Nuvation Energy BMS Curie Software

Release Notes

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BMS Software Version: Curie Update 1 and Curie Update 2

Table of Contents

1. Revision History

Version	Details	Date
1.0	Initial release for Curie Update 1 and Curie Update 2 firmware	2020-09-10

2. Introduction

This document provides a summary of software changes for the Curie Software release.

Nuvation Energy Software Release Naming Convention

Nuvation Energy BMS software releases have *names* along with *version numbers*. The release names are in alphabetical order to easily identify newer releases. For example: Ampere -> Babbage -> Curie.

There are two releases for Curie—Curie Update 1 and Curie Update 2

Curie Update 1 (19.11.1)

Applies to stack-level products like:

- High-Voltage BMS
- High-Voltage BMS (modules only)
- Low-Voltage BMS

Curie Update 2 (19.11.2)

Applies to multi-stack products like:

- Grid Battery Controller
- Battery Control Panel
- Multi-Stack Controller

Finding the currently installed version

To find the current version of software installed on your battery management system:

- At the stack-level, check the *Service* screen in the Operator Interface.
- At the multi-stack level, check the *About* screen in the Multi-Stack Operator Interface.

2.1. UL 1973 compatibility

All Curie releases are compatible for UL 1973 certification.

Stack-Level

To maintain firmware compatibility for the UL 1998 safety assessment, the stack-level firmware

must maintain a specific CRC on its program image. The last UL 1998 audited firmware release for the battery management system stack was Curie Update 1.

Multi-Stack Level

Curie Update 2 is considered compatible for UL 1973 certification as there are no stack firmware changes in this release.

2.2. Upgrading your battery management system

> If you would like to upgrade your Stack Switchgear or Battery Control Panel, please contact support@nuvationenergy.com for assistance with the upgrade process. These products are customized for their specific end-application and require additional considerations in the upgrade process.

Upgrades from releases prior to Curie can use the Quick Start Wizard to generate a representative Curie configuration to start from. The Quick Start Wizard is may be accessed online through https://ncloud.nuvationenergy.com.

Operational configuration from a prior pre-Curie configuration can be transferred to this Curie configuration file using your *Product Manual*.

Upgrades from Curie Update 1 to Curie Update 2 require no additional configuration changes.

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

3. Curie Update 1

Curie Update 1 (19.11.1) applies only to stack-level products like:

- High-Voltage BMS
- High-Voltage BMS (modules only)
- Low-Voltage BMS

> **(!)** If you would like to upgrade your Stack Switchgear, please contact support@nuvationenergy.com for assistance with the upgrade process. These products are customized for their specific end-application and require additional considerations in the upgrade process.

The software changes for Curie Update 1 are with respect to the Babbage Update 1 software release.

3.1. What's New

The following features were introduced into Curie Update 1

1. Software changes required to complete functional safety under UL 1998
2. Addition of open wire detection to Nuvation Energy BMS

3.1.1. Functional Safety

The main purpose of the Curie release was to allow the firmware to meet UL 1998 functional safety to allow for compliance to higher level UL standards (such as UL 1973). The functional safety applies to both the Low-Voltage BMS and the High-Voltage BMS products.

The *Nuvation Energy BMS: Safety Manual* was created to guide Nuvation Energy BMS owners on how to configure their system to comply with a UL 1973 review. This is a step by step instruction manual that provides a check list of configuration steps that the UL reviewer will request.

> **(i)** Please contact support@nuvationenergy.com for access to the *Nuvation Energy BMS: Safety Manual*.

There are many aspects of these changes to the software. These release notes provide a summary of the operational aspects to these changes and are detailed in the following subsections.

3.1.1.1. Factory Configuration

The battery management system maintains a configuration section referred to as a factory configuration. The factory configuration includes data related to UL 1998 safety configuration. The factory configuration can be locked and prevent any further factory configuration updates. Once the factory configuration is locked, all registers in components affected by factory configuration are read only. Refer to your *Product Manual* for details on factory configuration.

All other configuration for the battery management system remains in the same configuration

sections and operates the same way as in prior software releases.

3.1.1.2. Restricted Component Access

As part of a UL 1998 review, the battery management system has separated several components which have restricted access for safety certified systems. The access restriction occurs after a factory configuration has been locked. In such a case, restricted components cannot be written to by external interfaces (HTTP, CAN, Modbus) or used with register address redirection (such as the GPO). Refer to your *Product Manual* for a listing and details on restricted components and limitations to access.

3.1.1.3. Operational Faults

A new set of operational faults were added to the battery management system which are meant to define the safe limits of a battery.

If there is no intent to achieve UL 1973 certification, then these faults could be considered redundant to the existing operational faults and can be disabled. These operational faults do not have a configurable hysteresis and will immediately disconnect the battery stack upon being tripped. A summary of these faults is listed below:

- `pi_fault_config_factory_verify`
- `pi_fault_factory_verify_wdt`
- `sc_fault_config_factory_verify`
- `sc_fault_factory_verify_wdt`
- `stack_fault_cell_over`
- `stack_fault_cell_under`
- `stack_fault_voltage_over`
- `stack_fault_voltage_under`
- `stack_fault_charge_current_over`
- `stack_fault_discharge_current_over`
- `stack_fault_charge_therm_over`
- `stack_fault_charge_therm_under`
- `stack_fault_discharge_therm_over`
- `stack_fault_discharge_therm_under`
- `stack_fault_ci_therm_consistency`
- `stack_fault_open_shunt`
- `stack_fault_short_shunt`
- `stack_fault_therm_circuit_fail`

The following operational faults are also new faults introduced for UL safety certification. These faults should remain enabled for general battery management system operation.

- sc_fault_ci
- sc_fault_clocks
- sc_fault_config_factory
- sc_fault_fault_pilot_state_mismatch
- sc_fault_linkbus_power
- sc_fault_ram_test_wdt
- sc_fault_rom_test_wdt
- stack_fault_cell_wdt
- stack_fault_therm_wdt
- stack_fault_ci_wdt
- stack_fault_open_wire_wdt
- stack_fault_open_wire
- stack_fault_power_wdt

> **ⓘ** Refer to your *Product Manual* for details on all these faults noted in this section.

3.1.1.4. Thermistor Operational Restrictions

For UL 1973 compliance, there are additional runtime validations on the thermal measurements. These validations required some limitations to the use and installation of thermistors to the battery cells. These limitations are summarized as follows:

1. There is a minimum of 2 and a maximum of 7 thermistors that can be installed per Cell Interface
2. The locations of the uninstalled thermistors is specific and must match the locations defined in your *Product Manual* .
3. There is a thermal consistency check applied to all thermistors connected to the same Cell Interface. These thermistors should experience similar cooling where they are installed. Suggestions for how to manage the installation of thermistors is detailed in your *Product Manual* .

If UL 1973 safety certification is not required, these limitations to thermal measurements are not required.

3.1.2. Open Wire Detection

Nuvation Energy has developed an open wire detection algorithm to allow the detection of open wire connections to cells. This algorithm is integrated into the Operator Interface and allows:

- Control to execute an open wire test (even in a operating stack deployment)
- Display of the cells which have failed the open wire test
- Display of diagnostic data from the open wire test.

The configuration of the open wire detection is described in your *Product Manual*.

3.2. Component/Register Name Changes or Removal

The following are specific component/register name changes or removal outside of the previous new features described earlier. These descriptions capture important changes from Babbage Update 2, but are not exhaustive.

If there are questions as per register/component name changes, please contact Nuvation Energy support at support@nuvationenergy.com.

3.2.1. Removed Cell Interface Temperature Measurements

The measurements of internal Cell Interface temperatures and related faults/warnings was removed from the firmware. Nuvation Energy has determined that the accuracy of the measurements could not be compensated by additional calibration. Cell balancing no longer limits operation based on the maximum Cell Interface temperature.

Components/registers removed:

- `sc_fault_ci_therm_hi`
- `sc_warn_ci_therm_hi`
- `sc_trig_ci_therm_hi`
- `sc_fault_ci_therm_lo`
- `sc_warn_ci_therm_lo`
- `sc_trig_ci_therm_lo`
- `stack_cell_balancer[0].max_ci_enable_temperature`

3.2.2. Removed Thermal Aggregate Faults

The following aggregated thermal faults were removed.

- `stack_fault_therm_hi`
- `stack_fault_therm_lo`

These faults were considered redundant to the individual charge/discharge thermal faults.

3.2.3. Moved Power Interface Persistence

The persistence of configuration data on the Power Interface used to be managed by the component `pi_persist`. All configuration data on the Power Interface was moved to the factory configuration. The configuration for a Power Interface is now managed within the component `pi_factory_persist` and the component `pi_persist` has been removed.

3.2.4. Removed Delayed Fault Pilot Fault

The fault `stack_delayed_fault_state` was removed in this release. This fault represents a configurable delayed fault summary that is used to drive the fault pilot in the Nuvation Energy BMS.

In Curie Update 1, the value of the delayed fault summary used by the fault pilot can be read from the register `sc_gpo_fault_pilot.value`.

> **ℹ** This register cannot be used with a general purpose output (GPO) on the battery management system because `sc_gpo_fault_pilot` is a safety critical component and register address redirection of the GPO can not be applied to it.

3.2.5. Renamed Fault Summary Components/Registers

There were some naming changes to the components/registers which summarized the faults and warnings for the battery management system. A summary of these changes are as follows:

- Component `stack_safety` was renamed to `stack_trigger_summary`

- Register `stack_safety[0].safe` was renamed to `stack_trigger_summary[0].no_faults`

- Added the register `stack_trigger_summary[0].faults` which is the opposite of `stack_trigger_summary[0].no_faults`

- Removed the registers `stack_safety[0].safe_to_charge` and `stack_safety[0].safe_to_discharge`.

  - These registers can be replaced by the registers `stack_current_limit[0].charge_current_disable` and `stack_current_limit[0].discharge_current_disable` respectively.

  - Note that these replacement registers are opposite in logic to the original registers.

3.2.6. Renamed Current Faults

The current faults were renamed to be explicit about the charge/discharge direction of the faults.

- The fault `stack_fault_current_lo` was renamed to `stack_fault_charge_current_hi`.

- The fault `stack_fault_current_hi` was renamed to `stack_fault_discharge_current_hi`.

4. Curie Update 2

Curie Update 2 (19.11.2) applies only to multi-stack products like:

- Grid Battery Controller
- Battery Control Panel
- Multi-Stack Controller

To maintain compatibility, the stack firmware and corresponding Nuvation Energy BMS Operator Interface must be upgraded to Curie Update 1.

> If you would like to upgrade your Battery Control Panel, please contact support@nuvationenergy.com for assistance with the upgrade process. These products are customized for their specific end-application and require additional considerations in the upgrade process.

The software changes for Curie Update 2 are with respect to the Curie Update 1 software release.

4.1. What's New

This update ensures the following behavior of pack SoC when read over Modbus point `801 SoC` or register `pack_charge[0].soc`:

- That all stacks are at 0% SoC when the pack SoC reads 0%. Otherwise the pack SoC remains at 1%.
- That all stacks are at 100% SoC when the pack SoC reads 100%. Otherwise the pack SoC remains at 99%.

> As there were no stack firmware changes, Curie Update 2 is compatible for UL 1973 certification.

From time to time Nuvation Energy will make updates to Nuvation Energy 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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