Battery Management System Reference Design

Maxell All-solid-state Battery + Nano Energy™ Collaboration Board

REFLVBMS002-EVK-001

Introduction

This User's Guide provides the information and necessary procedures to operate and evaluate the Maxell's All-solid-state Battery (PSB401010H) + Nano Energy™ Collaboration Board. It includes the board schematic, peripheral parts list, and operating instructions.

Please note that this board has been prepared for the purpose of simple evaluation of Maxell's All-solid-state Battery and Nano Energy™ characteristics, and we cannot guarantee its quality. In addition, this evaluation board is intended to be used by professionals for research and development purposes. This board is not intended to be used in mass production products or any part thereof.

Note: Nano Energy™ is a trademark or registered trademark of ROHM Co., Ltd.

Description

This collaboration board charges the All-solid-state battery (PSB401010H) manufactured by Maxell, and outputs the power stored in the battery by stepping up and stabilizing it. The Power Supply and RESET ICs with Nano Energy technology maximize the battery life.

For the specifications of the Linear charger dedicated for Maxell's All-solid-state battery, RESET IC, and Step-up DC-DC converter IC that realize these functions, please refer to the datasheet in ROHM Co. Ltd. website. For the specifications of All-solid-state battery (PSB401010H), please refer to datasheet in Maxell's website.

Maxell, Ltd., web site (https://www2.maxell.co.jp/) Maxell's All-solid-state battery special web site (https://biz.maxell.com/en/rechargeable_batteries/allsolidstate.html)	
Battery	PSB401010H
ROHM Co., Ltd. web site (https://www.rohm.com)	
Linear Charger	BD7090NUV
Step-up DC-DC converter	BD8B133NVX (Under development *As of January 2023)
RESET	BU49xxFVE (xx : Number indicating detection voltage)

Storage Precautions

The board is equipped with a battery.

When storing the board, keep it in a bag to prevent short-circuit between the positive and negative terminals of the battery.

Set the EN jumper on the board to "L" to turn off the DC-DC converter.

Operating conditions

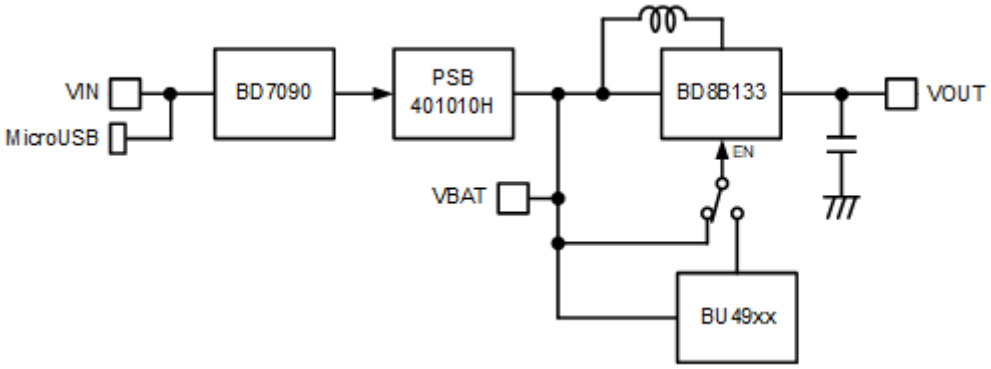


Figure 1：Block Diagram of Battery and each ICs

Figure 1 shows the block diagram of the collaboration board. The charger IC (BD7090NUV) starts charging the Battery (PSB401010H) by applying voltage to the VIN pin or MicroUSB connector. If charging is not required, leave the VIN pin and MicroUSB connector open. The RESET IC (BU49xx) constantly monitors the PSB404010H's voltage and forcibly stops the operation of the DC-DC converter when the Battery voltage falls below BU49xx's threshold voltage. (The RESET IC is optional; without the RESET IC, the step-up DC-DC converter can be operated up to its operational range.) The DC-DC converter (BD8B133NVX) converts the power stored in the PSB404010H battery with high efficiency. The discharge time is determined by the stored power of the Battery.

Below are the recommended operating conditions for the Maxell All-solid-state battery + Nano Energy collaboration board:

Item	Symbol	Min	Typ	Max	Unit	Conditions
Charge Input Voltage	V_{IN}	2.9	-	5.5	V	Charger Input
Output Current	I_{OUT}	-	-	*1	mA	*1 (All solid-state battery capacity: 30mA)/boost-up ratio
Operating Ambient Temperature (Charging)	$T_{a,chg}$	-20	-	105	°C	Depends on all solid-state battery regulations
Operating Ambient Temperature (Discharge)	$T_{a,dischg}$	-40	-	125	°C	Depends on DC-DC and all solid-state battery provisions

Table 1：Recommended Operating Conditions

Typical characteristics are shown below. For detailed characteristics, please refer to the datasheet of each IC.

Item	Symbol	Min	Typ	Max	Unit	Conditions
DC-DC converter off voltage	$V_{dcdcoff}$	0.9	-	-	V	UVLO detection of DC-DC converter
DC-DC converter on voltage	V_{dcdcon}	-	0.9	1.1	V	UVLO detection of DC-DC converter
Output voltage setting range	V_{OUTSEL}	3.0	-	3.3	V	2-step setting (VSEL=L or H)
Output Voltage Accuracy	V_{TOL}	-4.0	0.0	4.0	%	Iout＝0mA
Startup load	R_{stup}	3.0	-	-	kΩ	Activatable load resistance
Charge voltage	V_{CHG}	-	2.6	-	V	R8=100kΩ,R9=332kΩ
Charge current	I_{CHG}	-	4.0	-	mA	R3A=1.5kΩ, R3B=124kΩ
termination current	I_{TERM}	-	0.15	-	mA	R4=332kΩ

Table 2：Typical Specification Values of ICs (Excerpt)

Board Overview

This board achieves area-saving mounting by using an ultra-small All-solid-state battery and a Nano Energy IC encapsulated in an ultra-small package. Since the board has a charging function and a discharging function for battery management on the same board, the overall characteristics of the "battery + power supply" can be evaluated.

In addition, by mounting a RESET IC, it is possible to turn on/off the step-up DC-DC converter at any battery voltage. (Since the RESET IC is not mounted on this board, it is specified within the operation range of the step-up DC-DC converter.)

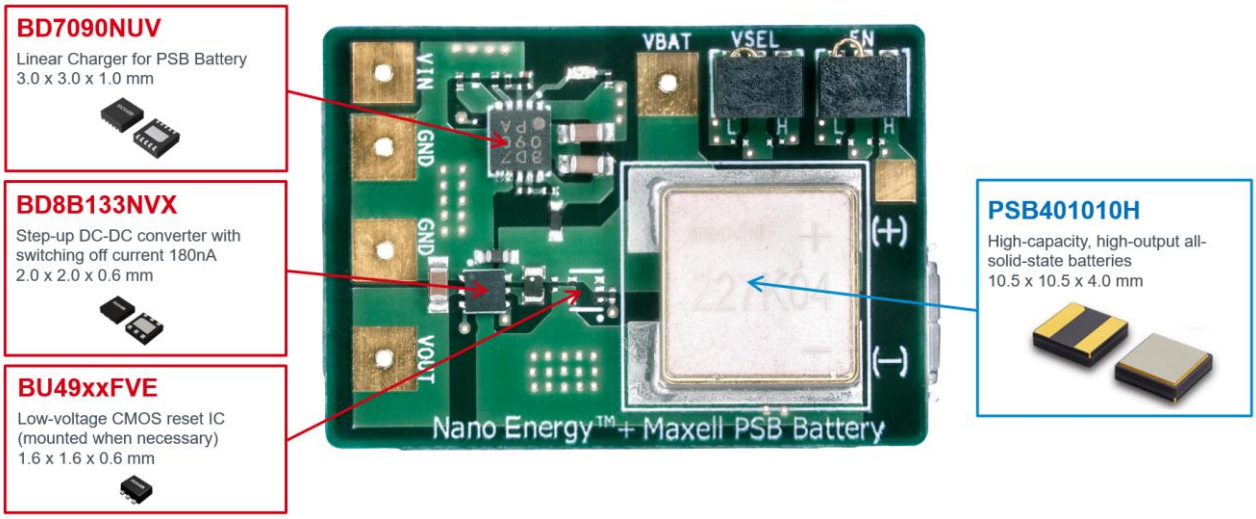
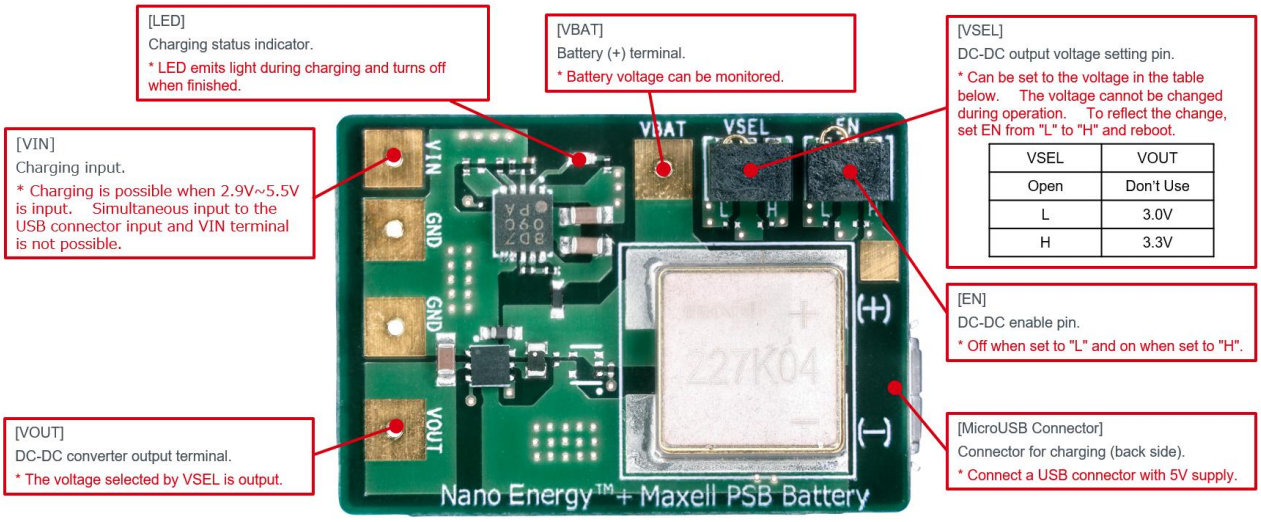


Figure 2 : Collaboration Board Mounted Products

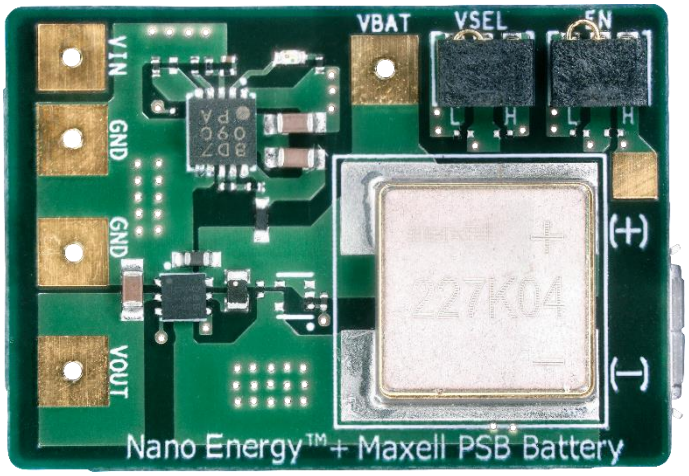
Board Description



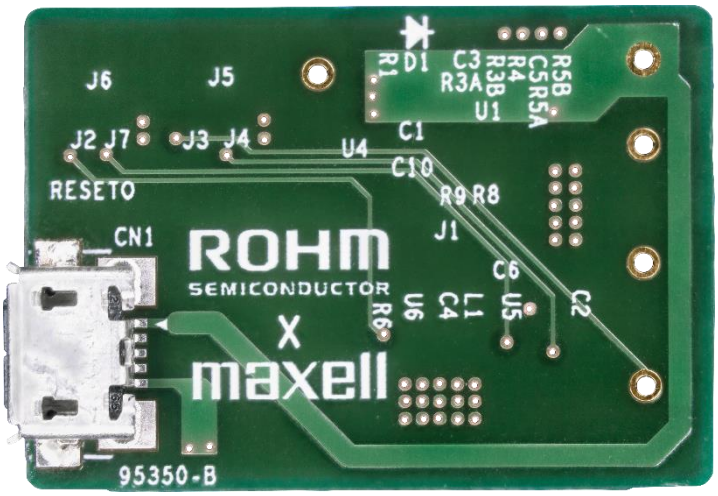
The factory default pin settings are EN=L, VSEL1=L, and VSEL2=L.

Figure 3 : Collaboration Board Pin and Jumper Description

Board photo



Top View



Bottom View

Figure 4 : Collaboration Board Photo

About Jumper Settings

The board uses HHP-3 jumpers manufactured by MAC EIGHT CO., LTD..

To set the state of the jumpers, short the center terminal of the HHP-3 to the H side terminal or L side terminal as specified on the silk.

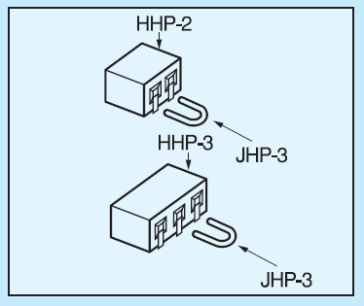
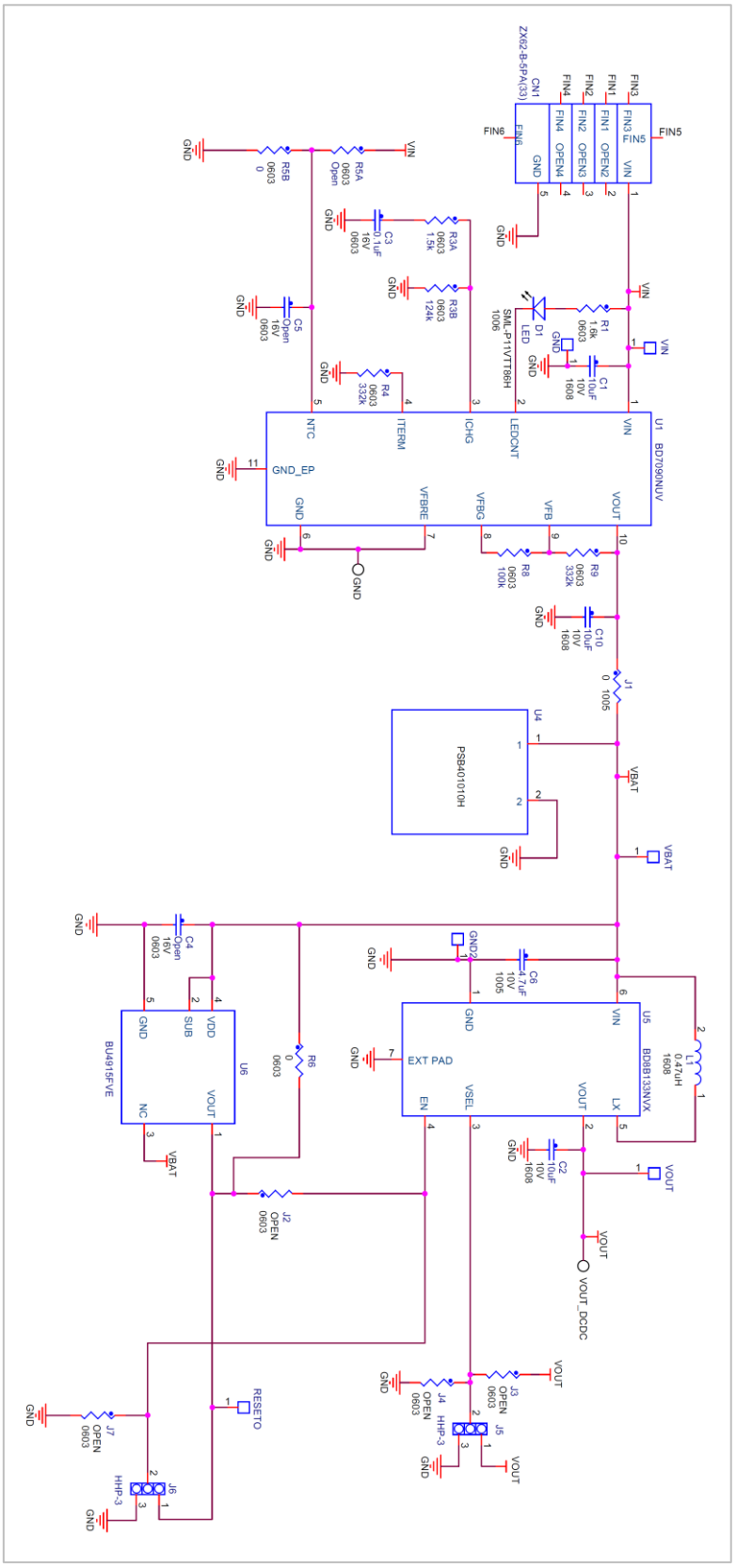


Figure 5：Terminal Jumper Description

Board Schematic



Note: Refer to the parts list on the next page for the fixed value of parts.

Figure 6 : Board Schematic

Parts List

Unit	Part	Value	Description		
Charger	U1	-	IC	ROHM	BD7090NUV
	R1	1.6kΩ	Resistor	ROHM	MCR006
	R3A	1.5kΩ	Resistor	ROHM	MCR006
	R3B	124kΩ	Resistor	ROHM	MCR006
	R4	332kΩ	Resistor	ROHM	MCR006
	R5A	EMPTY	Resistor		
	R5B	0Ω	Resistor	ROHM	MCR006
	R8	100kΩ	Resistor	ROHM	MCR006
	R9	332 kΩ	Resistor	ROHM	MCR006
	C1	10μF	Capacitor	Murata	GRM188Z71A106KA73D
	C3	0.1μF	Capacitor	Murata	GRM033C71C104KE14D
	C5	EMPTY	Capacitor		
	C10	10μF	Capacitor	Murata	GRM188Z71A106KA73D
	D1	-	LED	ROHM	SML-P11VTT86RH
RESET	U6	EMPTY	IC		
	R6	0Ω	Resistor	ROHM	MCR006
	C4	EMPTY	Capacitor		
DC-DC	U5	-	IC	ROHM	BD8B133NVX
	C2	10μF	Capacitor	Murata	GRM188Z71A106KA73D
	C6	4.7μF	Capacitor	Murata	GRM155D71A475ME15D
	L1	0.47μH	Inductor	Murata	DFE18SANR47MG0#
Battery	U4	-	Battery	Maxell	PSB401010H
Other	J1	0Ω	Jumper	ROHM	PMR01ZZPJ000
	J2	EMPTY	Jumper		
	J3	EMPTY	Jumper		
	J4	EMPTY	Jumper		
	J5	-	Jumper	マックエイト	HHP-3
	J6	-	Jumper	マックエイト	HHP-3
	J7	EMPTY	Jumper		
	CN1	-	Connector	HIROSE	ZX62-B-5PA(33)

Table 3：Parts List of Collaboration Board

Board Operating Procedure

■ **Procedure for charging All-solid-state battery PSB401010H**

Input a DC voltage of 2.9V~5.5V (current capability of 10mA or more) between VIN and GND. Alternatively, connect a USB line supplying 5 V to the MicroUSB connector mounted on the back side.
5 V cannot be applied simultaneously to the VIN pin and the MicroUSB connector.
The LED turns on while charging the PSB401010H and turns off when charging is complete.
When the EN jumper is set to "H", the DC-DC converter operates during charging.

■ **DC-DC converter output procedure**

To operate the DC-DC converter, set EN = H.
When startup is completed, the voltage of the step-up DC-DC converter is output from the VOUT pin.

■ **DC-DC converter output voltage setting procedure**

① Turn off the DC-DC converter with EN = L.
② Set the VSEL jumper state to the desired output voltage (see table below).
③ Set EN = H to turn ON the DC-DC converter. VOUT will be equal to the configured voltage output.

VOUT	VSEL
1.8V	Open (Don't Use)
3.0V	L
3.3V	H

Table 4：DC-DC Converter Output Voltage Setting with VSEL Jumper

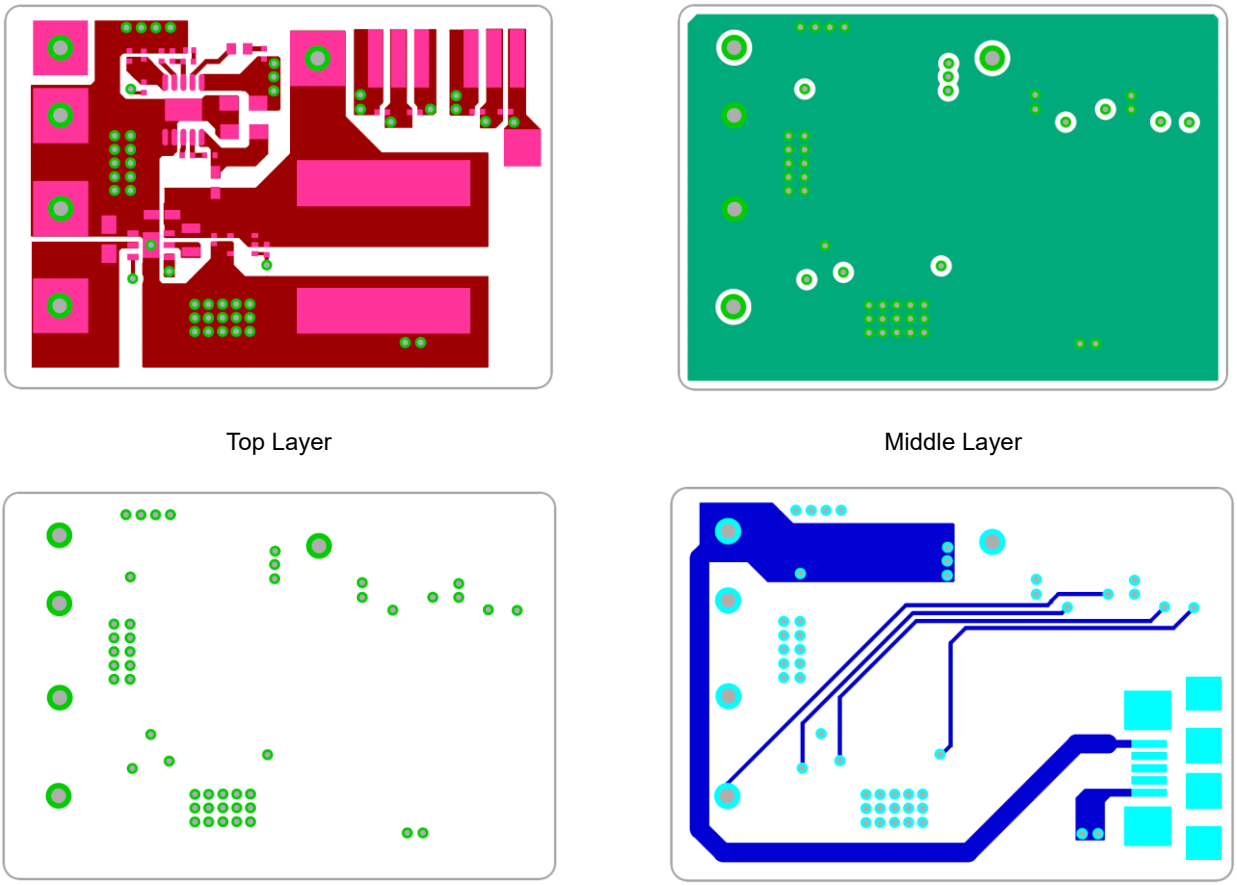
Board PCB Layout

■ **PCB information**

Layers	Material	Board dimension	Copper thickness
4	FR-4	30mm x 21mm x 1.0mm	1oz (35μm)

Table 5 : PCB Information

■ **Board Layout**



Top Layer　　Middle Layer

Middle2 Layer　　Bottom Layer

Figure 7 : Collaboration Board Layout

Specification Notes

- The step-up DC-DC converter on this board is equipped with a development product. Although we have thoroughly checked the operation of the board, we will replace the board if it is defective in operation.

- Since the battery terminals are exposed, when storing the product, stop the DC-DC converter by setting EN=L and store the product in individual bags to prevent the battery terminals from short-circuiting.

- The output current of the step-up DC-DC converter is limited by the battery capacity, so do not connect a load that exceeds the battery capacity.

- Since RESET (battery voltage monitoring IC) is not mounted on this board, it operates up to the lower input limit of the step-up DC-DC converter. When the battery voltage is lower than the nominal voltage, heavy load start-up should not be performed. It may not be possible to start up due to high internal resistance of the battery.

Revision History

Revision	Note
001	Create New.
002	Corrected from BD8B133NWX to BD8B133NVX.

Notes

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