



NUVATION BMS™

Low-Voltage Battery Controller

NUV300

Datasheet

2017-12-08, Rev. 1.13

Table of Contents

System Overview	3
Operating Limits	4
Hardware Overview	8
Power, Monitoring, and Control Connections	8
Cell Voltage and Temperature (J8)	9
Current Shunt and +VPOWER (J7).....	9
Contactors and -VPOWER (J6)	10
Control GPIO (J5).....	10
Communication Connections.....	11
Link Out (Expansion Interface) (J1)	11
Ethernet (J2).....	11
CAN (J3).....	11
RS-485 Modbus RTU (J4)	11
Mechanical Overview	12
Ordering Info.....	13

List of Tables

Table 1: Electrical Characteristics	4
Table 2: Environmental Conditions	7
Table 3: Battery Controller Power Wire Fuse Selection Guide	8

List of Figures

Figure 1: Example System Diagram.....	3
Figure 2: Mechanical Drawing of Battery Controller.....	12

System Overview

The Nuvation BMS™ Low-Voltage Battery Controller (BC) can be used as a complete Battery Management System (BMS) to manage up to 12 or 16 battery cells in series.

An example configuration is shown in Figure 1.

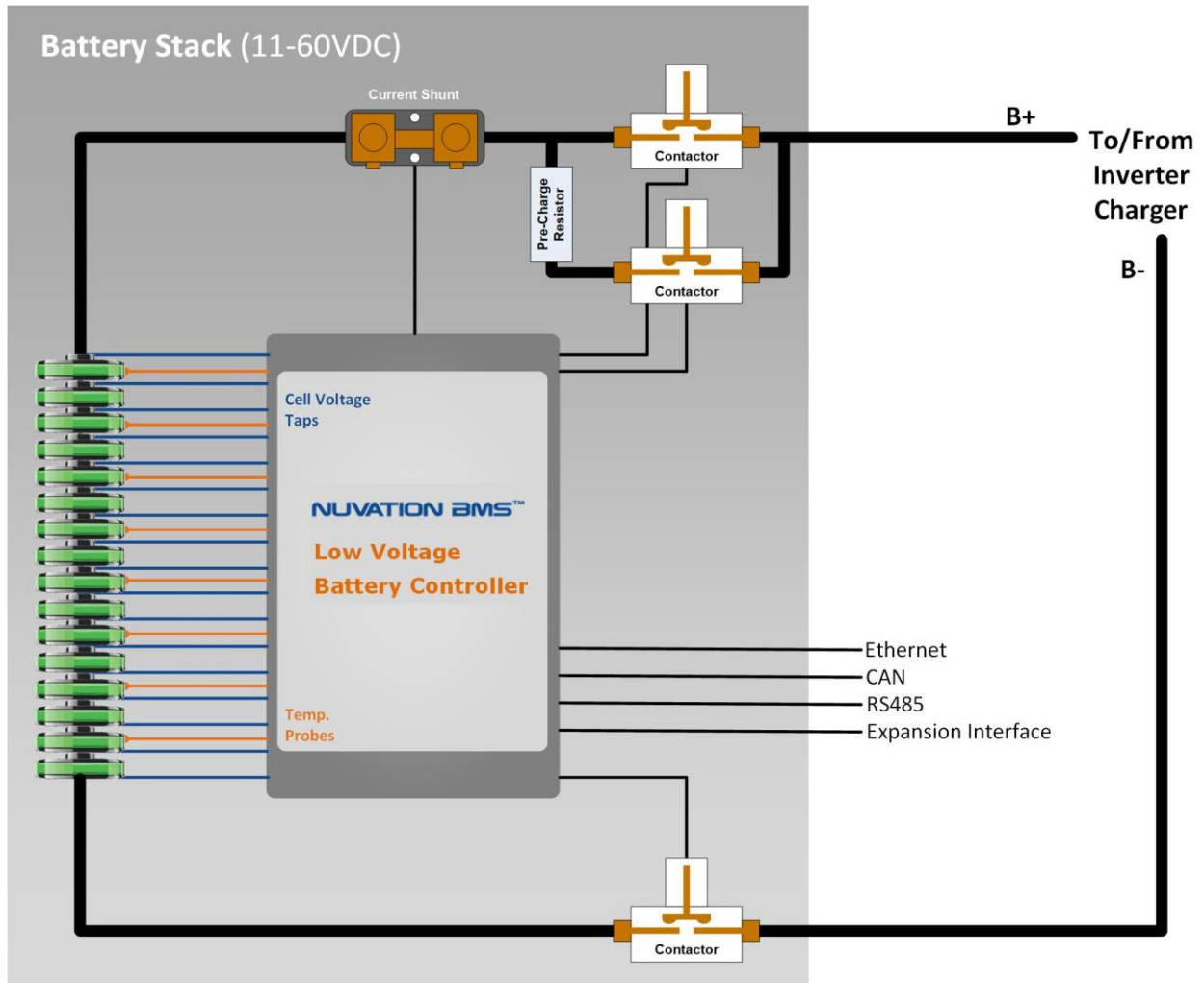


Figure 1: Example System Diagram

Operating Limits

Table 1: Electrical Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Stack Power Specification						
+VBAT	Input DC Voltage		11	-	60	V
	Input Current	+VBAT = 48V DC	-	-	580	mA
Battery Cells Specification						
C(n)	Input Cell Voltage Range		0	-	5	V
Vsum	Voltage between C0 and C12	BC12	11	-	60	V
	Voltage between C0 and C16	BC16	22	-	60	V
	Voltage between C0 and C8	BC16	11	-	-	V
	Voltage between C8 and C16	BC16	11	-	-	V
TME	Total Measurement Error		±0.1	±1.2	±1.6	mV
I(n)	Cell Balancing Current	C(n) = 4V	304	307	310	mA
Temperature Sensors Specifications						
I(n)	Output Current to Temperature Sensor		-	-	300	uA
Rt(n)	Temperature Sensor Resistance at 25°C		-	10	-	kΩ
T(n)	Input Temperature Sensor Voltage Range	Cell 0 = 0V	0	-	3	V
Contactors Specification						
+VCOIL	External Coil Power Supply Input		5	24	40	V
	External Coil Power Supply Continuous Current	+VCOIL = 24V	-	-	2.8	A
	External Coil Power Supply Pulse Current (<150ms)	+VCOIL = 24V	-	-	20	A
+24V	Internal Coil		-	24	-	V



Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Power Supply Voltage					
	Internal Coil Power Supply Continuous Current		-	-	1	A
	Internal Coil Power Supply Pulse Current (<150ms)		-	-	2.4	A
COIL(n)	Coil Driver Output Voltage		-	+VCOIL	-	V
	Coil Driver Output Continuous Current	+VCOIL = 24V	-	-	2.8	A
	Coil Driver Output Pulse Current (<150ms)	+VCOIL = 24V	-	-	5	A
Ethernet Specifications						
ETH_Protocol	Ethernet data speeds		10	-	100	Base-T
ETH_Connector	Ethernet jack rating		-	Cat5e	-	
Current Shunt Specifications						
VSHUNT_REF	Reference Output Voltage		-	1.25	-	V
	Reference Output Current		-250	0	250	μA
Vdiff	Differential voltage between VSHUNT_BAT and VSHUNT_LOAD		-1.0	0	1.0	V
Vmes	Measurement resolution		-	143	-	nV
Current Shunt Thermistor Specifications						
+VTHERM	Thermistor Output Voltage		-	2.5	-	V
	Thermistor Output Current	+VTHERM = 2.5V	-	-	250	μA
Rt	Thermistor Resistance at 25°C		-	10	-	kΩ
GPIO-Out						
Vmax	Open Blocking Voltage	Between *_A and *_B, or between *_B and *_A	-	-	60	V
Imax	Closed Maximum Current	Between *_A and *_B, or	-	-	400	mA



Symbol	Parameter	Conditions	Min	Typ	Max	Units
		between *_B and *_A				
Ron	Closed-State Resistance	Between *_A and *_B, or between *_B and *_A	-	-	2	Ω
GPIO-In						
Turn-On	Turn On Threshold Voltage		0	-	3.8	V
	Turn-On Threshold Current		-	0.25	2	mA
Turn-Off	Turn-Off Threshold Voltage		4.8	-	5	V
	Turn-Off Threshold Current		0.1	0.2	-	mA
Vmax	Off Voltage	Iin = 0mA	-	-	5	V
Imax	On Current	Vin = 0V	-	-	9	mA
Modbus Specifications						
Rterm	Termination resistance tolerance		118.8	120	121.2	Ω
	Power rating		-	-	0.125	W
Vod	Driver differential output		1.5	2	-	V
Io	Output current		-60	-	60	mA
tr	Output Signal Rise Time		0.3	0.7	1.2	μs
tf	Output Signal Fall Time		0.3	0.7	1.2	μs
Isolation	Rated Isolation		-	-	60	V
Link Out - Expansion Interface Specifications						
IP_LINK	Output Current		-	-	20	mA
IN_LINK	Output Current		-	-	20	mA
Symbol	Parameter	Conditions	Min	Typ	Max	Units
CAN Specifications						
Rterm	Termination resistance tolerance		118.8	120	121.2	Ω
	Power rating		-	-	0.125	W
CAN_P	Dominant Output		2.9	3.5	4.5	V
	Recessive Output		2	2.3	3	V
	Output Current		10	-	70	mA
	Output Signal Rise Time		-	20	50	ns
	Output Signal Fall		-	20	50	ns



Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Time					
CAN_N	Dominant Output		0.8	1.2	1.5	V
	Recessive Output		2	2.3	3	V
	Output Current		10	-	70	mA
	Output Signal Rise Time			20	50	Ns
	Output Signal Fall Time			20	50	Ns
Isolation	Rated Isolation		-	-	60	V

Table 2: Environmental Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Thermal Specifications						
Ta	Operating Temperature		-40	25	60	°C
	Storage Temperature		-40	25	60	°C
Humidity Specifications						
RH	Operational RH		5	-	85	%
	Storage RH		5	-	85	%
Shock and Vibration Specifications						
Vertical	Vertical shock/vibration		-	-	10	m/s ²
Longitudinal	Longitudinal shock/vibration		-	-	10	m/s ²
Transverse	Transverse shock/vibration		-	-	10	m/s ²
Pulse vibration	On each axis		-	-	245	m/s ²

The Battery Controller is designed to comply with industry EMC standards for FCC and IC Class A, and European EN55032 Class A. It is designed for EMI and ESD performance to EN55024, including the IEC/EN 61000-4-X series of tests.

All components are EU RoHS/China RoHS compliant.



WARNING: Exceeding the maximum ratings will damage the module.

Hardware Overview

The Battery Controller module contains analog circuitry which converts the cell voltage, current and temperature to digital values. It also contains processing capability to read these values and software to support decision making so that it can operate as a stand-alone battery management system. The external interfaces to this module are:

- Cell voltage and temperature sense connector
- Current shunt connector
- Four (4) contactor coil driver outputs
- Four (4) optically isolated digital inputs
- Four (4) optically isolated digital outputs
- 10/100 Base-T Ethernet port (Modbus-TCP)
- Isolated CAN 2.0 port
- RS-485 (Modbus-RTU) port
- Battery stack expansion interface connector
- Fault and communication indicator LEDs

The Battery Controller is available in two models:

1. The NUV300-BC-12 which can monitor up to 12 series-connected cells
2. The NUV300-BC-16 which can monitor up to 16 series-connected cells

Power, Monitoring, and Control Connections

While the maximum input voltage to the Battery Controller will not exceed 60V (which is not generally considered a level dangerous to humans) precaution should be taken to avoid any short circuits, as high current levels could present a burn and fire hazard.

The following subsections describe the external interfaces in more detail. For wiring/pinout information, please refer to the *Nuvation BMS™ Low-Voltage Battery Controller Installation Guide*.

The user is required to provide and install a fuse in one or both power wires (+VPOWER and -VPOWER) depending on the system grounding scheme. The current rating of the fuse must be chosen based on the voltage of the supply to the Battery Controller (i.e. battery stack voltage if battery-powered or external DC supply voltage if externally powered).

Table 3: Battery Controller Power Wire Fuse Selection Guide

Stack Voltage	Fuse Current Rating	Example Part Number
12V Battery (9-16V)	8A	Eaton P/N: BK/ABC-8-R
24V Battery (18-32V)	4A	Eaton P/N: BK/ABC-4-R
36V Battery (27-	2.5A	Eaton P/N: BK/ABC-2-1/2-R



48V)		
48V Battery (36-60V)	2A	Eaton P/N: BK/ABC-2-R

Cell Voltage and Temperature (J8)

The Cell voltage and temperature sense connector (J8) is a 40-pin Samtec Mini Mate™ connector. This interface is used to connect the battery cell voltage sense wires as well as up to eight 10kΩ NTC thermistors to the Battery Controller module. The temperature sensors are referenced to Cell 0 (the negative end of the most negative cell) so care must be taken to ensure that they remain electrically isolated from any other cell voltage terminals. These sensors are used by the Battery Controller to sense over and under temperature conditions. This interface also carries the cell balancing current (approximately 300mA at 3.9V) and the wires should be sized accordingly. Cell 0 must be connected to the negative terminal of the lowest potential cell in the module and Cell 12 (or Cell 16 in a BC16 module) must be connected to the positive terminal of the highest potential cell in the module. If fewer cells are used, unused inputs should be tied to:

- BC-12 module: tie unused inputs to cell 12
- BC-16 module: tie unused inputs to cell 8 or 16

Note: A minimum of 11V must be present between Cell 0 and Cell 12 in a BC12 variant, and a minimum of 11V must be present between Cell 0 and Cell 8 as well as between Cell 8 and Cell 16 in a BC16 variant.

Connector Vendor: Samtec Inc.

Series: IPL1

Circuits: 40

Manufacturer Part Number: IPL1-120-01-L-D-RA1-K

Mating Cable Harness Connector Housing: IPD1-20-D or IPD1-20-D-M

Mating Cable Harness Connector Crimp Pins: CC79R-2024-01-L for 20-24 AWG

Current Shunt and +VPOWER (J7)

The Current shunt connector (J7) is a 6-pin Mini-Fit® Jr. Molex connector. This interface is used to connect the current shunt and a 10kΩ NTC thermistor on the current shunt to the Battery Controller. The positive operating power for the Battery Controller (+VPOWER) is provided to this connector. The user needs to supply and install a fuse according to Table 3.

Connector Vendor: Molex Inc.

Series: Mini-Fit

Circuits: 6

Manufacturer Part Number: 39-30-1062

Mating Cable Harness Connector Housing: 39-01-2065

Mating Cable Harness Connector Crimp Pins: 39-00-0073 for 18-24AWG

Contactors and -VPOWER (J6)

The Contactors connector (J6) is a 12-pin Mini-Fit® Jr. Molex connector. This interface is used to drive up to four (4) external contactor coils and to select their power source. The negative operating power for the Battery Controller (-VPOWER) is provided to this connector. The user needs to supply and install a fuse according to Table 3. Contactor coils receive their operating power from the connector's +VCOIL terminal. The Battery Controller's internal 24V supply is available to power the coils and, in that case, each output is capable of sourcing a maximum of 1A continuously, or a pull-in surge of up to 2.4A. **When using the Battery Controller's internal 24V supply to drive contactor coils, the sum of all four output currents must not exceed 1A continuous.**

Alternatively, contactors may be powered from an external 5V to 40V DC source, as may be appropriate for the coils. In that case, each output is capable of sourcing a maximum of 2.8A continuously, or a pull-in surge of up to 5A. **When using an external DC power source to drive contactor coils, the sum of all four output currents must not exceed 2.8A continuous.**

Connector Vendor: Molex Inc.

Series: Mini-Fit

Circuits: 12

Manufacturer Part Number: 39-30-1122

Mating Cable Harness Connector Housing: 39-01-2125

Mating Cable Harness Connector Crimp Pins: 39-00-0073 for 18-24AWG

Control GPIO (J5)

The GPIO connector is a 24-pin Samtec Mini Mate™ connector. This interface provides connections to isolated general purpose inputs and outputs, and also special function inputs that:

- enable the power supply
- invoke or force a system shutdown
- clear system faults
- invoke a factory reset

The functionalities of the general purpose inputs and outputs are configurable by the end-user to match their needs.

Connector Vendor: Samtec Inc.

Series: IPL1

Circuits: 24

Manufacturer Part Number: IPL1-112-01-L-D-RA-K

Mating Cable Harness Connector Housing: IPD1-12-D or IPD1-12-D-M

Mating Cable Harness Connector Crimp Pins: CC79R-2024-01-L for 20-24 AWG

Communication Connections

Link Out (Expansion Interface) (J1)

The Link Out interface connector is a standard Cat5e RJ45 jack. This interface is used for a couple different purposes:

- To connect the Battery Controller to an expansion module
- To provide monitoring of multiple additional banks of cells in parallel with those connected to the BC
 - Where independent current measurement and contactor control is not required for each parallel stack

A green LED on the interface connector jack indicates link activity.

Ethernet (J2)

The Ethernet jack is a standard Cat5e RJ45 jack. This interface is used as the primary means of connecting an external system to the Battery Controller to configure the operating parameters, observe the status, and perform maintenance such as firmware upgrades. It may also be used as a means of controlling an external battery charger/inverter and communicating with a vehicle central controller, grid-attached site controller, etc.

Two LEDs on the Ethernet jack indicate link status (green LED) and network activity (yellow LED).

CAN (J3)

The CAN connector is a standard Cat5e RJ45 jack. This interface provides an isolated CAN 2.0 port. This interface can be used to control an external battery charger/inverter and communicating with the external system (such as a vehicle central controller, grid-attached site controller, etc.). Jumper-selectable resistive bus termination is available upon request. A green LED on the CAN connector indicates CAN bus activity.

RS-485 Modbus RTU (J4)

The RS-485 connector is a standard Cat5e RJ45 jack. This interface provides an isolated RS-485 (Modbus-RTU) port. This interface can be used to control an external battery charger/inverter and communicating with the external system (such as a vehicle central controller, grid-attached controller, etc.). Jumper-selectable resistive bus termination is available upon request. A green LED on the RS-485 connector indicates Modbus activity.



Mechanical Overview

The overall dimensions of the Battery Controller are 220mm X 125mm X 30mm. Extra space should be provided around the module to allow for easy installation/maintenance. The Battery Controller should be securely mounted in a vertical orientation with the Cell Connections connector (J1) in the top left corner, in an environment that permits free movement of air for convection cooling. Other orientations are possible depending on the specific thermal performance needs for the given application.

The Battery Controller weighs approximately 0.4kg.

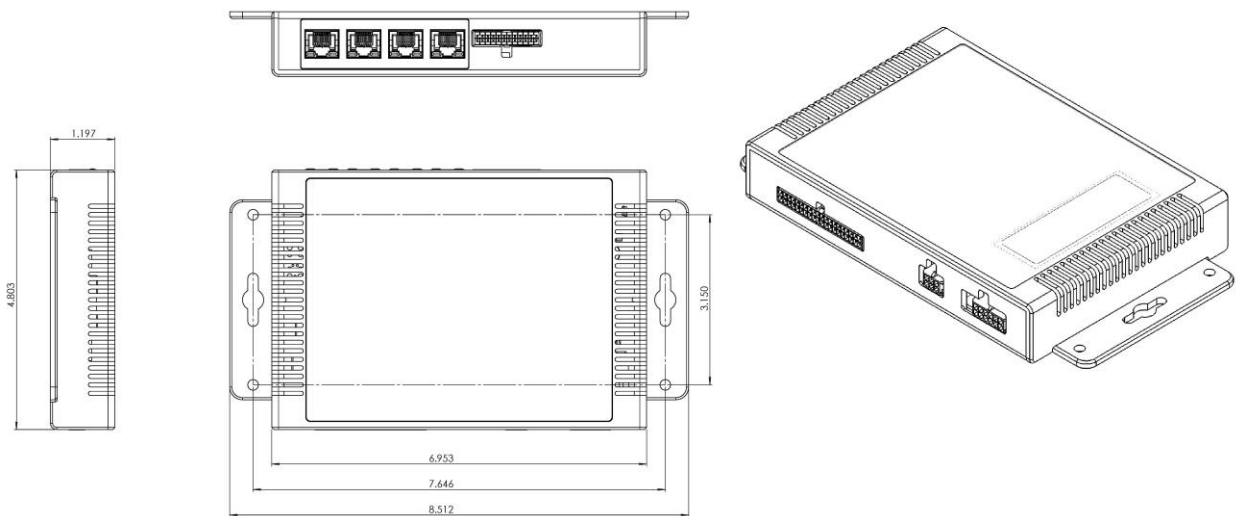


Figure 2: Mechanical Drawing of Battery Controller

Ordering Info

Model Number	Description
NUV300-BC-12-P	Low-Voltage Battery Controller 12-cell with Enclosure
NUV300-BC-12-U	Low-Voltage Battery Controller 12-cell Unpackaged
NUV300-BC-12-CSK	Low-Voltage Battery Controller 12-cell with Enclosure and cable-kit
NUV300-BC-16-P	Low-Voltage Battery Controller 16-cell with Enclosure
NUV300-BC-16-U	Low-Voltage Battery Controller 16-cell Unpackaged
NUV300-BC-16-CSK	Low-Voltage Battery Controller 16-cell with Enclosure and cable-kit

DISCLAIMER: From time to time Nuvation Energy will make updates to the Nuvation BMS™ in response to changes in available technologies, client requests, emerging energy storage standards and other industry requirements. The product specifications in this document therefore, are subject to change without notice.

