

Operating and Service Instructions

BRUNO

MICROPROCESSOR-CONTROLLED
DC SYSTEM WATCHDOG



p/n JA0102-61

User Notes

PLEASE READ AND FOLLOW ALL SAFETY INSTRUCTIONS

NOTICE

- 1) Before using the Bruno DC System Watchdog, read all instructions and cautionary markings on:
 - A) this equipment, B) charger, C) battery, and D) any other equipment to be used in conjunction with Bruno.
- 2) This manual contains important safety and operating instructions, and should therefore be filed for easy access.
- 3) Remove all jewelry, watches, rings, etc. before proceeding with installation or service.
- 4) Maintain at least 6in / 152mm of free air on all vented surfaces for cooling. Allow sufficient clearance to open the front panel for servicing.
- 5) Connect or disconnect the charger and/or battery only when Bruno is off, to prevent arcing or burning.
- 6) Do not operate Bruno if it has been damaged in any way. Refer to qualified service personnel.
- 7) Do not disassemble Bruno. Only qualified service personnel should attempt repairs. Incorrect reassembly may result in explosion, electrical shock, or fire.
- 8) Do not install Bruno outdoors, or in wet or damp locations, unless specifically ordered for that environment.
- 9) Do not use Bruno for ANY purpose not described in this manual.



WARNING

- 1) Do not touch any uninsulated parts of Bruno, especially the input and output connections, as there is the possibility of electrical shock.
- 2) During normal operation, batteries may produce explosive gas. Never smoke, use an open flame, or create arcs in the vicinity of Bruno or the battery.
- 3) Turn Bruno off before connecting or disconnecting the battery to avoid shock hazards and/or equipment damage.
- 4) De-energize and lock out all dc power sources to Bruno before servicing.
- 5) Do not operate Bruno with any power source that does not match the specified dc voltage ratings. Refer to the data nameplate decal affixed to the outside panel for operational requirements.

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1.1 Storing Bruno

If you store Bruno for more than a few days before installation, you should store it in its original shipping container, and in a temperature controlled, dry climate. Ambient temperatures of 0 to 122 °F / -18 to 50 °C are acceptable.

1.2 Reporting Shipping Damage

If upon delivery of Bruno you discover any damage or shortage, make notation on all copies of delivering carrier's delivery receipt before signing and notify the delivery person of your findings. If loss or damage is discovered after delivery, notify delivering carrier immediately and request an inspection. The manufacturer does not assume any liability for damage during transportation or handling.

Should the products require an inspection by (or return to) the manufacturer, please contact your sales representative for further instructions. Any returned material must be properly packed in compliance with shipping regulations. It is preferable to use the original shipping materials if possible. Mark the outside of the shipping container with the Return Material Authorization (RMA) number issued by the manufacturer.

1.3 Unpacking and Inspecting Bruno

Carefully remove all shipping materials from Bruno. Remove Bruno from the shipping pallet for inspection. Save all shipping materials until you are sure that there is no shipping damage.

Once Bruno is unpacked, inspect the unit for possible shipping damage. If shipping damage has occurred, refer to Section 1.2 for proper reporting.

1.3.1 Inspection Checklist

- ☐ enclosure exterior and interior are not marred or dented
- ☐ there is no visible damage to exterior or interior components
- ☐ all internal components are secure
- ☐ printed circuit boards are firmly seated on their standoffs
- ☐ all hardware is tight and all wiring terminations are secure
- ☐ ***Operating & Service Instructions*** manual is included
- ☐ all items on the packing list received

1 Receiving & Unpacking

1.4 Moving Bruno

Bruno is housed in a NEMA Type 1 Style-5054 enclosure. Once you have established that Bruno is undamaged, identify the weight and dimensions of the unit. Refer to table below.

1.4.1 Bruno Model Weights & Dimensions

Continuous Current Rating (Adc)	Enclosure Type	Weights
50	Style-5054	58 lb / 26.4 kg
100	Style-5054	62 lb / 28.1 kg
150	Style-5054	contact factory
200	Style-5054	contact factory

Bruno does not feature top lifting eyes for moving. Move Bruno with a forklift whenever possible, using the supplied shipping pallet. Lift Bruno into a wall-mount or rack-mount installation, using a heavy-duty sling or a scissors lift.

1.5 Mounting Bruno

Bruno must be installed in a manner that allows easy access to the right side of the two (2) front panel dc disconnects. Side and bottom access is required for routing wires from the charger, battery, and system dc loads. Choose a mounting method for the Bruno Style-5054 enclosure from the following choices:

1.5.1 Wall-Mounting Bruno

Wall-mounting is the standard means of installing Bruno. When wall-mounting Bruno, consider the following:

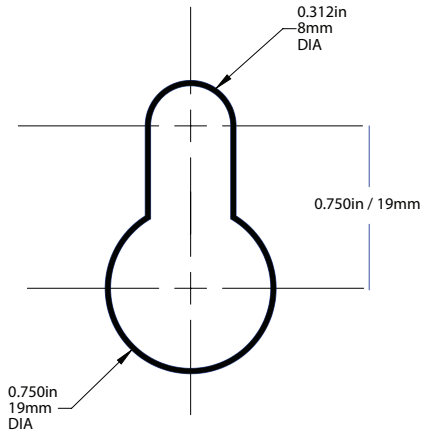
1. Refer to Style-5054 enclosure outline drawing ([JE5262-00](#)) in Appendix B.
2. The wall must be strong enough to properly support the weight of Bruno, plus a safety factor of at least two (2) times. See the weight table in Section 1.4. The weight of Bruno may be different, depending on the features and model of the unit.
3. Be conscious of planned dc wiring to and from Bruno, selecting conduit entrances carefully. Use of the pre-fab knockouts on the sides or bottom of the enclosure will allow removal of the cabinet shroud (and internal access for servicing) without removal of the unit from the wall.
4. The location:
 - » Should be free of drips and splatter. If falling particles and liquids are a problem, install a NEMA Type-2 drip shield accessory.
 - » Should be between 0 and 122 °F / -18 and 50 °C, with relative humidity between 0% and 95% non-condensing.
 - » Must be free of flammable or explosive materials.
5. Maintain at least 6in / 152mm of free air on all vented surfaces for cooling.
6. Maintain at least 36in / 914mm front clearance for access to Bruno for operation and maintenance.

1 Receiving & Unpacking

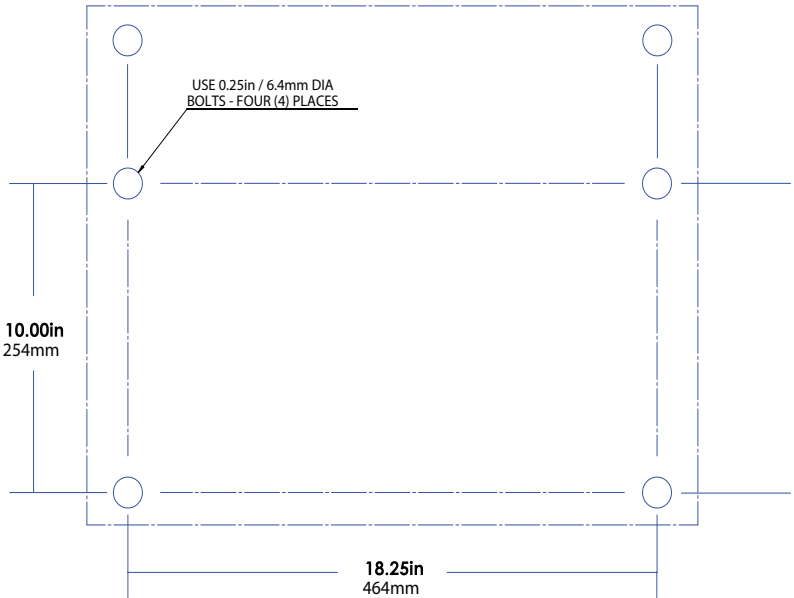
PROCEDURE

Install four (4) 0.25in / 6.4mm anchor bolts (not supplied) rated to support the weight of Bruno, plus a safety factor of at least two (2) times, into the wall. Place Bruno onto the anchor bolts, add appropriate mounting hardware, and tighten securely. Refer to the following graphics for Bruno wall-mounting pattern and specification.

KEYHOLE SLOT USED ON STYLE-5054 MOUNTING FLANGE



WALL-MOUNTING PATTERN STYLE-5054 ENCLOSURE



NOTICE

Six(6) key-hole slots are provided on back of enclosure as shown, for wall-mounting with 0.25in / 6.4mm diameter hardware.

1 Receiving & Unpacking

1.5.2 Floor-Mounting Bruno

To install Bruno onto a horizontal surface, the standard enclosure does not need to be modified, but a special floor mounting accessory (p/n EI0192-00) is required. The kit includes a set of mounting brackets that elevate the top of Bruno approximately 47in / 119mm above floor level, with provisions for floor anchoring. The kit also includes appropriate hardware and installation instructions for the floor-mounting procedure.

When floor-mounting Bruno, consider the following:

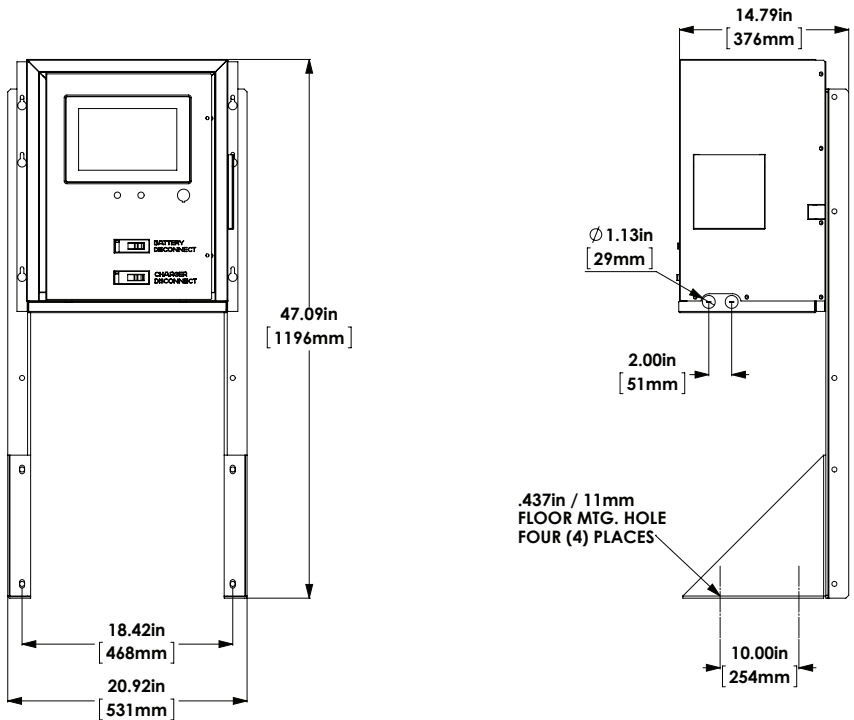
1. Locate anchor bolt holes at least 4.25in / 108mm from any wall, to allow clearance behind the mounting brackets.
2. Be conscious of planned dc wiring to Bruno, selecting conduit entrances carefully. Use of the pre-fab knockouts on the sides or bottom of the enclosure will allow removal of the cabinet shroud (and internal access for servicing) without removal of the unit from the floor stand.
3. The location:
 - » Should be free of drips and splatter. If falling particles and liquids are a problem, install a NEMA Type-2 drip shield accessory.
 - » Should be between 0 and 122 °F / -18 and 50 °C, with relative humidity between 0% and 95% non-condensing.
 - » Must be free of flammable or explosive materials.
4. Maintain at least 6in / 152mm of free air on all vented surfaces for cooling.
5. Allow 36in / 914mm front clearance for operation and maintenance.

PROCEDURE

Install (4) 0.25in / 6.4mm anchor bolts (not supplied) rated to support the unit weight plus a safety factor of at least two (2) times, into the floor. Assemble the floor-mounting accessory to the anchor bolts as shown. Place Bruno onto the vertical posts, add appropriate mounting hardware, and tighten. Refer to the following graphics for floor mounting patterns and enclosure footprints.

1 Receiving & Unpacking

FLOOR-MOUNTING IMAGE STYLE-5054 ENCLOSURE



1 Receiving & Unpacking

1.5.3. Rack-Mounting Bruno

Bruno can be installed into most 23in / 584mm and 24in / 610mm relay racks with standard EIA hole spacing. Bruno enclosure does not need to be modified for rack mounting, but a special accessory (p/n EI0193-00) is required. The kit includes two (2) mounting brackets, appropriate hardware, and Installation Instructions for the rack-mounting procedure.

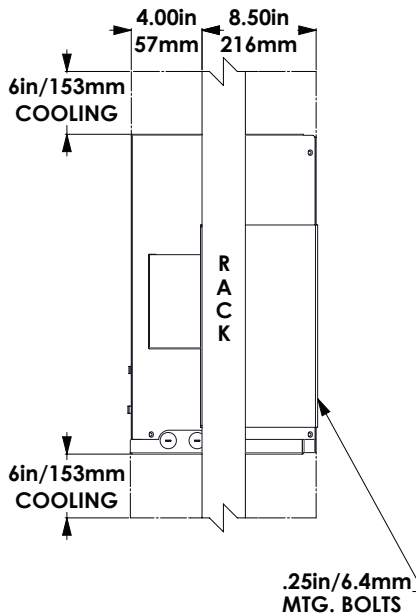
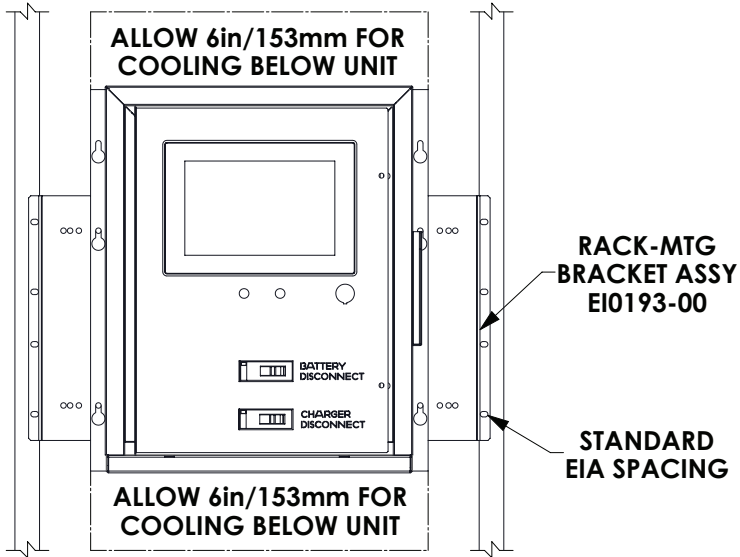
When rack-mounting Bruno, consider the following:

1. The rack must be strong enough to properly support the weight of Bruno. See the Weight Table located in Section 1.4
2. Be conscious of planned dc wiring of Bruno, selecting conduit entrances carefully. Note the standard pre-fab conduit knockouts located on the sides, top and bottom of the enclosure. Ensure that planned conduit is accessible after Bruno is rack-mounted.
3. The location:
 - » Should be free of drips and splatter. If falling particles and liquids are a problem, install a NEMA Type-2 drip shield accessory.
 - » Should be between 0 and 122 °F / -18 and 50 °C, with relative humidity between 0% and 95% non-condensing.
 - » Must be free of flammable or explosive materials.
4. Maintain at least 6in / 152mm of free air on all vented surfaces for cooling.
5. Allow at least 36in / 914mm front clearance for operation and maintenance.

PROCEDURE

To rack mount Bruno, first install the mounting brackets into the rack using proper hardware (not supplied). Second, mount Bruno onto the installed brackets, using the supplied kit hardware. Provide at least 6in / 152mm of free air above and below Bruno for cooling. Refer to the following graphics for the rack-mounting configurations.

RACK-MOUNTING IMAGES - STYLE-5054 ENCLOSURE



2 Wiring

2.1 Mechanical Diagram and Component Location

Bruno is composed of the following basic components:

- A3 - Human Machine Interface (HMI)
- P-USB - External Universal Serial Bus Interface
- A1 - Programmable Logic Controller (PLC)
- A2 - Interface I/O Board
- K1 - Main DC Contactor
- SW1 - Battery Disconnect, *or optional circuit breaker (CB1)*
- SW2 - Charger Disconnect, *or optional circuit breaker (CB2)*
- A24 - Power Supply (24Vdc)
- Battery Connection Terminals (*SW1 or CB1*)
- Charger Connection Terminals (*SW2 or CB2*)
- TB(+/-) - System Load & Test Connection Terminals
- Q1 - Fail-Safe Bypass Switch (SCR module)
- GND - Ground Terminal
- R1 - Battery Shunt
- R2 - Charger Shunt
- R5 - Float Current Shunt (*on Interface I/O Board*)
- K6 and K7 - Remote Sense Relays (*on Interface I/O Board*)
- TB3 - Charger Remote Sense Terminals (*on I/O Board*)
- TB6 - Battery Remote Sense Terminals (*on I/O Board*)

Refer to the figures and descriptions in this section for location of previous nineteen (19) components.

Other components in Bruno Parts Lists (*but not defined in Section 2*):

- A10 - External Battery Temperature Probe
- A32 - Flash Memor Card (32Gb)
- A42 - Ambient Temperature Probe
- AX-SW1 - Auxiliary Switch on Battery Disconnect
- CR4 - Clamping Diode (*for K4 relay*)
- DS01/DS02 - HHS Green/Red Indicators (LED)
- K4 - Battery Open Test Relay
- R3 - Battery Open Test Load Resistor

For a detailed mechanical drawing and Bruno component location, see DC System Watchdog Internal Component Layout: Style-5054 Enclosure ([JE5263-00](#)).

2.1.1 Human-Machine Interface

The Human-Machine Interface (A3) touch screen, or “HMI”, is the main feature on the outer door of Bruno enclosure. See Figure 2-1 below. Bruno utilizes a 10.1 in / 257mm, 1280 x 800 pixel capacitive touch screen for control and logging capability. The IP69 rated front glass panel is resistive to the toughest of elements and is backed by our 5-Year Warranty.

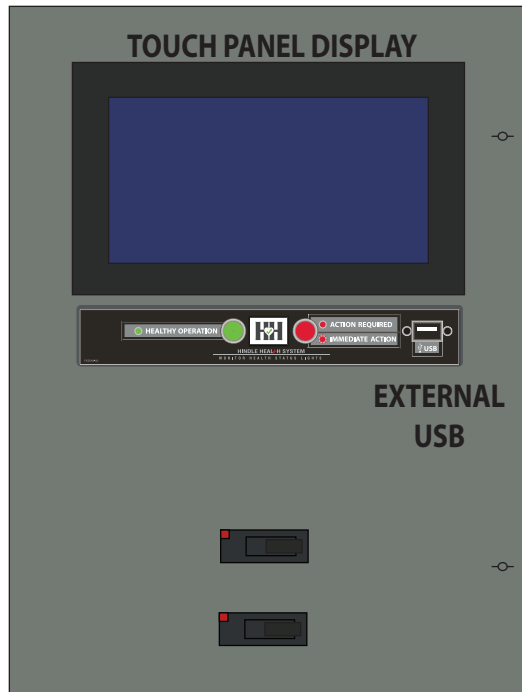


Figure 2-1

2 Wiring

2.1.2 Universal Serial Bus Interface

The USB interface (P-USB) is mounted on the outer door below the touch-screen display (A3). See Figure 2-1. This allows the user to download data from or upload information to Bruno without opening the enclosure door.

2.1.3 Programmable Logic Controller

The PLC (A1) is mounted to the back of the HMI (A3). See Figure 2-2A below. It is the controller between the Interface I/O Board (A2) and HMI (A3). This device should never be removed except under the direction of a certified Bruno technician or the factory.

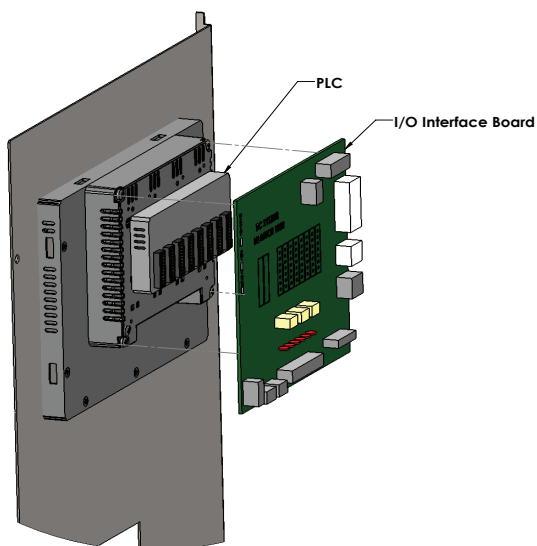


Figure 2-2A

2.1.4 Interface I/O Board

The Interface I/O (A2) is a green printed circuit board mounted to the back of the PLC (A1). See Figure 2-2A on the previous page. It is the user signal connection point for the PLC. The Interface I/O Board (A2) provides inputs and outputs for the user to make external connections to Bruno. It features user terminal blocks (TB3, TB4, TB5, TB6, etc.).

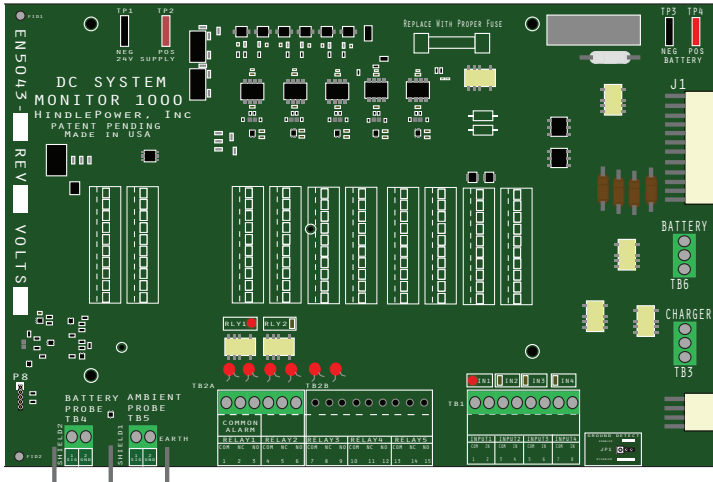


Figure 2-2B

For further information on Interface I/O Board (A2), see detail drawing ([JE5264-00](#)).

2 Wiring

2.1.5 Main DC Contactor

The Main DC Contactor (K1) is mounted on the back panel of the Bruno base. See Figure 2-3 below. The contactor is used to isolate the battery from the charger and system loads during certain tests.

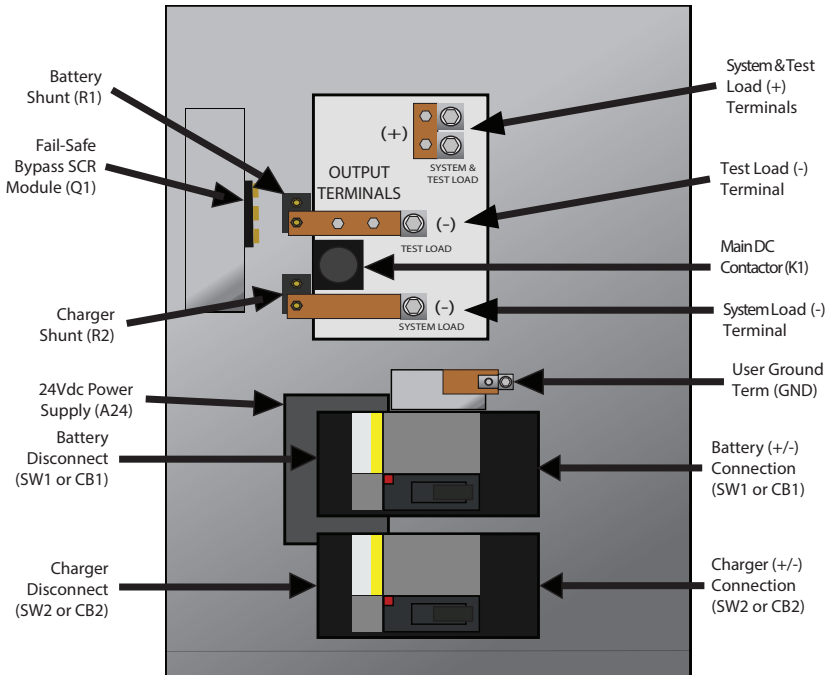


Figure 2-3

2.1.6 Battery Disconnect (switch or breaker)

The Battery Disconnect Switch (SW1) is mounted on the breaker bracket middle. See Figure 2-3 above. The actuator can be accessed from the front panel door cutout. The Battery Switch (SW1) is used to disconnect the battery from the dc system. An optional 20 kAIC Battery Circuit Breaker (CB1) can be supplied in place of the switch.

2.1.7 Charger Disconnect (switch or breaker)

The Charger Disconnect Switch (SW2) is mounted on the breaker bracket bottom. See Figure 2-3. The actuator can be accessed from the front panel door cutout. The Charger Switch (SW2) is used to disconnect the charger from the dc system. An optional 20 kAIC Charger Circuit Breaker (CB2) can be supplied in place of the switch.

2.1.8 Power Supply (24Vdc)

The 24Vdc Power Supply (A24) is located on the base of the enclosure. See Figure 2-3. The Power Supply is a small dc-to-dc converter, which provides 24 Volts from the system load (+/-) to power Bruno's logic, display, and controls.

2.1.9 Battery Connection Terminals (on SW1 or CB1)

Bruno's site battery connection terminal utilizes the right side of the Battery Disconnect Switch (SW1) or Circuit Breaker (CB1). See Figure 2-3. The switch (or breaker) features CU-AL compression lugs.

2.1.10 Charger Connection Terminals (on SW2 or CB2)

Bruno's site charger connection terminal utilizes the right side of the Charger Disconnect Switch (SW2) or Circuit Breaker (CB2). See Figure 2-3. The switch (or breaker) features CU-AL compression lugs.

2.1.11 System Load & Test Load Connection Terminals (+/-)

System Load & Test Load Connection Terminals are supplied as part of the phenolic I/O panel assembly, mounted to the back panel of the unit. See Figure 2-3. These terminals are "box type" CU-AL compression lugs. Separate and discrete terminals are supplied for System Load and Test Load negative (-) connections. One (1) common terminal is supplied, with two (2) lugs, for both System Load and Test Load positive (+) connections.

2 Wiring

2.1.12 Fail-Safe Bypass (SCR module)

The Safety Bypass Switch (Q1) is a Silicon-Controlled Rectifier (SCR) Module located on the left inside wall of the unit. See Figure 2-3. It is used to protect the system load in the event of a failure of the Main Contactor (K1), and ensures the system loads are never disconnected from the battery and dc power source.

- When the Main Contactor is open or fails, the fail-safe bypass provides a means of discharging and charging the battery.
- If the system voltage drops below the battery voltage, the charger output fails, or the charger dc output breaker opens during a discharge test, the battery will immediately supply current to the load.

2.1.13 Ground Terminal

The user Ground Terminal (GND) is located just above the Battery Disconnect Switch (SW1). See Figure 2-3. An optional copper bus bar is available for connection external to the enclosure.

2.1.14 Battery Shunt

The Battery Shunt (R1) is located above and to the left of the Main Contactor (K1). See Figure 2-3. Connected to the negative(-) test load bus, the shunt measures battery current in the system. A positive(+) value means charging, and a negative(-) value means discharging of the battery.

2.1.15 Charger Shunt

The Charger Shunt (R2) is located below and to left of the Main Contactor (K1). See Figure 2-3. Connected to the negative(-) system load bus, the shunt measures charger current in the dc system.

2.1.16 Float Current Shunt

The Float Current Shunt (R5) is located on the back of the Interface I/O Board (A2). See Figure 2-4. It is connected on the negative(-) side of the dc bus, and measures small levels of battery float current. The shunt (R5) is protected by a self-resettable fuse (A2-F1), also mounted on the Interface I/O Board.

2.1.17 Remote Sense Relays

(for future use)

2.1.18 Charger Remote Sense Terminals

(for future use)

2.1.19 Battery Remote Sense Terminals

The Battery Remote Sense Terminals (TB6) are located on the right side of the Interface I/O Board (A2). See Figure 2-5. They connect Bruno directly to the battery, reducing voltage drop found in long wire runs, and are used to sense precise battery voltage.

NOTICE If calibration is necessary in the field, this option must be unwired before zeroing the battery voltage reading.

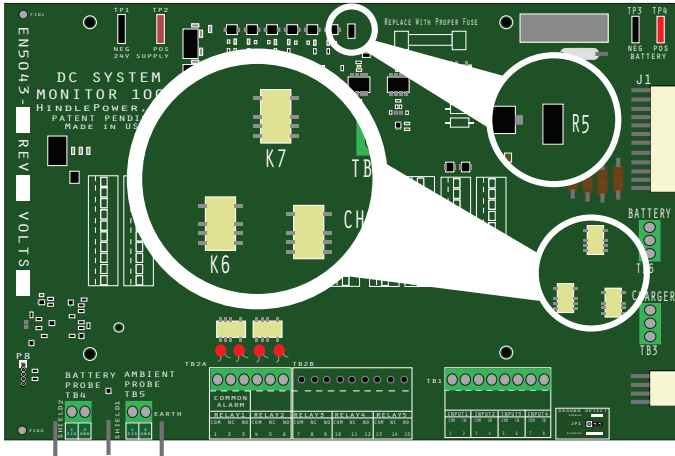


Figure 2-4

2 Wiring

2.2 Making DC Connections

*Bruno is a commercial product, and **not** intended for use at any time in a residential environment.*

*Bruno is powered from the dc bus, and there are **no** ac voltages present in the device.*

It is the responsibility of the installer of Bruno to provide suitably sized charger, battery, and dc load wiring.

Follow these steps to connect Bruno:

1. Size dc wiring to minimize voltage drops. Acceptable wire sizes depend on the installation. As a guideline, the voltage drop should not exceed 1% of nominal dc system voltage at full current. Refer to the table below to determine voltage drops for various wire sizes, currents, and distances. The drop for cable runs should be minimized by using the largest wires possible.

Wire Sizing Chart (typical) Voltage Drop 100ft / 30.5m of wire (for copper @68 °F/20 °C)												
Wire Size (AWG)	DC Current (Amperes)											
	6	12	16	20	25	30	40	50	75	100	125	150
#16	2.5V	5.0V	6.7V	8.2V	10.5V	-	-	-	-	-	-	-
#14	1.6V	3.2V	4.2V	5.3V	6.6V	-	-	-	-	-	-	-
#12	1.0V	2.0V	2.6V	3.3V	4.2V	-	-	-	-	-	-	-
#10	0.63V	1.3V	1.7V	2.1V	2.6V	3.0V	4.0V	5.0V	-	-	-	-
#8	0.40V	0.80V	1.1V	1.3V	1.7V	1.9V	2.5V	3.1V	-	-	-	-
#6	0.25V	0.50V	0.66V	0.83V	1.1V	1.2V	1.6V	2.0V	3.0V	-	-	-
#4	0.16V	0.32V	0.42V	0.52V	0.65V	0.70V	1.0V	1.2V	1.9V	2.5V	-	-
#2	-	-	-	-	-	0.50V	0.63V	0.80V	1.2V	1.6V	2.0V	-
#0	-	-	-	-	-	0.30V	0.40V	0.50V	0.74V	1.0V	1.2V	1.5
#00	-	-	-	-	-	0.23V	0.31V	0.40V	0.60V	0.80V	1.0V	1.2V
#000	-	-	-	-	-	0.20V	0.25V	0.31V	0.46V	0.62V	0.77V	1.0V
EXAMPLE: 100ft / 30.5m of #8 AWG wire @ 25A has 1.7V drop												

2. For more accurate measurement of battery voltage, remote sense wiring (at A2-TB6) is recommended.
3. All specific requirements of your facility take precedence over these instructions.

NOTICE The table on the preceding page denotes voltage drop **only**. The ampacity of the wire depends on the wire rating, the installation conditions, and National Electrical Coade (NEC) requirements.

PROCEDURE

1. Run properly-sized dc supply wiring from the charger, battery, and system dc loads to Bruno.
2. Connect charger wiring directly to the Disconnect Switch (SW2+/-) input. Securely tighten CU-AL compression screws.
3. Connect battery wiring directly to the Disconnect Switch (SW1+/-) input. Securely tighten CU-AL compression screws.
4. Connect system dc load positive(+) wiring to the CU-AL compression lug (TB-LD+) on the I/O panel.
5. Connect system dc load negative(-) wiring to the CU-AL compression lug (TB-SL-) on the I/O panel.
6. If a test load is utilized, connect test load positive(+) wiring to the CU-AL compression lug (TB-LD+) on the I/O panel.
7. If a test load is utilized, connect test load negative(-) wiring to the CU-AL compression lug (TB-TD-) on the I/O panel.
8. Securely tighten all CU-AL compression screws.

2 Wiring

2.2.1 Wiring Remote Voltage Sense

Bruno currently features two (2) different remote voltage sense contacts for creating direct (and more precise) signal connections to system voltage sources (e.g. charger and battery). These contacts are accessed via two (2) terminal blocks (TB6/TB3) on the right side of the Interface I/O Board (A2). See Figure 2-5.

2.2.1.1 Wiring Charger Remote Voltage Sense

The Charger Remote Voltage Sense is a **future** feature, and is not used at the time of printing of this manual. No connections are necessary at terminal block (TB3).

2.2.1.2 Wiring Battery Remote Voltage Sense

If measurement accuracy of battery voltage is higher than typical, a special circuit can be used. Using this feature bypasses voltage drops seen in smaller wires carrying large amounts of current.

Use #22-14 AWG twisted pair signal wiring, and ensure proper polarity. Connect the Battery Remote Voltage Sense (TB6-1) to the positive (+) terminal of the battery. Connect the Battery Remote Voltage Sense (TB6-3) to the negative (-) terminal of the battery.

Once the remote voltage sense connection is made to the battery, the System Configuration setting must be changed to have the System Voltage Sense set to "Battery" rather than "Internal". Battery voltage will now be sensed at the battery, rather than internal to Bruno.

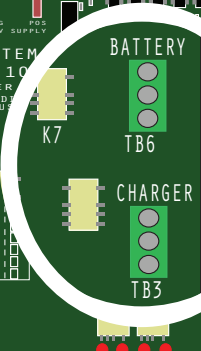


Figure 2-5

2 Wiring

2.2.2 Wiring Output Relays on the Interface I/O Board

The Output Relays are found on the Interface I/O Board (A2), which is mounted to the inside surface of the front panel door. These relays change state after a routed alarm has become active, or the power to Bruno is lost. One (1) form-C alarm contact is provided per relay point, and is accessible via terminal block (TB2) on the Interface I/O Board (A2). A common relay and one (1) additional relay is provided as standard. Up to four (4) relays total are possible on the Interface I/O Board as an option.

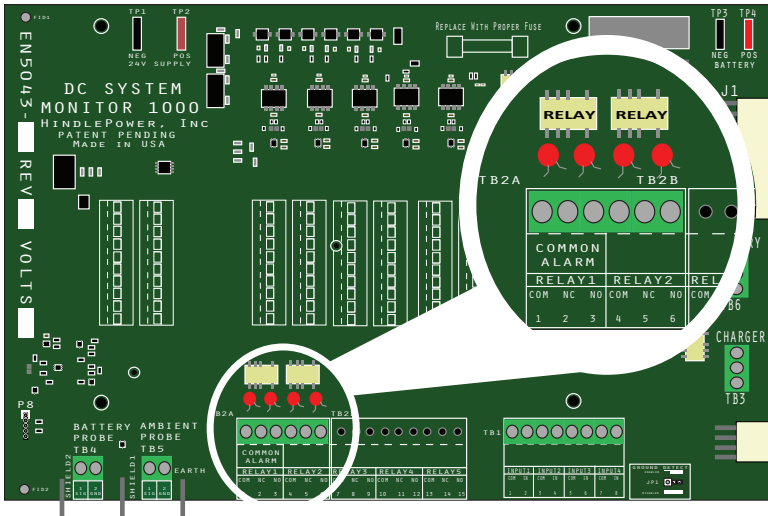


Figure 2-6

For wiring to and from the Interface I/O Board (A2), see the standard Connection Diagram ([JE5266-00](#)) in Appendix B.

⚠ WARNING If Bruno Output Relays are to drive inductive dc loads (e.g. a larger dc relay), an external protective diode **must** be applied at the dc coil to avoid equipment damage. See **Application Note** ([JD5011-00](#)).

PROCEDURE

1. De-energize and lock out all dc voltages to Bruno.
2. Allow internal voltages and heat to dissipate.
3. Route the output relay wiring to the Interface I/O Board (A2) through one of the unused enclosure knockouts.
4. Allow 30in / 762mm of wire inside the enclosure. Excess wire should be trimmed.
5. Route output relay wires to Bruno front panel door by following the existing harness past the door hinge. Use two (2) wire ties and allow a 4-6in / 102-153mm loop for the hinge.
6. Trim wires to the proper length for connection to Strip 0.25in / 6.4mm of insulation from the wires.
7. Make connections at the Output Relay contacts (A2-TB2).
8. Securely tighten all compression screws.
9. After checking all wires and connections, re-energize the system.

NOTES:

1. Relays feature one (1) set of form-C alarm contacts rated at 0.5A @ 125 Vac/Vdc (maximum).
2. TB2 is compression type, accepting #22-14 AWG wire.
3. Terminals are labeled in non-alarm condition.
4. If user alarm contacts (TB2) are to drive inductive dc loads (e.g. a larger dc relay) an external protective diode **must** be installed at the dc relay to avoid equipment damage. See *Application Note* ([JD5011-00](#)).

2 Wiring

2.2.3 Wiring Input Alarms

There are four (4) connections for Input Alarms on the Interface I/O Board (A2) at terminal block (TB1). These can be used to sense an external relay state from contact closures. The input alarms are 24 Vdc **wet** contacts. No external voltage is necessary. Each alarm can be assigned an alarm **name**, so they can be logged by Bruno as an event. In addition, the Input Alarms can be assigned to the Common Alarm, or one(1) of the other Output Relays on the Interface I/O Board (A2).

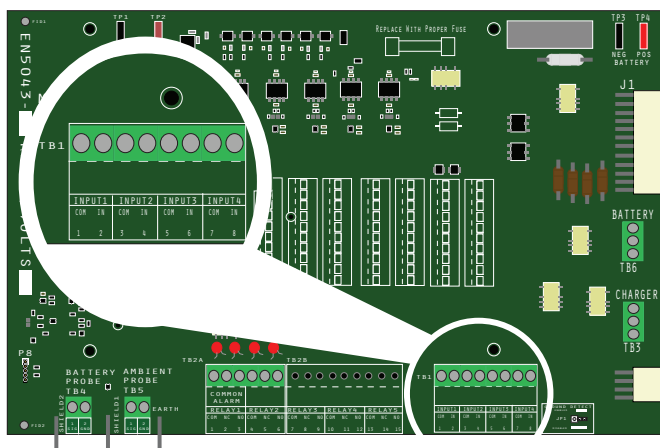


Figure 2-7

PROCEDURE

1. De-energize and lock out all dc voltages to Bruno.
2. Allow internal voltages and heat to dissipate.
3. Route the input alarm wires to the Interface I/O Board (A2) through one of the unused enclosure knockouts.
4. Allow 30in / 762mm of wire inside the enclosure. Excess wire should be trimmed.
5. Route input alarm wires to the Bruno front panel door by following the existing harness past the door hinge. Use two (2) wire ties and allow a 4-6in / 102-153mm loop for the hinge.
6. Trim wires to the proper length for connection to A2-TB1, and strip 0.25in / 6.4mm of insulation from the wires.

7. Make the connections at A2-TB1. Terminals are labeled in non-alarm condition.
8. Securely tighten compression screws. A2-TB1 is compression type, accepting wire sizes #22-14 AWG.
9. After checking all wires and connections, re-energize the system.

2.2.4 Wiring Temperature Probes

Two (2) types of temperature probes are used with Bruno:

1. Battery Temperature Probe (A10), connected to TB4
2. Ambient Temperature Probe (A42), connected to TB5

NOTICE *The temperature data will not record correctly and other temperature related functions will not operate properly if these temperature probes are not connected.*

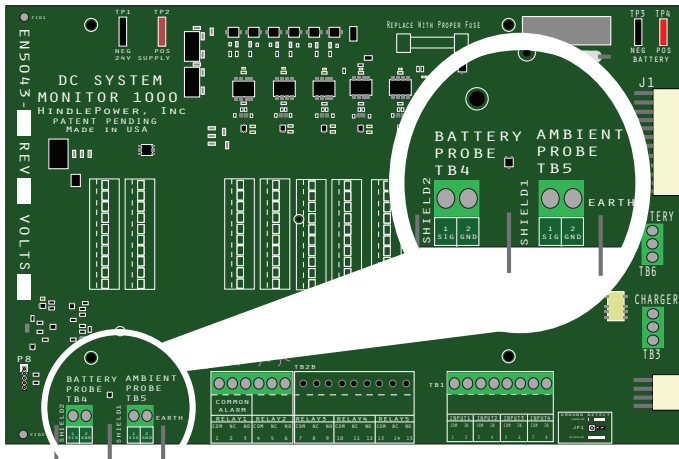


Figure 2-8

2 Wiring

2.2.5 Battery Temperature Probe

The Bruno Battery Temperature Probe (A10) is mounted to the battery. For VRLA or NiCd batteries, the probe is typically mounted to a cell near the **center** of the battery. This position should represent the average battery temperature, as some cells near the ends may differ in temperature. If there are several tiers of batteries in the series string, probe is often connected to the center cells on the top or highest tier. An alternate location for mounting the probe is on an inter-cell connector between adjacent cells. The two (2) wires from the probe are routed to the Interface I/O Board (A2) mounted on the back of the HMI (A1). These wires are secured by tightening the compression screws on terminal block (TB4). The shield wire from the temperature probe is connected to the “shield” connector on the Interface I/O Board (A2).

2.2.6 Ambient Temperature Probe

The Ambient Temperature Probe (A42) should be appropriately located to measure the average ambient temperature of the battery room. The probe should be located near the battery and half the distance from the floor to the ceiling on a wall. There should be no heat generating sources directly next to or near the probe.

The two (2) wires from the probe are routed to the Interface I/O Board (A2) mounted on the back of the HMI (A1). These wires are secured by tightening the compression screws on terminal block (TB5). The shield wire from the temperature probe is connected to the “shield” connector on the Interface I/O Board (A2).

2.2.7 Ground Fault Enable / Disable

To enable or disable the Ground Fault Circuit, move jumper (JP1) on the Interface I/O Board (A2) to the respective position as shown in Figure 2-9. It is recommended that the Ground Fault Circuit on Bruno be the **only** ground detection circuit in the dc system. If there is another ground fault circuit that must remain active, the sensitivity of all related ground fault circuits in the system will decrease.

NOTICE If Bruno ground fault circuit is disabled, the associated pages, trending and alarming will not operate correctly.

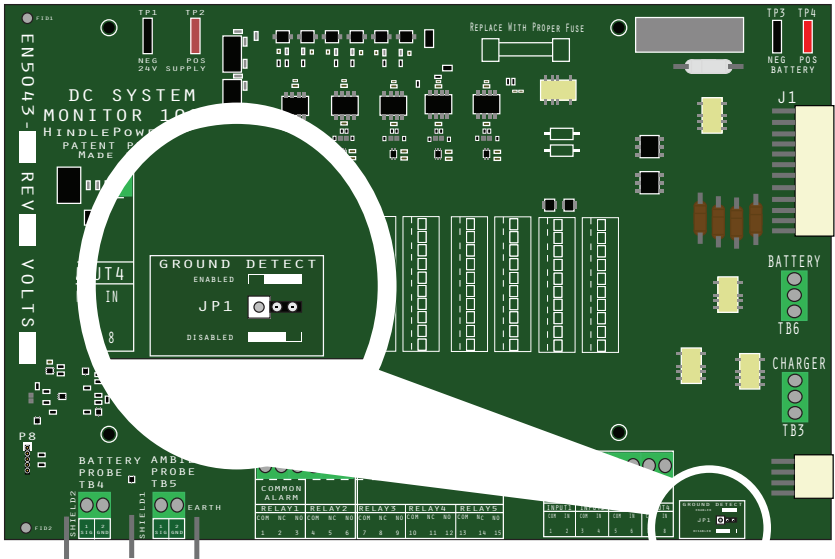


Figure 2-9

2 Wiring

2.2.8 Wiring Bruno Communications

2.2.8.1 Wiring Ethernet Connections

Ethernet connections on Bruno contain a standard RJ-45 connector with an integrated switch. It will support copper 10/100 Mbps Ethernet connections. Two (2) Ethernet ports are provided as standard on Bruno. The Ethernet communications ports support multiple protocols (e.g. Modbus and network-based functionality).

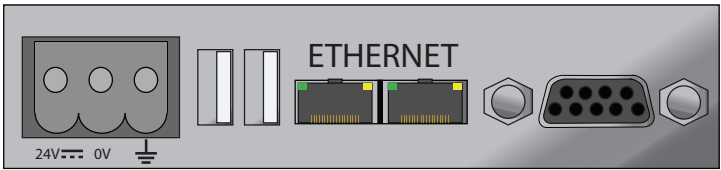


Figure 2-10

2.2.8.2 Wiring Serial Connections

One (1) Serial connection is provided as standard on Bruno.

- **Wiring RS-485 Connections:**
Serial RS-485 connections can be made by using a DB-9 connector. The appropriate pinout is shown below in Figure 2-11.

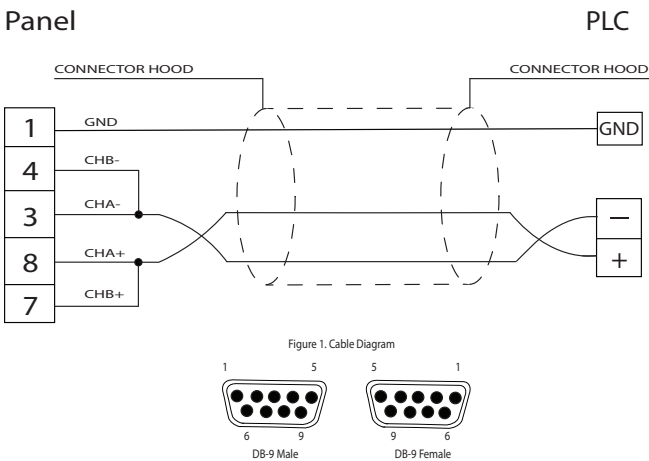


Figure 2-11

- **Wiring RS-232 Connections:**
Serial RS-232 connections can be made by using a DB-9 connector. The appropriate pinout is shown below in Figure 2-12.

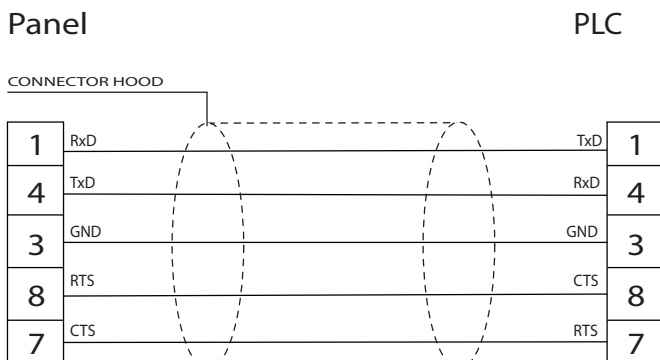
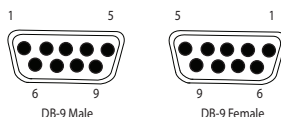


Figure 1: Cable Diagram



2.3 Internal Wiring

Bruno internal components are connected with flame-retardant Switchboard Insulation System (SIS) type wiring, identified on each end with number-coded markers. Power and signal wire insulation is black (non PVC). All ground wires are green with yellow stripe.

For a point-to-point Connection Diagram of Bruno's internal components, refer to detail drawing ([JE5266-00](#)).

3 Startup & Configuration

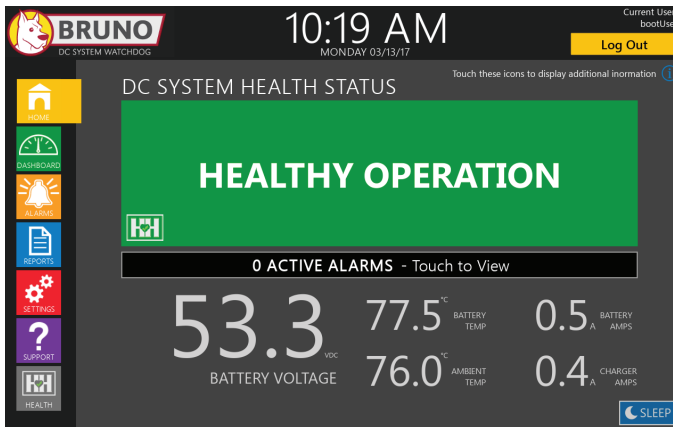
3.1 HMI Display Orientation

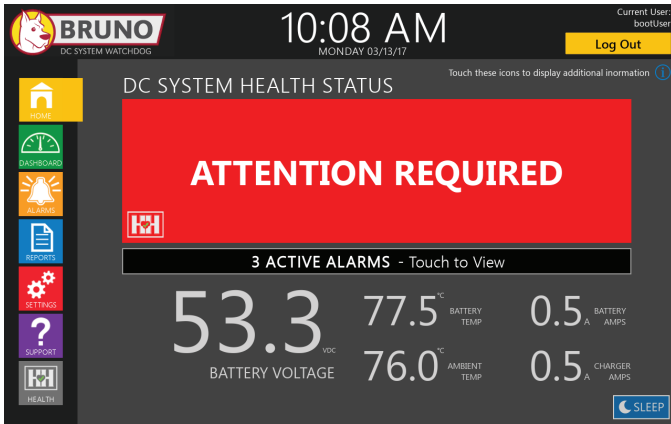
The Bruno HMI display (A3) is a high-resolution “capacitive” touch screen. All controls are entered by touch on the active screen surface. There are seven (7) main pages indicated by icons on the left side of each screen. These icons used for navigating the different pages of Bruno are:

- HOME
- DASHBOARD
- ALARMS
- REPORTS
- SETTINGS
- SUPPORT
- HEALTH

The current date, day and time is located in the top center of all of the main pages.

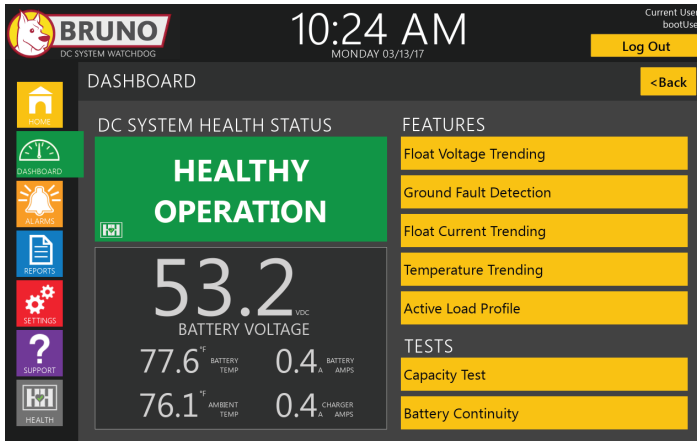
3.1.1 HOME





The HOME page shows the current dc system health status, and alerts the user of any active alarms.

3.1.2 DASHBOARD



The DASHBOARD page shows the current dc system health status, as well as key current operating parameter conditions of the system (e.g. Battery Voltage, Battery Amps, Charger Amps, Battery Temperature, and Ambient Temperature).

NOTICE Provided that the battery is **not** charging or discharging, "Charger Amps" represents total dc system current loading.

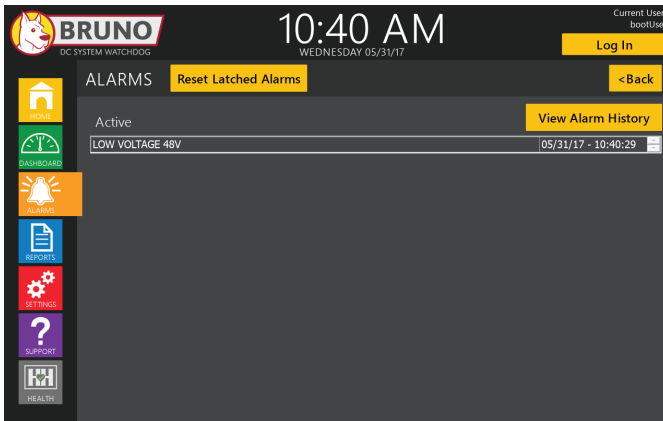
3 Startup & Configuration

To access the main features of Bruno use the following icons:

- Float Voltage Trending
- Ground Fault Detection
- Float Current Trending
- Temperature Trending
- Active Load Profile (Facility Demand)
- Capacity Test
- Battery Continuity

Pressing each button will take you to an individual page which graphically depicts the monitored or collected data for the parameter. The details of each of these features are discussed in detail in Section 3.3.

3.1.3 ALARMS



The ALARM page displays current status of any active alarm, type of alarm, date of the alarm, and the Alarm Limit value exceeded. It also shows details of historical alarms that have occurred. Up to one (1) month of past alarms can be indicated on the screen showing the description, start time, and date of the alarms. After one (1) month, alarms are archived in the internal database and may be accessed through the REPORTS page.

3.1.4 REPORTS

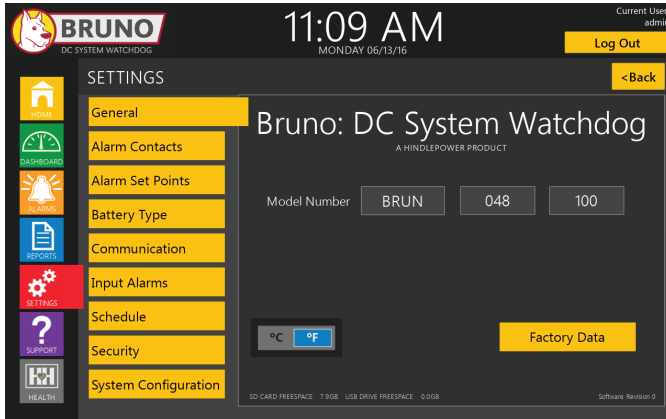


The REPORTS page is used to generate standardized PDF reports and CSV files containing raw data. The user selects the reports and/or data they want to download and selects “Generate Reports”. A box will appear and ask the user to insert a thumb drive into the front panel connector (P-USB). After inserting the drive, a second page appears which prompts the user for the report time period, company name, battery and substation identification information which will be added into the report.

3 Startup & Configuration

3.1.5 SETTINGS

NOTICE Users with a “read only” access level will be able to view Bruno settings, but will not be able to modify them.



The buttons on the left side of this page take the user to specific settings sections. For specific detail on how to input settings into Bruno, see Section 3.3. There are nine (9) subset sections of the SETTINGS page:

3.1.5.1 General

The General Settings page displays Bruno DC System Watchdog model number. The date and time are adjusted (or set) on this page, as well as whether temperature parameters are displayed either in Fahrenheit (°F) or Centigrade (°C). Factory Data can also be accessed from this page. Contact your service provider if it is necessary to make changes to these parameters.

3.1.5.2 Alarm Contacts

There are a total of two (2) standard relay contacts in Bruno. One (1) of which is a Common Alarm relay. On the Alarm Contacts page, these relays can be set as non-latching (default), or latching. The time delay of all relays can be set from 0 to 999 seconds. Relays that are set as latching can be force-reset from this page. A test button is included on this page for each relay to test that the relay is functioning properly.

3.1.5.3 Alarm Set Points

The standard alarms that can be configured on this page are:

- DC System Bus Voltage
- Battery Float Voltage
- DC System Ground Fault
- High Float Current
- High Battery Temperature
- Low Battery Temperature
- High Battery Temperature Difference
(battery temperature rise above ambient)
- Battery Continuity

3.1.5.4 Battery Type

The battery manufacturer, model, and discharge data are entered into this page. These parameters are used in the calculation of battery capacity when performing a discharge capacity test.

- **Manufacturer Data:** The battery manufacturer, model, type, Ampere-hour rating, and system voltage are entered.
- **Battery Set Points:** Basic battery information is entered such as number of cells, specific gravity, high and low battery per cell float voltage.
- **Discharge Data:** Nine (9) data points for discharge data can be entered for a specific end voltage. Time is entered in hours and discharge current values in Amperes. This data will be used to calculate battery capacity from a discharge capacity test. The value above and below the discharge rate must be entered for proper results.

3.1.5.5 Communication

Set and configure the available communication protocols of Bruno.

- Modbus over Serial
- Modbus over Ethernet

3 Startup & Configuration

3.1.5.6 Input Alarms

There are four (4) input alarms. Each can be assigned a custom alarm name. For each input alarm, the user can set the contact as normally-open (NO) or normally-closed (NC). The user can also assign the alarm output to one (1) of two (2) alarm relays, and decide whether to alert the common alarm. Each input alarm can be tested by using the “Test Alarm” button.

3.1.5.7 Schedule

The Schedule page defines the required NERC inspection or test activities and intervals. It also defines when the last activity took place, and when the next activity is required.

3.1.5.8 Security

The Security page allows administrative control to limit access to Bruno based on need. It allows a system administrator to add, delete and edit users access to portions of Bruno.

3.1.5.9 System Configuration

The System Configuration allows the user to input details of the battery charger connected to the dc system:

- charger type
- Ampere rating
- temperature compensated
- voltage sense (remote or internal)

3.1.6 SUPPORT

The SUPPORT page provides contact information for technical service and sales support.

3.1.7 HINDLE HEALTH SYSTEM

- Testing

This page allows you to input additional test data for specific test requirements related to NERC compliance. These are:

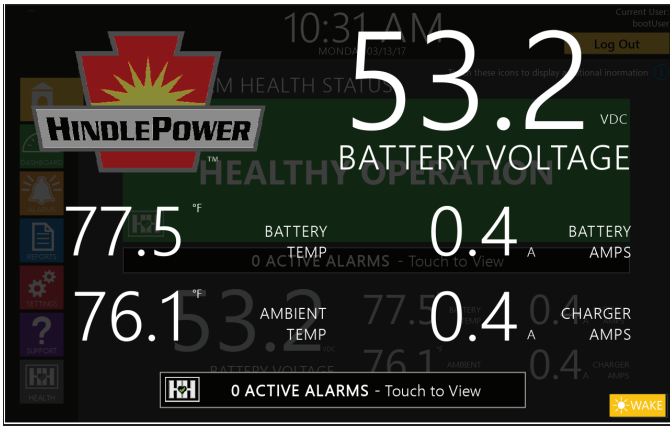
- » Connection Resistance
- » Electrolyte Levels
- » Condition of Rack
- » Visual Inspection

- Setup Wizard

This section allows the operator to change or input basic setup information into the unit:

- » Adjust the NERC maintenance requirement schedule.
- » Configure the system alarm settings.
- » Adjust basic battery information and alarm parameters.
- » Adjust third-party input alarm parameters.

3.1.8 SLEEP



The SLEEP page shows the key current operating parameters of the system (e.g. Battery Voltage, Battery Current, Charger Current, Battery Temperature, and Ambient Temperature). The key parameters on this page are large so they can easily be seen from a distance. The backlight on the page is dimmed to reduce power consumption and act as a screen saver.

3 Startup & Configuration

3.2 Starting Bruno

⚠ WARNING It is important to check for the proper polarity at all connection points. Using a digital multimeter, check the polarity of the battery, charger, system load and auxiliary wiring, including remote sense wiring. Failure to have proper polarity will result in damage to the equipment, possible injury, and even death!

3.2.1. Checking Installation

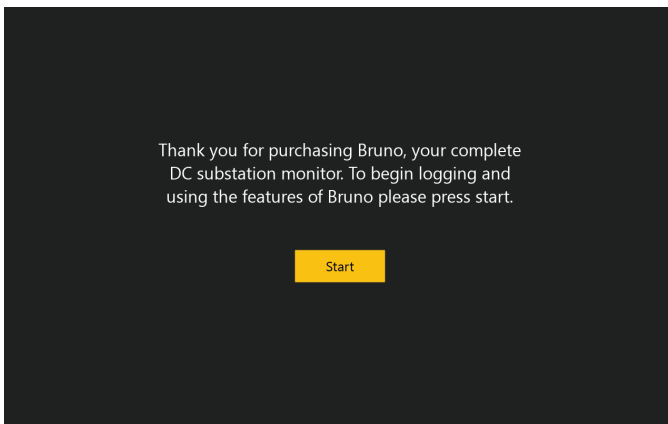
Confirm installation instructions are followed carefully. Check the polarity of the charger, battery, system loads, and auxiliary wiring.

NOTICE There is no ac input supply to Bruno.

3.2.2. Understanding Startup Sequence

Once polarity has been checked, with the Battery Disconnect (SW1) and Charger Disconnect (SW2) in the open position, power the battery charger to its normal operating state. With the charger in operation, switch the Charger Disconnect (SW2) to the closed (on) position. Bruno will power on and go through start-up sequence.

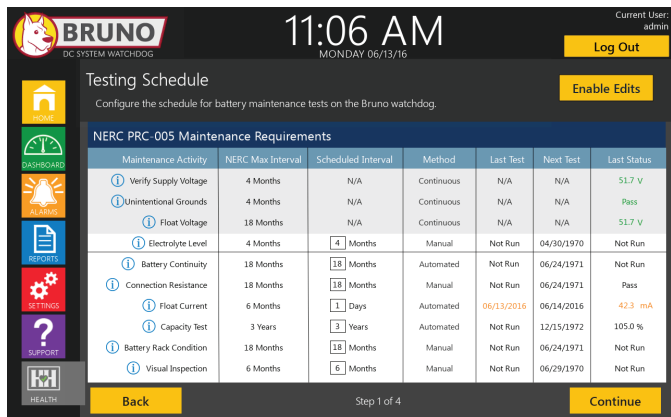
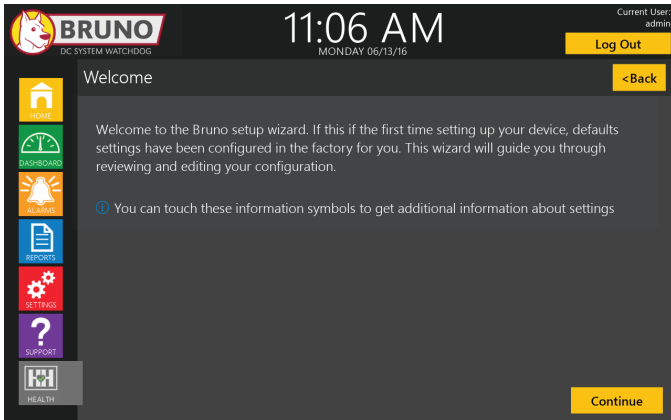
When the boot sequence has completed, the HOME screen will display. If Bruno is being powered on for the first time, a page will appear prompting the user to press start to begin recording data as seen as seen in the following graphic. At this point, close the Battery Disconnect Switch (SW1), connecting the battery to the dc system. If this is the first time powering up Bruno, the user will be prompted to press start to begin recording data, and should do so at this time.




3.2.3 Bruno Quick Start Menu

After the boot sequence is complete, the Bruno HOME page will display. Default parameters set at the factory will be active on Bruno. By pressing the HEALTH button the user can access the Setup Wizard, which will walk the user through verifying or changing critical parameters. If the Date and Time displayed are incorrect, they can be changed by going to the SETTINGS page. All of the parameters that can be changed in the Setup Wizard can be changed on the SETTINGS page.

The following screens are from the “Setup Wizard”. Parameters shown in any of the boxes can be edited or changed by pressing “Enable Edits”. Over-writing or changing any parameter results in an immediate change to that parameter.



3 Startup & Configuration

**BRUNO**
DC SYSTEM WATCHDOG

11:07 AM
MONDAY 06/13/16

Current User:
admin

Log Out

Enable Edits

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT

HEALTH

System Alarms


Configure the trigger values and relay mappings for system alarms.

Alarm	Setpoint	Output Relay	Triggers Common Relay
Battery Continuity	N/A	None	✓
Battery Temperature Deviation From Ambient	15.0	None	✓
Low Bus Voltage	48.0 V	None	✓
High Bus Voltage	57.6 V	None	✓
Ground Imbalance Voltage	10.0 V	None	✓

Back

Step 2 of 4

Continue

**BRUNO**
DC SYSTEM WATCHDOG

11:08 AM
MONDAY 06/13/16

Current User:
admin

Log Out

Enable Edits

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT

HEALTH

Battery Setup

Battery parameters and alarm configuration

Battery Info

Manufacturer

Model

Type **VRLA**

Ah Rating **0**

Number of Cells **24**

System Voltage **48.0**


Nominal Specific Gravity **1.125**

Battery Parameters

Alarm	Setpoint	Output Relay	Triggers Common Relay
Discharge	N/A	None	✓
Low Temperature	50.0 °F	None	✓
High Temperature	87.0 °F	None	✓
Low Float Voltage	48 V	None	✓
High Float Voltage	57.6 V	None	✓
High Float Current	100 mA	None	✓

Back

Continue

**BRUNO**
DC SYSTEM WATCHDOG

11:08 AM
MONDAY 06/13/16

Current User:
admin

Log Out

Enable Edits

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT

HEALTH

Third-Party Alarms

Third-party alarms can be input into the Bruno watchdog by using a contact closure to connect two terminals of the unit. Names can be assigned to these custom alarms and the normal operation state of the contact can be specified. For wiring information, please refer to the user manual or setup guide.

Input	Input Contact Type	Alarm Name	Output Relay	Triggers Common Relay
Input 1	N.O.	Custom Alarm 1	None	✓
Input 2	N.O.	Custom Alarm 2	None	✓
Input 3	N.O.	Custom Alarm 3	None	✓
Input 4	N.O.	Custom Alarm 4	None	✓

Back

Step 4 of 4

Continue

After the start-up is complete, Bruno will return to the HOME page and indicate dc system health status.

3.3 Configuring Bruno

Bruno is a new generation of dc system monitors. It was designed to monitor the entire dc system (charger, battery, and dc loads), and provide a simple report structure to give the user a detailed snapshot of dc system health. It also helps troubleshoot parts of a dc system that needs attention. This section details how to configure Bruno.

You can change the settings of Bruno using the capacitive touch screen while the system is operating. The changes you make take effect immediately and are saved internally. If Bruno is taken out of service (powered off), and then later returned to service, Bruno restarts, using the last set values.

3.3.1 SETTINGS Page

The main page utilized for making setting changes to Bruno is the SETTINGS page. There are nine (9) buttons associated with this page to access other pages for setting parameters. These are:

- General
- Alarm Contacts
- Alarm Set Points
- Battery Type
- Communication
- Input Alarms
- Schedule
- Security
- System Configuration

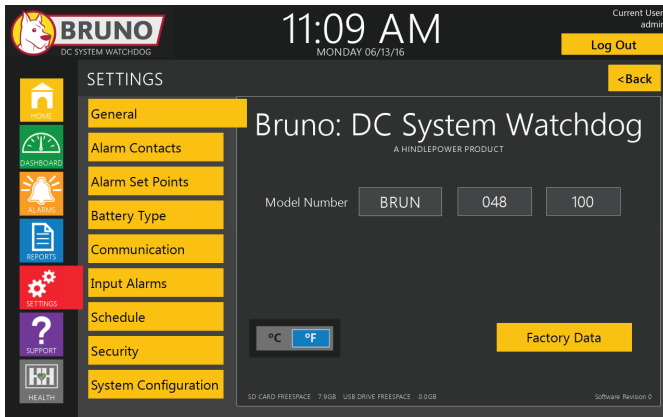
3 Startup & Configuration

3.3.2. General Parameter Settings

The General settings page displays the Bruno factory-coded model number. Temperature parameters are displayed in Fahrenheit (°F) or Centigrade (°C). Time is displayed in a 12-hour clock. Factory Data settings can also be accessed from this page. However, these areas are password protected. Contact your service provider if it is necessary to make changes to these parameters.

Procedure

- Bruno Model Number is shown on this screen. This number cannot be changed or edited.
- The current date and time is changed thru Settings -> General -> Factory Data -> Time. A Windows number keypad will appear to modify the date and time.
- To change all temperature parameters from Centigrade (°C) to Fahrenheit (°F), touch the temperature parameter you wish to use, until the correct parameter is highlighted. Only one (1) temperature parameter can be used for all temperature readings on Bruno.
- The factory data button is protected, and only available to the administrator. Contact your service provider to make changes to these settings.



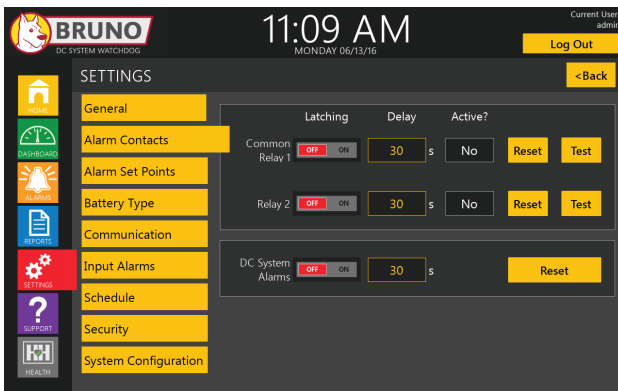
3.3.3 Setting the Active Alarm Contacts

There are a total of two (2) standard relay contacts in Bruno. One (1) of which is a Common Alarm relay. These relays can be set as non-latching (default) or latching and active or not active. The time delay of all relays can be set from 0 to 999 seconds. Relays that are set as latching, can be force reset from this page. A test button is included on this page for each relay to test that the relay is functioning properly.

PROCEDURE

- Two (2) alarm contact relays exist (Relay 2 and Common). They can be set as either “latching” or “non-latching”, by touching the “ON”(green) or “OFF”(red) part of the Latching switch.
- The delay time of each alarm relay is set by touching Delay Time Number. A keypad will appear.
- Enter the time delay you require and press “enter” on the keypad. This will change the time delay.
- A box next to the time delay adjustment indicates whether the relay is active “YES” or not “NO”.
- To force a latching relay to reset, press the “Reset” button next to the appropriate relay.
- Pressing the relay “Test” button activates the relay as long as the button is held. This verifies the relay is functioning properly.

NOTICE *This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.*



3 Startup & Configuration

3.3.4 Setting Alarm Set Points

Standard alarm set points are set or adjusted on this page.

This page shows all eight (8) standard alarms:

- DC System Bus Voltage
 - » DC System High Voltage
 - » DC System Low Voltage
- Battery Float Voltage
- DC System Ground Fault
- High Float Current
- High Battery Temperature
- Low Battery Temperature
- High Battery Temperature Difference
(temperature difference between battery and ambient)
- Battery Continuity

If needed, one (1) of these alarms can be assigned to the Interface I/O Board (A2) configurable relay (Relay 2). Contacts for Relay 2 are accessible from terminal block (TB2A-4/5/6). Each alarm can also be set to trigger the Common Alarm (Relay 1), if required. The user can also test each individual alarm on this page. The dc ground fault alarm has settings for both positive (+) and negative (-) ground fault voltage.

3.3.4.1 DC System Voltage

The screenshot displays the BRUNO DC System Watchdog interface. At the top, the time is 11:10 AM on Monday 06/13/16, and the current user is 'admin'. The 'SETTINGS' menu is open, showing various configuration options. The 'Alarm Set Points' option is selected, leading to a screen where specific alarm thresholds can be configured. The 'DC System Bus Voltage' alarm is highlighted, showing a set point of 57.6 V. Other alarms listed include Battery Float Voltage, DC System Ground Fault, High Float Current, High Battery Temperature, Low Battery Temperature, High Temperature Difference, and Battery Continuity. The 'Test Alarm' button is used to verify the alarm functionality.

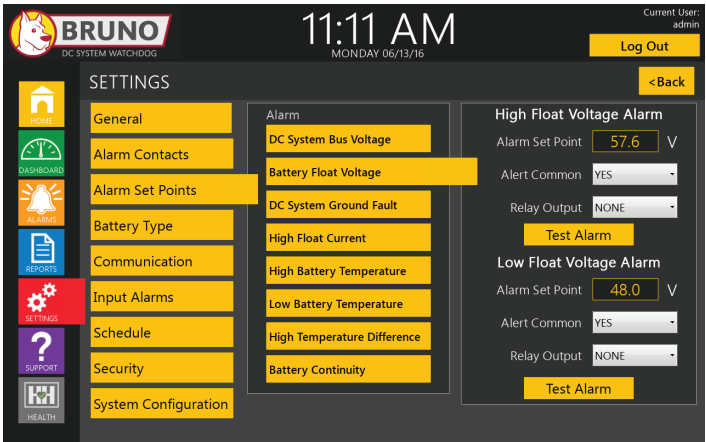
Procedure

- To adjust the DC System Bus Voltage settings, touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm set point and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can either be set to have a relay output or none. Touch the drop down arrow and select “none” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3 Startup & Configuration

3.3.4.2 Battery Float Voltage



Procedure

- To adjust the Battery Float Voltage settings touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm set point and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3.3.4.3 DC System Ground Fault



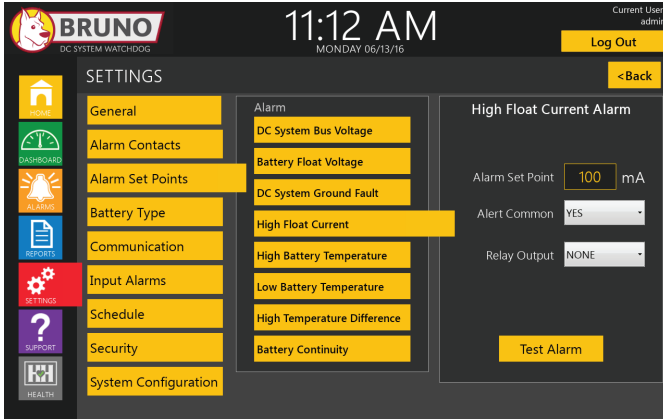
Procedure

- To adjust the Ground Fault settings touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm setting and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3 Startup & Configuration

3.3.4.4 High Float Current Alarm



Procedure

- To adjust the High Float Current Alarm settings touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm set point and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3.3.4.5 High Battery Temperature Alarm



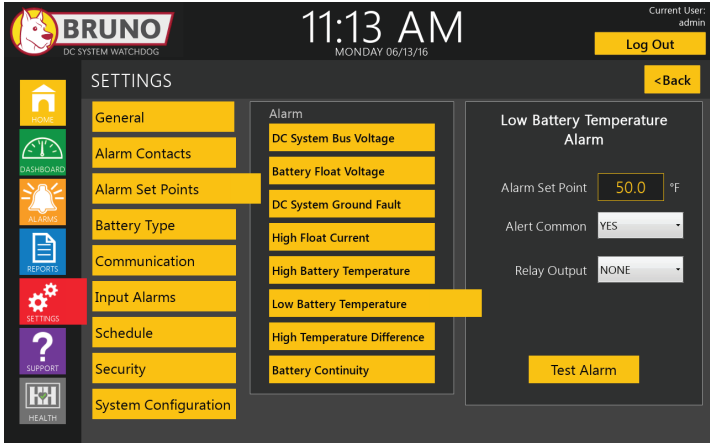
Procedure

- To adjust the High Battery Temperature Alarm settings touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm setting and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3 Startup & Configuration

3.3.4.6 Low Battery Temperature Alarm

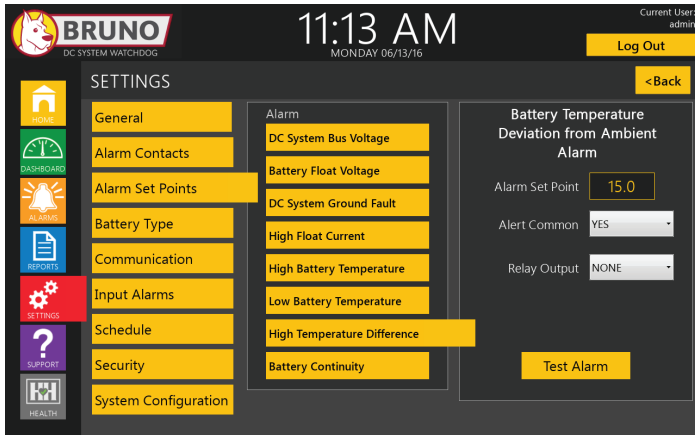


Procedure

- To adjust the Low Battery Temperature Alarm settings touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm setting and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3.3.4.7 High Battery Temperature Difference Alarm



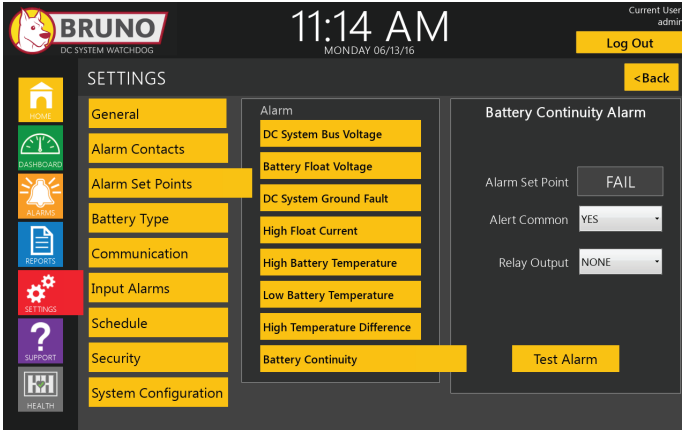
Procedure

- To adjust the High Battery Temperature Difference Alarm settings touch the “Alarm Set Point” box. A keypad will appear.
- Enter the value of the alarm setting and press “enter”.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3 Startup & Configuration

3.3.4.8 Battery Continuity Alarm



Procedure

- Battery Continuity does not have a set point. This is a pass/fail test. The voltage setting at which the test fails is pre-set at the factory at 10% below the bus voltage.
- If you wish the alarm to alert the common alarm, touch the drop down arrow and select either “YES” or “NO”.
- The alarm can be set to have a relay output or none. Touch the drop down arrow and select “NONE” or “desired relay”.
- Press the “Test Alarm” button to test the alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3.3.5 Loading Battery Type Data

The information in this section is used by Bruno to calculate battery capacity, calculate correct float charge current values and establish set point parameters for the battery operation. Information can only be entered manually in this section. On request, the information can be pre-installed or programmed into Bruno at the factory.

3.3.5.1 Manufacturer Data

The screenshot shows the Bruno DC System Watchdog interface. At the top, the logo and 'DC SYSTEM WATCHDOG' are on the left, the time '11:14 AM' and date 'MONDAY 06/13/16' are in the center, and 'Current User: admin' with a 'Log Out' button is on the right. A left sidebar contains icons for Home, Dashboard, Alarms, Reports, Settings (highlighted), Support, and Health. The main area is titled 'SETTINGS' and contains a list of menu items: General, Alarm Contacts, Alarm Set Points, Battery Type, Communication, Input Alarms, Schedule, Security, and System Configuration. A 'Battery Information' sub-menu is open, showing 'Manufacturer Data' (highlighted), 'Battery Set Points', and 'Discharge Data'. The 'Manufacturer Data' screen displays input fields for 'Manufacturer', 'Model', 'Type' (a dropdown menu currently showing 'VRLA'), 'Ah Rating' (set to '0'), and 'System Voltage' (set to '48.0'). A '<Back' button is in the top right corner of the settings area.

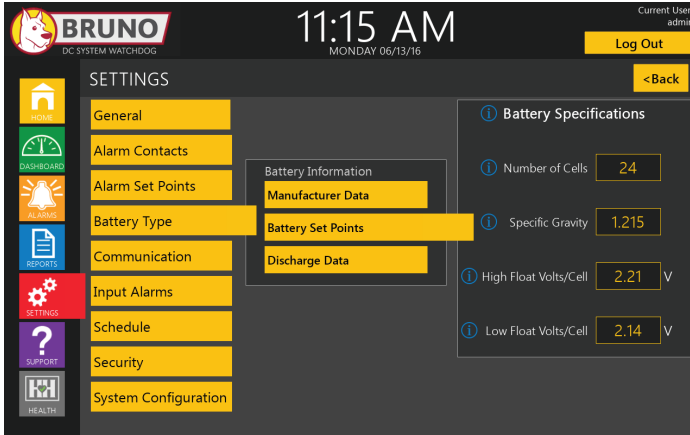
Procedure

- To enter the manufacturer and model number of the battery, touch the appropriate box and a full keyboard will appear.
- Enter the information and press “Enter”.
- To enter the type of battery touch the drop down arrow and select either “VRLA”, “Vented Lead-Acid”, or “Ni-Cad”.
- To enter the Ah Rating of the battery, touch the “Ah Rating” box and a full keypad will appear. Enter the required information and press “Enter”.
- To enter the System Voltage of the battery, touch the “System Voltage” box and a full keypad will appear.
- Enter the required information and press “Enter”.

NOTICE Ah rating for lead acid batteries is typically the 8 hour capacity to an end voltage of 1.75V/cell at 77 °F. For a nickel cadmium battery this rating is typically the 5 hour capacity to an end voltage of 1.00V/cell at 68 °F. Consult the battery manufacturer for other ratings.

3 Startup & Configuration

3.3.5.2 Battery Set Points



Procedure

- To enter the number of cells in the battery touch the “Number of Cells” box. A keypad will appear.
- Enter the required number of cells and press “enter”.
- To enter the specific gravity of the battery, touch the “Specific Gravity” box. A pop up keypad will appear.
- Enter the required value and press “enter”.
- To enter the value of the high float voltage per cell, touch the “High Float Volts/Cell” box. A pop up keypad will appear.
- Enter the required value and press “enter”.
- To enter the value of the low float voltage per cell, touch the “Low Float Volts/Cell” box, a pop up keypad will appear. Enter the required value and press “enter”.

3.3.5.3 Battery Discharge Data

Discharge Rate Table

Number of table entries (2-9)

Discharge Time (hours)	Discharge Rate (Amps)
<input type="text" value="8.0"/>	<input type="text" value="6.0"/>
<input type="text" value="6.0"/>	<input type="text" value="8.0"/>
<input type="text" value="5.0"/>	<input type="text" value="9.0"/>
<input type="text" value="2.0"/>	<input type="text" value="17.0"/>
<input type="text" value="1.0"/>	<input type="text" value="26.0"/>

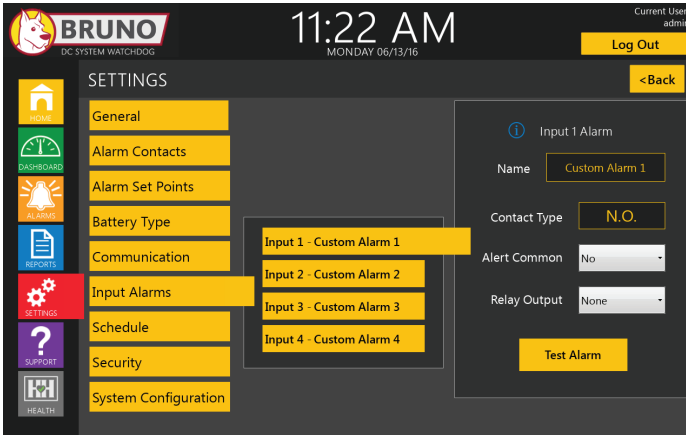
Procedure

- There are up to nine (9) pairs of input data points for time and current values that can be entered for a specific discharge end voltage. Enter the number of table entries from 2 - 9.
- To input the discharge time and current settings touch the adjacent boxes below the “Discharge Time in Hours” and “Discharge Rate in Amps”. A keypad will appear.
- Enter the value of the time and discharge current setting for each value and press “Enter”.
- The discharge data input should match the Ah capacity rating entered and the discharge end voltage expected for the Ah capacity (e.g. 100Ah at the 8hr rate to 1.75V/cell - the discharge data used should be for an end voltage of 1.75V/cell).
- Data above and below the average discharge time should be entered for proper operation.

NOTICE Battery discharge data can be obtained using battery manufacturer’s data sheet.

3 Startup & Configuration

3.3.6 Setting Input Alarms



- There are four (4) input alarms in Bruno.
- Each input can be given a custom name. To enter a custom name, touch the “Input Alarm Name” box, a keyboard appears.
- Enter the name and press “Enter”.
- Each alarm set point can be set as either, normally-open (NO) or normally-closed (NC). This is set by touching the “Contact Type” box to indicate either NO or NC.
- Each alarm can be assigned to a relay output. To assign a relay output, touch the drop down box for “Relay output” and select either None, or Relay 2.
- To alert the common alarm, touch the drop down box for “Alert Common” and select “Yes” or “No”.
- Press the “Test Alarm” button to test each alarm function.

NOTICE This will create an entry in the Alarm Log. Do not use this test function without notifying a supervisor this test is being performed.

3.3.7 Schedule

The Schedule section of the SETTINGS page provides information on the maintenance requirements activities, maximum activity interval per **NERC PRC-005***, current scheduled interval last activity date, and next scheduled activity date.

PROCEDURE

- Scheduled intervals (months, days or years) can be edited based on the users' requirements by typing in the required interval.
- Touch the "Schedule Interval Box" to change. A keypad will appear.
- Enter the required number and press "Enter". The "Next Test" date is automatically scheduled based on the "Last Test" date.

** The North American Electric Reliability Corporation (**NERC**) establishes required test intervals for particular parameters and is defined to aid the Electric Utility entity meet their Protection System Maintenance Program (PSMP) test requirements.*

*The test intervals specified in Bruno are based on the **PRC-005** standard revision in effect at the time of the last installed software release. Always check to be sure the current installed test intervals meet the present NERC standard revision requirement.*

- The following tests and checks are scheduled in this section in accordance with NERC PRC-005*:
 1. Verify Supply Voltage
 2. Unintentional Grounds
 3. Float Voltage
 4. Electrolyte Level
 5. Battery Continuity
 6. Connection Resistance
 7. Float Current
 8. Capacity Test
 9. Battery Rack Condition
 10. Visual Inspection

3 Startup & Configuration



08:23 AM
FRIDAY 09/16/16

Current User:
default user

Log In

SETTINGS

Home

Dashboard

Alarms

Reports

Settings

Support

Health

General

Alarm Contacts

Alarm Set Points

Battery Type

Communication

Input Alarms

Schedule

Security

System Configuration

NERC PRC-005 Maintenance Requirements

Maintenance Activity	NERC Max Interval	Scheduled Interval	Last Test	Next Test
① Verify Supply Voltage	4 Months	Continuous	N/A	N/A
① Unintentional Grounds	4 Months	Continuous	N/A	N/A
① Float Voltage	18 Months	Continuous	N/A	N/A
① Electrolyte Level	4 Months	4 Months	09/16/2016	01/14/2017
① Battery Continuity	18 Months	18 Months	09/12/2016	03/06/2018
① Connection Resistance	18 Months	18 Months	09/16/2016	03/10/2018
① Float Current	6 Months	18 Days	09/15/2016	09/16/2016
① Capacity Test	3 Years	3 Years	Not Run	09/01/2019
① Battery Rack Condition	18 Months	18 Months	09/16/2016	03/10/2018
① Visual Inspection	6 Months	6 Months	09/16/2016	03/15/2017

- The following baseline parameters are recorded once every hour. These event logs cannot be modified:
 1. float voltage
 2. ambient temperature
 3. battery temperature
 4. ground Imbalance (unintentional grounds)
 5. supply voltage

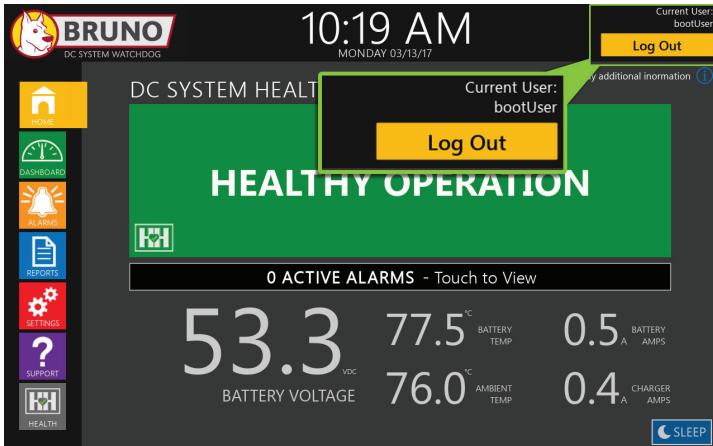


3.3.8 Security

This section allows the user to set up security for Bruno. Different levels of security restrict access to some features of Bruno.

3.3.8.1 Logging In

The top right corner of the screen has a “Log In” button and indicates the name of the “current user”. Press this button to change the current user and level of access.



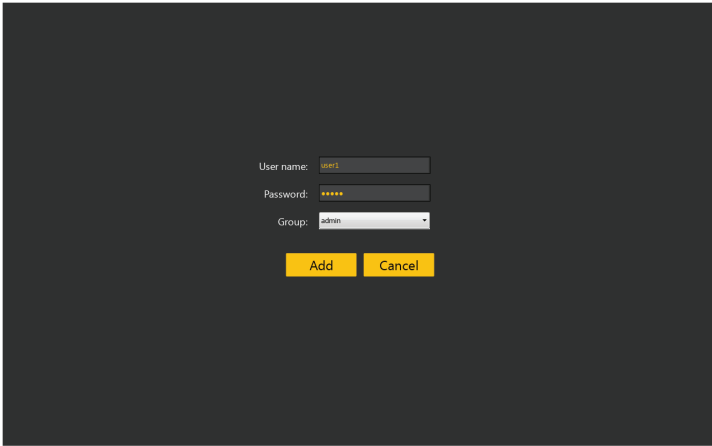
3.3.8.2 Restricting Access to Bruno Users

Bruno can be configured for a tiered user level structure that limits access to certain features and read/write abilities. Logging in or out will be saved to the event log. The below settings can be accessed from the Settings > Security menu on Bruno.

3 Startup & Configuration

3.3.8.3 Adding Users

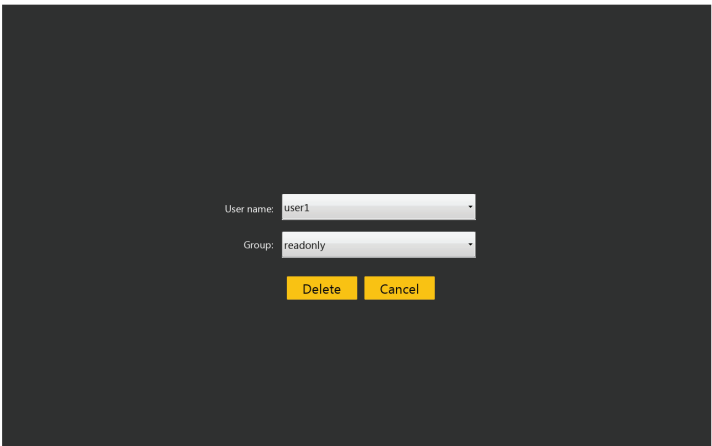
To add a user, a group, user name, and password must be given to each user. Settings on passwords, log off time, and comments can be made from this page at the time of user creation. There is no limit to the number of users permitted.



A screenshot of a web interface for adding a user. The background is dark gray. The form is centered and contains the following elements: a text input for 'User name' with 'user1' entered, a password input for 'Password' with six asterisks, and a dropdown menu for 'Group' with 'admin' selected. Below these inputs are two yellow buttons: 'Add' and 'Cancel'.

3.3.8.4 Deleting Users

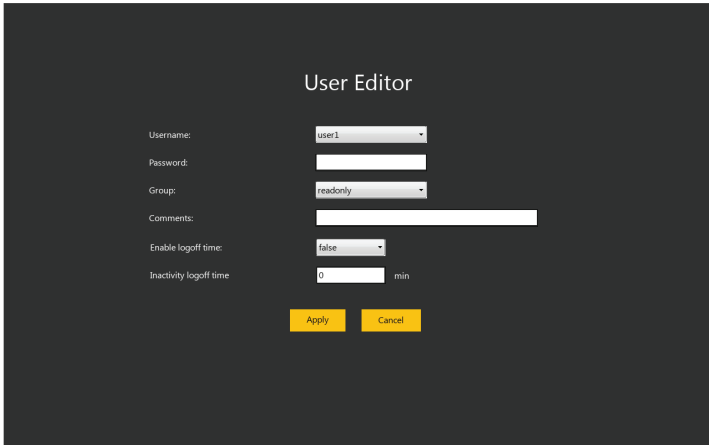
To remove a user, select the user name and group from the drop-down menu and press the delete button. Be careful not to delete admin user.



A screenshot of a web interface for deleting a user. The background is dark gray. The form is centered and contains the following elements: a dropdown menu for 'User name' with 'user1' selected, a dropdown menu for 'Group' with 'readonly' selected, and two yellow buttons: 'Delete' and 'Cancel'.

3.3.8.5 Editing Users

Changes to existing users can be made from this page. The admin user can change the password, log off time, and other user related parameters.



The screenshot shows a 'User Editor' form with the following fields and values:

Field	Value
Username:	user1
Password:	
Group:	readonly
Comments:	
Enable logoff time:	false
Inactivity logoff time:	0 min

At the bottom of the form are two buttons: 'Apply' and 'Cancel'.

3.3.8.6 User Groups

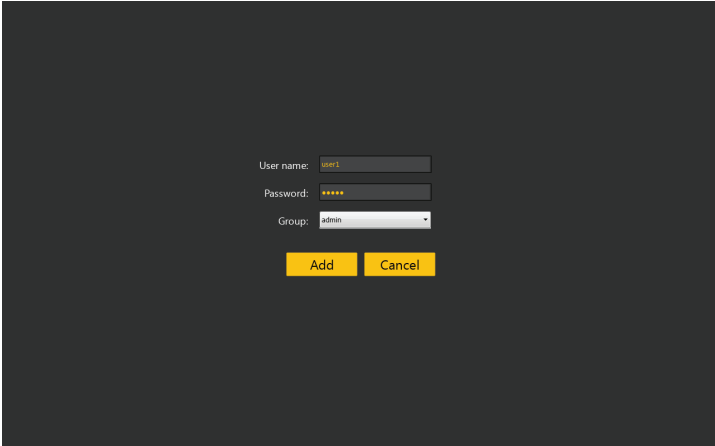
Users can be set to have four various user group levels. The user group levels standard on Bruno are “all access”, “read only”, “test only”, and “no access”. The user groups consist of different levels of permissions for the accessing user.

- **All access** – This allows the accessing user to access all allowable features in Bruno.
- **Read Only** – This user group allows the user to only view settings but not perform any tests or change any settings.
- **Test Only** – This user group allows the user to perform tests and change test related settings. No changes to non-test related settings can be made.
- **No Access** – This user group allows the user to only access the sleep page and related functionality.

3 Startup & Configuration

3.3.8.7 Boot User

Upon start-up of Bruno the boot user is automatically loaded on startup, or when logging out of another user profile. This user can be restricted to a specific level of functionality using the “edit users” function.



The screenshot shows a dark-themed user management interface. In the center, there is a form with three input fields: 'User name:' containing 'user1', 'Password:' containing five asterisks, and 'Group:' with a dropdown menu showing 'admin'. Below these fields are two yellow buttons: 'Add' and 'Cancel'.

3.3.9 System Configuration

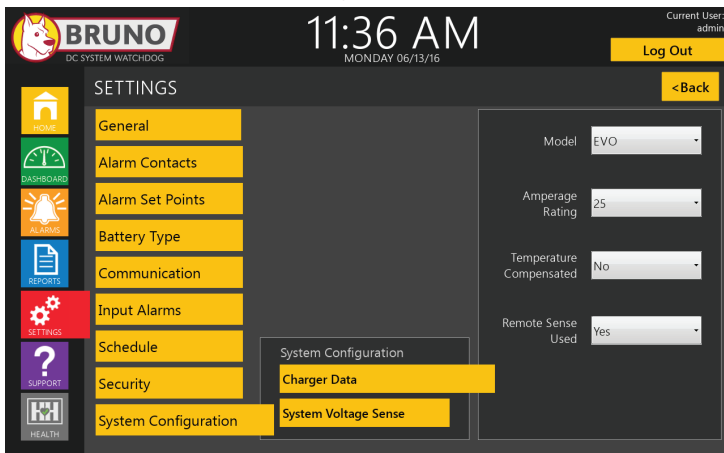
This section allows the user to input important information about the battery charger into Bruno.

3.3.9.1 Charger Data

This menu allows the user to edit battery charger information such as the model, dc output current rating, if temperature compensation is active, and if remote voltage sense is used.

PROCEDURE

- Bruno will interface with any industrial battery charger. The drop down box allows the user to select charger type:
 - » ATevo
 - » AT10.1
 - » AT30
 - » generic
- The “Amperage Rating” box selects the nominal dc current output rating of the battery charger (e.g. 25A, 50A, 75A, 100A, and 150A).
- For the “Temperature Compensated” drop down box, select either “Yes” or “No” to indicate whether the dc output of the battery charger is temperature compensated.
- The “Remote Sense Used” drop down box will define where the voltage sense for the charger is placed. Select either “Yes” for battery, or “No” for charger.



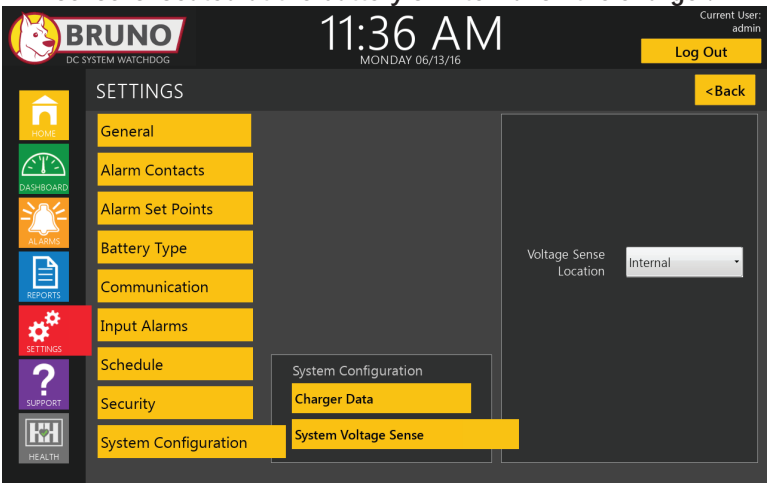
3 Startup & Configuration

3.3.9.2 System Voltage Sense

This section determines the location of the “Remote Sense”.

PROCEDURE:

- Indicate with the drop down box whether the remote voltage sense is located at the battery or internal on the charger.



NOTICE Internal voltage sense must be used when performing a capacity test using Bruno. This system setting must be set to “external (at the battery)” when using remote voltage sensing.

(future)

4 Basic Operation

4.1 Basic Operation

Bruno is designed as the interface between the battery charger, the battery, and the loads in a dc system. It is designed to aid the facility engineer in determining the reliability of the dc system. It also helps meet documentation, monitoring, and maintenance program requirements of the North American Energy Reliability Corporation (NERC).

Bruno is programmed to alert the user when any parameter within the dc system is out of an established range. These parameters include dc system voltage, battery float voltage, battery float current, ambient and battery temperature, and the temperature rise of the battery above ambient. Bruno is capable of continuous monitoring of these critical parameters.

It also provides on-demand standardized reports for compliance or maintenance requirements. Raw data can be downloaded in Microsoft Excel readable comma separated value (CSV) format as needed for detailed analysis of any particular parameter.

During an ac supply outage, where the battery is required to support the system, a detailed graph of critical parameters (battery voltage, temperature, and load current) is recorded and can provide detail as to the performance of the dc system.

With the addition of an external dc load (either constant current or resistive), Bruno can aid the user in performing a discharge capacity test, calculate the results, store, trend and correlate the data to previous discharge tests.

Where monitored parameters are outside established norms, the Hindle Health System will alert the operator to help identify and locate the source of the problem within the dc system.

Bruno touch screen is designed to provide an intuitive and simple interface for the user. Active buttons are either highlighted or expanded to aid the user in navigating the menu.

The main screens can be accessed from anywhere in the menu without stepping back through the menu. Other screens are displayed during configuration changes, testing, report generation, viewing alarm history, accessing support information or when more detailed status is required than what is provided on the HOME page.

The manufacturer of Bruno encourages users to provide feedback as to any questions, issues or improvements they would recommend in operation of Bruno.

4.2 HMI Display and Controller

The Bruno front panel display is a rugged, industrial-rated 10.1in / 257mm “true glass” capacitive touch screen with full vector graphic support. The display is the primary Human-Machine Interface, or “HMI”. All features of Bruno are programmed through the HMI (A3) touch screen. The screen utilizes high resolution graphics of 1280 x 800 pixels with dimmable backlit display and screen saver.

The Programmable Logic Controller (A1) is mounted to the back of the HMI (A3), and is the main control for operation of Bruno and data logging.

4 Basic Operation

ELECTRICAL SPECIFICATIONS (VOLTAGE)					
Parameter	24Vdc	48Vdc	130Vdc	260Vdc	Comments
Operating Voltage Range (Vdc)	18-30	36-60	90-150	180-300	(0 to 122 °F / -18 to 50 °C)
Maximum Float Current Measurement	1000mA	1000mA	1000mA	1000mA	
Alarm Relay Contact Rating	0.5A resistive	0.5A resistive	0.5A resistive	0.5A resistive	120Vac / 125Vdc (external protection diode required if powering dc loads)
	24V wetting voltage provided	24V wetting voltage provided	24V wetting voltage provided	24V wetting voltage provided	NC or NO contact
Capacity Test Pilot Contact (K4)	0.5A resistive	0.5A resistive	0.5A resistive	0.5A resistive	30 Vdc
Battery Open Test Resistance	50Ω	100Ω	300Ω	600Ω	10% tolerance
ELECTRICAL SPECIFICATIONS (CURRENT)					
Parameter	50A CCR	100A CCR	150A CCR	200A CCR	Comments
Battery Maximum Current (continuous)	55 Adc	110 Adc	165 Adc	220 Adc	
Charger Maximum Current (continuous)	55 Adc	110 Adc	165 Adc	220 Adc	
SW1 (battery)	20 kAIC	20 kAIC	20 kAIC	20 kAIC	
SW2 (charger)	20 kAIC	20 kAIC	20 kAIC	20 kAIC	

MECHANICAL SPECIFICATIONS				
Parameter	50A CCR	100A CCR	150A CCR	200A CCR
Battery Disconnect Wire Size (SW1)	#8 - 3/0 AWG	#8 - 3/0 AWG	#8 - 4/0 AWG	#8 - 4/0 AWG
Charger Disconnect Wire Size (SW2)	#8 - 3/0 AWG	#8 - 3/0 AWG	#8 - 4/0 AWG	#8 - 4/0 AWG
System & Test Load Connection Wire Size	#1 - 350 MCM AWG	#1 - 350 MCM AWG	#1 - 350 MCM AWG	#1 - 350 MCM AWG

ENVIRONMENTAL SPECIFICATIONS	
Parameter	Bruno
Ambient Temperature	(0 to 122 °F / -18 to 50 °C)
Audible Noise	less than 65 dBA
Cooling	natural convection
Operating Humidity	0/95% RH non-condensing

4 Basic Operation

HMI SPECIFICATIONS					
Parameter	24Vdc	48Vdc	130Vdc	260Vdc	Comments
Display / Backlight	TFT color / LED				
Colors	64K				
Backlight Life	40,000 hours or more (time of continuous operation until the brightness of the backlight reaches 50% of the rated value when the surrounding air temperature is 25 °C)*				
Front panel USB	version 2.0, maximum 32 GB				
SD Card	32 GB				
* Extended use in environments where the surrounding air temperature is 40°C or higher may degrade backlight quality/reliability/durability.					

4.3 Data and Data Storage Capability

Data storage is based on the size of the SD card installed. For the factory default data logging parameters, Bruno will store data for up to ten (10) years.

Consult the factory for storage capability for different data logging parameters.

4.4 Software Revision Changes

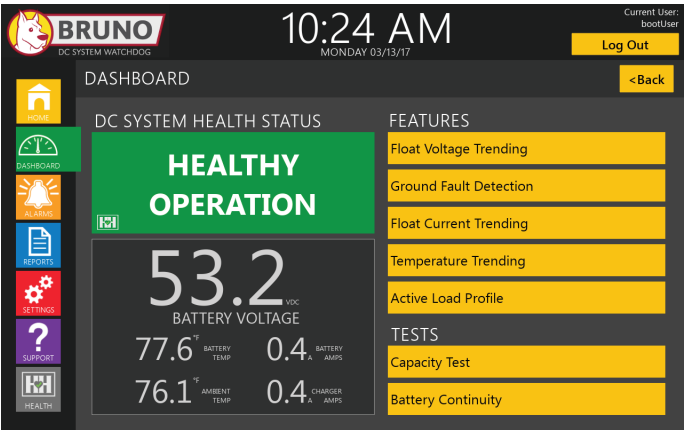
New versions of software are easily uploaded to Bruno through the USB connector without affecting any existing data stored on the system.

4.5 Fail Safe Design

Bruno uses a patented fail-safe design to ensure the dc supply is always available to supply power to the critical system loads under normal, ac failure, or Bruno component failure conditions. During battery continuity tests and float current tests, the battery charger provides all dc power to the loads. Bruno connects the battery to the loads through a rectifier circuit. Any change in ac voltage to the battery charger, dc output failure, or open dc circuit breaker of the battery charger will terminate any tests and instantaneously ensure the availability of the battery, protecting critical loads.

5 Trending & Testing Features

5.1 Dashboard Features



5.1.1 DC System Health Status

The upper left part of the screen indicates whether the System is “Healthy” or “Attention Required”. This same information is indicated on the HOME screen.

5.1.2 Operating Conditions

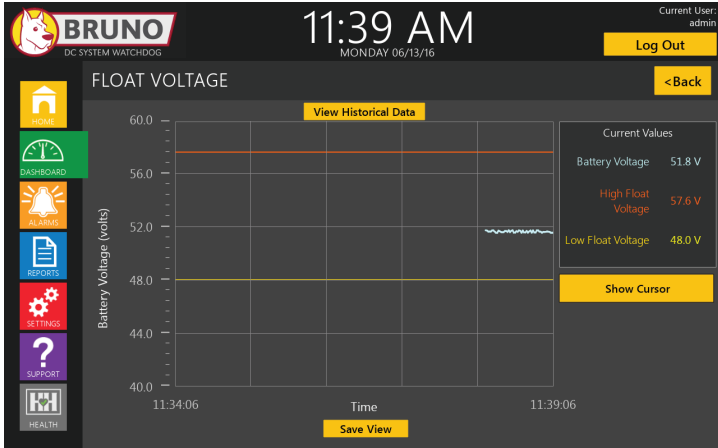
The current operating parameters are displayed below the DC System Health Status. These include:

- Battery Voltage
- Battery Amps
- Charger Amps
- Battery Temp
- Ambient Temp

5.1.3 Features

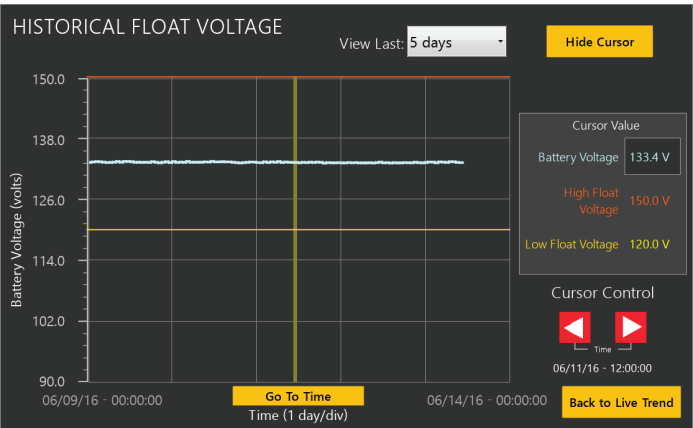
The Feature buttons are located on the right side of the DASHBOARD screen. These buttons allow the user to view different logged and trended data values as well as perform certain pre-programmed tests.

5.1.3.1 Float Voltage Trending



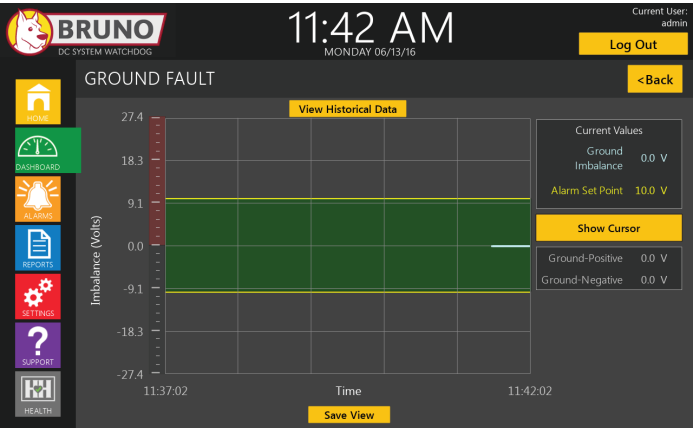
- The graph displayed shows the battery voltage as well as high and low float voltage alarm values. The live graph view samples values every second and provides a live view of changes in float voltage values over a 5-minute period.
- By pressing the view historical data button you can view prior Float Voltage data in increments from 4 hours up to 5 years. Select the desired time from the drop down arrow on the top of the graph under "View Last". The historical data is continually logged according to a pre-set logging schedule of one data point per hour.
- The user can highlight a particular event by touching the "Show Cursor" button which will place a cursor on the graph. The cursor can be moved left or right with the arrows at the lower right of the screen to highlight a particular event. The values under the cursor are displayed on the screen under "Cursor Value".
- Pressing "back to live trend" returns the screen to the live data feed.

5 Trending & Testing Features



- The user can download the current view of the graph in PDF by inserting a USB drive and pressing the “Save View” button.

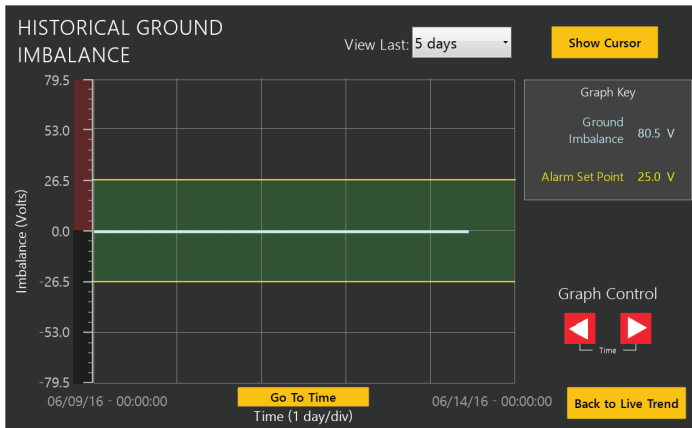
5.1.3.2 Ground Fault Detection



- The graph displayed shows the ground imbalance voltage, as well as the ground imbalance fault alarm point. The live graph view samples values every second and provides a live view of changes in ground imbalance values over a 5 minute period.

5 Trending & Testing Features

- By pressing the “View Historical Data” button you can view the data in increments from 4 hours up to 5 years by selecting the desired time from the drop down arrow on the top of the graph under “View Last”. The historical data is continually logged according to a pre-set logging schedule of one data point per hour.
- The user can highlight a particular event by touching the “Show Cursor” button which will place a cursor on the graph. The cursor can be moved left or right using the Cursor Control arrows at the lower right of the screen to highlight a particular event. The values under the cursor are displayed on the screen under “Cursor Value”.
- Pressing “Back to Live Trend” returns to the live data feed screen.

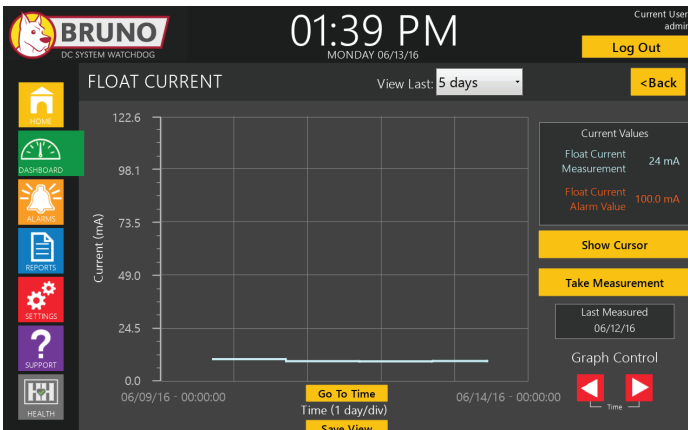


- The user can download the current view of the graph in PDF onto a USB by inserting a USB and pressing the “Save View” button.

5 Trending & Testing Features

5.1.3.3 Float Current Trending

Float current measurements are valuable when data is trended over some time period. **IEEE450/1106/1188** all discuss establishing a baseline after the battery is in service for an initial period of time. An upper limit for float current should be established based on experience or with the assistance of the battery manufacture. Increase in float current can be caused by many factors (e.g. increased internal resistance in cells, low electrolyte levels, loose inter-cell connections, etc.) that typically require attention by the user.



- Float current values are taken automatically on a user pre-set schedule of a minimum of once per day or manually by pressing the “Take Measurement” button.
- Bruno will only take a float current measurement if the following conditions are met:
 - » The last equalize charge of the battery has been more than 72 hours.
 - » The last battery discharge has been more than 72 hours.
- In the manual mode, if these conditions are not met a pop up box appears stating “The Battery is Discharged & This Test Cannot be Completed”. If the conditions are met the “Take Measurement” button changes to indicate “Measurement In Progress”.

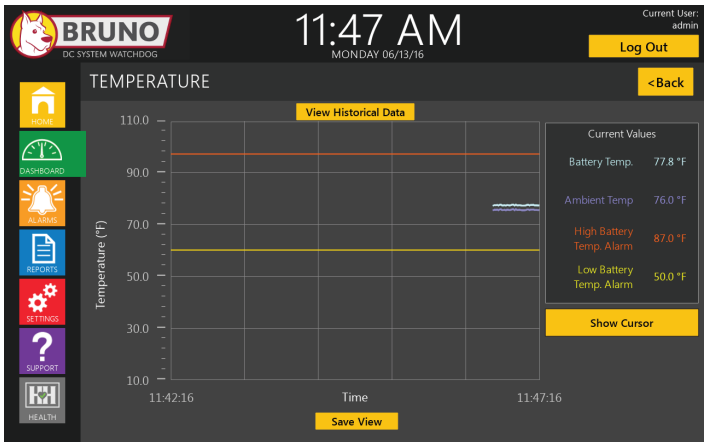
- The graph displayed shows the float current measurement and the alarm value.
- Historical float current data can be accessed by pressing the “Historical Data” button. This page will depict in table format the last seven float current measurements. Additional information can be accessed from the reports page.

NOTICE *If the battery charger connected to Bruno has a temperature compensated output, Bruno displays the float current as measured. If the connected battery charger is not temperature compensated, Bruno adjusts the float current based on the measured battery temperature. See the Set Up screens.*

- Below the Current Value section Graph Key the “Last Measured” value is displayed.
- The historical trended data can be viewed on the graph in increments from 1 day up to 5 years by selecting the required time from the drop down arrow on the top of the graph under “View Last”.
- Users can highlight a particular value by touching the “Show Cursor” button which will place a cursor on the graph. The cursor can be moved left or right using the Cursor Control arrows at the lower right of the screen to highlight a particular event. The values under the cursor are displayed on the screen under “Cursor Value”.

5 Trending & Testing Features

5.1.3.4 Temperature Trending



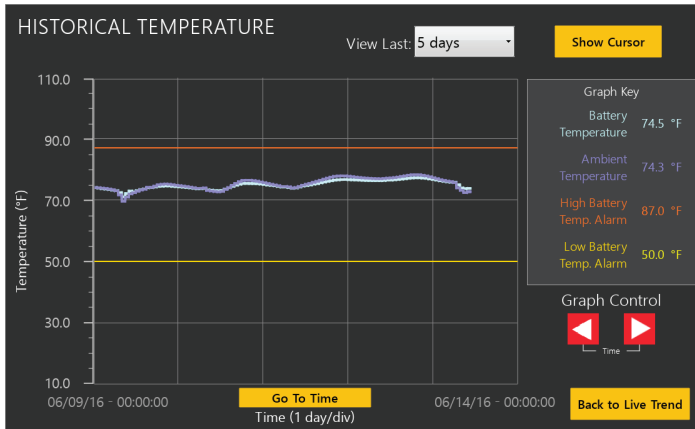
- The graph displayed shows the battery temperature and ambient temperature as well as high and low battery temperature alarms. The live graph view samples values every second and provides a live view of changes in battery and ambient temperature values over a 5 minute period.

NOTICE

In order for Bruno to provide accurate data, two (2) external temperature probes must be connected: an ambient probe and a battery temperature probe. The battery probe is connected either to the negative terminal of a cell in the middle of the battery or the side of a cell jar near the same location. The location of the battery probe should be in the middle of a battery string and the warmest potential location (e.g. top row center of a two-tier rack).

5 Trending & Testing Features

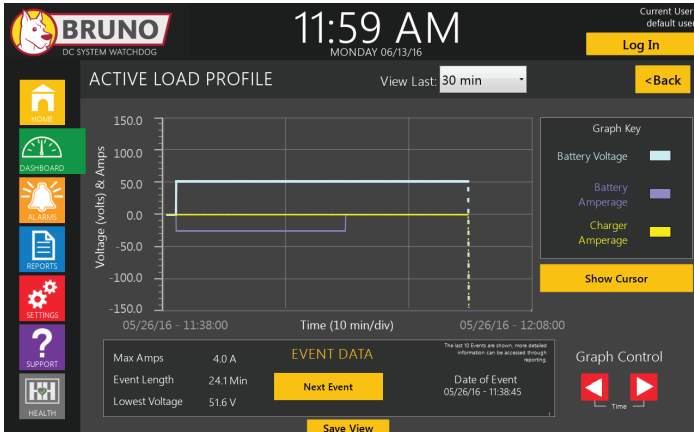
- By pressing the “View Historical Data” button you can view the data in increments from 4 hours up to 5 years by selecting the required time from the drop down arrow on the top of the graph under “View Last”. The historical data is continually logged according to a pre-set logging schedule of one data point per hour.



- The user can download the current view of the graph in PDF onto a USB by inserting a USB and pressing the “Save View” button.

5 Trending & Testing Features

5.1.3.5 Active Load Profile



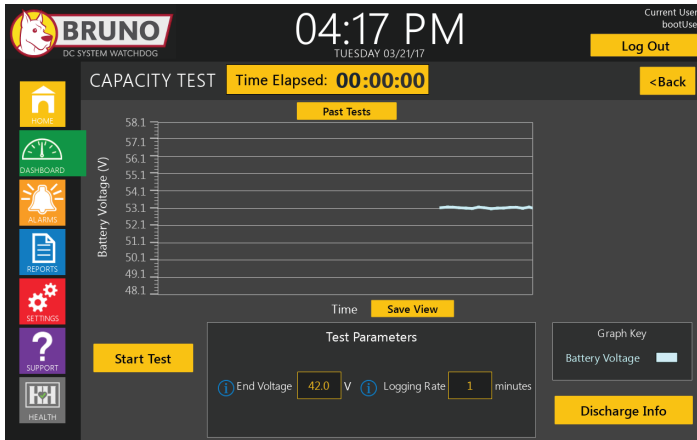
- This data is only logged when there is any event that results in a minimum of 1.0 Ampere discharge of the battery. All Active Load Profile Events are logged at the 1 second rate. The data will continue to be logged as long as the battery is being discharged and for an additional period of 10 minutes after the end of the discharge. The graph displayed shows the Battery Voltage, Battery Amperage and Charger Amperage.
- The historical time display of the graph can be viewed in increments from 1 min up to 5 years by selecting the required time from the drop down arrow on the top of the graph under "View Last".
- The user can highlight a particular event by touching the "Show Cursor" button, which will place a cursor on the graph. The cursor can be moved left or right, using the Cursor Control at the lower right of the screen. The values under the cursor are displayed on the screen under "Cursor Value".
- Event Data is displayed in the box below the graph. The Date of the Event, Maximum Amps, Lowest Voltage, and duration of the event are displayed. By pressing the "Next Event" button the event summary data jumps to the previous event. If there are "No Events", this is indicated in the Event Data box.
- The user can download the current view of the graph in PDF onto a USB by inserting a USB and pressing the "Save View" button.

5.1.4 Tests

The Test buttons are located on the right and below the Feature buttons. These buttons allow the user to perform a capacity discharge test (with an external discharge load) and a battery continuity test.

5.1.4.1 Capacity Test

IEEE standards recommend trending of capacity test results from the time of installation of the battery. Bruno helps the user accomplish this by storing the capacity test results and providing reports of the values trended over time.



NOTICE Information icons ⓘ are used on this page and in the HEALTH section. Touch these symbols at any time and they will provide information on the parameters or settings in question.

- This page allows the user to perform a discharge capacity test on the battery system attached to Bruno.
- In order to utilize this function a discharge load must be connected to the load test terminals; Test/System Load (+) and Test Load (-) of Bruno (see Figure 2-3 in Section 2.1). This can either be a constant current load or a constant resistance load.

5 Trending & Testing Features

⚠ CAUTION The test load must have a disconnect switch and this must be open when the test load is connected to Bruno.

- After connecting the test load, the Main Contactor (K1) will keep the test load from being connected across the battery until the test is ready to be performed.

⚠ CAUTION A separate battery should be connected in parallel with the loads and battery charger to protect the system in the event of an outage during the capacity test. Connect the spare battery at the Test/System Load (+) and System Load (-) load terminals. The connected parallel battery should have a voltage as close as possible to the dc bus voltage before being connected into the system to avoid arcing.

- Make sure the data for the battery being tested is input into Bruno. This information can be input in “Settings/Battery Type” or by pressing the “Discharge Info” button at the bottom right of the Capacity Test page.
- Make sure the remote sense from the charger is connected to Bruno (TB3) and the remote sense from Bruno (TB6) is connected to the battery terminals. For more information on wiring the remote voltage sense see Section 2.2.
- On the Capacity Test page, input the “Test Parameters”.
- The discharge test ends at the “End Voltage” specified in the Test Parameters box.
- If using a manufacturer supplied test load, the load will be disconnected from the battery automatically when the test is terminated.
- If a user supplied test load is used, Bruno will **not** disconnect the load from the battery. This **must** be performed manually by the operator.

⚠ CAUTION Failure to disconnect the test load at the end of test may result in damage to the battery. The test load must be disconnected from the system before the system load is re-connected.

- End Voltage: Input the system end voltage (e.g. 105Vdc, 42Vdc, etc.) for the end of the discharge test when using Automatic Mode.

NOTICE *It is important that the remote voltage sense leads for Bruno be connected to the pos+/neg- terminals of the battery (See section 2.3). Also check to make sure the dc system bus voltage shown on the Dashboard screen is the same as the voltage measured from the battery pos+/neg- terminals. If not, contact your service channel.*

- **Logging Rate:** Recommended logging rate for capacity tests is 1 reading/minute. Logging rates can be set from 1 reading per minute up to 1 reading per 999 minutes.
- The Bruno Capacity Test is started by pressing the “Start Test” button. After pressing the “Start Test” button, Bruno will count down 30 seconds before starting the test. At the end of the 30 second count-down, the Main Contactor (K1) will open separating the battery from the charger, and the Battery Open Test Relay (K4) will close. If a manufacturer-supplied test load is used, K4 will activate the contactor in the test load, putting load across the battery. If a user-supplied test load is used, the operator will need to manually connect the load to the battery utilizing some safety device such as a circuit breaker or fuse.
- When the test starts, the “Time Elapsed” counter will re-set to all zeros [00:00:00] and begin counting the test time.
- If the battery charger is disconnected from the dc bus at the start of the test, the discharge test will terminate after 1 minute to protect the dc system loads.

NOTICE The battery charger should remain connected to the dc bus during the capacity test, to charge the spare battery and feed the system loads.

- The test can be stopped any time by pressing “Stop Test”. This will stop the discharge clock and open the Battery Test Relay (K4), disconnecting the manufacturer supplied test load. User-supplied loads will have to be disconnected manually.

5 Trending & Testing Features

- The battery system voltage will be displayed on the graph. The discharge parameters will be displayed in the box to the right of the graph and will show the following:
 - » Battery Voltage
 - » Battery Current
 - » Battery Capacity (at the end of the test)
 - » Start Temperature
 - » Temperature Correction Factor (per IEEE 450/1106/1188)
- The test is measuring the overall capacity of the battery and not individual cells. It is critical to manually monitor the individual cell voltages at fixed points during the discharge to identify any cells that may be showing low capacity or that have the potential to drop to zero volts or go into reverse polarity. At a minimum for 1 hour discharges, voltages should be monitored at the beginning of the test and every 15 minutes until the end of the test. For longer tests, such as 4-8 hour discharges, voltages should be monitored every hour and then every 15 minutes during the last hour of the test. Any cells not meeting the capacity requirements should be identified and marked for future actions. If any cells approach zero volts the test should be paused, the cells bypassed in accordance with the procedures specified in IEEE450/1106/1188, and the test end voltage reset for the new number of cells and the test restarted.

5 Trending & Testing Features

- When the test is complete, the total elapsed time will display at the top of the screen and the percent of nominal capacity will be shown in the box on the right.
- The user can download the current capacity test page view in PDF onto a USB drive by pressing the “Save View” button.
- Past historical capacity test results can be viewed on the screen by pressing the “Past Tests” button.

BRUNO
DC SYSTEM WATCHDOG

01:34 PM
MONDAY 06/13/16

Current User:
default user

Log In

<Back


HISTORICAL CAPACITY

PAST TEST RESULTS

Date	Result	Test Length	Average Current	Start Temperature	End Voltage
06/09/16	0.1 %	0.7 m	2.0 A	77.7 °F	51.8 V
06/09/16	0.1 %	0.7 m	1.8 A	77.6 °F	51.8 V
05/26/16	0.0 %	0.0 m	0.0 A	77.7 °F	51.7 V
05/26/16	0.0 %	0.0 m	0.0 A	77.9 °F	51.7 V
05/26/16	116.3 %	34.9 m	30.0 A	77.6 °F	51.8 V
05/26/16	2.6 %	0.8 m	28.7 A	77.6 °F	51.6 V
05/26/16	7.2 %	2.2 m	29.3 A	77.6 °F	51.6 V


5 Trending & Testing Features


5.1.4.2 Battery Continuity


**BRUNO**
DC SYSTEM WATCHDOG


01:19 PM
MONDAY 06/13/16


Current User:
default user
Log In



HOME



DASHBOARD


ALERTS


REPORTS


SETTINGS


SUPPORT


HEALTH

BATTERY CONTINUITY

CONTINUITY
VERIFIED

Last Test 06/13/16

Lowest Voltage 51.6 V

START TEST

PAST TEST RESULTS

Date	Result	Lowest Voltage
06/13/16	Pass	51.6V
06/09/16	Pass	51.6V
06/09/16	Pass	51.6V
06/09/16	Pass	51.6V
05/12/16	Pass	51.6V
05/12/16	Pass	51.6V
05/12/16	Pass	51.6V
05/12/16	Pass	51.6V

- This test is performed by opening Main Contactor (K1), and placing a small internal fixed load of approximately 0.5 Amperes through the battery. The battery voltage is monitored, and if the pre-set voltage is maintained, the battery is considered to have continuity (**not** open). The Open Battery Set Point is pre-set at the factory at 10% below the dc bus voltage.
- Press “START TEST” to begin the continuity test. The test will run for 3 min.
- The last test date will appear below the “Battery Continuity” banner and the lowest voltage recorded during the test.
- Past test results showing the date, test result and lowest voltage are shown to the right of the screen.

(future)

6.1 List & Descriptions of Reports

The REPORTS page allows you to generate and download reports based on past logged data. Generic *Adobe* Portable Document Format (PDF) reports are generated and can be used to support NERC PSMP or other local maintenance requirements. In addition, Comma-Separated Value (CSV) data files can be downloaded for viewing and customizing in MS Excel format, and manipulated to generate detailed custom reports. Reports can be selected for individual parameters or a “Select All” button is available to select all reports for download.

Reports available in PDF:

- Report Cover – Contains user-populated information on the substation.
- NERC Compliance – This report shows the last time each of the NERC PRC-005 maintenance requirements tests have been executed, next scheduled execution, and status of each test.
- Alarm Report – For each system alarm, this report page shows the number of times it was triggered, the current set point, current alarm status, and the last alarm date.
- Temperature – Contains a trend graph of the temperature and a summary of the temperature trend.
- Float Voltage – Contains a trend graph of the float voltage and a summary of the float voltage trend.
- Float Current – Contains a trend graph of the float current and a summary of the float current trend.
- Active Load Profile – Contains a plot of the latest active load event along with a summary of up to 6 previous events.
- Battery Continuity – Contains the date and result of up to seven (7) previous battery continuity tests.
- Battery Capacity Test – Shows the trend graph of the last capacity test along with a summary of up to 6 previous tests.
- Baseline Data – Two (2) CSV files containing voltage and temperature data, one containing the full log of trended data, the other containing monthly summaries.
- Active Load Profile – Two (2) CSV files, one containing event summaries and one containing data logged during each event.

- Capacity Test – Two (2) CSV files, one (1) containing capacity test summaries and one (1) containing data logged during each test.
- Float Current – A CSV file containing the result of each float current test.
- Alarm Data – A CSV file containing data on status changes for each system alarm.
- Event Data – A CSV file containing data on system events such as set point changes.
- Hindle Health Logs – CSV files containing information on the connection resistance, electrolyte level, rack condition, and visual inspection tests.



6.2 Generate Reports

When you press the “Generate Reports” button a screen appears that allows you to select the report time period and input, company name, battery and station identification.

You can then either elect to “Generate” or “Cancel” the report generation operation.

7.1 Auxiliary Inputs & Outputs

The Interface I/O Board (A2) is mounted to the door-mounted PLC (A1). It features terminal blocks for connection of output alarm relays (TB2A) and input alarms from third party sources (TB1).

7.1.1. Output Alarm Relays

These relay contacts transfer when one or more of the standard Bruno alarm(s) become active. One set of contacts is provided, and is accessible via terminal block (TB2) on the Interface I/O Board. Refer to Figure 2-6 in Section 2.2.2. Two (2) relays are provided as standard. Up to five (5) relays as options are possible on the Interface I/O board.

Each relay has an associated red LED. These serve as a debugging aid, and will illuminate when respective relays are in alarm.

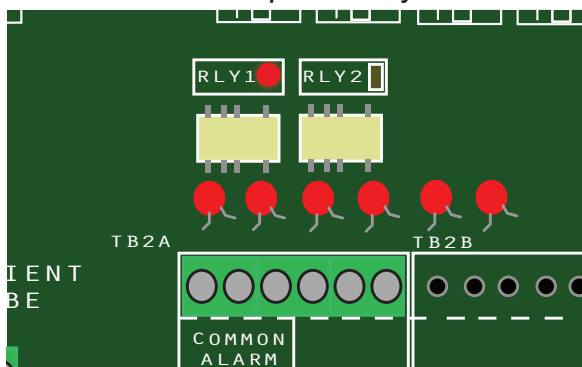


Figure 7-1

NOTES:

1. Relays feature one (1) set of form-C alarm contacts rated at 0.5A @ 125 Vac/Vdc (maximum).
2. TB2A is compression type, accepting #22-14 AWG wire.
3. Terminals are labeled in non-alarm condition.
4. Each relay is configurable to change state based on any alarm condition, and can be latched or non-latched. Delay switching to active state is based on a pre-programmed interval of time.
5. If user alarm contacts (TB2) are to drive inductive dc loads (e.g. a larger dc relay) an external protective diode **must** be installed at the dc relay to avoid equipment damage. See *Application Note* ([JD5011-00](#)).

7.1.2 Input Alarm

There are four (4) connections for input alarms at TB1 on the I/O Interface Board (refer to Figure 7-2). These can be used to sense external relay or contact closures and can be assigned an alarm name so they can be logged by Bruno as an event. In addition, they can be assigned to the common or the other output relay on the I/O Interface Board.

Each input alarm has an associated red LED. Depending on the Bruno configuration with third party devices, the LED can aid as a debugging tool to indicate the state of the relay.

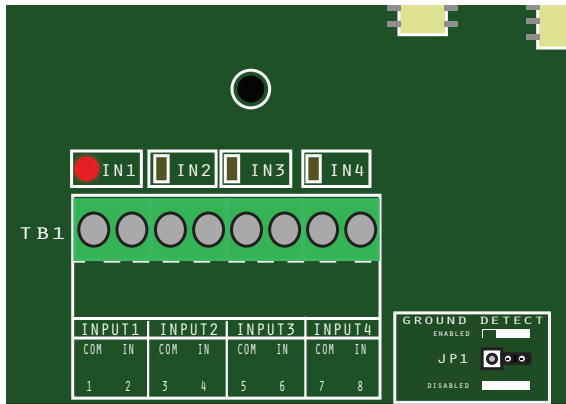
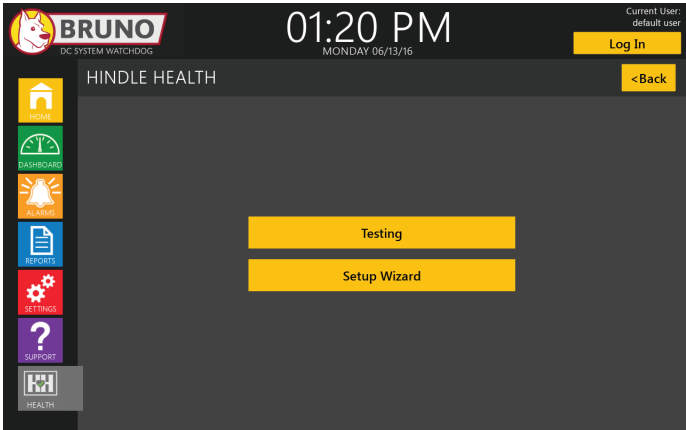


Figure 7-2

8 Hindle Health System

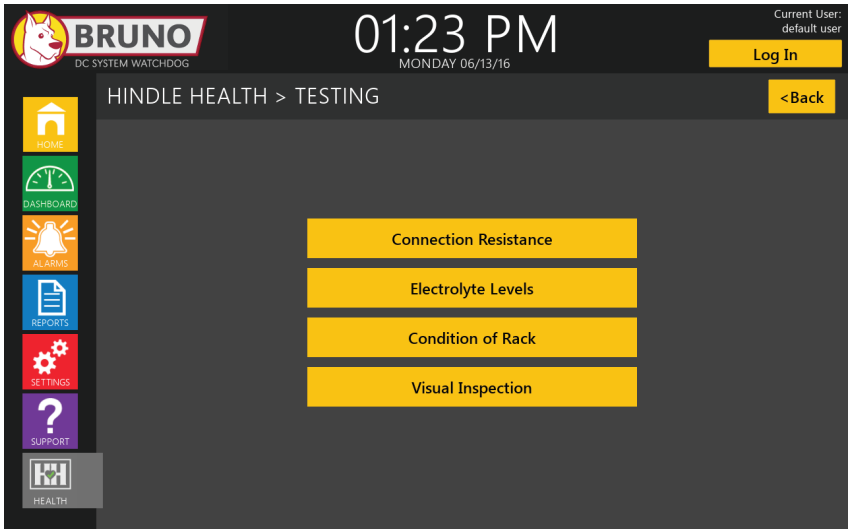
8.1 General

The HINDLE HEALTH SYSTEM™ provides the user with two (2) screens. “Testing” allows the user to input optional inspection and test information about their battery and rack. “Setup Wizard” allows the user to make changes to the basic alarm parameters and maintenance scheduling requirements.



8.1.1 Testing

The Testing screen allows the user to input data into Bruno for logging and report purposes.




8.1.1.1 Connection Resistance

The connection resistance screen gives the user the option of recording the strap resistance on Bruno. If the user opts to independently record the connection resistance values, Bruno will ask the user to confirm that all values have been measured and recorded. The user must confirm this for Bruno to record a successful test in this case.

If the user chooses instead to record per-cell resistance on Bruno, the system will prompt the user for inter-cell connection resistance values for each connection based on the number of cells entered in the battery information settings. The resistance values must be manually measured by the user with a micro-Ohmmeter or other appropriate tool. All values are recorded in micro-Ohms ($\mu\Omega$) and should be entered as such. After all values have been recorded, Bruno will return to the testing screen.

8 Hindle Health System



BRUNO
DC SYSTEM WATCHDOG

01:21 PM
MONDAY 06/13/16

Current User:
default user
[Log In](#)

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT


HEALTH

HINDLE HEALTH > TESTING > CONNECTION RESISTANCE [<Back](#)

Would you like to record connection resistance per cell?
[YES](#) [NO](#)

Have you measured and recorded all relevant connection resistance values?
[YES](#) [NO](#)

[Save](#)



BRUNO
DC SYSTEM WATCHDOG

01:22 PM
MONDAY 06/13/16

Current User:
default user
[Log In](#)

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT

HEALTH

HINDLE HEALTH > TESTING > CONNECTION RESISTANCE [<Back](#)

Would you like to record connection resistance per cell?
[YES](#) [NO](#)

[<](#)

Cell 1-2

[▶](#)

Previous Resistance:
N/A

Current Resistance

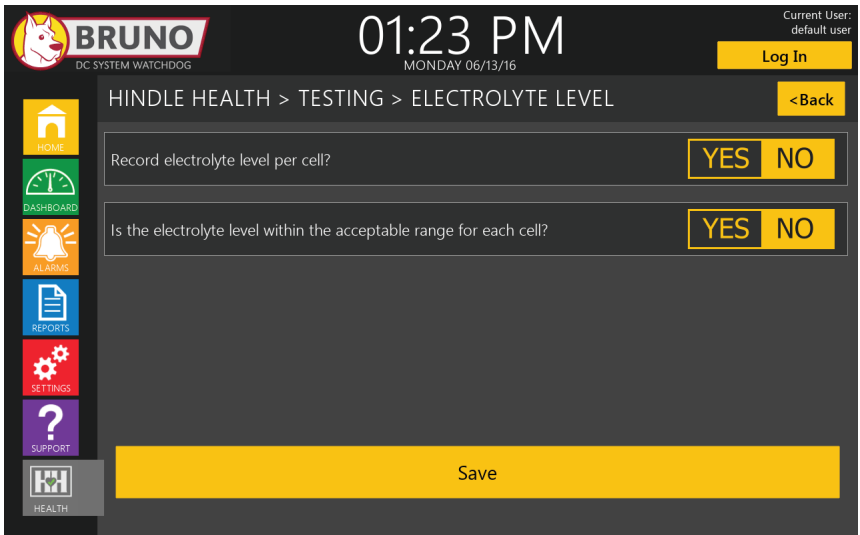
1

 $\mu\Omega$

[Save](#)

8.1.1.2 Electrolyte Level

The electrolyte level screen gives the user the option of recording the per-cell electrolyte levels on Bruno. If the user chooses not to record per-cell levels, Bruno will ask the user to confirm that all cells have an electrolyte level within the acceptable range. The user must confirm this for Bruno to record a successful test in this case.




The screenshot shows the Bruno DC System Watchdog interface. At the top, there is a header bar with the Bruno logo (a dog's head) and the text "BRUNO DC SYSTEM WATCHDOG" on the left. In the center, the time "01:23 PM" and date "MONDAY 06/13/16" are displayed. On the right, it says "Current User: default user" and has a "Log In" button. Below the header, the main content area is titled "HINDLE HEALTH > TESTING > ELECTROLYTE LEVEL" with a "< Back" button. The main area contains two prompts: "Record electrolyte level per cell?" with "YES" and "NO" buttons, and "Is the electrolyte level within the acceptable range for each cell?" with "YES" and "NO" buttons. At the bottom, there is a large yellow "Save" button. On the left side, there is a vertical menu with icons for HOME, DASHBOARD, ALARMS, REPORTS, SETTINGS, SUPPORT, and HEALTH.

If the user chooses instead to record per-cell electrolyte levels on Bruno, the system will prompt the user for each cell's electrolyte level based on the number of cells entered in the battery information settings. For each cell, the user will be asked to adjust a bar graph to represent as closely as possible the current electrolyte level in the cell. The bar graph has six (6) possible selections: Low, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, Full, and Overfull. "Low" and "Overfull" are considered outside the acceptable range and are used if the level is below the "Low" line or above the "Full" line on the cell respectively. All other values indicate values within the acceptable range. After all values have been recorded, Bruno will return to the testing screen.

8 Hindle Health System

8.1.1.3 Condition of Rack

- This screen provides a checklist for visual inspection of the battery rack that matches the requirements of **IEEE 450**. The individual inspection items are checked off by touching the “check” mark next to the item.
- Inspection items:
 - » no rust, corrosion or deterioration on the rack
 - » 10% of rack fasteners checked for tightness
 - » verify intercell spacers between each cell
 - » check intercell spacers for deterioration
 - » space between end rails and end cell is less than 3/16in
 - » verify rail insulators are in place



BRUNO
DC SYSTEM WATCHDOG

01:24 PM
MONDAY 06/13/16

Current User:
default user

Log In

HINDLE HEALTH > TESTING > RACK CONDITION

<Back

Battery Rack Condition

No rust, corrosion, or deterioration on rack	✓	Space between end rails and the end cell is less than 3/16"	✓
10% of rack fasteners checked for tightness	✓	Verify rail insulators are in place	✓
Verify intercell spacers between each cell	✓		
Check intercell spacers for deterioration	✓		

Save To Log

- After checking off items on the check list, all data can be saved with the appropriate time/date stamp by pressing the “Save to Log” button.

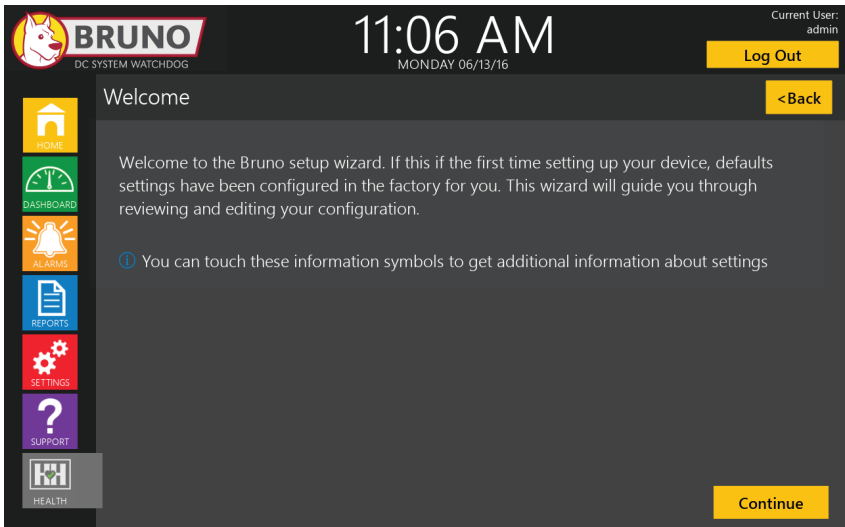
8.1.1.4 Visual Inspection

- This screen provides a checklist for visual inspection of the battery that matches the requirements of **IEEE 450**. The individual inspection items are checked off by touching the “check” mark next to the item.

- Inspection items:
 - » verify correct electrolyte levels
 - » no deterioration on cell jars, cover and seals
 - » examine each plate for sulfation
 - » examine plates for color
 - » flame arrestors present and in good condition
 - » check internal bus bar to plate connections
 - » examine internal plates, spacers and sediment
 - » inspect each cell for post growth
 - » verify terminals are coated with anti-corrosive grease
- After checking off items on the list, all data can be saved with appropriate date/time stamp by pressing “Save to Log” button.

8.1.2 Setup Wizard

8.1.2.1 Welcome




The “Setup Wizard” button takes you to a series of pages designed to help review and configure Bruno settings. The first introductory screen will welcome you to the setup wizard and introduce you to the Information Icons. Press “Continue” on this page to go on to the first setup screen.

8 Hindle Health System

NOTES:

- The system will have default settings loaded at the factory based on the ratings and options selected for your Bruno. If changes to these settings are desired the “Enable Edits” button must be selected on the page where changes are desired.
- Information icons ⓘ are used in the Hindle Health section. Touching these symbols at any time will provide information on the parameters or settings in question.

8.1.2.2 Testing Schedule



BRUNO
DC SYSTEM WATCHDOG

11:06 AM
MONDAY 06/13/16

Current User:
admin

Log Out

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT

HEALTH

Testing Schedule

Configure the schedule for battery maintenance tests on the Bruno watchdog.

Enable Edits

NERC PRC-005 Maintenance Requirements

Maintenance Activity	NERC Max Interval	Scheduled Interval	Method	Last Test	Next Test	Last Status
ⓘ Verify Supply Voltage	4 Months	N/A	Continuous	N/A	N/A	51.7 V
ⓘ Unintentional Grounds	4 Months	N/A	Continuous	N/A	N/A	Pass
ⓘ Float Voltage	18 Months	N/A	Continuous	N/A	N/A	51.7 V
ⓘ Electrolyte Level	4 Months	4 Months	Manual	Not Run	04/30/1970	Not Run
ⓘ Battery Continuity	18 Months	18 Months	Automated	Not Run	06/24/1971	Not Run
ⓘ Connection Resistance	18 Months	18 Months	Manual	Not Run	06/24/1971	Pass
ⓘ Float Current	6 Months	1 Days	Automated	06/13/2016	06/14/2016	42.3 mA
ⓘ Capacity Test	3 Years	3 Years	Automated	Not Run	12/15/1972	105.0 %
ⓘ Battery Rack Condition	18 Months	18 Months	Manual	Not Run	06/24/1971	Not Run
ⓘ Visual Inspection	6 Months	6 Months	Manual	Not Run	06/29/1970	Not Run

Back


Step 1 of 4

Continue

The first setup screen in the wizard is the testing schedule. This will show the configured testing intervals in the context of **NERC PRC-005**. After reviewing the schedule and making any necessary changes, press “Continue” to move on to the System Alarms page.



8.1.2.3 System Alarms



BRUNO
DC SYSTEM WATCHDOG

11:07 AM
MONDAY 06/13/16

Current User:
admin

Log Out

System Alarms

Enable Edits

Configure the trigger values and relay mappings for system alarms.

Alarm	Setpoint	Output Relay	Triggers Common Relay
Battery Continuity	N/A	None	✓
<i>i</i> Battery Temperature Deviation From Ambient	15.0	None	✓
<i>i</i> Low Bus Voltage	48.0 V	None	✓
<i>i</i> High Bus Voltage	57.6 V	None	✓
<i>i</i> Ground Imbalance Voltage	10.0 V	None	✓

Back


Step 2 of 4

Continue

The System Alarms page will allow you to configure the set points for Bruno system alarms, as well as select a desired output relay for each alarm, and whether or not the alarm will trigger the common relay. After reviewing the settings and making desired adjustments, press “Continue” to advance to battery setup.

8 Hindle Health System

8.1.2.4 Battery Setup



BRUNO
DC SYSTEM WATCHDOG

11:08 AM
MONDAY 06/13/16

Current User:
admin

Log Out

Enable Edits

HOME

DASHBOARD

ALARMS

REPORTS

SETTINGS

SUPPORT

HEALTH

Battery Setup

Battery parameters and alarm configuration

Battery Info

Manufacturer

Model

Type VRLA

Ah Rating 0

Number of Cells 24

System Voltage 48.0

Nominal Specific Gravity 1.125

Battery Parameters


Alarm	Setpoint	Output Relay	Triggers Common Relay
Discharge	N/A	None	✓
Low Temperature	50.0 °F	None	✓
High Temperature	87.0 °F	None	✓
Low Float Voltage	48 V	None	✓
High Float Voltage	57.6 V	None	✓
High Float Current	100 mA	None	✓

Back

Continue

The Battery Setup page is divided into two (2) sections. The first, battery info, is where general information about the battery such as manufacturer, model number, battery type, etc. can be entered. The second section, battery parameters, is for configuring battery-related alarms. Similar to the previous system alarm page, the alarm set points, output relays, and common relay triggering can be configured in the battery parameters section. After reviewing this page, press “Continue” to advance to the final page of the setup wizard.

8.1.2.5 Third-Party Alarms



BRUNO
DC SYSTEM WATCHDOG

11:08 AM
MONDAY 06/13/16

Current User: admin
Log Out

HOME
DASHBOARD
ALARMS
REPORTS
SETTINGS
SUPPORT
HEALTH

Third-Party Alarms

Third-party alarms can be input into the Bruno watchdog by using a contact closure to connect two terminals of the unit. Names can be assigned to these custom alarms and the normal operation state of the contact can be specified. For wiring information, please refer to the user manual or setup guide.

Input	Input Contact Type	Alarm Name	Output Relay	Triggers Common Relay
Input 1	N.O.	Custom Alarm 1	None	✓
Input 2	N.O.	Custom Alarm 2	None	✓
Input 3	N.O.	Custom Alarm 3	None	✓
Input 4	N.O.	Custom Alarm 4	None	✓

Back
Step 4 of 4
Continue

The final page in the wizard is the Third-Party Alarms page. This page is where alarm signals external to Bruno are configured. External contactors can be used to input up to four external alarms into Bruno. On this page you can configure the input contact type, alarm name, output relay, and common alarm triggering for each input alarm. The input contact type can be either normally-closed (NC) or normally-open (NO). The configured alarm name can be up to 23 characters.

NOTICE For additional information on wiring third-party alarms, refer to the section “Wiring the Input Relays on the Interface I/O board”.

Standard Installation Guide (active substation)

Overview

Bruno is an integrated tool for monitoring the complete dc portion of the substation. It is tightly integrated to offer unparalleled tools for testing, data collection, and reporting. The installation of Bruno into an active substation can be done easily with the appropriate tools.

This guide assumes the user has already read the manual sections on mounting and wiring Bruno. This installation process should take 4-8 hours depending on the complexity level of your dc system.

Please read this guide and Bruno manual in its entirety before attempting installation. For a diagram of Bruno's function, along with its relationship to other substation components, refer to DC System Watchdog Electrical Schematic ([JE5265-00](#)).

Safety Procedure

All NEC, local, and applicable site policies supersede this guide when installing Bruno. Appropriate care must be taken to ensure correctness as dangerous voltage and current levels exist in the substation dc system. The installation should be done by competent electrical technicians who have read and fully understand the Bruno Operating & Service Instructions manual, as well as associated equipment. This installation note is intended to be a guide.


Required Materials

- Appropriately sized and rated wire (ampacity, temperature, wire length run, etc)
- Appropriately sized and fully charged back-up battery (required)
- Appropriately sized and operational back-up charger (optional)
- All necessary tooling
- Digital Multi-Meter (DMM)

Procedure

After Bruno has been appropriately mounted, follow these steps for proper electrical installation:

1. Prior to beginning the installation procedure, connect a spare battery and a spare charger directly in parallel with the system load. The backup system must be in place to prevent the loss of dc power during the installation procedure.

 **WARNING** The spare battery and spare charger should be at the same voltage level of the existing battery and charger in the dc system to minimize any arc flash due to different potentials.

2. Wiring the Battery to Bruno
 - » Ensure Bruno's Battery Disconnect Switch (SW1) is in the **OFF** (open) position.
 - » Connect the battery to the Battery Disconnect Switch (SW1).
 - » Verify polarity is correct with a DMM.
3. Wiring the Battery Charger to Bruno
 - » Ensure Bruno's Charger Disconnect Switch (SW2) is in the **OFF** (open) position.
 - » Connect the battery charger to the Charger Disconnect Switch (SW2).
 - » Verify the polarity is correct with a DMM.
 - » Connect the battery charger's remote sense to Bruno.
 - » Verify polarity is correct with a DMM.
4. Connecting the System Loads
 - » Ensure SW1 and SW2 are in the **OFF** (open) position.
 - » Connect system loads to the Bruno CU-AL compression lugs.
 - » Verify polarity is correct with a DMM.
5. Starting Up Bruno
 - » With charger powered on, **close** Bruno's Charger Disconnect Switch (SW2).
 - » Ensure Bruno powers up correctly.
 - » Close Bruno's Battery Disconnect Switch (SW1).
 - » Remove the secondary battery and charger from the system.
 - » Allow Bruno DC System Watchdog to operate normally.

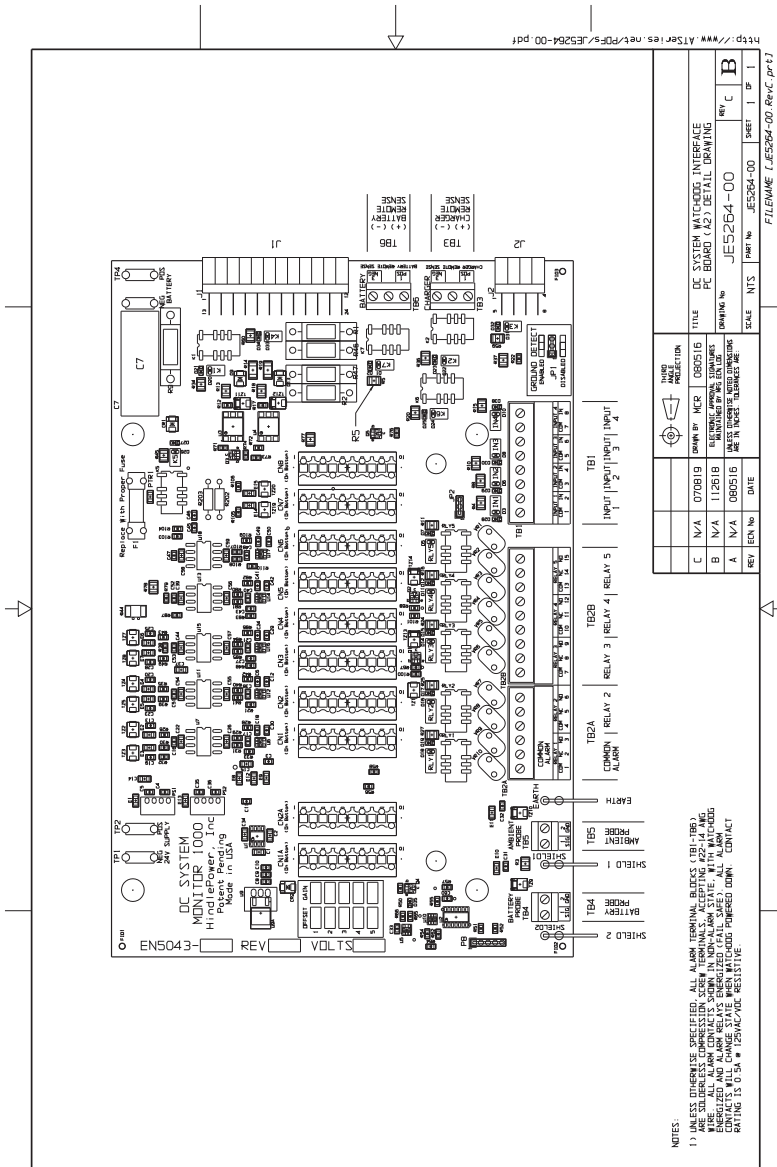
1) NEMA-1 Style-5054 Enclosure Outline (JE5262-00)



2) Style-5054 Internal Component Layout (JE5263-00)



3) DCSW INTERFACE PC BOARD LAYOUT (JE5264-00)

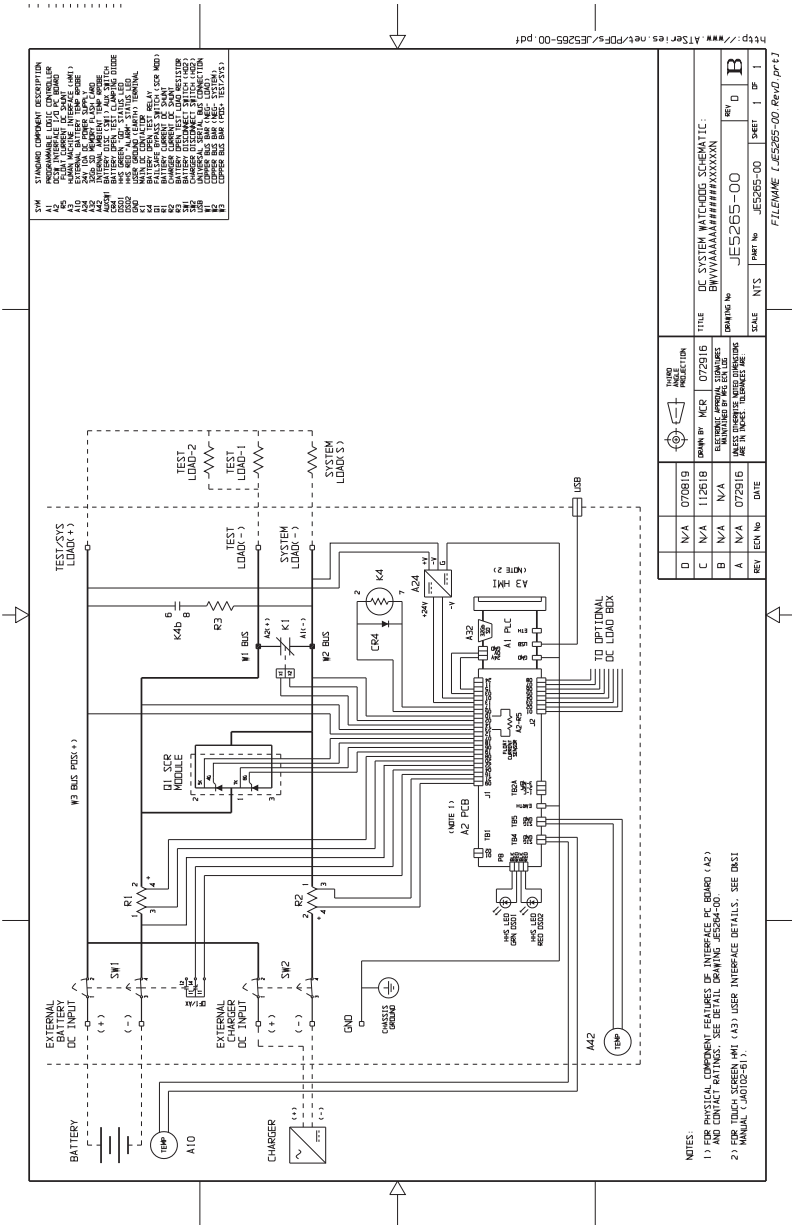


<http://www.atseries.net/PDFs/JE5264-00.pdf>



Appendix B - Standard Drawings

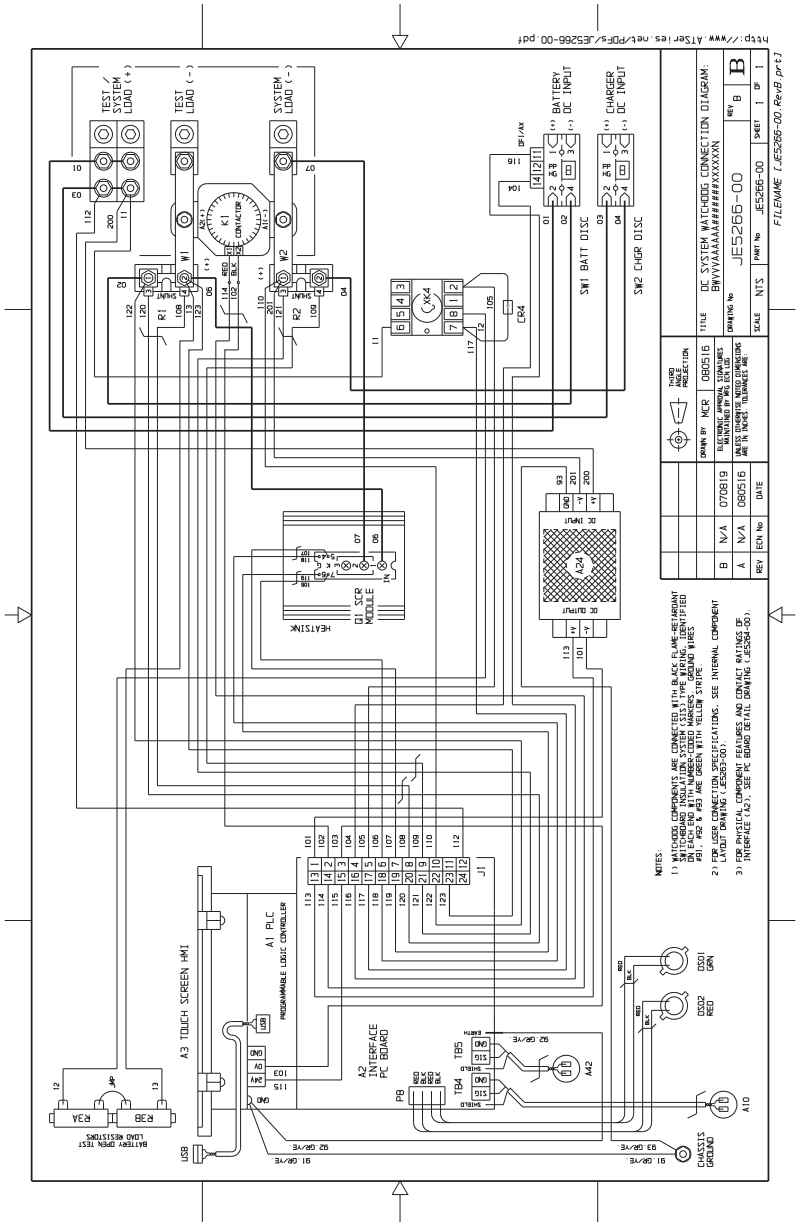
4) DC SYSTEM WATCHDOG SCHEMATIC (JE5265-00)



<http://www.atseries.net/PDFs/JE5265-00.pdf>



5) DCSW CONNECTION DIAGRAM (JE5266-00)



<http://www.atseries.net/PDFs/JE5266-00.pdf>

Appendix C - Document Control Information

DOCUMENT NUMBER

The text and graphics contained within this manual are controlled by the Bruno manufacturer's internal part number (**JA5125-00**). The revision level and dates of this manual's text and graphics are listed below. These controls supercede all other available dates. The first and last page of this manual are reserved for company-specific front and back cover artwork. Any revision levels, revision dates, or document numbers featured on the first two and last two pages of this manual refer to the cover artwork only.

DOCUMENT INFORMATION

Document No.: **JA5125-00**
Revision Level: **1J**
Filename: **JA5125-00.Rev1J.2019-07-15.indd**
Last Saved: **July 20, 2021 11:51 AM**
Printed: ***not available in Adobe InDesign***

PARTS DATA PACKAGE

A job-specific customized Parts Data Package report is supplied with every shipped Bruno DC System Watchdog. The data listed in this report supercedes any information featured in product literature, standard documentation, and/or quote documents. The parts and quantities listed are applicable only to the Bruno featuring the same serial number listed on the Parts Data Package report.

DRAWINGS

A customized record drawing package is available for any Bruno, featuring a unit-specific drawing list / data nameplate detail, outline drawing, itemized internal component layout, electrical schematic with component ratings, and a full connection diagram. If the standard drawings featured in this manual are not sufficient, please contact your Sales Representative for drawing availability from the Bruno manufacturer.

Any job-specific custom drawings supplied with a Bruno supercede the standard drawings featured in the Appendix. The standard drawings and corresponding page numbers featured in this section may not be included with custom printed manuals, when job-specific custom drawings are supplied.

ONLINE AVAILABILITY

An unlabeled version of this operating and service instruction manual is available online at <http://www.ATSeries.net/PDFs/JA0102-61.pdf>. Other related product operating manuals, feature and accessory special instructions, standard drawings (including the ones listed in this manual), field service instructions, and product application notes for the AT Series microprocessor-controlled battery chargers and battery charger products are available online at <http://www.ATSeries.net/>. Saved in Adobe Acrobat Portable Document Format (PDF), they are readily available for downloading and printing.

If revision levels differ between the drawings embedded in this manual and the full online PDF drawings, refer to document with the higher revision level. For document availability of private-labeled manuals and/or standard drawings, please contact your sales representative or visit the web site listed on the back cover of this manual.

