



FIRSTLINE[®] BMS

**Guide Specification for
Wireless Battery Monitoring System**

1.0 Scope

This specification defines the minimum requirements for a predictive FirstLine Wireless Battery Monitoring System (BMS), manufactured by Staco Energy Products Co. (Staco), with test, analysis, and remote monitoring control capabilities. Unless noted otherwise, Staco shall provide all required hardware.

2.0 Warranty

The system shall be warranted against defects in design, materials, workmanship, and overall performance for 24 months from the date of the initial shipment of the system and up to 30 months from date of approved commissioning.

3.0 Agency Listings

The systems shall be listed under the following:

UL standards in accordance with Low Voltage Device

Comply with IEC/EN61010-1 standard in accordance to Low Voltage Directive (2006/95/EC) and is authorized to use the CE marking.

NCC Rules and authorized to use the NCC marking

Complies with Part 15 of the FCC Rules. Operation is subject to the following two Conditions

- (1) device may not cause harmful interference, and
- (2) device must accept any interference received, including interference that may cause undesired operation.

4.0 BMS Wireless Monitoring System Description

The BMS shall monitor the battery system specified. The system shall be capable of automatically monitoring, displaying, and recording all battery parameters described in this specification. The BMS shall transmit all battery data to a Data Collector Module. The BMS shall also be capable of remote polling over Ethernet connection using TCP/IP, RS485, Dry Contact Output Port and Input Dry Contact Port.

5.0 System Specifications

5.1 Data Collection Module (DC-LCD)

The Data Collection Module shall wall mounted with 6.4" LCD Graphic Touch Screen that receives transmitted signals from the Battery Measurement Kit (BMK) and String Measurement Kit (SMK) and continuously monitor, analyze and store battery parameters. Equipped with touch screen LCD color display for access to all battery parameters and BMS settings and shall provide RS485 and Ethernet communication for remote monitoring.

5.2 The maximum receiving distance from any Battery Measurement Kit (BMK) or String Measurement Kit (SMK) shall be rated at 164 ft. in non-concealed room/cabinet. The recommended distance shall be 98 ft. for optimum performance.

5.3 Continuous storage shall be up to 40 months at 5mins recording interval. Recording interval shall be user settable.

Data Collection Module Specification

Operating Temperature	0 - 40°C / 32-104°F
Relative Humidity	95%
Input Power Supply	12Vdc/48Vdc
Power Consumption	Maximum 12W
Receiving Interface	RF 2.4G for wireless
Communication Ports	Ethernet x 1

	RS 485 x 1 Output Dry Contact Output Port x1 Input Dry Contact Port x 1
Monitoring Nodes	Maximum 256 nodes per system
Display Type	LCD 6.4", Graphic Touch Screen
Storage Media	2 Gigabyte SD/MMC Flash Memory Card ⁽²⁾
Dimension (H x W x D)	9.83" x 14.9" x 3.2."
Weight	6.6 lbs

5.2 Battery Measurement Kit (BMK)

Shall measure battery cell voltage and impedance and transmit the measured signal to the Data Collector for analyze and storage. The BMK shall be capable of accepting an optional Temperature Sensor (TES) Module to measure the battery terminal temperature.

When the battery voltage is too low the BMK shall automatically cut off to stop working to avoid battery voltage over discharge due to failure charger or power outage. The Cut Off Voltage shall be programmable.

The BMS shall have an On/Off, Reset and Setting buttons as well as LED indicators for Error and Communication status.

Battery Measurement Kit Specification

Cell Voltage Options	2V	6V	12V > 66Ah or 12V <65Ah (depends on ah of Battery Cell used)	
Cell Voltage Measure Range	1.48~4.00V	4.2~8.0V	8.5~16.0V	
Accuracy	±0.1%			
Battery Impedance Resolution	0.01mΩ	0.03mΩ	>66Ah	<65Ah
			0.03mΩ	0.10mΩ
Cut Off Voltage	1.48V~1.55V (Default 1.5V)	4.2V~4.5V (Default 4.5V)	8.5V~9.3V (Default 9.0V)	
Start Up Voltage	1.65V	4.8	9.6V	
Temperature Measured Range	0 - 100°C / 32 - 212°F			
Accuracy	±1°C / 1.8°F			
Operating Temperature	0 - 50°C / 32 - 122°F			
Humidity	95%			
Power Consumption	≤ 0.5W			
Input Impedance	1MΩ			
Transmitting Interface	RF 2.4G Wireless			
Sampling Rate	1Hz (or 1 sampling interval per second)			
Dimension (H x W x D)	1.07" x 3.94" x 2.75"			
Weight	3.4 oz			

5.3 String Measurement Kit (SMK)

Shall measure one (1) Battery String voltage and transmit the measured signal to the Data Collector for analyze and storage. The SMK shall be capable of connecting the optional Hall CT Kit (HCT) Module of various ratios to measure one (1) battery string current and an optional Temperature Sensor (TES) Module to measure the battery terminal temperature.

The SMK shall have an On/Off, Reset and Setting buttons as well as LED indicators for Error and Communication status.

String Measurement Kit Specification

Voltage Measured Range	0-620Vdc
Normal Voltage Range	20-620Vdc
Accuracy	±0.2% of normal voltage
Current Measured Range	0-3000A
Accuracy	±3%
Temperature Measured Range	0 - 100°C / 32 - 212°F
Accuracy	±1°C / 1.8°F
Operating Temperature	0 - 50°C / 32 - 122°F
Humidity	95%
Input Power Supply Range	35 - 60Vdc
Power Consumption	Maximum 3W
Input Impedance	1MΩ
Transmitting Interface	RF 2.4G Wireless
Sample Rate	1Hz
Dimension (H x W x D)	1.07”x 3.94” x 2.75”
Weight	3.1 ozs

5.4 Battery Terminal Auxiliary Connector Board/Terminal (BTA)

A Battery Terminal Auxiliary connector board/terminal shall come in 3 different diameter sizes: 6φ (6mm), 8φ (8mm) and 10φ (10mm). The battery terminal size shall be verified by the user before purchase. The BTA board is designed for ease of installation of the BMK (Battery Measurement Kit) onto each battery cell. Two (2) of each BTA board/terminal for each battery cell is required; 1 for positive the “+” terminal and 1 for negative the “-“terminal of each battery cell.

5.5 12V DC Power Supply (DPS)

A DC Power Supply shall be included that converts a single-phase 120VAC power source to 12V DC and supply power to the Data Collector (DC-LCD). One power supply required for each Data Collector.

DC Power Supply Specification

Input Power	120Vac 50/60Hz
Output Power	12Vdc, 12Watt
Input Power Plug	NEMA 5-15P
Dimension (WxHxD)	3.94” x 1.07” x 2.75”
Weight	3.1 oz

5.6 48V DC Power Supply

A DC Power Supply converts single-phase 120VAC power source to 48V DC supply power to the String Measurement Kit (SMK). One DC power supply, maximum of 5 SMK Modules can operate per each power supply. The DC Power Supply shall have a NEMA 5-15P plug.

DC Power Supply Specification

Input Power	120Vac 50/60Hz
Output Power	48Vdc, 20Watt
Input Power Plug	NEMA 5-15P
Dimension (WxHxD)	3.94" x 1.07" x 2.75"
Weight	3.1 oz

5.7 Optional Temperature Sensor (TES)

A Temperature Sensor shall be connected with the Battery Measurement Kit (BMS-BMK) to measure individual battery cell terminal temperature or connected with the String Measurement Kit (BMS-SMK) to measure environment temperature.

Measure Range	0 - 100°C / 32 - 212°F
Length	118"

5.8 Optional Extension Antenna (ANT)

An optional Extension Antenna (recommended) shall be available and attached to the BMK or SMK to increase the transmitting-receiving signal strength to enhance performance. However, the addition of the extension antenna DOES NOT increase the transmitting-receiving distance between the BMK, SMK and DC-LCD.

5.9 Hall CT Kit (HCT)

An Optional Hall CT Kit shall be available multiple amperes to measure battery string current data and shall connect to the SMK.

Hall CT Ratings	50A	100A	300A	600A	2000A
Dimension (H x W x D)	2.16" x 7.64" x 5.04"			3.35" x 7.64" x 8.98"	
Weight	1.43 lbs		1.76 lbs		11.02lbs

6.0 Data Collector Capability

6.1 The Data Collector screen shall be divided into three fields:

- Page Selection
- System Information
- Functions Selection

6.2 The Data Collector Module Functions shall have the following System Status

Overview

- Display occurring event(s)
- By clicking on the displayed event, view real time battery measurement curves
- Provide system status overview

6.3 The Menu shall have the ability to search for various functions:

- Real Time Monitor
- Event Log
- Battery Charge/Discharge Record and Analysis

- Language
- A6.3.1 Administrator Logo
- Initial log in by clicking [Administrator Login] and enter default password.
- Upon successful log in, the [Setup] and [Administrator Password Change] icons shall appear on the [Menu] page.
- Click [Administrator Logout] to log out.

6.3.2 Administrator Password Change

- Allows user to change the Administrator Password.
- To change password, enter the default password and you will be prompt to enter new password. Password should be minimum 4 numeric codes up to maximum 12 numeric codes.

6.3.3 Real-Time Monitor

6.3.3.1 The System Select Page shall displays the voltage, current (only if HCT is installed) and ambient temperature (only if TES is installed) parameters of each connected system.

6.3.3.2 The String Select Page shall display the voltage, current (only if HCT is installed) and temperature (only if TES is installed) parameters of each connected battery string.

6.3.3.3 The Cell Table shall have the following functions and information:

- Click [Detail] on the [String] icon to display the battery block table of that particular string.
- Display the voltage, impedance and temperature (only if TES is installed) parameters of individual connected battery blocks.
- Click on the individual [NODE] icon to view its real time measurement curve.

The reading value shall show in different color for state the status of each battery cell. Cell is normal, red is too high, blue is too low and gray is the measure kit link fail.

6.3.3.4 Bar Graph Tab shall

- Display the voltage and impedance in bar graphs of all the connected batteries in that particular battery string.
- Click on individual bar shall display the information box of that particular battery cell. Clicking this information box shall display the real time curve of that particular battery cell.

6.3.3.5 Percentage Tab shall

- Display the average percentage readings of voltage and impedance parameters of all the connected batteries in that particular battery string.
- Clicking on an individual bar shall display the information box of that particular battery cell. By click the information box it shall display the real time curve of that particular battery cell.

6.3.3.6 Curve Tab shall

- Display the voltage, impedance and temperature measurement curves of a particular battery cell within the most recent 180sec time frame
- Clicking on any part of the curve shall display the history curve of that particular battery cell.

6.3.3.7 History Curve Tab shall

- Provide individual battery cell historic measurement data.
- Clicking [Real Time Curve] shall return to the real-time measurement curve.
- Clicking [Start Time] shall set the start time of the history curve.

- Drag the curve to change the starting time of the measurement.

6.3.4 Battery Charge/Discharge Record and Analysis

6.3.4.1 Record selection shall







- Enable user to record the battery performance during system charge and discharge test.
- Procedures
 1. Go to “Battery Test” page. In the [Record] dialog box, select the desired system (eg. UPS System 1), and click [Start Record]
 2. Command the UPS to perform battery charge/discharge test.
 3. Once the UPS starts its charge/discharge test, a [Data Recoding] dialogue box shall pop-up on the Data Collector screen. Click [Stop Record] to stop the recording.
 4. Shall allow user to type remarks pertaining to this test in the [Memo] box. Click "OK" to save the test records. The maximum length of the memo is up to 16,000 characters.

6.3.4.2 View selection shall

- Enable user to review the recorded battery performance during past & present system charge and discharge tests.
- Procedures
 1. Go to “Battery Test” page. In the [View] panel, select the desire historic parameter you want to view from the [View Type] box.
 2. There shall be four selections in [View Type];
 - (i) Battery History: Individual battery cells historic data.
 - (ii) Batteries of String: Historic data of all batteries connected to the particular string.
 - (iii) String History: Individual battery strings historic data.
 - (iv) Stings of System: Historic data of all battery strings connected to the particular system
 3. Clicking [View Record] shall display the log file.

6.3.5 Event Log Selection

6.3.5.1 Go to [Menu] page and click [Event Log].

- Event log can be viewed according to the desire [Year], [Month] , [Day] and [Today].
- Select [Year] and use the arrow keys   to select the desire year you wish to review. The newest 1000 logs of the desire year will be shown.
- Select [Month] and use the arrow keys   to select the desire month you wish to review. The newest 1000 logs of the desire month will be shown.
- Select [Day] and use the arrow keys   to display the desire day you wish to review. The newest 1000 logs of the desire day will be shown.

6.3.6 Language selection shall

Clicking the Language Tab shall allow the language to be that shown on the LCD display of Data Collector.

6.3.7 Setup Selection shall allow

- The [Setup] shall provide a menu with options to configure the Battery Monitoring System.
- The [Setup] icon shall only appear on the [Menu] page after successful Administrator Login.
- Clicking on the [Setup] shall open the setup menu page.

6.3.8 Alarm Condition & Data Record Setup shall allow

- Alarm Condition setup
- Enable the user to set the conditions to trigger alarms in the system or turn off the alarms.

The settable parameters shall be:

System

- System voltage
- Total current(+/- indicates direction of current)
- Temperature(only if TES is connected)

Battery String

- String voltage
- String current (+/- indicates direction of current)
- Temperature(only if TES is connected)

Battery (cell)

- Battery Voltage
- Impedance
- Temperature (Only if TES is connected)

Referring to the display page on the Data Collector shall show, all “High” or “Low” “level 2 values where alarms will trigger.

- All “High” or “Low” “level 1 value shall be to turn off the alarms.

Data Record setup shall

- Enable user to select the type of recording, set the recording periods and recording conditions.
- FIFO: The Data Collector will use First In, First Out principle to record the batteries data, if this function is selected. Otherwise the data will be recorded until the storage space full.
- Enable Record: The Data Collector will record all batteries data continuously, if this function is selected.
- The record interval time shall be set from 1 second to 60 minutes.

Intelligent Record mode shall:

- The Intelligent record interval time shall be set from 1 second to 60 minutes.
- Start recording only according to following conditions
 - System voltage exceeds the set value
 - System voltage drops below the set value
 - System current exceeds the set value
 - System current drops below the set value
 - String voltage exceeds the set value
 - String voltage drops below the set value
 - String current exceeds the set value
 - String current drops below the set value
- Max. Intelligent Record Time shall be set from 1 minute to 60 hours.
 - When the length of Intelligent Record time more than this maximum time, Data Collector shall stop Intelligent Record mode automatically.
- In order to save data storage capacity and collect necessary batteries information, user shall use this function for set a shorter recording time interval during battery charge and discharge periods, while float charge with a longer recording time interval.

6.3.9 System Time Setup Tab shall

- Enabler user to set the current time of Data Collector.

6.3.10 Ethernet & e-Mail Setup tab shall

- Allows the user to set up the Ethernet interface parameters, web server parameters for the Data Collector as well as enable alarm alerts via

6.3.11 Impedance pu Setup Tab

- The Data Collector shall offer and uses pu value to come as the battery impedance expression way. The pu value offer user a simple way to observe the change of impedance of battery cell.

The definition of pu value is as follows,

$$pu = \frac{\text{Battery impedance}}{\text{Battery impedance base}}$$

- This page shall enable user to set the battery cell impedance base value. There are three types of setting:
- Select Auto set impedance base while battery voltage over than xx V:
When the battery cell voltage first reached the preset, the impedance value measured by the BMK at that time shall become its base value.
Recommend to use floating charge voltage of battery cell as the voltage value.
- All batteries base is xx mΩ:
Using xx mΩ to become the impedance base for all batteries of this system .
- Clicking Set shall take the setting effect.
- Using the current time value as the impedance base:
Click this icon shall take the setting effect.
- Clicking Clear all batteries impedance base shall clear impedance base and the Data Collector shall no longer regard pu as impedance.

6.3.12 Dry Contact Setup page shall enable user to set the Input and Output Dry Contacts.

- Input Dry Contact: There shall be two types of settings.
- None: No action if the input dry contact is active by external switch.
- Intelligent Record: The Intelligent Record will be enabling if the input dry contact is active by external switch.
- Output Dry Contact : There shall be two types of settings.
- Intelligent Record: Refer to section 6.2.8.1 Intelligent Record.
- Measure Value Out of Range: Refer to section 6.2.8.1 for setup the alarm condition.

6.3.13 Data Collector Setup shall be for each accessory

- Temperature Unit:
- Check to select display temperature in Degree Celsius or Degree Fahrenheit.
- RS-485 Baud Rate:
- Set communication speed for RS485 communication. The speed range shall be from 2400 to 115200.
- Data Collector ID:
- Set unique identification numbers for each Data Collector when use RS485 communication for remote monitoring. The range of ID shall be from 1 to 255.

7.0 BMS Web Monitoring Guide

The Data Collector of the BMS shall be built with a web server function. Through various network devices (eg. Computer) connected in the same Ethernet Network with the Data Collector via its RJ45 port, this function shall allow the user to monitor real-time information and download report from Data Collector using a web browser.

7.1 Access the Data Collector information shall be available using a web browser:

The procedures to enter the Data Collector web server function using a computer web browser (eg. Internet Explorer) shall be as follows:

1. On the Data Collector [Setup] page, clicking on [Ethernet & e-mail Setup].
2. On the [Ethernet & e-mail Setup] page, verify the IP Address and Port. The URL to enter in the computer web browser shall be as such: http://192.168.1.123:1234.
3. User shall now access the Data Collector from the web browser after entering the URL.

7.2 Web Monitoring Page Overview

Once the Data Collector has been successfully accessed using the web browser, the web monitoring page of the Data Collector appears on the connected Computer Monitor. The page screen shall be divided into 2 areas: "Browsing Toolbar" and "Information and Functions".

Clicking [Home] shall return to main menu, Clicking [Back] shall to return to previous page.

7.3 Web Monitoring Functions

7.3.1. Information and Status

This page shall display the list of system connected to the BMS, a summary of the recorded events and the real-time display of system parameters; system voltage, system current and ambient temperature.

In the [System name] field, clicking [UPS System 1/2] shall show the connected battery string information.

Clicking Download Event log (.cvs) shall allow download of the event log list.

7.3.2 System Information

This page shall display the list of battery string(s). The display shall show the real-time readings of the battery string parameters; battery string voltage, current and temperature. Selecting [String] shall display the connected batteries cell information. Clicking [Export Report] shall view the report on the particular system.

7.3.3 String Information

This page shall display the list of battery cells of the string, and displays the real-time readings of the battery cell voltage, impedance and temperature.

7.3.4 Export Report

When the user has selected [Export Report] on the "System Information" page it shall be displayed, the user can select the types of report to export by clicking [Yearly Report] or [Monthly Report] or [Daily Report].

7.3.5 Yearly Report shall

- Displays the annual data of desired String of the desired System.
- The information shall show the average readings (cell voltage, impedance and temperature) of individual battery cells, over a twelve months period of the selected year. Red text shall indicate the readings exceed the pre-set value, and blue text shall indicate the readings are below the pre-set value.
- Clicking the "Show Curve" for each cell shall display the battery measurement curve. Moving the mouse cursor to any point on the curve shall display its recorded value.
- On the top right hand corner of the screen, clicking "Export csv file" shall export data into CSV (Comma Separated Values) format for data processing.

7.3.6 Monthly Report Tab shall

- Displays the monthly data of the desired System.
- The information shall show the average readings (cell voltage, impedance and temperature) of individual battery cells, over a thirty days period of the selected month. Red text shall indicate the readings exceed the pre-set value, and blue text shall indicate the readings are below the pre-set value.
- Clicking the “Show Curve” for each cell shall display the battery measurement curve. Moving the mouse cursor to any point on the curve shall display its recorded value.
- On the top right hand corner of the screen, clicking “Export csv file” to export data into CSV (Comma Separated Values) format for data processing.

7.3.7 Daily Report

- Displays the daily data of the desired System.
- The information shall show the hourly readings (cell voltage, impedance and temperature) in that particular day of individual battery cells. Red text shall indicate the readings exceed the pre-set value, and blue text shall indicate the readings are below the pre-set value.
- Clicking “Show Curve” for each cell shall display the battery measurement curve. Moving the mouse cursor to any point on the curve shall display its recorded value.
- On the top right hand corner of the screen, clicking “Export csv file” shall export data into CSV (Comma Separated Values) format for data processing.

8.0 User’s Guide

Each system shall have one set of owner’s manuals, which include the following information as a minimum: Installation, commissioning and operating instructions. Additional copies shall be downloadable for the Staco Web Site.

9.0 Testing

9.1 Factory Acceptance Tests: The BMS shall be factory tested to demonstrate the functionality and performance required by this specification, if pre-installed at the factory.

9.2 Site Acceptance Tests: Staco shall prepare site acceptance tests procedures, which shall be used to validate the functionality and performance required by this specification.

10.0 System Installation, Start-up, Commissioning and Training

Staco shall provide a field start-up engineer to install the BMS system on site if not pre-installed at the factory. After installation, the Staco field engineer shall start up the system and perform all required site acceptance tests to demonstrate that the system meets the functionality and performance requirements of this specification.

11.0 Manufacturer

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