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NUVATION BMS™

Installation Guide

Nuvation BMS™ Low-Voltage Battery Controller

2018-10-08, Rev. 2.0

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Important Safety Information

The content in this document must be followed in order to ensure safe operation of Nuvation BMS™.

Do **NOT** connect the `J7: Current Shunt / +V Power` connector to the Battery Controller until all other connections have been made.

Properly insulate or remove any unused wires. Unused wires can couple excessive system noise into Nuvation BMS which can disrupt communication and lead to undesirable behaviors.

Please be aware of high voltages present in your system and follow all necessary safety precautions.

The provided module enclosures are not fire enclosures.

Depending on battery chemistry, there might be a nominal voltage per cell which adds up in series and is always present. There are many different battery chemistries with different current capacities, and so high voltage with high current capacity may be present while connecting the Nuvation BMS. You must use proper electrical safety precautions when handling any part of the Nuvation BMS. Neither Nuvation Energy or any of its employees shall be liable for any direct, indirect, incidental, special, exemplary, personal or consequential harm or damages (including, but not limited to, procurement or substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this product.

The Nuvation BMS relies on your system charger to charge the battery cells; do not leave your charger off while the Nuvation BMS is powered from the stack for prolonged periods of time. The Nuvation BMS should be shut down when the system is in storage to minimize the drain on the cells.

1. Introduction

Thank you for choosing Nuvation BMS™

Nuvation BMS™ Low-Voltage Battery Controller is an enterprise-grade battery management system with features that extend battery life, ensuring battery safety, and cell balancing.

You can take advantage of the highly configurable browser-based user interface and custom-tune Nuvation BMS™ Low-Voltage Battery Controller to your specific target application.

1.1. About this Guide

This *Installation Guide: Nuvation BMS™ Low-Voltage Battery Controller* provides wiring instructions to connect your Nuvation BMS™ Low-Voltage Battery Controller to your system.

Once you have successfully completed the installation process, please follow instructions in the Operator Interface Guide for accessing and configuring the Nuvation BMS™ Operator Interface for the Battery Controller.

We thrive on your feedback and what we build is driven by your input. Please submit support tickets to support@nuvationenergy.com.

2. 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

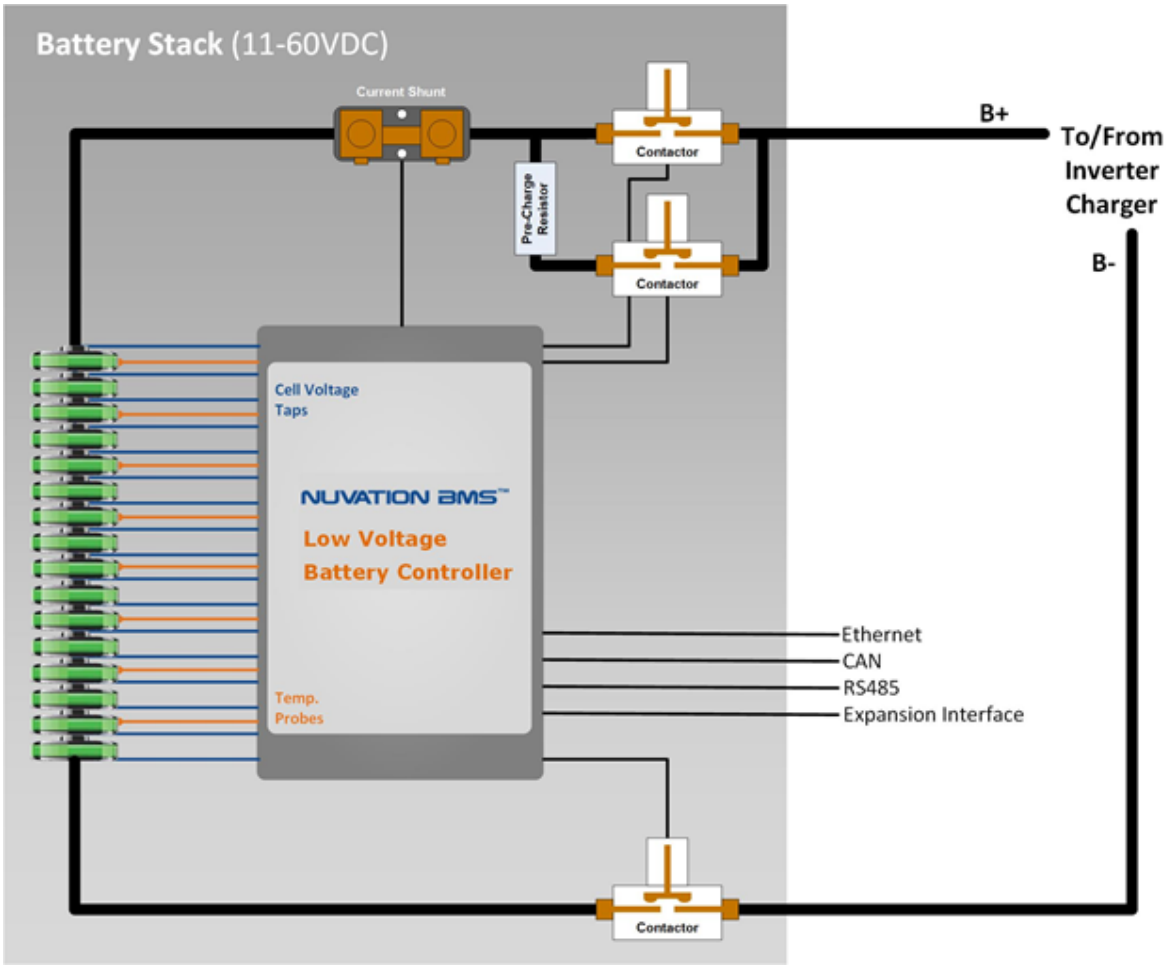


Figure 1. Nuvation Low-Voltage BMS™ System Overview

3. Battery Controller

3.1. Overview

Nuvation BMS™ Low-Voltage Battery Controller module safely manages up to 12 or 16 cells by measuring cell voltage, temperature and current and applying software decision-making to control contactors, communicate with energy storage controllers, and interface with general purpose I/O.

Battery Controller is able to operate as a stand-alone battery management system, requiring no additional Nuvation BMS modules to manage a stack of up to 12 or 16 cells.

Battery Controller is available in two models:

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

3.2. GPIO Block

The GPIO and control inputs are accessible at the `J5: Control / GPIO connector`.

The general-purpose outputs from the Battery Controller are implemented using optical MOSFET switches. These outputs are non-polarized, presenting an on-resistance of typically 2Ω and capable of carrying 400mA of DC or RMS current when activated. GPIO Circuit Diagram shows a high level circuit diagram for the GPO pins.

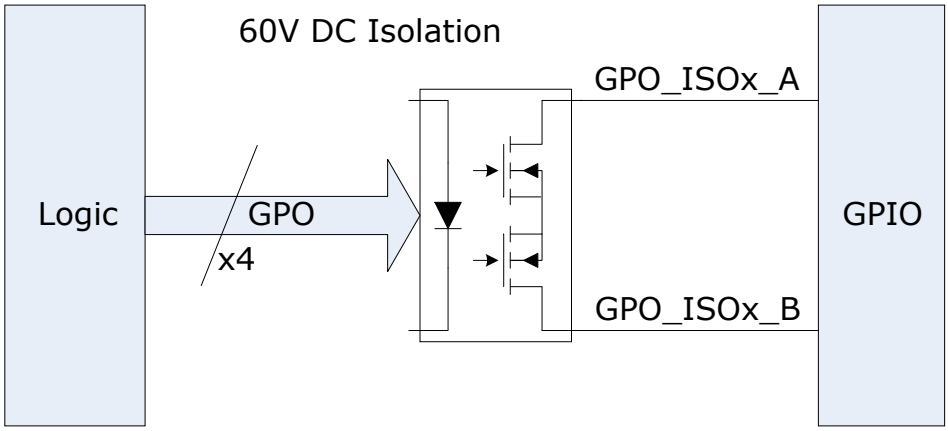


Figure 2. GPIO Circuit Diagram

The general-purpose and specific-purpose (`FAULT_CLEAR`, `FACTORY_RESET`, `SHUTDOWN`) inputs to the Battery Controller are implemented using optical isolation components. The current source for these inputs is provided in the Battery Controller and each input is activated by providing a simple contact closure to the common point.

The *BMS Enable* input differs slightly from the other specific-purpose inputs. This control requires a contact closure between the `BMS_ENABLE#` and `VBOT` signals and must not be referenced to the common point of the other inputs. It is used to start the Battery Controller after it has been shut down due to activation of the `SHUTDOWN` input, low battery, or some other condition invoked under software control. `BMS_ENABLE#` is pulled up to the battery stack positive (potentially 60V away from `VBOT`) so the switch/external controller must be tolerant of the maximum battery stack voltage.

3.3. CAN Bus and RS485 / Modbus RTU Block

The CAN Bus communication channel is available on the `J3: CAN` connector. The RS485 / Modbus RTU communication channel is available on the `J4: RS485 / Modbus RTU` connector.

These communication channels are isolated from the battery stack and share their common reference with each other, with the general-purpose I/O, and with the specialized control inputs. A 120Ω bus termination is required on each end of the bus for these communication channels. Termination is not provided within the Battery Controller on stock production units.

3.4. Power Supply, Current Shunt, and Contactor Drivers

Operating power, including primary power source for operating the contactor coils, is connected to the Battery Controller at two connectors: positive to the `J7: Current Shunt / +V Power` connector, and negative to the `J6: Contactors / -V Power` connector.

The current shunt, which is connected in series with the battery stack at the positive end, connects its sense points to the Battery Controller at the `J7: Current Shunt / +V Power` connector.

Up to four system contactors may be connected and controlled by the Battery Controller, connecting to the Battery Controller at the `J6: Contactors / -V Power` connector.

3.5. Mechanical Dimensions

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.

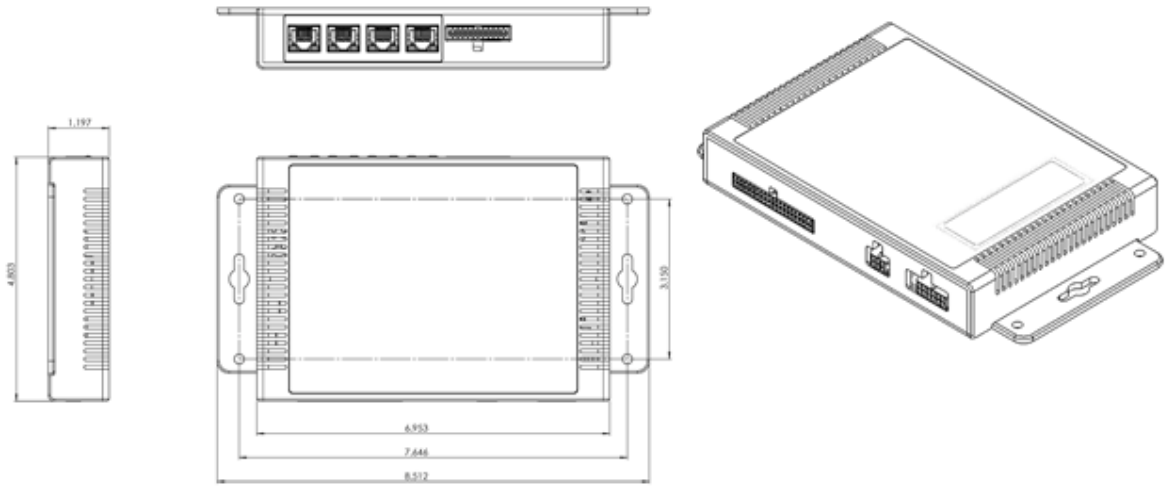


Figure 3. Mechanical Drawing of Battery Controller

3.6. Electric Connections

3.6.1. Overview

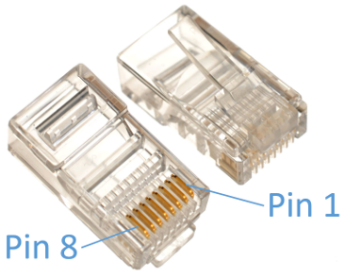
The Battery Controller module has eight connectors. Each connector is described in the following sections in detail.

3.6.2. J1: Link Out

In certain situations, it may be required to monitor more than 16 cells in series, as such is the case with 2V lead-acid cells. This connector is used to connect to an additional cell interface module to manage more cells and thermistors. Contact support@nuvationenergy.com for application details.

RJ-45 Plug Details describes a typical compatible plug for the `J1: Link Out` jack.

Table 1. RJ-45 Plug Details



Conec 391J00039X	
Manufacturer	Conec
Housing	391J00039X
Housing material	Polycarbonate UL94V-0
Circuits	8

Crimp terminal	insulation displacement
Wire gauge range	AWG24-26 stranded or solid

The `Link Out` interface connector is a standard RJ45 Cat5e rated jack. This interface is used to connect the Battery Controller to an expansion module, to provide monitoring additional cells/thermistors.

Table 2. Link Out Connector Pin Assignment

Pin	Connection	Description	Connected to Device
1	No Connect	Not Connected	No Connect
2	No Connect	Not Connected	No Connect
3	No Connect	Not Connected	No Connect
4	No Connect	Not Connected	No Connect
5	No Connect	Not Connected	No Connect
6	No Connect	Not Connected	No Connect
7	LINKBUS_N	Link Bus differential pair negative	Expansion module
8	LINKBUS_P	Link Bus differential pair positive	Expansion module

3.6.3. J2: Ethernet / Modbus TCP

The Ethernet / Modbus TCP jack is a standard RJ45 Cat5e rated 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.

RJ-45 Plug Details describes a typical compatible plug for the `J2: Ethernet / Modbus TCP` jack.

Table 3. Ethernet / Modbus TCP Connector Pin Assignment

Pin	Connection	Description	Connected to Device
1	TD_P	Transmit differential pair positive	External Equipment
2	TD_N	Transmit differential pair negative	External Equipment
3	RD_P	Receive differential pair positive	External Equipment
4	NUL45	Unused; connected to Pin 5 and terminated	External Equipment
5	NUL45	Unused; connected to Pin 4 and terminated	External Equipment
6	RD_N	Receive differential pair negative	External Equipment
7	NUL78	Unused; connected to Pin 8 and terminated	External Equipment
8	NUL78	Unused; connected to Pin 7 and terminated	External Equipment

3.6.4. J3: CAN

The CANBus 2.0 connector is a standard RJ45 Cat5e rated jack. This interface provides an isolated CANBus 2.0 port.

CANBus termination is not provided within the Battery Controller on stock production units. Standard 120Ω termination must be installed at each end of the CANBus network.

RJ-45 Plug Details describes a typical compatible plug for the J3: CAN jack.

Table 4. CANBus RJ45 Connector Pin Assignment

Pin	Connection	Description	Connected to Device
1	CAN_P	CAN bus differential pair positive	External Equipment
2	CAN_N	CAN bus differential pair negative	External Equipment
3	COMIO	Common reference shared with GPIO	External Equipment
4	No Connect	Not Connected	No Connect
5	No Connect	Not Connected	No Connect
6	No Connect	Not Connected	No Connect
7	COMIO	Common reference shared with GPIO	External Equipment
8	No Connect	Not Connected	No Connect

3.6.5. J4: RS485 / Modbus RTU

The RS-485 connector is a standard RJ45 Cat5e rated jack. This interface provides an isolated RS-485 (Modbus-RTU) port.

RS485 termination is not provided within the Battery Controller on stock production units. Standard 120Ω termination must be installed at each end of the Modbus-RTU network.

RJ-45 Plug Details describes a typical compatible plug for the J4: RS485 / Modbus RTU jack.

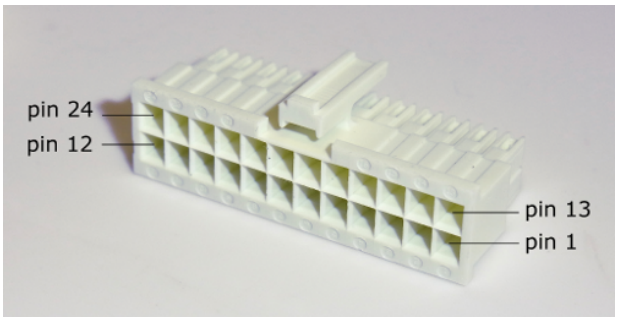
Table 5. RS485 / Modbus RJ45 Connector Pin Assignment

Pin	Connection	Description	Connected to Device
1	No Connect	Not Connected	No Connect
2	No Connect	Not Connected	No Connect
3	No Connect	Not Connected	No Connect
4	MODBUS_P	MODBUS differential pair positive	External Equipment
5	MODBUS_N	MODBUS differential pair negative	External Equipment
6	No Connect	Not Connected	No Connect
7	No Connect	Not Connected	No Connect
8	COMIO	Common reference shared with GPIO	External Equipment

3.6.6. J5: Control / GPIO

J5: Control / GPIO plug housing and terminal details describes the recommended plug and crimp terminals to be used with the J5: Control / GPIO connector.

Table 6. J5: Control / GPIO plug housing and terminal details



Samtec IPD1-12-D	
Manufacturer	Samtec Inc
Housing	IPD1-12-D
Housing material	Nylon (Zytel® PA66) UL94V-2
Circuits	24
Crimp terminal	CC79R-2024-01-L
Wire gauge range	AWG20-24 stranded

This interface provides connections to isolated general purpose inputs and outputs, and also specific function inputs that can be used to:

- 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 configured by the end-user to match their needs.

Table 7. GPI, GPO, and Special Function Connector Pin Assignment

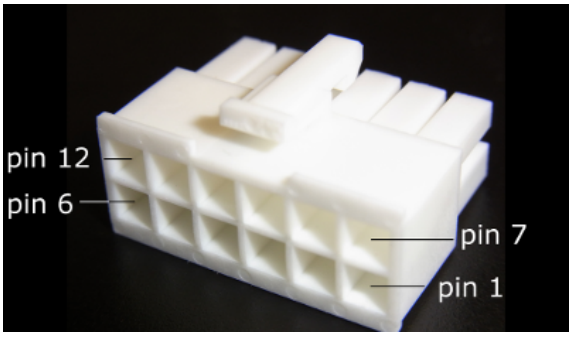
Pin	Connection	Description	Connected to Device
1	GPO_ISO0_A	Digital Output 0	External Equipment
2	GPO_ISO1_A	Digital Output 1	External Equipment
3	GPO_ISO2_A	Digital Output 2	External Equipment
4	GPO_ISO3_A	Digital Output 3	External Equipment
5	+5V_GPIO_ISO	Isolated +5V I/O Power Supply	External Equipment
6	GPI_ISO0_K	Input detector 0	External Equipment
7	GPI_ISO1_K	Input detector 1	External Equipment
8	GPI_ISO2_K	Input detector 2	External Equipment
9	GPI_ISO3_K	Input detector 3	External Equipment
10	FAULT_CLEAR#	Momentary to COMIO to clear faults	Processor GPI via logic elements
11	FACTORY_RESET#	Hold to COMIO during startup to perform a factory reset	Processor GPI via logic elements

Pin	Connection	Description	Connected to Device
12	BMS_ENABLE#	Momentary to VBOT to enable BMS; Hold to VBOT to defeat Shutdown	Power supply enable gate
		NOTE: different reference from other inputs	
13	GPO_ISO0_B	Digital Output 0	External Equipment
14	GPO_ISO1_B	Digital Output 1	External Equipment
15	GPO_ISO2_B	Digital Output 2	External Equipment
16	GPO_ISO3_B	Digital Output 3	External Equipment
17	COMIO	Isolated I/O Power Supply Common Reference	External Equipment
18	COMIO	Isolated I/O Power Supply Common Reference	External Equipment
19	COMIO	Isolated I/O Power Supply Common Reference	External Equipment
20	COMIO	Isolated I/O Power Supply Common Reference	External Equipment
21	COMIO	Isolated I/O Power Supply Common Reference	External Equipment
22	COMIO	Isolated I/O Power Supply Common Reference	External Equipment
23	SHUTDOWN#	Momentary to COMIO to invoke shutdown; Hold to COMIO to force shutdown	Processor GPI via logic elements, hard shutdown (no software) via logic elements with longer press
24	VBOT		VBOT

3.6.7. J6: Contactors / -V Power

J6: Contactors / -V Power plug housing and terminal details describes the recommended plug and crimp terminals to be used with the `J6: Contactors / -V Power` connector.

Table 8. J6: Contactors / -V Power plug housing and terminal details



Molex 39-01-2125	
Manufacturer	Molex Incorporated
Housing	39-01-2125
Housing material	Nylon UL94V-0
Circuits	12

Crimp terminal	39-00-0073
Wire gauge range	AWG18-24 stranded

This interface is used to drive up to four (4) external contactor coils and to select their power source. The negative operating power is provided in a fused connection to this connector.

Connecting to Contactor Coils

The Battery Controller provides coil drivers for contactor coils up to 24V DC. The Battery Controller's internal 24V power supply may be used to power the coils if the following conditions are satisfied:

- 24V coils are connected
- The worst-case coil inrush current is below 1.5A
- The sum of all connected coil currents is less than 1A

To use the internal power supply, connect together pins 11 (`+VCOIL`) and 12 (`+24V`) of J6 to deliver +24V to the `+VCOIL` input. Pin 5 (`VCOIL_RETURN`) is left disconnected and should be insulated to prevent shorts.

Other coil voltages in the 12V-24V range and total currents of up to 1.5A/coil may be supported through the use of an external DC power source. Such a supply must be connected between `+VCOIL` (pin 11) and `VCOIL_RETURN` (pin 5) of J6.

As depicted in Connection example for powering the Battery Controller from external DC power source, if an external power supply is used to power the Battery Controller instead of the battery stack, the `VCOIL_RETURN` (pin 5) connection of `J6` must be externally connected to the bottom of the battery stack. If using a dedicated external power supply to power the contactor coils, connect the common return of that supply to this pin.

Coil back-EMF protection is provided by the Battery Controller that clamps at 40V. External clamping diodes of lower voltages may be connected if required.

The bottom of the attached battery stack is internally connected to the common return path for all contactor coils (pins 1~5 of `J6`). It is recommended that no ground connection be made at the coils to avoid creating an inadvertent ground fault or ground loop.

Contactor coils are to be connected between the `COILn_HI` and COM pins of J6 as required. When the Battery Controller activates a contactor, the `COILn_HI` output is driven to a `VCOIL` voltage level.

Unused contactor coil wires should be properly insulated or removed. Refer to Connection example for powering the Battery Controller from cells and Connection example for powering the Battery Controller from external DC power source for use of the `–VPOWER` connection at `J6`.

Contactor coils, internal and external supply connections to `J6` are shown in Connection to J6: Two 24V contactor coils powered from internal supply and Connection to J6: Four contactor coils powered from external supply.

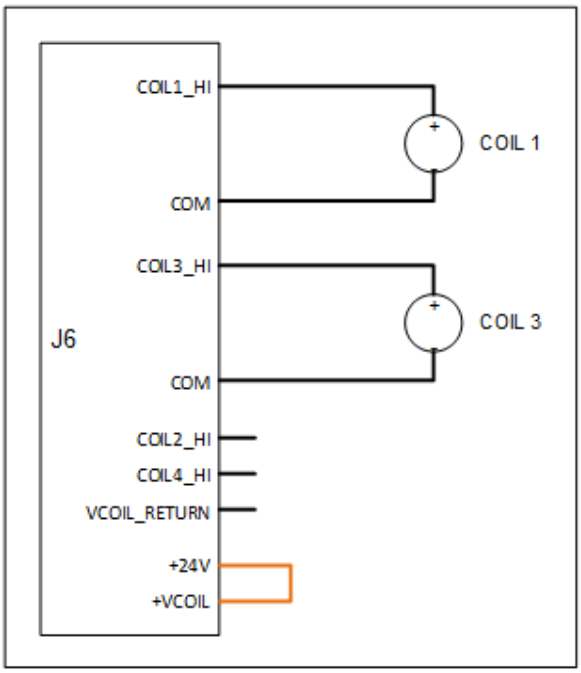


Figure 4. Connection to J6: Two 24V contactor coils powered from internal supply

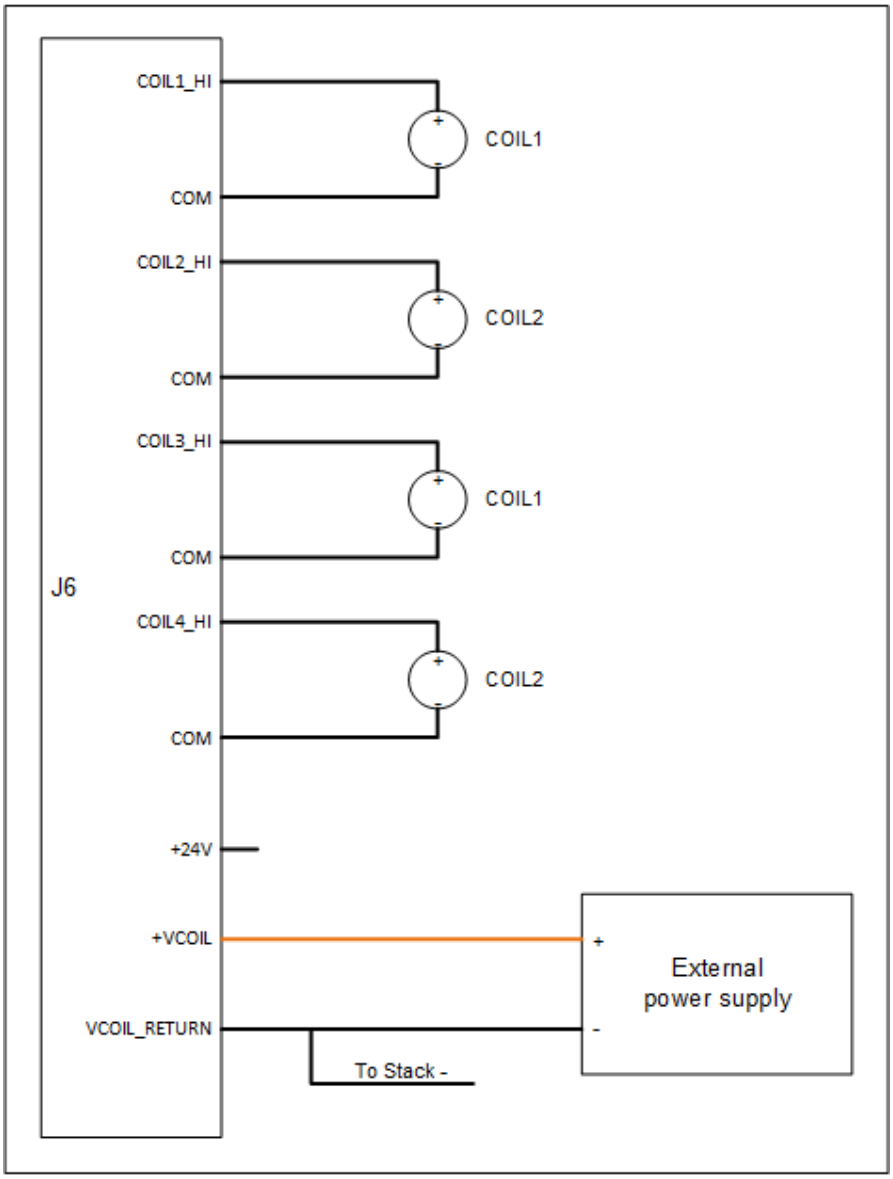


Figure 5. Connection to J6: Four contactor coils powered from external supply

Table 9. Stack Power Return and Contactors Connector Pin Assignment

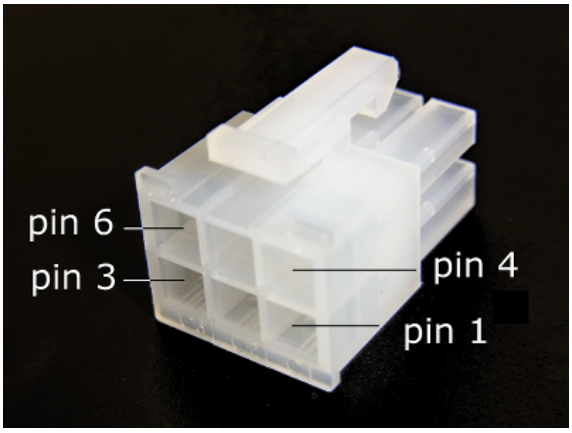
Pin	Connection	Description	Connected to Device
1	COM	Negative Coil 1	Contactor 1 negative coil connection
2	COM	Negative Coil 2	Contactor 2 negative coil connection
3	COM	Negative Coil 3	Contactor 3 negative coil connection
4	COM	Negative Coil 4	Contactor 4 negative coil connection

Pin	Connection	Description	Connected to Device
5	VCOIL_RETURN	Negative reference for external supply	External Power Supply. Refer to Connection example for powering the Battery Controller from cells and Connection example for powering the Battery Controller from external DC power source for additional requirements
6	-VPOWER	Power return of Battery Controller	Bottom of Stack
7	COIL1_HI	Positive Coil 1	Contactor 1 positive coil connection
8	COIL2_HI	Positive Coil 2	Contactor 2 positive coil connection
9	COIL3_HI	Positive Coil 3	Contactor 3 positive coil connection
10	COIL4_HI	Positive Coil 4	Contactor 4 positive coil connection
11	+VCOIL	12~24V Contactor Coil Power Supply	Connect to external power supply, or to pin 12 if driving contactor coil from internal power supply
12	+24V	Internal Power Supply	Connect to pin 11 if driving contactor coils from internal power supply

3.6.8. J7: Current Shunt / +V Power

J7: Current Shunt / -V Power plug housing and terminal details describes the recommended plug and crimp terminals to be used with the `J7: Current Shunt / +V Power` connector.

Table 10. J7: Current Shunt / -V Power plug housing and terminal details



Molex 39-01-2065	
Manufacturer	Molex Incorporated
Housing	39-01-2065
Housing material	Nylon UL94V-0
Circuits	6

Crimp terminal	39-00-0073
Wire gauge range	AWG18-24 stranded

This interface is used to connect the current shunt and the (optional) 10kΩ NTC thermistor on the current shunt to the Battery Controller. The positive operating power is provided in a fused connection to this connector.

This connection must only be made after all other connections to the Battery Controller have been made.

Connecting to a Current Shunt

The Battery Controller requires the shunt to be on the high side (positive end) of the battery stack. The VSHUNT_REF signal is used to compensate for the voltage drop in the sense wires as well as to provide the positive reference for measuring the overall voltage of the stack. VSHUNT_BAT and VSHUNT_LOAD carry the differential voltage measurement from the shunt. VSHUNT_BAT must be closest to the battery cells and VSHUNT_LOAD must be closest to the Stack Fuse so that the measured current has the correct polarity. Run all three wires close together to minimize outside interference.

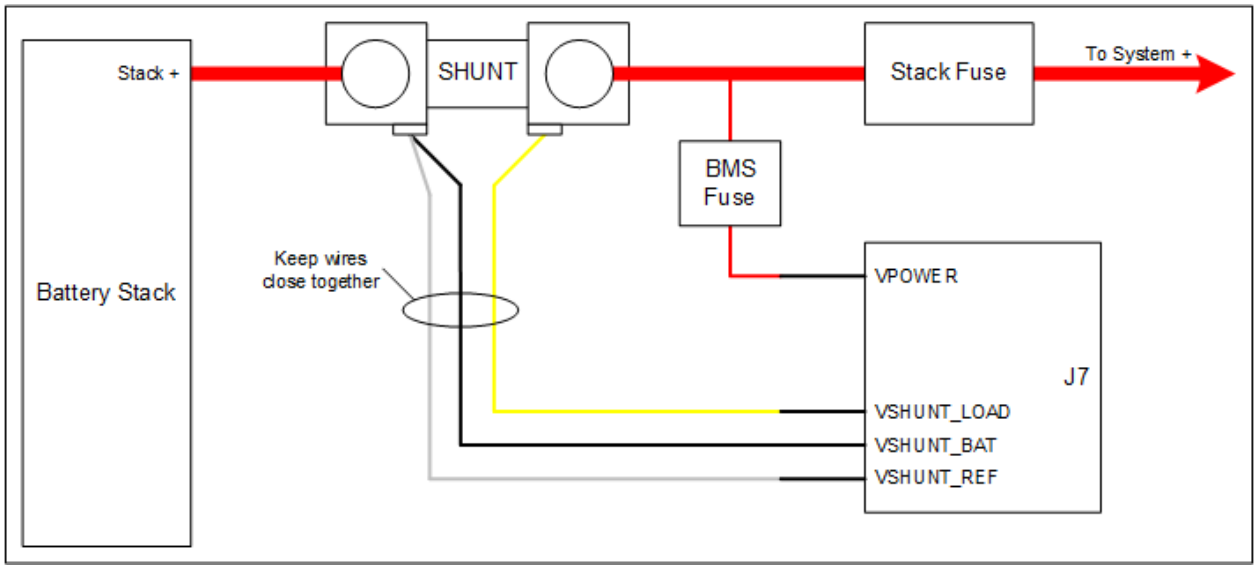


Figure 6. Current shunt and Power fuse connection to J7

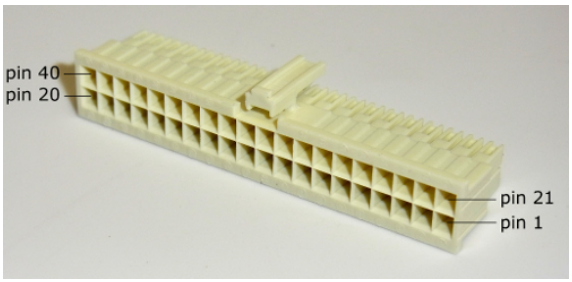
Table 11. Current Shunt Connector Pin Assignment

Pin	Connection	Description	Connected to Device
1	+VPOWER	Main power supply input	Positive end of the stack or other power source
2	No Connect	Not Connected	No Connect
3	No Connect	Not Connected	No Connect
4	VSHUNT_LOAD	Differential voltage input; Load side	Load side of current shunt
5	VSHUNT_BAT	Differential voltage input; Battery side	Battery side of current shunt
6	VSHUNT_REF	Voltage reference for voltage measurement	Battery side of current shunt

3.6.9. J8: Cell Voltage / Temperature

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.

Table 12. J8: Cell Voltage / Temperature plug housing and terminal details



Samtec IPD1-20-D	
Manufacturer	Samtec Inc
Housing	IPD1-20-D
Housing material	Nylon (Zytel® PA66) UL94V-2
Circuits	40
Crimp terminal	CC79R-2024-01-L
Wire gauge range	AWG20-24 stranded

Battery Cell Connections

The following two models of the Battery Controller are available, supporting a variety of cell counts and voltage ranges:

NUV300-BC-12: Connected cells are monitored internally by a single functional block. This functional block requires a minimum stack voltage of 11V to operate and measure its input voltages. The total voltage across the stack can be up to 60V. Unused cell tap wires should be connected to the last cell in the stack. See NUV300-BC-12: Connecting 12 cells to J8 and NUV300-BC-12: Connecting 8 cells to J8 for examples of how to connect cells to the NUV300-BC-12.

NUV300-BC-16: Connected cells are monitored internally by two functional blocks, each measuring eight cells (C0 to C8 and C8 to C16). Each functional block requires a minimum of 11V across it to operate and measure its input voltages. The total voltage across the stack can be up to 60V. See NUV300-BC-16: Connecting 16 cells to J8, NUV300-BC-16: Preferred method of connecting 11 cells to J8 and NUV300-BC-16: Less optimal method of connecting 11 cells to J8 for examples of how to connect cells to the NUV300-BC-12.

Groups do not need to contain the same number of cells but the maximum and minimum voltage limits must be met, as stated in Battery Controller supported cell connections.

Table 13. Battery Controller supported cell connections

Battery Controller	Cell groups	Max cell inputs per group	Max cell voltage per input	Max total voltage across group	Max total voltage across all groups	Min voltage per group
NUV300-BC-12	1	12	5V	60V	60V	11V

Battery Controller	Cell groups	Max cell inputs per group	Max cell voltage per input	Max total voltage across group	Max total voltage across all groups	Min voltage per group
NUV300-BC-16	2	8	5V	40V	60V	11V

The same style of connector is used for cell voltage and temperature sensor connection in both the NUV300-BC-12 and NUV300-BC-16. The names of the pins for the J8 connector are given in Battery Cell Voltage and Temperature Probes connector pin assignment.

Table 14. Battery Cell Voltage and Temperature Probes connector pin assignment

Pin	Connection	Description	Connected to Device
1	TPROBE1	External Temperature Probe Input 1	10kΩ NTC Thermistor
2	VBOT_TEMP	External Temperature Probe Reference 1	10kΩ NTC Thermistor
3	TPROBE2	External Temperature Probe Input 2	10kΩ NTC Thermistor
4	VBOT_TEMP	External Temperature Probe Reference 2	10kΩ NTC Thermistor
5	TPROBE3	External Temperature Probe Input 3	10kΩ NTC Thermistor
6	VBOT_TEMP	External Temperature Probe Reference 3	10kΩ NTC Thermistor
7	TPROBE4	External Temperature Probe Input 4	10kΩ NTC Thermistor
8	VBOT_TEMP	External Temperature Probe Reference 4	10kΩ NTC Thermistor
9	TPROBE5	External Temperature Probe Input 5	10kΩ NTC Thermistor
10	VBOT_TEMP	External Temperature Probe Reference 5	10kΩ NTC Thermistor
11	TPROBE6	External Temperature Probe Input 6	10kΩ NTC Thermistor
12	VBOT_TEMP	External Temperature Probe Reference 6	10kΩ NTC Thermistor
13	TPROBE7	External Temperature Probe Input 7	10kΩ NTC Thermistor
14	VBOT_TEMP	External Temperature Probe Reference 7	10kΩ NTC Thermistor
15	TPROBE8	External Temperature Probe Input 8	10kΩ NTC Thermistor
16	VBOT_TEMP	External Temperature Probe Reference 8	10kΩ NTC Thermistor
17	NC	No connect	
18	NC	No connect	
19	NC	No connect	
20	NC	No connect	
21	NC	No connect	
22	NC	No connect	
23	VCELL16	Cell 16 voltage sense	Connect to positive terminal of Cell 15
24	VCELL15	Cell 15 voltage sense	Connect to positive terminal of Cell 14
25	VCELL14	Cell 14 voltage sense	Connect to positive terminal of Cell 13

Pin	Connection	Description	Connected to Device
26	VCELL13	Cell 13 voltage sense	Connect to positive terminal of Cell 12
27	VCELL12	Cell 12 voltage sense	Connect to positive terminal of Cell 11
28	VCELL11	Cell 11 voltage sense	Connect to positive terminal of Cell 10
29	VCELL10	Cell 10 voltage sense	Connect to positive terminal of Cell 9
30	VCELL9	Cell 9 voltage sense	Connect to positive terminal of Cell 8
31	VCELL8	Cell 8 voltage sense	Connect to positive terminal of Cell 7
32	VCELL7	Cell 7 voltage sense	Connect to positive terminal of Cell 6
33	VCELL6	Cell 6 voltage sense	Connect to positive terminal of Cell 5
34	VCELL5	Cell 5 voltage sense	Connect to positive terminal of Cell 4
35	VCELL4	Cell 4 voltage sense	Connect to positive terminal of Cell 3
36	VCELL3	Cell 3 voltage sense	Connect to positive terminal of Cell 2
37	VCELL2	Cell 2 voltage sense	Connect to positive terminal of Cell 1
38	VCELL1	Cell 1 voltage sense	Connect to positive terminal of the lowest cell in the 12 or 16 cell module
39	VCELL0	Bottom of stack reference	Connect to negative terminal of the lowest cell in the 12 or 16 cell module
40	VSTACK_SENSE	Voltage sense reference	Connect to negative terminal of the lowest cell in the 12 or 16 cell module

Connecting to a Battery Controller - 12 channel (NUV300-BC-12)

Refer to Battery Cell Voltage and Temperature Probes connector pin assignment for the pin name assignment of the cell voltage and temperature sensor connector J8 for the NUV300-BC-12.

Connecting to the NUV300-BC-12 is very straightforward since all connected cells belong to a single group.

It is important to connect all cells in ascending voltage order, such that the negative terminal of the most negative (bottom) cell connects to VCELL0 of J8, and the positive terminal of each cell connects in ascending voltage order to VCELL1, VCELL2, etc. If fewer than 12 cells are connected, then the top cell and all unused cell inputs between the top cell and VCELL12 must be connected to VCELL12. Inputs VCELL13 through VCELL16 may be left disconnected, as shown in NUV300-BC-12: Connecting 8 cells to J8.

Use a separate wire to connect input VSTACK_SENSE to the negative end of the most negative (bottom) cell.

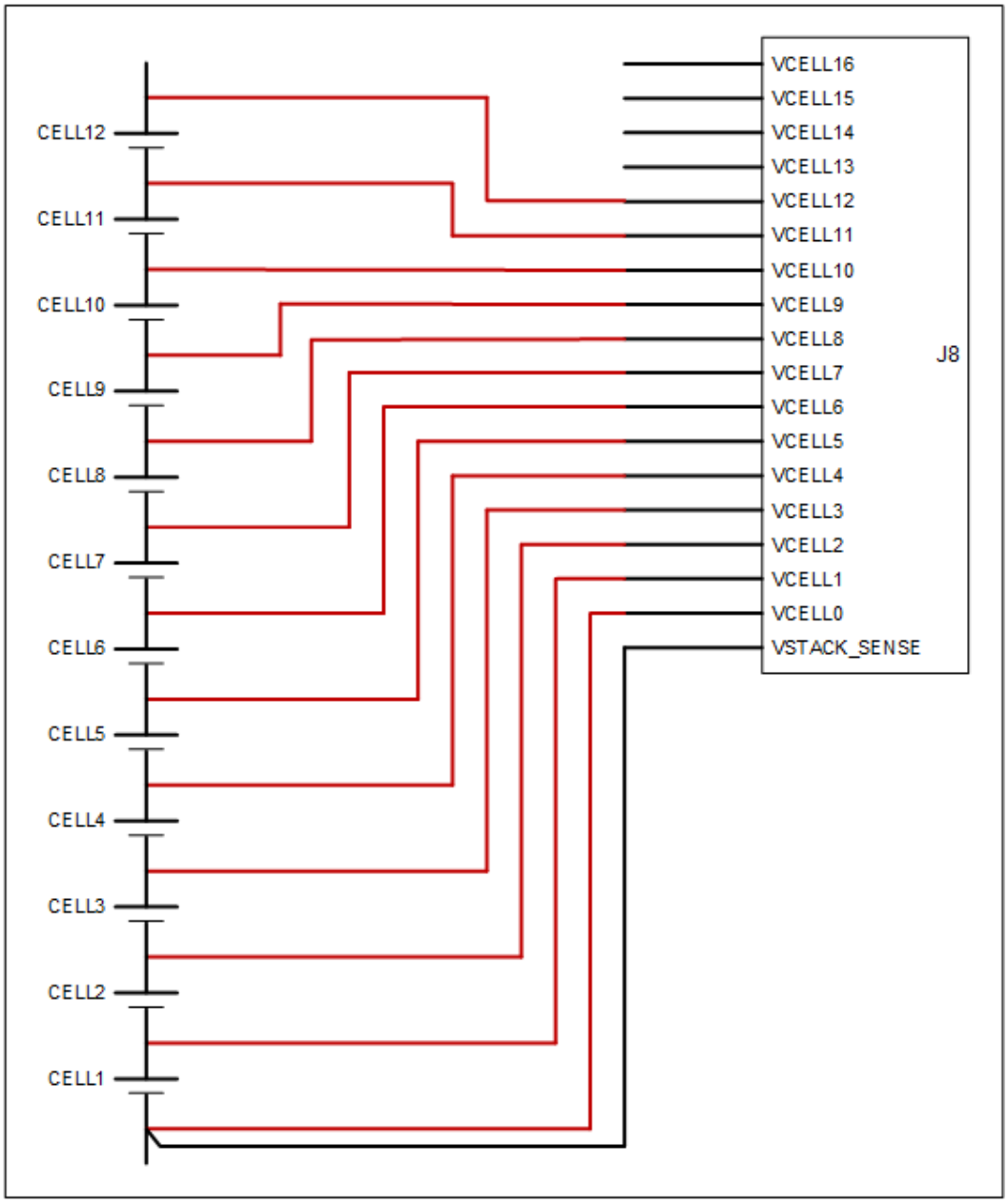


Figure 7. NUV300-BC-12: Connecting 12 cells to J8

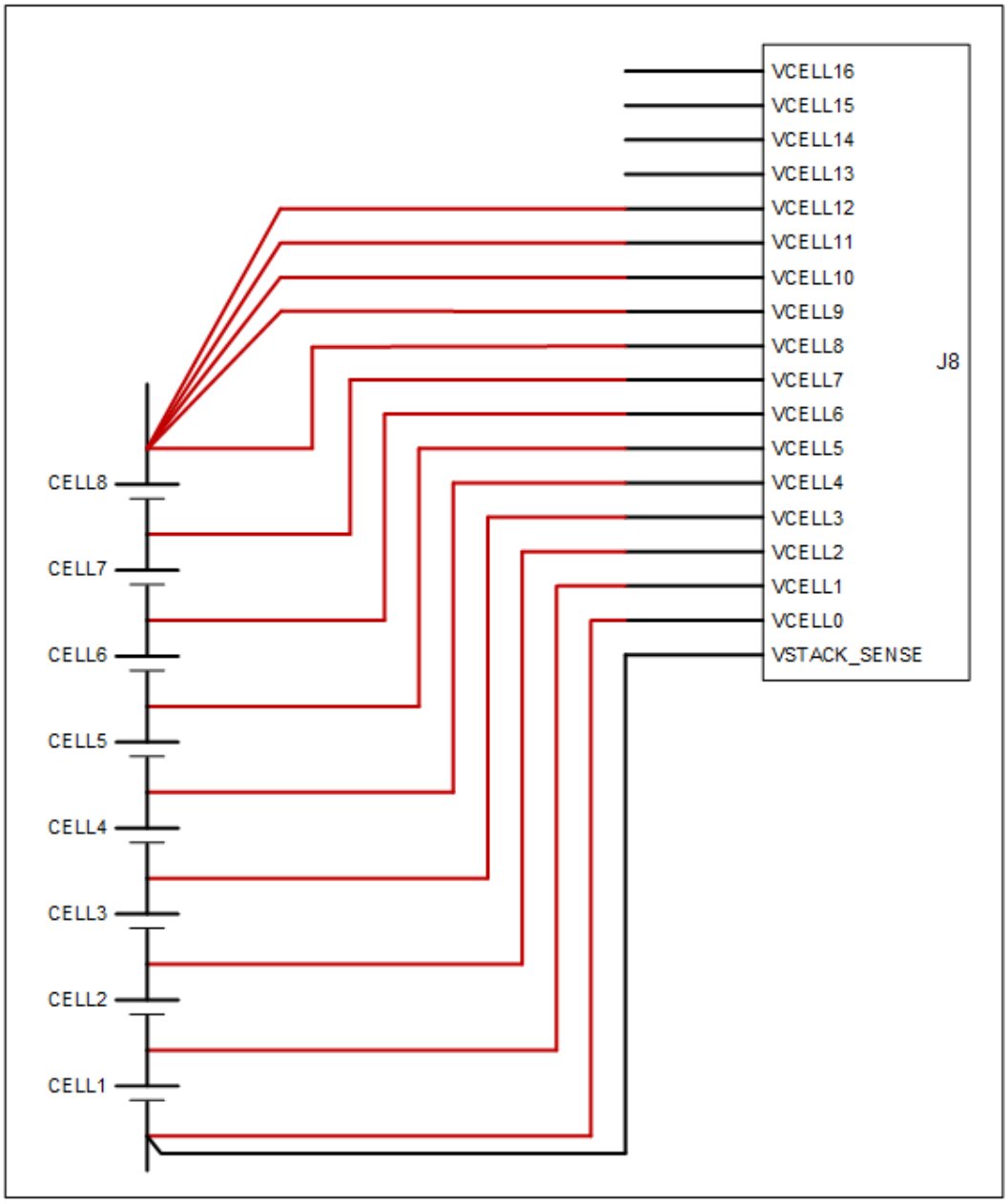


Figure 8. NUV300-BC-12: Connecting 8 cells to J8

Connecting to a Battery Controller - 16 channel (NUV300-BC-16)

Refer to Battery Cell Voltage and Temperature Probes connector pin assignment for the pin name assignment of the cell voltage and temperature sensor connector `J8` for the NUV300-BC-16.

The NUV300-BC-16 requires division of the connected cells into two groups. Each group is comprised of a sequentially-connected subset of the connected cells and the groups may be of different cell counts to a maximum of eight cells per group.

It is important to connect all cells in ascending voltage order, such that the negative terminal of the most negative (bottom) cell of the more negative group connects to `VCELL0` of `J8`, and the positive terminal of each cell in that group connects in ascending voltage order to `VCELL1`, `VCELL2`, etc. If fewer than 8 cells are connected in the more negative group, then that group's top cell and

all unused cell inputs between the group's top cell and VCELL8 must be connected to VCELL8.

Recognizing that the positive terminal of the top cell of the more negative group always connects to the negative terminal of the bottom cell of the more positive group and to VCELL8, the positive terminals of the cells in the more positive group must connect in ascending voltage order to VCELL9, VCELL10, etc. If fewer than 8 cells are connected in the more positive group, then that group's top cell and all unused cell inputs between the group's top cell and VCELL16 must be connected to VCELL16.

NUV300-BC-16: Connecting 16 cells to J8 shows the connection of 16 cells to a NUV300-BC-12 controller. It is recommended to use a NUV300-BC-12 for an 11-cell stack, but if a NUV300-BC-16 must be used, an example of the correct connection of 11 cells to a NUV300-BC-16 is presented in NUV300-BC-16: Preferred method of connecting 11 cells to J8. A less desirable connection example is shown in NUV300-BC-16: Less optimal method of connecting 11 cells to J8 which assumes 3 cells are sufficient to provide the required 11V minimum to the lower group.

Use a separate wire to connect input VSTACK_SENSE to the negative end of the most negative (bottom) cell of the more negative group.

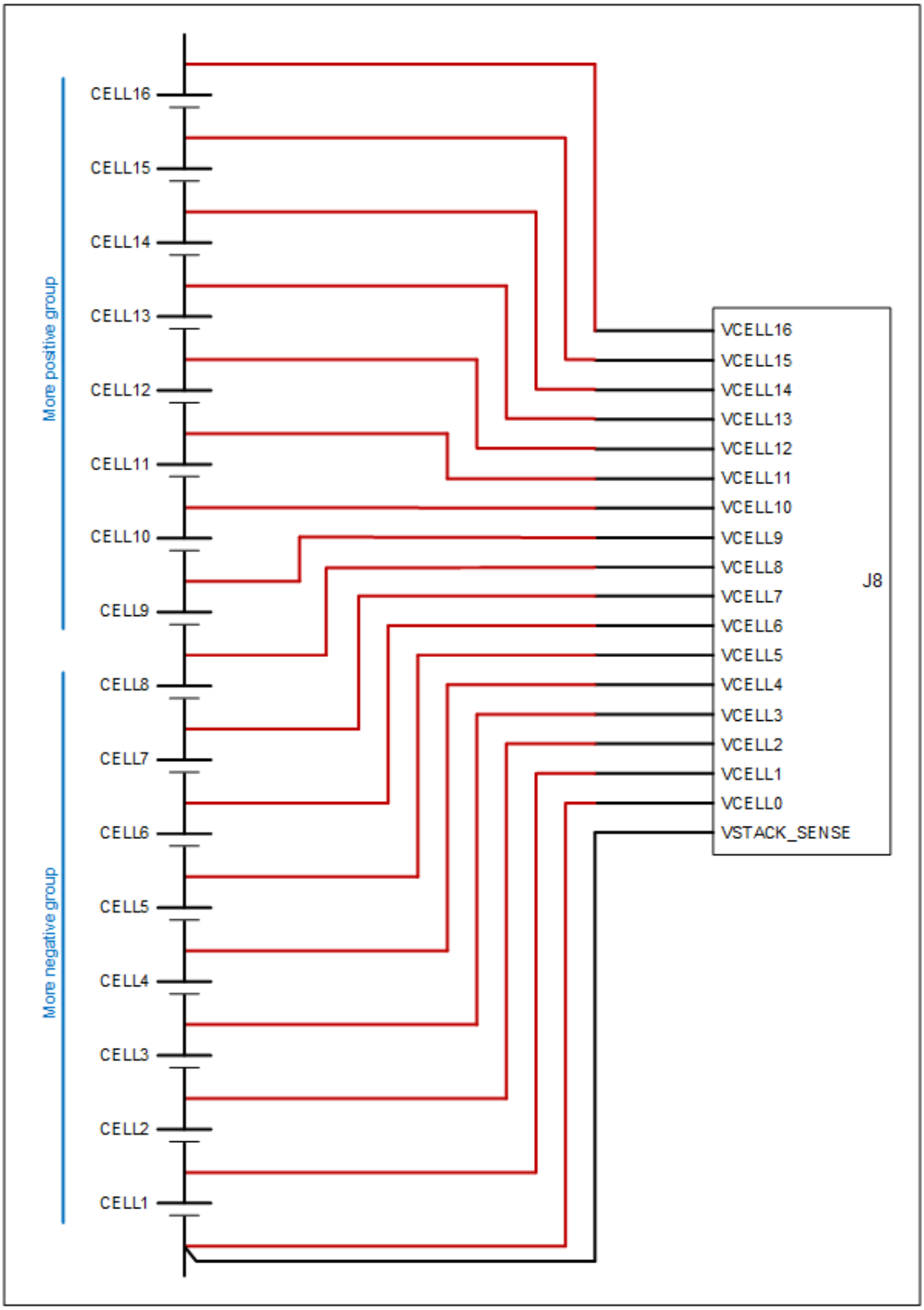


Figure 9. NUV300-BC-16: Connecting 16 cells to J8

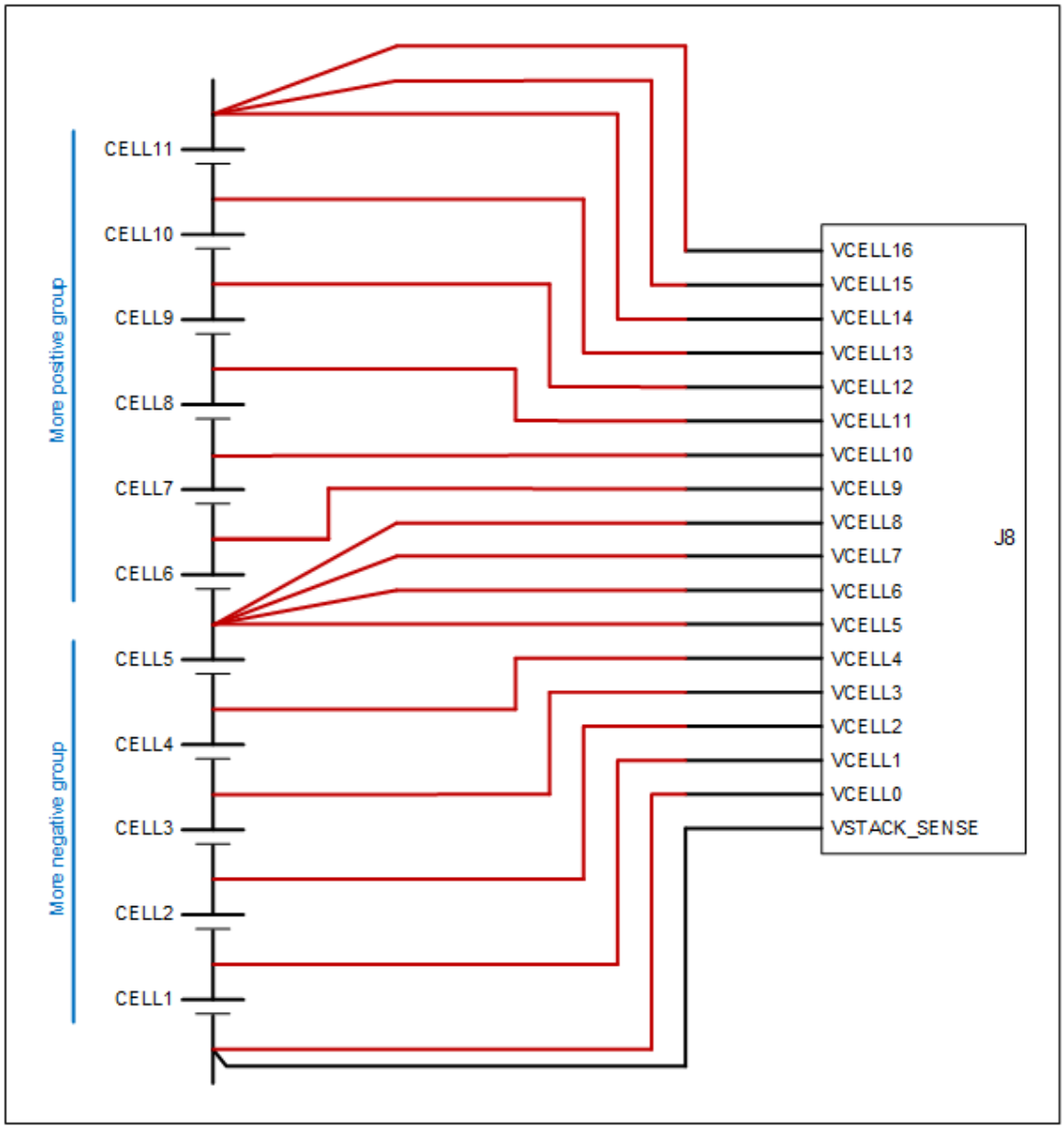


Figure 10. NUV300-BC-16: Preferred method of connecting 11 cells to J8

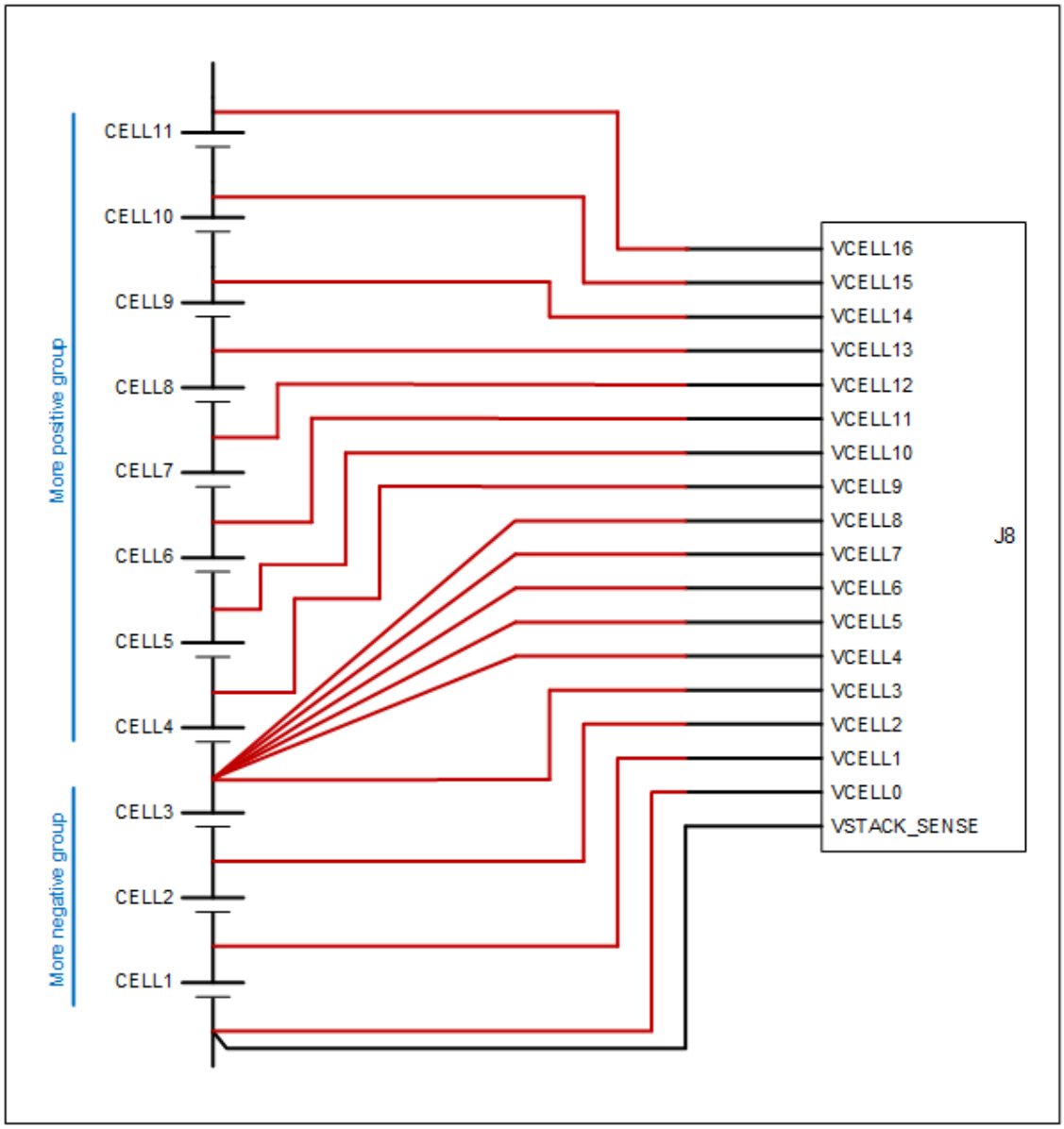


Figure 11. NUV300-BC-16: Less optimal method of connecting 11 cells to J8

Temperature Sensor Connections

Refer to Battery Cell Voltage and Temperature Probes connector pin assignment for the pin name assignment of the temperature sensor connections for the cell voltage and temperature sensor connector J8.

The Battery Controller supports monitoring of up to eight temperature channels for measuring cell temperature.

The sensors supported are negative temperature coefficient (NTC) thermistor type, with a 25°C resistance of 10kΩ. Thermistors supplied with the wiring harnesses may be one of the sensors listed in Thermistor details. Refer to the Software Reference Manual for instructions on how to configure the Battery Controller to use other thermistors.

Table 15. Thermistor details

Manufacturer	Part number	Type	R25	Range
Murata Electronics	NXFT15XH103FA2B100	NTC thermistor	10kΩ	-40°C ~ 125°C
US Sensor	USP10982	NTC thermistor	10kΩ	-55°C ~ 80°C

Thermistors are 2-leaded non-polarized devices. One lead of each sensor is to be connected to the `TPROBEn` pin of connector `J8`, where `n` denotes the channel on which that sensor's signal is measured. The other lead of each sensor is to be connected to one of the `VBOT_TEMP` pins of connector `J8`. Unused temperature input wires should be properly insulated or removed.

3.7. Grounding and Fusing

The Battery Controller enables connection to a series-connected stack of monitored cells up to a total voltage of 60V. The lowest potential (the negative end) of the connected stack also serves as the common return for the contactor coils as well as the reference for the Battery Controller's internal circuitry and power supply. Any connection to earth or chassis ground must be made outside of the Battery Controller.

The contactor coils return to the same potential as the most negative end of the attached stack regardless of whether this point is connected to ground.

An earth or chassis ground connection may be made to any single point in the connected cell stack as required by the application. The cell stack may also be left isolated from earth or chassis. Fusing of the cell stack where it connects to provide operating power to the Battery Controller is required externally.

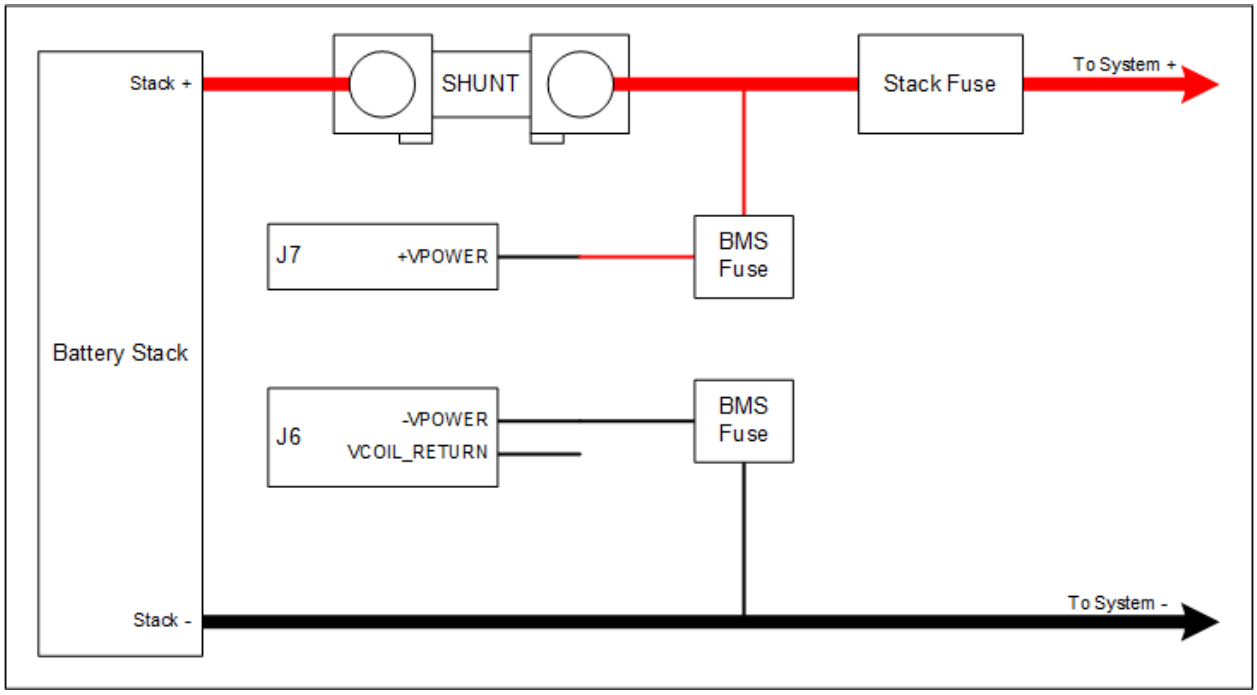


Figure 12. Connection example for powering the Battery Controller from cells

If the load side of the current shunt is grounded:

- A fuse is required at the negative power connection point only, in line with the connection to pin 6 of the `J6: Contactors / -V Power` connector

- Connect pin 6 of the J6: Contactors / -V Power connector through a fuse to the negative end of the stack
- Connect pin 1 of the J7: Current Shunt / +V Power connector directly to the load side of the current shunt, or to ground

If the most negative end of the stack is grounded:

- A fuse is required at the positive power connection point only, in line with the connection to pin 1 of the J7: Current Shunt / +V Power connector
- Connect pin 1 of the J7: Current Shunt / +V Power connector through a fuse to the load side of the current shunt
- Connect pin 6 of the J6: Contactors / -V Power connector directly to the negative end of the stack, or to ground

If no ground connection exists within the stack or if a ground connection is made somewhere other than at an end:

- Fuses are required at both the positive and negative power connection points to the Battery Controller, in line with each of pin 1 of the J7: Current Shunt / +V Power connector and pin 6 of the J6: Contactors / -V Power connector
- Connect pin 1 of the J7: Current Shunt / +V Power connector through a fuse to the load side of the current shunt
- Connect pin 6 of the J6: Contactors / -V Power connector through a fuse to the negative end of the stack

Fuse(s) are not supplied and must be selected based on the operating voltage range of the connected battery stack. Use the following table as a guide to select either one or two fuses of the same capacity.

Fuse current ratings	
12V Battery (9-16V)	8A
24V Battery (18-32V)	4A
36V Battery (27-48V)	2.5A
48V Battery (36-60V)	2A

3AB/3AG fast-response cartridge fuses and in-line fuse holders are commonly used for this application

An external 9-60V DC power source may be used (instead of the connected battery stack) to power the Battery Controller and power the contactor coils. The positive of this source must connect through a fuse to pin 1 of the J7: Current Shunt / +V Power connector and the negative of this source must connect through a fuse to pin 6 of the J6: Contactors / -V Power connector. In this situation, pin 5 of the J6: Contactors / -V Power connector must be connected directly to the most negative end of the stack. This will connect the negative of the external power source to the most negative end of the attached stack, so caution must be exercised when choosing the power source to ensure that this is acceptable and safe.

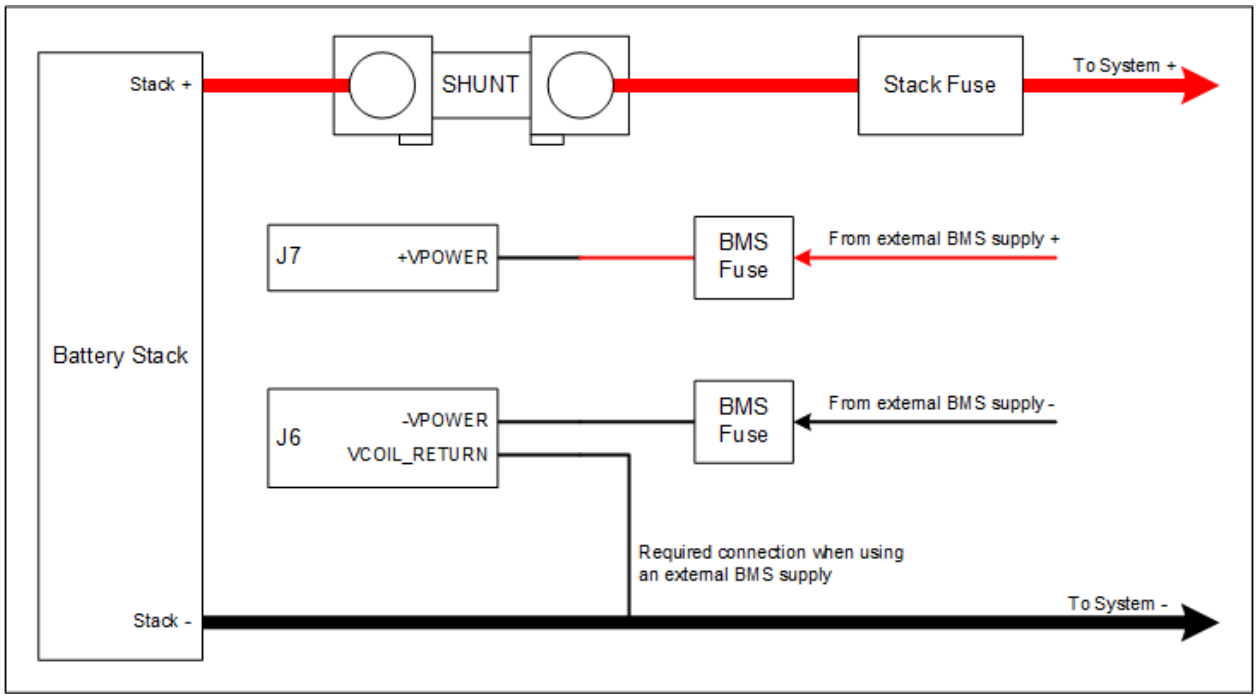


Figure 13. Connection example for powering the Battery Controller from external DC power source

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