR03EZPF6804	6.8 M/1608/1%	Rohm Semiconductor	-
13	R12, R22, R32	ESR03EZPF2704	2.7 M/1608/1%	Rohm Semiconductor	-
14	R13, R23, R33	ESR03EZPF9104	9.1 M/1608/1%	Rohm Semiconductor	-
15	R24, R34	ESR03EZPF1005	10 M/1608/1%	Rohm Semiconductor	-
16	R25, R35	ESR03EZPF8204	8.2 M/1608/1%	Rohm Semiconductor	-
17	CN11, CN21, CN22, CN31, CN32	2.54 mm 4pin	-	-	non mount
18	CN36	2.54 mm 3pin	-	-	non mount
19	CN12, CN13, CN23, CN24, CN25, CN33, CN34, CN35	2.54 mm 2pin	-	-	non mount
20	CN26	2.54 mm 1pin	-	-	non mount

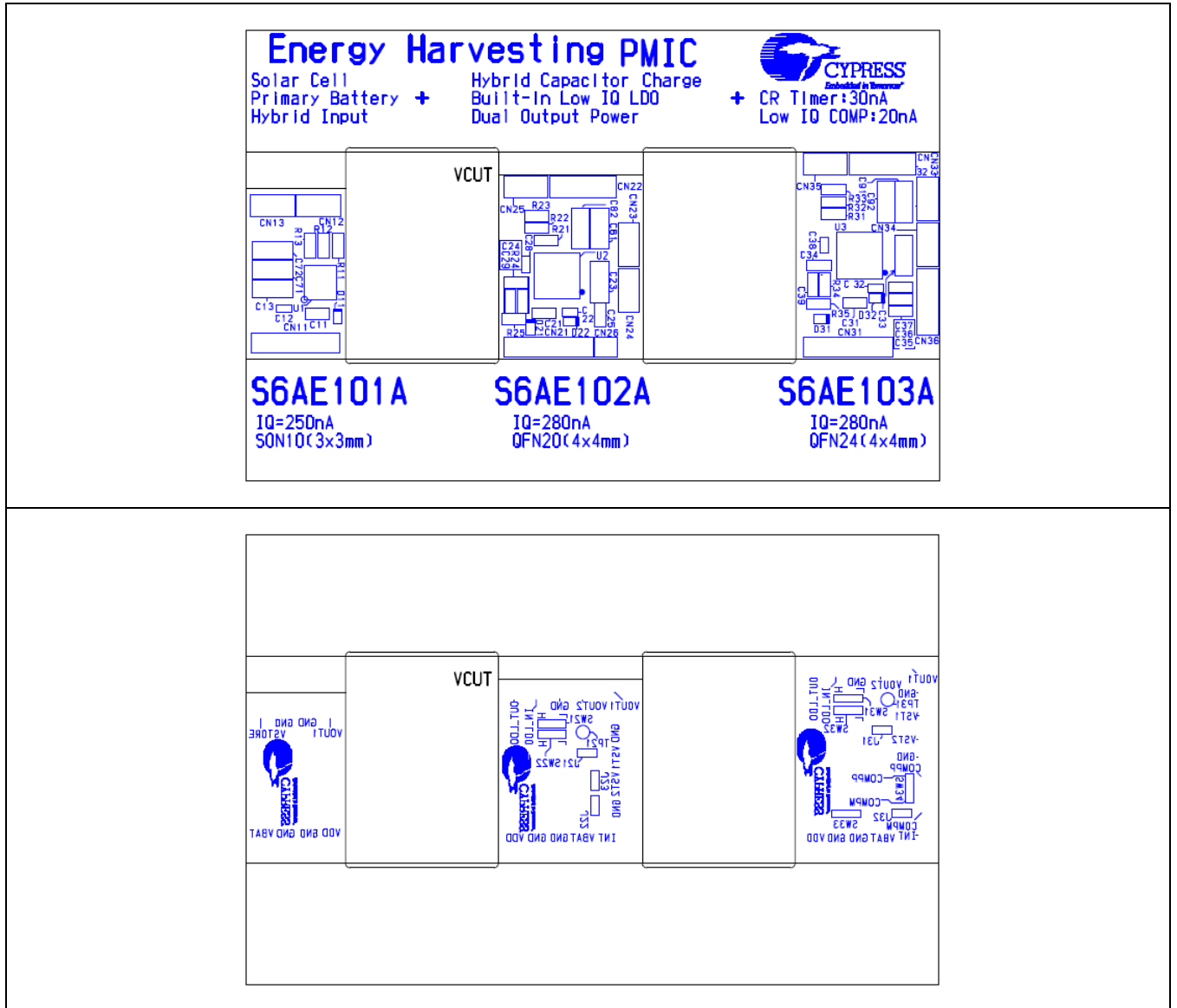
These components are compliant with RoHS, but ask each vender for details if necessary.

Notes : This is for S6SAE100A00VA1001 Rev02

# 7. Components Layout



Figure 7-1 Top, Bottom





# 8. Silk and Layout



Figure 8-1 Layer1

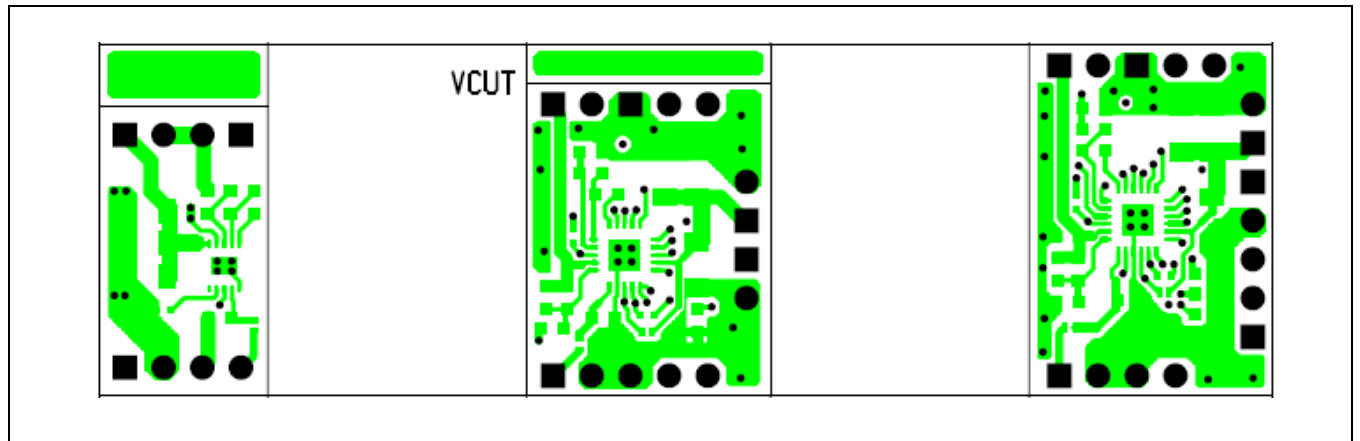


Figure 8-2 Layer2

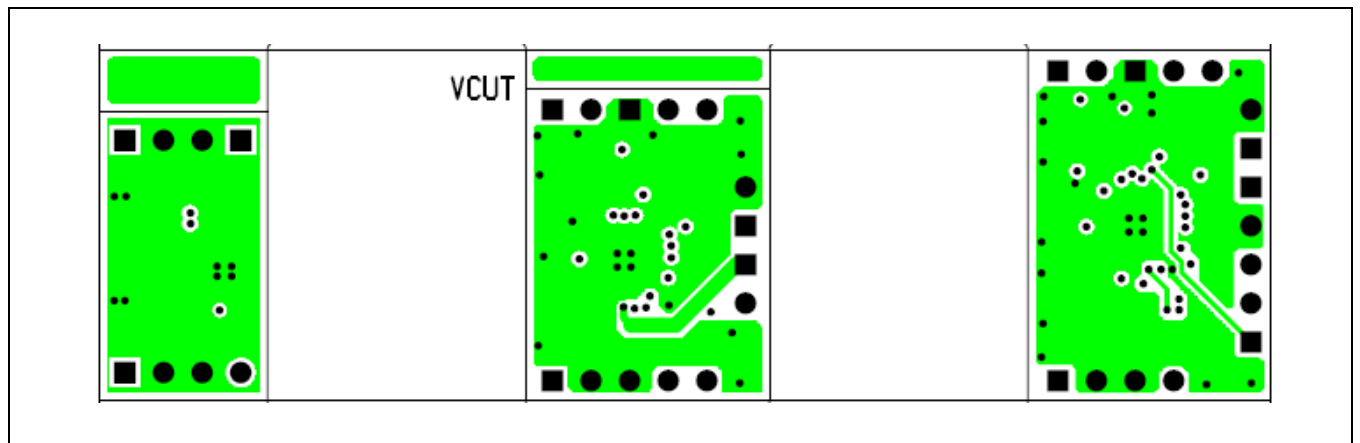


Figure 8-3 Layer3

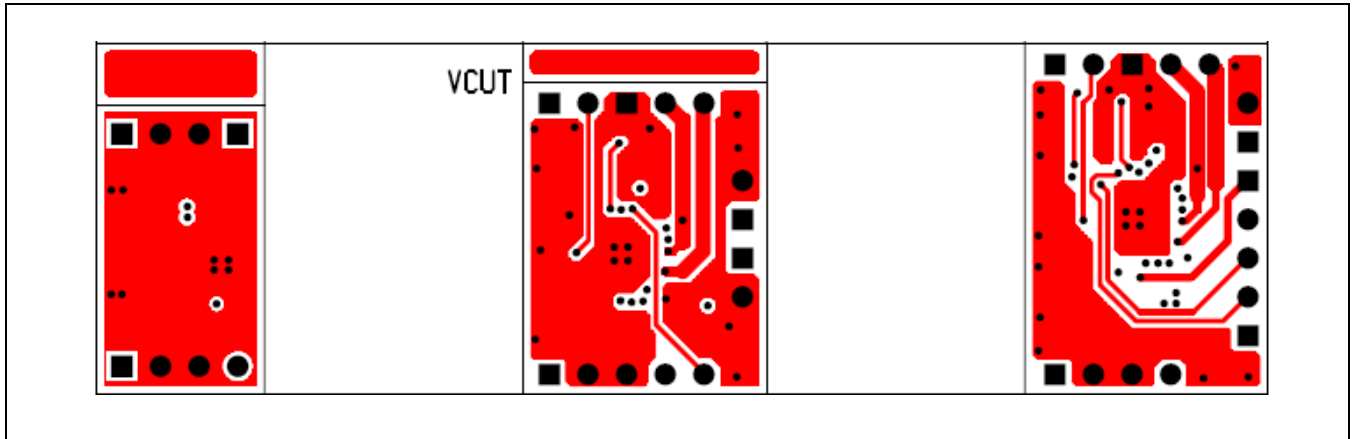
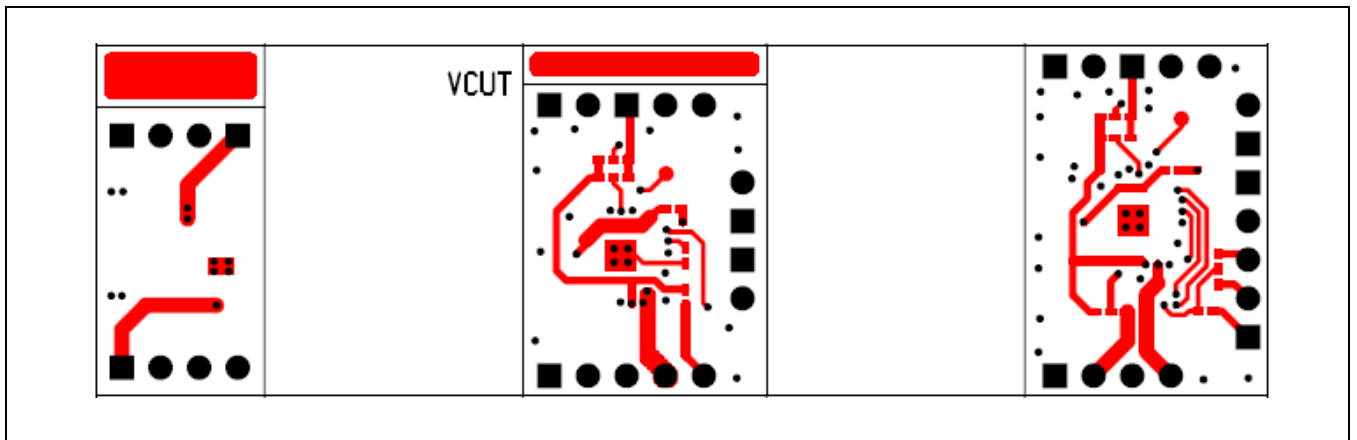


Figure 8-4 Layer4

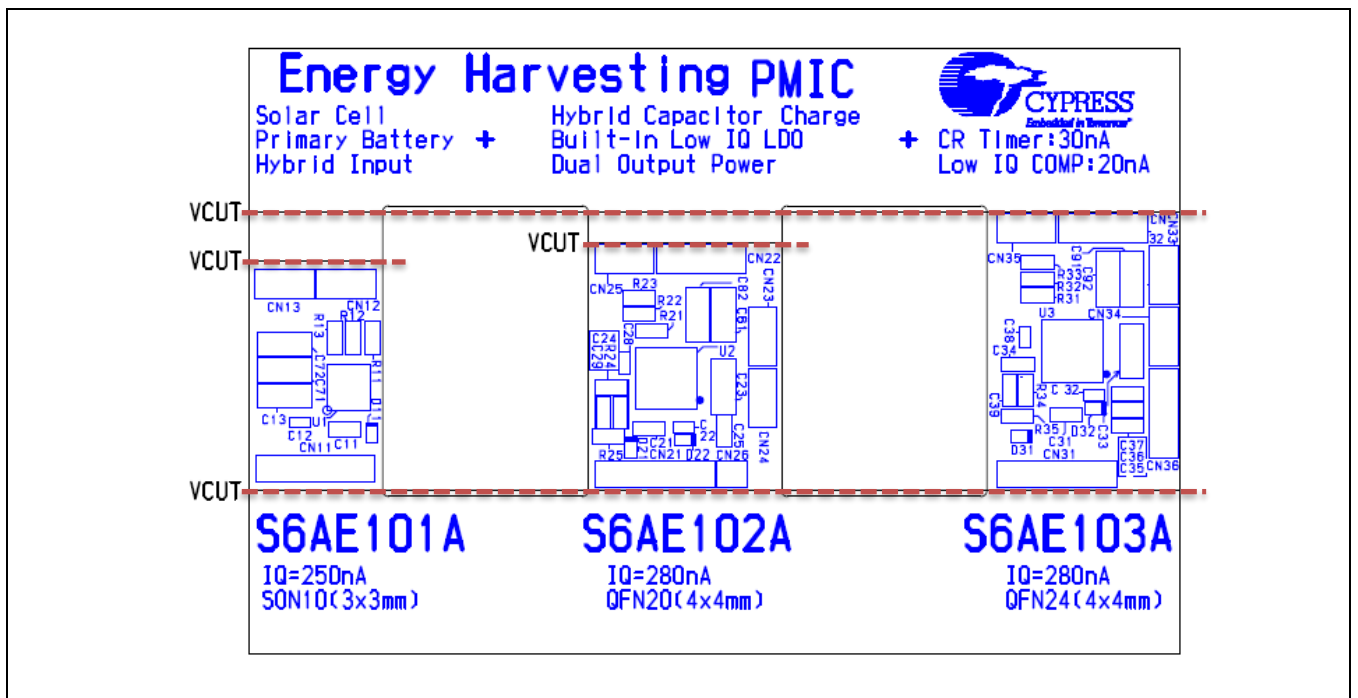


# 9. Board Splitting



The PCB can be cut along the V-cut line. The torsional stress on the board is reduced, when a force is applied to the entire V-cut line.

Figure 9-1 Board



# 10. Ordering Information



**Table 10-1 Ordering Information**

Part Number	EVB Revision	Note
S6SAE100A00VA1001	Rev. 2.0	-

# 11. Major Changes



Spansion Publication Number: S6SAE100A00VA1001\_SS901-00040

**Table 11-1 Major Changes**

Page	Section	Change Results
Revision 1.0		
-	-	Initial release

**NOTE:** Please see “Revision History” about later revised information.

# Revision History



## Document Revision History

Document Title: S6SAE100A00VA1001 Energy Harvesting PMIC S6AE10xA Evaluation Board Operation Guide			
Document Number: 002-08728			
Revision	ECN No.	Origin of Change	Description of Change
**	-	TAOA	New Specification
*A	5131017	ATTS	*A is for S6SAE100A00VA1001 Rev01 Table2-1 Description of output voltage is changed
*B	5490542	ATTS	*B is for S6SAE100A00VA1001 Rev02 Figure 5-1 Updated LDO Circuit, VSTORE1,2 Circuit. Table 6-1 Updated component List 7. Componets Layout updated 8. Silk and Layout updated
*C	6213631	YSAT	Adapted new Cypress logo