



## **NUVATION BMS™**

### **NUV300 Datasheet**

### **Nuvation BMS™ Low-Voltage Battery Controller**

2018-10-08, Rev. 2.0

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# 1. System Overview

The Nuvation Low-Voltage BMS™ can be used as a complete battery management system to manage up to 12 or 16 battery cells in series.

An example configuration is shown in [Nuvation Low-Voltage BMS™ System Overview](#)

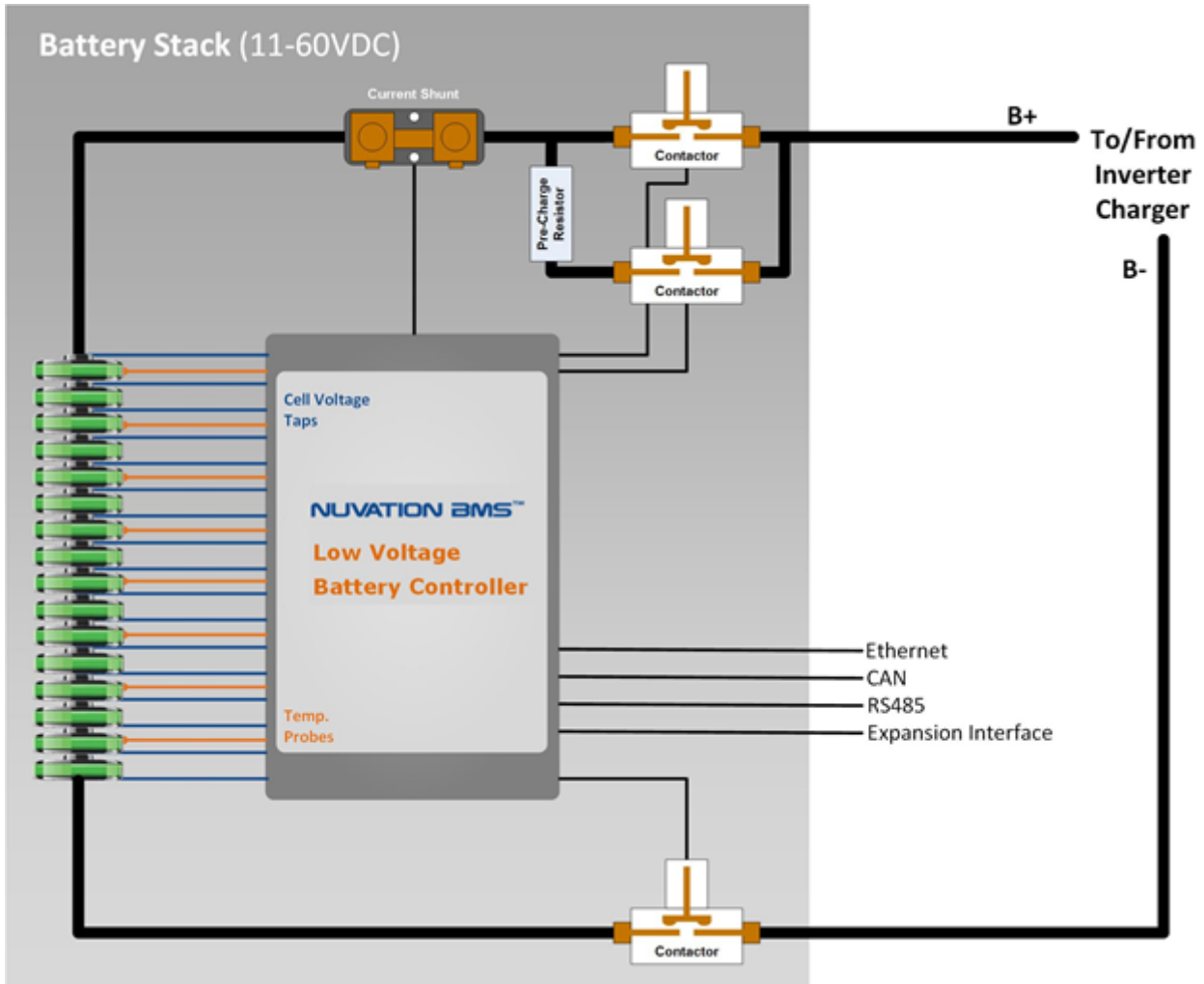


Figure 1. Nuvation Low-Voltage BMS™ System Overview

## 2. Operating Limits

This section states the operating limits of the Battery Controller.



Exceeding the maximum ratings will damage the module.

### 2.1. Stack Power Specification

Table 1. Stack Power Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
+VBAT	Input DC Voltage		9	48	68	V
	Input Current	+VBAT = 48V DC	70	580	1250	mA



While Low-Voltage BMS is designed for an input voltage of 11-60VDC, testing has confirmed that the unit experiences no degradation when using an input voltage up to 68VDC. However, for applications that exceed 60VDC, please consider Nuvation High-Voltage BMS or contact Nuvation Support.



The +VBAT input current depending on the loads the Low-Voltage BMS is driving. Without contactors, the Low-Voltage BMS draws approximately 70mA at 48VDC. With all contactors connected and energized, it can draw up to 1.25A at 48VDC.

### 2.2. Battery Cells Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
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	-	40	V
	Voltage between C8 and C16	BC16	11	-	40	V
TME	Total Measurement Error		±0.1	±1.2	±1.6	mV
I(n)	Cell Balancing Current	C(n) = 4V	304	307	310	mA

### 2.3. Temperature Sensors Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I(n)	Output Current to Temperature Sensor		-	-	300	µA
Rt(n)	Temperature Sensor Resistance at 25C		-	10	-	kΩ
T(n)	Input Temperature Sensor Voltage Range	Cell 0 = 0V	0	-	3	V

## 2.4. Contactors Coil Driver Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
+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	Output Voltage		-	24	-	V
	Output Continuous Current		-	-	1	A
	Output 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
	Reverse Clamp Voltage	+VCOIL = 24V	40	-	49	V



Nuvation BMS does not include an internal free-wheeling protection diode on contactor coil-driver circuits, as it has been found to cause premature contactor failure.

## 2.5. Ethernet Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
ETH_Protocol	Ethernet data speeds		10	-	100	Base-T
ETH_Connector	Ethernet jack rating		-	Cat5e	-	

## 2.6. Current Shunt Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
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

## 2.7. GPIO-Out

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Vmax	Open Blocking Voltage	Between *_A and *_B, or between *_B and *_A	-	-	60	V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I <sub>max</sub>	Closed Maximum Current	Between *_A and *_B, or between *_B and *_A	-	-	400	mA
R <sub>on</sub>	Closed-State Resistance	Between *_A and *_B, or between *_B and *_A	-	-	2	Ω

## 2.8. GPIO-In

Symbol	Parameter	Conditions	Min	Typ	Max	Units
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
V <sub>max</sub>	Off Voltage	I <sub>in</sub> = 0mA	-	-	5	V
I <sub>max</sub>	On Current	V <sub>in</sub> = 0V	-	-	9	mA

## 2.9. RS-485 Modbus-RTU Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
R <sub>term</sub>	Termination resistance tolerance		118.8	120	121.2	Ω
	Power rating		-	-	0.125	W
V <sub>od</sub>	Driver differential output		1.5	2	-	V
I <sub>o</sub>	Output current		-60	-	60	mA
t <sub>r</sub>	Output Signal Rise Time		0.3	0.7	1.2	μs
t <sub>f</sub>	Output Signal Fall Time		0.3	0.7	1.2	μs
Isolation	Rated Isolation		-	-	60	V

## 2.10. Link Out - Expansion Interface Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
IP_LINK	Output Current		-	-	20	mA
IN_LINK	Output Current		-	-	20	mA

## 2.11. CAN Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
R <sub>term</sub>	Termination resistance tolerance		118.8	120	121.2	Ω
	Power rating		-	-	0.125	W

Symbol	Parameter	Conditions	Min	Typ	Max	Units
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 Time		-	20	50	ns
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

## 3. Environmental Conditions

### 3.1. Thermal Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Ta	Operating Temperature		-40	25	60	C
	Storage Temperature		-40	25	60	C

### 3.2. Humidity Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
RH	Operational RH		5	-	85	%
	Storage RH		5	-	85	%

### 3.3. Shock and Vibration Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Vertical	Vertical shock/vibration		-	-	10	m/s <sup>2</sup>
Longitudinal	Longitudinal shock/vibration		-	-	10	m/s <sup>2</sup>
Transverse	Transverse shock/vibration		-	-	10	m/s <sup>2</sup>
Pulse vibration	On each axis		-	-	245	m/s <sup>2</sup>

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.

## 4. Hardware Overview

The Battery Controller contains analog-to-digital measurement circuitry which reads cell voltage, current and temperature values. It also contains processing capability and software to support decision making and allowing it to 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
- Expansion interface connector for additional Cell-Interface modules
- Fault and communication indicator LEDs

The Battery Controller is available in two models:

1. The NUV300-BC-12 which can monitor up to 12 voltage channels
2. The NUV300-BC-16 which can monitor up to 16 voltage channels

### 4.1. 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 Low-Voltage BMS™ Installation Guide*.

You are 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 2. 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 (27-48V)	2.5A	Eaton P/N: BK/ABC-2-1/2-R
48V Battery (36-60V)	2A	Eaton P/N: BK/ABC-2-R

#### 4.1.1. 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.

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 provides cell voltage input and a means for balancing the cells. The cable wire should be rated for at least 750mA to tolerate the worse-case current. Pins 39 and 40 must be connected to the negative terminal of the lowest potential cell in the module and pin 27 (or pin 23 in a NUV300-BC-16) must be connected to the positive terminal of the highest potential cell in the module. All unused voltage inputs should be tied to the next highest potential voltage sense input. In this way, all pins should be connected with the exception of pins 23, 24, 25 and 26 in a NUV300-BC-12.



A minimum of 11V must be present between Cell 0 and Cell 12 in a NUV300-BC-12, 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 NUV300-BC-16.

Table 3. Connector details for Cell Voltage and Temperature (J8) cable

<b>Connector Vendor</b>	Samtec Inc.
<b>Series</b>	IPL1
<b>Circuits</b>	40
<b>Manufacturer Part Number</b>	IPL1-120-01-L-D-RA1-K
<b>Mating Cable Harness Connector Housing</b>	IPD1-20-D or IPD1-20-D-M
<b>Mating Cable Harness Connector Crimp Pins</b>	CC79R-2024-01-L for 20-24 AWG

#### 4.1.2. 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, optionally, a 10kΩ NTC thermistor to measure shunt temperature. The positive operating power for the Battery Controller (+VPOWER) is provided to this connector. You will need to supply and install a fuse according to [Battery Controller Power Wire Fuse Selection Guide](#).

Table 4. Connector details for Current Shunt and +VPOWER (J7) cable

<b>Connector Vendor</b>	Molex Inc.
<b>Series</b>	Mini-Fit
<b>Circuits</b>	6
<b>Manufacturer Part Number</b>	39-30-1062
<b>Mating Cable Harness Connector Housing</b>	39-01-2065
<b>Mating Cable Harness Connector Crimp Pins</b>	39-00-0073 for 18-24AWG

#### 4.1.3. 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. You will need to supply and install a fuse according to [Battery Controller Power Wire Fuse Selection Guide](#).

Contactors 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 or 2.4A peak.

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.

Table 5. Connector details for Contactors and -VPOWER (J6) cable

<b>Connector Vendor</b>	Molex Inc.
<b>Series</b>	Mini-Fit
<b>Circuits</b>	12
<b>Manufacturer Part Number</b>	39-30-1122
<b>Mating Cable Harness Connector Housing</b>	39-01-2125
<b>Mating Cable Harness Connector Crimp Pins</b>	39-00-0073 for 18-24AWG

#### 4.1.4. 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 BMS
- 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.

Table 6. Connector details for Control GPIO (J5) cable

<b>Connector Vendor</b>	Samtec Inc.
<b>Series</b>	IPL1
<b>Circuits</b>	24
<b>Manufacturer Part Number</b>	IPL1-112-01-L-D-RA-K
<b>Mating Cable Harness Connector Housing</b>	IPD1-12-D or IPD1-12-D-M
<b>Mating Cable Harness Connector Crimp Pins</b>	CC79R-2024-01-L for 20-24 AWG

## 4.2. Communication Connections

#### 4.2.1. Link Out (Expansion Interface) (J1)

The Link Out interface connector is a standard Cat5e RJ45 jack. This interface is used to connect the Battery Controller to an expansion module.

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

#### 4.2.2. 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 provides an interface that an external controller may use to read and write registers in order to make decisions regarding the overall system.

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

#### 4.2.3. CAN (J3)

The CAN connector is a standard Cat5e RJ45 jack. This interface provides an isolated CAN 2.0 port. It provides an interface that an external controller may use to read and write registers in order to make decisions regarding the overall system.

Jumper-selectable resistive bus termination is available upon request. A green LED on the CAN connector indicates CAN bus activity.

#### 4.2.4. 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. It provides an interface that an external controller may use to read and write registers in order to make decisions regarding the overall system.

Jumper-selectable resistive bus termination is available upon request. A green LED on the RS-485 connector indicates Modbus activity.

## 5. 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.



Dimensions in the diagram below are shown in inches

The Battery Controller should be securely mounted in a vertical orientation, in an environment that permits free movement of air through all ventilation slots for convection cooling. The Cell Connections connector (J1) should be facing up or to the left. If it is to be used with a battery chemistry such as lead-acid, which does not require balancing, the Battery Controller may be mounted horizontally, with the ventilation slots oriented upwards. It is not advisable to mount the Battery Controller on the underside of a horizontal surface.

The Nuvation BMS™ Low-Voltage Battery Controller weighs approximately 0.4kg.

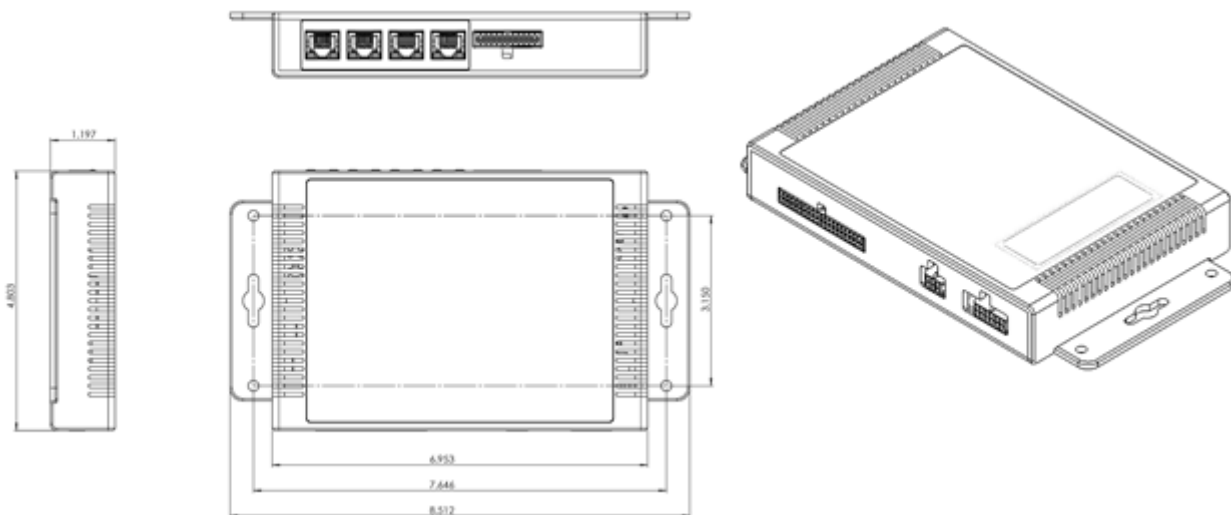


Figure 2. Mechanical Drawing of Battery Controller

## 6. Ordering Information

Model Number	Description
NUV300-BC-12-P	Nuvation Low-Voltage BMS™ - 12 channel Battery Controller
NUV300-BC-12-U	Nuvation Low-Voltage BMS™ - 12 channel Battery Controller, PCB assembly only (no enclosure)
NUV300-BC-12-CSK	Nuvation Low-Voltage BMS™ - 12 channel Starter Kit (see note below)
NUV300-BC-16-P	Nuvation Low-Voltage BMS™ - 16 channel Battery Controller
NUV300-BC-16-U	Nuvation Low-Voltage BMS™ - 16 channel Battery Controller, PCB assembly only (no enclosure)
NUV300-BC-16-CSK	Nuvation Low-Voltage BMS™ - 16 channel Starter Kit (see note below)



### *Customer Starter Kits*

A Customer Starter Kit includes the Battery Controller module with enclosure and a cable kit to get you started.

Please visit <https://nstore.nuvationenergy.com> for more details.

*Nuvation BMS™, Nuvation High-Voltage BMS™, Nuvation Low-Voltage BMS™ and Nuvation BMS™ Grid Battery Controller are trademarks of Nuvation Energy. 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.*

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