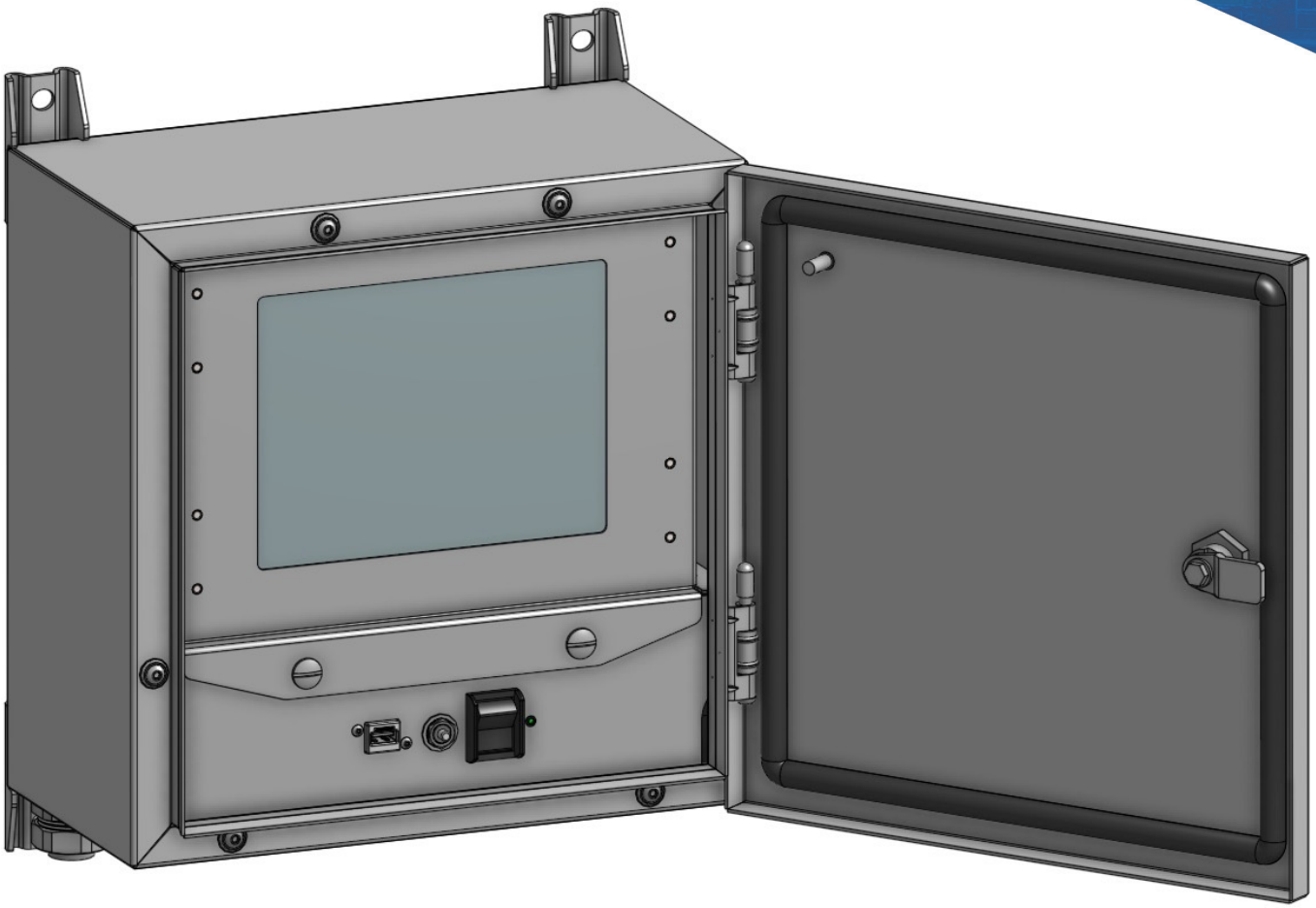
OPERATIONS MANUAL

Compact Brush Condition Monitoring

Document #: EZDP-2123



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1. About Cutsforth

Cutsforth specializes in developing innovative new technologies and services to support the power generation industry. Cutsforth's patented EASYchange® brush holder design, online truing service, InsightCM™ condition monitoring software, and patented shaft grounding and monitoring systems have been installed across the globe in generators of all sizes and in nearly every industry application, including nuclear, natural gas, coal, wind, and hydroelectric.

Cutsforth's knowledge and commitment to excellence drives our innovative solutions for the changing needs of the power industry. Whether it is a quick response to a critical situation or a new way of solving an old problem, our commitment to quality ensures that our customers receive best-in-class products and services—Cutsforth is the Power of Innovation.

Cutsforth, Inc. started back in 1991 as a small company focused primarily on making replacement brush holders for generators and exciters. Today, after 30+ years in business, Cutsforth's experience and innovative designs have brought its best-in-class excitation brush holder and shaft grounding replacements and collector ring services to some of the world's largest power companies.

1.1. Cutsforth Products

- EASYchange® Removable Brush Holders
- EASYchange® Brush Condition Monitoring
- Cutsforth Shaft Grounding Systems
- Rotor Flux Monitoring
- Electro-Magnetic Interference Monitoring
- InsightCM™ Condition Monitoring Software

1.2. Cutsforth Field Services

Cutsforth provides comprehensive product installations for all product offerings as well as on-site training after the installation. We work efficiently during your outage to ensure a smooth upgrade to our innovative solutions such as Product Installations, Online Collector Ring and Commutator Truing, Spiral Groove Restoration, and Consulting and Emergency Services.

1.3. Cutsforth Automation and Control Services

Cutsforth provides comprehensive Automation and Control services which include data historian integration, InsightCM™ integration, DCS logic, engineered drawings and much more. This further complements our turnkey monitoring system installations.

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1.4. Cutsforth Electrical Contracting Services

In addition to our Field Service installation services, Cutsforth offers turn-key services including the electrical contractor scope of work as an additional service in select regions within the US. With this service offering, Cutsforth can greatly simplify the process of monitoring product installation from beginning to end.

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2. Legal Information

2.1. Limited Warranty

This document is provided 'as is' and is subject to being changed, without notice, in future editions. Cutsforth reviews this document carefully for technical accuracy; however, CUTSFORTH MAKES NO EXPRESS OR IMPLIED WARRANTY AS TO THE ACCURACY OF THE INFORMATION WITHIN THIS MANUAL AS IT RELATES TO SPECIFIC INSTALLATION. THE CUSTOMER IS RESPONSIBLE FOR VERIFYING INSTALLATION AND OPERATING CONDITIONS AT EACH INSTALLATION LOCATION AND FOR EACH GENERATOR TYPE. Cutsforth warrants that its hardware products will be free of defects in materials and workmanship that cause the product to fail to substantially conform to the applicable Cutsforth published specifications for one (1) year from the date of invoice.

For a period of ninety (90) days from the date of invoice, Cutsforth warrants that (i) its software products will perform substantially in accordance with the applicable documentation provided with the software, and (ii) the software media will be free from defects in materials and workmanship. If Cutsforth receives notice of a defect or non-conformance during the applicable warranty period, Cutsforth will, in its discretion: (i) repair or replace the affected product, or (ii) refund the fees paid for the affected product. Repaired or replaced hardware will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer. If Cutsforth elects to repair or replace the product, Cutsforth may use new or refurbished parts or products that are equivalent to new in performance and reliability and are at least functionally equivalent to the original part or product. You must obtain an RMA number from Cutsforth before returning any product to Cutsforth. Cutsforth reserves the right to charge a fee for examining and testing Hardware not covered by the Limited Warranty.

This Limited Warranty does not apply if the defect of the product resulted from improper or inadequate maintenance, installation, repair, or calibration performed by a party other than Cutsforth; unauthorized modification; improper environment; use of an improper hardware or software key; improper use or operation outside of the specification for the product; improper voltages; accident, abuse, or neglect; or a hazard such as lightning, flood, or other act of nature.

THE REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND THE CUSTOMER'S SOLE REMEDIES, AND SHALL APPLY EVEN IF SUCH REMEDIES FAIL OF THEIR ESSENTIAL PURPOSE.

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2.3. Patents

Please send patent information requests to patents@cutsforth.com.

2.4. Federal Communications Commission Requirements

2.4.1. Brush Condition Monitoring - Controller

Controller: Utilizes Intel RF module 8265NG

FCC ID: PD98265NG

IC ID: 1000M-8265NG

2.4.2. Brush Health Sensor

Part #: EBHS001

FCC ID: 2ARPJ-EBHS001

IC ID: 24545-EBHS001

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

Caution: The user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

2.5. ISED Canada Regulatory Compliance Statement

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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3. Safety Information

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

3.1. Safety Conventions

Additional information.

Indicates an action or specific equipment area that can result in personal injury or death from an electrical hazard if proper precautions are not taken.

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury or equipment damage.

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

Indicates possible injury from rotating parts.

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

3.2. General Safety Instructions

Only qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury should work with Cutsforth products. Among the many considerations are the following:

- Avoid contact with energized circuits.
- Avoid contact with rotating parts.
- Never install any component that appears not to be functioning in a normal manner.
- Always ensure proper installation of the holder assembly and shaft grounding rope.

Before working on the generator, de-energize, lock out, and tag out all power sources to the generator, shaft, and accessory devices. Electric shock and death may result due to failure to heed this warning.

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High-voltage and rotating parts can cause serious or fatal injury. Installation, operation, and maintenance of this product must be performed only by qualified personnel, in accordance with all applicable safety regulations and guidelines.

Cutsforth recommends that workers do not change Shaft Contact Assembly (SCA) meter ropes while the generator is energized and/or operational. It is recommended that meter ropes be inspected and if necessary, changed during outages when the generator has been secured. Since the SCA is generally installed in relatively close proximity to the collector/brush gear (energized equipment) and or other rotating hazards in this area of the generator, it may pose a risk to workers that may include but are not limited to the following:

- Risk of entanglement or rotational injury attempting to remove/insert a meter rope.
- Risk of electrical shock.
- Risk of creating a short circuit between energized parts and ground.

These conditions and limitations are to be carefully considered at the time of installation. It is recommended that procedures and policies be implemented by the end user so as to realize the full function of the monitoring system but avoid potential hazards. These conditions generally do not apply to the Shaft Grounding Assembly (SGA) equipment installation.

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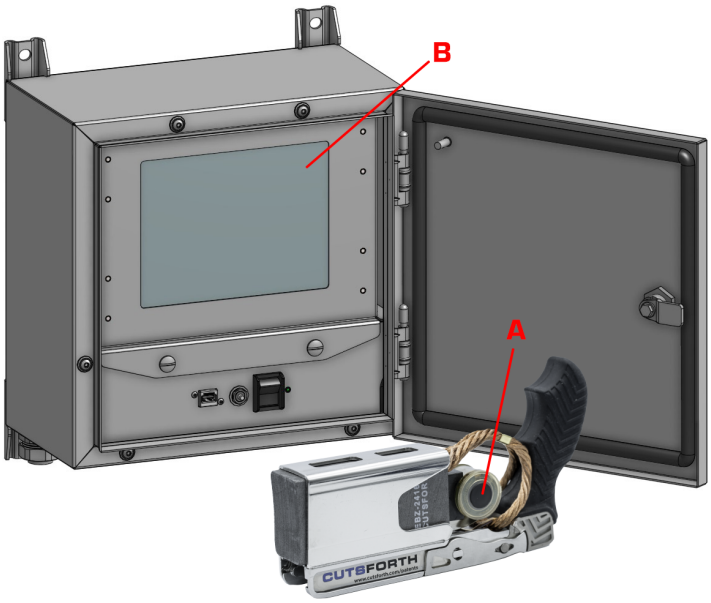
4. EASYchange Brush Condition Monitoring

For nearly 20 years, Cutsforth has installed over 35,000 of the best-in-class brush holders on turbine generators worldwide. Now, with our exclusive EASYchange® Brush Condition Monitoring, Cutsforth offers an even better way to operate your generator's brush-type excitation. Brush performance metrics can now be delivered to the control room system and maintenance can be performed based on brush condition, rather than a calendar.

Automated measurements and brush health analytics allow plant operators to improve the efficiency of technicians' daily and weekly tasks by dispatching them to the collector when maintenance is actually needed.

The Brush Condition Monitoring System is composed of:

- a Cutsforth-developed industrial data logger product known as the Brush Health Sensor (BHS) **(A)** shown installed on the EASYchange® brush holder, and
- a Sensor Controller touch-screen interface **(B)** that compiles the data collected from several BHS units installed with the EASYchange® brush holders.



Cutsforth's patented hardware and technology processes and transmits the following data points over a 2.4 GHz wireless link to local displays as well as via Modbus protocol into a plant's DCS, Historian, or InsightCM™.

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5. Compact Brush Condition Monitoring (cBCM) Technical Specifications

5.1. Controller Technical Specifications

- USB 2.0
- Touchscreen interface
- 2.4 GHz RF interface
- Operating Temperature -20 to 70˚C (-4 to 158˚F)
- Communication to plant control room has three interface options:
  - Modbus TCP over Ethernet
  - Modbus RTU over RS-232
- AC Main Power in:
  - Input voltage: 85 - 264 Vac, 47 - 63Hz
  - Input power: 150W Max
- Enclosure is NEMA 4X rated when closed

5.2. BHS Technical Specifications

- Operating Temperature: 0 to 105˚C (32 to 221˚F)
- Battery powered from Lithium metal primary cells
- LED lights on sensors to provide visual feedback for operators
- Push button activation on each sensor
- 2.4 GHz RF transceiver
- IP6X dustproof

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5.3. Data from Controller

Most Recent Recorded Values (Local)	Configurable Brush Health Alerts (Local)	Historical Data Trending (Output to Historian)
▪ Usable Brush Length (%) ▪ Brush Vibration (Mils Displacement, Pk-to-Pk) ▪ Temperature	▪ Brush Length Warnings ▪ High Vibration ▪ Temperature	▪ Usable Brush Length ▪ Vibration ▪ Ambient Temperature at Brush Health Sensor (BHS) ▪ BHS Battery Life ▪ System Status ▪ System Date/Time ▪ Temperature See Modbus Interface (page 41) for a complete list.

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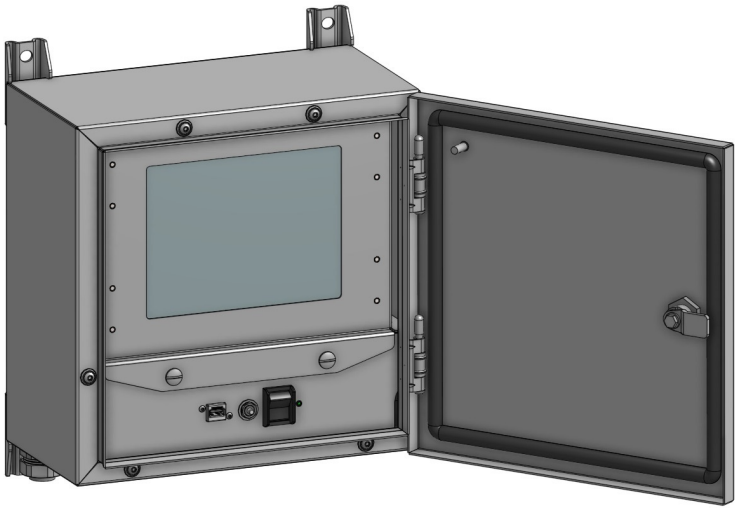
6. Controller Overview

The Controller receives data from the Brush Health Sensors (BHS) at regular intervals. It presents information based on the received data to users locally using up to two industrial displays, and to remote users over Modbus TCP or Modbus RTU.

At the generator, the Controller user interface visually alerts users of short brushes and high vibrations based on plant-defined thresholds. This same critical data and more can also be relayed to the control room, reducing unnecessary physical inspections.

Brush health historical analytics are logged by the system and available on the Brush Detail screen for each brush holder location. Ultimately, the combination of recent and historical brush health analytics will improve operator efficiencies and optimize a plant's staff utilization.



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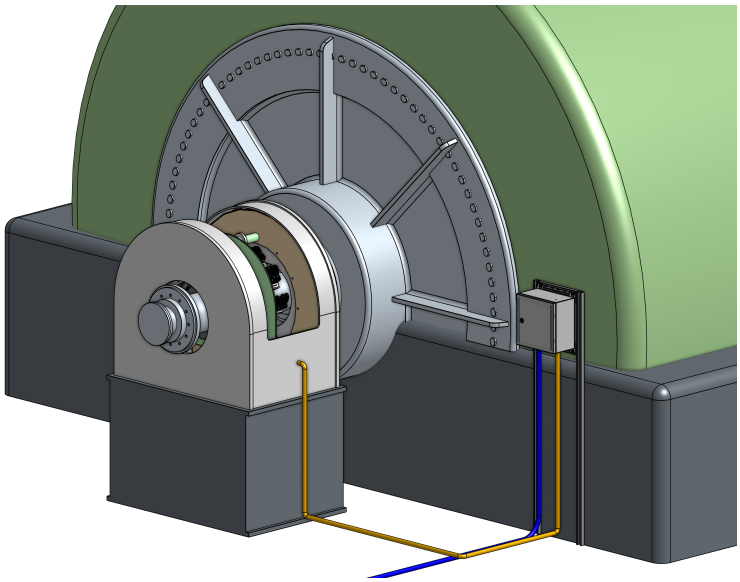
7. Compact Brush Condition Monitoring System Installation

This section covers the installation process of the Brush Condition Monitoring System and the routing of the antenna signal wire. Before beginning the installation, thoroughly review the Compact Brush Condition Monitoring System Installation Planning Guide (EZDP-2122). The major installation steps consist of:

1. Mount the Brush Condition Monitoring System Enclosure (page 15)
2. Run Power to the Brush Conditioning Monitoring System (page 17)
3. Route the Antenna Cabling (page 18)
4. Install Brush Holder Label Clips (page 19)



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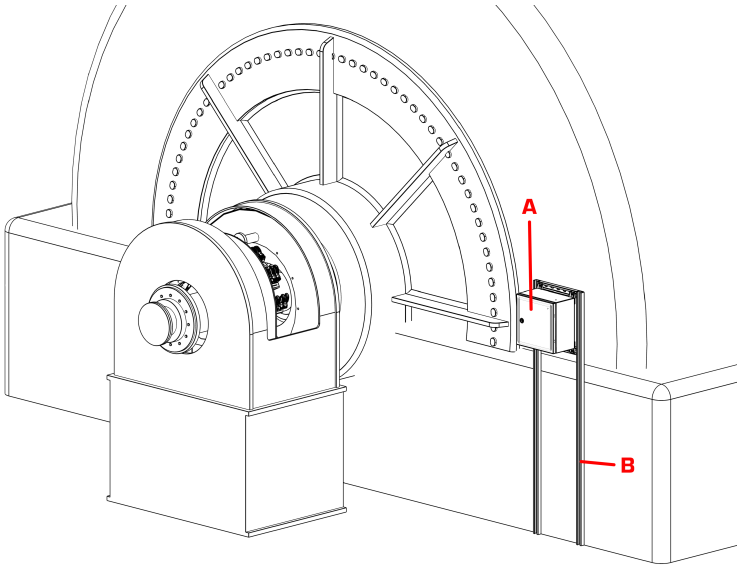
7.1. Mounting the Brush Condition Monitoring System Enclosure

This section covers the placement and mounting requirements for the Brush Condition Monitoring System enclosure.

7.1.1. Brush Condition Monitoring System Mounting Requirements

The Brush Condition Monitoring System **(A)** requires a minimum of two Unistrut rails **(B)** for mounting. Mount the enclosure as close to the exciter brushes as possible, while maintaining operator safety, to optimize the user experience.



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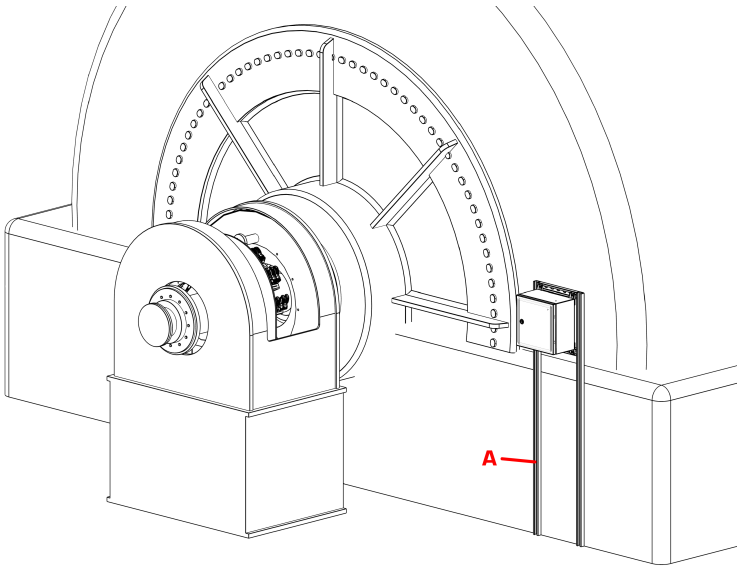
7.2. Running Power to the Brush Conditioning Monitoring System

The Brush Condition Monitoring System has an internal enclosed AC/DC converter which requires power input of 85-264V AC at 47-63 Hz (250W max). The power output of the internal power supply is 24V DC (150W max). The power input cabling should be run to the Brush Condition Monitoring System in ¾ in trade-size, liquid-tight conduit **(A)**.



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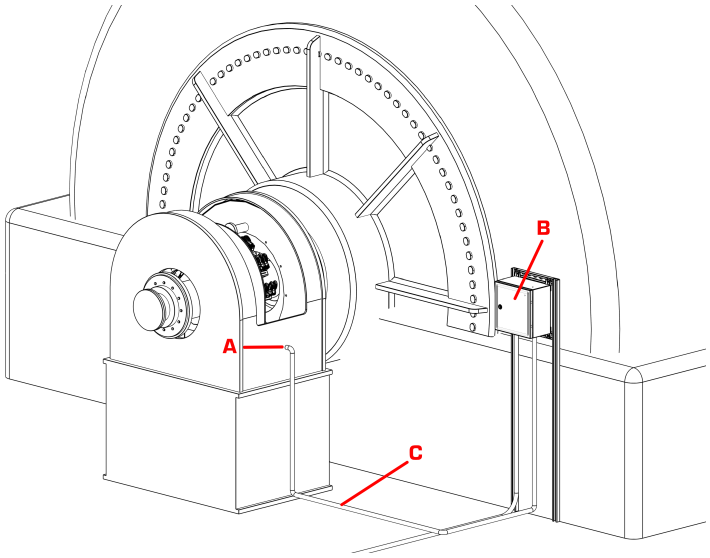
7.3. Route the Antenna Cabling

The Brush Condition Monitoring System requires the use of an antenna to enable ideal communication to and from the Brush Health Sensors. The ideal antenna mounting location may vary between installations. If you are unsure about the placement of the antenna, refer to the Antenna Placement Mode (page 39) section of this manual.

In most cases, the ideal antenna location will be inside the exciter housing. If this is the case:

1. Drill a hole through the lower portion of the exciter housing **(A)**.
2. Mount the antenna to the inside of the exciter housing with its connector extending through the newly drilled hole.
3. On the outside of the exciter housing, route a ½ in trade size liquid-tight conduit from the antenna to the Brush Condition Monitoring System **(B)** to run the antenna cable **(C)**.



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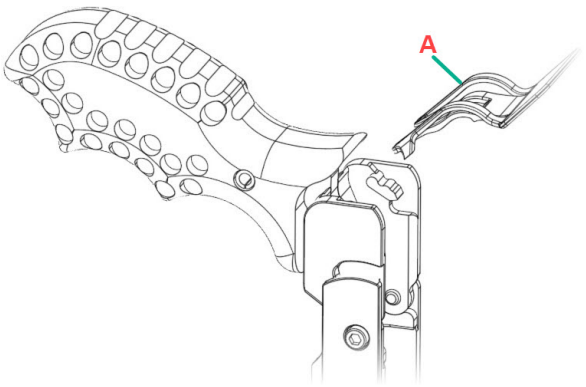
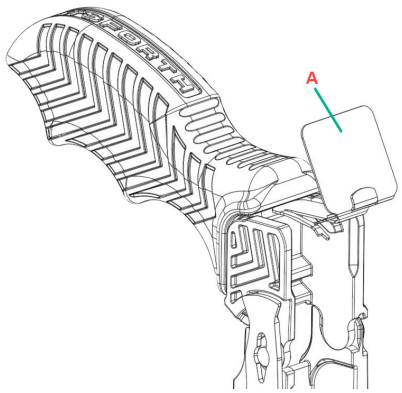
7.4. Install Brush Holder Label Clips

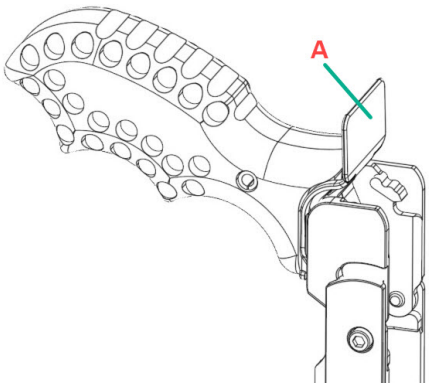
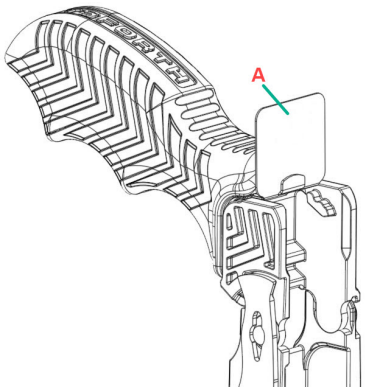
Installing brush holder label clips can assist in easily identifying brush positions as they relate to the Brush Condition Monitoring System display. The label clips often use an alphanumeric nomenclature to identify the row and path of each brush. For example, brush '2B' would refer to the brush located in row '2' and path 'B'.

To install the label clips:

1. Orient the label clips **(A)** as shown.

EZBA-001 Brush Holder	EZBA-018 Brush Holder
	

2. Guide the label clip **(A)** under the brush holder handle until you feel the label clip lock into place. The final resting position is shown here:

EZBA-001 Brush Holder	EZBA-018 Brush Holder
	

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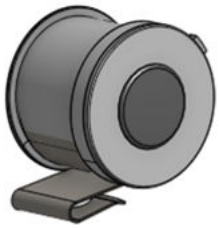
8. Connecting Brush Health Sensors

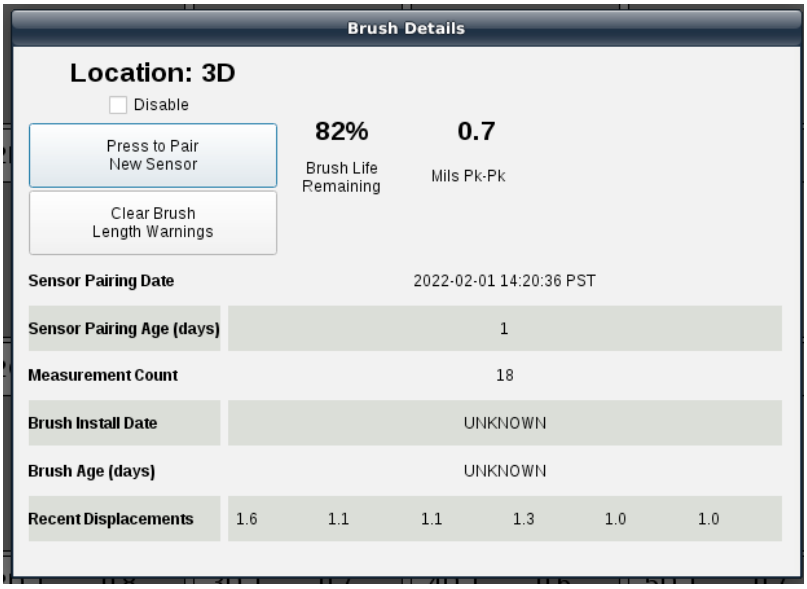
The Brush Health Sensor (BHS) is a data logging device that processes sensor data and reports it back to the Sensor Controller at a regular interval over a 2.4 GHz wireless link. Up to 216 Brush Health Sensors may be connected to a single Brush Condition Monitoring System. The 2.4 GHz antenna is a PCB trace style antenna.



8.1. Pair a New Sensor

To pair a new sensor:

1. From the home screen, select the brush holder location where you want to place the new sensor.
2. When that brush holder location's menu appears, push **Press to Pair New Sensor**,



3. Press the button on the sensor you wish to pair.
4. Wait until a "pairing successful" message is returned.
5. Once pairing has successfully completed, install the brush and sensor in the proper position on the collector ring.

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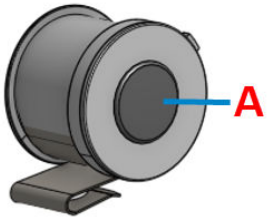
8.2. Frequency of Sensor Updates

Sensors are factory programmed to update data and communicate with the Controller once every hour. However, the operator can manually wake up the sensor at any time by pressing the button **(A)** on the sensor. This forces the Controller to collect data from that sensor at that time. The frequency of the automatic sensor data updates can be adjusted from the Advanced Configuration screen.



8.3. Unpair a Sensor

To unpair a sensor, press and hold the button on the sensor for three seconds until the two LEDs on the sensor flash three times.

This indicates that the sensor has been unpaired. The data for that sensor/location will remain visible on the Controller home page until the next regular data collection interval passes. At that point, the Controller home screen will update accordingly.

8.3.1. Replacing a Sensor

The method used to replace Brush Health Sensors is the same as that of standard brush springs. For instructions on installing/uninstalling brush springs, please see your EASYchange Operations Manual.

8.4. Brush Health Sensor Battery Life

The power source for the device is three Panasonic BR1632A Lithium Metal primary batteries soldered into the device. In the case of a low battery in a Brush Health Sensor, the Brush Condition Monitoring System will display a low battery warning. At that point, the sensor will have roughly 30 days of battery life remaining.

Operational Battery Life: 2+ Years (Will vary depending on user-defined measurement interval)

Storage Battery Life: 10 Years

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9. Using the Controller User Interface

Before powering the Controller breaker to the “ON” position, first inspect the Controller to ensure that there are no foreign materials inside the Controller, no damaged components, or loose wire connections.

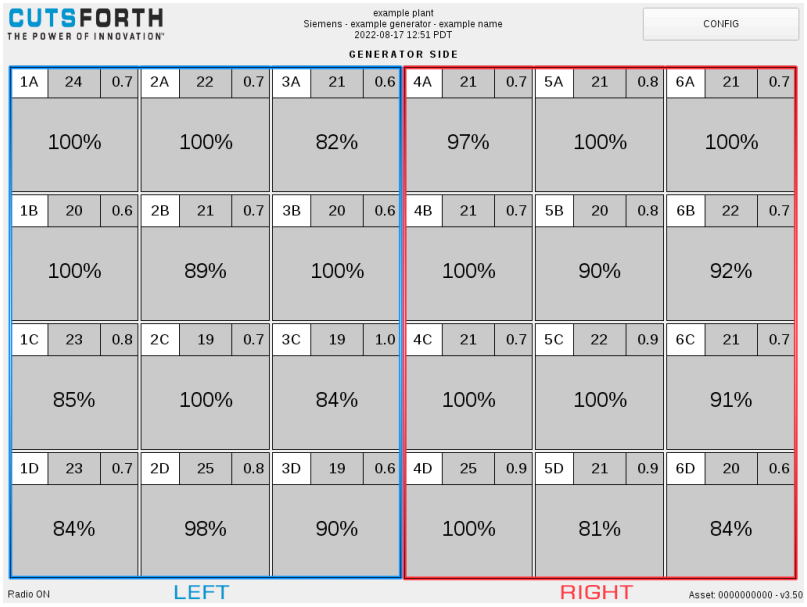
9.1. Power On the Controller

To power on the Controller, locate the switch towards the bottom of the panel and flip it to the "ON" position. The system will automatically boot to the Brush Condition Monitoring software.

9.2. Controller Screen Layout

The diagrams in this section illustrate how the Controller screen layout correlates to the brushes on your generator. The Advanced Configuration screen contains an option to select the generator reference label location. This allows the user to arrange the home screen in a way that makes the most sense for their unit configuration and Controller mounting location.

This is the Controller screen layout. The below example shows the generator reference label location at the top of the screen.



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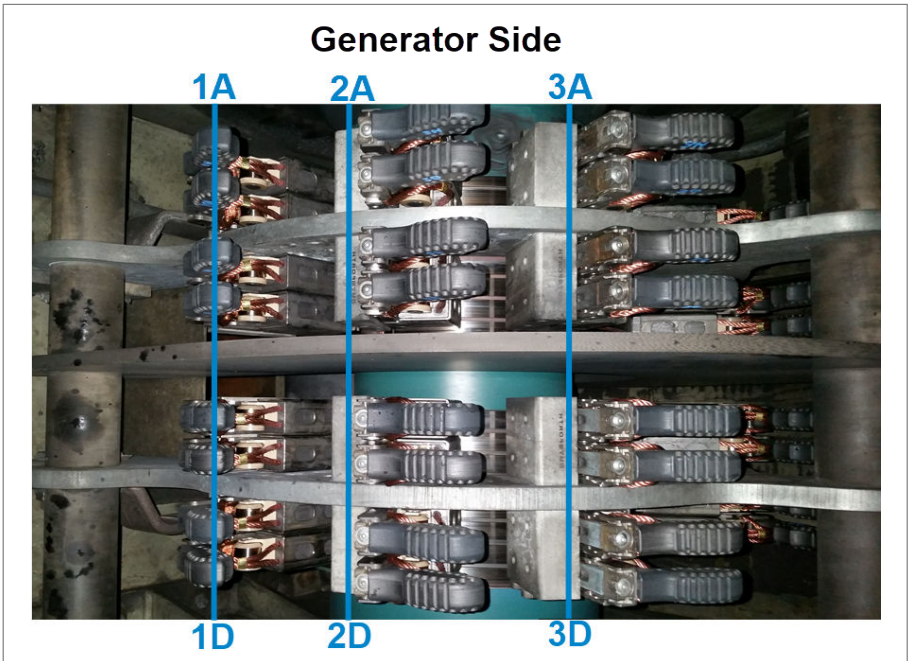
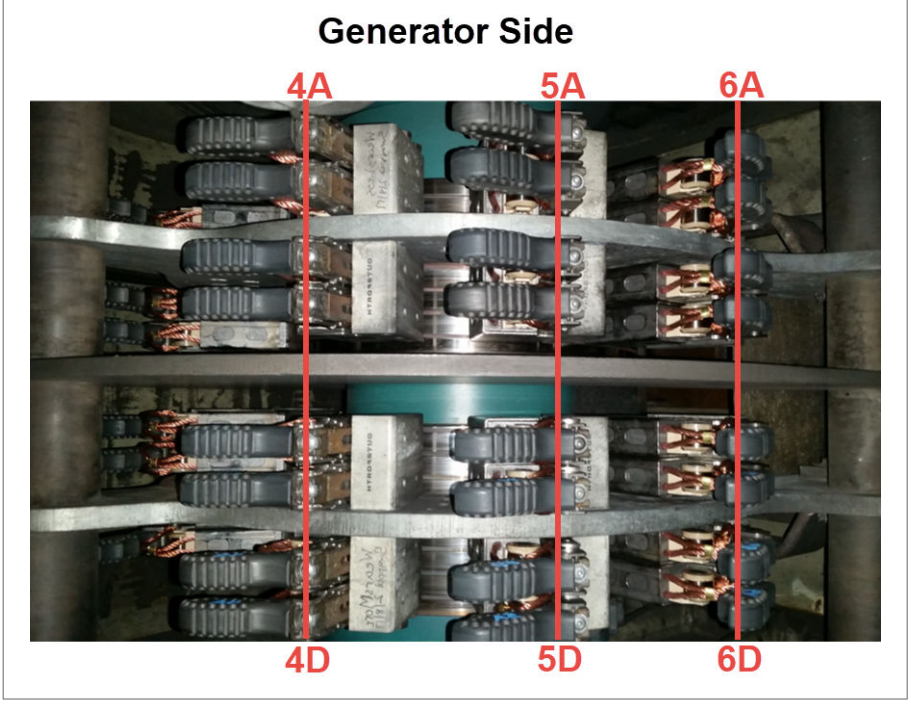
The following diagrams show the brushes with the left (blue) and right (red) rows highlighted.





9.3. Navigating the Controller Screen

Once the Controller has been powered on, the top level view of the user interface screen appears:

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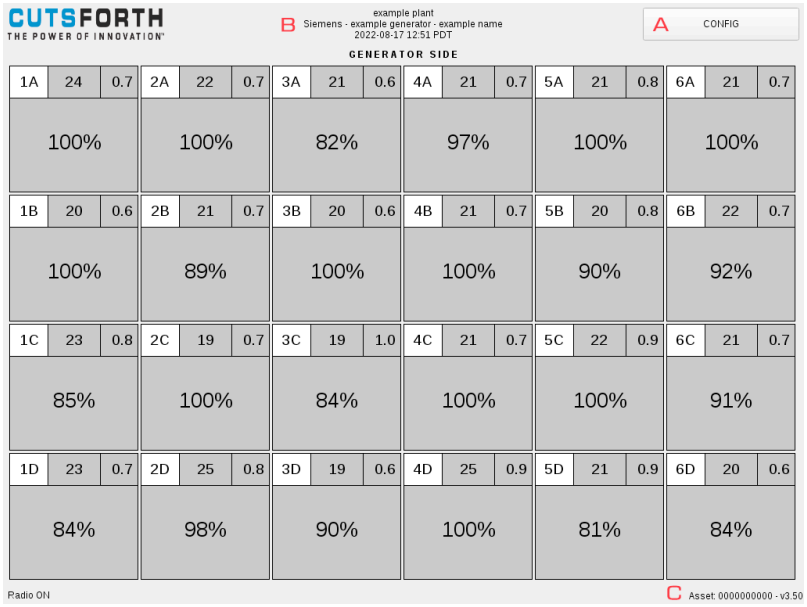
- Press **Config (A)** to open the Primary Configuration window.
- Information in the top center of the user interface screen **(B)** shows plant name, generator manufacturer, name and type, and current time; all of which can be modified within Advanced Configuration.
- Asset tag and Controller Application version are shown in the bottom right corner **(C)**.



9.4. Power Off the Controller

To power off, repeat the power on sequence in reverse order.

Another option for power off is to:

1. Plug in an external USB keyboard.
2. Press **ALT+F4** to close out of the application.
3. Press **ALT+F4** again to bring up the Power menu.
4. Select your desired option (shut down, restart, etc.).
5. If shutting down, wait for the system to fully shut down, then flip the power switch on the panel to the "OFF" position.

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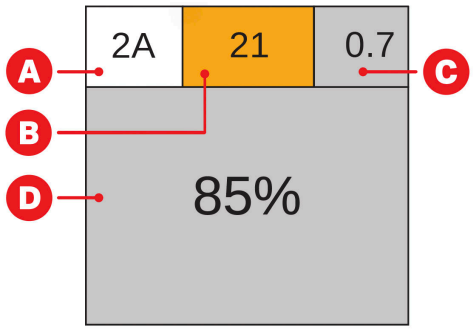
10. Brush Status Indication

The individual brush status indicators provide the following information:



- **A** **Location**
- **B** **Temperature** (Peak Average in Degrees Celsius)
- **C** **Brush Vibration/Displacement** (Mils Peak-to-Peak)
- **D** **Usable Brush Life Remaining**

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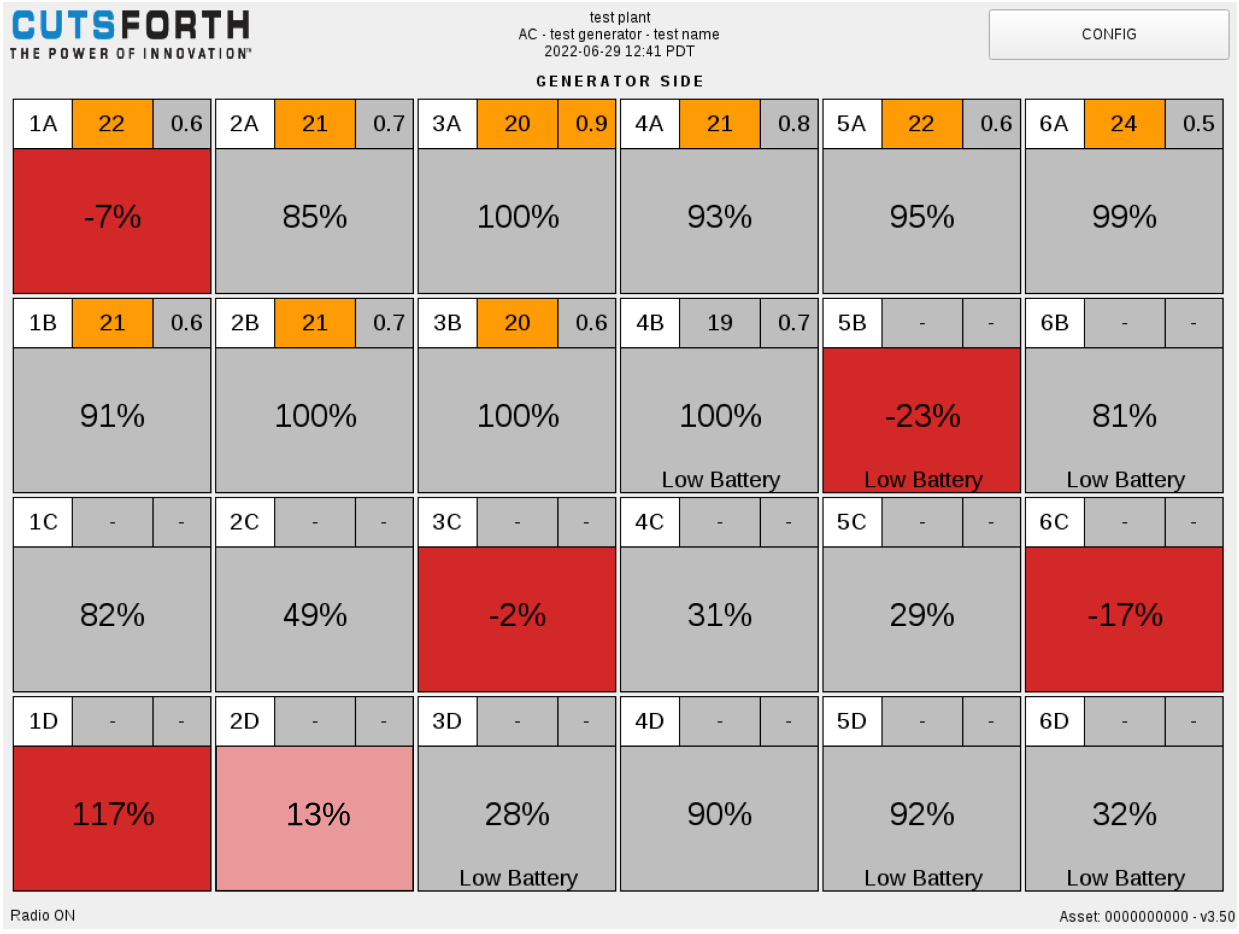
10.1. Color Definitions

The background color of the brush status indicator area changes depending on the remaining brush length:

- Red indicates the remaining brush length is less than or equal to 0%
- Pink indicates that the remaining brush length is less than or equal to the threshold set in the Configuration window (which is 5% by default)

The background color of the displacement area will be orange if the brush displacement value is greater than or equal to the threshold set in Configuration window (which is set to 6 mils of displacement by default).

This figure shows possible background colors of different areas of the brush status indicator:



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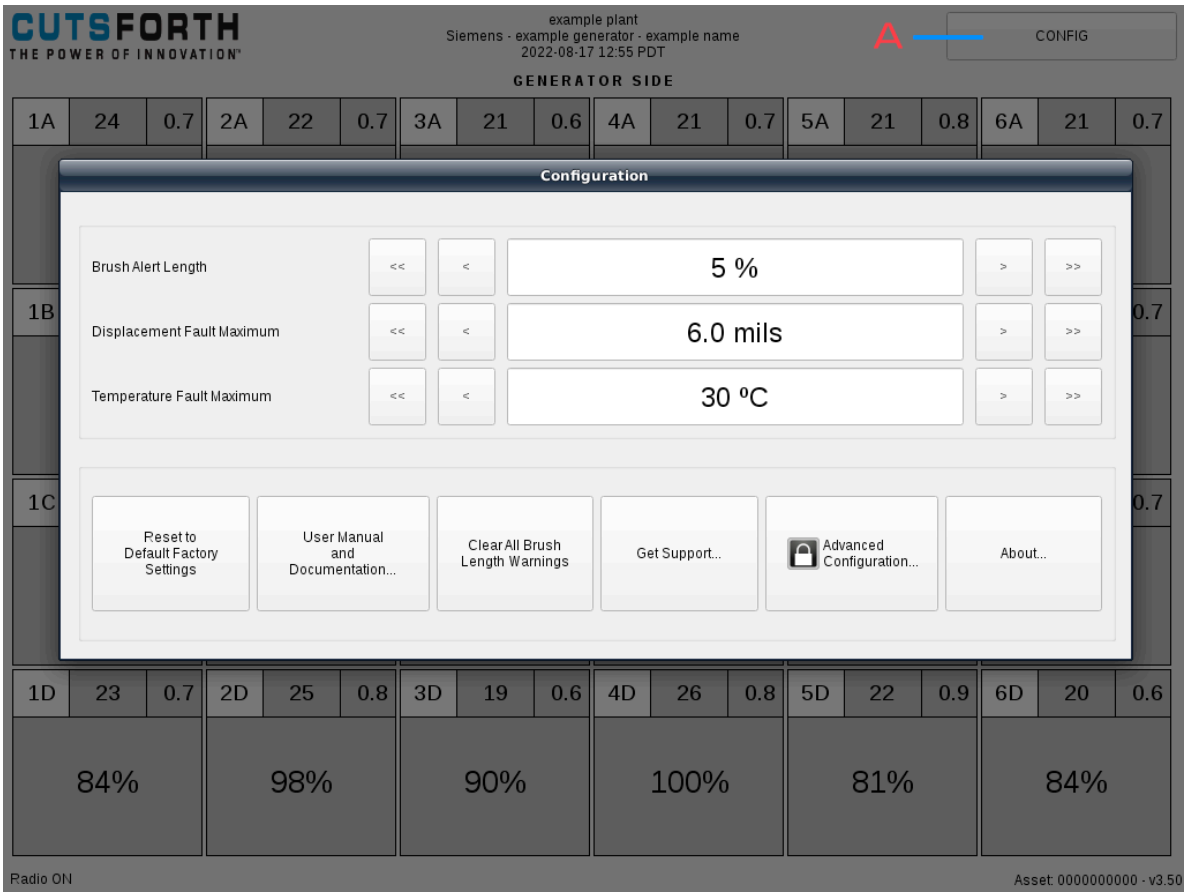
11. Configure the Brush Condition Monitoring System Settings

The following settings can be changed in the Configuration window:

- Remaining brush length warning in percent (at this level location background color will change to pink)
- High threshold for displacement (at this level displacement background color will change to orange)

To configure the Brush Condition Monitoring System settings:

1. Press **Config (A)** to open the Configuration window.



2. Click anywhere on the shaded area outside of the Configuration window to close it. If any settings have changed, a Save changes dialog appears.

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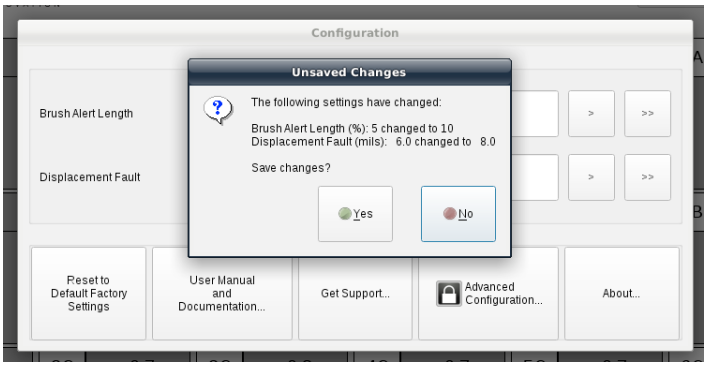

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12. Advanced Configuration Settings

Some of the steps in these sections will require the use of a USB keyboard, USB mouse, and/or a USB storage drive. The use of a USB hub or splitter is often beneficial.

The Advanced Configuration window provides an option for the operator to:

- Export Data and Event Logs (page 32)
- Update the Controller Application (page 33)
- Update the Brush Health Sensor Firmware (page 34)
- Set the Brush Condition Monitoring System Time (page 35)

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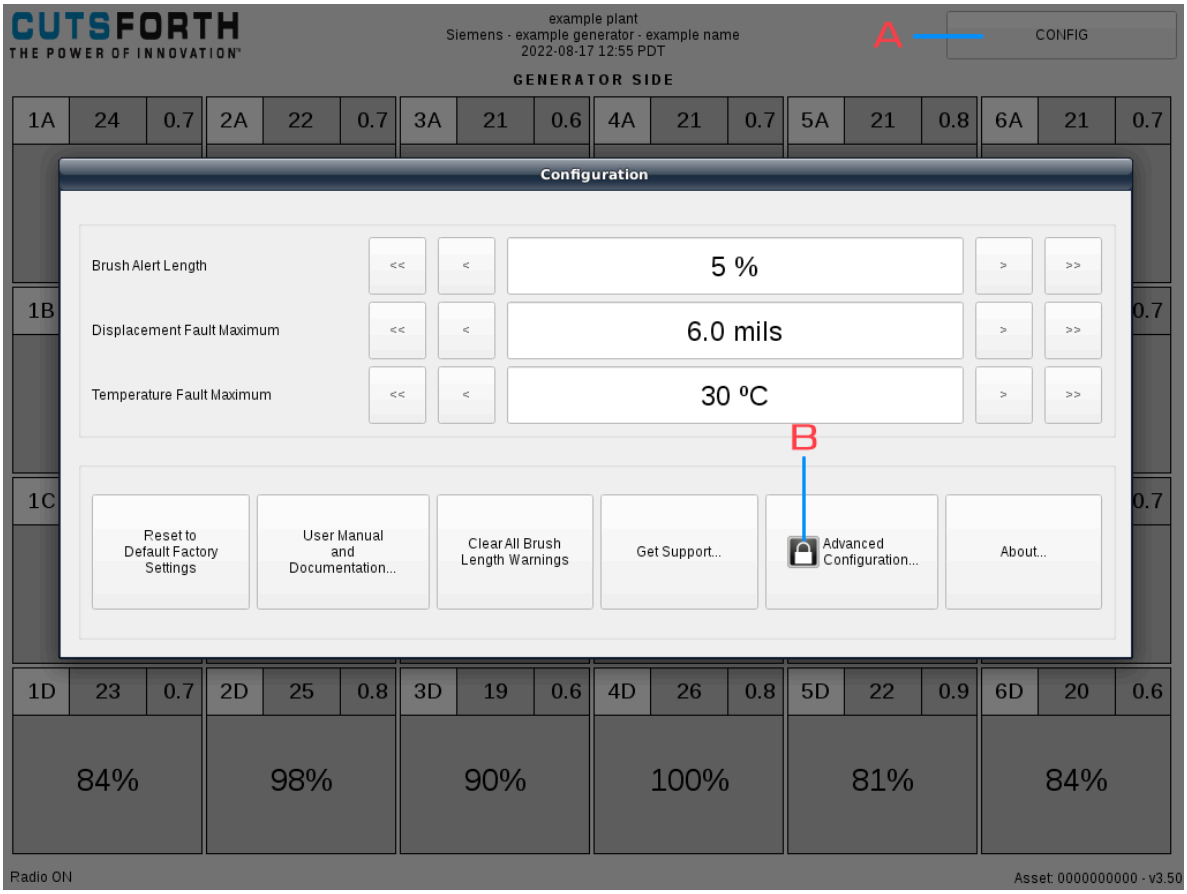
12.1. Access the Advanced Configuration Window

1. Press **Config (A)**.
2. Press **Advanced Configuration (B)**.



3. Enter the administrative password to open the Advanced Configuration window. Contact support@cutsforth.com for access information.

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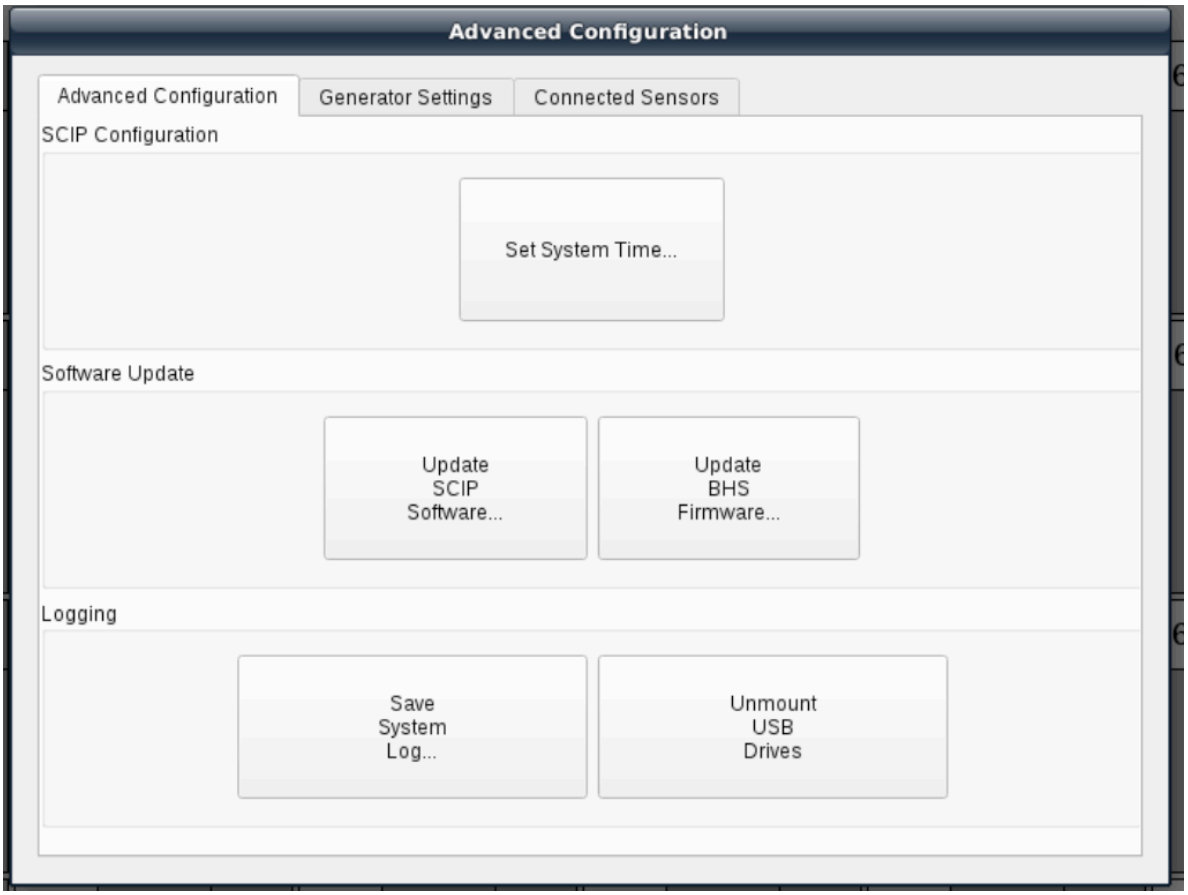

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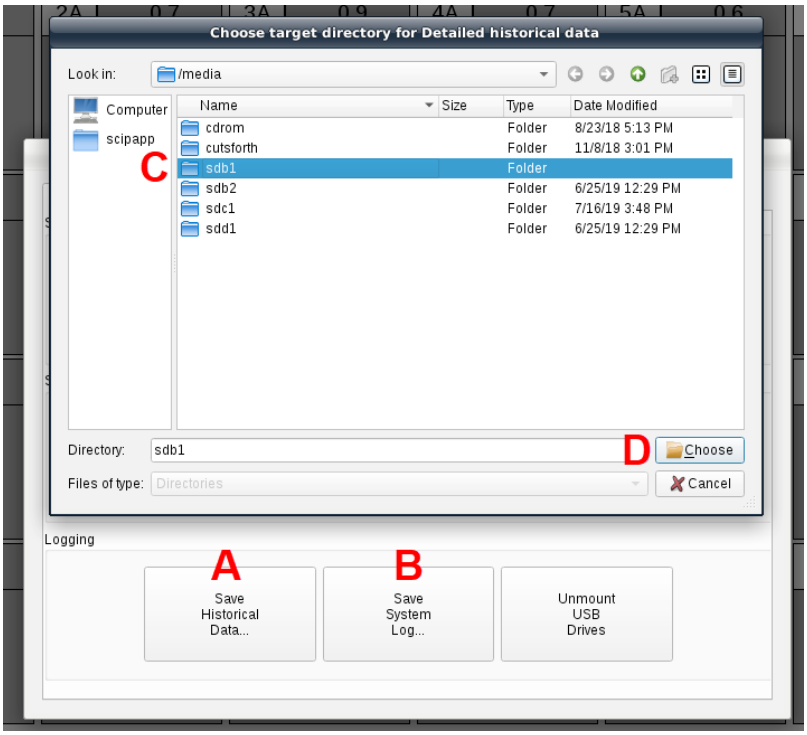
12.2. Export Data and Event Logs

1. Plug in a USB drive.
2. Press one of the following:
   a. Press **Save Historical Data** (A) to export data.
   b. Press **Save System Log** (B) to export a system event log.
3. Select the sdb1 folder (C).
4. Press **Choose** (D). This exports sensor samples to a .csv file on the USB drive.



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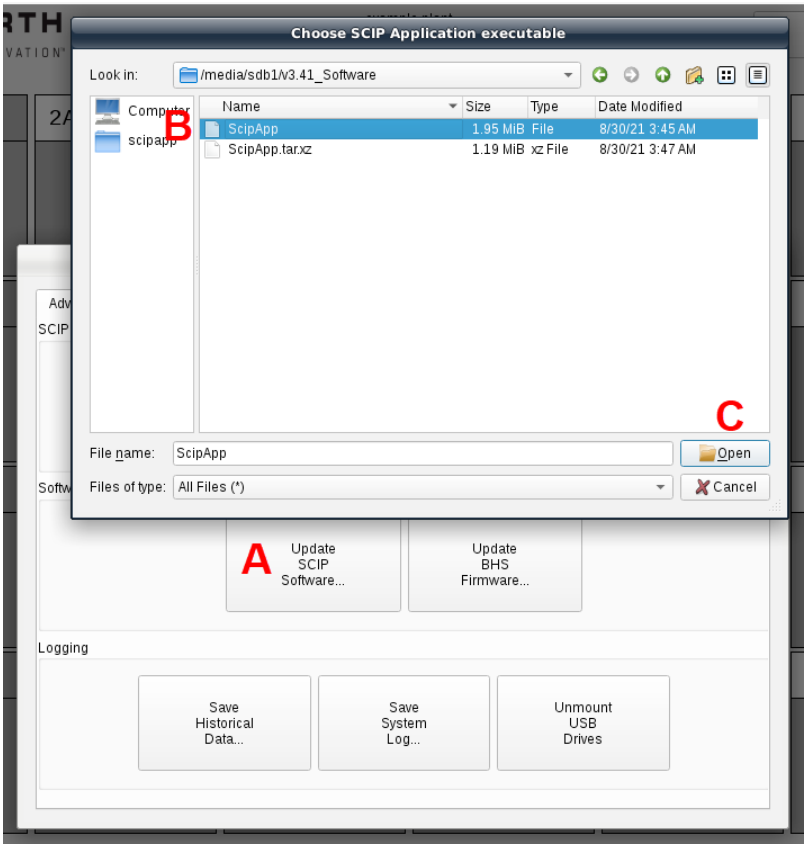
12.3. Update the Controller Application

To update the Controller Application utilizing an external USB device loaded with new software:

1. Plug in a USB drive with the new Controller Application.
2. Press **Update SCIP Software (A)**.
3. Open the sdb1 folder and navigate to ScipApp binary.
4. Select **ScipApp binary (B)** and press **Open (C)**.
5. The Controller Application will restart.



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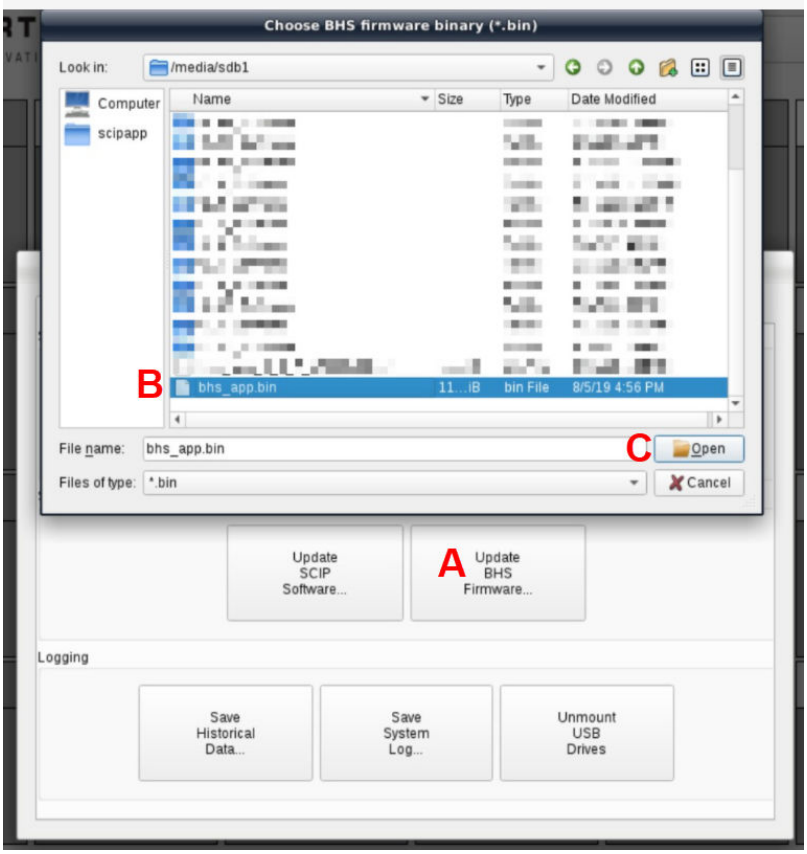
12.4. Update the Brush Health Sensor Firmware

To update the sensor firmware:

1. Plug in a USB drive with the new firmware.
2. Press **Update BHS Firmware (A)**.
3. Open the sdb1 folder and navigate to the latest firmware binary.
4. Select the firmware binary **(B)** and press **(C)**.
5. The application imports the new firmware and stages it for update.



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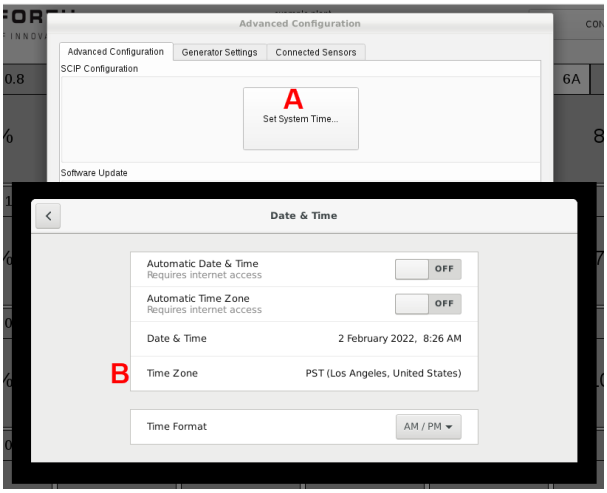
12.5. Set the Brush Condition Monitoring System Time

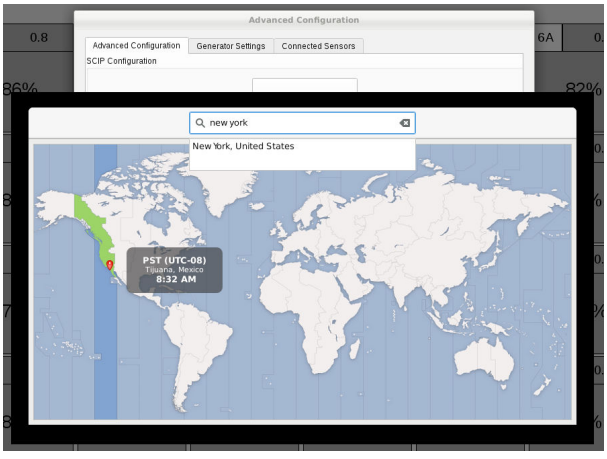
To set the Brush Condition Monitoring System time:

1. Press **Set System Time** (A).
2. Press **Time Zone** (B).

> **Automatic Time Zone** must be turned off in order to manually set the time zone.



3. Select a time zone by pressing on the map or by entering a city name in the search bar and selecting from the drop-down list.



4. Press **Alt + F4** to close the Time Zone Selection window.
5. Press **Date and Time** (C).

> **Automatic Date and Time** must be turned off in order to manually set the date and time.

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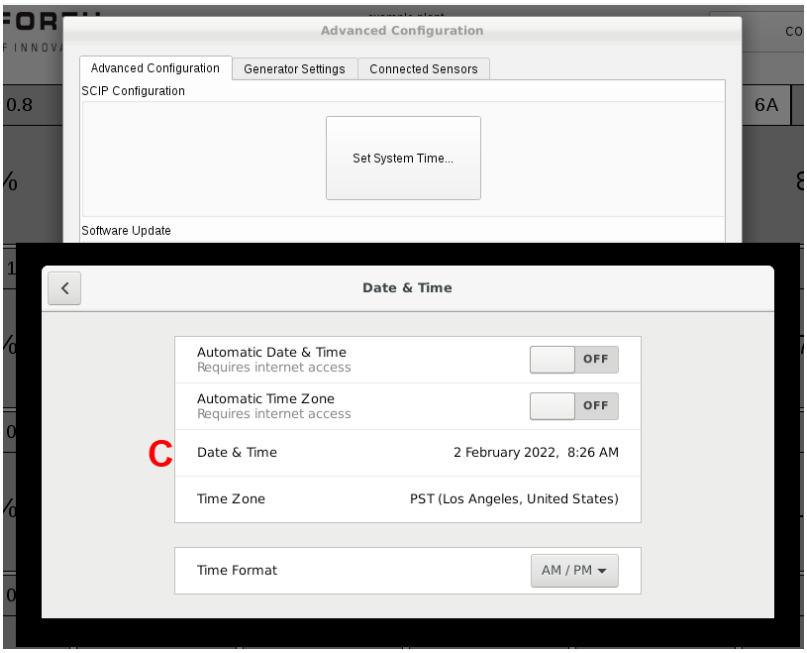
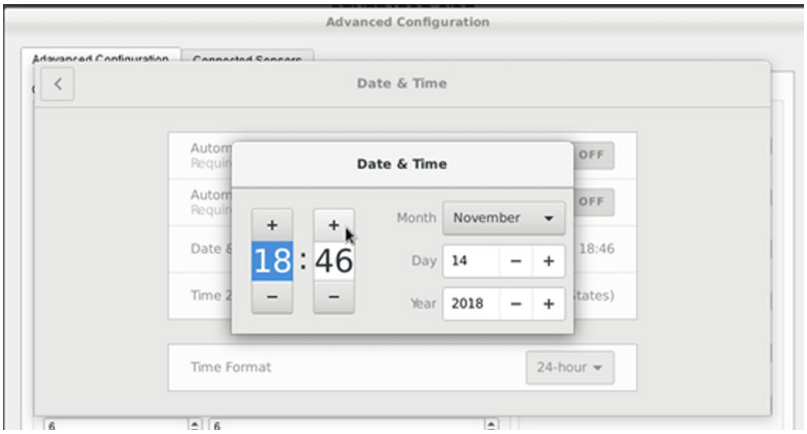


6. Set the date and time and press the **Esc** key to close the date and time editor.



7. Press **Alt + F4** to close the Date and Time window and return to the Advanced Configuration Window.
8. Click anywhere on the shaded area outside of the Advanced Configuration window to close it.

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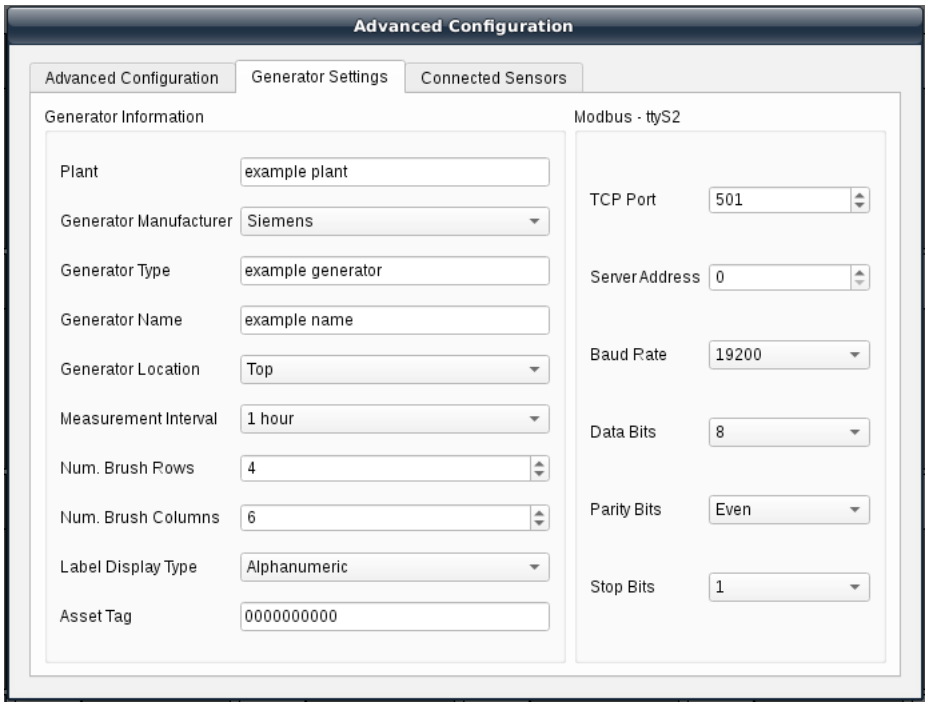
13. Generator Settings

To access the Generator Settings page, enter the Advanced Configuration screen and navigate to the Generator Settings tab. The following settings can be changed from this page:

- Plant name
- Generator manufacturer, type, and name
- Location of on-screen generator reference label
- Measurement interval (how often sensors will report data)
- Number of brushes (number of rows and number of columns)
- Brush numbering label display type (alphanumeric vs. numeric)
- Modbus TCP port
- Modbus RTU serial interface settings

Some of the steps in these sections will require the use of a USB keyboard, USB mouse, and/or a USB storage drive. The use of a USB hub or splitter is often beneficial.



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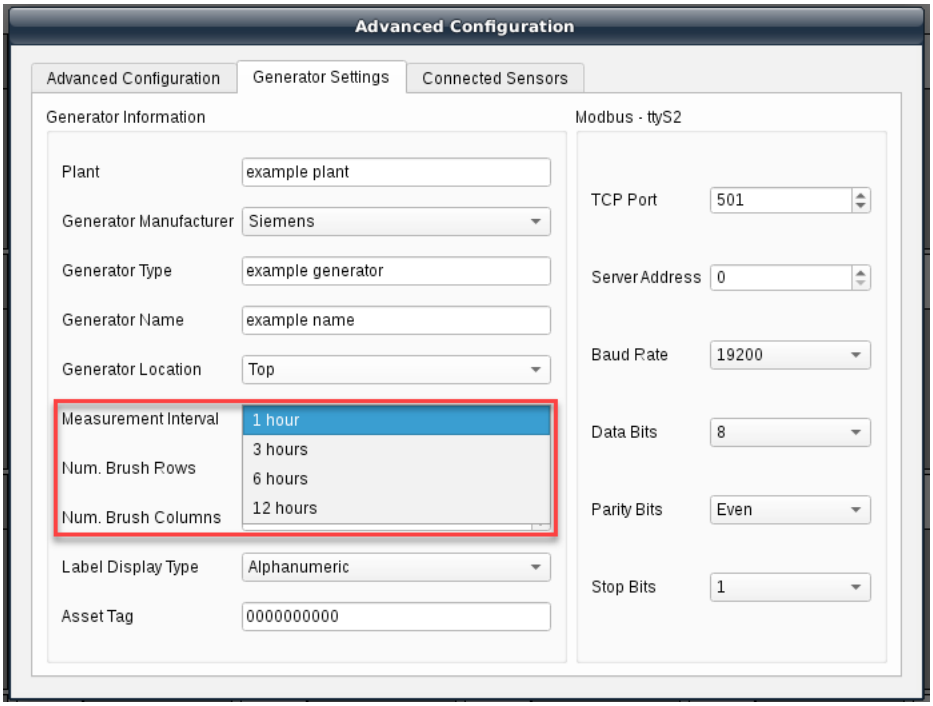
13.1. Measurement Interval

The Brush Condition Monitoring (cBCM) System collects data sets from the Brush Health Sensors (BHS) during regular measurement intervals. This measurement interval is a user-configurable setting from the Generator Settings page with options of 1, 3, 6, or 12 hours. Please note that battery life of the BHS is directly impacted with the frequency of data collection.



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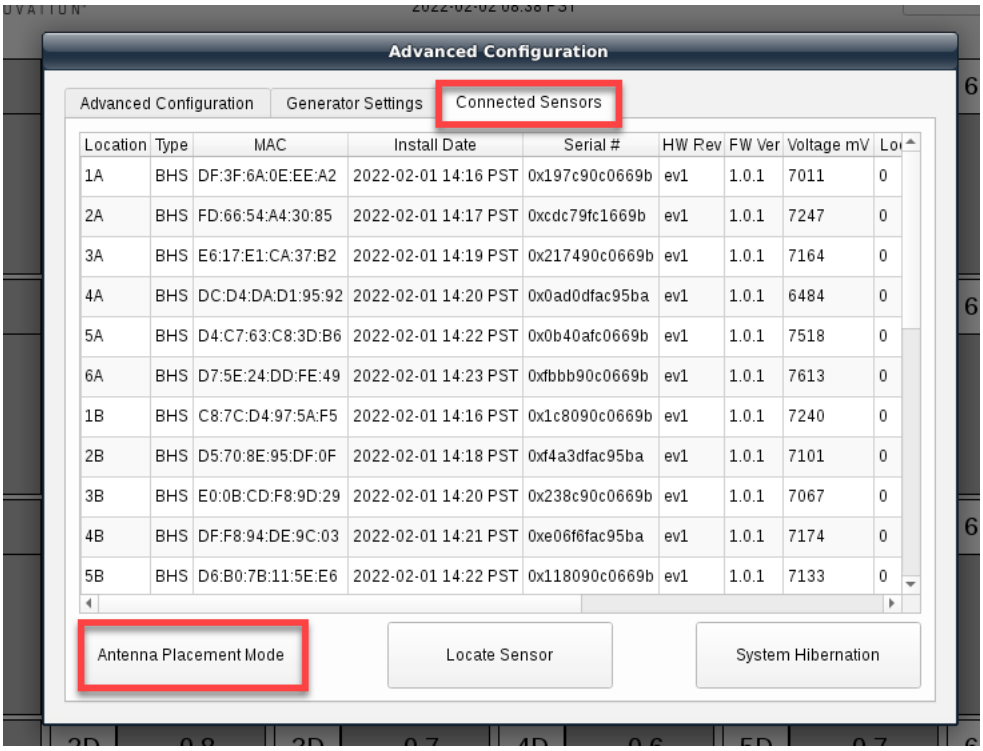
14. Antenna Placement Mode

> ⚠ Sensor batteries will drain at a faster than normal rate during antenna placement mode.

To enter antenna placement mode, navigate to the Connected Sensors tab in the Advanced Configuration window and press **Antenna Placement Mode**.



In antenna placement mode, brush status indicators show radio signal strength instead of sensor data. Background color changes depending on the strength of the radio signal:

- **Red:** Weak or unknown signal strength
- **Pink:** Moderate signal strength
- **Gray:** Strong signal strength

Two numbers are shown for every location:

- The left number is the signal strength on the Primary Controller side (quality of the radio link from sensor to the Primary Controller).
- The right number is the signal strength on the sensor side (quality of the radio link from Primary Controller to sensor).

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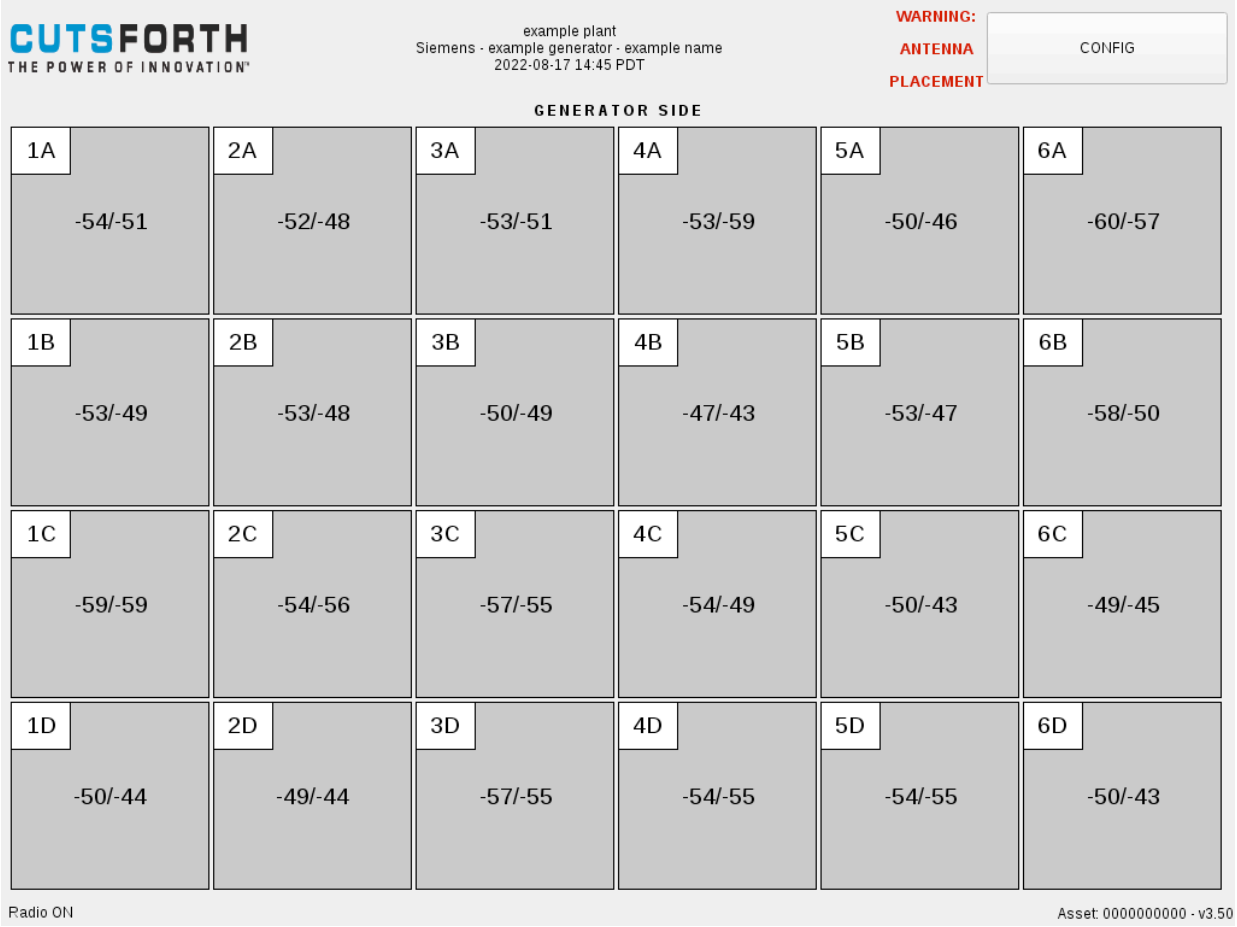
Please allow around one hour for all sensors to report signal strength. To exit antenna placement mode, navigate back to the Connected Sensors tab in the Advanced Configuration window, and press **Antenna Placement Mode**. To prevent excessive battery drainage, the cBCM system will automatically quit antenna placement mode after two hours.



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15. Modbus Interface

Refer to this table when programming the Modbus output on your Brush Condition Monitoring System:

Brush	Name	Value Type	Value Unit	Register Type	Address (Base 1)	Physical Address (Base 0)	Supported Functions
0-229	Sensor Low Batt	boolean	flag	Discrete Input	10000 - 10229	0x000 - 0x0E5	0x02 Read Discrete Input
0-229	Sensor Malfunction	boolean	flag	Discrete Input	10230 - 10459	0x0E6 - 0x1CB	0x02 Read Discrete Input
0-229	Replace Brush Now (Critical)	boolean	flag	Discrete Input	10460 - 10659	0x1CC - 0x2B1	0x02 Read Discrete Input
0-229	Replace Brush Soon (Alert)	boolean	flag	Discrete Input	10690 - 10919	0x2B2 - 0x397	0x02 Read Discrete Input
0-229	High Vibration Warning	boolean	flag	Discrete Input	10920 - 11149	0x398 - 0x47D	0x02 Read Discrete Input
0-229	Sensor Sample Old	boolean	flag	Discrete Input	11150 - 11379	0x47E - 0x563	0x02 Read Discrete Input
0-229	Temperature Critical	boolean	flag	Discrete Input	11380 - 11609	0x564 - 0x649	0x02 Read Discrete Input
0-229	Length Error	boolean	flag	Discrete Input	11610-11839	0x64A - 0x72F	0x02 Read Discrete Input
0-229	Brush Length	short	% remaining	Input Register	30000 - 30229	0x000 - 0x0E5	0x04 Read Input Register
0-229	Pk-to-Pk Displacement	word	0.001 mils	Input Register	30230 - 30459	0x0E6 - 0x1CB	0x04 Read Input Register
0-229	Temperature	short	deg C	Input Register	30460 - 30689	0x1CC - 0x2B1	0x04 Read Input Register
N/A	System Status	word	bitfield: b0 : Hibernation Mode (1 - Enabled, 0 - Disabled) b1-15: RFU	Input Register	330920	0x398	0x04 Read Input Register
N/A	System Time	word	POSIX time (LSB - MSB)	Input Register	30921 - 30922	0x399 - 0x39A	0x04 Read Input Register

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Brush	Name	Value Type	Value Unit	Register Type	Address (Base 1)	Physical Address (Base 0)	Supported Functions
N/A	Short Brush Count	word	number of brushes that must be replaced immediately	Input Register	30923	0x39B	0x04 Read Input Register
N/A	Near-Short Brush Count	word	number of brushes that will need replacement soon	Input Register	30924	0x39C	0x04 Read Input Register
N/A	High Vibration Brush Count	word	number of sensors reporting high vibration	Input Register	30925	0x39D	0x04 Read Input Register
N/A	Sensor Error Count	word	number of sensors reporting errors	Input Register	30926	0x39E	0x04 Read Input Register
N/A	Low Battery Total	word	number of sensors reporting low battery	Input Register	30927	0x39F	0x04 Read Input Register
0-229	Battery Voltage	word	mVolts	Input Register	30928 - 31157	0x3A0 - 0x485	0x04 Read Input Register
0-229	RSSI Value	word	decibel milliwatts (dBm)	Input Register	31158 - 31387	0x486 - 0x56B	0x04 Read Input Register
0-229	BHS MAC address (lo byte, little-endian)	word	n/a	Input Register	31388 - 31617	0x56C - 0x651	0x04 Read Input Register
0-229	BHS MAC address (mid byte, little endian)	word	n/a	Input Register	31618 - 31847	0x652 - 0x737	0x04 Read Input Register
0-229	BHS MAC address (hi byte, little-endian)	word	n/a	Input Register	31848 - 32077	0x738 - 0x81D	0x04 Read Input Register
0-229	SensorError Register with Sensor Error Flags	word	n/a	Input Register	32078 - 32307	0x81E - 0x903	0x04 Read Input Register
N/A	Old Samples Count	word	number of sensors reporting old samples	Input Register	32308	0x904	0x04 Read Input Register

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Brush	Name	Value Type	Value Unit	Register Type	Address (Base 1)	Physical Address (Base 0)	Supported Functions
N/A	Temperature Critical Count	word	number of sensors reporting critical temperature	Input Register	32309	0x905	0x04 Read Input Register
N/A	Length Error Count	word	Number of sensors reporting brush length errors	Input Register	32310	0x906	0x04 Read Input Register

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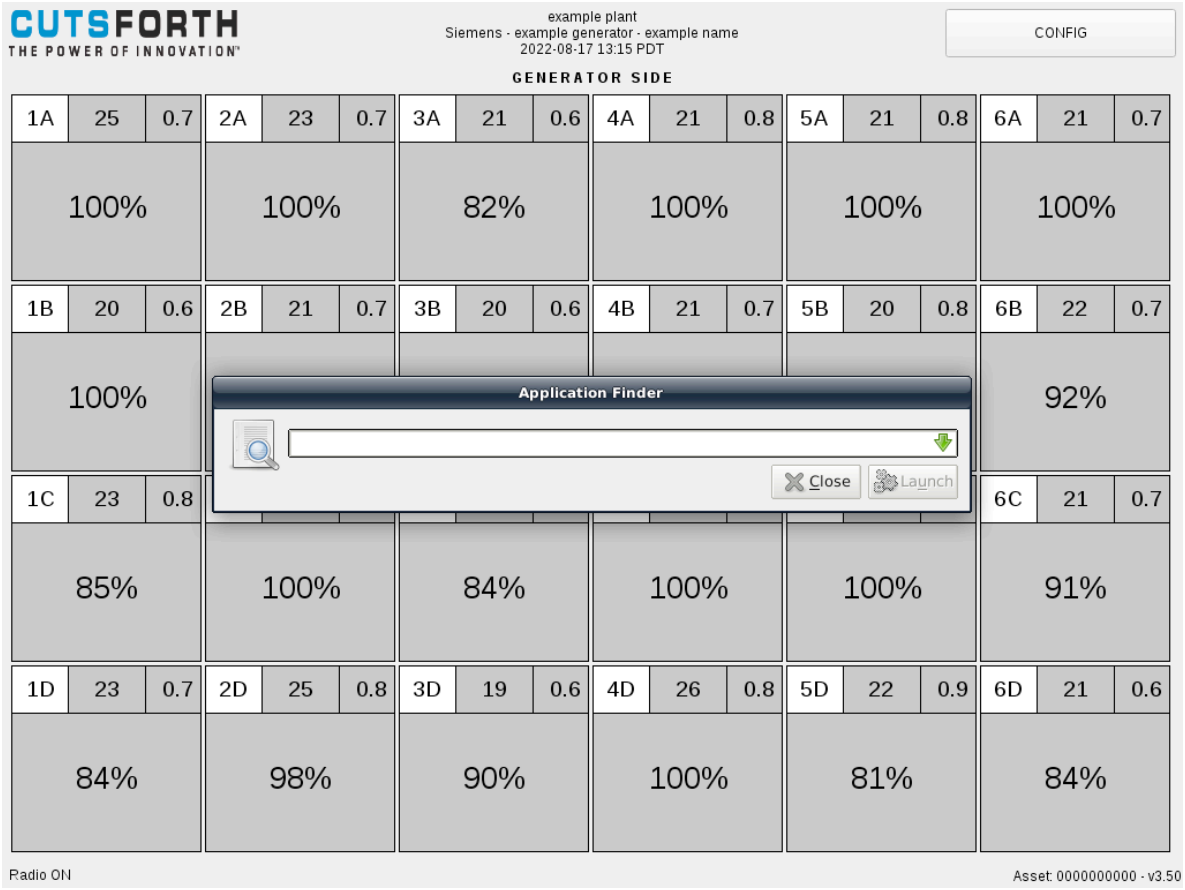
15.1. Entering a Static IP Address

1. Plug the USB keyboard into the BCM system.
2. Press **Alt+F2** to pull up the Application Finder.



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3. Click on the green arrow that is pointed down to display the window of options.

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4. Scroll down, select **Network Connections**, and click **Launch**.

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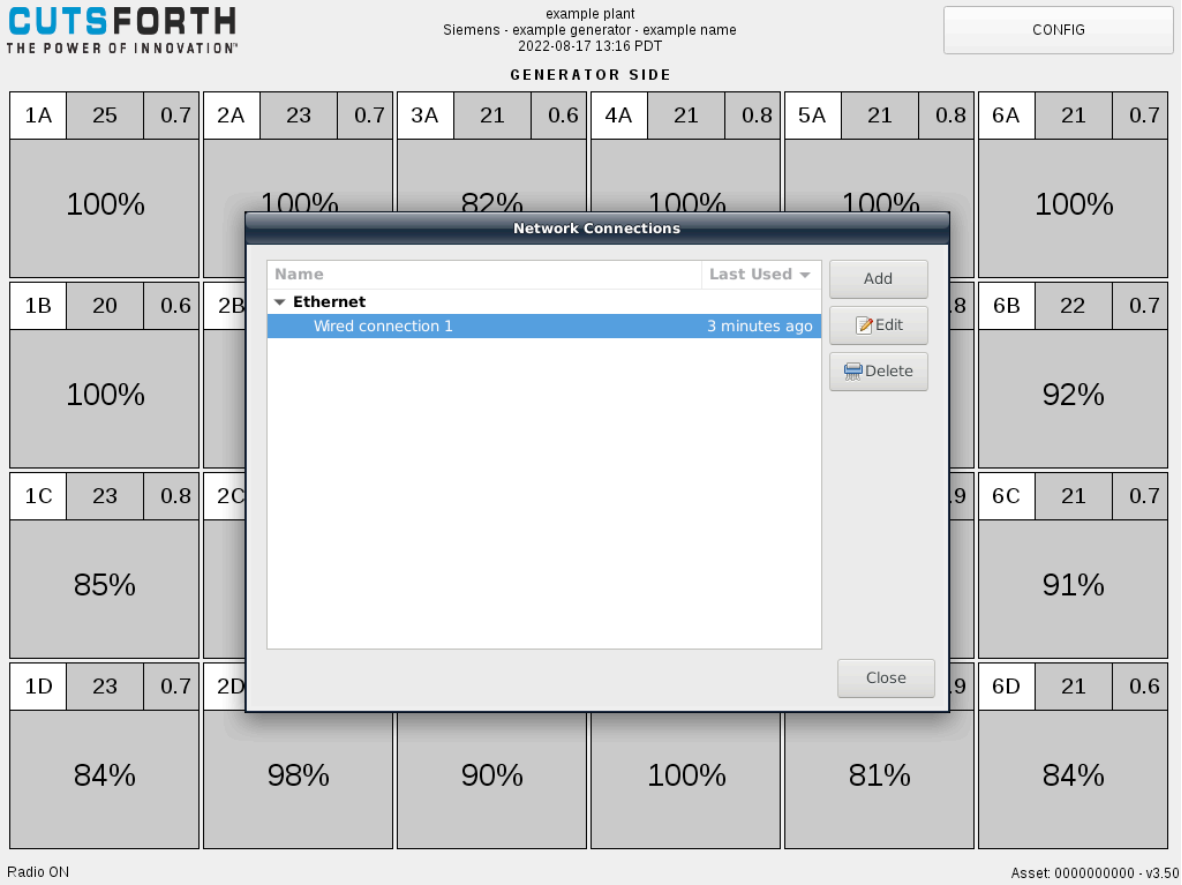
5. Double-click **Wired Connection 1**.



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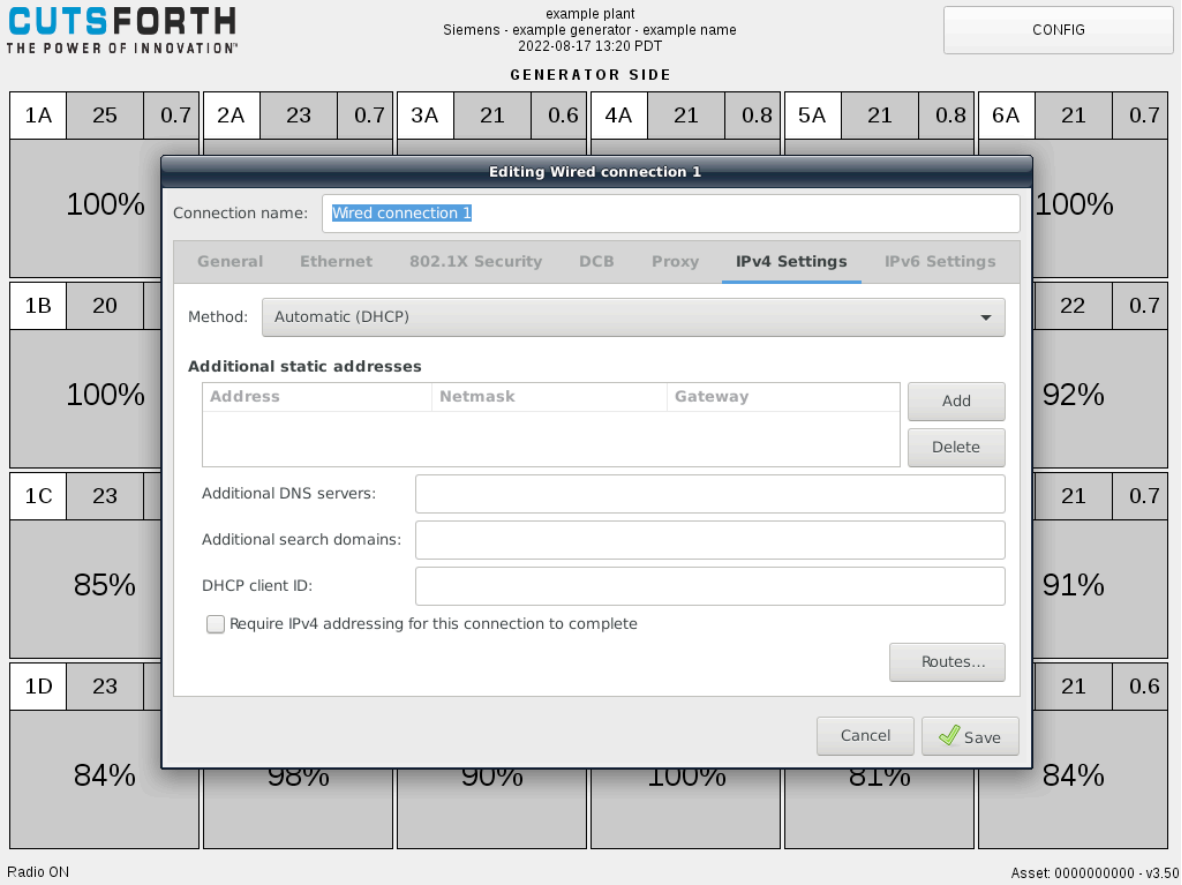
6. Select the IPv4 Settings tab.



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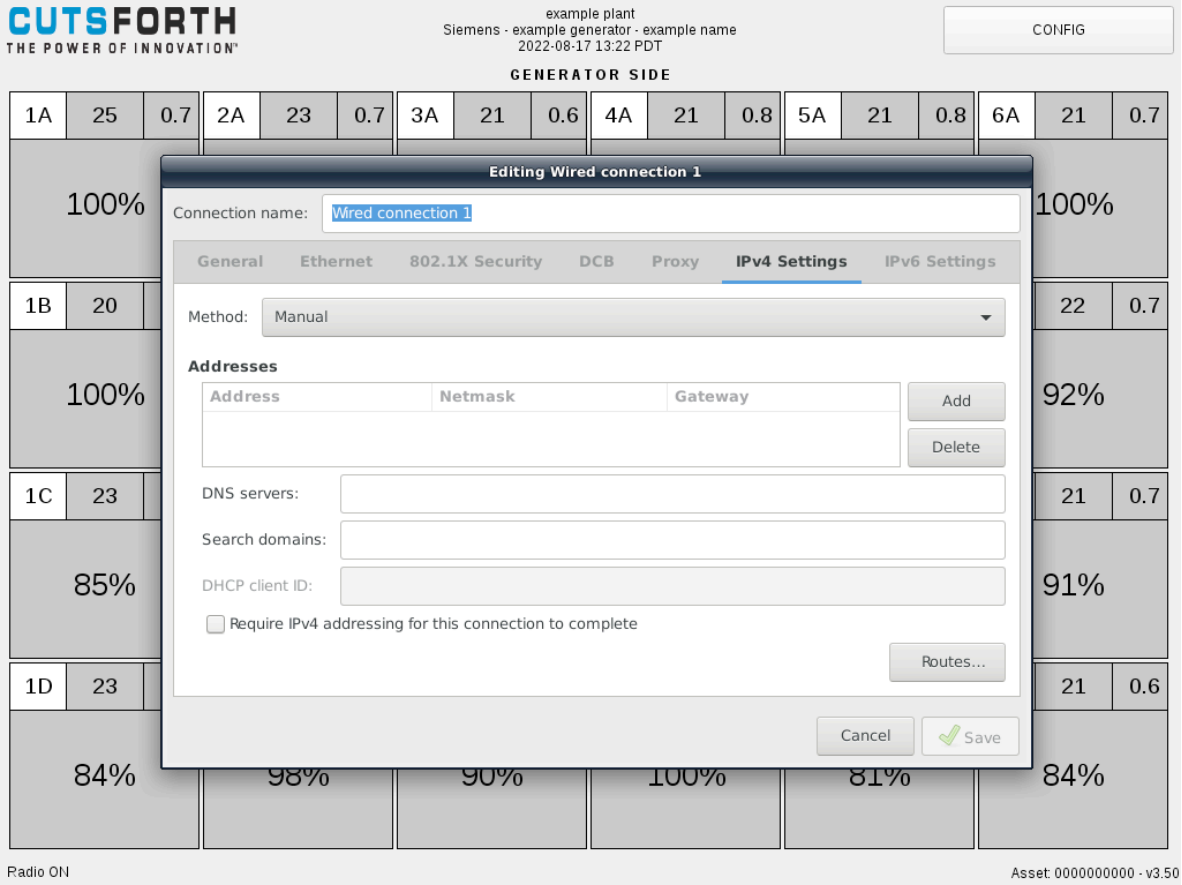
7. Under the Method drop-down, select **Manual** to change IP configuration settings to **static**.



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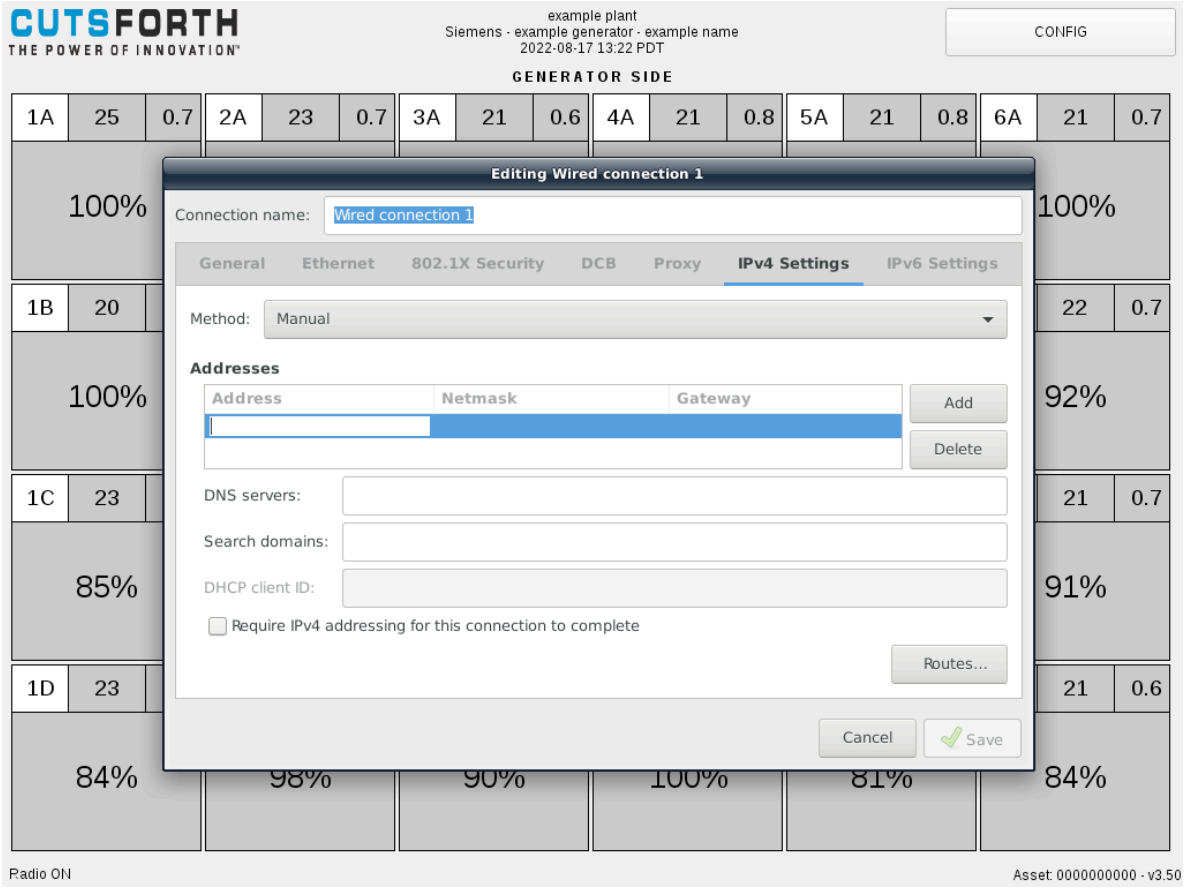
8. Click **Add**.



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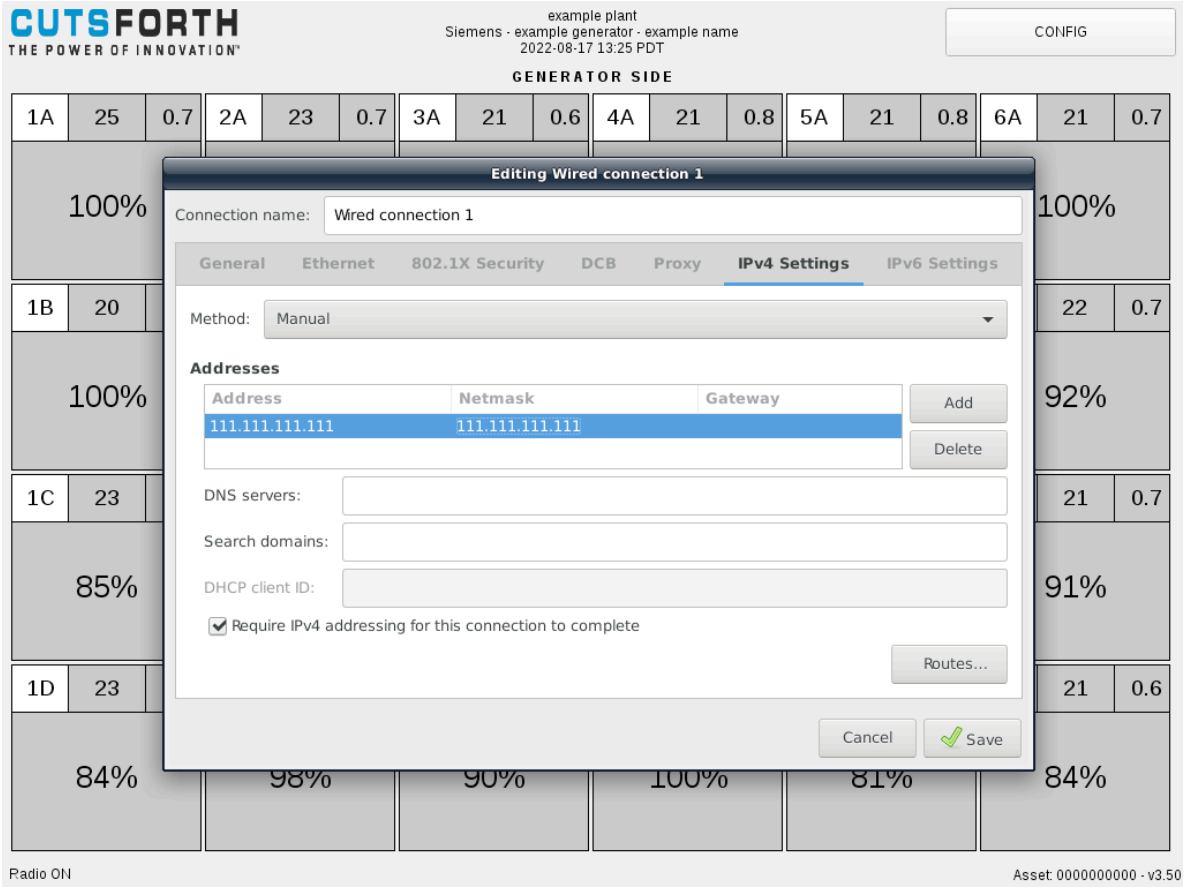
9. Enter the desired addressing information, and click **Save** when you are finished.



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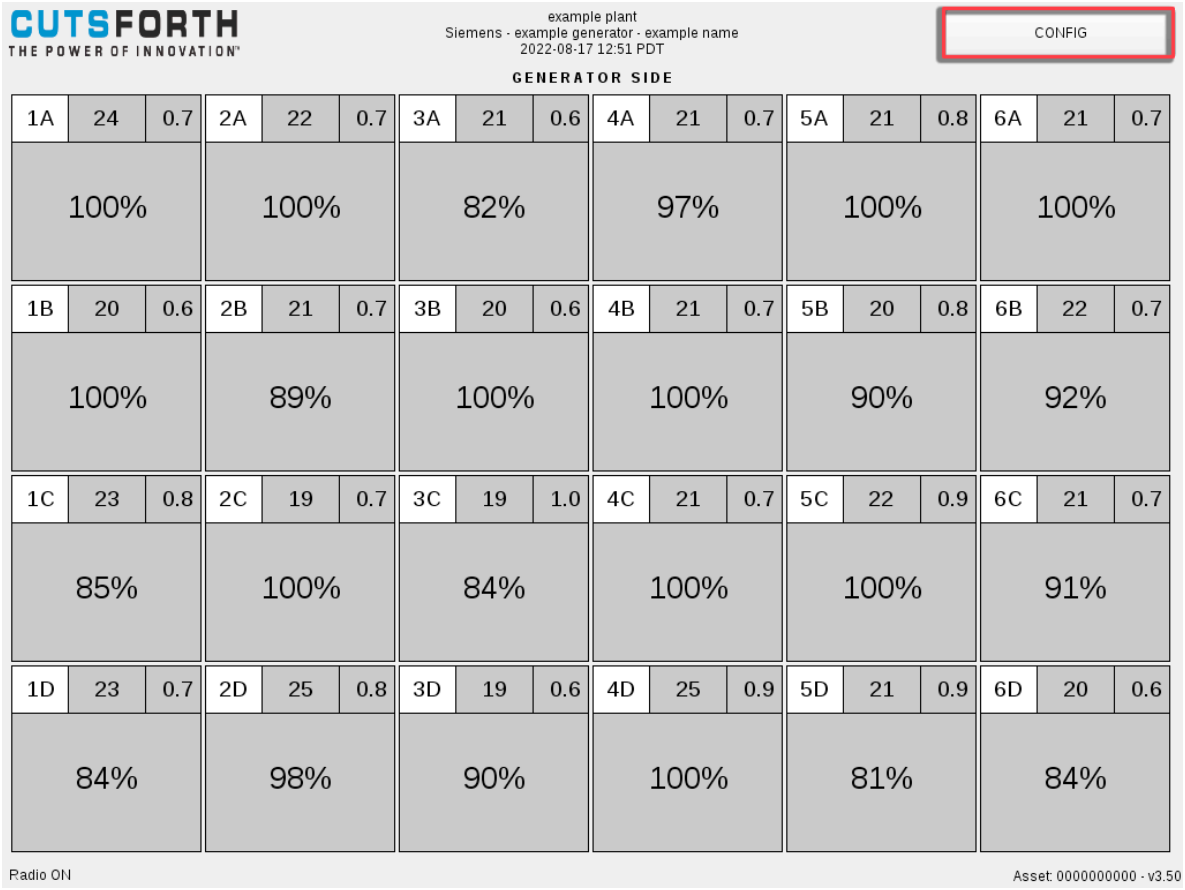
15.2. Locating the MAC Addresses

1. Connect a USB keyboard to the BCM system.
2. From the BCM Application Home Screen, press **CONFIG** in the upper-right corner.



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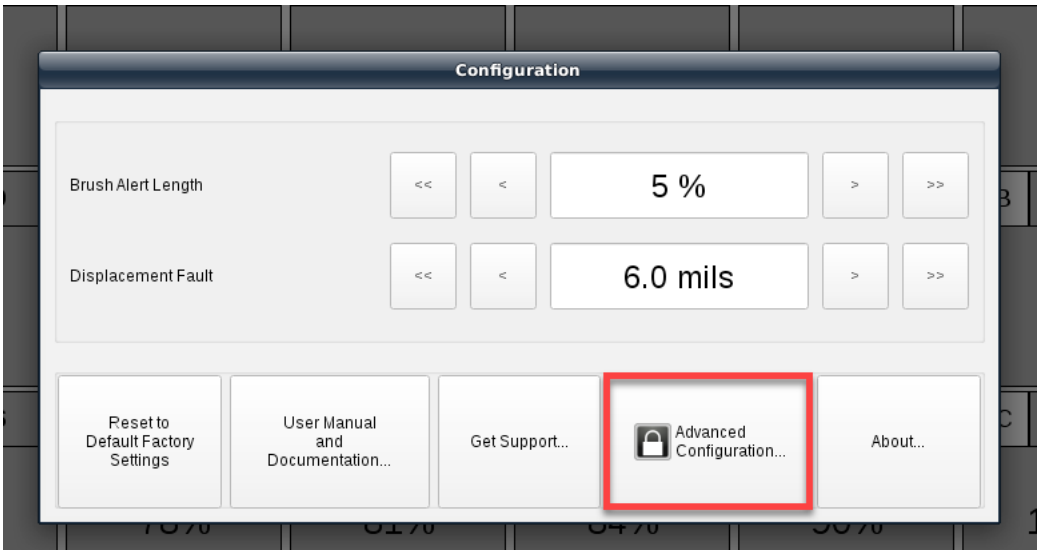
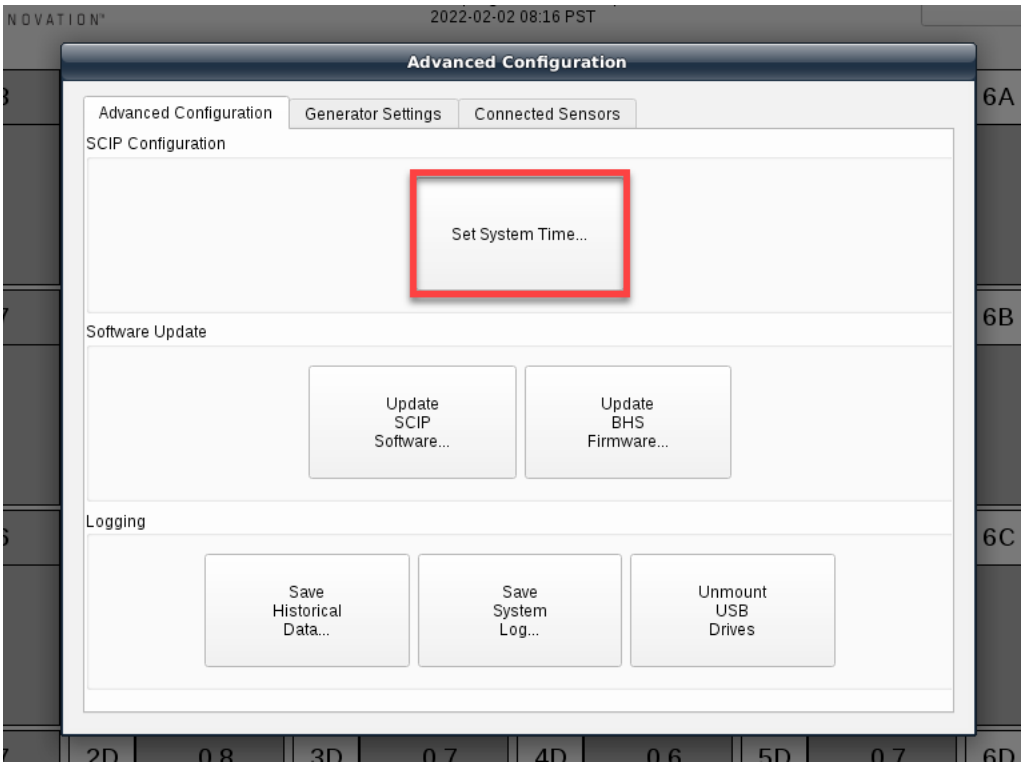
3. At the bottom of the Configuration screen, press **Advanced Configuration**. When prompted, enter the administrative password.



4. In the lower-right corner of the Advanced Configuration screen, press **Set System Time**.



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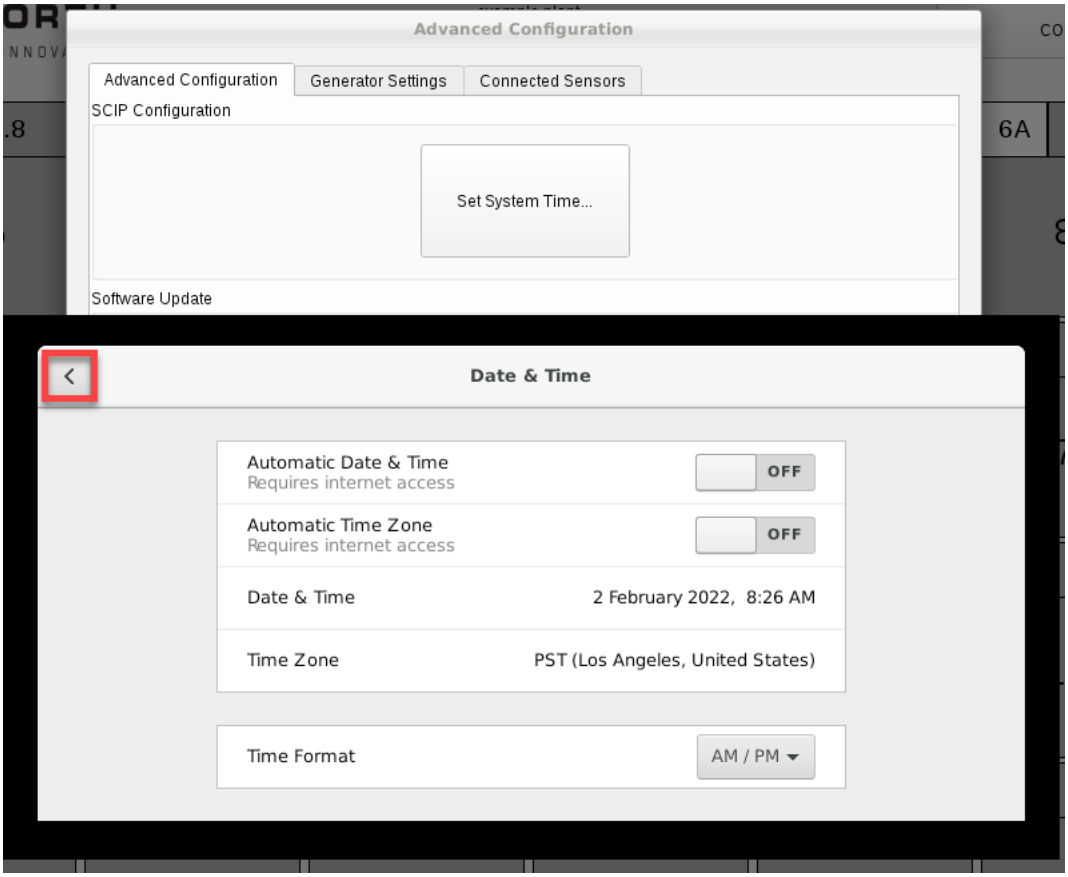
5. From the Data & Time screen, press the back button in the upper-left corner.



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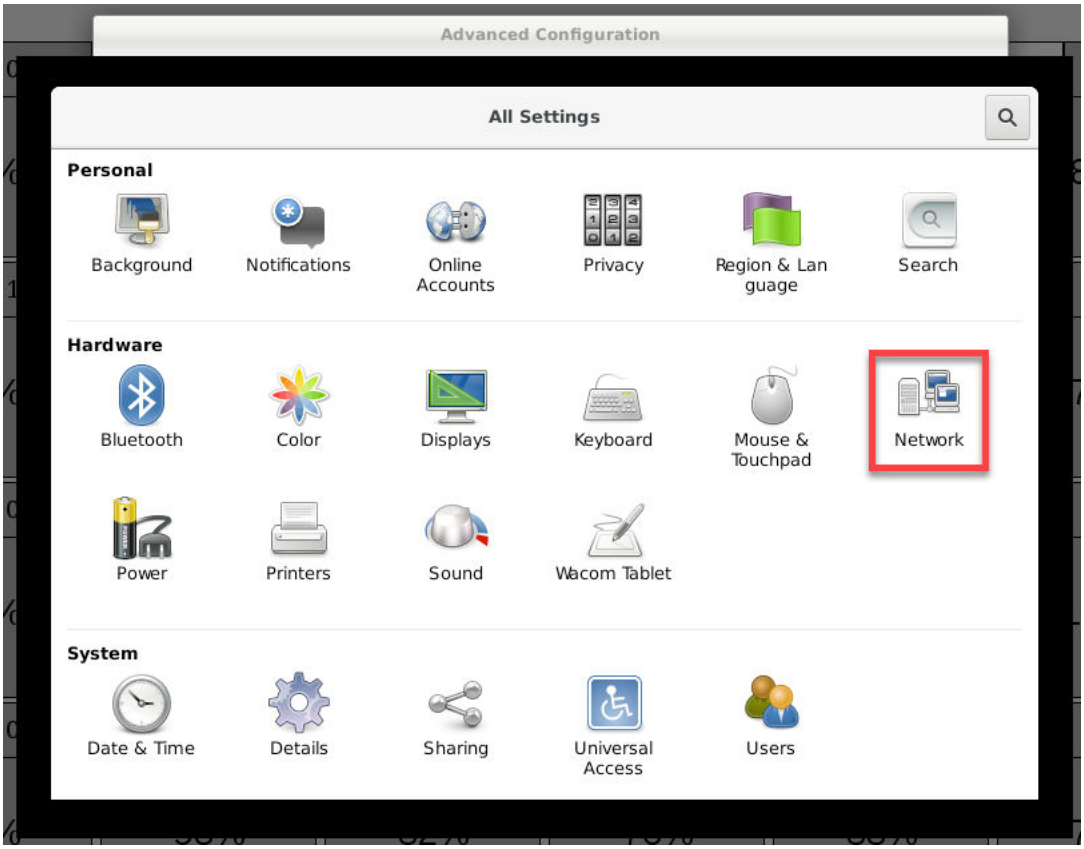
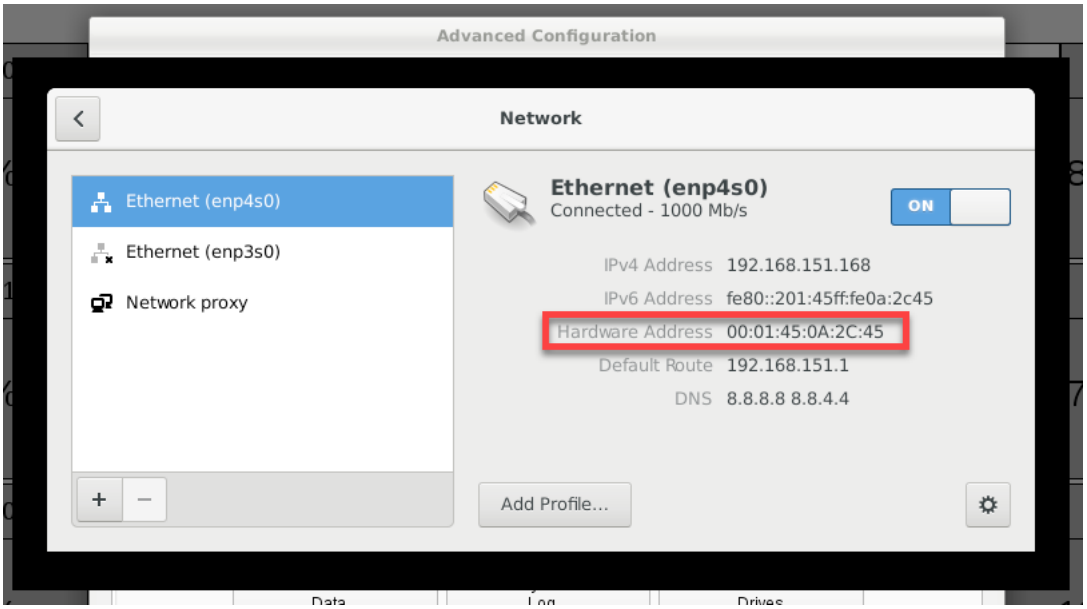
6. From the All Settings menu, select **Network**.



7. The MAC addresses will be listed as “Hardware Address” under each “Ethernet” option in the list on the left hand side.



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16. Glossary

antenna	A device, typically mounted inside the exciter enclosure, which helps facilitate wireless communications between the Brush Condition Monitoring System and the Brush Health Sensors.
Antenna Placement Mode	An optional mode included in the Brush Condition Monitoring System which displays the wireless signal strength of each sensor in or order to assist in successful placement of the antenna.
attenuation	The reduction of the amplitude of a signal due to excessive cable length.
AWG	American Wire Gauge
Brush Condition Monitoring System	A Cutsforth EASYchange monitoring system that performs automated measurements and brush health analytics that allow plant operators to improve the efficiency of technicians' daily and weekly tasks by dispatching them to the collector when maintenance is actually needed.
Brush Health Sensor (BHS)	A wireless sensor integrated into the brush spring which communicates with the Brush Condition Monitoring System.
Controller	The main enclosure of the Brush Condition Monitoring System, which contains the computer and power supply as well as the main touchscreen interface.
DCS	Distributed Control System
LOTO	Lock-out, tag-out
Modbus RTU	Modbus Remote Terminal Unit
Modbus TCP	Modbus Transmission Control Protocol

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