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MB39C831-EVB-03

Ultra Low Voltage Boost PMIC Energy Harvesting, Evaluation Board Operation Guide

Doc. No. 002-08720 Rev. *B

Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709
www.cypress.com

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Preface

Purpose of this manual and intended readers

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.

Notice on this document

All information included in this document is current as of the date it is issued. Such information is subject to change without any prior notice.

Please confirm the latest relevant information with the sales representatives.

Caution of the products described in this document

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

⚠ **WARNING**	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.
Electric shock, Damage	Before performing any operation described in this manual, turn off all the power supplies to the system. Performing such an operation with the power on may cause an electric shock or device fault.
Electric shock, Damage	Once the product has been turned on, do not touch any metal part of it. Doing so may cause an electric shock or device fault.
⚠ **CAUTION**	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.
Cuts, Damage	Before moving the product, be sure to turn off all the power supplies and unplug the cables. 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.
Cuts	The product contains sharp edges that are left unavoidably exposed, such as jumper plugs. Handle the product with due care not to get injured with such pointed parts.
Damage	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. Doing so may cause a malfunction due to overloading or shock.
Damage	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 .Inappropriate operating or storage environments may cause a fault.
Damage	Use the product within the ranges given in the specifications. Operation over the specified ranges may cause a fault.
Damage	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.
Damage	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.
Damage	Always turn the power off before connecting or disconnecting any cables from the product. When unplugging a cable, unplug the cable by holding the connector part without pulling on the cable itself. Pulling the cable itself or bending it may expose or disconnect the cable core, resulting in a fault.
Damage	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.

Contents

1. Description

The MB39C831-EVB-03 is the evaluation board for the energy harvesting (Power Management) IC, MB39C831. This evaluation board is capable of accepting solar or thermal electric power source.

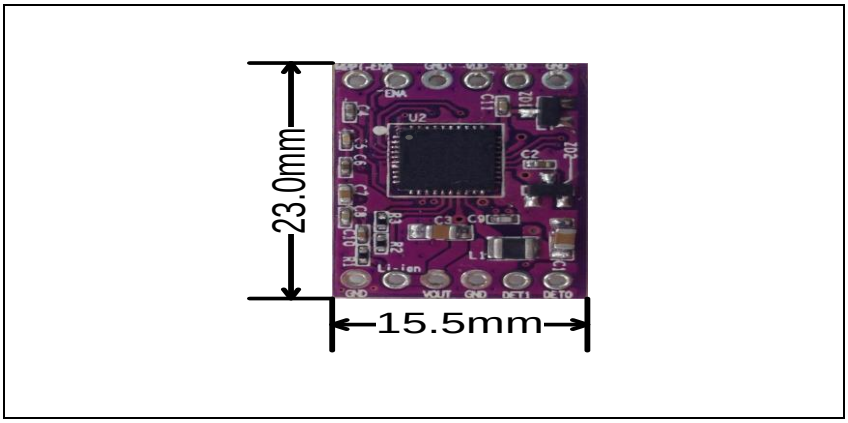
2. Evaluation Board Specification

Table 1. Evaluation Board Specification

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input voltage	VDD	-	0.3	-	4.75	V
Input current	VDD	-	0.75	-	5[1]	mA
Output voltage	VOUT	See Table 5	3.0	-	5	V
Output current	VOUT	VDD=0.6 V, VOUT=3.3 V	8	-	-	mA
		VDD=3.0 V, VOUT=3.3 V	80	-	-	mA
		VDD=3.1 V, VOUT=3.3 V VDD=3.4 V, VOUT=3.6 V VDD=3.9 V, VOUT=4.1 V	-	-	240[1]	mA

[1]: This parameter is not be specified. This should be used as a reference to support designing the circuits. Please see the MB39C831 datasheet (DS405-00014) for more information.

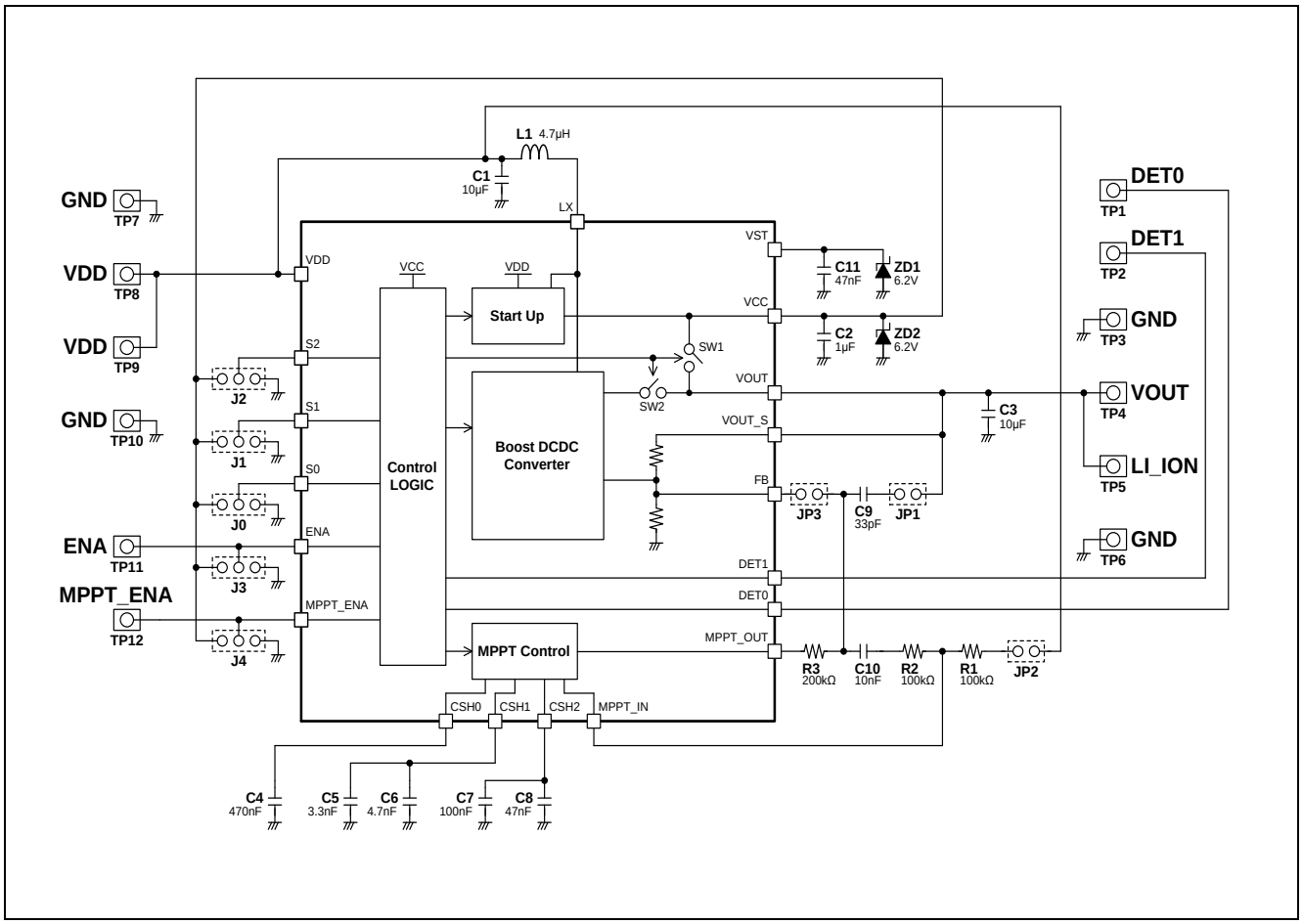
Figure 1. Board Size



Board size: 15.5 mm × 23.0 mm, Layer: 2-layer board, Thickness: 1.6 mm, Type: RF4

3. Block Diagram

Figure 2. Block Diagram



4. Pin Descriptions

4.1 Input/Output Pin Descriptions

Table 2. Input/Output Pin Descriptions

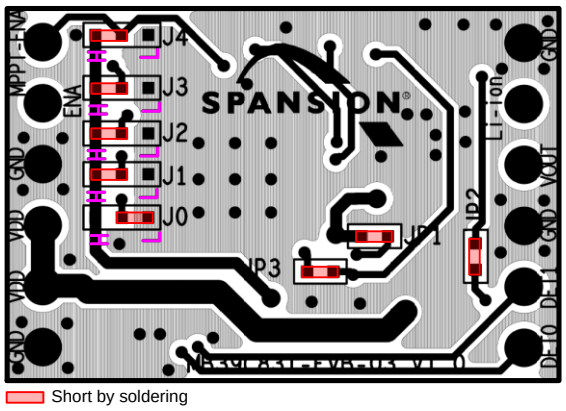
Pin No.	Pin Name	I/O	Description
TP1	DET0	O	Output pin for state notification
TP2	DET1	O	Output pin for state notification
TP3	GND	-	GND pin
TP4	VOUT	O	DC/DC converter output pin
TP5	LI_ION	O	DC/DC converter output pin
TP6	GND	-	GND pin
TP7	GND	-	GND pin
TP8	VDD	I	DC power input pin
TP9	VDD	I	DC power input pin
TP10	GND	-	GND pin
TP11	ENA	I	DC/DC converter control input pin
TP12	MPPT_ENA	I	MPPT control input pin

4.2 Jumper Descriptions

Table 3. Jumper Descriptions

Jumper	Function Description	Initial Setting
J0	Soldering jumper for S0 high/low selection	L
J1	Soldering jumper for S1 high/low selection	H
J2	Soldering jumper for S2 high/low selection	H
J3	Soldering jumper for ENA high/low selection	H
J4	Soldering jumper for MPPT_ENA high/low selection	H
JP1	Soldering jumper for short/open between VOUT pin and capacitor C9	Short
JP2	Soldering jumper for short/open between VDD pin and resistor R1	Short
JP3	Soldering jumper for short/open of FB wire	Short

Figure 3. Initial Settings



4.3 MPPT Value Settings in Charge Mode

Table 4. MPPT Value Settings in Charge Mode

J0 (S0)	J1 (S1)	J2 (S2)	J3 (ENA)	J4 (MPPT_ENA)	MPPT Value [%] (Typ)
L	L	L	H	H	50
H	L	L	H	H	55
L	H	L	H	H	60
H	H	L	H	H	65
L	L	H	H	H	70
H	L	H	H	H	75
L	H	H	H	H	80 (Initial setting)
H	H	H	H	H	85

4.4 Preset Voltage Settings in Constant Voltage Mode

Table 5. Preset Voltage Settings in Constant Voltage Mode

J0 (S0)	J1 (S1)	J2 (S2)	J3 (ENA)	J4 (MPPT_ENA)	Preset Output Voltage [V] (Typ)
L	L	L	H	L	3.0
H	L	L	H	L	3.3
L	H	L	H	L	3.6
H	H	L	H	L	4.1
L	L	H	H	L	4.5
H	L	H	H	L	5.0
L	H	H	H	L	prohibited
H	H	H	H	L	prohibited

5. Setup

5.1 Charge Mode (MPPT Mode)

1. Connect a Li-ion battery not lower than 2.6 V to TP5 (LI_ION pin).
2. Apply a DC voltage to TP8 or TP9 (VDD pins). However, since an input voltage (VDD pin voltage) is adjusted by the MPPT, the adjusted input voltage should be set to become larger than 0.35 V (Min. input voltage at start-up). For the adjusted input voltage, see the following.

   Adjusted input voltage (VDD pin voltage) [V] ≥ 0.35 (Min. input voltage at start-up) [V]

   Example calculation for the adjusted input voltage

   Input voltage: 1.0 [V]

   MPPT value: 80 [%]

   Adjusted input voltage [V] = $\frac{1.0\ [V]}{80 / 100}$ = 0.8 [V]
3. When the boost converter can obtain sufficient electric power for an operation, the charge is stared to the Li-ion battery. The Li-ion battery is charged between 2.6 V and 4 V. When the battery reaches 4 V, the charge is stopped.
4. To change the MPPT value, change the jumper settings, J0, J1, and J2 (see Table 6).

Figure 4. Solar Energy Harvesting in Charge Mode (MPPT Mode)

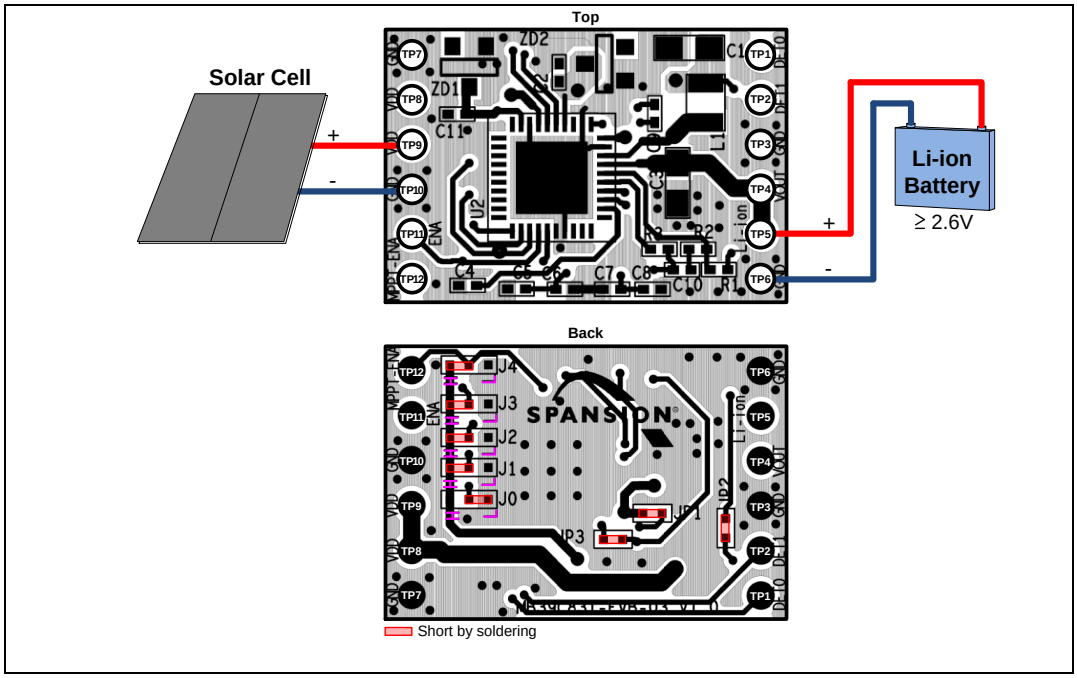


Table 6. Jumper Settings for Charge Mode (MPPT Mode)

J0 (S0)	J1 (S1)	J2 (S2)	J3 (ENA)	J4 (MPPT_ENA)	JP1 (VOUT Wire)	JP2 (VDD Wire)	JP3 (FB Wire)	MPPT Value [%] (Typ.)
L	L	L	H	H	Short	Short	Short	50
H	L	L	H	H	Short	Short	Short	55
L	H	L	H	H	Short	Short	Short	60
H	H	L	H	H	Short	Short	Short	65
L	L	H	H	H	Short	Short	Short	70
H	L	H	H	H	Short	Short	Short	75
L	H	H	H	H	Short	Short	Short	80 (Initial setting)
H	H	H	H	H	Short	Short	Short	85

5.2 Constant Voltage Mode

1. Open J0, J1, J2, J4, JP1, JP2, and JP3 to remove the solders.
2. Set S0, S1, S2, and MPPT_ENA by soldering J0, J1, J2, and J4 jumpers (see Table 7).
3. Apply a DC voltage to TP8 or TP9 (VDD pins). However, a power shown in section 9.1 is required to start-up the boost converter.
4. The preset voltage set by J0, J1 and J2jumpers is outputted from TP4 or PT5 (VOUT pin or LI_ION pin).
5. To change the output voltage, change the jumper settings, J0, J1 and J2 (see Table 7).

Figure 5. Solar Energy Harvesting in Constant Voltage Mode

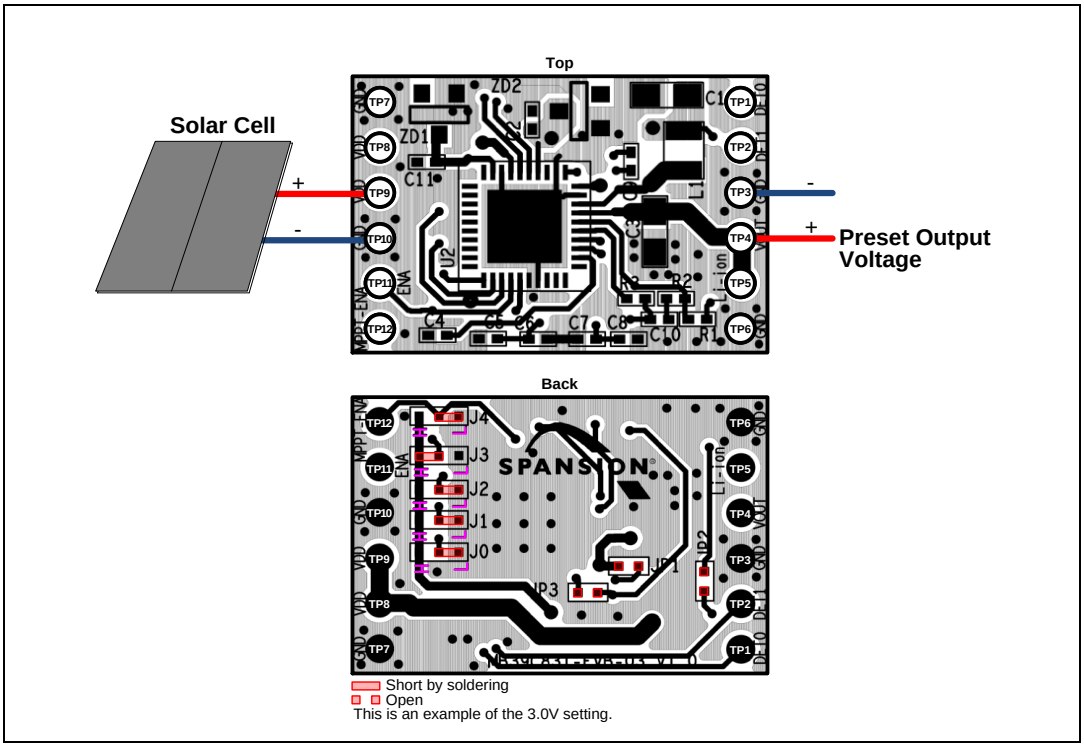
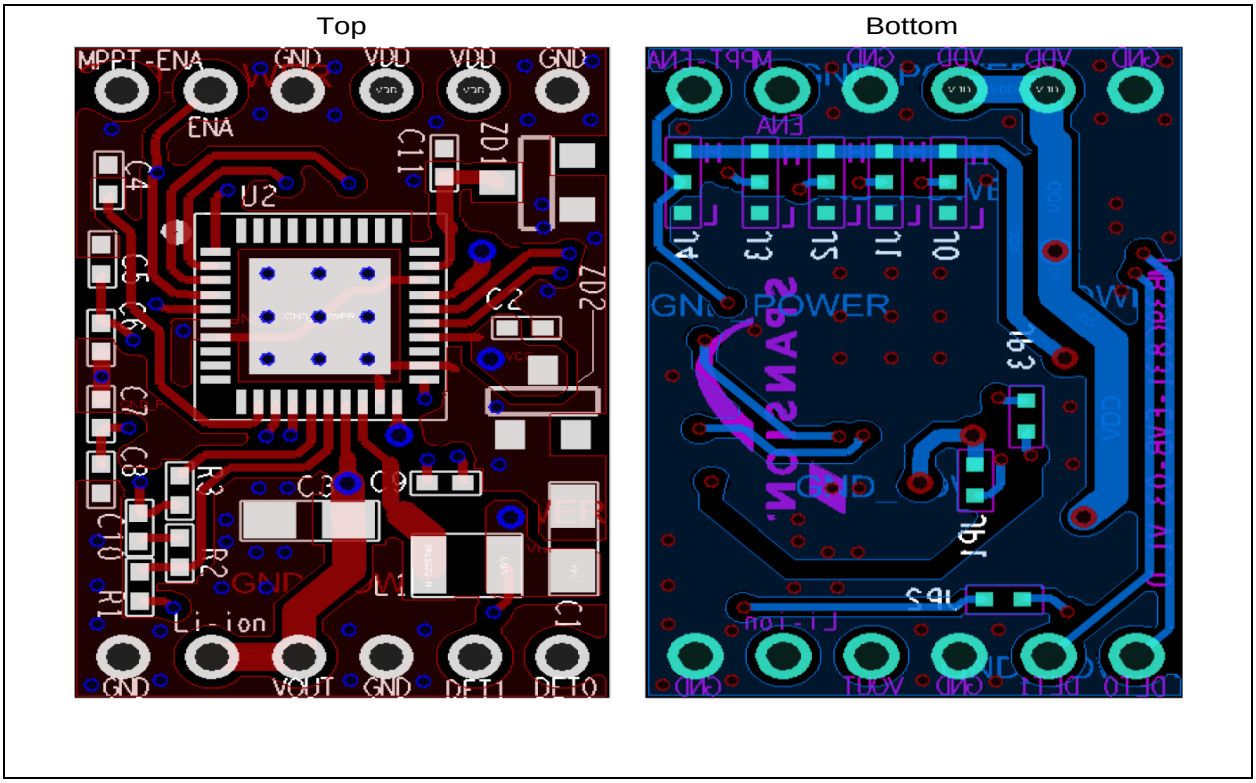


Table 7. Jumper Settings for Constant Voltage Mode

J0 (S0)	J1 (S1)	J2 (S2)	J3 (ENA)	J4 (MPPT_ENA)	JP1 (VOUT Wire)	JP2 (VDD Wire)	JP3 (FB Wire)	Preset Output Voltage [V](Typ.)
L	L	L	H	L	Open	Open	Open	3.0
H	L	L	H	L	Open	Open	Open	3.3
L	H	L	H	L	Open	Open	Open	3.6
H	H	L	H	L	Open	Open	Open	4.1
L	L	H	H	L	Open	Open	Open	4.5
H	L	H	H	L	Open	Open	Open	5.0
L	H	H	H	L	Open	Open	Open	prohibited
H	H	H	H	L	Open	Open	Open	prohibited

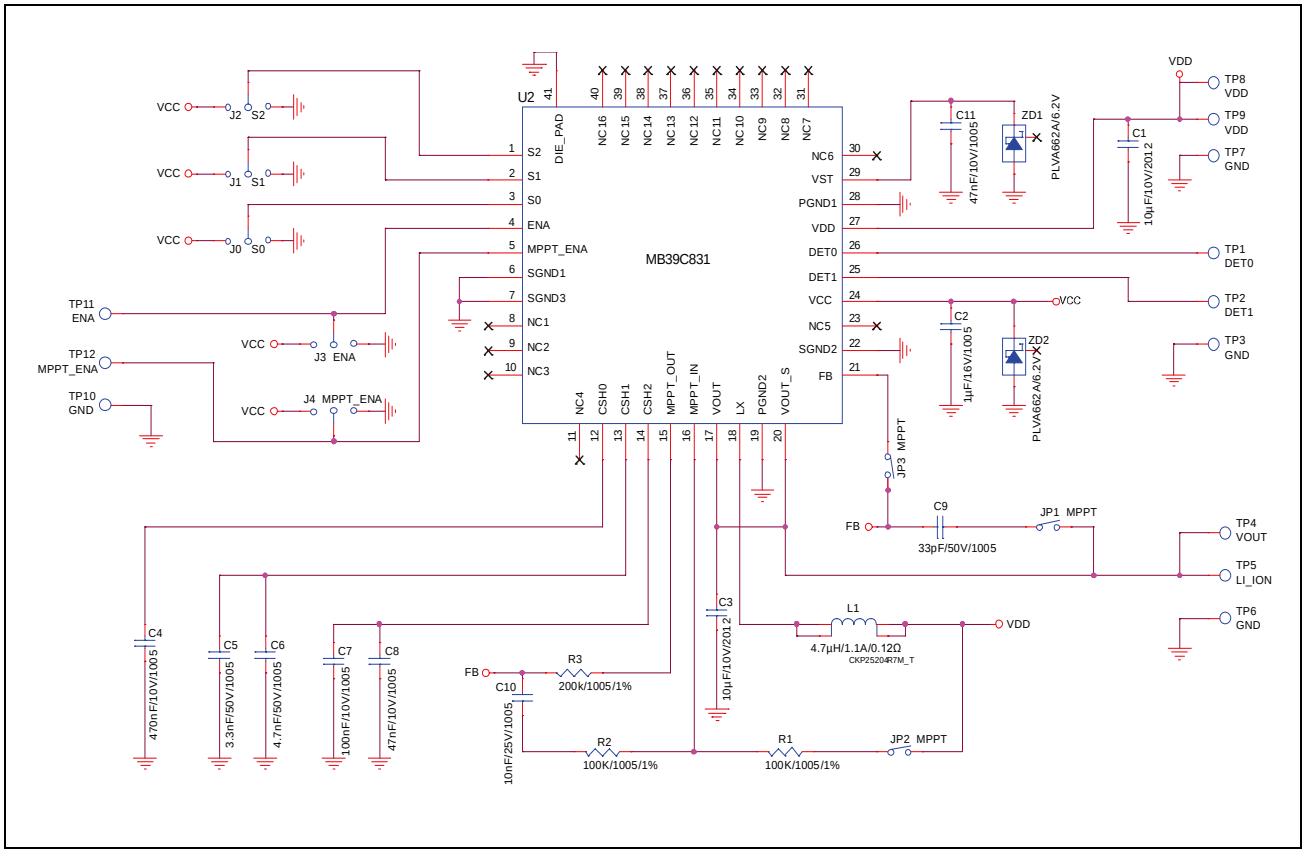
6. Layout

Figure 6. Layout



7. Circuit

Figure 7. Circuit



8. Component List

Table 8. Component List

No.	Comp. No.	Mount	Vender	Class.	Part Number	Rating	Note
1	C1	Mount	Murata	capacitor	GRM21BR71A106KE51	10 V	10µF, 2012, ±10%, X7R
2	C3						
3	C2	Mount	Murata	capacitor	GRM155R61C105KA12	16 V	1µF, 1005, ±10%, X5R
4	C4	Mount	Murata	capacitor	GRM155R71A474KE01	10 V	470nF, 1005, ±10%, X7R
5	C5	Mount	Murata	capacitor	GRM155R71H332KA01	50 V	3.3nF, 1005, ±10%, X7R
6	C6	Mount	Murata	capacitor	GRM155R71H472KA01	50 V	4.7nF, 1005, ±10%, X7R
7	C7	Mount	Murata	capacitor	GRM155R71A104KA01	10 V	100nF, 1005, ±10%, X7R
8	C8	Mount	Murata	capacitor	GRM155R71A473KA01	10 V	47nF, 1005, ±10%, X7R
9	C11						
10	C9	Mount	Murata	capacitor	GRM1552C1H330JA01	50 V	33pF, 1005, ±5%, JIS(CH)
11	C10	Mount	Murata	capacitor	GRM155R71E103KA01	25 V	10nF, 1005, ±10%, X7R
12	J0	Solder	---	jumper	---	---	2 lands jumper
13	J1						
14	J2						
15	J3						
16	J4						
17	JP1	Solder	---	jumper	---	---	3 lands jumper
18	JP2						
19	JP3						
20	L1	Mount	TAIYO YUDEN	inductor	CKP25204R7M-T	1.1A	4.7µH, 2520, ±20%
21	U2	Mount	Cypress	IC	MB39C831	7 V	QFN40pin
22	TP1	Not mount	Mac8	terminal	WL-8	---	1 pin terminal
23	TP2						
24	TP3						
25	TP4						
26	TP5						
27	TP6						
28	TP7						
29	TP8						
30	TP9						

No.	Comp. No.	Mount	Vender	Class.	Part Number	Rating	Note
31	TP10						
32	TP11						
33	TP12						
34	R1	Mount	KOA	resistor	RK73H1ETTP1003F	0.063 W	100 kΩ, 1005, ±1%,
35	R2						
36	R3	Mount	KOA	resistor	RK73H1ETTP204F	0.063 W	200 kΩ, 1005, ±1%,
37	ZD1	Mount	NXP Semi.	zener diode	PLVA662A	Vz=6.2 V	Lz=250 µA,
38	ZD2						

Murata: Murata Manufacturing Co., Ltd.

TAIYO YUDEN: TAIYO YUDEN CO., LTD.

Cypress: Cypress Semiconductor.

Mac8: Mac-Eight Co.,Ltd.

KOA: KOA Corporation

NXP Semi.: NXP Semiconductors

9. Application Notes

9.1 Harvester

The MB39C831 is designed for a harvester having a high power generation capacity, such as an outdoor solar cell. It is not possible to start up with a small indoor solar cell.

9.2 Power Requirement in Start-Up in Constant Voltage Mode

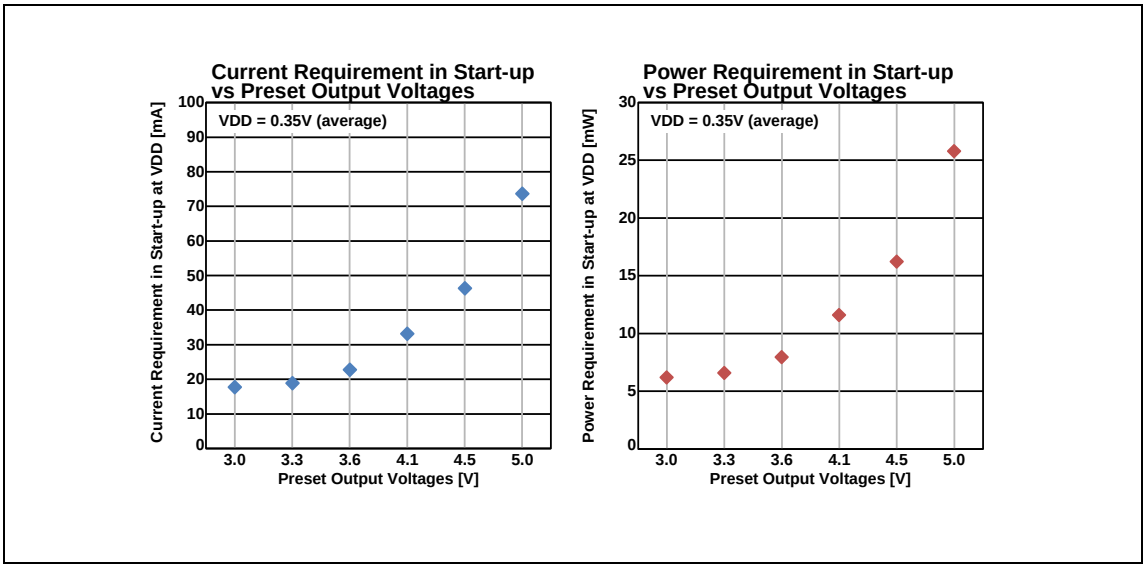
The VDD (VDD = 0.35 V) voltage is applied from constant voltage source.

Table 9. Power Requirement in Start-Up

Preset Output Voltage Setting [V]	Average Voltage in Start-Up at VDD [V]	Current Requirement in Start-Up at VDD [mA]	Power Requirement in Start-Up at VDD [mW]
3.0	0.35	17.7	6.20
3.3	0.35	18.8	6.58
3.6	0.35	22.7	7.95
4.1	0.35	33.1	11.59
4.5	0.35	46.3	16.21
5.0	0.35	73.6	25.76

VDD voltage is applied from constant voltage source.

Figure 8. Current and Power Requirement in Start-Up

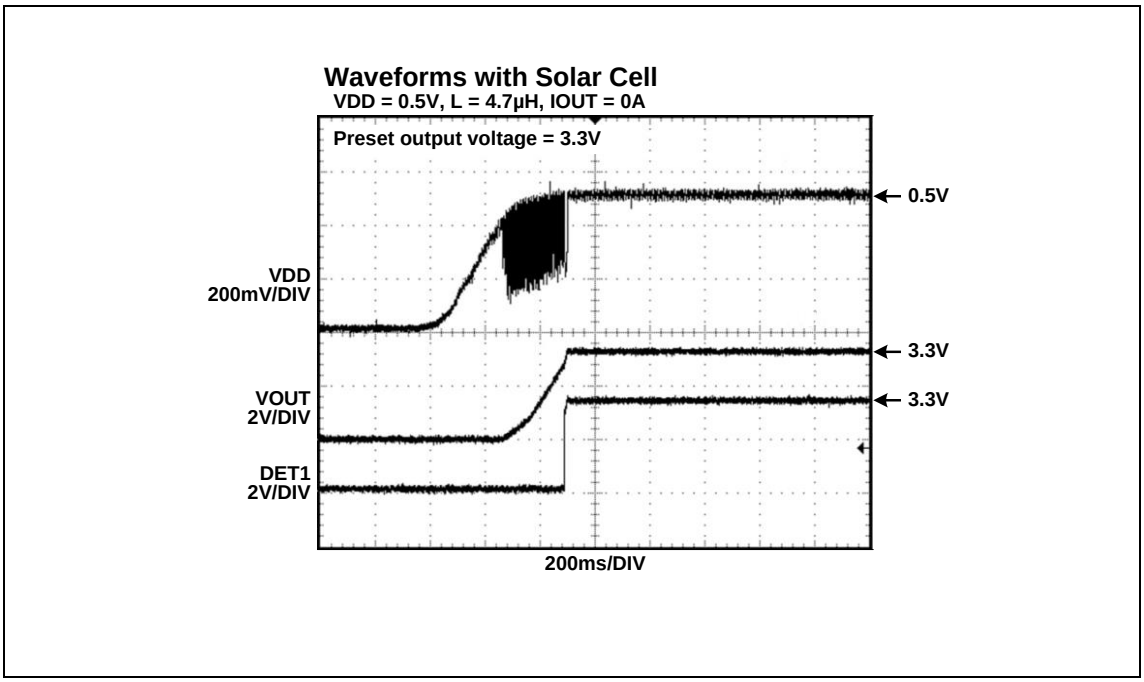


VDD voltage is applied from constant voltage source.

9.3 Waveform of VDD/VOUT Voltages in Start-up in Constant Voltage Mode

The followings are the waveform of the VDD/VOUT voltages in start-up when a solar cell is connected.

Figure 9. Waveform of VDD/VOUT Voltage in Start-up



The current requirements in start-up are shown in Table 10 when the VDD current is applied from constant current source (because a solar cell operates close to a constant current source). For each preset output voltage, select a right harvester to satisfy the following current value in start-up.

Table 10. Current Requirement in Start-Up at VDD

Preset Output Voltage[V]	Current Requirement in Start-Up at VDD[mA]
3.0	8.4
3.3	23.8
3.6	42.2
4.1	51.9
4.5	63.6
5.0	87.9

VDD current is applied from constant current source.

9.4 Quick Start Guide

1. First, apply 3.3 V to the VOUT pin by the voltage source that is a substitute for Li-ion battery (see the Figure 10).
2. Connect a solar cell (release voltage = 1 V, short circuit current = 500 mA) to VDD pin.
3. Apply light (3300Lx) to the solar cell.
4. When the charging operation is started, the average voltage of VDD pin (voltmeter) becomes about 0.8 V, and the current of VOUT pin (ammeter) becomes about -14 mA.

Figure 10. Test Circuit in Charge Mode

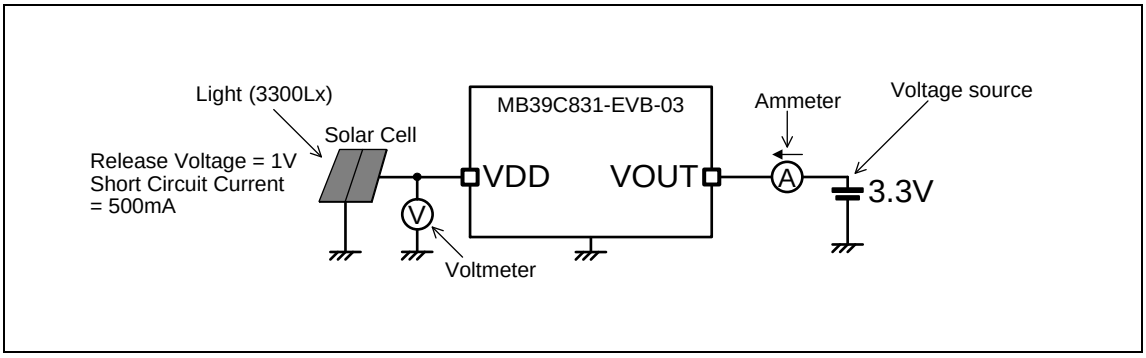
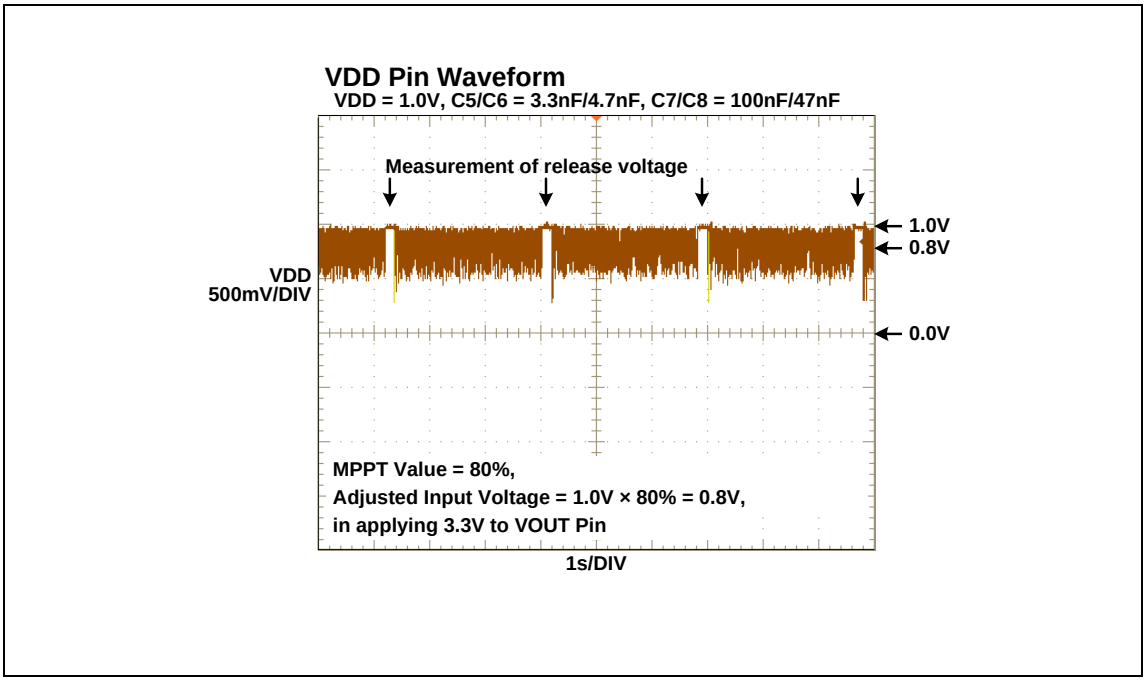


Table 11. Measurement Data

Item	Pin name	Note	Min	Typ	Max	Unit
Voltmeter	VDD	Check the average voltage	-	0.8[1]	-	V
Ammeter	VOUT	Current flows to the voltage source	-	-14[1]	-	mA

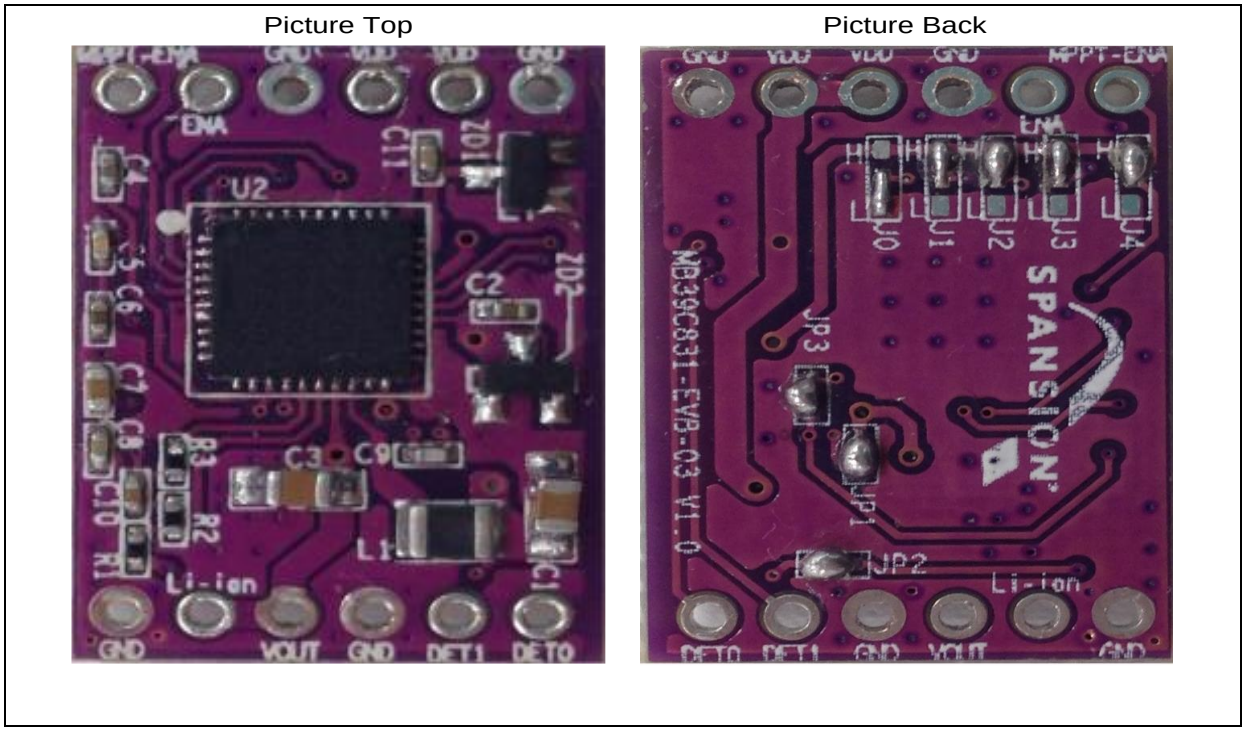
[1]: These data are not specified in the datasheet, using the test circuit, shown in Figure 10. These data should be used as a reference to support designing circuits.

Figure 11. VDD Pin Waveform in Charge Mode



10. Picture

Figure 12. Picture



11. Ordering Information

Table 12. Ordering Information

Part Number	EVB Revision	Note
MB39C831-EVB-03	Rev 1.0	---

12. Revision History

Document Revision History

Document Title: MB39C831-EVB-03, Ultra Low Voltage Boost PMIC Energy Harvesting, Evaluation Board Operation Guide Document Number: 002-08720			
Revision	Issue Date	Origin of Change	Description of Change
**	02/04/2015	EIFU	Initial Release
*A	05/26/2016	EIFU	Migrated Spansion guide “SS901-00033-1v0-E“ to Cypress format.
*B	12/26/2017	EIFU	Updated the Cypress logo and copyright informtion.