Eagle Eye Power Solutions, LLC

Centroid Snet 2 Version 2.x.x

Battery Management Software

User Manual Version 030719

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1. Centroid Viewer Overview

Centroid Viewer, Eagle Eye's proprietary battery management software, is included with most BQMS, iPQMS, BDS-Pro, and BMS-icom battery monitoring solutions. An exception to this is if any of these systems are ordered to communicate via Modbus only.

The purpose of Centroid Viewer is to provide an easy to use graphical user interface to manage battery measurement data. The software provides complete data analysis, including real-time viewing of parameters as well as trending on a string and cell/unit level. Measured data can be exported to PDF or Excel.

It is possible for Centroid Viewer to manage all battery systems installed on a company network, this could include hundreds of systems installed over a large geographic location. Alternatively, standalone installations can be installed per battery system, which allows Modbus out directly from a dedicated PC; this is the only solution which allows the software and Modbus to be used simultaneously.

The software can be installed as the Server or Client. The Server aspect handles all communication between the battery monitoring systems and Clients. The Clients are basically instances of Centroid Viewer installed on other PC's on the same network; these installations point to the IP address of the Server PC.

1.1 System Requirements

Listed below are the recommended system requirements for Centroid Viewer based on the two most common methods of installation:

General requirements:

- 64-bit Windows based operating system (Windows 7, 8, 8.1, 10)
- .NET-Framework 4.5 or higher
- Active Internet connection for email alerts

Installation for management of a single battery system on a dedicated PC:

- CPU-Type: Intel® Core™ i3 Processor 3.1 GHz
- Memory: 4 GB
- Display Resolution: 1280 x 1024
- Disk Space: 500 GB

NOTE: The above requirements are for monitoring no more than one battery system registered in the software.

Installation for management of multiple systems on a dedicated PC:

- CPU-Type: Intel® Core™ i7 Processor
- Memory: 8 GB
- Display Resolution: 1280 x 1024
- Disk Space: 2 TB

2. Installation

Centroid Snet 2 has several components which need to be installed prior to use. All software components need to be installed on a dedicated PC which will act as the “Server PC”; this PC will be responsible for communication with all BMS systems installed in the field. The required components are explained below.

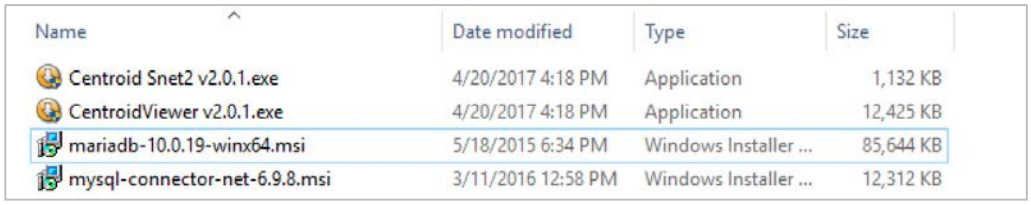
- **MariaDB:** The database server
- **MySQL Connector:** Driver for database server
- **Centroid Snet 2:** A Windows service that runs in the background on the Server PC. This service manages the measurement data from the BMS systems via a proprietary protocol. The service must be running at all times in order for measurement data to populate in Centroid Viewer.
- **Centroid Viewer:** The main user interface, all interaction occurs within this program.

2.1 Installation Steps

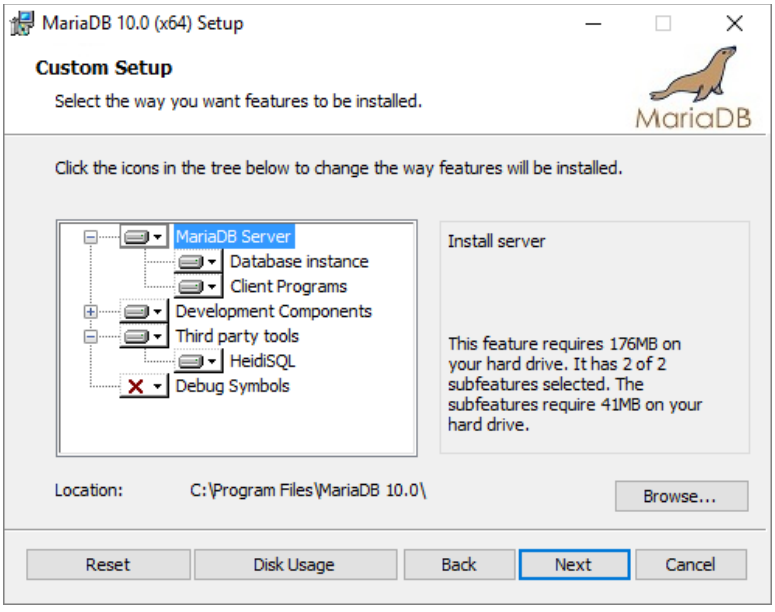
The software is provided on a **USB Drive** that is included with the system. A download link can also be obtained by contacting Eagle Eye directly.

Step 1: Install MariaDB

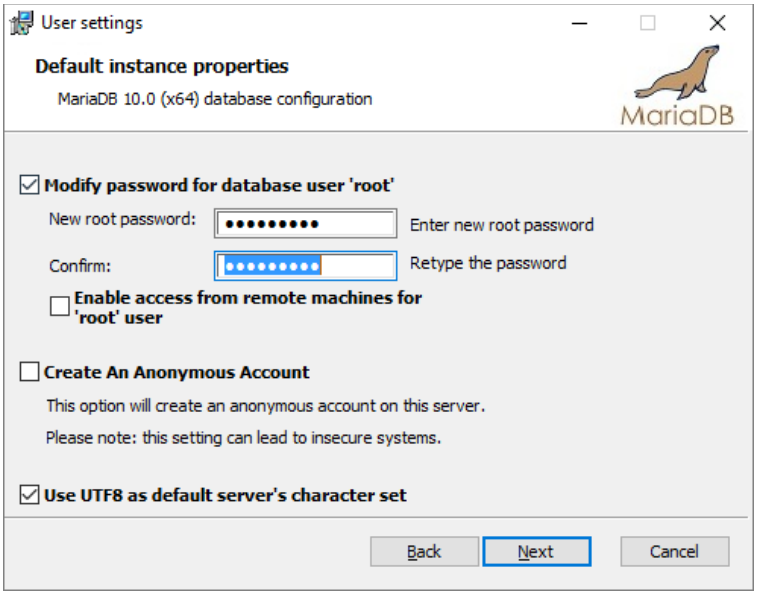
1. Execute *mariadb-10.0.19-winx64.msi*



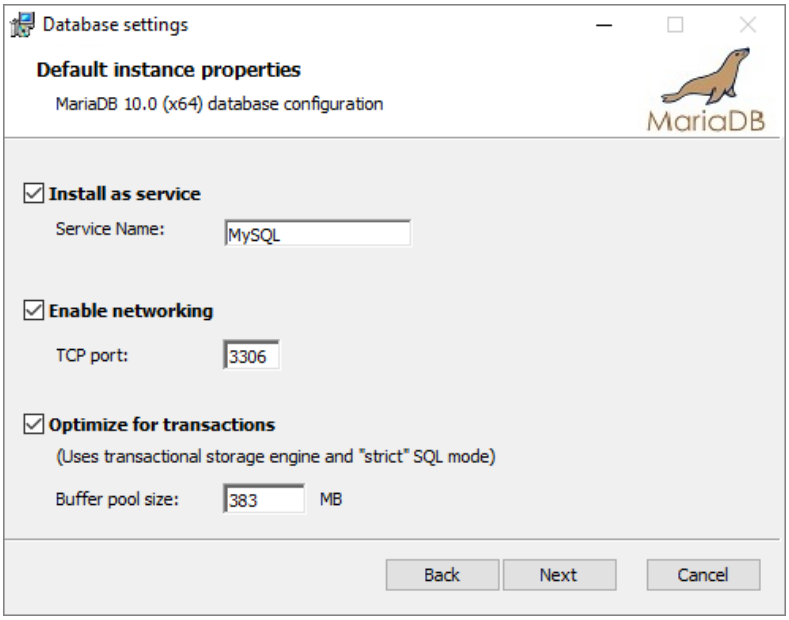
2. Progress the installation to the screen below. Leave all the options as default and click *Next*



3. For the root password, enter “admin1234” (without quotes). Check *Use UTF8 as default character set* and click *Next* to continue



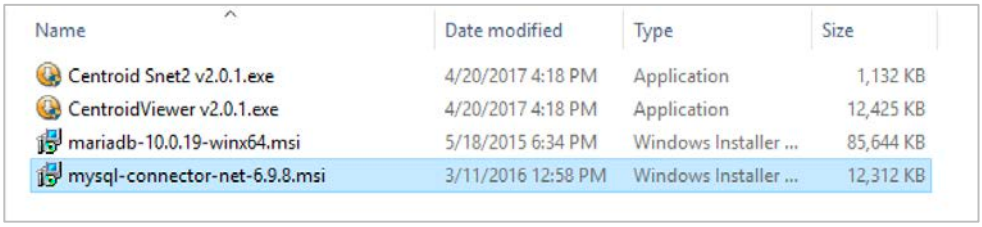
4. On the Database settings screen, leave all boxes checked with the default values and click *Next* to continue



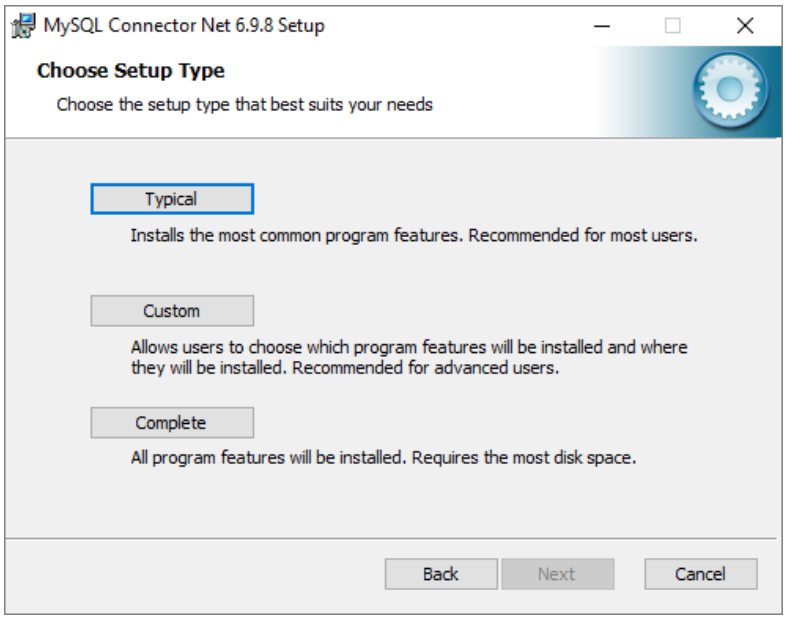
5. Progress through the remainder of the installation and click *Finish* at the end to complete the install

Step 2: Install MySQL Connector

1. Execute *mysql-connector-net-6.9.8.msi*



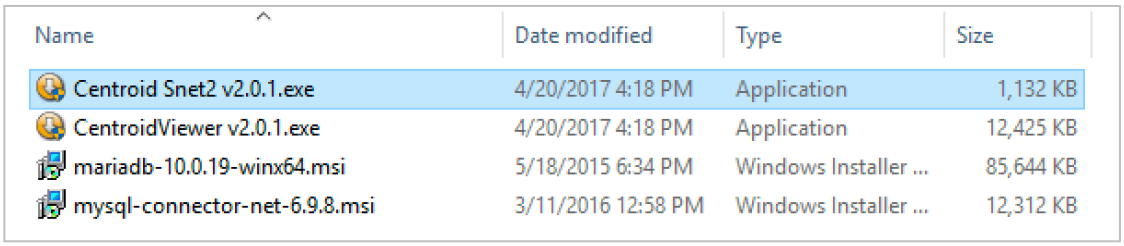
2. Progress through the install and select *Typical*



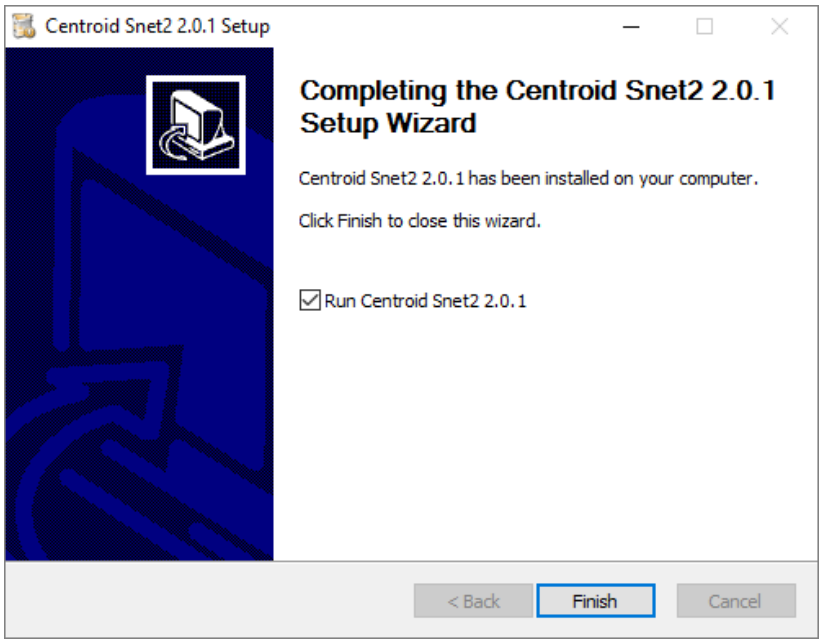
3. Click *Next* and progress through the rest of the installation to install MySQL Connector

Step 3 – Install Centroid Snet 2 and Centroid Viewer V2.x.x

1. Execute *Centroid Snet2 v2.x.x.exe,* be sure to *"Run as administrator"*

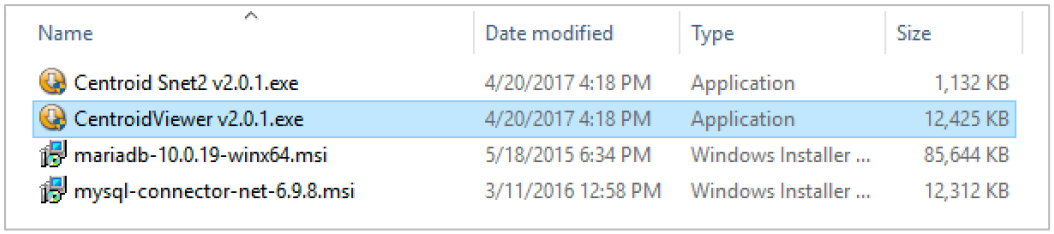


2. Progress through the install. On the last screen, make sure “Run Centroid Snet2 2.x.x” is checked, then click finish.



NOTE: A message may appear that says *“Centroid Snet 2 has stopped working”.* If this occurs, just click *Cancel*. The program will still be installed correctly.

3. Execute *CentroidViewer v2.x.x.exe*

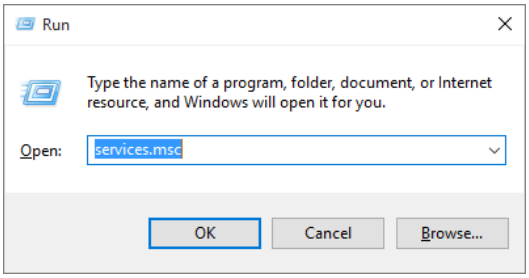


4. Follow the prompts to complete the installation, the checkbox to run the program does not need to be checked

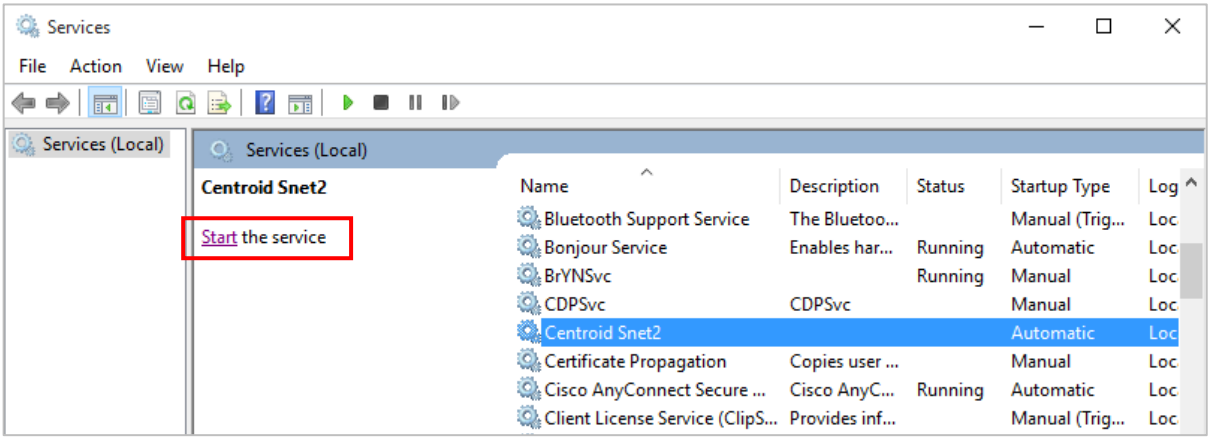
2.2 Start Centroid Snet 2 Service

After the software installation, the Snet 2 Service needs to be started for the program to operate correctly.

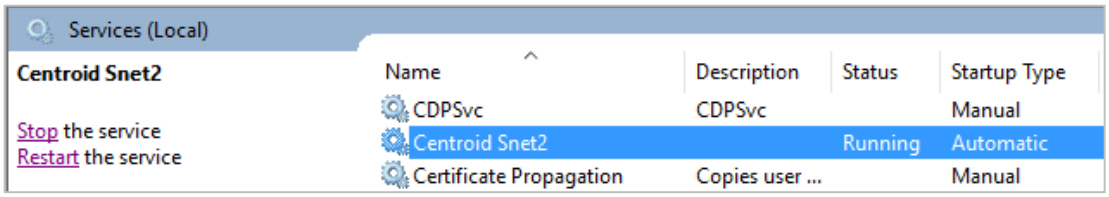
1. Open the ***Run*** command (Win key + R) and type “services.msc” as shown below.



2. With the Services window open, select ***CentroidSnet 2*** and then click ***Start*** on the left as shown below.



3. After starting the service, it should display as “Started” or “Running” under the status column.



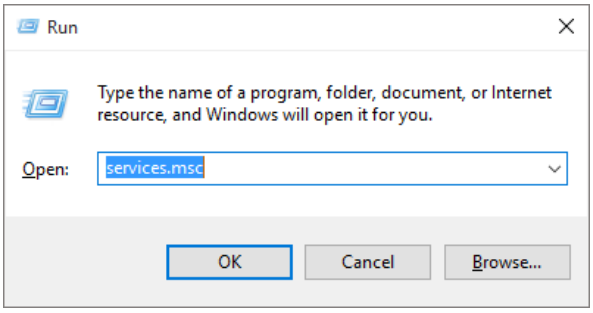
2.3 Updating Centroid Snet 2

This section will outline the steps to update Centroid Snet 2 to the latest version.

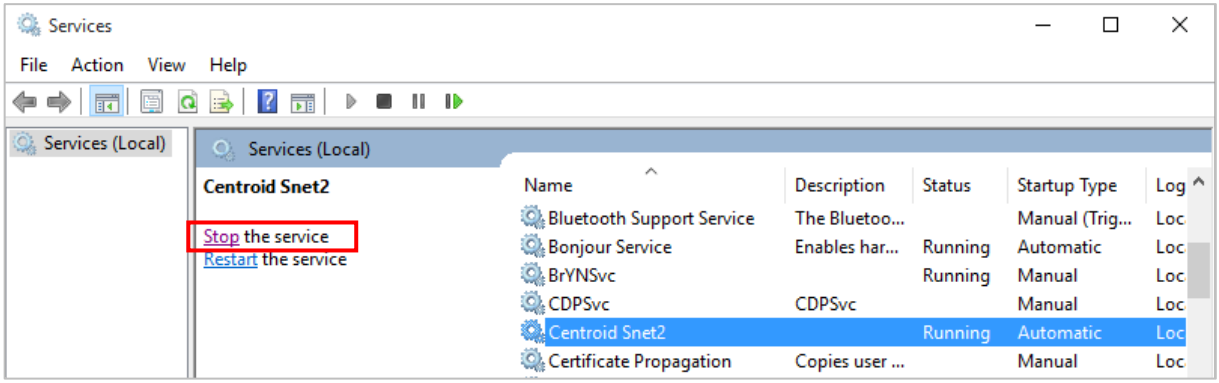
NOTE: These steps only apply to Centroid Snet 2 version 2.x.x. If updating from version 1.x.x. please contact Eagle Eye.

Step 1 – Stop the Centroid Snet 2 Service

1. Close Centroid Viewer. Open the ***Run*** command (Win key + R) and type “services.msc”.

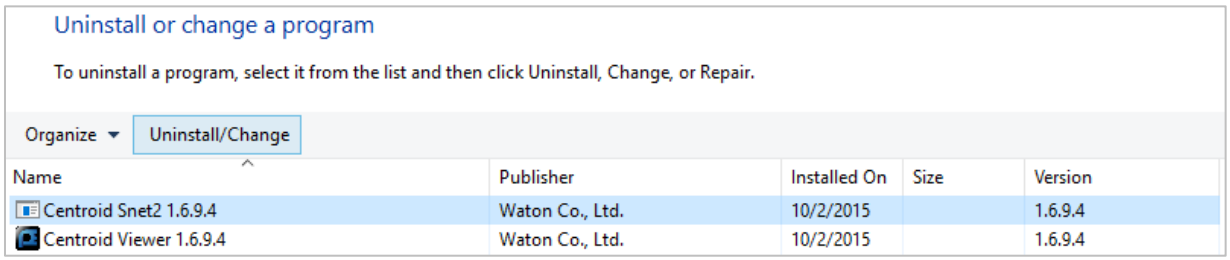


2. In Services, select ***CentroidSnet 2*** and then click ***Stop*** on the left.



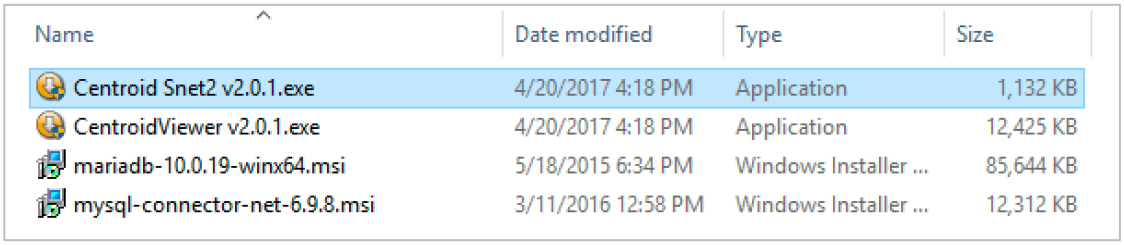
Step 2 – Uninstall Centroid Snet 2 and Centroid Viewer

1. Open **Programs and Features** from the **Control Panel** and uninstall Centroid Snet2 and Centroid Viewer.

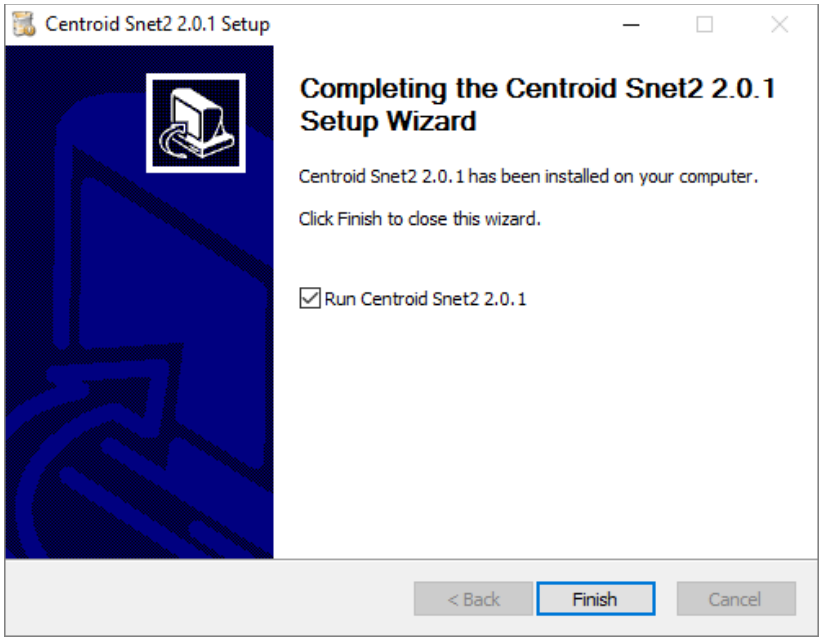


Step 3 – Install New Version of Centroid Snet 2 and Centroid Viewer

1. Execute *Centroid Snet2 v2.x.x.exe,* be sure to *"Run as administrator"*

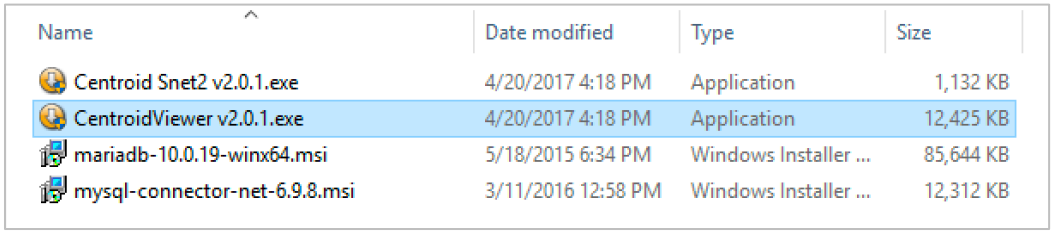


2. Progress through the install. On the last screen, make sure "Run Centroid Snet2 2.x.x" is checked, then click finish.



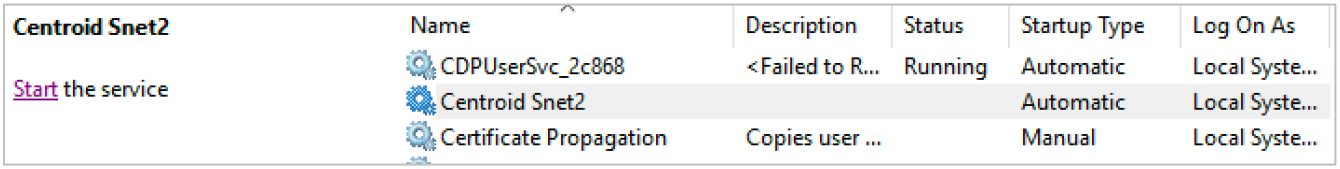
NOTE: A message may appear that says *"Centroid Snet 2 has stopped working".* If this occurs, just click *Cancel*. The program will still be installed correctly.

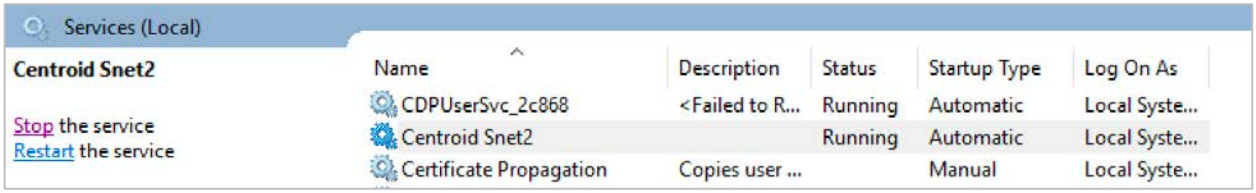
3. Execute *CentroidViewer v2.x.x.exe*



4. Follow the prompts to complete the installation, the checkbox to run the program does not need to be checked

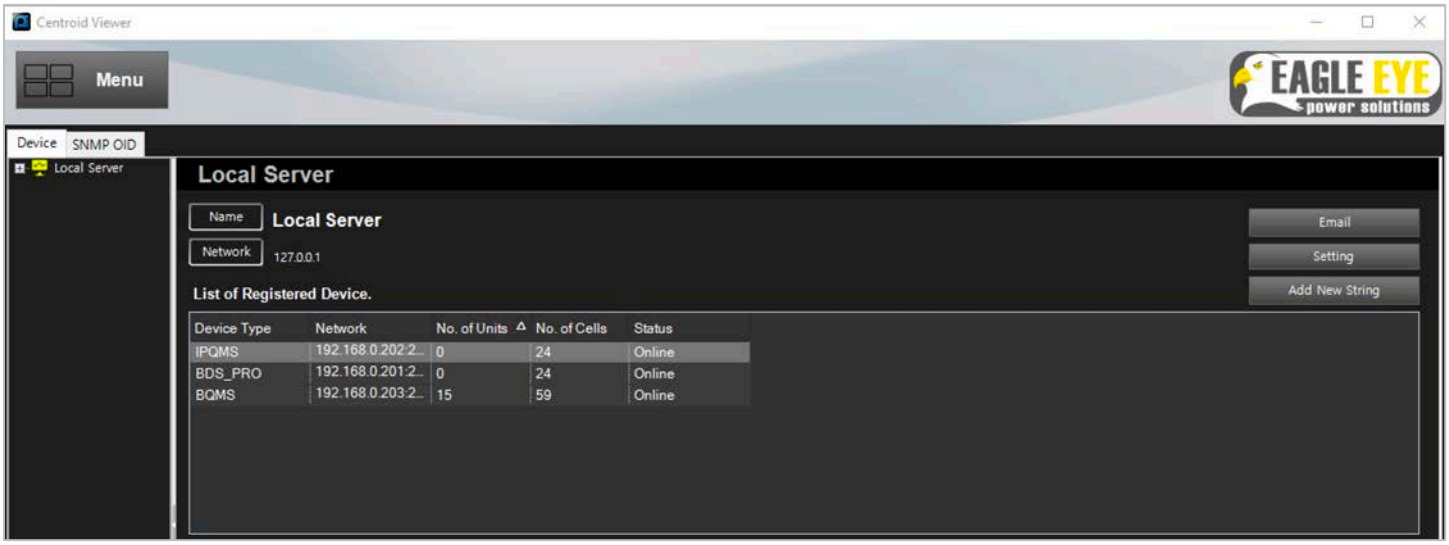
5. Open the Services window and start the Centroid Snet 2 service





6. With the service running, open Centroid Viewer, all of the registered systems should be online and the measurement data history should be present

> **NOTE:** If updating to V2.1.15 or later, a new login screen will be displayed that requires a username and password. Refer to Section 3.1 for login information.



3. Getting Started with Centroid Viewer

This section will outline how to get started using Centroid Viewer: the graphical user interface for viewing and managing the installed battery monitoring systems. All reporting and data trending is also done within Centroid Viewer.

Centroid Viewer can be installed as a client on multiple computers on the same private network. Client versions can perform the same functionality as the server, depending on the user rights configured for the client. See section 4.6 for more information on setting up client PCs.

Additionally, Centroid Viewer can act as a Modbus server for up to (15) 120-cell battery systems.

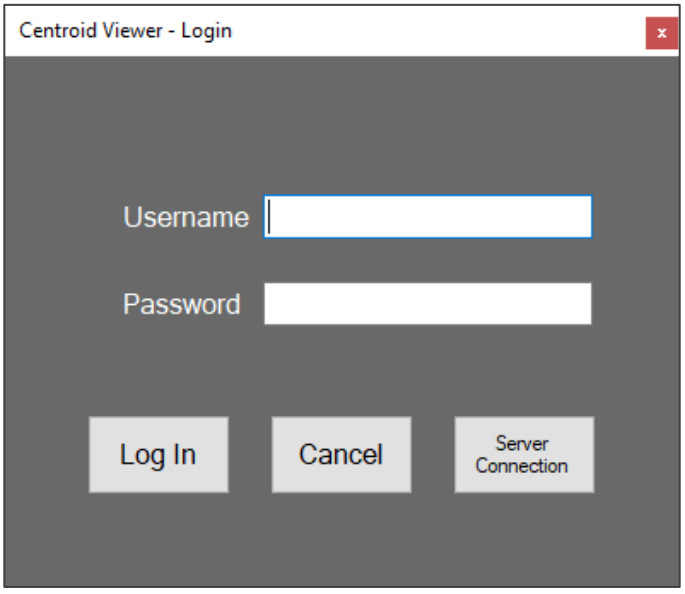
3.1 Creating a Site

Upon starting Centroid Viewer, you will be presented with a login window.

3.1.1 Default Login Credentials

The default login credentials are:

Username: admin
Password: 1234



Note: The Centroid Snet 2 service must be running before logging in. If the service is stopped, it will say “Unable to contact server.”

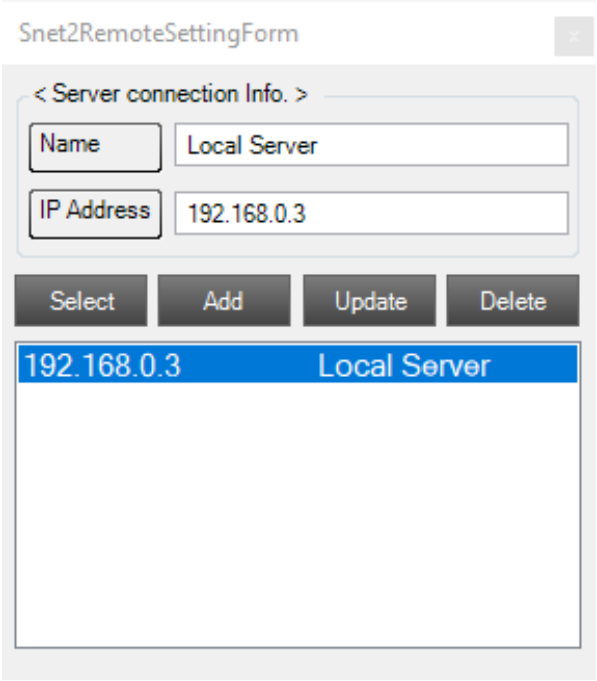
For more information about setting up administrative rights, refer to section 4.6.

3.1.2 Server Connection

At first login, you may need to configure the server connection so that Centroid Viewer connects to the correct Server IP. The “Server IP” is the static IP address of the PC that the Centroid Snet 2 service is running on.

1. Click the **Server Connection** button.
2. Type in a name for the server.
3. Type in the server IP address
4. Click the **Add** button.
5. Select the newly added **“Local Server”** IP then click Select to close the window.

These steps are the same when using Centroid Viewer as a client. The client will point to the IP of the Snet 2 service.

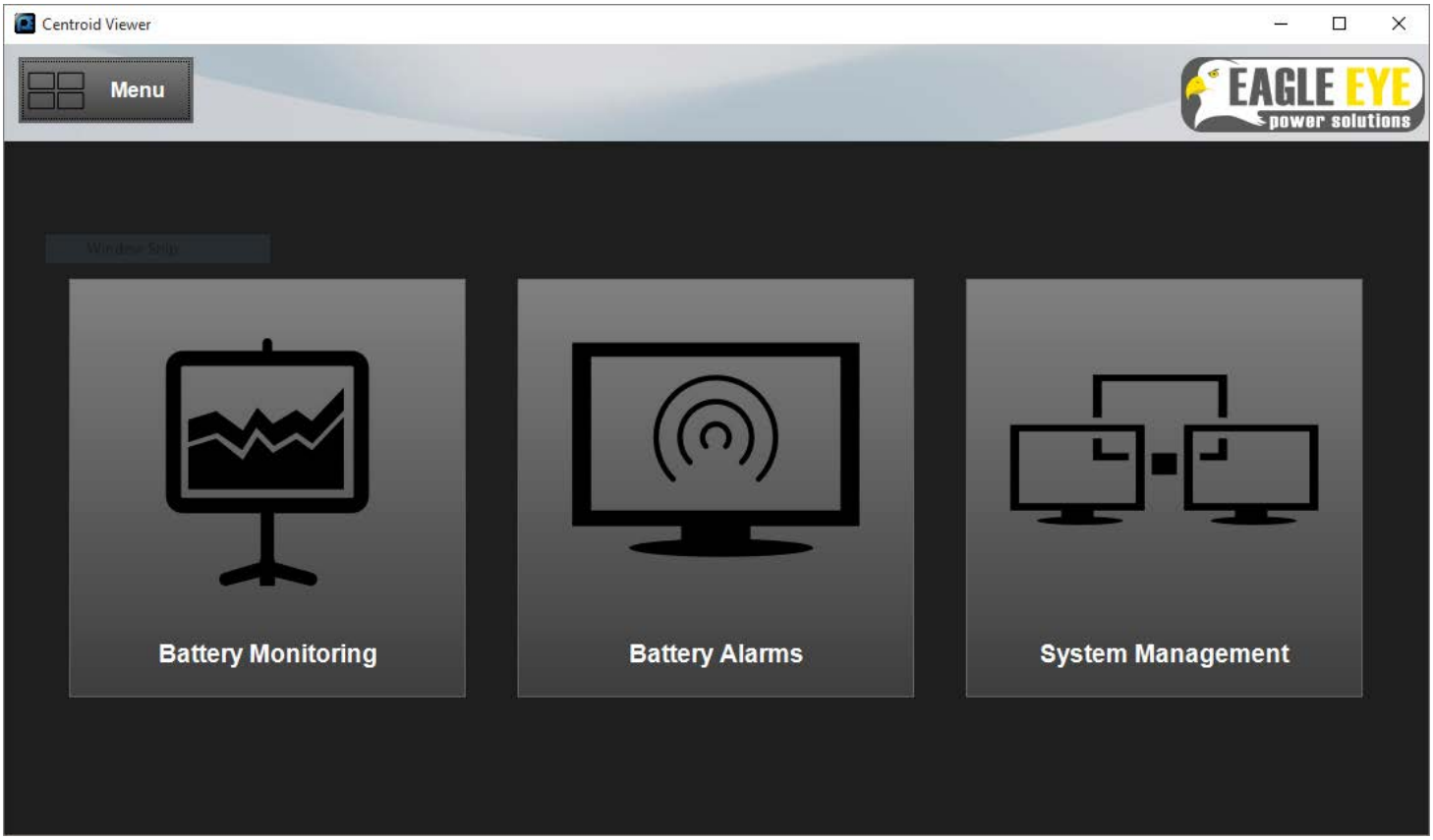


3.2 Creating a Site

Upon logging into Centroid Viewer, the main dashboard will be shown as below. There are three main sections to access from the dashboard:

- **Battery Monitoring:** Displays measured values, recorded discharge logs, and bank history.
- **Battery Alarms:** Displays all active alarms for any given system.
- **System Management:** Displays registered and unregistered BMS systems.

Menu: The Menu button is present at all times and displays the three areas of the software: Battery Monitoring, Battery Alarms, and System Management.



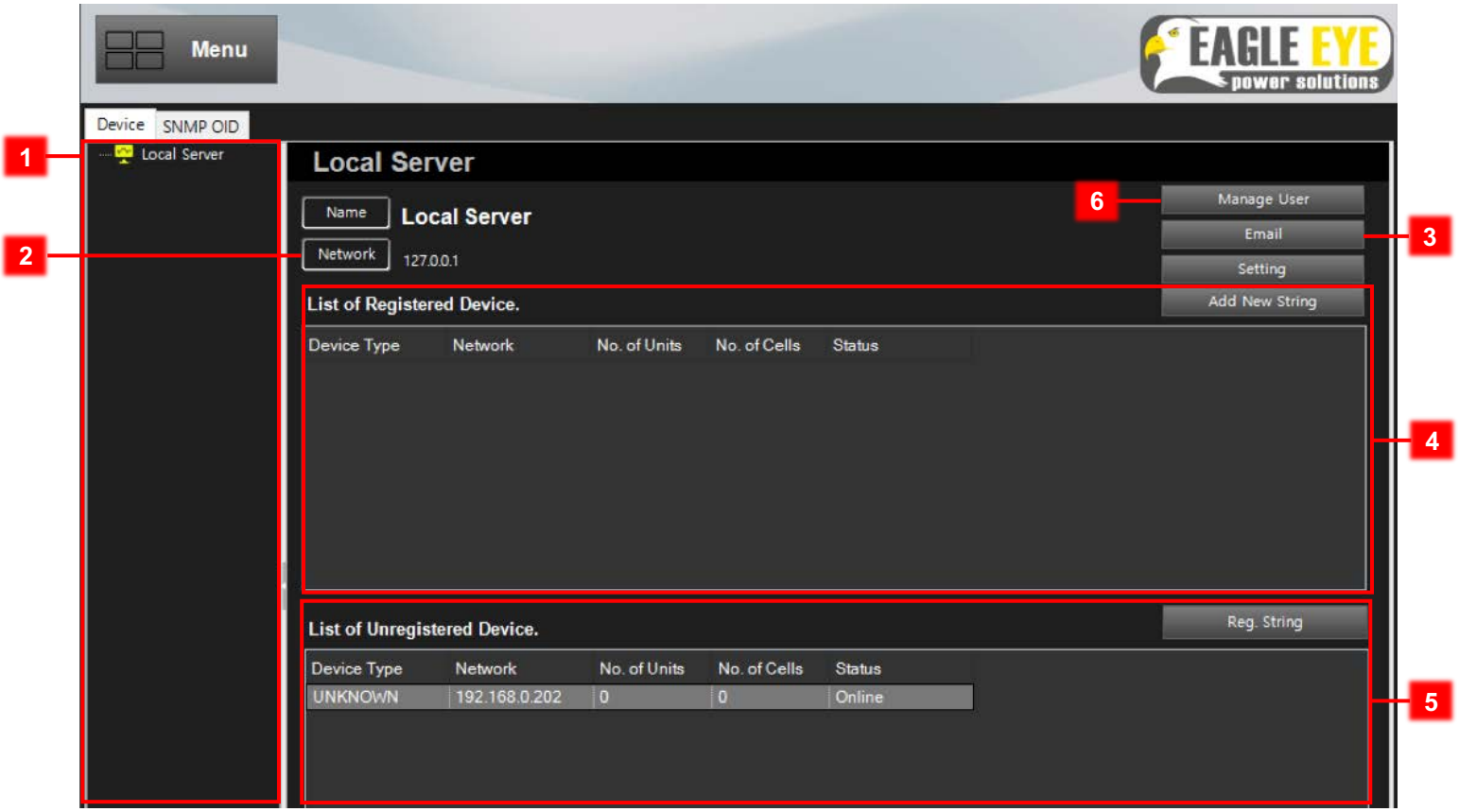
Each of these sections will be described in detail on the following pages.

4. System Management

The System Management section of the software is used for the following purposes which will be covered step-by-step in this section:

- Registering new BMS systems into the software.
- Adding new sites to the software.
- Confirming the IP address of the Server PC (for client installations).
- Configuring user accounts and user privileges.

4.1 System Management Overview



(1) Local Server: The name of the network in which the systems are installed on. All Sites and Systems will appear under the Local Server.

(2) Network: IP address of the Server PC that is running the Snet 2 Service.

(3) Email: Configuration for setting up email alerts.

(4) List of Registered Devices: List of all systems currently registered in the software.

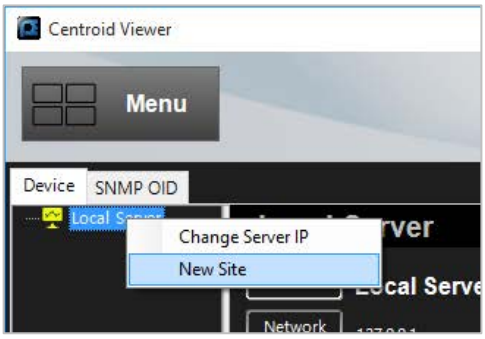
(5) List of Unregistered Devices: List of systems which the software recognizes (by IP) but have not been registered.

(6) Manage User: Add, modify, or delete users.

4.2 Creating a Site

A site is a location under the Local Server which can have systems added to it. The term “Site” can refer to a physical location such as a battery room, plant, substation, building, etc. Sites must be made before adding systems to them.

1. Right click ***Local Server*** and select ***New Site***.

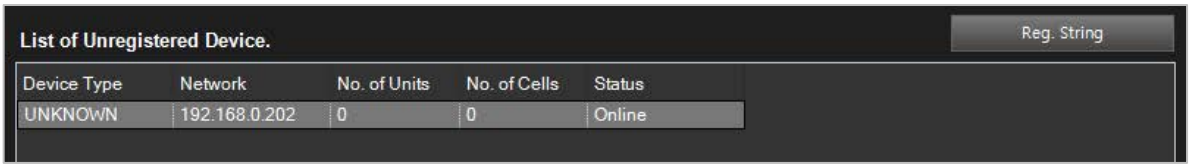


2. Enter a name for the site and click ***Save*** to create the site.
3. The new site will appear under the ***Local Server.***

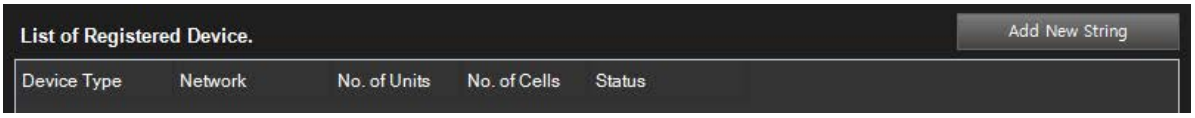
4.3 Registering Systems into Centroid Viewer

All battery monitoring systems installed must be registered in the software. Unregistered systems will appear under the list of unregistered devices as an IP address. **Click here for a video tutorial.**

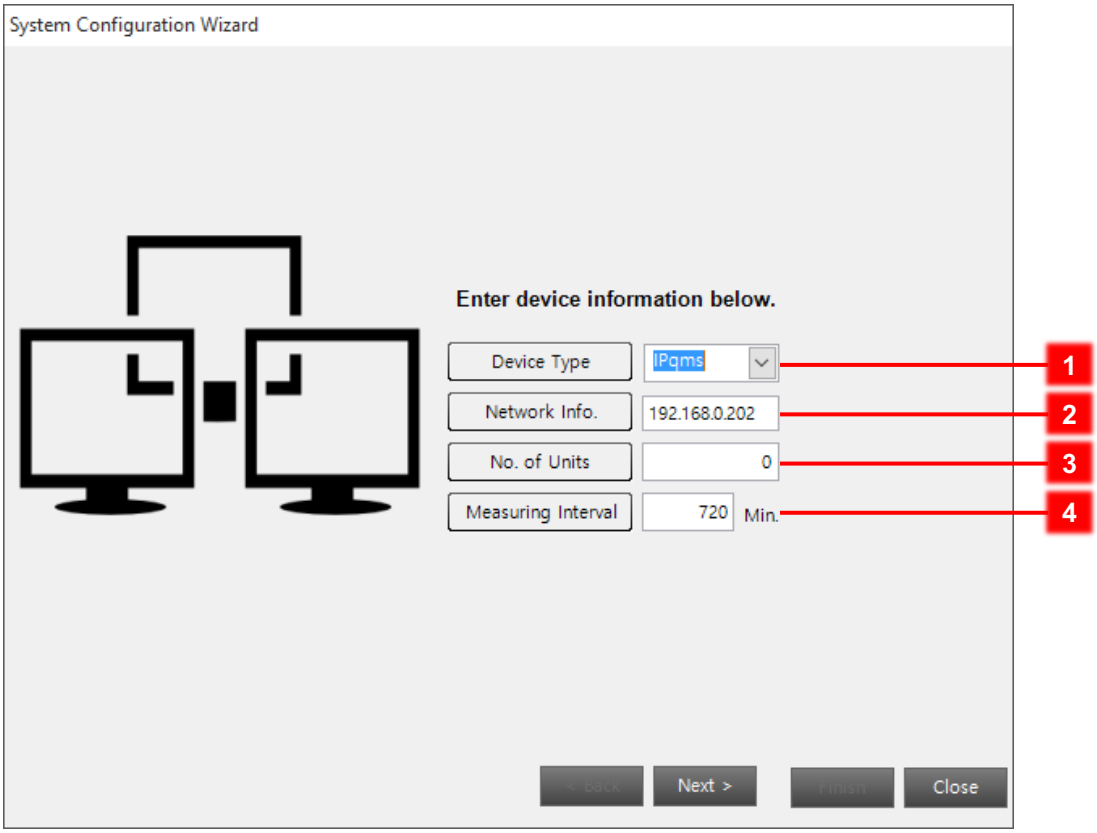
1. There are two ways to add a new system:
   - If the system is already connected to the network, it must be registered from the ***List of Unregistered Devices***. Identify the IP address of the system you want to register and click the ***Reg. String*** button.



   - If the system is not yet connected to the network, it can still be added given that the IP address of the system is known. To add a system before it is connected to the network, click the ***Add New String*** button.



2. Regardless of how the system will be added, the **System Configuration Wizard** will appear. This allows parameters for the system to be configured.



(1) Device Type: Select the MPU type (BQMS, iPQMS, BDS-Pro, or BMS-icom)

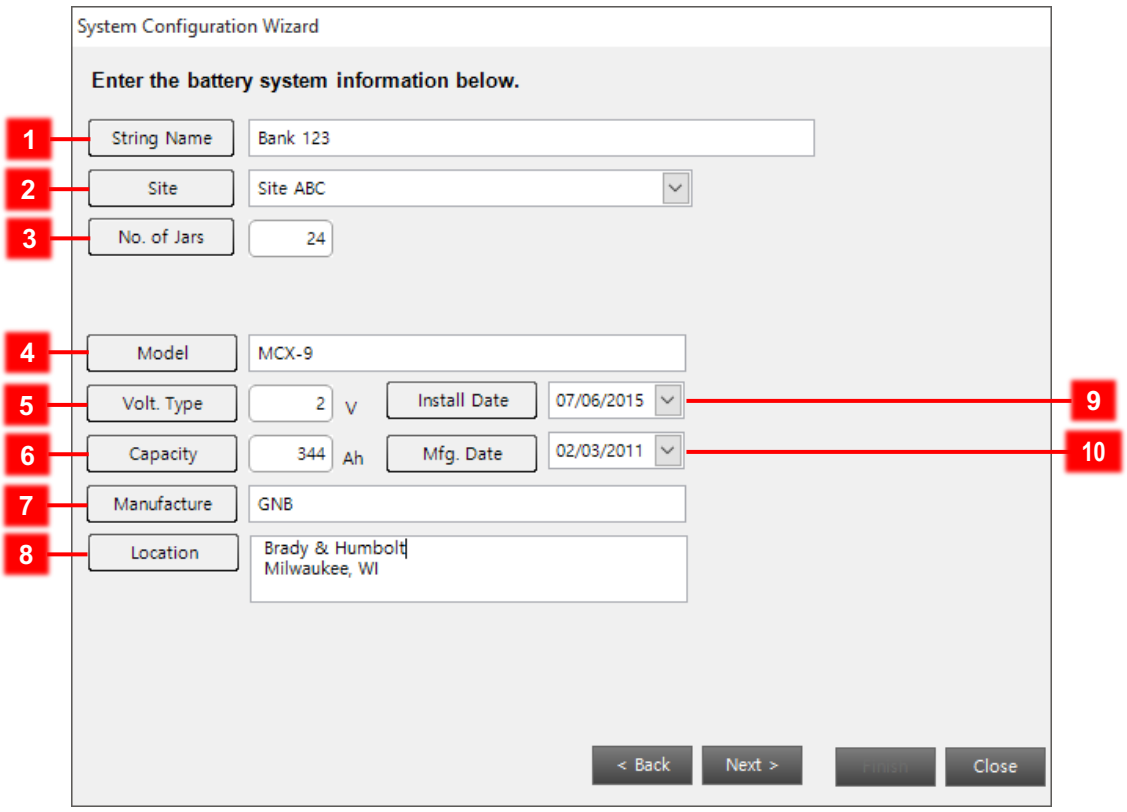
(2) Network Info: Confirm the IP address of the MPU.

(3) No. of Units: Value varies depending on the MPU type:

- **BQMS:** Enter the number of Modules installed on the system.
- **iPQMS:** Enter the number of Relaying Units installed on the system. If only 1, then leave as 0.
- **BDS-Pro:** Always leave as 0.
- **BMS-icom:** Always leave as 0.

(4) Measuring Interval: Time in minutes between measurement cycles (can be changed at any time.)

3. Click the ***Next*** button to progress to the next window.
4. Enter the battery system information on the next window.



(1) String Name: Enter the name of the string / battery system being monitored.

(2) Site: Select the name of the site where the battery system is installed (must have been created before opening the System Configuration Wizard.

(3) No. of Jars: Enter the number of units (jars or cells) being monitored.

(4) Model: Enter the battery model number from the manufacturer.

(5) Volt. Type: Enter the total voltage of the battery system in V.

(6) Capacity: Enter the battery capacity in Ah.

(7) Manufacturer: Enter the name of the battery manufacturer.

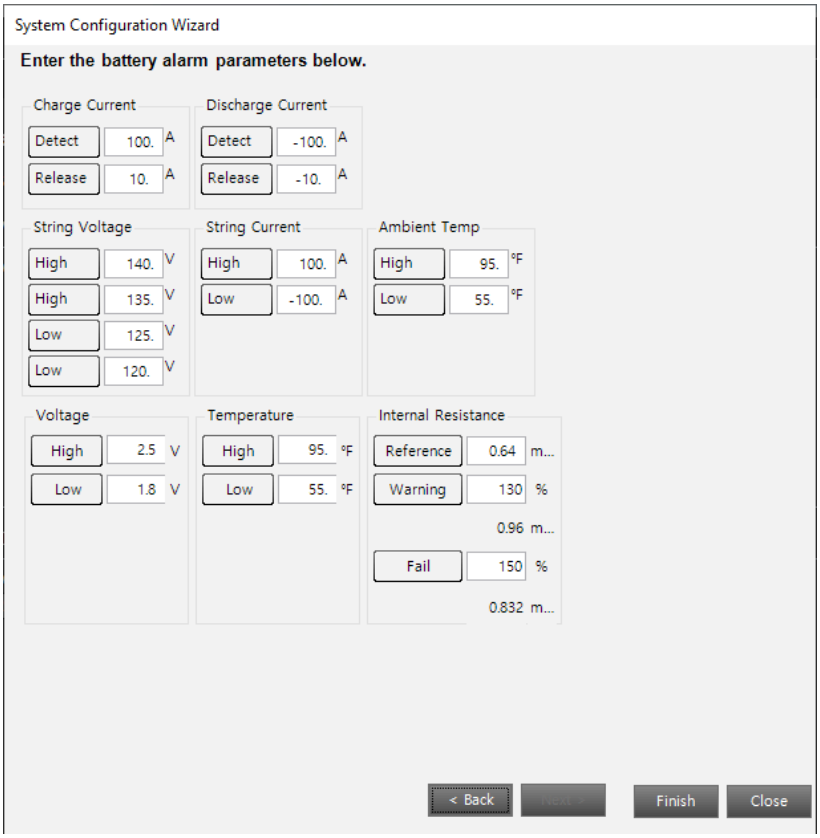
(8) Location: Enter the address or name of place the battery system is located.

(9) Install Date: Enter the install date of the battery monitoring system.

(10) Mfg. Date: Enter the date the batteries were manufactured.

5. Click the ***Next*** button to continue.

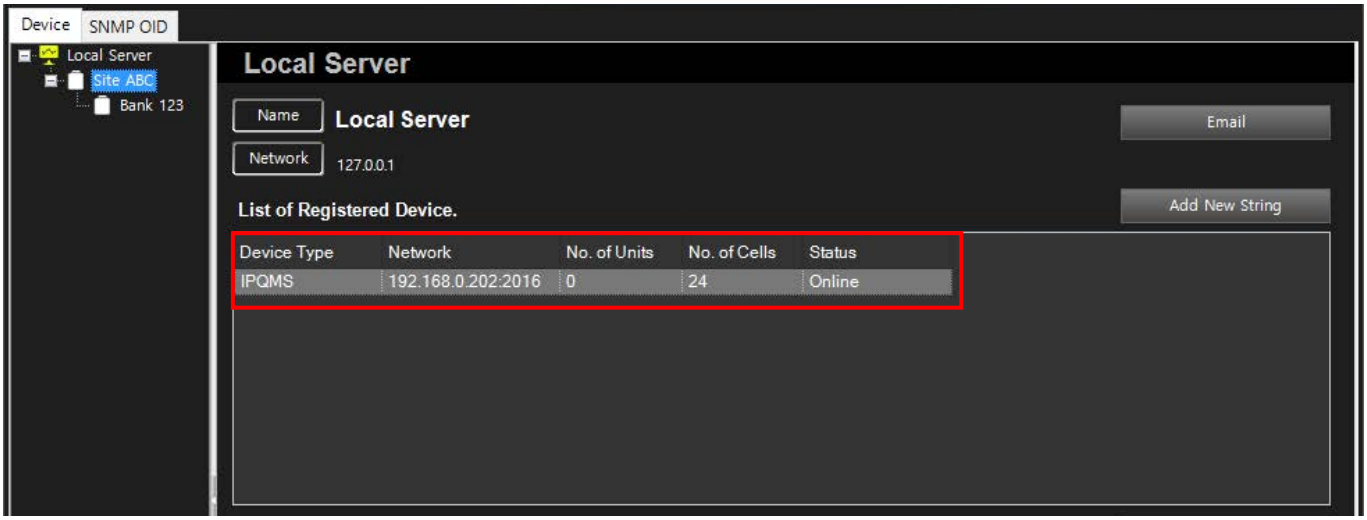
6. Enter the battery system alarm information on the next window. For further explanation on the alarm parameters, refer to **Appendix A.**



Note: All alarm parameters can be changed at any time. It is not necessary to set the parameters on this screen.

7. Click the ***Finish*** button to add the system.

8. The system will now appear under the list of registered devices.



9. All systems which are successfully registered in Centroid Viewer will appear under the list of registered devices. This list will confirm the following details:

    - Device Type
    - IP Address
    - Number of Units
    - Number of Cells/Units
    - Communication Status

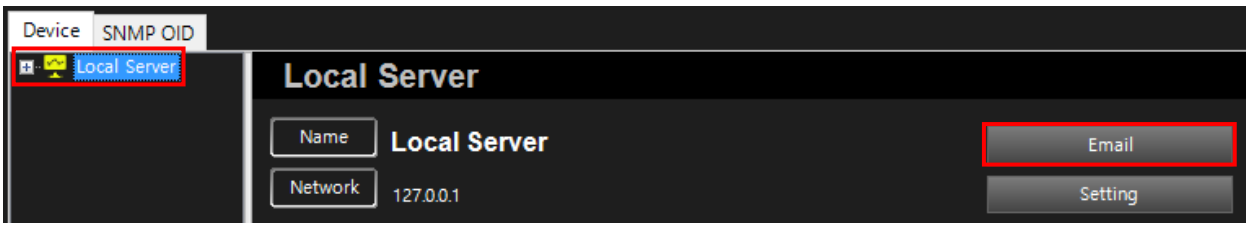
4.4 Configuring Email Alerts

Centroid 2 has the option to send out email alerts to notify users of any new alarms that may be occurring on any battery system being monitored with an Eagle Eye BMS. One email address must be used as the host to send email alerts out. Additional recipients must be configured under the host email account. To send alerts to SMS, contact your mobile phone provider to determine the email to SMS address for your mobile number.

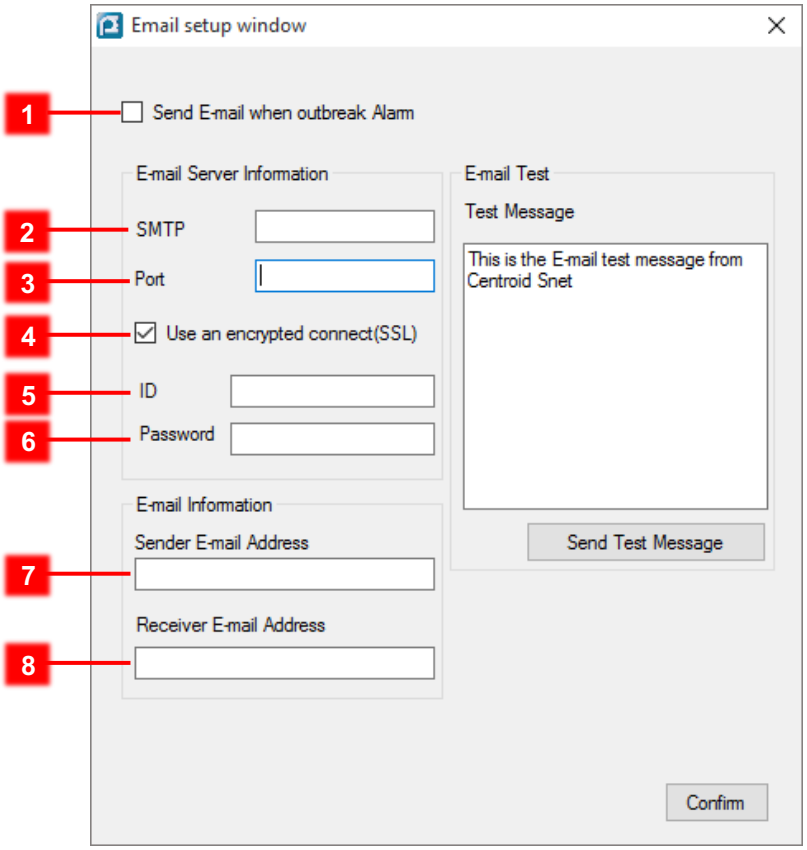
The Email Alert functionality has the following requirements:

- An active internet connection on the Server PC
- SMPT settings for the host email account

1. To configure email alerts, click **Local Server** then click the **Email** button.



2. The Email Setup Window will allow you to input the email information.



(1) Confirm whether or not to use Email alerts (can be disabled at any time)

(2) Enter the SMPT address

(3) Enter the SMPT port

(4) Verify whether or not to use secure connection

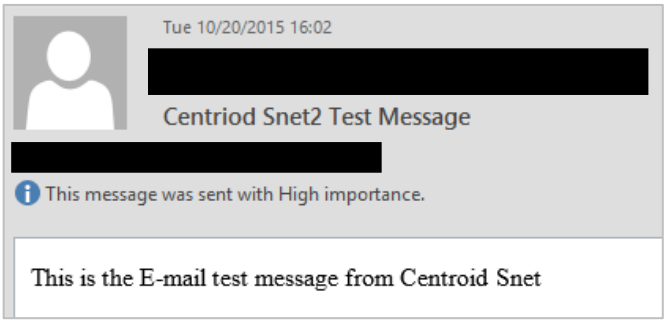
(5) Enter the email address of the host email account

(6) Enter the password of the host email account

(7) Enter the email address of the host account again

(8) Enter the email address of the account which will receive the email alerts (can be the same address as the host)

3. Test that the email alert settings are configured properly by clicking the **Send Test Message** button. Check the receiver email account to confirm that the test message was received.



4. When setup is complete, be sure to check “Send Email when outbreak Alarm” to enable the email alerts.

> **NOTE:** It is recommended to disable email alerts until all alarm settings are configured. This will prevent an excessive number of email alerts being sent out during setup.

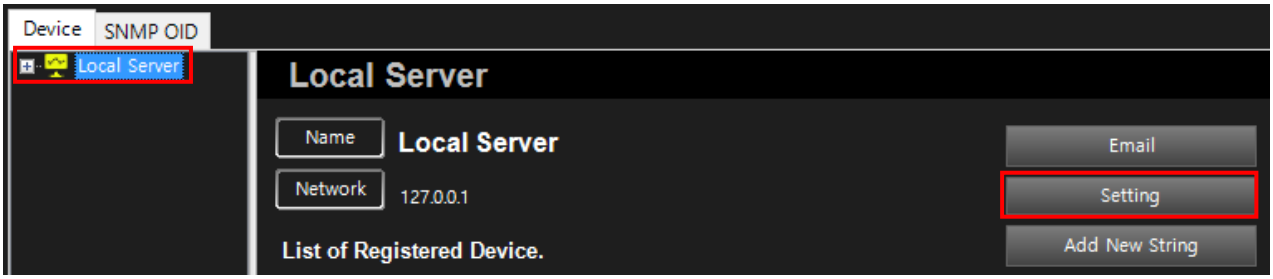
5. Successful email alerts will display the name of the bank / string, the jar (if applicable), the alarm type, and the measured value.

6. It is recommended to occasionally send test emails to ensure the service is operating correctly.

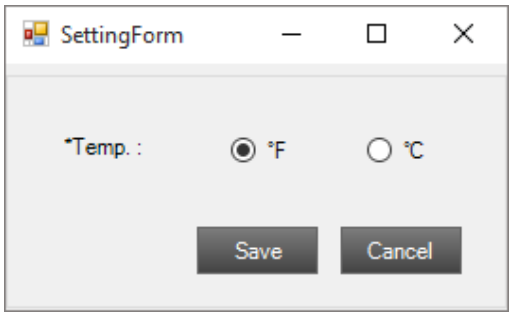
4.5 Temperature Unit Setting

The temperature unit in the software can be selectable between Celsius and Fahrenheit. To change the temperature unit, follow the steps below:

1. Click **Local Server** then click the **Setting** button.



2. Select the unit of temperature and click the **Save** button.



3. Centroid Viewer will restart and the new temperature unit will be reflected in the measurement readings.

4.6 Configure User Accounts

Centroid Viewer includes the option to configure user accounts that have different levels of privilege within the software. User accounts can be useful for both the Server PC and Client PCs connected.

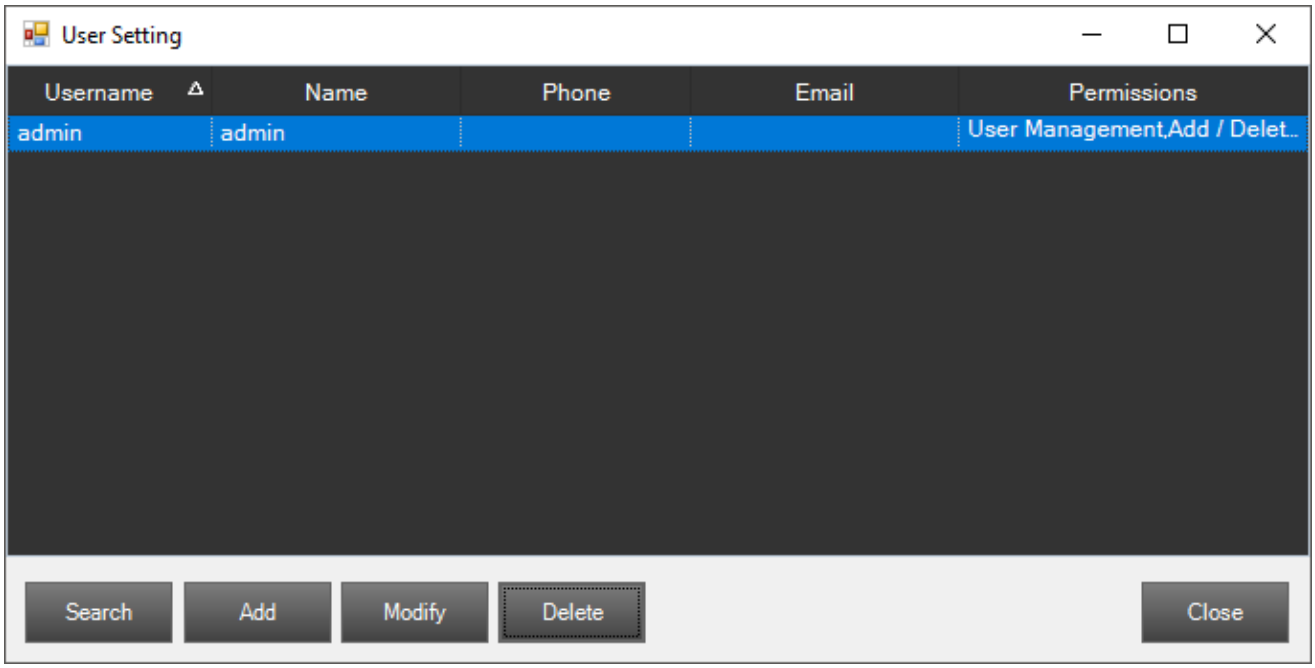
4.6.1 Example User Setup

An example user account setup could be as follows:

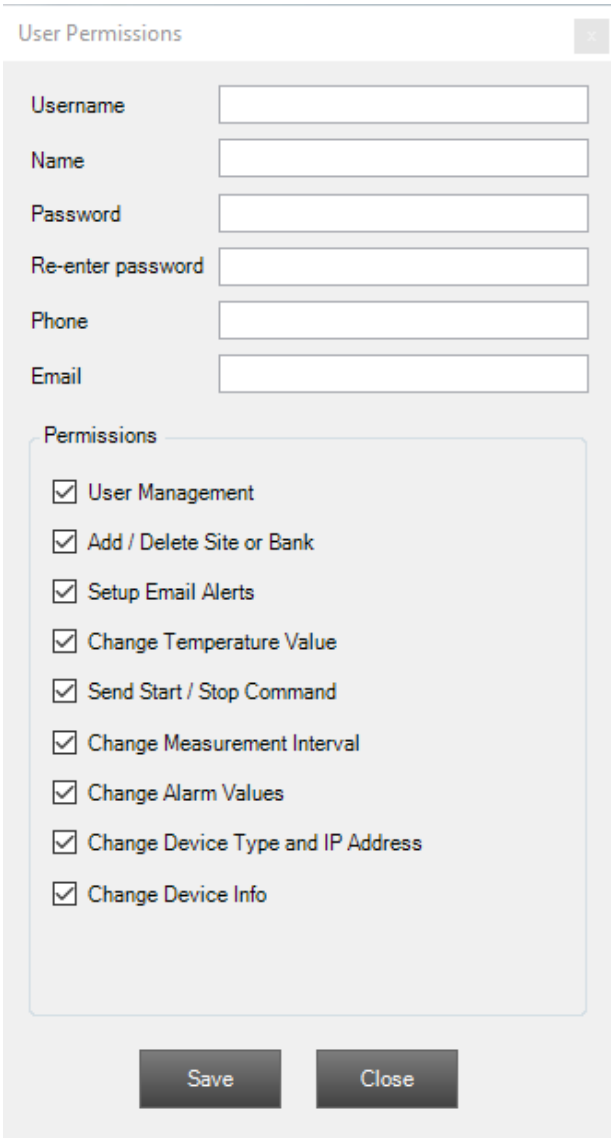
User	Core Privileges
Administrator	Add/modify/delete users Add/modify/delete systems Adjust alarm settings Adjust system settings Data analysis and reporting
Operator	Add/Modify/Delete systems Adjust alarm settings Adjust system settings Data analysis and reporting
Technician	Data analysis and reporting

4.6.2 User Account Management

To add/modify/delete a user, click the **User Management** button under System Management. The user setting window will open as shown below.



Adding a new user or modifying an existing user will open the User Permissions window shown below. Check the desired privilege for each user and click the **Save** button. Note that when modifying existing users, Centroid Viewer must be restarted for changes to take effect.



4.6.3 Switch User & Change Password

1. To switch users, click the user icon on the upper right of the window and click “Log Off”.
2. To change password of the user that is logged in, click the same icon and click “Change Password.”

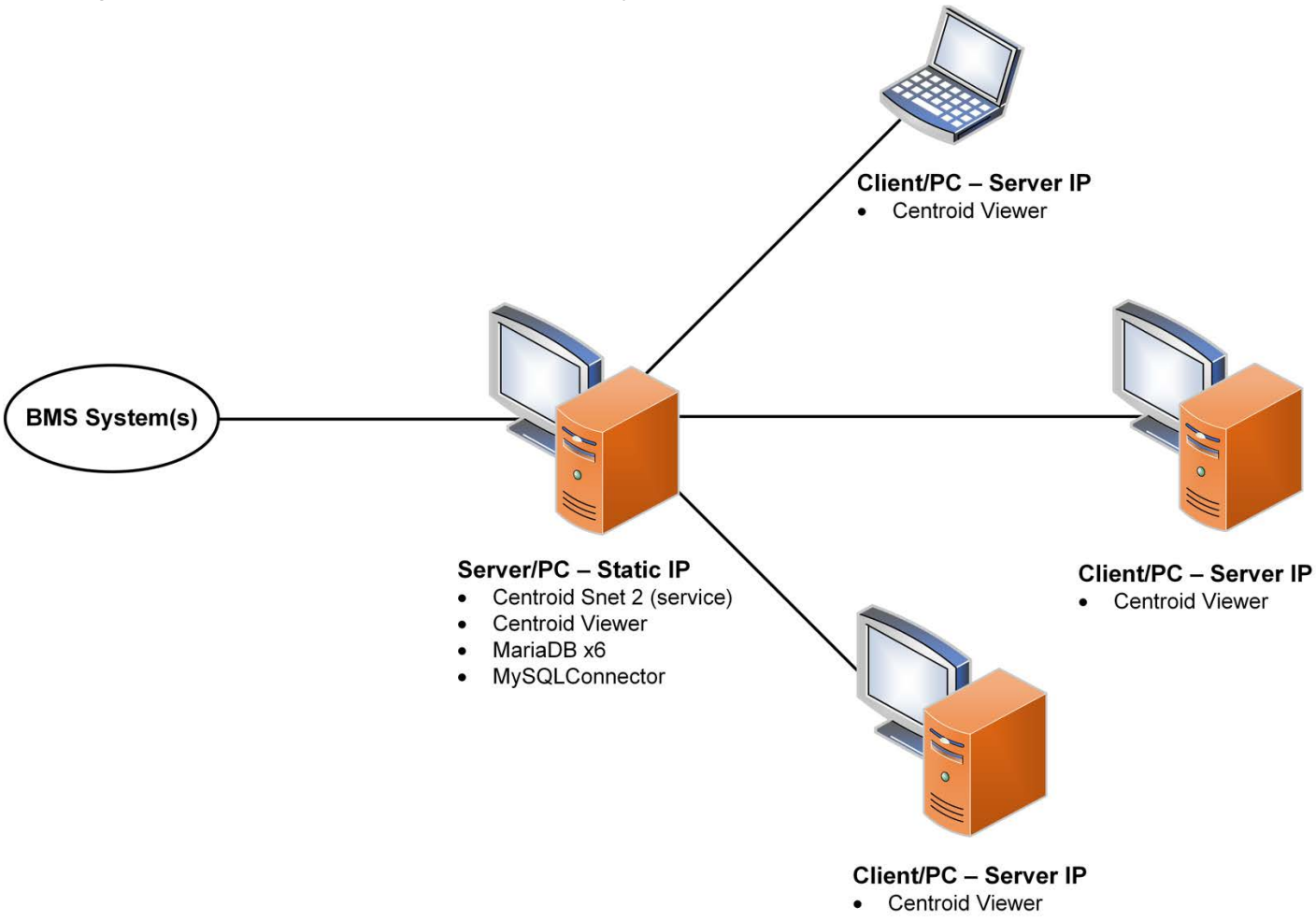
4.6 Using Centroid on Multiple Computers

Multiple users on different computers can view and manage the data in Centroid Snet 2 by using the client functionality of Centroid Viewer.

4.6.1 Client Software Setup

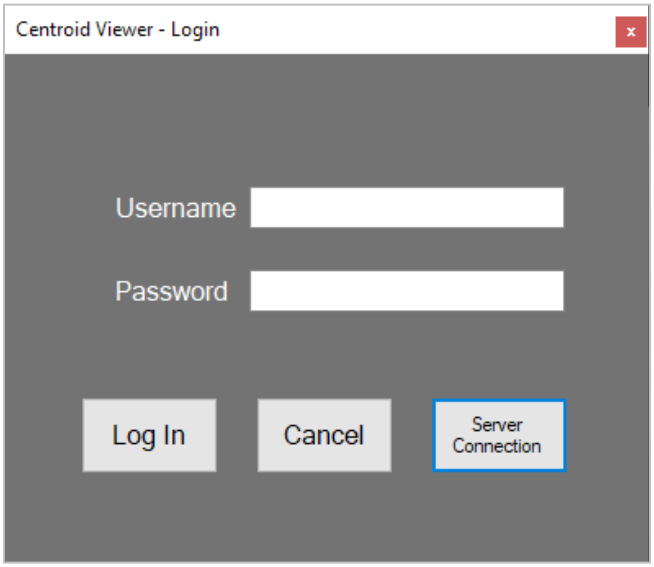
The client functionality uses the same version of Centroid Viewer that would be installed on the Server PC. The only requirement is that the client PC be on the same private network. Client PCs only require Centroid Viewer, they do not require the Centroid Snet 2 Service, MariaDB, or MySQLConnector.

The diagram below illustrates the client to server layout:

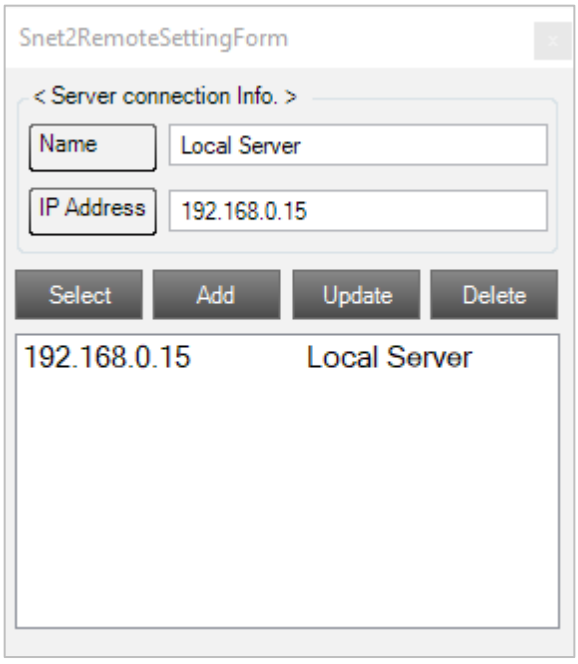


To connect to the Server PC:

1. Install Centroid Viewer
2. Launch the program
3. On the login screen, click the **Server Connection** button



4. Type the IP address of the Server PC (this is the same IP as the “Server IP” in Wiznet)
5. Click the Add button
6. Select the newly added IP address
7. Click the Update button
8. Close the window and login using the same credentials that your user would login to the Server PC
9. All of the systems from Centroid Viewer on the Server PC should be present with the same data



4.7 Modbus Setup

Centroid Viewer has the capability to output Modbus protocol. This allows the software to be used simultaneously with Modbus for integration to a SCADA, DCS, etc.

There is a limitation on the number of systems than can be registered when using Centroid Viewer as a Modbus server:

10. **Up to (15) 120-cell systems can be registered in the software**

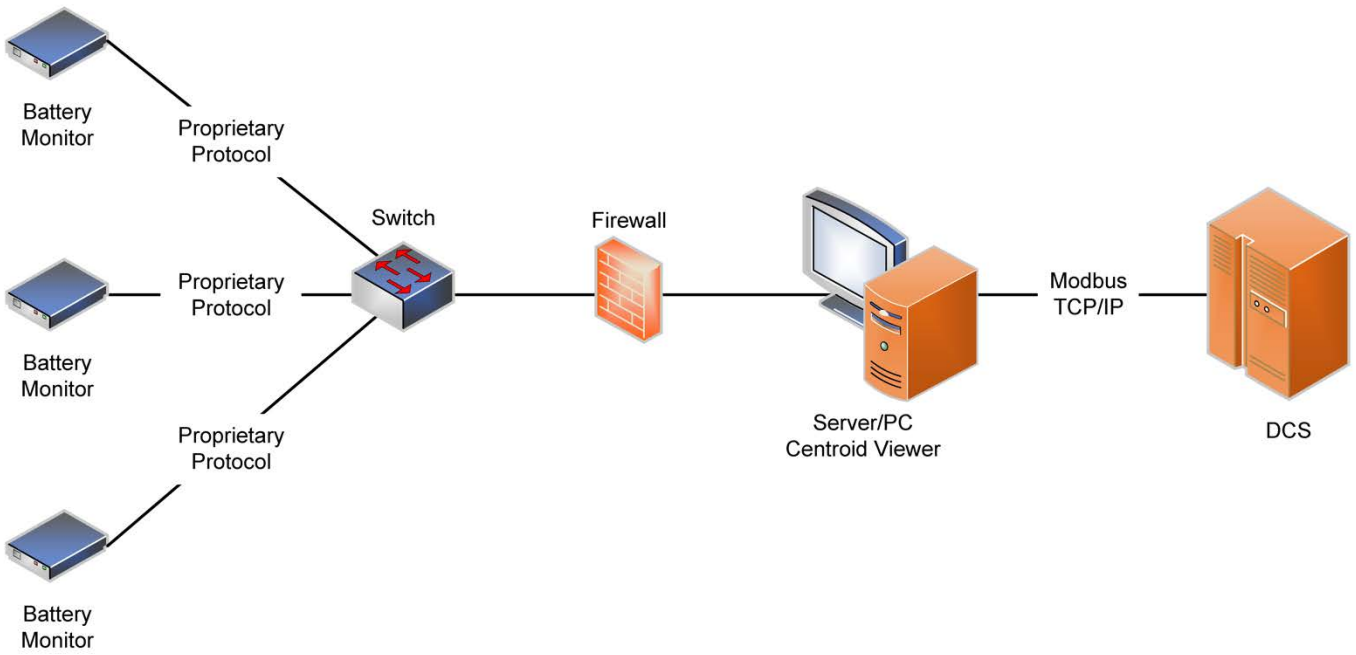
The systems can be made up of BQMS, iPQMS, or BDS units.

4.7.1 Modbus Communication Settings

General Settings:
Once a system is registered and online in Centroid Viewer, it can be setup to communicate out via Modbus TCP/IP. The Snet 2 Windows service must be running at all times.

- **Type:** TCP/IP
- **Port:** 502
- **Protocol:** Modbus/TCP
- **Communication IP:** Centroid Snet 2 IP

The diagram below illustrates the general configuration:

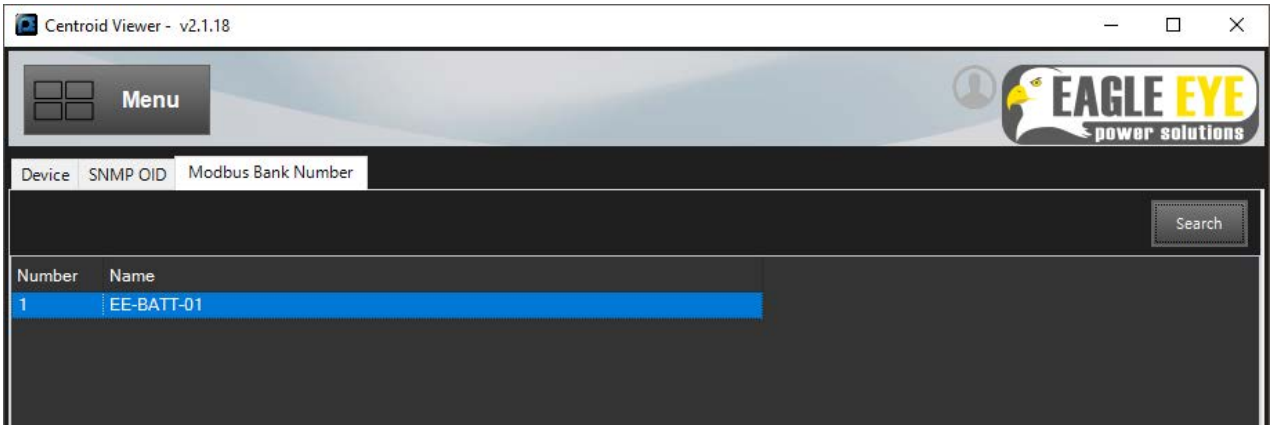


Bank Number:
Each bank registered in Centroid Viewer (up to 15) is assigned a bank number. The bank number is ordered 1 through 15 based on the order of the bank names alphabetically. For example:

Bank A = Bank 1
Bank B = Bank 2

The bank number is used for Modbus addressing. To determine the bank number of each bank:

1. In System Management, click **Modbus Bank Number**
2. Click the **Search** button
3. Each bank name with appear with its corresponding bank number on the left column.



Bank numbers cannot be assigned to any specific bank, they are strictly ordered alphabetically based on the user-defined name of each bank.

4.7.2 Modbus Data Map

The following tables contain the available data points for the Modbus output.

Read Input Register:

Request			
Item	Byte	Description	Example
Transaction ID	2	Increase by 1 on packet request Transaction ID of response must match	00 01
Protocol ID	2	Always 0	00 00
Data Length	2	Request packet's total length minus 6	00 06
Unit ID	1	Always 1	01
Function Code	1	Read input register	04
Starting Address	2	Request address value	7C 38
Quantity of Registers	2	Number of request data	00 32

Response (Centroid Snet 2)			
Item	Byte	Description	Example
Transaction ID	2	Increase by 1 on packet request Transaction ID of response must match	00 01
Protocol ID	2	Always 0	00 00
Data Length	2	Request packet's total length minus 6	00 67
Unit ID	1	Always 1	01
Function Code	1	Read input register	04
Byte Count	2	Request address value	64
Register Value	N*2	Requested data	N

Error (Centroid Snet 2)			
Item	Byte	Description	Example
Error Code	1	Error Code (0x83)	83
Exception Code	1	01 or 02 or 03 or 04	01

Address Map:

Start Address per Bank		
Bank Number	Reference	Data Address
Bank 1	30001	0000H
Bank 2	31001	03E8H
Bank 3	32001	07D0H
Bank 4	33001	0BB8H
…	30001 + ((Bank Number – 1) * 1000)	

Bank Data Address Map			
Item		Starting Offset (WORD)	To Determine Value
Communication	Online / Offline	0	Online: 1, Offline: 0
Battery Info	Total Voltage	2	/ 10
	Total Current	3	/ 10
	Ambient Temp	4	/ 10
Cell Data	Cell Voltage Avg	5	/ 100
	Cell Voltage Max	6	/ 100
	Cell Voltage Min	7	/ 100
	I.R Avg	8	/ 100
	I.R Max	9	/ 100
	I.R Min	10	/ 100
	Temp Avg	11	/ 10
	Temp Max	12	/ 10
	Temp Min	13	/ 10
Cell Voltage	Cell 1	100	/ 100
	Cell 2	101	/ 100
	…		
	Cell 199	298	/ 100
	Cell 200	299	/ 100
Cell Impedance	Cell 1	300	/ 1000
	Cell 2	301	/ 1000
	…		
	Cell 199	498	/ 1000
	Cell 200	499	/ 1000
Cell Temp	Cell 1	500	/ 10
	Cell 2	501	/ 10
	…		
	Cell 199	698	/ 10
	Cell 200	699	/ 10

Examples:

Bank No.	Cell No.	Value	Address	Hex	Decimal	Actual Value
2	N/A	String Voltage	1002	051E	1310	131.0 V
2	1	Cell Voltage	1100	00D5	213	2.13 V
2	1	Cell Impedance	1300	0567	1383	1.383 mΩ
2	10	Cell Temp.	1509	00B1	177	17.7 C

NOTE: Negative value processing: If the value entered is more than 32000, then it is treated as two's complement because it is negative.

5. Battery Monitoring

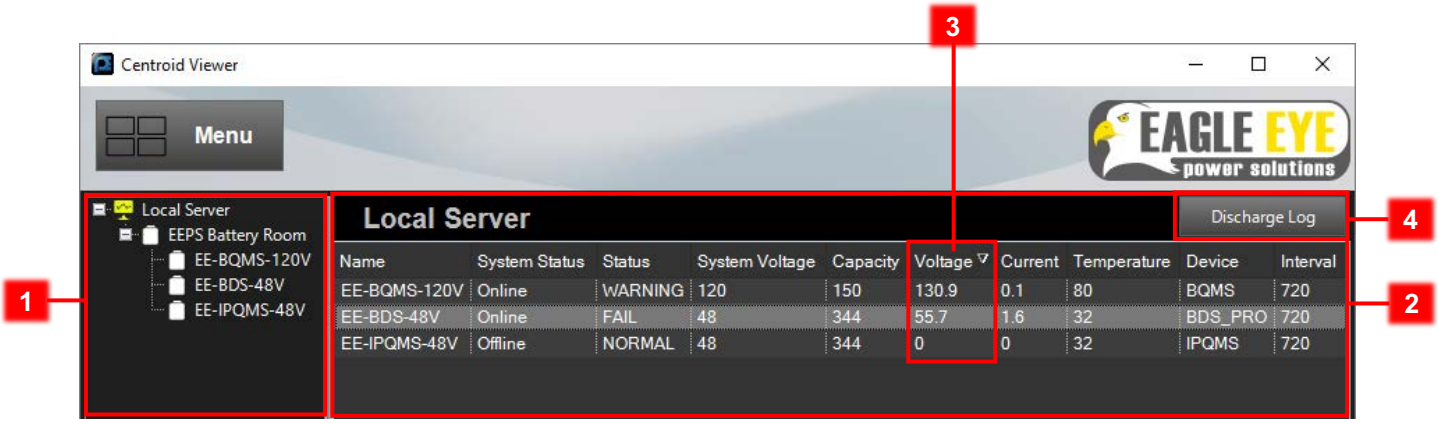
This section provides detailed information on the **Battery Monitoring** area of the software which is used for managing the measurement data captured from the BMS systems installed in the field. The Battery Monitoring section provides the following functionality, each of which will be covered in detail throughout this section:

- **Local Server** to display all registered BMS systems and their current status.
  - **Discharge Log** to playback all discharge events.
- **System Dashboard** to view each system individually.
  - **Summary View** to view summary of measured parameters and alarms.
  - **Overall View** to view set alarms and system information.
  - **Chart View** to view charts and graphs for all measured data.
  - **List View** to view measured data for all cells/units
  - **Reporting** (PDF & Excel) for a specific system.
  - **System History** to view all measured data from a specific BMS system from time of installation

5.1 Local Server

The Local Server view is the default view when opening the Battery Monitoring section of the software and has the following functionality:

- View all systems registered in the software
- Sort all systems by each column displayed in the Local Server view
- View the Discharge Log



(1) All sites and systems are registered under the Local Server. Click the **[+]** button next to Local Server to display all of the sites. Click the **[+]** button next to each site to display each system.

(2) Click the **Local Server** name to display all of the systems registered in the software. Each system will have a row with columns showing the System Name, Communication Status, Alarm Status, Nominal System Voltage, Capacity, Measured Voltage, Measured Current, Ambient Temperature (BQMS only), BMS Model, and Measurement Interval.

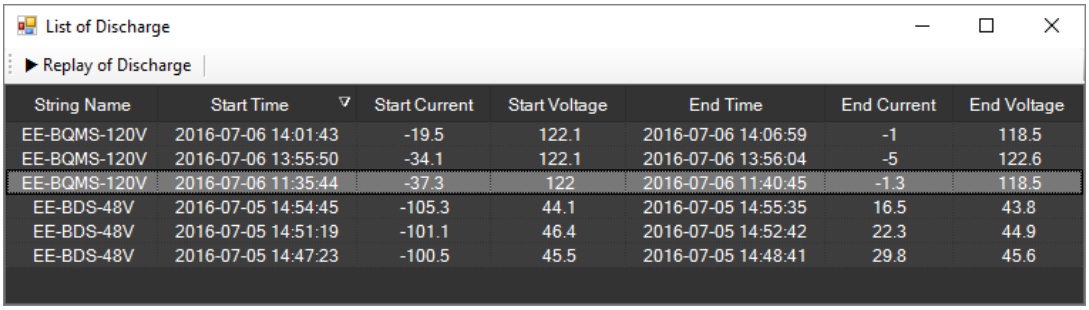
(3) Click each column name to sort by that column. For example, clicking the **System Status** column will allow all Offline systems to be shown from the top. Clicking the **Status** column will sort the systems by alarm status. This can be useful for showing which systems are in alarm quickly.

(4) Click **Discharge Log** to view the Discharge Log

5.1.1 Discharge Log

The **Discharge Log** contains records of all recorded discharge events for all systems registered under the Local Server. To learn more about how discharge events are recorded, refer to Appendix A.

1. To open the Discharge Log, click the **Local Server** icon then click the **Discharge Log** button in the upper right.
2. The Log will display all of the recorded discharges along with: String Name, Start Time, Start Current, Start Voltage and End Time, End Current, and the End Voltage for each test.



String Name	Start Time	Start Current	Start Voltage	End Time	End Current	End Voltage
EE-BQMS-120V	2016-07-06 14:01:43	-19.5	122.1	2016-07-06 14:06:59	-1	118.5
EE-BQMS-120V	2016-07-06 13:55:50	-34.1	122.1	2016-07-06 13:56:04	-5	122.6
EE-BQMS-120V	2016-07-06 11:35:44	-37.3	122	2016-07-06 11:40:45	-1.3	118.5
EE-BDS-48V	2016-07-05 14:54:45	-105.3	44.1	2016-07-05 14:55:35	16.5	43.8
EE-BDS-48V	2016-07-05 14:51:19	-101.1	46.4	2016-07-05 14:52:42	22.3	44.9
EE-BDS-48V	2016-07-05 14:47:23	-100.5	45.5	2016-07-05 14:48:41	29.8	45.6

3. Click any of the column titles to sort by that column.
4. To view a discharge, click **Replay of Discharge**.

(1) Displays the following information:

a. Battery bank name

b. Total number of cells/units

c. Total time of recorded discharge

d. Total time elapsed into the playback of the discharge

e. Date and time the recording started

f. Date and time the recording ended

g. Current time displayed in the playback

h. DC voltage and current values throughout the playback

(2) Print the discharge log to a printer or PDF file.

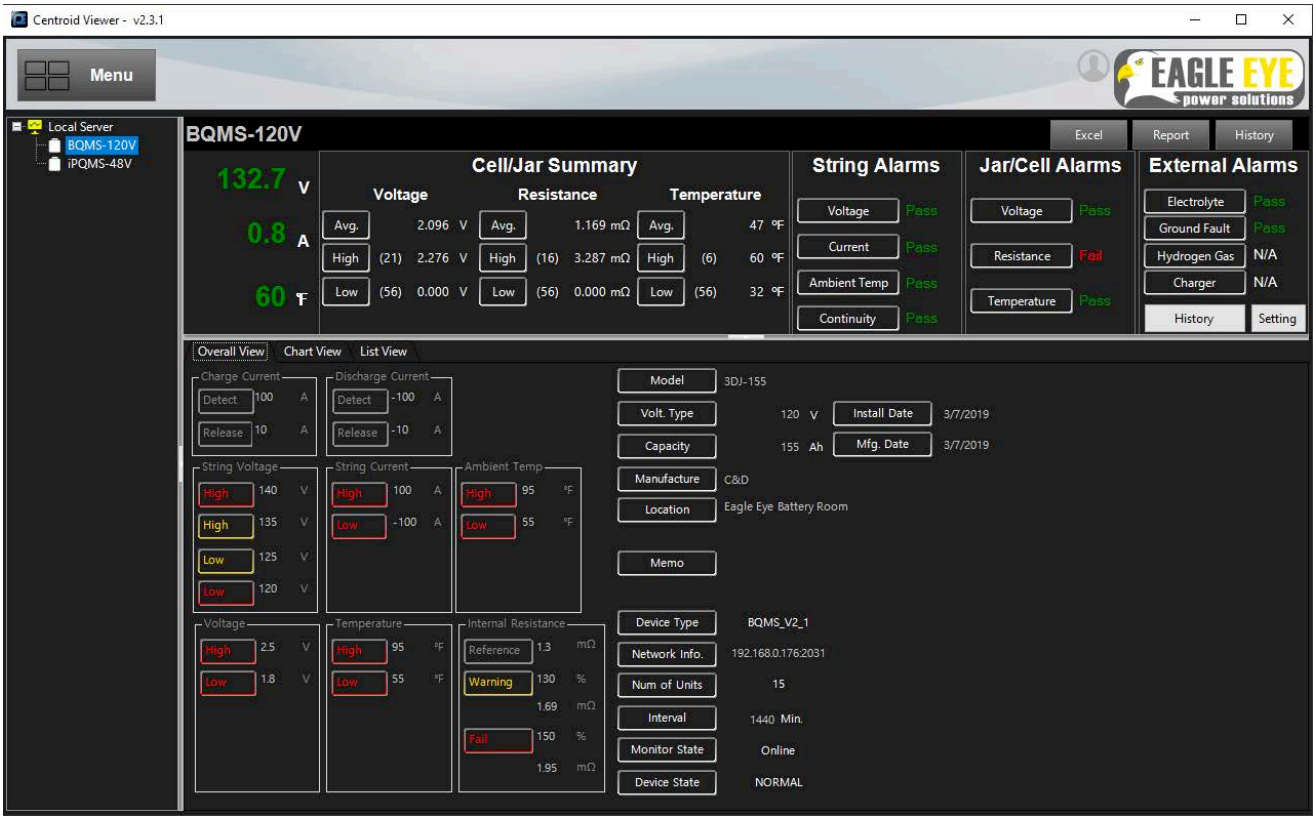
(3) Playback Controls (from left to right): Return to start of playback, play backwards, pause, play forward, skip to end of playback.

(4) String voltage and current graph.

(5) Cell voltage and cell resistance graph.

5.2 System Dashboard Interface

This section will explain the System Dashboard interface. To display the System Dashboard, click the System Name under **Local Server > Site Name**.



The System Dashboard has the following main areas:

- Summary View
- Overall View
- Chart View
- List View

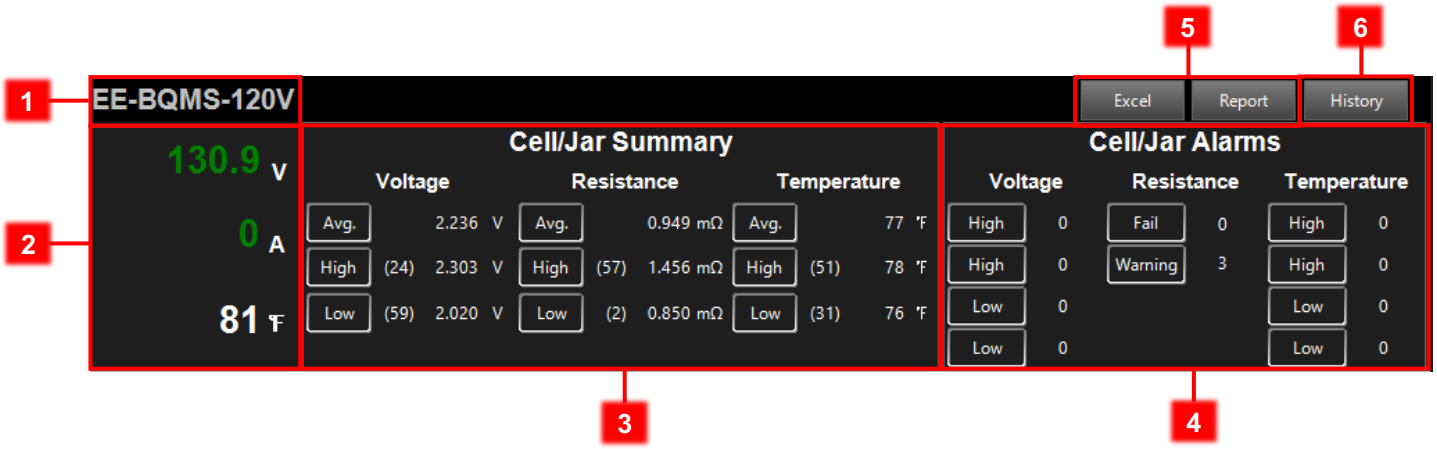
The System Dashboard section of the software provides the following functionality:

- View all measured data from the BMS
- View active alarms
- View and edit all alarm parameters
- View and edit system information
- Change the operating status of the BMS
- Change the measurement interval for cell resistance (cell voltage, resistance, and temperature for iPQMS & BDS)
- Generate PDF reports
- Export measurement data to Excel
- View detailed measurement history on a string and cell level

The various sections of the Individual System View are explained below:

5.2.1 Summary View

The Summary View is the top section of the Individual System view.



(1) System/String/Bank Name. Clicking the system name allows the name to be edited.

(2) String Voltage, Float/Charge/Discharge Current, & Ambient Temperature (BQMS only). Voltage and current measurements displayed as green when not in alarm and red when in alarm.

(3) **Cell/Jar Summary** displays a summary of values for the measured parameters of Cell Voltage, Cell Resistance, and Cell Temperature. The average, highest, and lowest values are displayed. The number in parenthesis refers to the actual cell for the high and low values. In the example above, cell 24 has the highest voltage of 2.303V, and cell 59 has the lowest voltage of 2.020V.

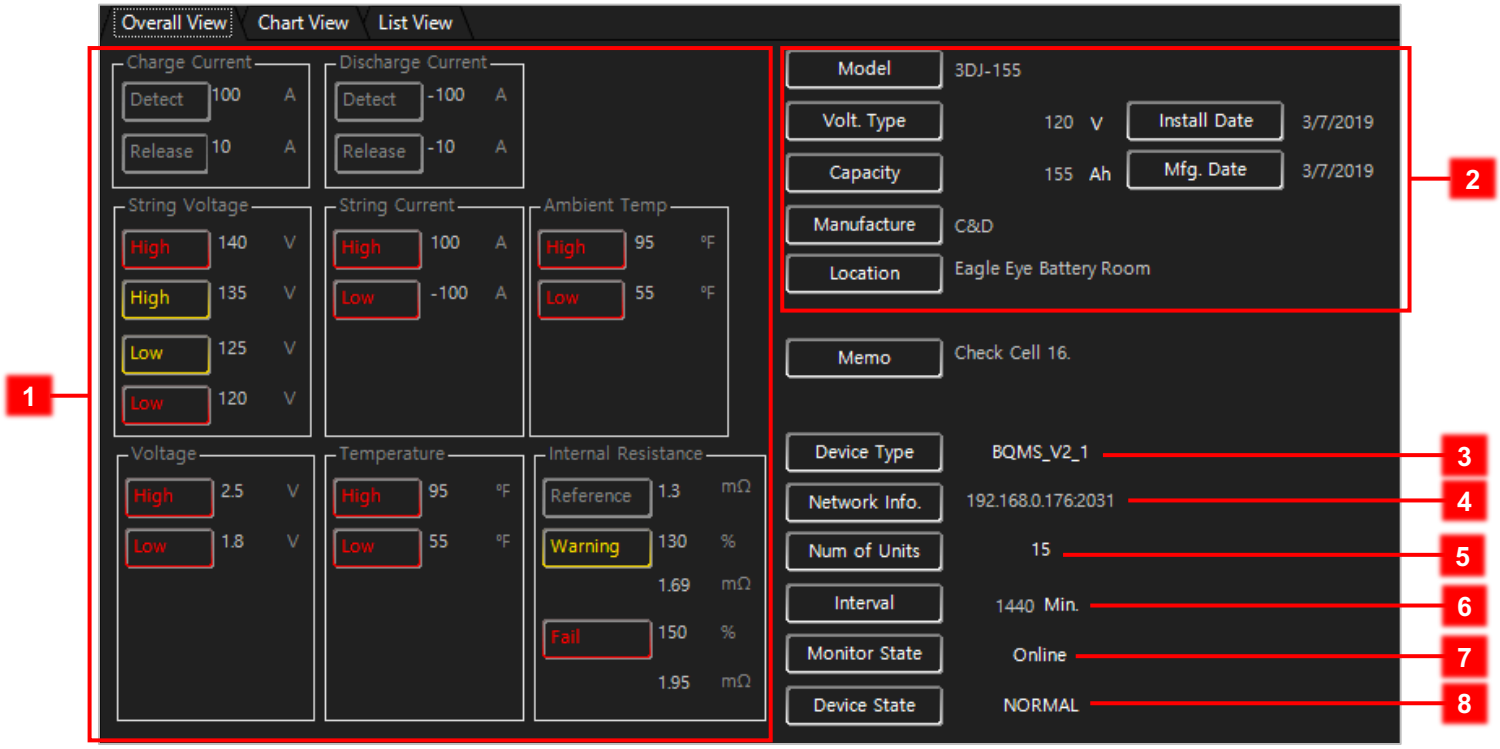
(4) **Cell/Jar Alarms** displays the number of alarms for each type of cell/jar alarm. The number of active alarms for each alarm type will be displayed to the right of the alarm. In the example above, the system has (3) Warning Resistance alarms.

(5) Reporting – refer to Appendix B for report examples.

(6) The **History** button allows viewing of the systems measurement history. Refer to Section 5.3 for more information on viewing system history.

5.2.2 Overall View Tab

The Overall View Tab displays the set alarm parameters and system information.



(1) Alarm Parameters: All set alarm parameters for the battery system are displayed here. For further explanation on the alarm parameters, refer to **Appendix A.**

(2) System Information: Entered information about the site and battery system is displayed here.

(3) Device Type: Displays the type of BMS which would have been entered when the system was registered.

(4) Network Info: Displays the IP address of the BMS. This cannot be edited here.

(5) Num of Units: Value entered when BMS was registered. This cannot be edited.

(6) Interval: Set value for how often resistance measurements are taken (cell voltage, resistance, and temperature for iPQMS & BDS Models). Click the value to change the measurement interval.

(7) Monitor State: Displays whether the BMS is Online or Offline. If the BMS is Offline, it is either turned off or there is an issue with communication between the BMS and the Server.

(8) Device State: Displays the current state of the BMS. There are (3) possible states:

a. **Normal:** The BMS is between measurement cycles and is operating normally.

b. **Resistance Measurement:** The BMS is currently measuring resistance on the system

c. **Stop:** The BMS is stopped and will not measure cell resistance (cell voltage, resistance, and temperature for iPQMS and BDS) until the measurement cycle is manually started again.

5.2.3 Chart View Tab

The Chart View tab displays graphs for: String Voltage, String Current, Cell/Unit Voltage, Cell/Unit Resistance, and Cell/Unit Temperature. The graphs can be interacted with in the following ways:

(1) Switch between the graphs by selecting the parameter to view.

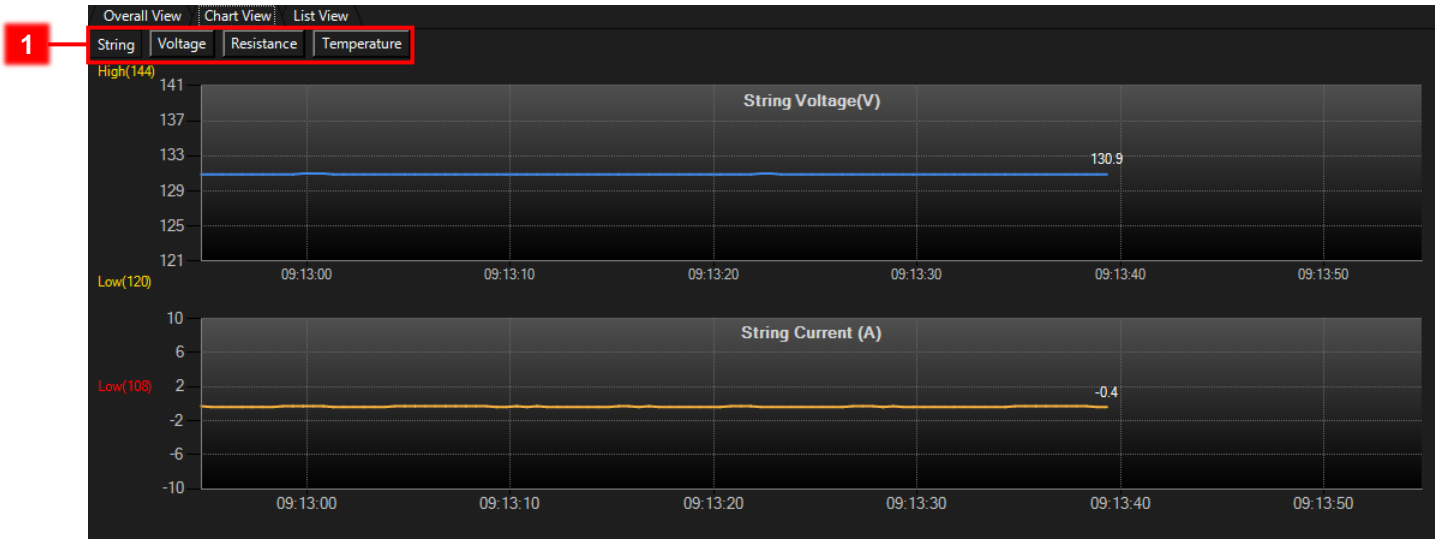
(2) View alarm threshold values on the left of the graph.

(3) Hover over any cell to view the cell # and measured value.

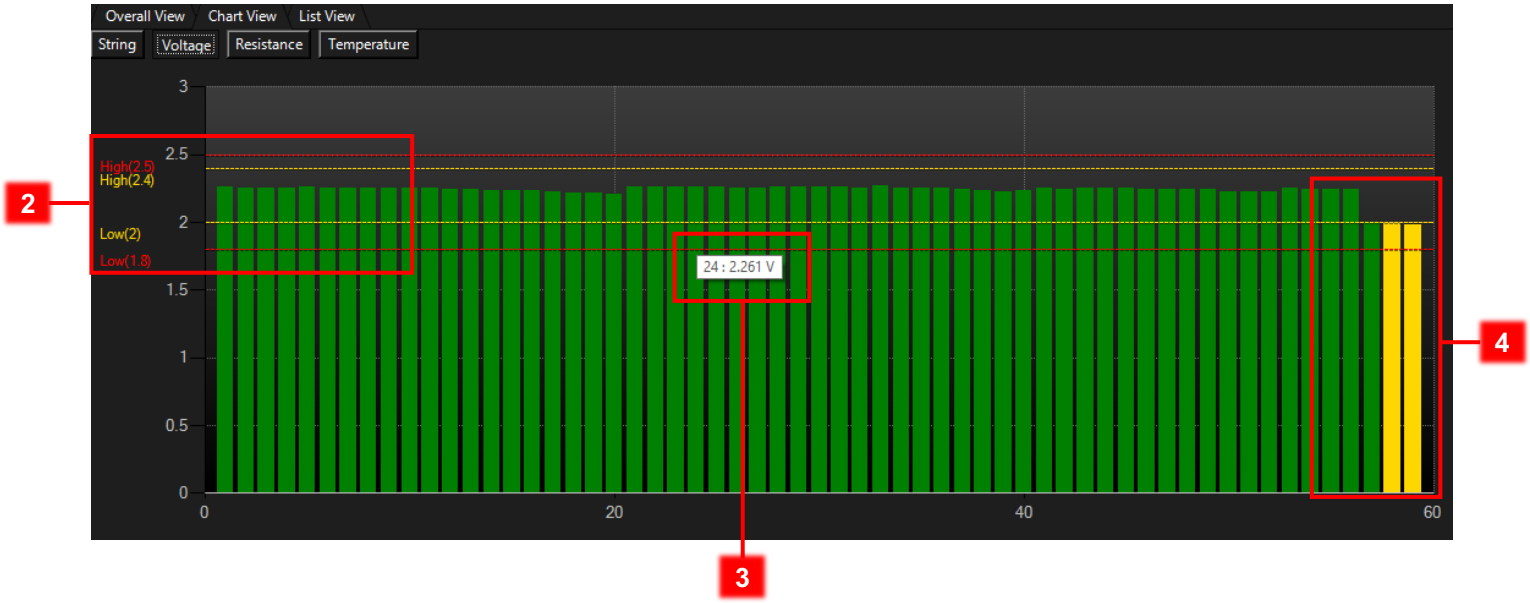
(4) Normal cells report in green, warning cells in yellow, and failed cells in red.

(5) Click and drag an area of the graph to zoom in.

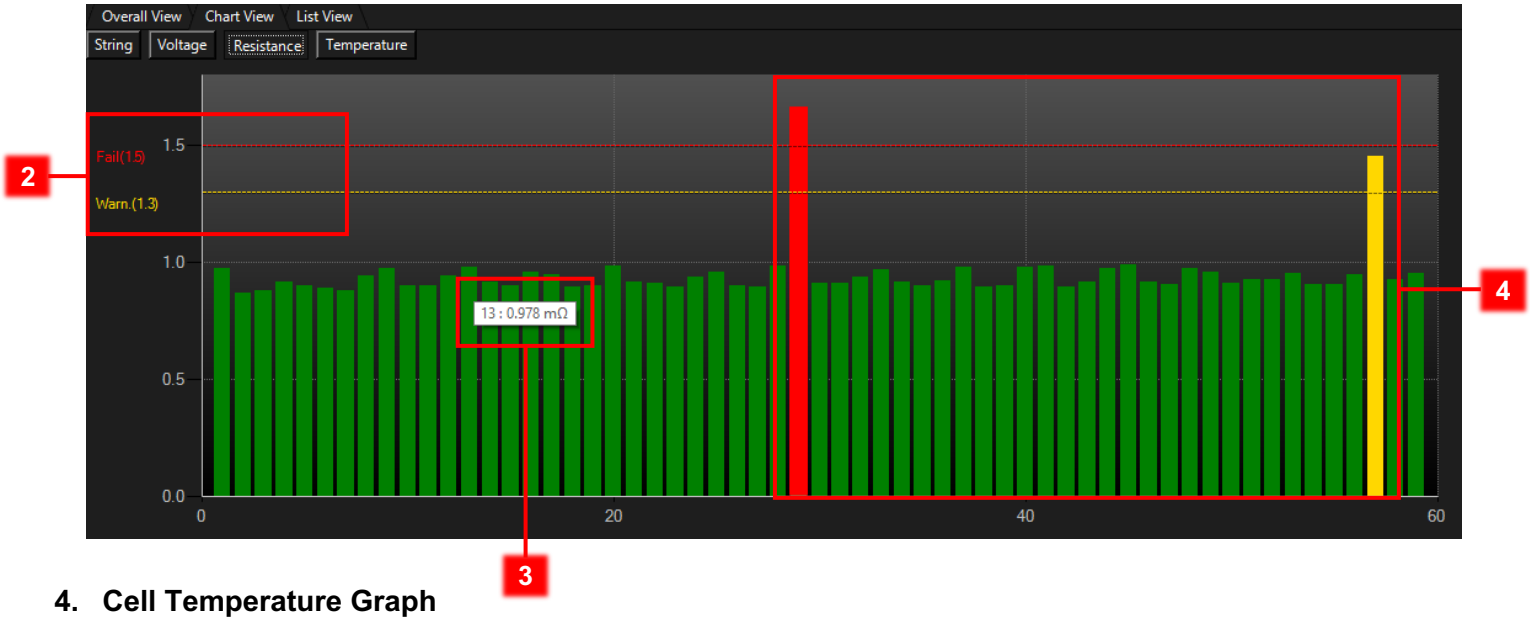
1. String Voltage and Current Chart



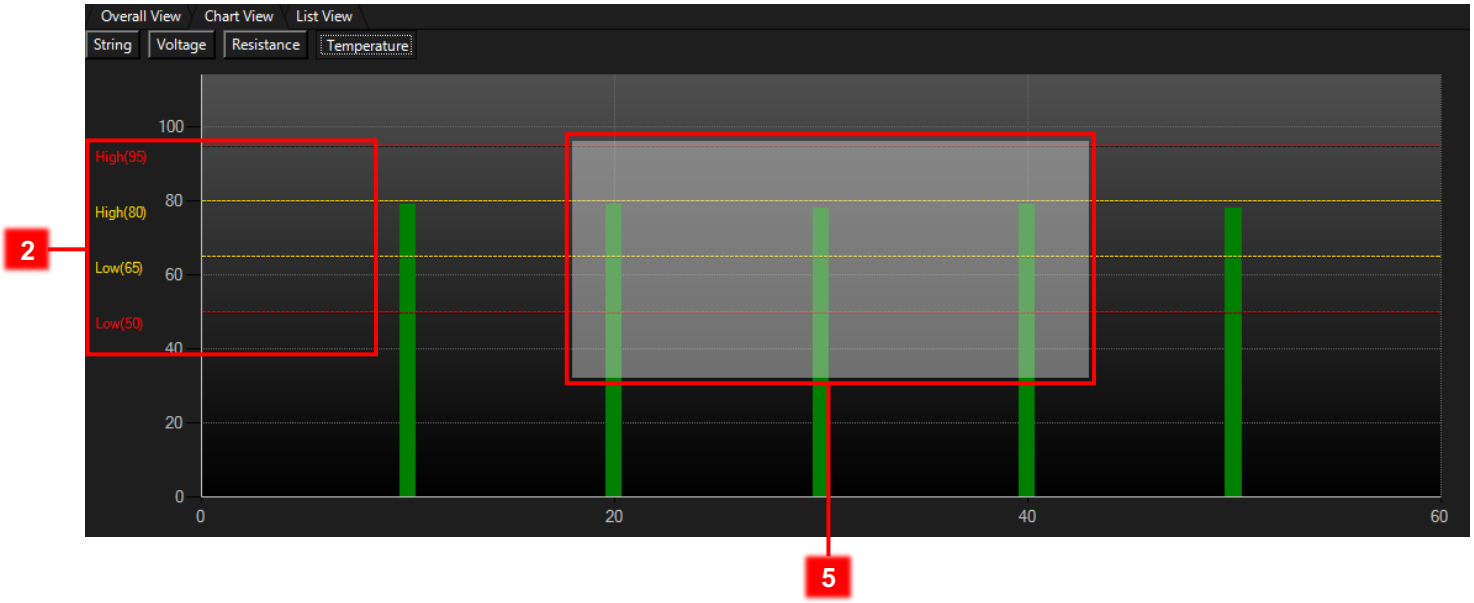
2. Cell Voltage Graph



3. Cell Resistance Graph

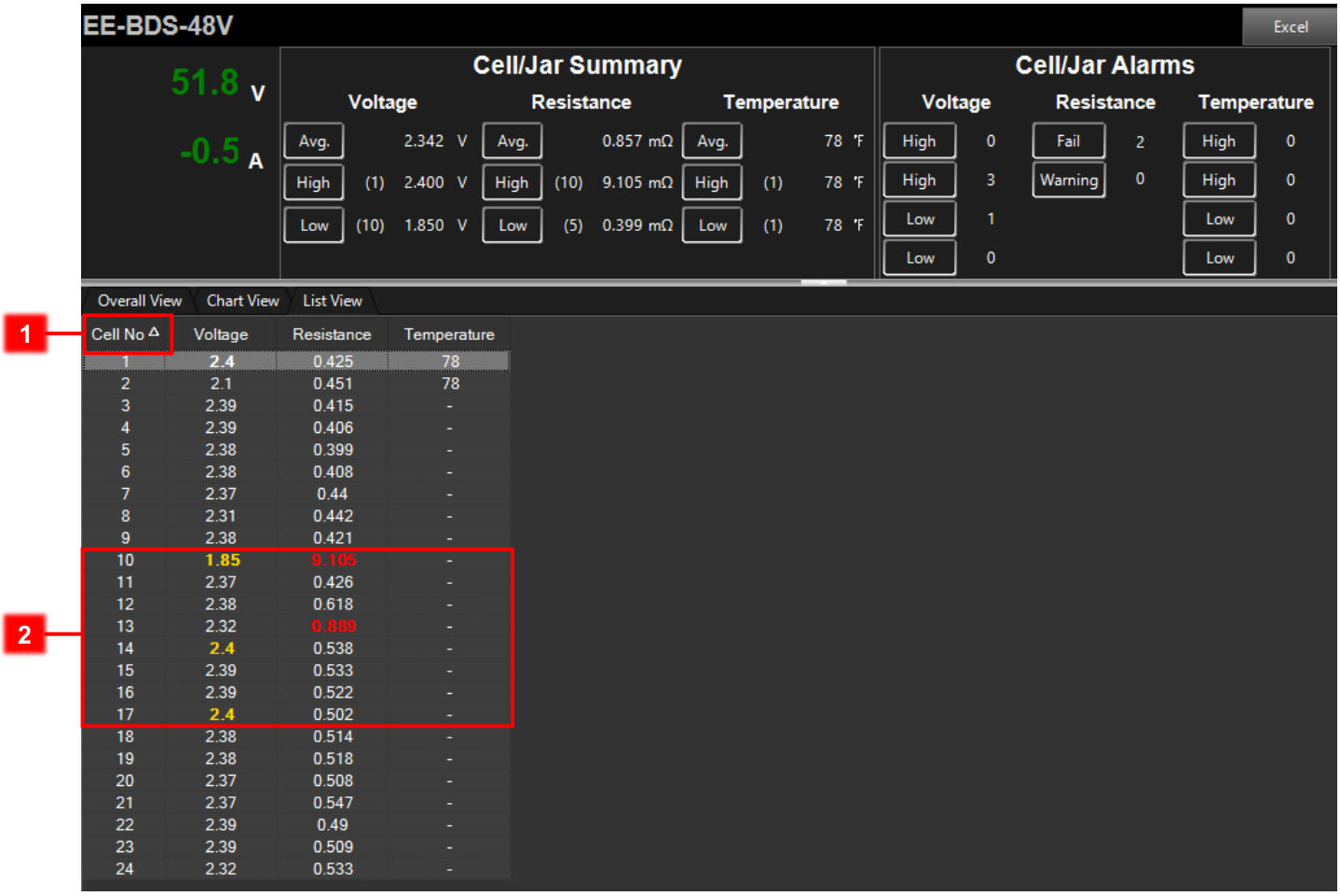


4. Cell Temperature Graph



5.2.4 List View Tab

The List View tab displays a list of the following measured parameters: Cell/Unit Voltage, Cell/Unit Resistance, and Cell/Unit Temperature. Opening this tab provides a complete display of all the measured parameters from the BMS system.



(1) Sort by column by clicking on the title of the column.

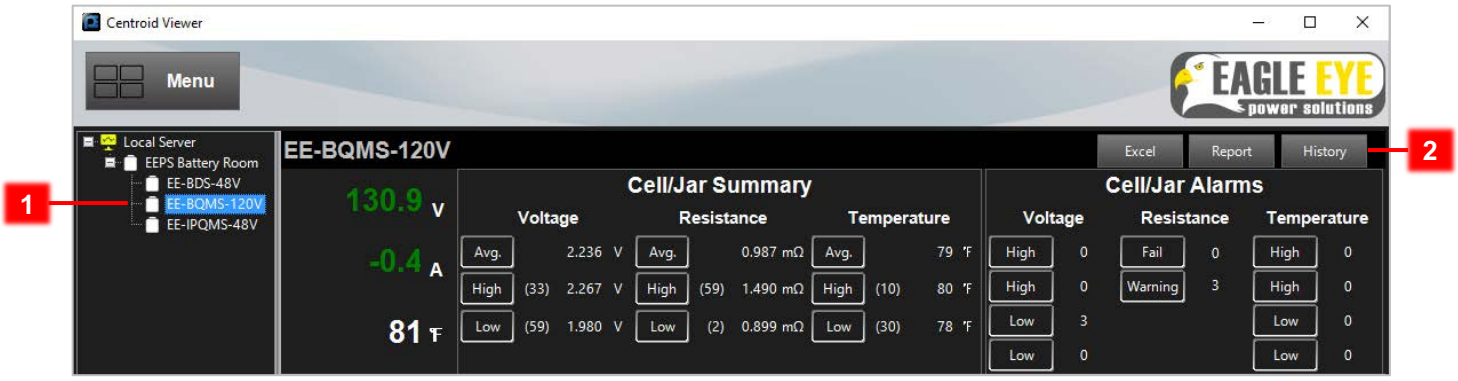
(2) Normal values report in white, warning values in yellow, and failed values in red.

5.3 History View

Under the System Dashboard is the History View which provides the following functionality:

- View all measured for a system from the time of installation.
- View measured data between two selectable dates.
- Trend individual cells between two selectable dates for:
  - Cell/unit voltage
  - Cell/unit resistance
  - Cell/unit temperature
- Export all measured data for a system to Excel.
- Export all measured data for a specific date to Excel.

1. To open the **History View** window, select the bank under the **Local Server** to open up the **System Dashboard** view. Then click the History button in the upper right corner.

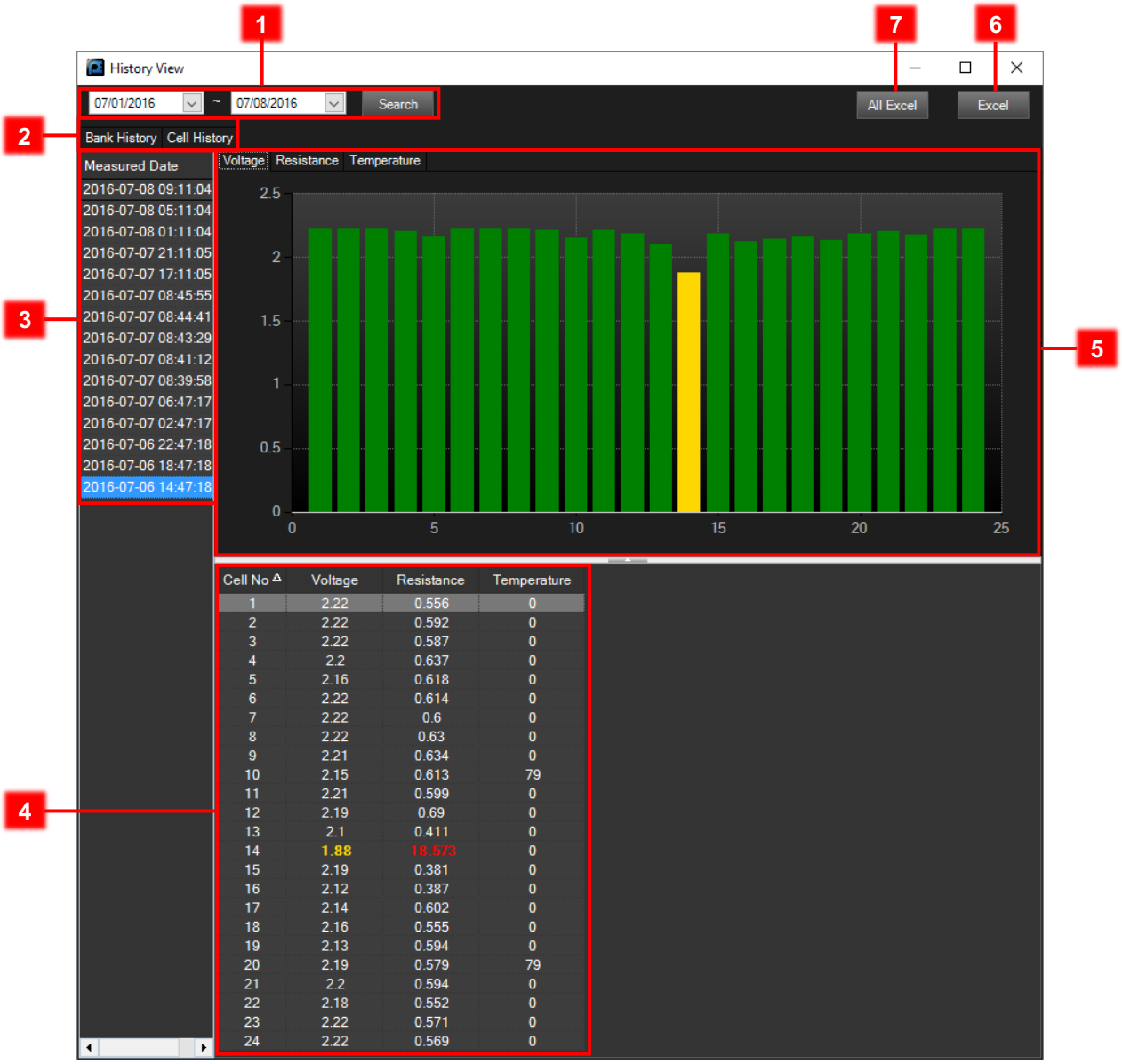


(1) Select the System you wish to view the history for.

(2) Click the **History** button to open the **History View** window.

5.3.1 String History View

After clicking the History button from the selected bank, the History window will open and the default view will show the String (Bank) History.



(1) Select the date range to view measurement data for.

(2) **Bank History** is displayed by default, click **Cell History** to view the history of each cell. (Section 5.3.2)

(3) The date and time of each measurement is displayed here. Select the specific date and time to view the measurement data.

(4) The cell/unit measurement data will appear for the selected date here.

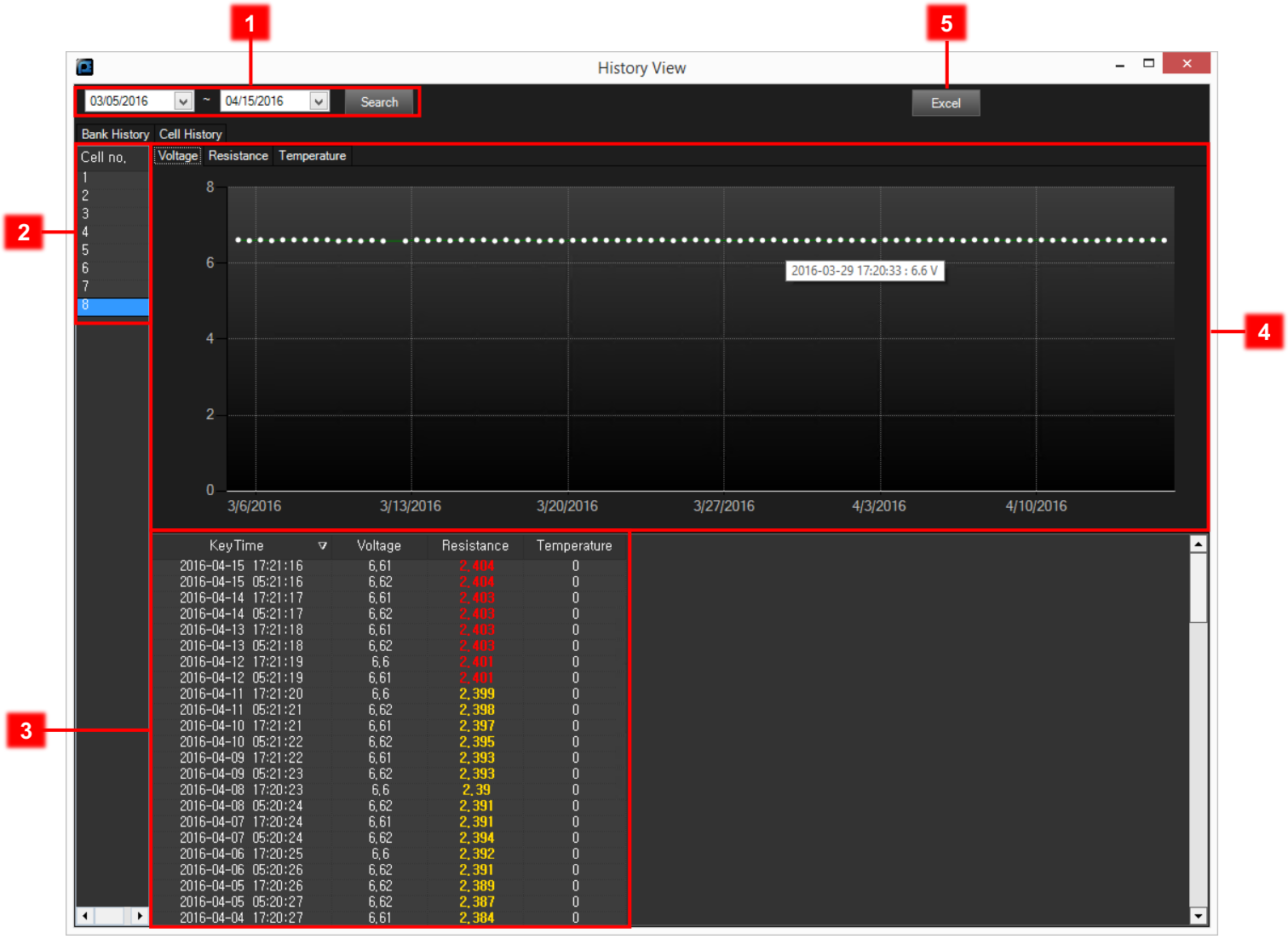
(5) The graphs for each cell/unit Voltage, Resistance, and Temperature will appear here. Click the tabs to change the chart to the desired measurement value.

(6) Export the current date and time measurement data to Excel.

(7) Export all measurement data for the selected bank to Excel.

5.3.2 Cell/Unit History View

The Cell/Unit History window allows viewing of each individual cell for voltage, resistance and temperature. This section allows trending for individual cells.



(1) Select the date range to view measurement data for.

(2) Select the individual cell/unit to view measurement data for.

(3) All measurement data for selected cell will appear here. Click each column title to sort by that column.

(4) Measurement data for the selected parameter is trended here; select the parameter to display the trending graph. Each point on the graph represents a measurement date and time. Hover the mouse over each point to view the actual date, time, and measured value.

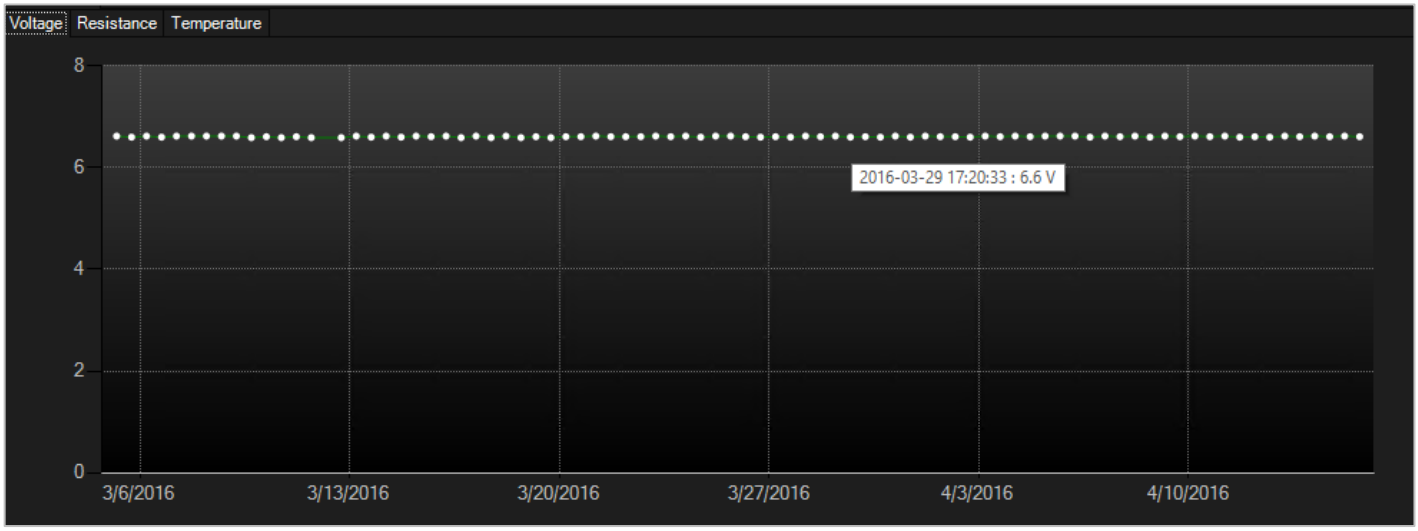
(5) Export the current date and time measurement data to Excel.

5.3.3 Cell/Unit Trending

As described in Section 5.3.4, the Cell/Unit History view allows trending of cell voltage, resistance, and temperature. These values are displayed on a color coded line-chart to easily view trending values.

1. Cell Voltage Trending

The graph below displays the internal/connection resistance of a specific cell over a 5-week period.

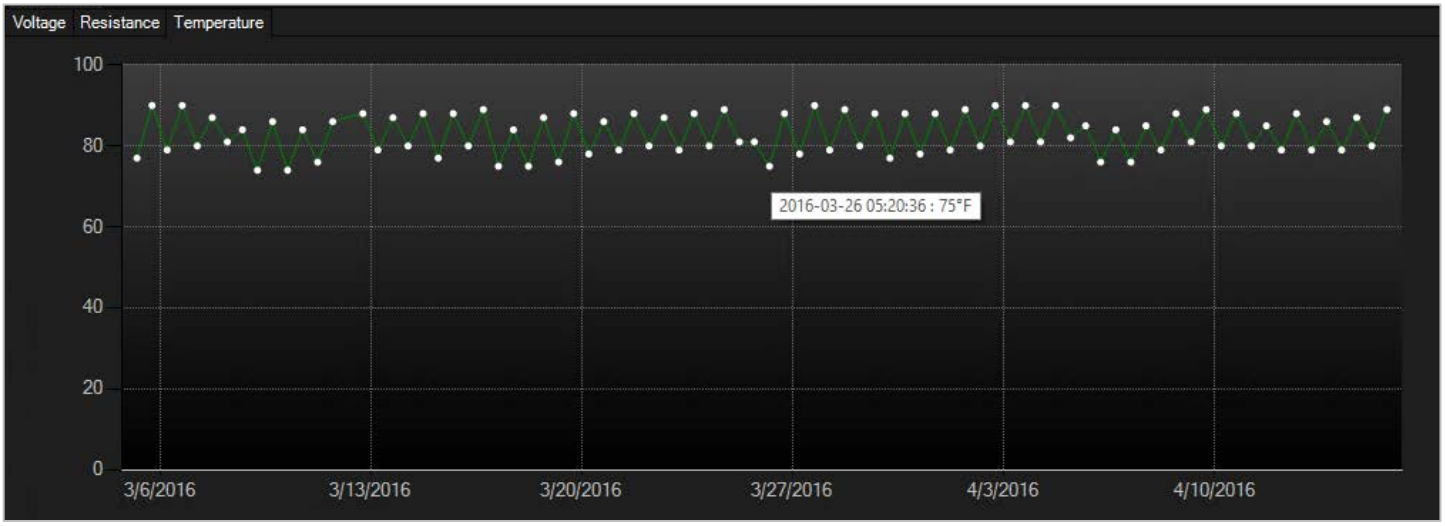


2. Cell/Connection Resistance Trending

The line-chart below displays the internal/connection resistance of a specific cell over a 5-week period. This cell went into WARNING alarm around 3/17/16 (line-chart changes from green to yellow) and continued to rise. The graph enables us to see that the cell alarm changed to FAIL on 4/12/16 (line-chart changes from yellow to red).

3. Cell Temperature Trending

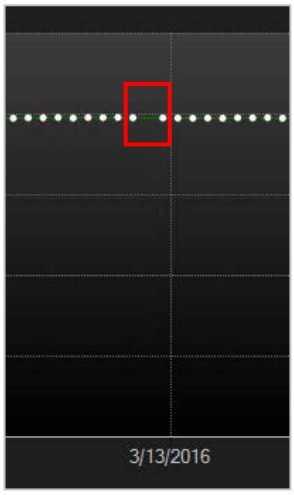
The line-chart below displays the cell temperature of a specific cell over a 5-week period. In this example the BMS was testing temperature twice per day in an outdoor cabinet. The chart clearly shows the difference in temperature between early morning and early evening.



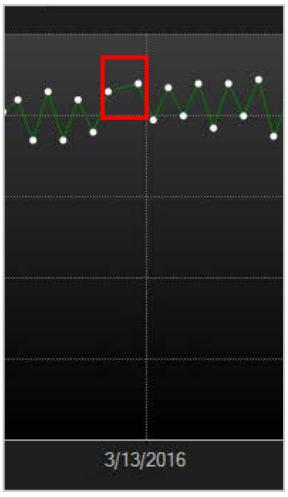
4. Identifying System Downtime

Each of the charts above shows a consistent gap where a measurement from the BMS was missed.
In this example, records for the system indicate that maintenance was performed on the date the gap is present. Gaps in the cell trending charts can be used to determine certain events which occurred on specific dates such as maintenance, communication failure, outages, etc.

Voltage Chart



Resistance Chart



Temp. Chart

6. Battery Alarms

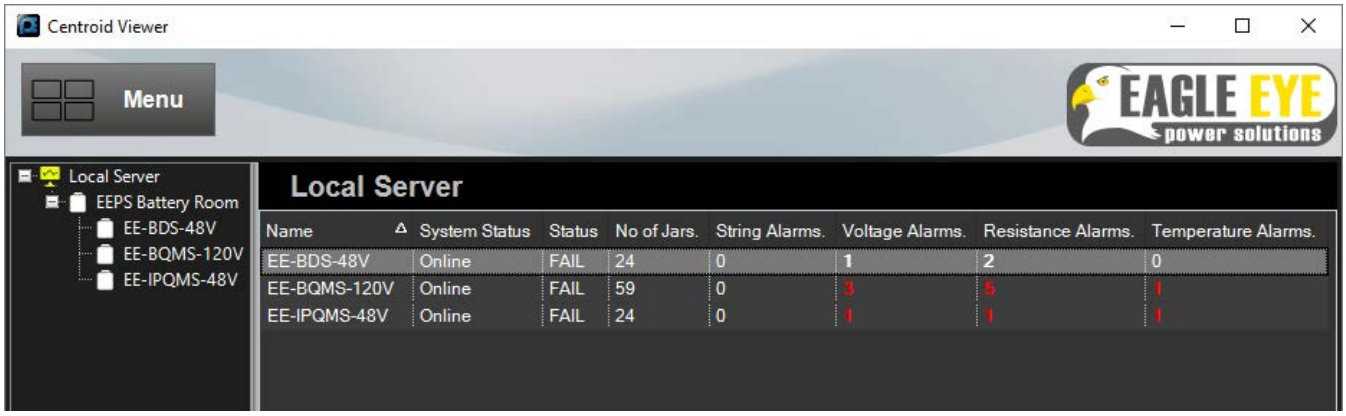
This section provides detailed information on the **Battery Alarms** area of the software. The Battery Alarms section provides the following functionality; each of which will be covered in detail throughout this section:

- **Local Server** display of all registered BMS systems with currently active alarms.
- **System View** displays all active alarms for each individual system.
    - **History View** displays all alarms that ever occurred on the system.

6.1 Local Server Alarm View

The Local Server Alarm View displays all systems registered under the Local Server. The default view has columns for the following information:

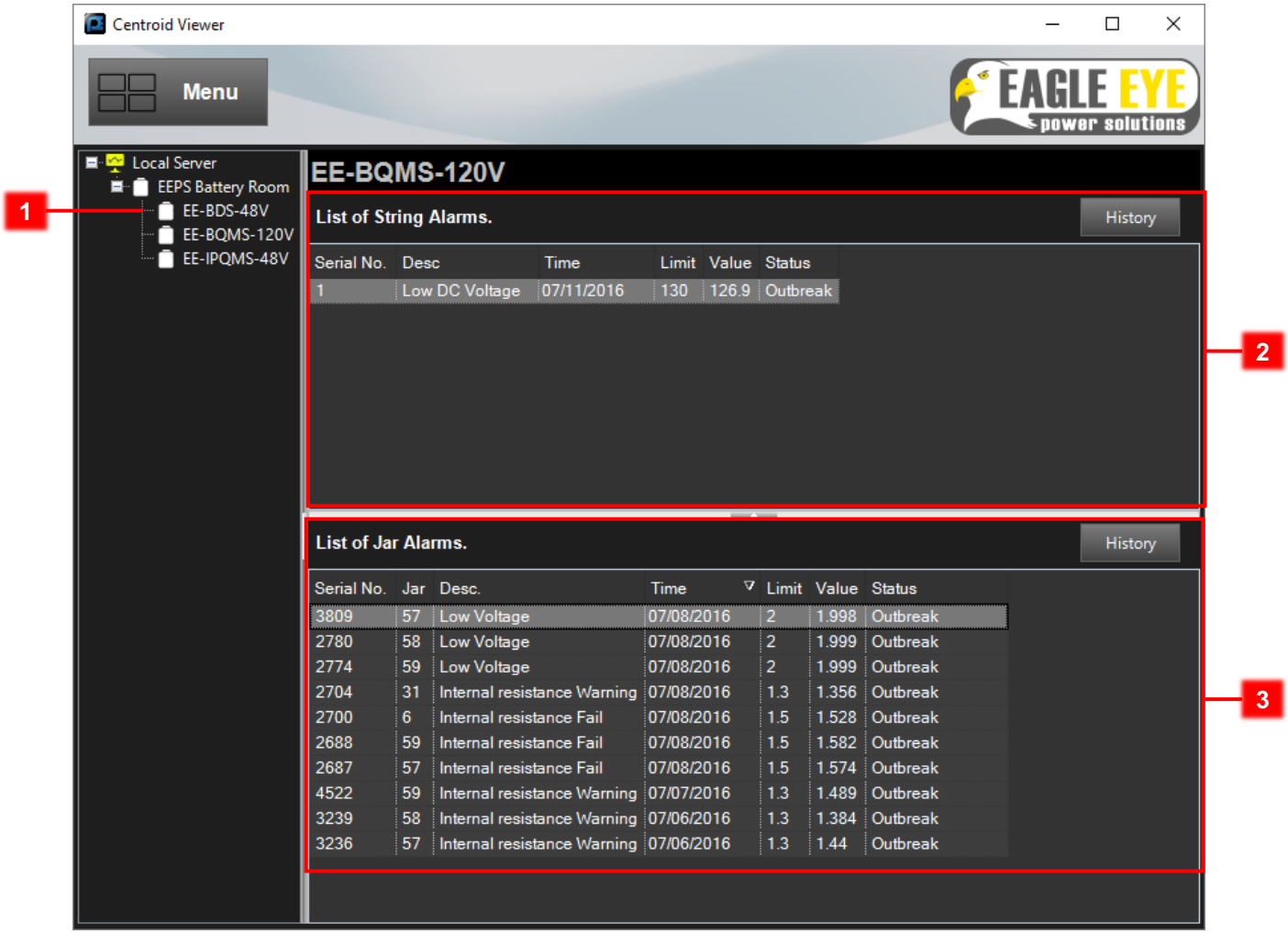
- System Name
- System Communication Status
- System Alarm Status
- No. of Cells/Units (Jars)
- String Alarms
- Voltage Alarms
- Resistance Alarms
- Temperature Alarms



The quantity of alarms per system is shown. If more than 0 alarms are present, the number is displayed in red.

6.2 System Alarm View

Clicking on an individual system under the Local Server will display the System Alarm View window. This area will display all of the active alarms on a battery system.



(1) Select an individual system to display the active alarms on that system.

(2) Active String alarms are listed here. Each alarm has the following information:

- Serial number
- Description of the type of alarm
- Date the alarm occurred
- The set alarm threshold
- The actual measured value
- The status of the alarm (all active alarms will display as “Outbreak”)

(3) Active Cell/Unit alarms are listed here.

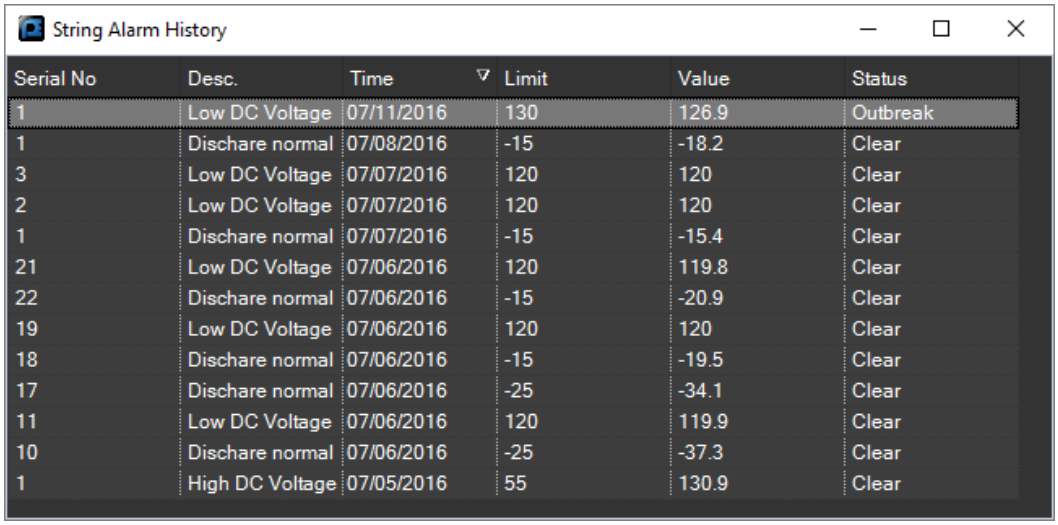
a. The same information from the cell alarms is shown here with addition of the cell/unit (jar) number.

6.2.1 Alarm History

Under the System Alarm View, the complete history of both string and cell/unit alarms can be viewed.

1. String Alarm History

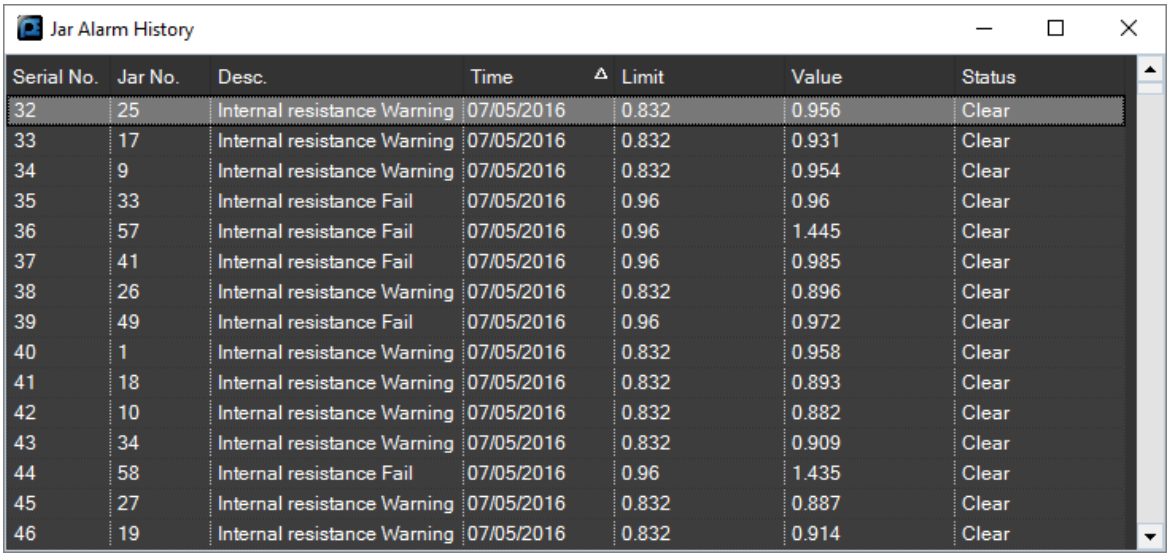
Under String Alarms click the **History** button to display the String Alarm History window.



Serial No	Desc.	Time	Limit	Value	Status
1	Low DC Voltage	07/11/2016	130	126.9	Outbreak
1	Dischare normal	07/08/2016	-15	-18.2	Clear
3	Low DC Voltage	07/07/2016	120	120	Clear
2	Low DC Voltage	07/07/2016	120	120	Clear
1	Dischare normal	07/07/2016	-15	-15.4	Clear
21	Low DC Voltage	07/06/2016	120	119.8	Clear
22	Dischare normal	07/06/2016	-15	-20.9	Clear
19	Low DC Voltage	07/06/2016	120	120	Clear
18	Dischare normal	07/06/2016	-15	-19.5	Clear
17	Dischare normal	07/06/2016	-25	-34.1	Clear
11	Low DC Voltage	07/06/2016	120	119.9	Clear
10	Dischare normal	07/06/2016	-25	-37.3	Clear
1	High DC Voltage	07/05/2016	55	130.9	Clear

2. Cell/Unit Alarm History

Under Cell/Unit (Jar) Alarms click the **History** button to display the Jar Alarm History window.



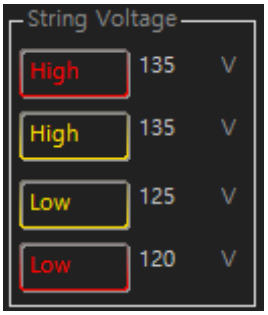
Serial No.	Jar No.	Desc.	Time	Limit	Value	Status
32	25	Internal resistance Warning	07/05/2016	0.832	0.956	Clear
33	17	Internal resistance Warning	07/05/2016	0.832	0.931	Clear
34	9	Internal resistance Warning	07/05/2016	0.832	0.954	Clear
35	33	Internal resistance Fail	07/05/2016	0.96	0.96	Clear
36	57	Internal resistance Fail	07/05/2016	0.96	1.445	Clear
37	41	Internal resistance Fail	07/05/2016	0.96	0.985	Clear
38	26	Internal resistance Warning	07/05/2016	0.832	0.896	Clear
39	49	Internal resistance Fail	07/05/2016	0.96	0.972	Clear
40	1	Internal resistance Warning	07/05/2016	0.832	0.958	Clear
41	18	Internal resistance Warning	07/05/2016	0.832	0.893	Clear
42	10	Internal resistance Warning	07/05/2016	0.832	0.882	Clear
43	34	Internal resistance Warning	07/05/2016	0.832	0.909	Clear
44	58	Internal resistance Fail	07/05/2016	0.96	1.435	Clear
45	27	Internal resistance Warning	07/05/2016	0.832	0.887	Clear
46	19	Internal resistance Warning	07/05/2016	0.832	0.914	Clear

Appendix A – Alarm Values

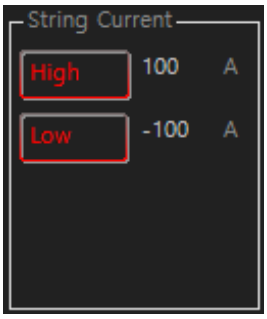
This section explains each alarm point that can be set in Eagle Eye's Centroid Viewer battery management software. The alarm points used are for example purposes only, Eagle Eye does not provide actual alarm point values. To best determine the alarm point values, contact the battery manufacturer or internal personnel that manage battery maintenance.

1. String Alarm Points

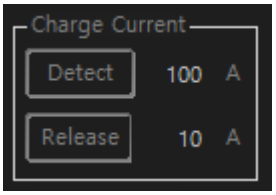
The following alarm points are on the bank/string level of the battery system.



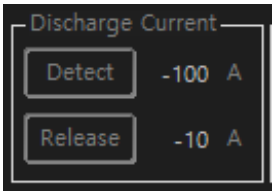
1) **String Voltage:** Alarm point for total voltage of the battery system.
   - **High** (red): Fail point for over voltage, usually due to overcharging.
   - **High** (yellow): Warning point for over voltage, usually due to overcharging.
   - **Low** (yellow): Warning point for under voltage, usually due to undercharging or failed cells.
   - **Low** (red): Fail point for under voltage, usually due to undercharging or failed cells.



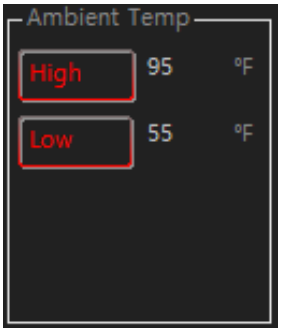
2) **String Current:** Alarm point for charge & discharge current measured from the battery system.
   - **High**: Fail point for over current, usually due to overcharging.
   - **Low**: Fail point for under current, based on charger output, external load/discharge.



3) **Charge Current:** Alarm detection points for charge current in positive amps.
   - **Detect:** System will record charge event when this change current value is detected.
   - **Release:** System will stop recording charge event when the charge current value drops to this value.



4) **Discharge Current:** Alarm detection points for discharge current in negative amps, system will record charge event when set points are detected. Recorded events can be replayed within the software.
   - **Detect:** System will record charge event when this discharge current value is detected.
   - **Release:** System will stop recording charge event when the discharge current value drops to this value.



5) **Ambient Temp:** Alarm detection point for ambient temperature at CCU (BQMS only).
   - **High**: Fail point for over temp., usually due to uncontrolled environment.
   - **Low**: Fail point for under temp., usually due to uncontrolled environment.

2. Cell/Unit Alarm Points

The following alarm points are on the cell/unit level of the battery system.

1) **Cell/Unit Voltage:** Alarm point for each individual cell/unit voltage.
   - **High**: Fail point for over voltage, usually due to overcharging.
   - **Low**: Fail point for under voltage, usually due to undercharging, open circuit, or battery state of health.

2) **Cell/Unit Temperature:** Alarm point for each individual cell/unit temperature. Only applies to units with a temperature sensor installed.
   - **High**: Fail point for high temperature. Usually caused by overcharging, high internal resistance, or uncontrolled environment.
   - **Low**: Fail point for low temperature. Usually due to uncontrolled environment.

3) **Cell/Connection Resistance:** Alarm point for each individual cell/connection resistance measured in milliohms (mΩ).
   - **Reference** [(1)]**:** Reference value for internal cell/connection resistance, all measured values are compared to this value.
   - **Warning:** Warning point for resistance, set as a percent of the reference value. Does not mean the battery is bad but indicates that the battery might be trending toward failure.
   - **Fail:** Fail point for internal resistance, set as a percent of the reference value. Often an indicator that a battery is bad or trending toward failure. Confirm connection resistance, internal resistance (with test meter), & BMS hardware before changing a battery.

(1) Note on Resistance Reference Value: The reference value should be determined individually per battery bank, even on banks with the same make/model of battery. Typically, battery resistance is not defined by the manufacturer. It is important to determine a reference/baseline with the equipment being used to test the battery. In the case of using Eagle Eye battery monitoring, only Eagle Eye BMS-Series battery monitors or IBEX-Series resistance testers should be used to determine the baseline.

The resistance value should be treated as a trending parameter. This means that it is important to establish a baseline early on, then continue to trend against that baseline with the same equipment throughout the life of the battery. It is generally the responsibility of the user to determine the baseline, however several methods are recommended when determining the baseline of a battery:

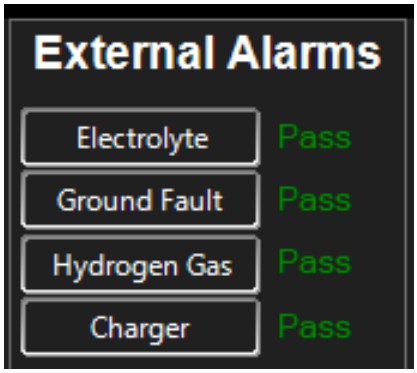
1. Test the internal resistance value of each cell/unit approximately 6 months after the batteries have been installed and use the average as the reference value. This gives the batteries time to settle and will provide a more accurate value than at the time of installation.

2. The above method might not always be possible, especially if installing the BMS to older batteries. In this case, measure the internal resistance of each cell/unit and use the average assuming that the readings from unit to unit do have considerable deviation.

When dealing with internal resistance, it is important to remember that it is not an exact science as compared to voltage and other parameters. There is room for some variation between cells/units within a battery system and the resistance is likely to increase throughout the life of the battery.

3. External Alarms

The following alarm points are based on compatible external hardware for the BQMS only. This includes the ELM-Series electrolyte level monitor, GFM-Series ground fault monitor, and HGD-Series has detectors. Additionally, alarming from compatible chargers can be input to the BQMS. All external alarms can be disabled if not applicable.



1) **Electrolyte:** Pass or Fail alarm for electrolyte level.
2) **Ground Fault:** Pass or Fail alarm for positive or negative ground fault.
3) **Hydrogen Gas:** Pass or Fail alarm for hydrogen gas level.
4) **Charger:** Pass or Fail alarm for charger AC.

Appendix B – Sample Reports

PDF Report

EAGLE EYE power solutions

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Stationary Battery Check Report

Basic Information

Print date : 5/24/2018

String Name	: Bank 1	Date	: 5/24/2018
Location	: Eagle Eye	Manufacturer	: C&D
Model	: 3DJ-155	Manufacture Date	: 6/1/2010
Voltage	: 125	Install Date	: 5/16/2018
Capacity	: 155		

Memo

- Check cell #17 on next PM.
- Check and refill low electrolyte levels

Alarm Status

String Voltage	: Pass	Cell Voltage	: Warning	Electrolyte Level	: Fail
String Current	: Pass	Resistance	: Fail	Ground Fault	: Pass
Ambient Temp	: Pass	Cell Temperature	: Pass	Hydrogen Gas	: N/A
Continuity	: Pass			Charger	: Pass

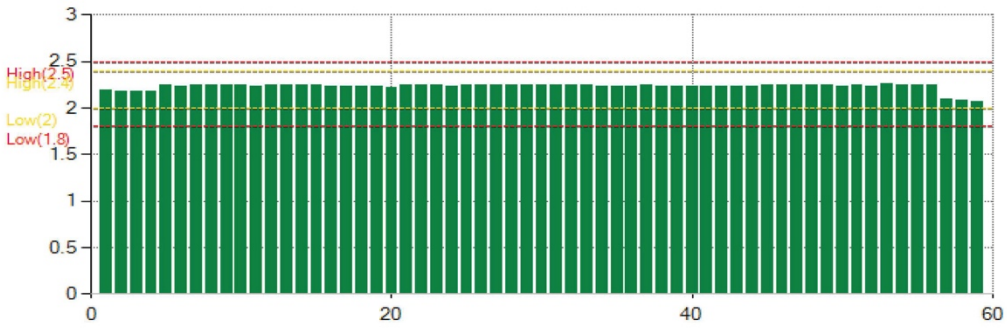
String Data

Voltage	134.4
Current	0.4
Ambient Temp	70

Cell Data

	Voltage	Resistance	Temperature
Average	2.23	1.082	2
Maximum	2.255	1.714	69
Minimum	2.071	0.919	0

Jar/Cell Voltage Graph



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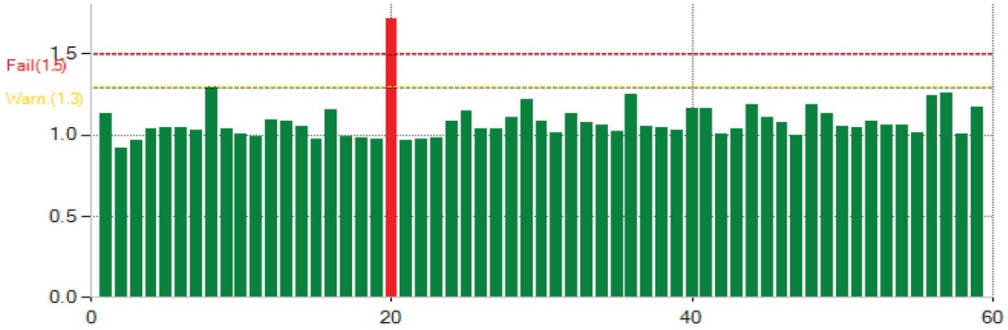
Cell/Connection Resistance Graph



Cell/Jar	Voltage	Resistance	Temperature	Status	Notes
1	2.192	1.127	-	NORMAL	
2	2.179	0.919	-	NORMAL	
3	2.181	0.967	-	NORMAL	
4	2.184	1.038	-	NORMAL	
5	2.252	1.046	-	NORMAL	
6	2.236	1.042	-	NORMAL	
7	2.243	1.026	-	NORMAL	
8	2.244	1.293	-	NORMAL	
9	2.251	1.035	-	NORMAL	
10	2.244	1.001	69	NORMAL	
11	2.24	0.989	-	NORMAL	
12	2.242	1.094	-	NORMAL	
13	2.249	1.087	-	NORMAL	
14	2.242	1.053	-	NORMAL	
15	2.242	0.976	-	NORMAL	
16	2.238	1.154	-	NORMAL	
17	2.239	0.989	-	NORMAL	
18	2.232	0.978	-	NORMAL	
19	2.228	0.975	-	NORMAL	
20	2.216	1.714	69	FAIL	Connection cleaned and re-torqued.
21	2.248	0.962	-	NORMAL	
22	2.246	0.97	-	NORMAL	
23	2.244	0.982	-	NORMAL	
24	2.239	1.082	-	NORMAL	
25	2.251	1.144	-	NORMAL	
26	2.25	1.035	-	NORMAL	
27	2.244	1.035	-	NORMAL	

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Cell/Jar	Voltage	Resistance	Temperature	Status	Notes
29	2.252	1.215	-	NORMAL	
30	2.248	1.082	68	NORMAL	
31	2.247	1.016	-	NORMAL	
32	2.244	1.132	-	NORMAL	
33	2.248	1.072	-	NORMAL	
34	2.234	1.058	-	NORMAL	
35	2.235	1.019	-	NORMAL	
36	2.232	1.249	-	NORMAL	
37	2.243	1.048	-	NORMAL	
38	2.239	1.041	-	NORMAL	
39	2.234	1.025	-	NORMAL	
40	2.232	1.166	68	NORMAL	
41	2.238	1.165	-	NORMAL	
42	2.233	1.006	-	NORMAL	
43	2.237	1.039	-	NORMAL	
44	2.239	1.185	-	NORMAL	
45	2.252	1.104	-	NORMAL	
46	2.253	1.074	-	NORMAL	
47	2.247	0.999	-	NORMAL	
48	2.246	1.188	-	NORMAL	
49	2.248	1.134	-	NORMAL	
50	2.235	1.052	69	NORMAL	
51	2.241	1.047	-	NORMAL	
52	2.236	1.082	-	NORMAL	
53	2.255	1.056	-	NORMAL	
54	2.25	1.061	-	NORMAL	
55	2.247	1.01	-	NORMAL	
56	2.241	1.245	-	NORMAL	
57	2.092	1.254	-	NORMAL	
58	2.08	1.002	-	NORMAL	
59	2.071	1.169	-	NORMAL	

Excel – Single Measurement Date

	A	B	C	D
1	EE-BQMS-120V	7/7/2016 16:50		
2	Cell No	Voltage	Resistance	Temperature
3	1	2.256	0.958	
4	2	2.244	0.862	
5	3	2.245	0.873	
6	4	2.245	0.905	
7	5	2.258	0.885	
8	6	2.244	0.865	
9	7	2.249	0.869	
10	8	2.248	0.925	
11	9	2.251	0.954	
12	10	2.24	0.882	77
13	11	2.246	0.906	
14	12	2.238	0.923	
15	13	2.255	0.984	
16	14	2.24	0.905	
17	15	2.245	0.897	
18	16	2.247	0.961	
19	17	2.251	0.931	
20	18	2.246	0.893	
21	19	2.248	0.914	
22	20	2.252	0.989	77
23	21	2.253	0.908	
24	22	2.251	0.908	
25	23	2.249	0.889	
26	24	2.245	0.927	
27	25	2.245	0.956	
28	26	2.245	0.896	
29	27	2.24	0.887	
30	28	2.239	0.979	

Excel – Overall Measurement

	A	B	C	D	E	
1	[EE-BQMS-120V]					
2	Cell No	07/05/16 12:51:21	07/05/16 13:45:01	07/05/16 13:45:58	07/06/16 01:46:01	07/06
3	1	2.256	2.253	2.253	2.259	
4	2	2.244	2.241	2.242	2.252	
5	3	2.245	2.246	2.244	2.251	
6	4	2.245	2.244	2.245	2.248	
7	5	2.258	2.257	2.257	2.265	
8	6	2.244	2.243	2.243	2.25	
9	7	2.249	2.248	2.246	2.253	
10	8	2.248	2.25	2.248	2.248	
11	9	2.251	2.251	2.251	2.254	
12	10	2.24	2.238	2.239	2.246	
13	11	2.246	2.241	2.242	2.239	
14	12	2.238	2.241	2.239	2.236	
15	13	2.255	2.251	2.251	2.252	
16	14	2.24	2.243	2.24	2.236	
17	15	2.245	2.244	2.246	2.238	
18	16	2.247	2.248	2.246	2.235	
19	17	2.251	2.253	2.256	2.23	
20	18	2.246	2.249	2.249	2.222	
21	19	2.248	2.244	2.246	2.214	
22	20	2.252	2.25	2.25	2.204	
23	21	2.253	2.255	2.254	2.261	
24	22	2.251	2.248	2.248	2.261	
25	23	2.249	2.249	2.249	2.251	
26	24	2.245	2.256	2.255	2.248	
27	25	2.245	2.243	2.246	2.255	
28	26	2.245	2.243	2.243	2.252	
29	27	2.24	2.241	2.243	2.244	
30	28	2.239	2.242	2.243	2.246	