



NUVATION BMS™

Operator Interface Guide

Multi-Stack

2017-12-22, Rev. 2.0

Table of Contents

1. Introduction	1
1.1. About this Guide	1
2. Setting up your Grid Battery Controller	2
2.1. Overview	2
2.2. Provision your Stacks	3
2.2.1. Overview	3
2.2.2. Connecting your Stacks	3
2.3. Modifying the Network Settings	3
2.4. Access the Operator Interface	5
2.4.1. Overview	5
2.4.2. Accessing the Operator Interface	5
2.5. Upload the Configuration File	6
2.5.1. Overview	6
2.5.2. Upload the Configuration file	6
2.5.3. Troubleshooting	6
2.6. Enable and Connect your Stacks	7
3. Using your Nuvation BMS™ Grid Battery Controller	10
3.1. The Dashboard Tab	10
3.1.1. Overview	10
3.1.2. Warnings and Faults	10
3.1.3. Pack Voltage	11
3.1.4. Pack Current	11
3.1.5. State of Charge	12
3.1.6. Depth of Discharge	12
3.1.7. Stack Voltage	13
3.1.8. Stack Current	14
3.1.9. Cell Voltage	15
3.1.10. Temperature	16
3.1.11. Nuvation BMS Status	17
Safety Status	17
Connection State	18
Information Table	18
Last Update	19
3.2. The Details Tab	20
3.2.1. Overview	20
Information Selector	20
3.2.2. Battery	21
3.2.3. Current Limiter	21
3.2.4. Safety	21
3.3. The Menu Options	23
3.3.1. Overview	23

1. Introduction

Thank you for choosing Nuvation BMS™

The Nuvation BMS™ manages rechargeable battery cells by limiting operation to within the cell's safe operating range, monitoring the state of the cells, estimating State-of-Charge and State-of-Health, reporting measured data, and interacting with the energy storage system controller.

The Nuvation BMS™ Operator Interface is a platform-agnostic (i.e. Windows, Linux, Mac, mobile OS) plug-and-play user interface. It allows energy storage system operators to manage the operation of their Nuvation BMS modules as well as internal and external communications.

With this Battery Management System, operators achieve peace of mind that their cells are protected.

1.1. About this Guide

This *Operator Interface Guide: Multi-Stack* covers the graphical dashboard and control of your Nuvation BMS™ via the Operator Interface.

This guide covers multi-stack installations using a Nuvation Energy. If you are using a Nuvation BMS™ High-Voltage Stack controller or a Nuvation BMS™ Low-Voltage Battery Controller please refer to the *Operator Interface Guide Single Stack*.



For purposes of this document, a multi-stack is defined as an installation that uses a Nuvation BMS™ Grid Battery Controller to aggregate information from multiple stacks.

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

2. Setting up your Grid Battery Controller

2.1. Overview

Your Grid Battery Controller allows you to control multiple stacks. You will need to setup and provision each stack before you start setup and provisioning of your Grid Battery Controller



For instructions on how to wire your Nuvation BMS to your energy storage system please refer to the *Nuvation BMS Installation Guide*

To get started with the configuration and setup your Grid Battery Controller you need to:

1. [Provision your Stack](#)
2. [Access the Operator Interface](#)
3. [Upload the Configuration File](#)
4. [Enable and Connect your Stacks](#)

Let's get started...

2.2. Provision your Stacks

2.2.1. Overview

Please refer to the *Installation Guide* and the *Operator Interface Guide* for your Nuvation BMS to setup and provision the individual stacks.

2.2.2. Connecting your Stacks

Once each stack is set up and configured you can change the network configuration for the individual stacks to talk to the Grid Battery Controller.

Following the instructions below, change the IP address of each stack to **192.168.4.x** (where **x** is not **1** or **10**).



Improperly modifying the network settings can result in a Nuvation BMS that cannot communicate over Ethernet. To restore the Nuvation BMS to its default IP address (192.168.1.21), you must initiate a factory reset action - refer to the Installation Guide for your Nuvation BMS for instructions.

Be sure to record the updated IP address, netmask, and gateway settings if you decide to make changes to these settings.

2.3. Modifying the Network Settings

1. Launch the Operator Interface for the stack
2. Unlock the Operator Interface by clicking the menu and **Unlock**
3. From the menu, select **Registers** to bring up the register browser page
4. Under the **Manual Register Configuration** panel, expand the row for Component Name **sc_ethernet**.



Use the find feature (**Ctrl + F**) in your browser to locate components in the page

Register Offset	Register Name	Description	Type	Units	Storage	
0x0	use_dhcp	Flag indicating if DHCP is used	Boolean	Flag	Configuration	<input type="button" value="Edit"/>
0x1	ip_address	IP address to be used in static configuration	IpAddress	IP	Configuration	<input type="button" value="Edit"/>
0x2	net_mask	Network mask to be used in static configuration	IpAddress	IP	Configuration	<input type="button" value="Edit"/>
0x3	gateway	Gateway address to be used in static configuration	IpAddress	IP	Configuration	<input type="button" value="Edit"/>
0x4	mac	MAC address of this board	UInt64	Value	Manufacturing	<input type="button" value="Edit"/>

5. Click the **Edit** button on the **ip_address** register. This will bring up the **Edit Register** dialog box
6. Change the IP address to **192.168.4.x** (where **x** is not **1** or **10**). Then click **Write**



The index field may be left blank for all operations.

7. Confirm that the value has been updated by clicking **Read**
8. Under the **Manual Register Configuration** panel, expand the row for component name **sc_locked_cfg_persist**.
9. Click the **Edit** button for the **save** register and write a value of **1**

Edit Register
×

Enter the component index and optional value of the register to read or write:

sc_locked_cfg_persist[].save

10. Verify that the configuration has been saved correctly by reading the error register. The value will be **0** if no errors have occurred.

The network settings have been updated.

2.4. Access the Operator Interface

2.4.1. Overview

The Operator Interface can be accessed from any computer/tablet with the latest Firefox or Chrome web browser. The OI is used to access the Grid Battery Controller in a multi-stack installation.

2.4.2. Accessing the Operator Interface

To access the Operator Interface, open a web browser and navigate to the IP address of the Grid Battery Controller. For example, if the Grid Battery Controller's IP address is **192.168.1.20**, open a web browser and go to <http://192.168.1.20>.



Browser Compatibility

The Operator Interface currently supports the most recent versions of Mozilla Firefox and Google Chrome. Other browsers such as Internet Explorer are not supported. Please install a supported browser before attempting to access the Operator Interface.

2.5. Upload the Configuration File

2.5.1. Overview

Your Grid Battery Controller needs a valid configuration file to operate.

For instructions on how to create and modify the configuration file, and to understand the various registers please refer to the Nuvation BMS™ Grid Battery Controller Firmware Reference Manual.

2.5.2. Upload the Configuration file

1. Ensure **Persist Configuration to BMS** is checked

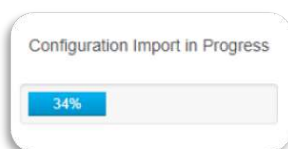


Persist Configuration to BMS

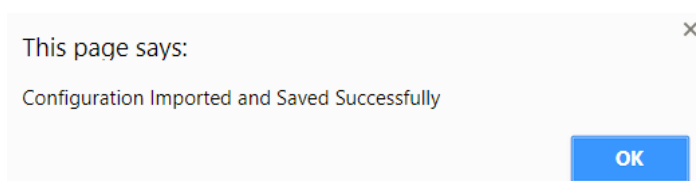
Enabling this option tells the Grid Battery Controller to persist the uploaded configuration file. If you are using known, good, configuration files you should check this box.

Disabling this option tells the Grid Battery Controller to not persist the newly uploaded configuration file. On reboot, the Grid Battery Controller will revert to the previous configuration file. This is useful when tweaking and testing configuration files. It allows you to recover from incorrect configuration settings by rebooting the Grid Battery Controller

2. Click **Import Configuration**
3. Select the configuration file to use and click **Open**
4. A dialog indicating progress will pop-up



5. Wait until a dialog box appears with the configuration upload result. It should indicate that the upload was successful.



2.5.3. Troubleshooting

During the configuration file upload, if you receive a **Register Write failure error**, ensure you have valid entries in your configuration file. For details on the various registers and their intended use, please refer to the Nuvation BMS™ Grid Battery Controller Firmware Reference Manual.



If the failures persist, please submit a support ticket with as much detail as possible to support@nuvationenergy.com.

2.6. Enable and Connect your Stacks

1. Navigate to the **Stack Status** tab. You should see details of the stacks that the Grid Battery Controller can communicate with.

NUVATION BMS™

Dashboard **Stack Status** Details

Overall BMS Status

ALL OK Connected 0/0

Clear Connect

Stack 1 Status

ALL OK

Disconnected Disabled

Connect

Enable

Name	Value
SOC	100%
Stack Voltage	38.3V
Stack Current	3.9A

Stack 2 Status

ALL OK

Disconnected Disabled

Connect

Enable

Name	Value
SOC	99%
Stack Voltage	38.2V
Stack Current	-0.1A

Stack 3 Status

ALL OK

Disconnected Disabled

Connect

Enable

Name	Value
SOC	30%
Stack Voltage	38.3V
Stack Current	0.0A

2. For each stack, click the **Enable** button. When all stacks are enabled your screen should look like this:

NUVATION BMS™

Dashboard Stack Status Details

Overall BMS Status



ALL OK


Clear




Connected
0/3

Connect

Stack 1 Status



ALL OK




Disconnected
Enabled

Connect


Disable

Name	Value
SOC	100%
Stack Voltage	38.3V
Stack Current	-1.1A

Stack 2 Status



ALL OK




Disconnected
Enabled

Connect


Disable

Name	Value
SOC	99%
Stack Voltage	38.2V
Stack Current	-0.1A

Stack 3 Status



ALL OK



Disconnected
Enabled

Connect

Disable

Name	Value
SOC	30%
Stack Voltage	38.3V
Stack Current	0.0A

- For each stack, click the **Connect** button. When all stacks are connected your screen should look like this:

NUVATION BMS™

Dashboard Stack Status Details

Overall BMS Status



ALL OK


Clear




Connected
3/3

Connect

Stack 1 Status



ALL OK




Connected
Enabled

Disconnect


Disable

Name	Value
SOC	100%
Stack Voltage	38.3V
Stack Current	3.4A

Stack 2 Status



ALL OK




Connected
Enabled

Disconnect


Disable

Name	Value
SOC	99%
Stack Voltage	38.2V
Stack Current	-0.1A

Stack 3 Status



ALL OK



Connected
Enabled

Disconnect

Disable

Name	Value
SOC	30%
Stack Voltage	38.3V
Stack Current	0.0A



Be mindful of your stack voltages when connecting. Stacks should be well balanced in relation to each other.

4. Refresh your Operator Interface

You are ready to use your Grid Battery Controller!

3. Using your Nuvation BMS™ Grid Battery Controller

3.1. The Dashboard Tab

3.1.1. Overview

The default tab of the Operator Interface is the Dashboard. The Dashboard contains a high-level overview on the state of the battery stack.

This is the only page required for daily monitoring of the battery stack.

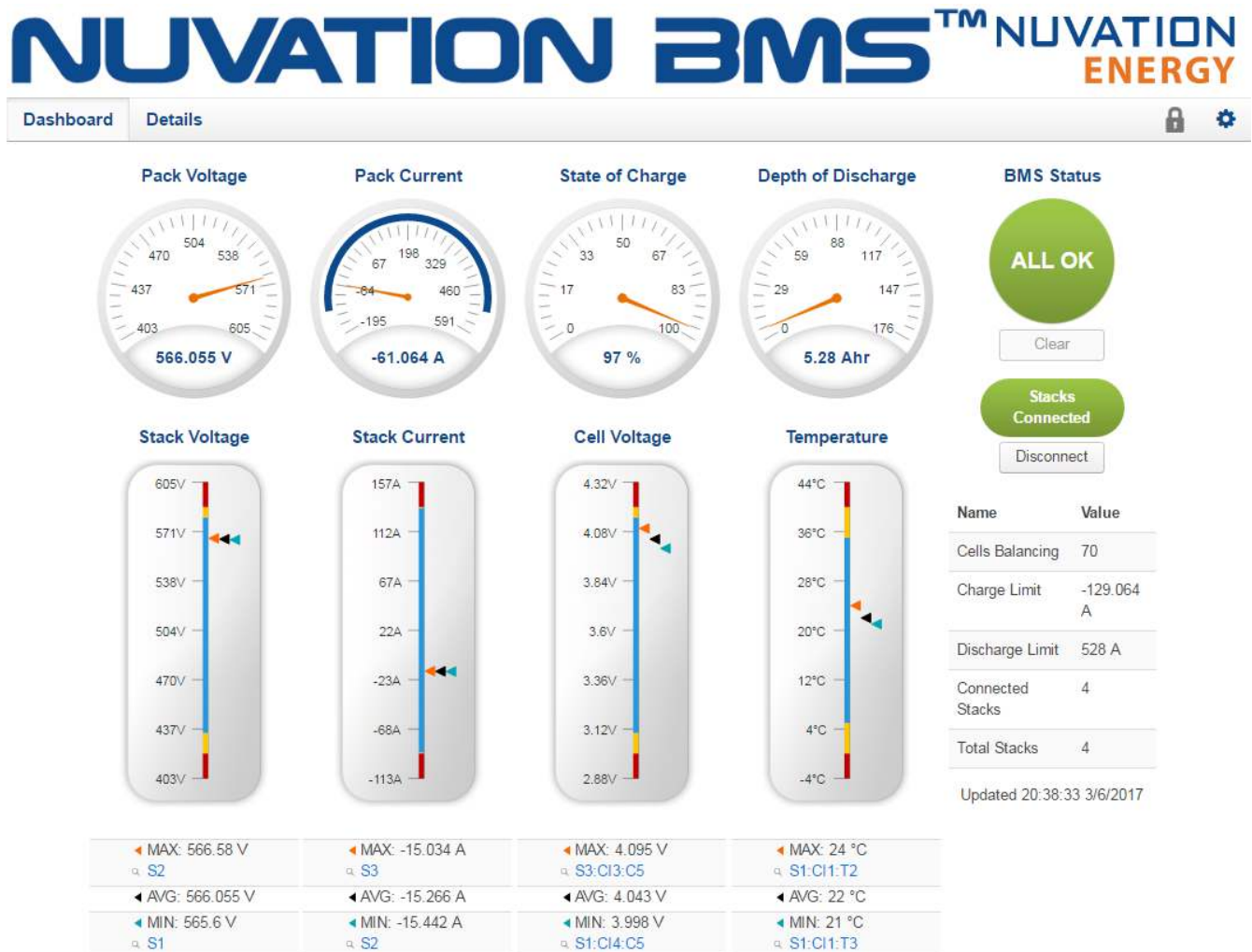





Figure 1. Nuvation BMS™ Operator Interface Multi-Stack Dashboard screenshot

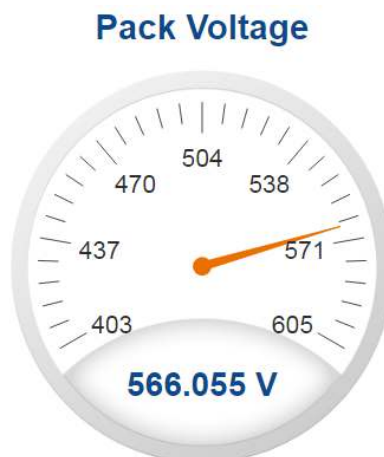
3.1.2. Warnings and Faults

Before going into the details of the gauges and information presented in the dashboard, it is important to understand what a fault and a warning Nuvation BMS status means.

	<p>A Nuvation BMS Warning indicates the state of the battery system has been detected outside of its normal operational range. The cause of the warning should be identified and a corrective action should be performed. For instance, if the warning is a thermistor temperature measurement has become too hot, the battery system should be cooled to bring the measurement back into the normal operational range.</p>
	<p>A Nuvation BMS Fault indicates the state of the battery system has been detected outside of its safe operational range. The cause of the fault must be identified and a corrective action must be performed. For instance, if the fault is a cell voltage measurement has become too low, the cell maintenance manual must be reviewed to identify what remedial actions are required.</p> <p>A Nuvation BMS Fault is more severe than a Nuvation BMS Warning and the source of the fault must be discovered and resolved before attempting to clear the Nuvation BMS Fault to continue operating the battery system.</p>
	<p>An ALL OK indicates that there are no faults or warning. This is the normal state for the Nuvation BMS.</p>

3.1.3. Pack Voltage

The pack voltage radial gauge shows the average stack voltage of the stacks connected to the common DC bus.



3.1.4. Pack Current

The pack current radial gauge shows the battery pack current which is the addition of each stack current that are connected to the common DC bus. The maximum charge current limit and the maximum discharge current limit is also shown. The acceptable current range is visualized on the gauge by the blue arc. An absence of the blue arc indicates the battery pack cannot be charged or discharged in its present condition.

A negative current value indicates the battery pack is charging. A positive current value indicates the battery pack is discharging.

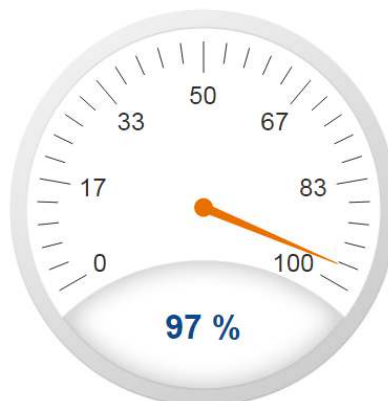
Pack Current



3.1.5. State of Charge

The State-of-Charge radial gauge shows the battery stack's State-of-Charge, which is an average SOC of the stacks connected to the common DC bus. The battery stack is empty when the State-of-Charge value is 0% and full when the State-of-Charge value is 100%.

State of Charge



3.1.6. Depth of Discharge

The Depth-of-Discharge radial gauge shows how much energy has been taken out of the battery stack. It is the sum of all stacks connected to the common DC bus. In an ideal energy storage system, defined as a system with no power losses, the amount of energy shown in this gauge needs to be added back into the battery pack to fill it back up to 100% SOC.

Depth of Discharge



3.1.7. Stack Voltage

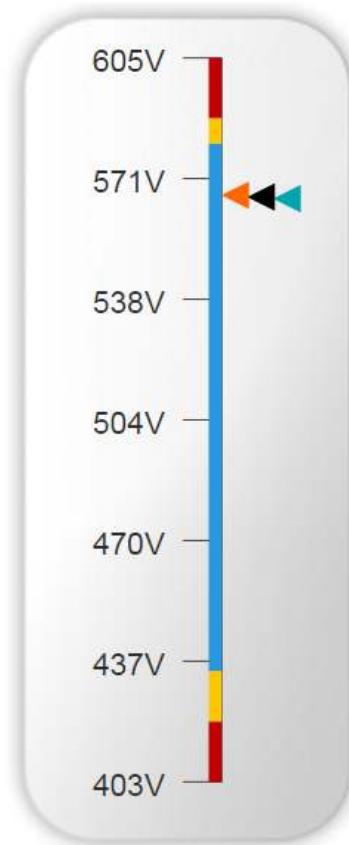
The stack voltage bar gauge shows the maximum, minimum and average stack voltage measurements within the battery pack.

The high stack voltage and low stack voltage warning and fault threshold is visualized on the gauge with yellow and red segments. The blue segment depicts the acceptable stack voltage range.

If a triangle enters the yellow segment, a warning has occurred. If a triangle enters the red segment, a fault has occurred.

The maximum and minimum stack location in the pack and their voltage value are shown below the gauge, along with the average stack voltage value.

Stack Voltage



◀ MAX: 566.58 V

🔍 S2

◀ AVG: 566.055 V

◀ MIN: 565.6 V

🔍 S1

3.1.8. Stack Current

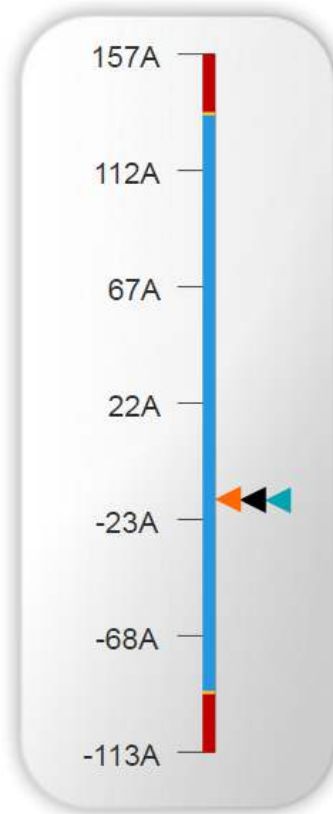
The stack current bar gauge shows the maximum, minimum and average stack current measurements within the battery pack.

The high stack discharge current and high stack charge current warning and fault threshold is visualized on the gauge with yellow and red segments. The blue segment depicts the acceptable stack current range.

If a triangle enters the yellow segment, a warning has occurred. If a triangle enters the red segment, a fault has occurred.

The maximum and minimum stack location in the pack and their current value are shown below the gauge, along with the average stack current value.

Stack Current



◀ MAX: -15.034 A
🔍 S3
◀ AVG: -15.266 A
◀ MIN: -15.442 A
🔍 S2

3.1.9. Cell Voltage

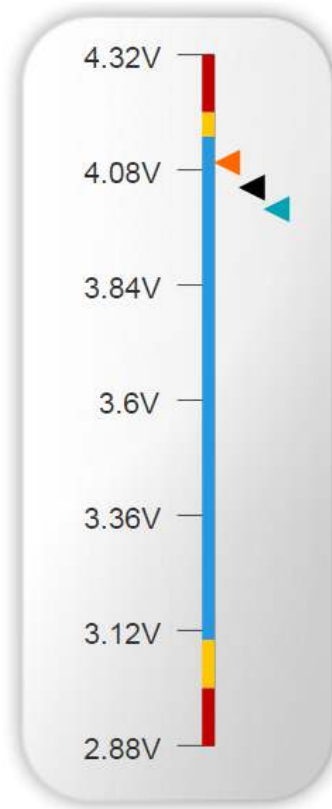
The cell voltage bar gauge shows the maximum, minimum and average cell voltage measurements within the stack.

The high cell voltage and low cell voltage warning and fault threshold is visualized on the gauge with yellow and red segments. The blue segment depicts the acceptable cell voltage range.

If a triangle enters the yellow segment, a warning has occurred. If a triangle enters the red segment, a fault has occurred.

The maximum and minimum cell location in the stack and their voltage value are shown below the gauge, along with the average cell voltage value.

Cell Voltage



◀ MAX: 4.095 V

🔍 S3:CI3:C5

◀ AVG: 4.043 V

◀ MIN: 3.998 V

🔍 S1:CI4:C5

3.1.10. Temperature

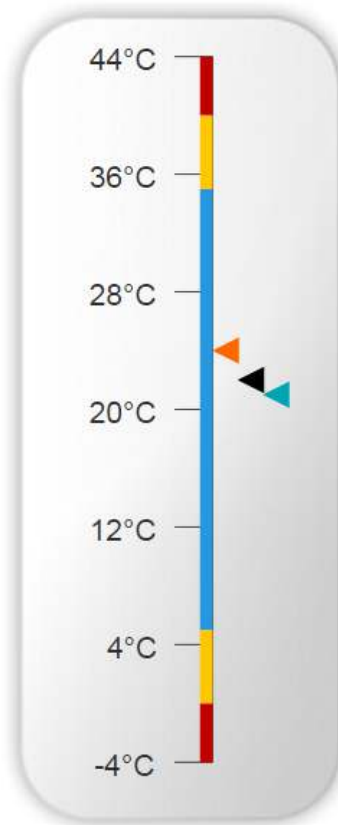
The temperature bar gauge shows the maximum, minimum and average cell temperature measurements within the stack.

The high cell temperature and low cell temperature warning and fault threshold is visualized on the gauge with yellow and red segments. The blue segment depicts the acceptable cell temperature range.

If a triangle enters the yellow segment, a warning has occurred. If a triangle enters the red segment, a fault has occurred.

The maximum and minimum cell location in the stack and their temperature value are shown below the gauge, along with the average cell temperature value.

Temperature



◀ MAX: 24 °C

🔍 [S1:CI1:T2](#)

◀ AVG: 22 °C

◀ MIN: 21 °C

🔍 [S1:CI1:T3](#)

3.1.11. Nuvation BMS Status

The Nuvation BMS status information contains information on the overall safety status of the battery stack, the battery stack connection state, number of cells balancing, maximum charge current limit, maximum discharge current, number of stacks connected, number of stacks installed in the battery pack, and the time and date of the last update of the Dashboard.

Safety Status

The Nuvation BMS safety state is shown in the big status circular indicator.



Figure 2. Three possible Nuvation BMS safety states

The normal state is **All OK** and the color of the indicator will be green. The warning state is **Warning** and the color of the indicator will be orange. The fault state is **Fault** and the color of the indicator will be red.

Clicking on the indicator will jump to a comprehensive status list of all warnings and faults active in the battery stack.

Clicking on the **Clear** button below the state will cancel any warnings and faults that are not self-clearing.

Connection State

The battery stack connection state is shown in the oval indicator.



Figure 3. Three possible connection states

Stack Disconnected in a red oval indicates the battery stack is unavailable to be charged or discharged.

Stack Pre-charging in an orange oval indicates the battery stack has connected its pre-charge circuit and is attempting to equalize the battery stack voltage to the system DC bus voltage.

Stack Connected in a green oval indicates the battery stack is available to be charged or discharged.

Clicking the **Connect** button initiates the stack connection sequence of events. The Nuvation BMS must be in the **All OK** state for the **Connect** button to be available.

Clicking the **Disconnect** button will disconnect the battery stack from the system DC bus.

Information Table

The information table shows the number of cells that are having excess energy bled off to maintain a balanced battery stack.

Name	Value
Cells Balancing	70
Charge Limit	-129.064 A
Discharge Limit	528 A
Connected Stacks	4
Total Stacks	4

The **Charge Limit** shows the maximum charge current limit value. The **Discharge Limit** shows the maximum discharge current limit value.

The **Charge Limit** and **Discharge Limit** values are visualized on the Stack Current radial gauge as the limits of the blue arc.

The **Connected Stacks** shows the number of stacks connected to the common DC bus. The **Total Stacks** shows the number of stacks installed in the battery pack.

Last Update

The **Updated** time and date shows the last time the Operator Interface had successfully communicated with the Nuvation BMS and updated all items in the Dashboard with values from the Nuvation BMS. The time and date is based on the local computer/tablet; it does not come from the Nuvation BMS.

Updated 21:42:07 4/6/2017
Error: Register read error

If a communication timeout has occurred, a notification appears beneath the **Updated** time and date. If a timeout has occurred, the information shown on the Dashboard is no longer recent.

3.2. The Details Tab

3.2.1. Overview

The Details tab contains a much more detailed view into the status of the Nuvation BMS. The data values shown in this tab can be easily copied into a spreadsheet as a means of capturing the current state of the Nuvation BMS for manual data recording purposes.

The Details tab has multiple sub-sections called *accordions* that can be expanded to reveal more information. You can have multiple accordions expanded at the same time.

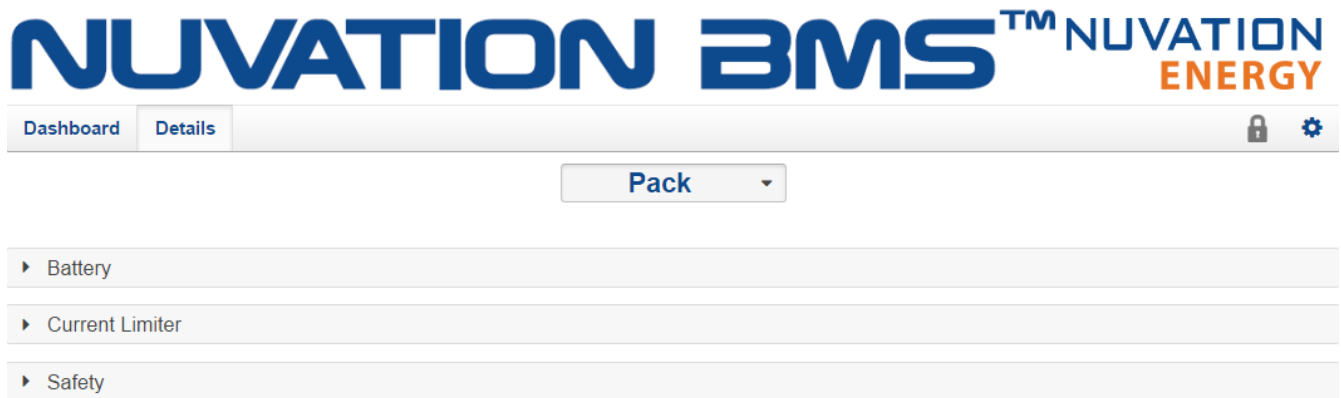


Figure 4. Nuvation BMS™ Operator Interface Details tab screenshot

Information Selector

The drop-down list at the top-center of the Details tab selects what content to display in the tab.

The Pack is the default option and it presents information on the overall battery pack.

The Stack option presents information on that specific battery stack. If a Stack is selected, refer to Operator Interface Guide for more information.



All 24 stacks are listed even when fewer than 24 stacks are installed. Only select stacks that are installed in the battery pack.

3.2.2. Battery

The Battery accordion contains values on the overall battery pack. This information is identical to the values shown in the radial gauges and bar gauges on the Dashboard, except that the stack voltage and stack current bar gauge information is omitted.

Battery		Last update: Thu Apr 06 2017 22:04:47 GMT-0400 (Eastern Daylight Time)
Register Name	Value	
Pack Voltage	566.055 V	
State of Charge	97 %	
Pack Current	-61.064 A	
Depth of Discharge	5.28 Ahr	
Average Cell Voltage	4.043 V	
Maximum Cell Voltage	4.095 V	
Minimum Cell Voltage	3.998 V	
Average Temperature	22 C	
Maximum Temperature	24 C	
Minimum Temperature	21 C	

Figure 5. Battery accordion in Details Tab

3.2.3. Current Limiter

The Current Limiter accordion contains the maximum charge current limit, maximum discharge current limit. This information is identical to the values shown in the Information Table on the Dashboard. The unit of the current limit values is mA.

Current Limiter		Last update: Thu Apr 06 2017 22:11:39 GMT-0400 (Eastern Daylight Time)
Register Name	Value	
Charge Limit	129064	
Discharge Limit	528000	

Figure 6. Current Limiter accordion in Details Tab

3.2.4. Safety

The Safety accordion contains a summary list of the number of Nuvation BMS faults and warnings active in the battery pack well as the overall status of the battery pack. An active fault or warning is shown as **Tripped**. In normal operation, all warnings and faults should be clear and the battery stack is safe to charge, safe to discharge and overall safe.

▼ Safety Last update: Thu Apr 06 2017 22:14:01 GMT-0400 (Eastern Daylight Time)

Register Name	Value
Overall Safe	Safe
Safe to Charge	Safe
Safe to Discharge	Safe
Communication fault	Clear
Battery fault	Clear
Warning	Clear
Communication Fault Count	0
Battery Fault Count	0
Warning Count	0

Clear Faults

Figure 7. Safety accordion in Details Tab

Clicking on the **Clear Faults and Warnings** button at the bottom of this accordion will clear any faults that are not self-clearing. It will not clear any warnings that are not self-clearing; the **Clear** button on the Dashboard must be used to clear warnings that are not self-clearing.

stack_warn_therm_lo[0].trig	Clear	Yes
stack_warn_current_hi[0].trig	Clear	Yes
stack_warn_current_lo[0].trig	Clear	Yes
stack_warn_voltage_hi[0].trig	Clear	Yes
stack_warn_voltage_lo[0].trig	Clear	Yes
sc_warn_ci_therm_hi[0].trig	Clear	Yes
sc_warn_ci_therm_lo[0].trig	Clear	Yes
stack_warn_combined_voltage_hi[0].trig	Clear	Yes
stack_warn_combined_voltage_lo[0].trig	Clear	Yes

Clear Faults and Warnings

Figure 8. Bottom of Safety accordion in Details Tab

3.3. The Menu Options

3.3.1. Overview

The menu to the right of the Operator Interface provides access to tools and advanced options. Some of these options may be locked to prevent accidental changes.

Ampere 17.12



Figure 9. Sample About screen

Nuvation BMS™, Nuvation High-Voltage BMS™, and Nuvation Low-Voltage BMS™ 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.

© Copyright 2017, Nuvation Energy