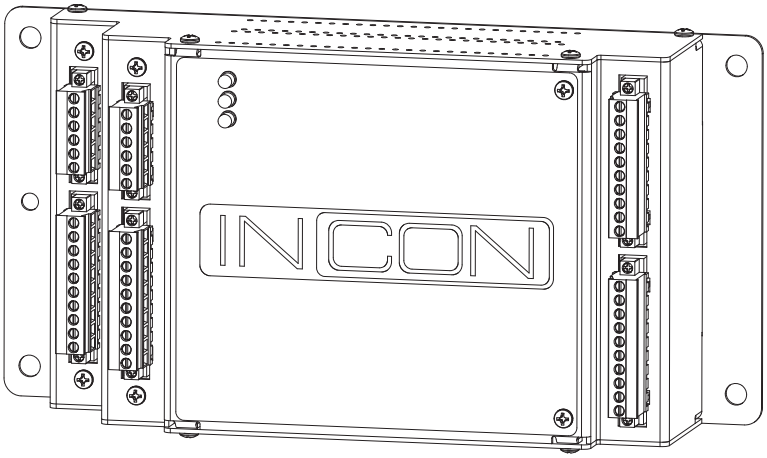
Franklin Electric
GRID SOLUTIONS

INCON™ OPTIMIZER3 CIRCUIT BREAKER MONITOR

USER GUIDE

000-1533 r5

MODEL
OM3D
OM3D-F
OM-MMK



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000-1533 r5

CONVENTIONS USED IN THIS MANUAL

This document includes safety precautions and other important information presented in the following format:

NOTE: This provides helpful supplementary information.

IMPORTANT: This provides important supplementary information and instructions to avoid damaging hardware or a potential hazard.

⚠ **CAUTION**: This indicates a potentially hazardous situation that could result in minor or moderate injury if not avoided. This may also be used to alert against unsafe practices.

⚠ **WARNING**: This indicates a potentially hazardous situation that could result in severe injury or death if not avoided.

⚠ **DANGER**: This indicates an imminently hazardous situation that will result in death if not avoided.

OPERATING PRECAUTIONS

⚠ **WARNING**: Important safety instructions. Before installing any Franklin Electric equipment, read this document and follow safety and operating instructions. Save these instructions.

⚠ **WARNING**: Do not disassemble any equipment; contact Franklin Electric when a repair is required. Incorrect reassembly may result in a risk of electric shock or fire.

⚠ **WARNING**: To avoid electric shock, abide by your company's safety practices and the following guidelines:

⚠ **WARNING**: Before working with electricity, remove personal metal items such as rings, bracelets, necklaces, watches, etc. A short-circuit current can be high enough to weld such items, causing a severe burn.

⚠ **WARNING**: Service work may only be performed by authorized personnel for procedures which they have satisfactorily been trained to execute.

⚠ **WARNING**: To avoid a risk of serious injury or death, DO NOT come into contact with ANY source of live, electric current.

⚠ **WARNING**: Avoid simultaneous contact with live conductors and enclosures, racks, or hardware that may be grounded.

⚠ **WARNING**: Refer to NFPA 70E for electrical safety guidelines and requirements including (but not limited to) use of Personal Protection Equipment (PPE). Examples include (but not limited to) electrical-insulating clothing/footwear and electrical-insulating rescue hooks (equipment).

⚠ **WARNING**: Always wear safety glasses with side shields.

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1 Introduction

The INCON® Optimizer3 Circuit Breaker Monitor delivers advanced automated reporting of all critical circuit breaker diagnostics to ensure uptime and facilitate predictive maintenance. The Optimizer3 is ideal for high-voltage, live or dead-tank, oil, vacuum or gas circuit breakers.

1.1 Documentation

- This document is intended for qualified installation persons.
- Instructions of this document are in English. All other language versions are translations of this original document.
- Illustrations in this document show a typical setup and are for instruction and description purposes only.
- Information given in this document is given as a guide only. It is the installer's responsibility to ensure that correct and safe procedures are always followed.
- This document and related documents are available from Franklin Electric at www.franklingrid.com.

1.1.1 Symbol Legend


Wear Protective Headwear


Wear Eye Protection


Wear Protective Clothing


Wear High-Visibility Clothing


Wear Protective Gloves


Wear Safety Footwear


Refer to instruction guide


Lockout/Tagout Electrical Equipment


Disconnect main plug from electrical outlet


Disconnect before carrying out maintenance or repair


General Warning


Warning: Electricity


No open flame; Fire, open ignition source and smoking prohibited

2 Safety/Security

2.1 General Safety Information

- Only perform procedures in this document that you are qualified and certified to perform.
- Personnel working on or with energized equipment must be authorized by relevant regulatory bodies to carry out such work and must have the appropriate training. Check with your employer and relevant regulatory body's rules for working with energized equipment.
- Obey all local laws, rules, regulations, and instructions in this document. In case of inconsistency or contradiction between information contained in this document and any laws, rules and regulations, obey the stricter of the two.
- Keep unqualified personnel at a safe distance during installation.
- Always wear all required PPE on-site and during installation.
- If it is necessary to remove safety/security devices, immediately reinstall the safety/security devices after completing the work.

2.2 Documentation Availability

2.2.1 Site Owner or Operator

Save this guide for future use, and make sure to provide it to anyone who services this equipment.

2.2.2 Miscellaneous

Always reference the guide(s) that came with the equipment for the most current and complete list of installation and safety precautions.

2.3 Hazard Assessment

Prior to beginning work and prior to recommencing work after leaving and returning to the worksite, a worksite, *pre-job hazard assessment* must be performed to identify safety and environmental needs. At a minimum, this hazard assessment should:

- Identify possible hazards and risks.
- Identify the safety needs of the job.
- Identify the correct procedures, practices and equipment.
- Eliminate unsafe conditions and actions from the worksite.
- Identify the need for personal protective equipment.
- Inspect equipment before use.
- Confirm sheaths of all cables are secured and undamaged.
- Confirm plugs and connectors are properly connected and serviceable.
- Perform ongoing risk assessment during the project.

2.4 Required Personal Protective Equipment (PPEs)

These PPEs are required during all phases of installation.


Wear Protective Clothing


Wear Eye Protection


Wear High-Visibility Clothing


Wear Protective Gloves


Wear Protective Headwear


Wear Safety Footwear

2.5 Cyber Security

This product is designed to be connected to and to communicate information and data via a network interface. It is solely the owner's responsibility to provide and continuously ensure a secure connection between the product and Owner's network or any other network (as the case may be).

The Owner shall establish and maintain appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

The manufacturer, Franklin Electric, and its affiliates are not liable for damages and/or losses related to such security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

3 Overview

3.1 Upon Receipt of Item(s)

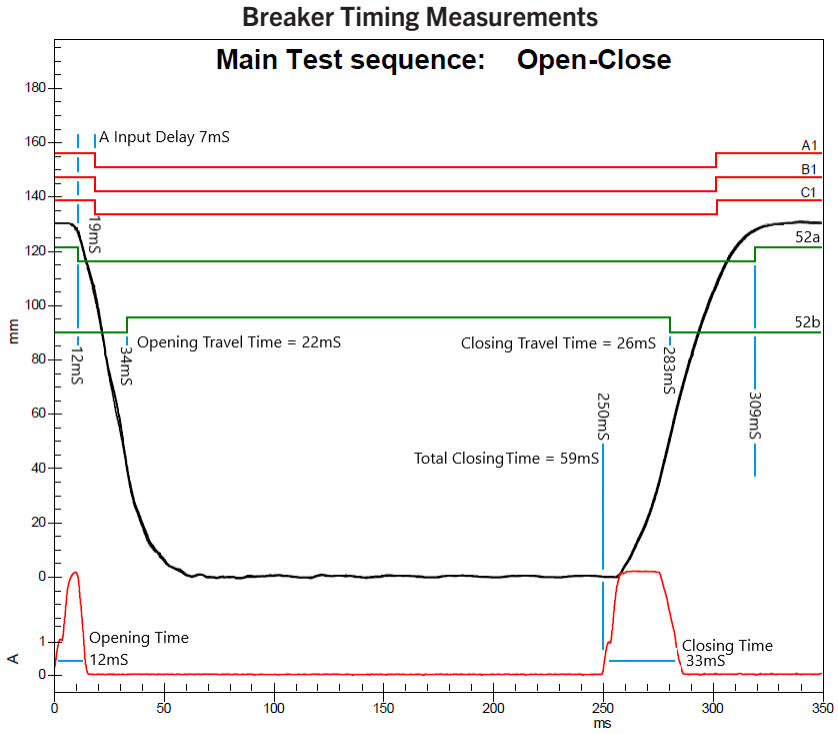
- Verify all items are in accordance with the order.
- Check all items for damage.
- If any item shows damage or is not in accordance with the order, inform Franklin Electric *immediately*.
- Remove the packaging material.
    - Follow all local laws, rules and regulations regarding disposal of discarded parts, packaging material or items and any subsequent components.

3.2 Technical Overview

NOTE: This guide is for the Optimizer3 with firmware version **1.11.1** and higher.

The Optimizer3 is an online continuous performance monitor for high voltage circuit breakers, providing information for the process of Condition-Based Maintenance. The Optimizer3 performs these main functions:

- Mechanism Timing (see example below).
- Status Monitoring of auxiliary systems.
- Estimation of interrupter condition as degraded by internal arcing effects.
- Measurement of SF_6 gas: Density, Pressure, and Dew Point Temperature.



Optimizer3 Data Measuring / Logging

The Optimizer3 measures and logs data for the following:

- Breaker status OPEN/CLOSE
- SF_6 Density
- SF_6 Temperature
- SF_6 Dew Point
- Sensor Malfunction
- Motor Run Time
- Motor Runs per Day
- Motor I^2T
- Motor Total Run Time
- Heater Status On/Off
- Heater Current
- Optimizer3 Line Voltage
- Ambient Cabinet Temperature
- Days since Last Operation
- Restrike Occurrence
- Contact Life; cumulative I^2T or IT
- Last Trip Coil Energized (TC1/ TC2)
- Open Latch Time
- Close Latch Time
- Open Average Velocity
- Close Average Velocity
- Open Operation Arcing Time
- Clearing Time
- Opening Travel Time
- Closing Travel Time
- Total Operation Count
- Non-Fault Operation Count
- Fault Operations Count

Optimizer3 SF_6 Sensors

The Optimizer3 continuously monitors SF_6 attributes utilizing these available sensors:

- Temperature-Compensated Pressure analog 4–20 mA.
- Temperature-Compensated Pressure and Temperature (model PSDP Digital Pressure Sensor).
- Density and Temperature (model DSDP Digital True Density Sensor).
- Density analog 4–20 mA.
- Dew Point Temperature analog 4–20 mA.

The Optimizer3 uses these measured attributes to calculate other user-defined properties in desired units. Optimizer3 calculates density, pressure, trends, trend rates, changes in mass, etc. Most attributes can be compared to static alarm settings for assertion when they go out-of-tolerance. Optimizer3 issues alarms via contacts, through DNP3.0 points, and via HTTPS web service, locally or remotely.

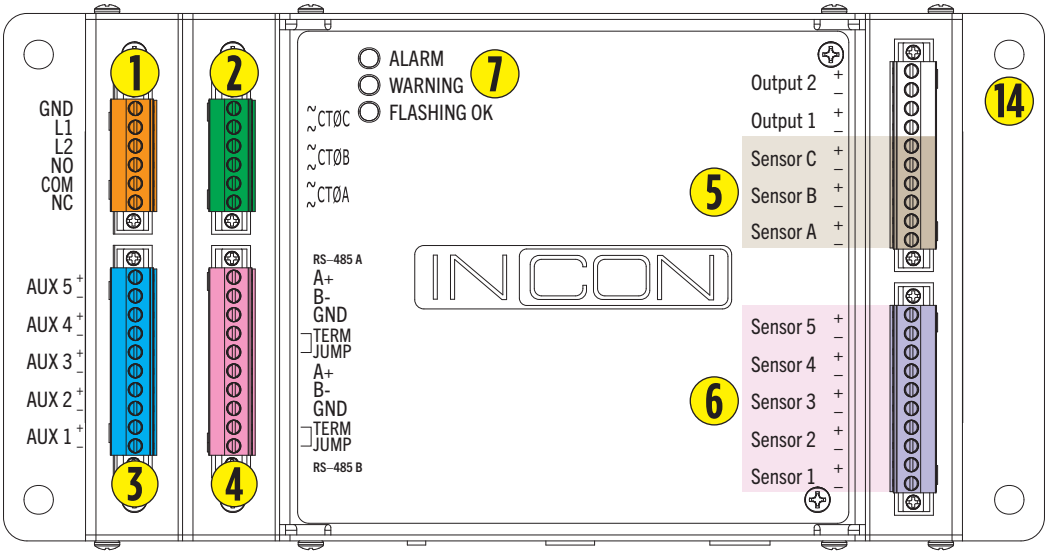
The Optimizer3 Installation has been kept simple, with few connections required to the circuit breaker control circuits. Simple electrical connections are made to trip and close circuits. Split-core Pickup Coils are attached to bushing CT secondary circuits. SF_6 gas sensors may be installed on the gas plumbing in several ways.

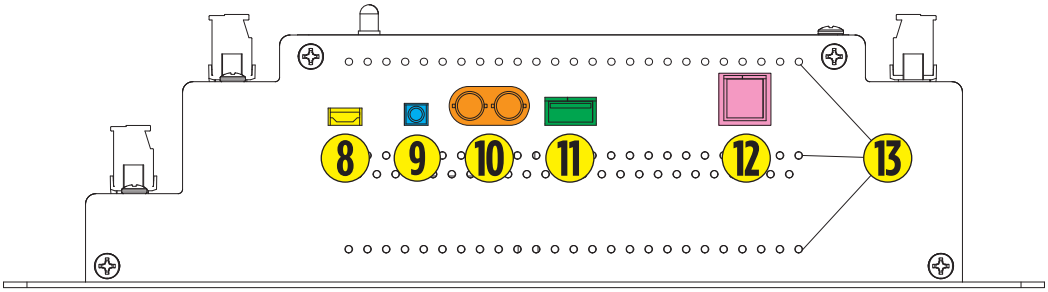
The Optimizer3 is useful on small sub-transmission circuit breakers to large EHV circuit breakers, and can be applied to any type of circuit breaker:

- Vacuum
- Bulk Oil
- Minimum oil
- Air Blast
- SF_6
- Live or Dead Tank

NOTE: Contact wear models vary slightly by manufacturer and technology used. During set up, the manufacturer's limits for contact wear and timing should be used. If this information is not available, then IEEE C37.06-1989 standard should be used as a guide.

3.2.1 Component Identification & Features

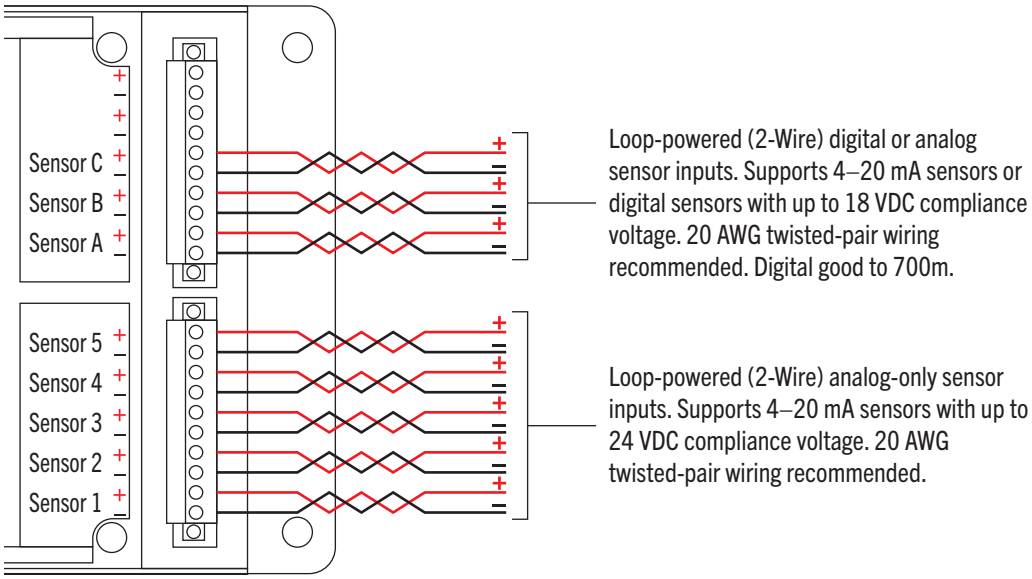




1. Power Input & Relay Output
2. CT Inputs
3. Timing Inputs
4. RS485 Ports
5. Digital / Analog Sensor Inputs
6. Analog Sensor Inputs
7. Status LEDs
8. Mini-USB Port
9. Ambient Temperature Sensor
10. Fiber-Optic Port (Ethernet 2 – optional)
11. USB 2.0 Port
12. Ethernet Port (Ethernet 1)
13. Vents
14. Mounting Holes

3.2.1.1 Sensor Inputs

The Optimizer3 includes eight inputs for sensors and five inputs for control signals.



Sensor inputs A, B, and C are dual-function. They accept either 2-Wire 4–20 mA analog sensors or 2-Wire Sensors with a Proprietary Digital Protocol. Sensor inputs 1–5 are 4–20 mA analog only and do not accept the digital protocol. For each 4–20 mA analog sensor, there is a corresponding setup area in the "Configuration" web pages where the scaling of the input is done. The digital sensors require no scaling (the Optimizer3 scales those signals automatically).

- 18 VDC sensor power is provided for sensors A, B, and C.
- 24 VDC sensor power is provided for sensors 1–5.

3.2.1.2 CT Inputs

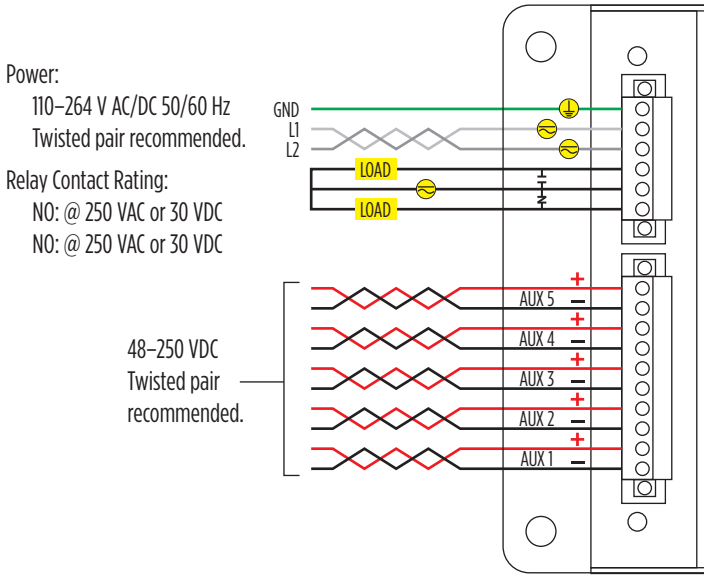
The Optimizer3 measures the current flowing through the bushing CT secondaries of the circuit breaker. These measurements are used in the contact wear calculations, arc time, and determination of fault versus non-fault operations. Line current is also logged. During installation, small split-core Pickup Coils are attached to the relevant bushing CT circuits, noting the bushing CT turns ratio. Depending on the maximum current expected in the bushing CT circuits, an optimal split-core Pickup Coil is selected. INCON® offers split-core pickup coils with the following full-scale ratings:

	Pickup Coil Ratings							
INCON® Part Number	CT-20	CT-30	CT-50	CT-100	CT-160	CT-250	CT-400	CT-800
Full Scale Rating (A)	20	30	50	100	160	250	400	800
Range (A)	1.4-20	2.1-30	3.5-50	7-100	11.2-160	17.5-250	28-400	56-800

Each "CT-nn" part number is for a set of three pickup coils, and are compatible with 50 or 60 Hz power systems. The split-core pickup coils snap on over existing insulated bushing CT secondary circuits without tools, and are rated 1.0 % accuracy and 0.05 VA burden at 5 A. Removal or disruption of bushing CT circuits is not necessary. Although referred to as a CT, these are sensors that give 0–5 VAC output for 0 to full scale current.

Control Inputs

The use of each input is determined by the circuit breaker application and mode of operation. Each control input is multi-function and is defined in the system “Configuration”. The control inputs are continuously monitored to detect when the control circuit nodes are in the active or inactive state. Each AUX Input is fused on both legs, optically isolated from the monitoring processor circuits, and has an input impedance of 540 kΩ. The Off/On voltage threshold is approximately 35 V.



3.2.1.3 Control Input Logic Monitoring

The logical state of each Control Input is continuously monitored and compared with the Input Polarity settings, in the context of the Input Mode setting. Based upon these settings, the Optimizer3 knows the normally expected logic state of each input, when the breaker is closed or open. If the voltage state of an input violates its closed or open state for longer than 3 seconds, the A-B Logic Alarm will activate. This alarm is self-clearing once the triggering condition returns to the normal state. A record of the alarm is logged in the Event History (dates/times the alarm occurred and was cleared).

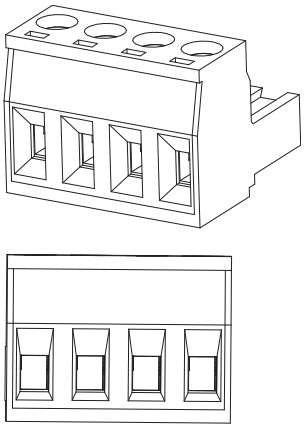
This A-B Logic Alarm serves as a Trip Coil Integrity Monitor in Input Modes 2, 4, 5, 6, and 7. The normal voltage state of the Control Input wired across the Trip Coil is low. The low impedance (approximately 50 Ω) of the Trip Coil, energized through the high-impedance Red Light, will normally produce a very low voltage to the Optimizer3 Control Input. If the Trip Coil impedance significantly increases or it becomes open-circuited, the voltage drop across the damaged coil will be high, causing the Optimizer3 to assert the A-B Logic Alarm.

3.2.1.4 Input Power, Grounding, Isolation

The Optimizer3 operates from station battery DC or AC station service. Nominal current draw is 0.5 A. The power input automatically accepts either AC or DC. Both power supply legs are fused. If external fuses are used, 3.15 A slow-blow are recommended. Power input leads are isolated from chassis and are floating and not referenced to ground.

Ground connection is internally connected to the metal chassis. *It is recommended that the ground be connected to the station ground or ground bar inside the circuit breaker cabinet.* Follow the electrical grounding standard in effect at the installation site (utility).

All wiring connections are made to removable pluggable terminal block connectors (see image to the right for an example). The Optimizer3 may be electrically isolated by pulling out all the connectors from their mating sockets. Follow the electrical isolation standard in effect at your utility. If fused-cutouts are desired, locate them physically near the Optimizer3 with 3.15 A slow-blow fuses for all input and control wiring. The Optimizer3 uses a switch-mode power supply with universal input. On power-up, it draws more than nominal current for 1 mS. Slow-Blow fuses are mandatory if external fuses are used.



IMPORTANT: The Optimizer3 contains flash storage (SD card) for booting the device and saving data. Flash storage has the potential to be corrupted under rare circumstances due to power loss while the software is writing to the SD card. The Optimizer3 has both hardware and software features to prevent corruption from occurring on boot-up or shut down.

The protection features begin working after 20 seconds of operation. It is important to make sure the power to the Optimizer3 is solidly connected to terminals without the chance of disconnection and loss of power during the first 20 seconds of operation.

3.2.1.5 Digital Inputs

Digital Inputs are AUX input channels that are unused, depending upon the Input Mode being used (see §6.9.6). There may be only one or two to choose from. When the AUX input is energized, the relay can be programmed to assert.

NOTE:

- See §5.7.2.11 for more on Digital Inputs.
- See §5.7.2.12 for more on Relay configuration programming.

3.2.1.6 Relay

The Optimizer3 is equipped with one Form C (SPDT) dry contact relay. The relay is asserted by the state of alarms or Digital Inputs. Fully programmable, the relay requires setup as it is unprogrammed in the default Configuration settings.

NOTE: See §5.7.2.12 for more on Relay configuration programming.

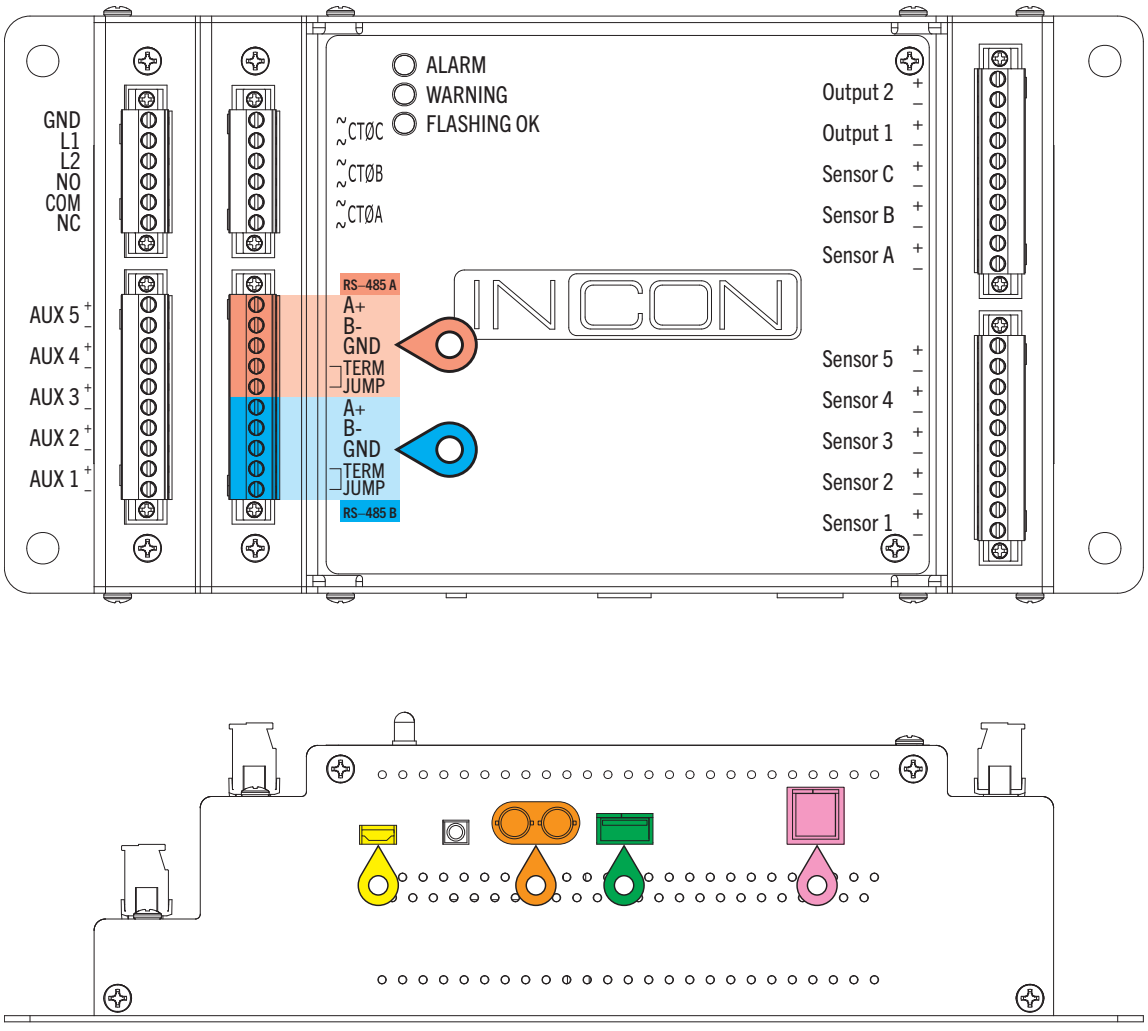
3.2.1.7 Communications

3.2.1.7.1 Communication Ports

Communication ports are used for Configuration of alarms and settings, history data retrieval, resets, data viewing, and data transfer using DNP3.0 protocol.

The Optimizer3 has several communication ports that can be used to interact with a computer network or other device(s). The following table provides a list of the ports and their associated devices.

Port (see above)	Connector	Function
RS-485A ( )	Pluggable Terminal Block	DNP3 Communication
RS-485B ( )		
Mini-B USB ( )	Mini-B USB	Network Connection
USB ( )	USB Type A	Flash Drive Connection
Fiber-Optic (Ethernet 2 – optional ( ))	Fiber-Optic	Network Connection
Ethernet (Ethernet 1 ( ))	RJ45	



RS-485

There are two RS-485 ports, RS-485A and RS-485B (they are half duplex) used for DNP3.0 communication only. No user interface actions can be done through this port. If the Optimizer3 is the last device in the network, a wire jumper is needed between terminals marked TERM JUMP. This jumper places an internal 120 Ω resistor into the circuit for termination (see the table below for Factory Defaults).

Factory Defaults	Value
Data Bits	8
Stop Bits	1
Parity	1
Baud Rate	9600 BPS
Flow Control	None

USB

USB Port is used for manual data dumping and password resetting (contact Technical Service). A USB memory stick with special script files is necessary to perform specific operations, each operation requires a different script. Script files must be located in the root directory of the USB memory stick. Files in directories on the memory stick will not be seen by the Optimizer3.

Mini-B USB

Mini-B USB Port default IP address from the factory is https://192.168.171.171 . Drivers may be required. It is recommended that the PC or laptop be connected to a network with internet access upon first connection to the Optimizer3 using the Mini-B USB (see §5.2). The PC or laptop will better be able to find the necessary driver files for the device. If this is not possible or does not work, a Mini-B USB driver file is included on the documentation memory stick, which is included with the Optimizer3. It also contains the Optimizer3 User's Guide, DNP3 Profile Document and other information. The Mini-B USB Port can be used for local data dumping, alarm resetting, downloading, and uploading configuration settings, firmware upgrades and all user interface functions.

Ethernet

IMPORTANT: RJ45 Cable Ethernet (Ethernet 1) and Fiber-Optic Cable (Ethernet 2) cannot have the same IP address. If this occurs, the network will be unstable. If these ports are accidentally set the same, connect to the Optimizer3 with the Mini-B USB port and change the configuration settings of the Ethernet ports so they are different IP addresses. *Ethernet 1 must be disabled for Ethernet 2 to function properly.*

NOTE: Fiber-Optic (Ethernet 2) is a hardware option included with the model **OM3D-F** only. *Even when so equipped, it is NOT turned on by default (must be enabled and configured before use).* Fiber-Optic hardware uses multi-mode-capable transceivers.

RJ45 Ethernet (Ethernet 1) and Fiber-Optic (Ethernet 2) with multiple-user ports are used with DNP3.0 and TCP/IP protocols. *Optimizer3 is multi-session so both (protocols) can be run simultaneously.* When connected to a secure local area network, the Optimizer3 can be accessed remotely with a web browser by using its unique IP address. Firmware upgrades may be performed (locally or remotely) via this port.

- RJ45 Ethernet (Ethernet 1): Default IP Address is https://192.168.168.168
- Fiber-Optic (Ethernet 2): Default IP Address is https://192.268.169.169 -100 Mbps ST to ST Connection.

NOTE:

- See §5.7.1 for information on Configuration Programming Navigation.
- See §5.7.2 for Network Configuration Programming.

Use settings as provided by your network administrator for RJ45 Ethernet and Fiber-Optic Ethernet network connection.

The settings for USB networking should be left as shown, so that the local access IP address is always known.

NOTE: The port addresses are saved in the .XML file during a configuration download. If multiple Optimizer3 monitors are to be configured using one setup file, the addresses can be edited with a word processor, then uploaded for each monitor.

Dynamic Host Configuration Protocol (DHCP) is a network protocol that enables a server to automatically assign an IP address to a computer from a defined range of numbers (i.e., a scope) configured for a given network.

Static IP address may be assigned (manually by giving it the XXX.XXX.XXX.XXX number), or they may be automatically assigned by pointing the Optimizer3 to a DHCP server that manages a range of addresses and “dynamically” assigns these addresses.

3.2.1.7.2 Communications Software

The Optimizer3 is a web server. A web browser is required to communicate with it using the TCP/IP protocol via the Mini-B USB port or either of the Ethernet ports. If DNP3.0 protocol is used, the DNP primary controlling device will have software for network communication. Optimizer3 responds to validated DNP commands.

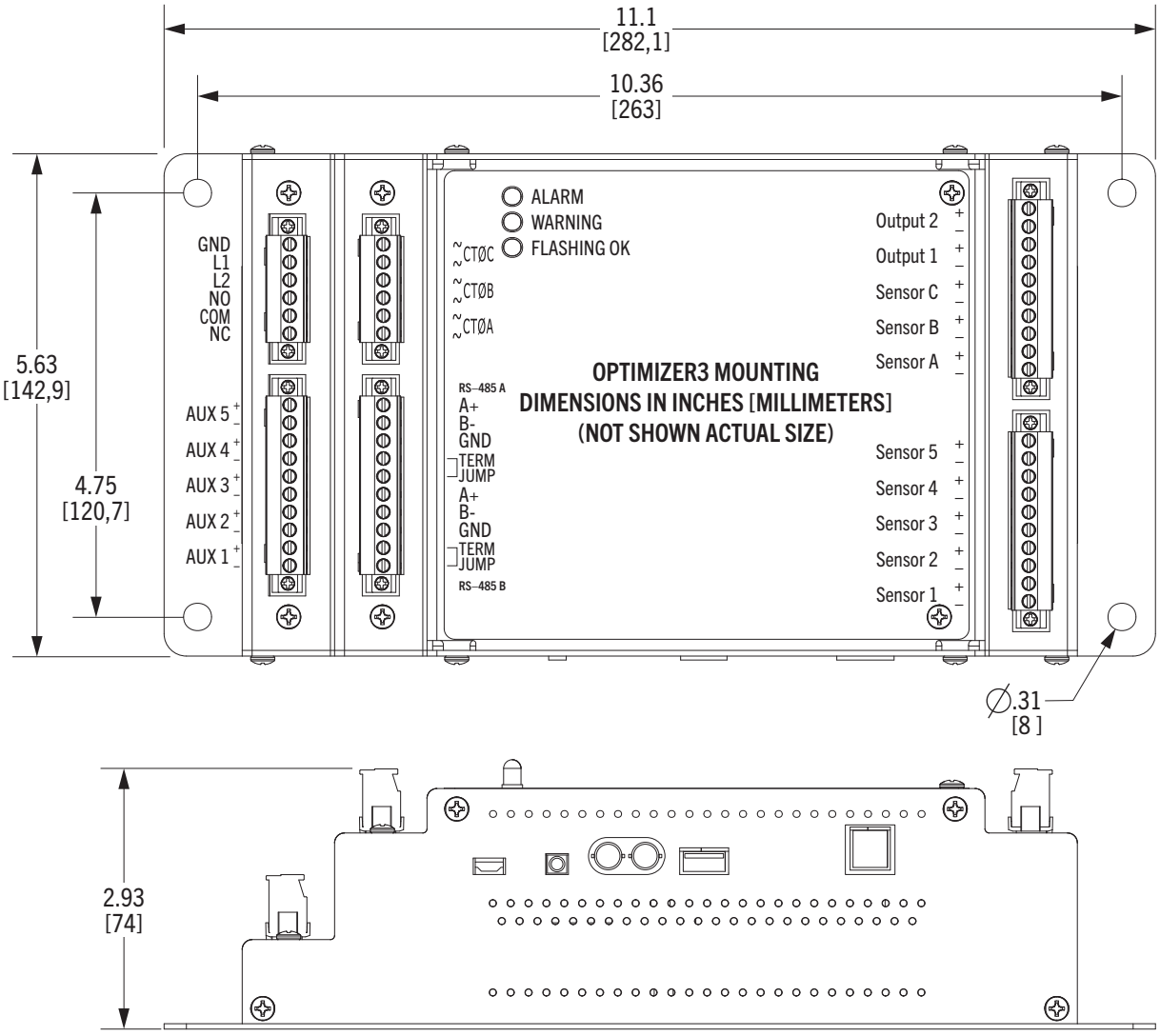
3.2.1.7.3 Self-Diagnostics

- A blinking green LED “Flashing OK” indicates normal operation of the microprocessor system.
- See §5.7.2.12 regarding programming the relay for use in a “fail-safe, self-diagnostic” mode.

3.2.2 Specifications

Item	Description
Size	11.125 W x 5.625 H x 2.625 D, Inches Nominal, Shipping Weight: 6 LBS
Input Power	110–250 VDC or 90–264 VAC (50/60 Hz). Power consumption is 60 VA max
Fuse Rating – L1 & L2 Power Inputs	Internally fused with 3.15 A slow-blow fuses
Fuse Rating – Aux Input	Internally fused with 0.25 amp slow-blow fuses (both + and – connections of each Aux Input)
Fuse Rating – Recommended External	3.15 A slow-blow or 3 A circuit breaker
Operating Temperature	–40° C to +65° C
Alarm Relay Contact	One form C, 1 A at 30 VDC, 2 A at 250 VAC rating (Common connection internally fused with 3.15 A slow-blow fuse)
Analog Sensor Input Accuracy	±1% max, ±0.5% typical
Pluggable Connector Wire Size	12–24 AWG
Data Storage- Non-volatile memory with capacity of:	
10,000 Application Events	
10,000 Alarm Events	
5000 Circuit Breaker Monitoring Events	
5000 SF_6 Gas Parameter Data Points	
750 Daily Summary Logs	
5000 3-Phase Line Current (measured and scaled from bushing CT secondaries)	
1000 Line Voltage Measurements (as measured at power input)	
5000 Ambient Temperature Measurements (as measured at the monitor)	
Test Standards:	
IEEE C37.10	
CISPR 16-2-1 (Conducted Emissions)	
CISPR 16-2-3 (Radiated Emissions)	
IEC61000-4-2 (ESD)	
IEC61000-4-3 (Radiated RF)	
IEC61000-4-4 (EFT)	
IEC61000-4-5 (Surge)	
IEC61000-4-6 (Conducted RF)	
IEC 61000-4-11 (Voltage Dips & Interrupts)	
IEC 61000-4-12 (Damped oscillatory wave – Power Ports)	
FCC Part 15, Subpart B; ICES-003 (Emissions)	

3.2.3 Dimensions



3.2.4 Required Tools

- (1) – One network connection cable*, being either a Mini-B USB (supplied) or an RJ45 Ethernet (standard or crossover) to initially connect the Optimizer3 to a PC.

  ***NOTE**: If Optimizer3 model OM3D-F is utilized, an additional Ethernet port option (Ethernet 2) is available to connect via Fiber-Optic (ST-to-ST Fiber-Optic duplex) cable.

4 Installation

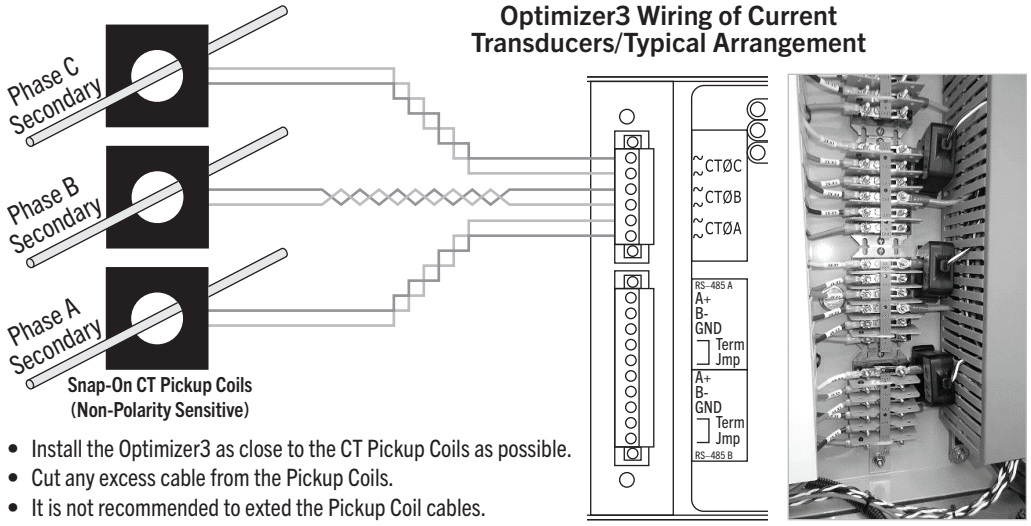
IMPORTANT: Read, understand, and follow information in §2 and §3 before beginning any process in this section.

NOTE: When the installation is complete, make sure this guide is left with the circuit breaker.

4.1 Optimizer3 Mounting Considerations

- The Optimizer3 is designed to be mounted vertically in the circuit breaker control cabinet and must be mounted so that the air vent holes on the top and bottom can provide cooling by convection air flow. *If Optimizer3 cannot be mounted vertically, the ambient temperature measured by the sensor may read slightly higher than expected.*
- Mounting the Optimizer3 as close as possible to the CT area will minimize Pickup Coil lead length and reduce the possibility of noise. The 20 AWG twisted pair leads should be cut to length and neatly run in a cable management product or secured with wire ties. The connections are not polarized even though they are colored black and white. If longer length is needed, do not extend the leads in the field (contact Franklin Electric Technical Service). The pickup coil output is 0–5 VAC.

Optimizer3 Wiring of Current Transducers/Typical Arrangement



Snap-On CT Pickup Coils (Non-Polarity Sensitive)

- Install the Optimizer3 as close to the CT Pickup Coils as possible.
- Cut any excess cable from the Pickup Coils.
- It is not recommended to exted the Pickup Coil cables.

Mounting Location Examples

- Interior Side Walls
- Swing Panels
- Other convenient locations providing convenient access to SF_6 plumbing:
  - Density Sensors,
  - Bushing CT circuits
  - Control Circuits

4.2 Additional Optimizer3 Mounting Considerations

- Operation/maintenance technicians may not have access to the control building where the protective relays are located. *If it is not possible to locate the Optimizer3 in the control cabinet, it may be installed in the control building. Most often this decision is based on access to communication links or SCADA RTU access.*
- Utilized as a *SF_6-Only* monitor (such as for monitoring compartments of GIS or SF_6 insulated bus), the Optimizer3 may be located up to 2000' from the digital SF_6 density or pressure sensors if 14 AWG wire is used. This makes it possible to locate the Optimizer3 in a control building, near communications access points.
- *If access to circuit breaker control cabinets is restricted, the Optimizer3 may also be installed in a separate enclosure (mounted to the frame of the circuit breaker).* Mounting the Optimizer3 in this configuration provides access without opening the circuit breaker control cabinet (without restriction of the breaker being taken out of service).

NOTE:

- There are two rows of pluggable connectors on the left side and one row on the right. Each plug is fastened by two screws, one on each end of each connector. *These must be tightened during installation to assure the plugs stay engaged and do not come loose from normal shock and vibration of the circuit breakers.*
- In the event that isolation or replacement of the monitor is required, unscrew the fasteners at each end and unplug the connectors.

4.3 Sensor Mounting Considerations

4.3.1 Dew Point Sensor

Mount the Dew Point Sensor as close as possible to the SF_6 tank. *Mounting the sensor a distance away from the tank will result in fluctuating measurements, affected by ambient temperature changes* (see §6.8).

5 Programming

IMPORTANT: Read, understand, and follow information in §2 and §3 before beginning any process in this section.

5.1 Pre-Programming Preparation

Before performing any programming:

- Ensure the Optimizer3 is fully installed per §4.
- Contact the Information Technologies department of the business, if available. Certain accounts may have restricted permissions to overcome before any changes are allowed to be made to TCP/IP settings.
    - The following instructions are written specifically for the Microsoft Windows® 11 operating system. For assistance with other operating systems, please contact Franklin Electric Technical Support.

5.2 Connecting A PC To The Optimizer3

The Web Browser Interface of the Optimizer3 is accessible through PC via a network connection. This connection can be established by either the Mini-B USB port or the Ethernet port.

NOTE: The Mini-B USB port is the RECOMMENDED and simplest way to directly connect to the Optimizer3 as it doesn't require any network configuration changes to be made.

5.2.1 Connecting Via Mini-B USB Cable (Recommended)

5.2.1.1 Connecting The Mini-B USB Cable

1. Plug the Mini-B USB connector into the Mini-B USB port of the Optimizer3.
2. Connect the other connector of the cable to the PC.
3. Turn on and login to the PC.

5.2.1.2 Accessing The Web Browser Interface

1. Open a web browsing application.
2. In the address bar of the web browsing application, enter "https://192.168.171.171".

NOTE: If there is a problem connecting, ensure the correct driver was loaded when connected by checking Device Manager of the PC. The device type for this connection is a Network adapter labeled "USB Ethernet/RNDIS Gadget". *Alternately, a Mini-B USB driver file is included on the documentation memory stick (included with the Optimizer3.*

5.2.2 Ethernet Connections

NOTE:

- The *standard* connection method uses a copper-wire Ethernet cable with RJ45 connectors at both ends, and is also referred to in this document as **Ethernet 1**.
- The *optional* connection method uses a Fiber-Optic (ST to ST) cable, and is also referred to in this document as **Ethernet 2**.

5.2.2.1 Connecting Via RJ45 Cable (Ethernet 1)

5.2.2.1.1 Connecting Cable

1. Plug one end of the cable into the RJ45 Ethernet port of the Optimizer3.
2. Connect the other end of the cable to the RJ45 of the PC.
3. Turn on and login to the PC.

5.2.2.1.2 Checking Ethernet Communication

1. Locate the Ethernet port on the Optimizer3.
2. Verify the orange RX light on the right side of the Ethernet port is flashing to confirm data is being received.
3. Verify the green link light on the left side of the Ethernet port is lit to confirm the connection is stable.

5.2.2.1.3 Checking Network Connection

1. Select “Start” button of the PC.
2. Search for and select “View network connections”.
3. Ensure the applicable Ethernet connection is enabled. If the connection status is disabled, enable it by right-clicking on the applicable Ethernet connection and selecting “Enable”.

5.2.2.2 Connecting Via Optional Fiber-Optic Cable (Ethernet 2)

5.2.2.2.1 Connecting Fiber-Optic Cable

1. Connect one end of the Fiber-Optic (ST to ST) cable into the Fiber-Optic port of the Optimizer3.
2. Connect the other end of the cable to the local area network’s Fiber-Optic interface. Ensuring the TX port of the Optimizer3 is connected to the RX port of the Fiber-Optic network interface, and the TX port of the Fiber-Optic network interface is connected to the RX port on the Optimizer3.
3. Turn on and login to the PC.

5.2.2.2.2 Checking Network Connection

1. Select “Start” button of the PC.
2. Search for and select “View network connections”.
3. Ensure the applicable Ethernet connection is enabled. If the connection status is disabled, enable it by right-clicking on the applicable Ethernet connection and selecting “Enable”.

5.2.2.3 Configuring PC Network Settings – Communication

1. Select the “Start” button of the PC.
2. Search for and select “View network status and tasks”.
3. Select “Change adapter settings” located in the left-hand column.
4. Right click on the applicable Ethernet connection and select “Properties”.
5. In the Ethernet Properties dialog box, under “This connection uses the following items”, ensure “Internet Protocol Version 4 (TCP/IPv4)” is marked as one of the items to use.
6. Double click on “Internet Protocol Version 4 (TCP/IPv4)”.
7. Make detailed notes on the current configuration of the TCP/IP settings shown in the Internet Protocol Version 4 (TCP/IPv4) Properties dialog box for use when programming is complete before moving forward in setting configuration.
8. Identify whether “Obtain an IP address automatically” or “Use the following IP address:” is selected in the Internet Protocol Version 4 (TCP/IPv4) Properties dialog box.
9. Continue to Section:
    - 5.2.2.4 if “Obtain an IP address automatically” is selected.

      OR
    - 5.2.2.5 if “Use the following IP address:” is selected.

5.2.2.4 Configuring TCP/IP Settings – "Obtain An IP Address Automatically"

If "Obtain an IP address automatically" is currently selected in the Internet Protocol Version 4 (TCP/IPv4) Properties dialog box:

1. Select the "Alternate Configuration" tab.
2. Select "User configured".
3. In the "IP address" entry box, enter an available IP address in the same subnet as the Optimizer3 Ethernet IP address.

   NOTE:

   - The default subnet mask of the Optimizer3 is 255.255.255.0.
   - The default Ethernet 1 IP address of the Optimizer3 is 192.168.168.168.
   - The default Ethernet 2 IP address of the Optimizer3 is 192.268.169.169.
   - For simplicity, it is recommended to set the value of the last octet by an offset of one from the Optimizer3 Ethernet IP address. For example, if the Ethernet IP address of the Optimizer3 is 192.168.168.168, configure the TCP/IP settings to have an IP address of 192.168.168.167.
4. In the "Subnet mask" entry box, enter the Ethernet subnet mask of the Optimizer3.
5. Ensure all remaining entry boxes are blank and click "OK".

5.2.2.5 Configuring TCP/IP Settings – "Use The Following IP Address"

If "Use the following IP address:" is currently selected in the Internet Protocol Version 4 (TCP/IPv4) Properties dialog box:

1. In the "IP address" entry box, enter an available IP address in the same subnet as the Optimizer3 Ethernet IP address.

   NOTE:

   - The default subnet mask of the Optimizer3 is 255.255.255.0.
   - The default Ethernet 1 IP address of the Optimizer3 is 192.168.168.168.
   - The default Ethernet 2 IP address of the Optimizer3 is 192.268.169.169.
   - For simplicity, it is recommended to set the value of the last octet by an offset of one from the Optimizer3 Ethernet IP address. For example, if the Ethernet IP address of the Optimizer3 is 192.168.168.168, configure the TCP/IP settings to have an IP address of 192.168.168.167.
2. In the "Subnet mask" entry box, enter the Ethernet subnet mask of the Optimizer3.
3. Ensure all remaining entry boxes are blank and click "OK".

5.2.2.6 Accessing The Web Browser Interface

1. Open a web browsing application.
2. In the address bar of the web browsing application, enter “https://<Ethernet IP address of the Optimizer3 USB>”. For example, to access the Web Browser Interface using the default Ethernet IP address of the Optimizer3 enter, “https://192.168.168.168”.

5.3 Initial Web Browser Interface Setup

Once the Web Browser Interface has been accessed per § 5.2.1.2 or § 5.2.2.6, a user will be able to perform initial Web Browser Interface setup.

5.3.1 Setting The Admin Password

When first accessing the Web Browser Interface, the initial web page will require a user to set a password for the administrator user.

1. Enter a password into both “New Password and “Repeat Password” that meets the following requirement:
   - 12–36 characters including one each of the following alpha-numeric characters: A-Z, a-z, 0-9, -_! &@?*+.()
2. Select “Set new password” to apply.
3. Enter “admin” into the “Username” entry box.
4. Enter the set password into the “Password” entry box.
5. Select “Submit”.

IMPORTANT: It is recommended to document the set password and keep in a safe location. Once the password is set, if it is forgotten, the user will need to use a backup code or wait to login until Franklin Electric Technical Support is able to assist the user with resetting it. For further information on backup codes, see § 5.8.3.

5.3.2 Initial Preferences Setup

Once the system has been fully installed and the Web Browser Interface is accessible, the user preferences may be set. See Section 5.8.4 for user preferences information.

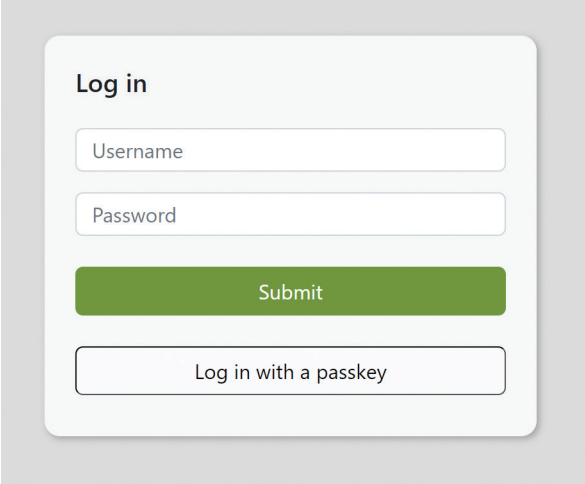
5.3.3 Initial Configuration Setup

Once the system has been fully installed and the Web Browser Interface is accessible, the system may be configured. See 5.7.1 and 5.7.2 for configuration information.

5.4 Web Browser Interface Navigation

5.4.1 Logging In

When logging into the Web Browser Interface, the user will either need to provide a password, a passkey, or both a password and passkey.



Password login:

If a trusted certificate hasn't been uploaded as described in §5.7.5, or multi-factor authentication hasn't been enabled as described in §5.8.2, a user will be able to login by entering their username and password.

Passwordless login:

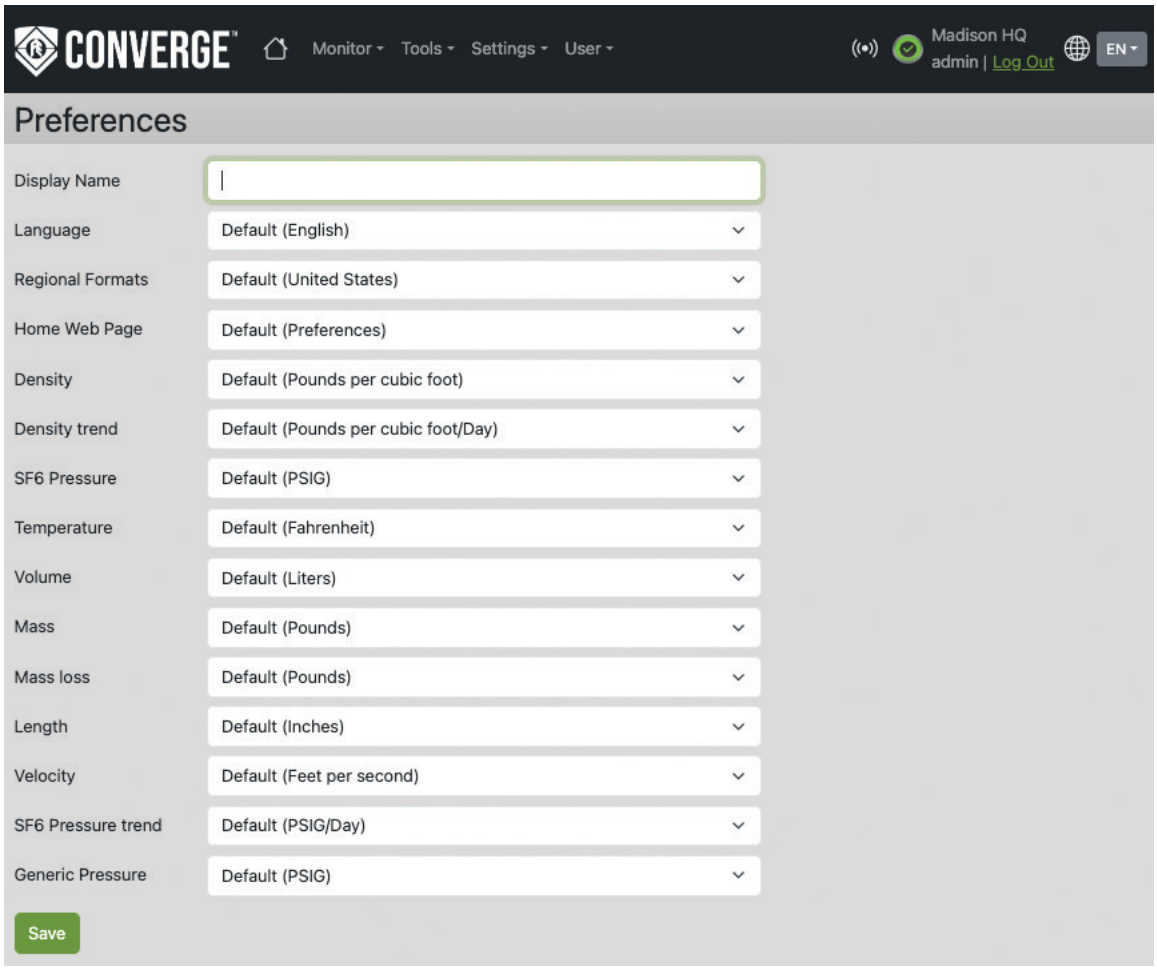
If a trusted certificate has been uploaded as described in §5.7.5, and a passwordless login has been enabled for a user's passkey as described in §5.8.2, a user will be able to select the "Log in with a passkey" option and login without using a password.

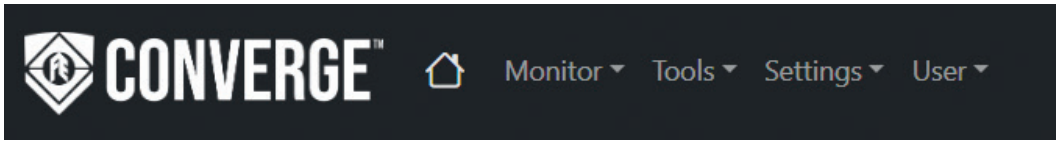
Multi-factor Authentication Login:

If a trusted certificate has been uploaded as described in §5.7.5, and a passkey has been registered for a user without selecting the "Enable passwordless login with this passkey" option as described in §5.8.2, a user will be prompted to provide a secondary form of authentication when logging in with a password.

5.4.2 Overview

The Web Browser Interface allows for simple navigation through the system (Home page is shown here for reference).

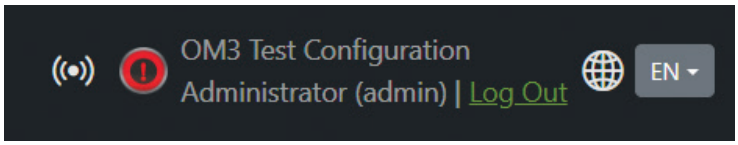




- : Clicking the home icon will bring the user to the home page as selected in user preferences. Please see §5.8.4 for user preferences information.
- Monitor: View various system status pages.
- Tools: Perform operational functions such as system upgrades, reboot the system, and erase data.
- Settings: Manage system settings and preferences.
- User: Manage user settings and preferences.

5.4.3 Status Icons

The Web Browser Interface header displays useful system status information.



- Connection Status: Displays the connection status of the system.

  – The system has a secure connection between the browser and the device

  – The system is connecting the browser to the device.

  –The system does not have a connection between the browser and the device.

- System Status: Displays the current status of the system. If the icon is yellow or red, click on it to learn more.

  – The container is in OK status.

  – The container is in Warning status.

  – The container is in Alarm status.

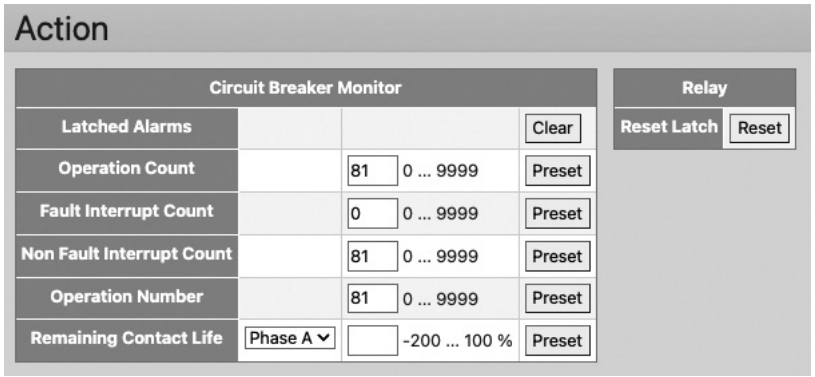
- Language Status: Displays the default language status.

  – Click the drop-down menu next to the globe icon to select the language of the Web Browser Interface.

5.5 Monitor

5.5.1 Action

The Action page displays available data based on programming configuration settings. Viewable tables and information may vary depending on availability of data.



5.5.2 Circuit Breaker Monitor

The Circuit Breaker Monitor page displays available data based on programming configuration settings. Viewable tables and information may vary depending on availability of data.

Circuit Breaker Monitor

Breaker State	Opened
Opening Time	Alarm
Opening Travel Time	Alarm
Closing Time	Alarm
Closing Travel Time	Alarm
Time Of Last Operation	Mar 13, 2023, 4:45:28 AM
Days Since Last Operation	169.2
No Operation Time	OK
Operation Count	81 - OK
Fault Interrupt Count	0 - OK
Non Fault Interrupt Count	81 - OK
Operation Number	81
Aux Input Failure	Alarm

	Phase A	Phase B	Phase C
RMS Current	7.0	8.0	8.0
Remaining Contact Life	100.0	100.0	100.0
Contact Life Warning	Disabled	Disabled	Disabled
Contact Life Danger	OK	OK	OK
Restrike	Disabled	Disabled	Disabled
Excess Arc	OK	OK	OK
Over Interrupting Time Limit	Alarm	Alarm	Alarm
Failed CT Pickup	OK	OK	OK

5.5.3 Sensors

The Sensors page displays available data based on programming configuration settings. Viewable tables and information may vary depending on availability of data.

Sensors

	Sensor A	Sensor B	Sensor C
Average Mass (lbs)	61.9	60.8	58.9
Mass Loss (lbs)	0.12	0.15	0.25
Density (lb/ft^3)	1985.2	1961.9	1950.8
Density Trend (lb/ft^3/day)	12.3	11.7	-37.2
Low Gas Alarm Forecast (days)	859	885	719
Pressure (PSIG)	72.5	72.2	71.7
Average Pressure (PSIG)	72.7	71.9	71.5
Pressure Trend (PSIG/day)	0.01	0.01	0.02
Trend Confidence Level (%)	85.8	85.2	81.7
Temperature (°F)	76.4	76.9	76.8
Trend Limit	OK	OK	OK
Forecast Limit	OK	OK	OK
Low Gas Danger Limit	OK	OK	OK
Low Gas Warning Limit	OK	OK	OK
Erratic Signal	OK	OK	OK
Sensor Malfunction	OK	OK	OK

	Ambient	Sensor 5
Temperature (°F)	71.1	116.9
Erratic Signal	OK	OK
Sensor Malfunction	OK	OK
Low Temperature Limit	OK	OK
High Temperature Limit	OK	OK

	Sensor 2
Heater	OFF
Current (A)	0.0
Low Current	OK

	Supply	Sensor 4
Voltage (V)	118.3	131.1
Today's Average (V)	119.1	132.3
Today's Minimum (V)	113.5	130.1
Today's Maximum (V)	120.3	132.8
Sample Count	833	484

	Sensor 1
Current (A)	10.2
Accumulated Run Time (hrs)	13.8
Average Run Time (sec)	35
Average Time Between Runs (hrs)	7.4
Run Frequency (average runs/day)	3.2

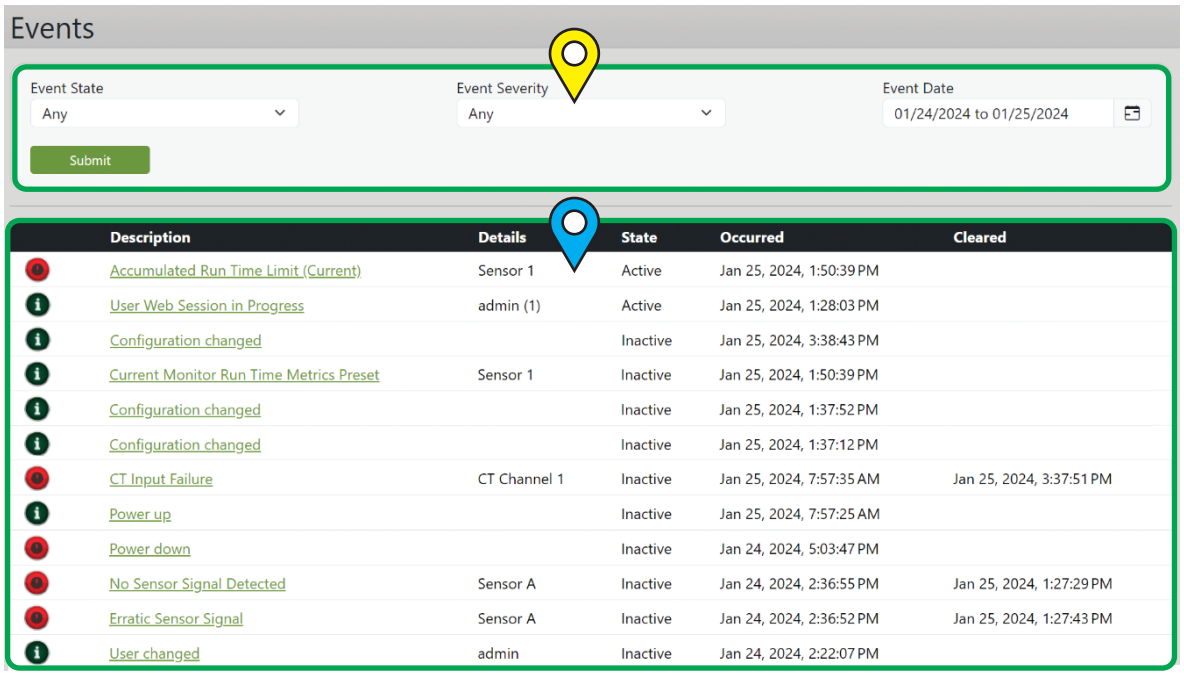
	Sensor 3
Dew Point (°F)	-37.7 °F
Average Dew Point (°F)	-37.8 °F

5.5.4 Export

The Export page displays available data and date ranges used to provide content for generating system reports.

5.5.5 Events

The Events page displays the event history log as configured by the user.



Event History Log Setup ( )

- **Event State**: Select “Any” to display all events, select “Inactive” to display inactive events, or select “Active” to display active events.
- **Event Severity**: Select “Any” to display all events or select “Alarms Only” to display events with an alarm status only.
- **Event Date**: Click the calendar icon to select the date range of events.
- **Submit**: Click “Submit” to apply the event history log setting changes made.

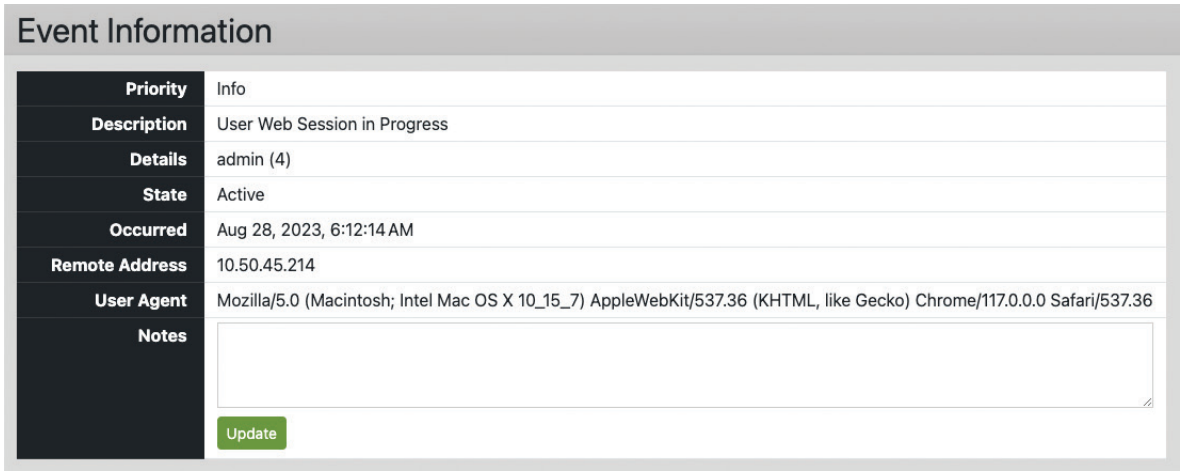
Event History Log Information ( )

– The event has an informational level severity.

– The event has a warning level severity.

– The event has an alarm level severity.

- **Description**: Displays a description of the event. Click on the description to view further event details. For further information about event descriptions, see § 7.1.
- **Details**: Displays further information about the event. Information displayed here could include the user or sensor channel or CT phase the event was related to.
- **State**: Displays the current state of the event. An “Active” state indicates the event is currently active. An “Inactive” state indicates the event is no longer active.
- **Occurred**: Displays the date and time of the event’s occurrence.
- **Cleared**: Displays the date and time the event was cleared if applicable.



Event Information

- Priority: Displays the event level severity.
- Description: Displays a description of the event. For further information about event descriptions, see § 7.1.
- Details: Displays further information about the event. Information displayed here could include the user or sensor channel or CT phase the event was related to.
- State: Displays the current state of the event. An “Active” state indicates the event is currently active. An “Inactive” state indicates the event is no longer active.
- Occurred: Displays the date and time of the event’s occurrence.
- *Content: Allows user to download applicable content.
- *Source: Identifies the event source.
- *Remote Address: Displays IP address of the connecting browser.
- *User Agent: Displays details about the browser.
- Notes: Allows user to document notes related to the event.

NOTE: Parameters denoted with (*) only appear for certain applicable events.

5.6 Tools

5.6.1 Upgrade

The Upgrade page allows users to update the firmware version of the Optimizer3. To download the most current firmware update, visit franklingrid.com and navigate to Products > Power Grid Monitoring > INCON® Optimizer3 > Downloads > Software.

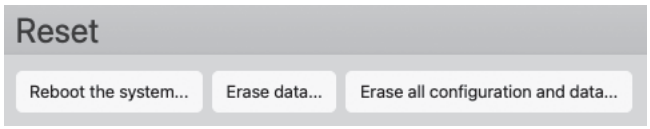
To upload a new firmware version:

1. Select “Select firmware file and start upgrade…”.
2. Select the firmware file from file explorer.
3. Select “Open”.
4. Wait until the loading bar has reached 100%, the “Firmware upgrade in progress” notification has disappeared, and the Web Browser Interface changes to a login page.
5. Re-login and confirm the firmware upgrade has completed by checking the version number in the bottom right-hand corner of the Web Browser Interface.

5.6.2 Reset

The Reset page allows a user to perform functions such as power cycling the system, erasing historical data, and resetting configuration settings.

IMPORTANT: These tasks should only be performed under direction from Franklin Electric Technical Support.



5.6.2.1 Reboot The System . . .

To power cycle (restart) the Optimizer3:

- Select **Reboot the system**..., a prompt “Are you sure…” will appear, select **OK**.

5.6.2.2 Erase Data . . .

To erase all historical data and keep existing configuration programming:

- Select **Erase data…**, a prompt “Are you sure…” will appear, select **OK**.

5.6.2.3 Erase All Configuration And Data …

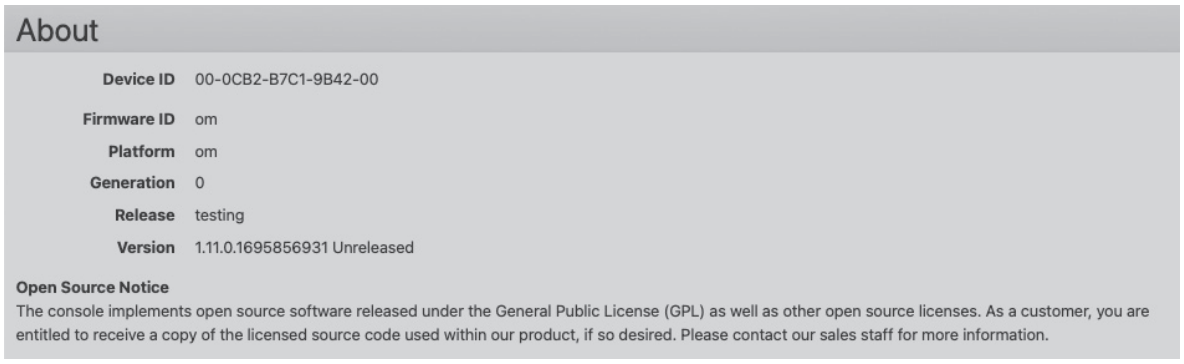
To erase all historical data and existing configuration programming:

- Select **Erase all configuration and data**, a prompt "Are you sure…" will appear, select **OK**.

IMPORTANT: It is important to remember that this will return all settings, including passwords and network settings, of the Optimizer3 to its default settings. If the default configuration contains an IP address different from the one currently in use, a user may need to locally reprogram the IP address into the Optimizer3 in order to communicate remotely. Be prepared to be on-site to regain access to the Web Browser Interface.

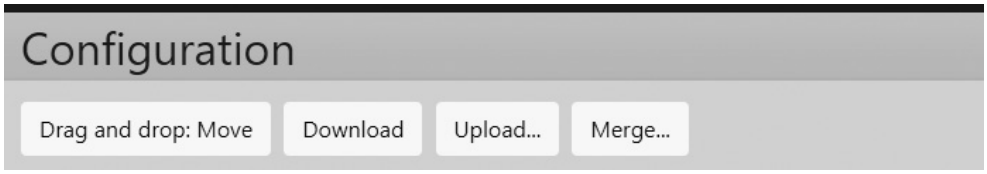
5.6.3 About

Displays basic identification information of the Optimizer3.



5.7 Settings

5.7.1 Configuration Navigation



5.7.1.1 Expand / Collapse Items

To expand / collapse all subsections within an individual section of programming:

- Click on the double arrows or anywhere within the title box of the section.

To fully expand / collapse all subsections and items within an individual section of programming:

- Click on the double arrows or anywhere within the title box while holding the CTRL key on the keyboard.

To fully expand / collapse all sections, subsections, and items of the configuration:

- Click on the double arrows or anywhere within the “Group” title box.

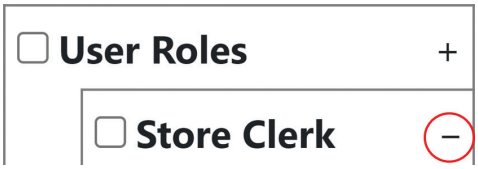
5.7.1.2 Add / Remove Items

To add an item within a subsection:

- Click on the “+” in the subsection title box.

To remove an item within a subsection:

- Click on the “-” in the subsection title box.



5.7.1.3 Drag & Drop: Copy

To copy the settings of subsections of programming:

1. Ensure the “Drag and drop:” button displays “Drag and drop: Copy”. If the button displays “Drag and drop: Move”, click the button to switch.
2. Click and hold the title of a subsection and drag it to another applicable title of a subsection to duplicate the parameters from the originally selected subsection.

NOTE: To determine if a subsection is able to be copied, hover over the title of the subsection. If the cursor changes to a cursor, it is able to be copied.

5.7.1.4 Drag & Drop: Move

To move the settings of subsections of programming:

1. Ensure the “Drag and drop:” button displays “Drag and drop: Move”. If the button displays “Drag and drop: Copy”, click the button to switch.
2. Click and hold the title of a subsection and drag it to another applicable title of a subsection to relocate the originally selected subsection.

NOTE: To determine if a subsection is able to be moved, hover over the title of the subsection. If the cursor changes to a cursor, it is able to be moved.

5.7.1.5 Download

To download a full circuit breaker configuration:

1. Select “Download”. (A "config.xml" file will automatically be saved to the computer's Downloads folder.)
2. Open the “Downloads” folder in file explorer and save the configuration file to the proper location.
3. Rename the file with a name that includes the site it represents and the date.

NOTE: The user may need to temporarily disable any pop-up blocker to download the configuration.

5.7.1.6 Download Selected

To download a partial configuration:

1. Select each configuration section to be included in the download by checking the box within the section.
2. Select “Download”. (A "config.xml" file will automatically be saved to the computer's Downloads folder.)
3. Open the “Downloads” folder in file explorer and save the configuration file to the proper location.
4. Rename the file with a name that includes the site it represents and the date.

NOTE: The user may need to temporarily disable any pop-up blocker to download the configuration.

5.7.1.7 Upload…

To upload a full circuit breaker configuration:*

1. Select “Upload”.
2. Select the configuration file from file explorer.
3. Select “Open”.
4. Select “Save” to apply configuration changes.

5.7.1.8 Merge…

To merge a partial configuration with an existing configuration:*

1. Select “Merge”.
2. Select the partial configuration file from file explorer.
3. Select “Open”.
4. Select “Save” to apply configuration changes.

***NOTE**: (§ 5.7.1.7 and § 5.7.1.8) It is important to remember that network parameters may be affected by the configuration change. If the downloaded file contains an IP address different from the one currently in use, a user may need to locally reprogram the IP address into the Optimizer3 in order to communicate remotely. Be prepared to be on-site to regain access to the Web Browser Interface.

5.7.1.9 Revert

While making configuration changes, to revert to the configuration settings from the most recently saved configuration:

- Select “Revert”.

5.7.1.10 Save

To apply configuration changes:

- Select “Save”.

5.7.2 Configuration

The configuration information in this section is presented in the following format:

General Configuration Programming Layout

☐ Group	Parameter Name	Parameter Value
☐ Configuration Section		
☐ Subsection		
☐ Subsection Item #		
☐ Subitem #	Selection 1	Information/Options
	Subsequent Selection 1	Information/Options
	Subsequent Selection 2	Information/Options
	Selection 2	Information/Options

Optimizer3 Configuration Programming Layout

☐ Group	Parameter Name	Parameter Value
☐ Sytem ID		
☐ System Preferences		
☐ Date/Time		
☐ User Roles		
☐ Networking		
☐ Diagnostics		
☐ RS-485		
☐ Sensors		
☐ Circuit Breaker Information		
☐ Circuit Breaker Monitor		
☐ Digital Inputs		
☐ Relay		
☐ DNP3		

5.7.2.1 System ID

☐ Group	Parameter Name	Parameter Value
☐ System ID	Site Name	» Enter the physical name of the site.
	ID Line 1	» Enter the circuit breaker ID.
	ID Line 2	*
	ID Line 3	*
	ID Line 4	*
	ID Line 5	*

NOTE: *Enter ID as needed.

5.7.2.2 System Preferences

The settings chosen for system preferences are the settings of:

- The Web Browser Interface when there is no user logged in.
- The Web Browser Interface for a user who is logged in and has selected "Default" user preferences.
- A notification that is sent from the system.

When a user is logged in, and they have chosen their own user preferences as shown in 5.8.4, the user's preferences will be applied to the Web Browser Interface for the duration of their session.

5.7.2.2.1 Language

Enter the preferred language for the Web Browser Interface.

☐ Group	Parameter Name	Parameter Value	
☐ System Preferences	Language	English English-United Kingdom	French Spanish-Castilian

5.7.2.2.2 Regional Formats

Select the preferred system regional format.

☐ Group	Parameter Name	Parameter Value		
☐ System Preferences	Regional Formats	United States Algeria Antigua and Barbuda Argentina Australia Austria Bahrain Belgium – French Belgium – German Bolivia Botswana Brazil Bulgaria Canada – English Canada – French Chile China Colombia Costa Rica Cuba Cyprus Denmark Republic Ecuador Egypt El Salvador France	Germany Guatemala Honduras Hong Kong – Chinese Hong Kong – English India – Arabic India – English India – Hindi Iraq Ireland Israel – English Israel – Hebrew Italy – German Italy – Italian Jordan Kuwait Lebanon Libya Liechtenstein Luxembourg – French Luxembourg – German Mexico Morocco New Zealand Nicaragua Nigeria Oman	Panama Paraguay Peru Philippines Poland Portugal Puerto Rico Qatar Russian Federation Saudi Arabia Singapore – Chinese Singapore – English Slovakia South Africa South Sudan Switzerland – French Switzerland – German Switzerland – Italian Syrian Arab Republic Taiwan Tunisia Turkey Dominican United Arab Emirates United Kingdom Uruguay Venezuela

5.7.2.2.3 Units

Select the preferred unit for each parameter below, to set “System Preferences”.*

NOTE:

- To set “Personal Preferences” that supercede “System Preferences”, see §5.8.4. “Personal Preferences” set in §5.8.4 override the “System Preferences” set here in terms of what is seen on screens served from the Optimizer3 to their browser. Each user’s “Personal Preferences” are stored in their browser cache.
- *DNP3 values are reported in Metric units by default (regardless of the units chosen in System Preferences). See §5.7.2.13 for settings allowing DNP3.0 values to be reported in the units chosen in the System Preferences.

☐ Group	Parameter Name	Parameter Value
☐ System Preferences	Language	English
	Regional Formats	United States
☐ Units	Density	» Pounds per cubic foot » Grams per liter
	Density trend	» Grams per liter / Day » Pounds per cubic foot / Day
	SF6 Pressure	» Kilopascal » Kilopascal absolute » Bar » Bar absolute » PSIG
	Temperature	» Celsius / Fahrenheit
	Volume	» Liters » Cubic feet » Cubic meters
	Mass	» Grams » Kilograms » Pounds
	Mass loss	» Grams » Kilograms » Pounds » Pound of CO_2 » Metric tons of CO_2
	Length	» Millimeters » Meters » Inches
	Velocity	» Meters per second » Feet per second
	SF6 Pressure trend	» Kilopascal / Day » Bar / Day » PSIG / Day
	Generic Pressure	» Kilopascal » Kilopascal absolute » Bar » Bar absolute » Megapascal

5.7.2.3 Date/Time

NOTE:

- If using a URL, the DNS server must be properly configured in the network settings of the Optimizer3.
- *If NTP Servers are not programmed*, navigate to Settings > Date/Time to set the date and time.
- Set Time Zone before setting Date/Time as changes to Time Zone afterward will impact set time.
- *If NTP servers are programmed*, DNP3 Time Synchronization must be disabled, and the DNP3 Controlling Station must not send time update commands.

☐ Group	Parameter Name	Parameter Value
☐ Date/Time	Time Zone	» Select the applicable time zone.
	NTP Servers	» Enter the URL/IP address of one or more Network Time Protocol servers. If NTP servers are programmed, the ability to set the date and time will be suspended until the NTP servers are removed.

5.7.2.4 User Roles

☐ Group	Parameter Name	Parameter Value
☐ User Roles		
☐ User Role #	Name	» Enter the user's name.
	Administrator	» Select "Yes" to grant the user full access of the system.
		» Select "No" to allow for customization of the user's access.
		NOTE: "Yes" allows the user to deny or allow access to each of the following abilities.
	Firmware upgrade	» Ability to upgrade system firmware versions.
	System reboot	» Ability to perform system reboots.
	Erase all configuration and data	» Ability to erase historical data/configuration settings.
	Erase data	» Ability to erase historical data.
	Set Date/Time	» Ability to set the current date and time.
	Change preferences	» Ability to modify the user's preferences.
	Diagnostics	» Ability to access diagnostic data.
	Change user password	» Ability to change the user's password.
	Manage user passkeys	» Ability to manage the user's passkeys.
	Manage user backup codes	» Ability to manage the user's backup codes.
	View events	» Ability to view event history.
	Annotate events	» Ability to enter information into the "Notes" section of individual event pages.
	Change configuration	» Ability to make configuration changes.

☐ Group	Parameter Name	Parameter Value
	View Status	» Select “Yes” or “No” for the ability to reset alarms, preset operation counters and remaining contact life.
	Take Action	» Select “Yes” or “No” for the ability to clear alarms, preset counters, reset trend data and a latched relay.
	Export Files	» Select “Yes” or “No” for the ability to download data from the sensors and CBM history logs.
	View Configuration	» Select “Yes” or “No” for the ability to look at configuration settings.

5.7.2.5 Networking

5.7.2.5.1 Ethernet 1 (RJ45)

IMPORTANT: When selecting “Automatic (DHCP)”, a random IP address is assigned to the device each time the Optimizer3 is turned on/off. If a non-changing IP address is required for any reason, a reserved IP address is needed. The reserved IP address will allow for the Optimizer3 to retain its IP address after firmware versions upgrades/reboots and for the Web Browser Interface access to remain available.

☐ Group	Parameter Name	Parameter Value
☐ Networking		
☐ Ethernet 1	Enable	» Select “Yes” or “No” whether the Ethernet network connection is to be enabled or not. **NOTE**: “Yes” allows the user to configure the IPv4 settings.
☐ IPv4	Method	» Select “Automatic (DHCP)” for the connecting network to automatically assign an IP address to the device through DHCP. » Select “Manual” to manually enter IPv4 address settings. **NOTE**: “Manual” allows the user to manually configure IPv4 settings.
	Address	» Enter the desired IP address of the device.
	Netmask	» Enter the netmask of the connecting network.
	Gateway	» Enter the gateway of the connecting network if the system is to connect to computers outside the subnet.
	DNS Servers	» Enter one or more DNS servers if URLs are to be used instead of IP addresses for external resources.
	Search Domains	» Enter the search domains of the connecting network if required.
	DHCP Server	» Select “Enable” to enable a DHCP Server on the interface. In most cases, this should be disabled.

5.7.2.5.2 Ethernet 2 (Fiber-Optic)

IMPORTANT: When selecting "Automatic (DHCP)", a random IP address is assigned to the device each time the Optimizer3 is turned on/off. If a non-changing IP address is required for any reason, a reserved IP address is needed. The reserved IP address will allow for the Optimizer3 to retain its IP address after firmware versions upgrades/reboots and for the Web Browser Interface access to remain available.

NOTE: Ethernet 1 must be disabled for Ethernet 2 to function.

☐ Group	Parameter Name	Parameter Value
☐ Networking		
☐ Ethernet 1		
☐ Ethernet 2	Enable	» Select "Yes" or "No" whether the Ethernet network connection is to be enabled or not. **NOTE**: "Yes" allows the user to configure the IPv4 settings.
☐ IPv4	Method	» Select "Automatic (DHCP)" for the connecting network to automatically assign an IP address to the device through DHCP. » Select "Manual" to manually enter IPv4 address settings. **NOTE**: "Manual" allows the user to manually configure IPv4 settings.
	Address	» Enter the desired IP address of the device.
	Netmask	» Enter the netmask of the connecting network.
	Gateway	» Enter the gateway of the connecting network if the system is to connect to computers outside the subnet.
	DNS Servers	» Enter one or more DNS servers if URLs are to be used instead of IP addresses for external resources.
	Search Domains	» Enter the search domains of the connecting network if required.
	DHCP Server	» Select "Enable" to enable a DHCP Server on the interface. In most cases, this should be disabled.

5.7.2.5.3 Wi-Fi

This feature is not currently available.

☐ Group	Parameter Name	Parameter Value
☐ Networking		
☐ Ethernet 1		
☐ Ethernet 2		
☐ Wi-Fi		

5.7.2.5.4 USB

☐ Group	Parameter Name	Parameter Value
☐ Networking		
☐ Ethernet 1		
☐ Ethernet 2		
☐ Wi-Fi		
☐ USB	Enable	» Select “Yes” or “No” whether the USB network connection is to be enabled or not. **NOTE**: “Yes” allows the user to configure the IPv4 settings.
☐ IPv4	Address	» Enter the desired IP address of the device.
	Netmask	» Enter the netmask of the connecting network.
	DHCP Server	» Select “Enable” to enable a DHCP Server on the interface. In most cases, and in order for the USB Type B port to function properly, this should be enabled. **NOTE**: “Enable” allows the user to configure DHCP Server settings.
☐ DHCP Server	**Start**	» Enter the starting IP address of the DHCP server to assign.
	Limit	» Enter the limit of IP addresses for the DHCP server to assign.
	Lease Time	» Enter the lease time of the assigned IP address. **NOTE**: In most cases, the default values in the DHCP Server section should not be changed.

5.7.2.6 Diagnostics

☐ Group	Parameter Name	Parameter Value
☐ Diagnostics		
☐ Remote Syslog	Mode	» Select the mode of the remote syslog if requested to by FE Technical Support. » Disabled » UDP » TCP/IP **NOTE**: UDP or TCP/IP allows the user to configure the remote syslog settings if requested to by FE Technical Support.*
	*Host	» Enter the remote syslog server URL/IP address.
	*Port	» Enter the port number for the remote syslog server.
☐ Secure Shell	Enabled	» Select “Yes” if requested to by FE Technical Support.

5.7.2.7 RS-485

☐ Group	Parameter Name	Parameter Value
☐ RS-485		
☐ Port A	Baud Rate	» Select the desired communication speed.
	Data Bits	» Select the desired parameter value.
	Parity	» Select the desired parameter value.
	Stop Bits	» Select the desired parameter value.
☐ Port B	Baud Rate	» Select the desired communication speed.
	Data Bits	» Select the desired parameter value.
	Parity	» Select the desired parameter value.
	Stop Bits	» Select the desired parameter value.

5.7.2.8 Sensors

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	Mode	» Select a setting from the dropdown menu. » Off » Analog Compensated Pressure* » Analog Density* » Current* » Dew Point* » Digital Compensated Pressure† » Digital Density† » Generic Pressure* » Heater Monitor UPSM-241* » LenSense 2TC/105* » LenSense 2TC/106* » LenSense 2TC/108* » LenSense 2TC/115* » LenSense 2TC/117* » LenSense 2TC/118* » LenSense 2TC/822* » Temperature* » Voltage*
☐ Sensor 2	Mode	*
☐ Sensor 3	Mode	*
☐ Sensor 4	Mode	*
☐ Sensor 5	Mode	*
☐ Sensor A	Mode	*†
☐ Sensor B	Mode	*†
☐ Sensor C	Mode	*†

NOTE:

- *Analog sensor inputs may be connected to input channels 1–5 and/or A–C.
- †Digital sensor inputs may only be connected to input channels A, B, and/or C.
- *See § 6 for additional information and configuration programming for "Applied Sensor Monitoring" scenarios.*

5.7.2.9 Circuit Breaker Information

☐ Group	Parameter Name	Parameter Value
☐ Circuit Breaker Information	Manufacturer	» Enter the name of the circuit breaker manufacturer.
	Voltage Rating	» Enter a value from 0–2000 KV.
	Max Interrupting Current	» Enter a value from 0–99999 A.
	Max Operations Count	» Enter a value from 0–9999.

5.7.2.10 Circuit Breaker Monitor

See §6.9 for additional information (📍).

☐ Group	Parameter Name	Parameter Value
☐ Circuit Breaker Monitor	Power System Frequency	» Select a setting from the dropdown menu. » 50 Hz » 60 Hz
	Bushing CT Turn Ration - n:1	» Enter a value from 0–9999.
	Current Transducer Rating	» Select a setting from the dropdown menu. » 20 A » 30 A » 50 A » 100 A » 160 A » 250 A » 400 A » 800 A
	Fault Detect Threshold	» Enter a value from 0–38400 A.
	Input Mode	» Select a setting from the dropdown menu. » 1 (Continuous A, With B Input) » 2 (Opening Coil, No B Input) » 3 (Continuous A, No B Input) » 4 (Opening Coil, With B Input) » 5 (Opening Coil, Closing Coil, With A and B Input) » 6 (2 Opening Coils, With A and B Input) » 7 (2 Opening Coils, Closing Coil, With A and B input)
	Stroke Length	» Enter a value from 0.00–0.76 m.
	Red Light/52A Input Select	» Select a value from 1–5.
	Green Light/52B Input Select	» Select a value from 1–5.
	Opening Coil 1 Select	» Select a value from 1–5.
	Opening Coil 2 Select	» Select a value from 1–5.
	Closing Coil Select	» Select a value from 1–5.
	Red Light/52A Input Polarity	» Select a setting from the dropdown menu.* » Positive » Negative
	Green Light/52B Input Polarity	*
	Opening Coil 1 Polarity	*
	Opening Coil 2 Polarity	*
	Closing Coil Polarity	*

☐ Group	Parameter Name	Parameter Value
	Operation Number Increments On	» Select a setting from the dropdown menu. » Open » Closed
	A Input Delay	» Enter a value from -50–100 mS.
	Contact Wear Mode	» Select a setting from the dropdown menu. » IxT » I^2xT
	Contact Life Danger Limit	» Enter a value from 0–99,000,000 A^2 x sec.
	Contact Life Warning Limit	» Select a value from 0–99%.
	Arcing Time Limit	» Enter a value from 0–165 mS.
	Interrupting Time Limit	» Enter a value from 0–999 mS.
	Opening Time Limit	» Enter a value from 0–999 mS.
	Closing Time Limit	» Enter a value from 0–999 mS.
	Opening Travel Time Limit	» Enter a value from 0–999 mS.
	Closing Travel Time Limit	» Enter a value from 0–999 mS.
	Total Closing Time Limit	» Enter a value from 0–999 mS.
	Operations Count Limit	» Enter a value from 0–9999.
	Fault Interrupt Count Limit	» Enter a value from 0–9999.
	Non-Fault Interrupt Count Limit	» Enter a value from 0–9999.
	No Operations Limit	» Enter a value from 0–999 days.
	Restrike Alarm	» Select a setting from the dropdown menu. » Enabled » Disabled
	CT Failure Alarm	» Select a setting from the dropdown menu. » Enabled » Disabled* **NOTE**: *If the OM3 is used on a single-pole breaker, with one CT input connected, this alarm must be disabled.

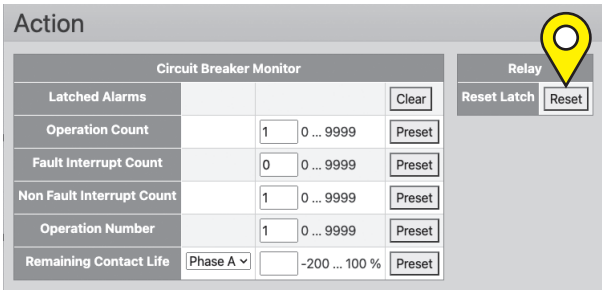
5.7.2.11 Digital Inputs

☐ Group	Parameter Name	Parameter Value
☐ Digital Inputs	Active State	High
☐ Channel 2	Active State	Low
☐ Channel 3	Active State	High
☐ Channel 4	Active State	High
☐ Channel 5	Active State	High

5.7.2.12 Relay

☐ Group	Parameter Name	Parameter Value
☐ Relay	Enabled	» Select a setting from the dropdown menu. » Yes » No
	Polarity	» Select a setting from the dropdown menu. » Normal » Invert
	Logic	» Select a setting from the dropdown menu. » AND » OR » XOR
	Latch	» Select a setting from the dropdown menu. » Yes » No
☐ Input 1	Type	» Select a setting from the dropdown menu. » None » Alarm » State
	Event Code	» Select an alarm from the dropdown menu.
	Event Key	» Select a sensor or CT channel from the dropdown menu (if available).

- If the Relay Input is an Alarm, it can be left in a generic mode, allowing any alarm to assert the relay.
- If only specific alarms are desired to assert the relay, further programming is needed to assign the Event Code, and possibly the Event Key.
- Select the Event Code from a menu of all possible alarms and conditions. *Some Event Codes allow an Event Key to limit the relay assertion to a specific CT phase or sensor channel associated with the Event.* In most cases, the Event Key can be set to "Any", which will allow any alarm event of the same Event Code to assert the relay.
- Relay programming is accomplished by adding an input for each alarm or Digital Input required to assert the relay.
- The relay's Polarity can be programmed to "Invert". This causes the relay to assert when no alarms are active and de-assert when an alarm occurs. This mode can be used to create a "fail-safe self-diagnostic" alarm of sorts. If the Optimizer3 should lose power or experience a catastrophic failure, the asserted relay would release. The normally closed contacts would close, notifying the supervisory system of the failure.
- If desired, the relay can be programmed to "Latch" in the asserted state. *This is useful for bringing attention to alarm conditions that are occasional or momentary.* The relay will remain in the asserted state until manually reset or until the Optimizer3 reboots. The Relay Latch Reset button is located on the Monitor > Action page ( ).



5.7.2.13 DNP3

NOTE: See §6.9.6, Example 2 for programming a binary DNP3 point to monitor relay.

- There are two operating modes for DNP3 communication:
  - Ethernet (TCP/IP)
  - Serial RS-485 (Port A or B)
- Refer to the Optimizer3 DNP3.0 Device Profile Document, p/n **000-0321**, for details on the Optimizer3's DNP implementation and a complete DNP3 Points List.
- Review the DNP3 Point List and decide what information from which sensors and which phases will be retrieved through DNP3.
- Program the Sensors, SF_6 Gas Monitor and Circuit Breaker Monitor sections first, *before programming the DNP3 section.*

☐ Group	Parameter Name	Parameter Value
☐ DNP3	Mode	» Select the mode (port) for DNP3 communication from the dropdown menu. » Disabled » TCP/IP – Set a communication port number from 1–65535 (TCP/IP Mode only) » RS-485 Port A » RS-485 Port B
	TCP/IP Communication Timeout	» Set the DNP3 connection duration from 0–120 minutes.
	Outstation Address	» Set the DNP3 address of the Optimizer3, from 0–65535.
	Primary Address	» Set the address of the DNP3 Primary, from 0 to 65535 (typically "1").
	Enable Unsolicited Messages	» Select a setting from the dropdown menu. » Yes* » No **NOTE**: *Allows the Optimizer3 to send DNP3 messages without polling from the DNP3 Primary. Also allows the Event Class of Analog DNP3 points to be individually assigned.
	Enable Time Synchronization	» Select a setting from the dropdown menu. » Yes** » No **NOTE**: **Allows the Optimizer's clock time to be updated by the DNP3. *This must be disabled when using an NPT time server.*
	Enable Units Conversion	» Select a setting from the dropdown menu. » Yes*** » No **NOTE**: DNP3 values are reported in Metric units by default (regardless of the units chosen in System Preferences). ***Selecting "Yes", allows the DNP3 values to be reported in the units chosen in the System Preferences.
	Logging Level	» Not applicable (for diagnostic purposes only).
☐ Binary		
☐ Analog		
☐ Counter		

5.7.2.13.1 Binary

☐ Group	Parameter Name	Parameter Value
☐ DNP3		
☐ Binary	Default static variation	» Select a binary object setting, sent by the Optimizer3 from the dropdown menu. » Group 1 Variation 1 – without flags » Group 1 Variation 2 – with flags
	Override defaults	» Select a setting from the dropdown menu. » Yes* » No **NOTE**: *When enabled, Group and Variation of each DNP3 binary point can be individually assigned.
	Number of measurements	» Enter a value from 0–200.** **NOTE**: **When a number is entered, numbered rows will appear below this section. *The number of the row is the DNP Point Index number.* The number of points can be changed at any time by changing the parameter value.
☐ 1	Category	» Select a specific group of binary data the DNP3 point will be chosen from (dropdown menu).* » Any » Circuit Breaker Monitor » Circuit Breaker Monitor Phase A » Circuit Breaker Monitor Phase B » Circuit Breaker Monitor Phase C » Other » Sensor 1 » Sensor 2 » Sensor 3 » Sensor 4 » Sensor 5 » Sensor A » Sensor B » Sensor C
	Source	» Select a specific binary data source to be assigned to the DNP3 point (dropdown menu).* » CT Failure C » Over Arcing Time Limit C » Over Danger Limit C » Over Interrupting Time Limit C » Over Warning Limit C **NOTE**: *Source is dependant on category selected. Category and source is assigned for each DNP3 point created.
☐ Analog		
☐ Counter		

5.7.2.13.2 Analog

☐ Group	Parameter Name	Parameter Value
☐ DNP3		
☐ Binary		
☐ Analog	Default static variation	» Select the type of analog objects sent by the Optimizer3 from the dropdown menu. » Group 30 Variation 1 – 32-bit with flags » Group 30 Variation 2 – 16-bit with flags » Group 30 Variation 3 – 32-bit without flags » Group 30 Variation 4 – 16-bit without flags » Group 30 Variation 5 – single-precision with flags » Group 30 Variation 6 – double-precision with flags
	Override defaults	» Select a setting from the dropdown menu. » Yes* » No **NOTE**: *When enabled, Group and Variation of each DNP3 analog point can be individually assigned.
	Number of measurements	» Enter a value from 0–200.** **NOTE**: **When a number is entered, numbered rows will appear below this section. *The number of the row is the DNP Point Index number.* The number of points can be changed at any time by changing the parameter value.
☐ 1	Category	» Select a specific group of analog data the DNP3 point will be chosen from (dropdown menu).* » Any » Circuit Breaker Monitor » Circuit Breaker Monitor Phase A » Circuit Breaker Monitor Phase B » Circuit Breaker Monitor Phase C » Other » Sensor 1 » Sensor 2 » Sensor 3 » Sensor 4 » Sensor 5 » Sensor A » Sensor B » Sensor C
	Source	» Select a specific analog data source to be assigned to the DNP3 point (dropdown menu).* » Sensor A Mass Loss » Sensor A Pressure » Sensor A Pressure Trend » Sensor A Pressure Trend Limit Value » Sensor A Temperature **NOTE**: *Source is dependant on category selected. Category and source is assigned for each DNP3 point created.
☐ Counter		

5.7.2.13.3 Counter

☐ Group	Parameter Name	Parameter Value
☐ DNP3		
☐ Binary		
☐ Analog		
☐ Counter	Default static variation	» Select the type of counter objects sent by the Optimizer3 from the dropdown menu. » Group 20 Variation 1 – 32-bit with flags » Group 20 Variation 2 – 16-bit with flags » Group 20 Variation 5 – 32-bit without flags » Group 20 Variation 6 – 16-bit without flags
	Override defaults	» Select a setting from the dropdown menu. » Yes* » No **NOTE**: *When enabled, Group and Variation of each DNP3 counter point can be individually assigned.
	Number of measurements	» Enter a value from 0–100.** **NOTE**: **When a number is entered, numbered rows will appear below this section. *The number of the row is the DNP Point Index number.* The number of points can be changed at any time by changing the parameter value.
☐ 1	Category	» Select a specific group of counter data the DNP3 point will be chosen from (dropdown menu).* » Any » Circuit Breaker Monitor » Circuit Breaker Monitor Phase A » Circuit Breaker Monitor Phase B » Circuit Breaker Monitor Phase C » Other » Sensor 1 » Sensor 2 » Sensor 3 » Sensor 4 » Sensor 5 » Sensor A » Sensor B » Sensor C
	Source	» Select a specific counter data source to be assigned to the DNP3 point (dropdown menu).* » None » Fault Interrupt Circuit » Non-Fault Interrupt Count » Operation Count » Operation Number **NOTE**: *Source is dependant on category selected. Category and source is assigned for each DNP3 point created.

5.7.2.13.4 Behavior

Flag Behavior

Online and Restart quality flag bits are used to indicate the status of DNP3 analog points.

- When the system is restarted or powered on, the Restart bit is asserted.
- When a valid sensor input is provided (no sensor errors), the Online flag is asserted, and restart is de-asserted.
- When a sensor error occurs, the Online flag is de-asserted.

Value Behavior

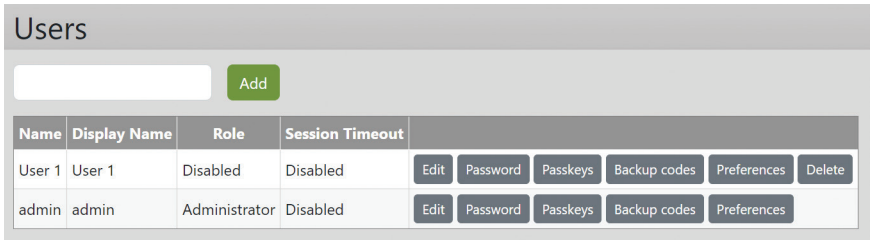
Under error-free conditions, each DNP3 analog point value is updated when the deadband value is exceeded. In the case of a sensor error, the previous value prior to the error remains as the analog point value and the DNP3 flag changes to offline. When the restart quality flag is asserted, the analog point value is set to 0.

Time Stamps

The time stamp is updated each time the DNP3 point value is updated using the system time of the Optimizer3. The Optimizer3 system time can be synchronized with an NTP server or from a DNP3 Controlling Station. The NTP server's IP address is specified in the Configuration Page, in the Date/Time group, 'NTP Servers' option. Multiple NTP servers can be used by placing a space between the addresses. To enable time synchronization from a DNP3 Controlling Station, set 'Enable Time Synchronization' to 'Yes' in the DNP3 configuration menu. The 'Time Synchronization Interval' can be set from this menu.

5.7.3 Users

The Users page displays all users of the system and allows an administrator to add, remove, and edit system users.



To add a user:

- Enter the name of the user in the blank entry box and select "Add".

To remove a user:

- Select "Delete" in the row of the user.

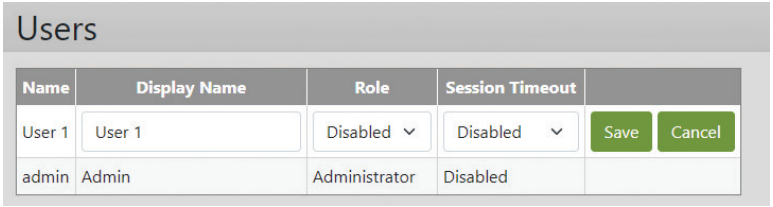
To edit a user:

- Select "Edit" in the row of the user to enter the Edit Users page shown in §5.7.3.1.

For information on Password, Passkeys, Backup codes, and Preferences, please see §5.8.

5.7.3.1 Edit Users

The Edit Users page displays all users of the system and allows an administrator to edit the display name, role, and session timeout limit of users.



To select a display name:

1. Enter the user display name that will be shown in the header of the Web Browser Interface into the Display Name entry box.
2. Select "Save" to apply changes.

To select a role:

1. Click the drop-down menu in the Role column to select a configured user role.
2. Select "Save" to apply changes.

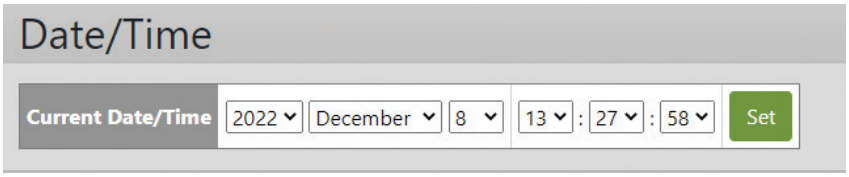
NOTE: For more information on creating, deleting, and editing user roles, see §5.7.3.

To select a Web Browser Interface session timeout limit for a user:

1. Click the drop-down menu in the Session Timeout column to select a pre-configured session timeout limit or select "Disabled" to disable the session timeout feature for the user.
2. Select "Save" to apply changes.

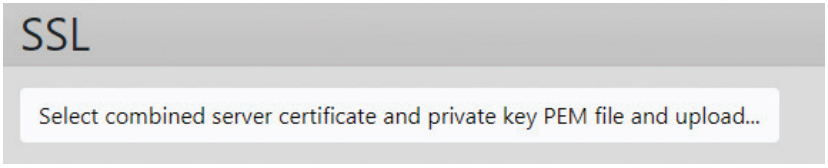
5.7.4 Date/Time

The Date/Time page displays the current date and time if an NTP server is configured or allows the user to set the date and time if an NTP server is not configured.



5.7.5 SSL

The Optimizer3 allows users to upload trusted certificates if they have created them.



To upload a trusted certificate:

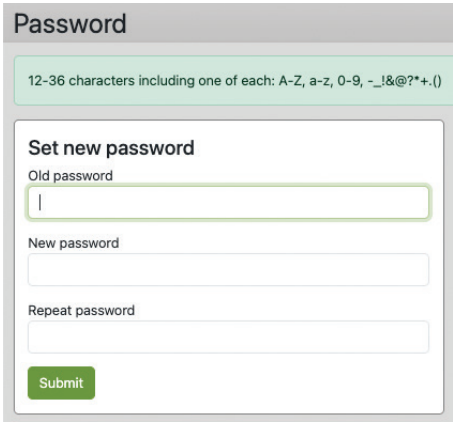
1. Click “Select combined server certificate and private key PEM file and upload…” and select the file to upload.
2. Reboot the system.

5.8 User

The “User” section of the Web Browser Interface allows a user to modify their user password, authenticators, backup codes, and preferences if the user role they have has been given permissions. For more information on users, see §5.7.3.

5.8.1 Password

To change the user’s password:

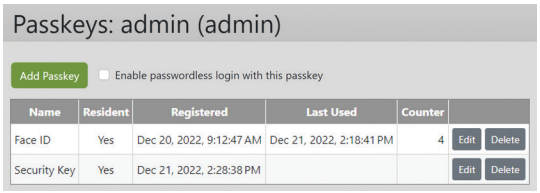


1. Enter the current password of the user into “Old password”.
2. Enter a password into both “New password” and “Repeat password” that meets the following requirement:
   - 12–36 characters including one each of the following alpha-numeric characters: A-Z, a-z, 0-9, -_! &@?*+.()
3. Select “Submit” to apply.

IMPORTANT: It is recommended to document the set password in a safe location. Once the password is set, if it is forgotten, the user will need to use a backup code or wait to login until Franklin Electric Technical Support is able to assist the user with resetting it. For further information on backup codes, see §5.8.3.

5.8.2 Passkeys

A passkey enabled with passwordless login allows a user to log into the system without having to use a password. Multi-factor authentication increases the security of an account by adding a secondary authentication requirement when logging in. More than one passkey may be configured.



- Name: Displays the name of the passkey.
- Resident:
  - Displays "Yes" if the passkey is able to be used for passwordless login.
  - Displays "No" if the passkey is only to be used as a secondary authentication factor.
- Registered: Displays the date the passkey was registered to the system.
- Last Used: Displays the date the passkey was last used.
- Counter: Displays the amount of times the passkey has been used.

To add an authenticator for the currently logged in user:

1. Make sure a trusted certificate has been uploaded as described in § 5.7.5.
2. Select "Add Passkey".

   NOTE: To enable passwordless login with this passkey, check the "Enable passwordless login with this passkey" box before clicking "Add Passkey".
3. Select which vehicle a passkey is to be created for in the dialog box.
4. Follow further instructions as shown in the dialog box.

To delete a passkey for the currently logged in user:

1. Select "Delete" in the row of the passkey to be deleted.
2. Select "Delete" in the row of the passkey to be deleted. Select "Cancel" to cancel any changes and return to the previous screen.

To edit a passkey for the currently logged in user:

1. Select "Edit".
2. Click the entry box under "Name" to rename the passkey. Select "Save" to save any changes. Select "Cancel" to cancel any changes and return to the previous screen.

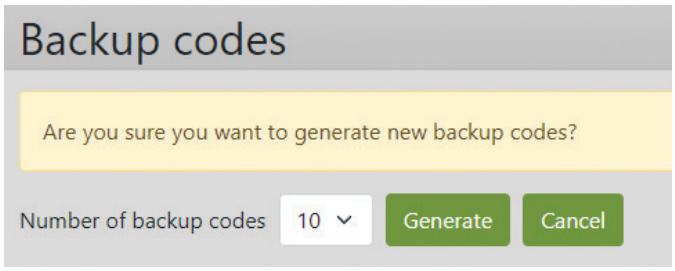
NOTE: Passwordless login requires a FIDO2 device and a supported web browser (see QR-code for further information).

TBGS0823-01
PEM File Instr for SSL-TLS Cert

SCAN / CLICK

5.8.3 Backup Codes

Backup codes are one-time-use backup passwords that may be generated and stored in a safe location in case of a forgotten password.



To generate backup codes for the user:

1. Select “Generate”.
2. Click the drop-down menu to select a number (1-10) of backup codes to generate.
3. Select “Generate”.
4. Document the backup codes and store them in a safe location. Once a user clicks “Continue” or leaves the current page, the backup codes will not be able to be displayed again.

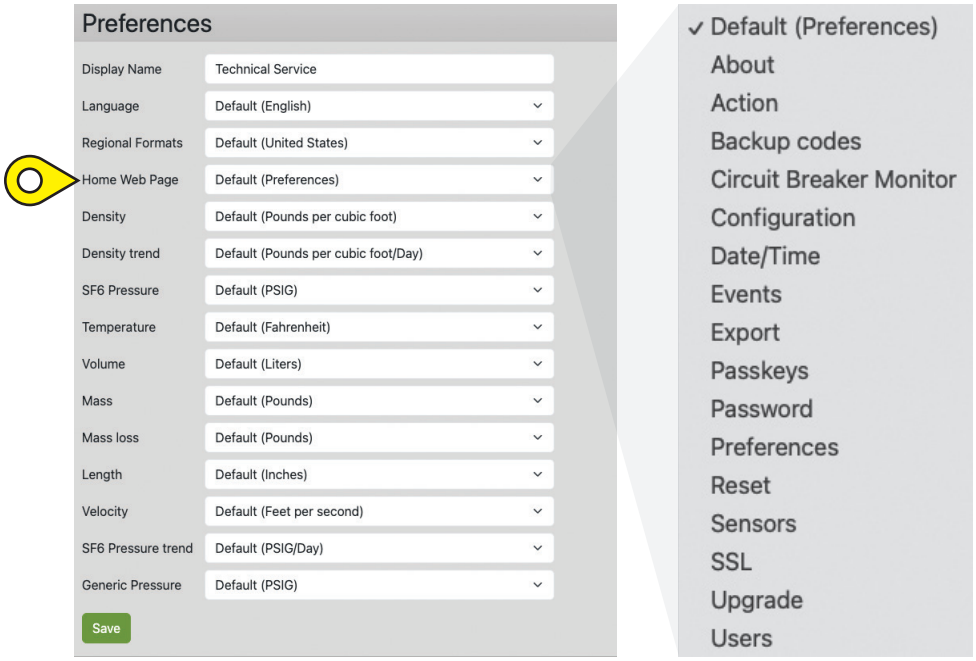
NOTE: Once backup codes have been generated, the Backup codes page will display the status of each backup code. If a code hasn’t been used, it will display “Available”. If a code has been used, it will display “Used on Date/Time”. To delete the generated backup codes, click “Delete”.

To use a backup code:

1. Access the Web Browser Interface login page.
2. Enter the username in the “Username” entry box.
3. Enter a previously generated backup code for the user in the “Password” entry box.
4. Select “Submit”.

5.8.4 Preferences

The settings chosen for user preferences are the settings of the Web Browser Interface for the duration of their session. Any preference that is left to "Default (___)" will be the same preference as selected in §5.7.2.2.3.



- **Display Name**: Enter the user display name that will be shown in the header of the Web Browser Interface.
- **Language**: Enter the preferred language for the Web Browser Interface.*
- **Regional Formats**: Select the preferred system regional format.*
- **Home Web Page** (📍): Select the web page that will appear when the user first logs into the Web Browser Interface or when the user clicks the 🏠 home icon.
- **Density**: Select the preferred unit type for SF_6 density.*
- **Density Trend**: Select the preferred unit type for SF_6 density trend.*
- **SF_6 Pressure**:
- **Temperature**: Select the preferred unit type for temperature.*
- **Volume**: Select the preferred unit type for volume.*
- **Mass**: Select the preferred unit type for SF_6 mass.*
- **Mass Loss**: Select the preferred unit type for SF_6 mass loss.*
- **Length**: Select the preferred unit type for length.*
- **Velocity**: Select the preferred unit type for travel velocity.*
- **SF_6 Pressure Trend**: Select the preferred unit type for SF_6 pressure trend.*
- **Generic Pressure**: Select the preferred unit type for generic pressure.*

NOTE: *See §5.7.2.2.3 for preference options.

5.9 Post-Programming Inspection

Inspection and Configuration Download Checklist

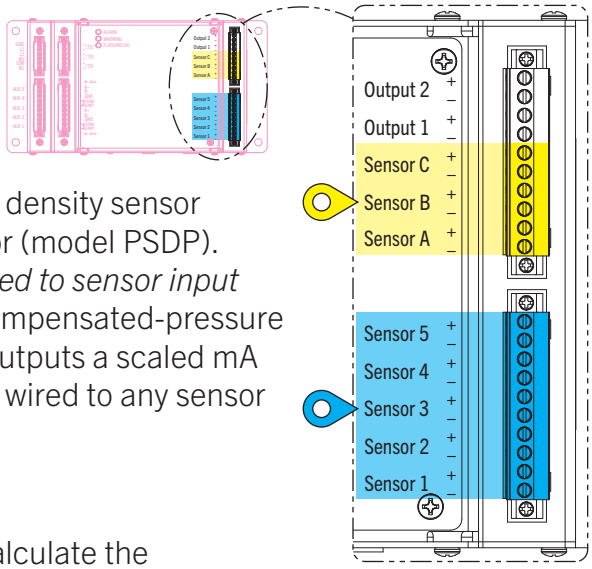
- ☐ Ensure there are no active alarms. If there are active alarms, see Section 7.1.
- ☐ Download and save a copy of the configuration. See § 5.7.1.5 for further information.

6 Applied Sensor Monitoring

NOTE: See §5.7.2.8 for a complete list of sensor Monitoring Modes.

6.1 SF_6 Gas Monitoring

NOTE: See §5.7.2.8 for basic sensor type programming configuration information.



The standard installation is for SF_6 density or pressure to be measured with the digital density sensor (model DSDP) or the digital pressure sensor (model PSDP). *These "digital" sensor types can only be wired to sensor input channels A, B or C* (📍). SF_6 temperature-compensated-pressure can be measured with an SF_6 sensor that outputs a scaled mA signal. These "analog" sensor types can be wired to any sensor input channel (📍 + 📍).

The Optimizer3 can measure:

- Density with the DSDP sensor and calculate the equivalent gas pressure.
- Pressure with the PSDP sensor and calculate the equivalent gas density. These calculations are based on entered SF_6 fill weight and fill pressure values (taken from the breaker's nameplate).
- A daily Density or Pressure Trend is calculated from the measured density or pressure and temperature (using gas law equations). The daily trend is the decrease or increase per day in density or pressure, averaged over a sliding 15-day period.

The Optimizer3 Continuous Monitoring:

In the following situations, the Optimizer3 continuously monitors the quality of the sensor signals and performs the indicated action:

- When the signal from a digital sensor is intermittent, weak or the Optimizer3 has lost sync with the sensor, an "Erratic Signal" error will be recorded.
- When the digital sensor signal is lost, a "Sensor Malfunction" error will be recorded.
- When the signal from an analog sensor is above or below the programmed signal high scale or low scale limits by 2% or more, a "Sensor Signal Range" error will be recorded.
- When the signal from an analog sensor is less than 2 mA, a "Sensor No Current" error will be recorded.

6.1.1 Monitoring Settings

The parameters for SF_6 are set in the Gas Monitor section of the SF_6 configuration programming. To access the configuration programming for SF_6:

- Sensors 1–5 must first be selected and Mode set to an analog parameter value (Pressure (📍) or Density (📍)).
- Sensor A, B, or C must first be selected and Mode set to a digital parameter value (Pressure (📍) or Density (📍)).

In the Gas Monitor section, the Units parameter determines which SF_6 measurement type (Pressure (📍) or Density (📍)) is to be displayed (Density is the default value). The System measurement units are given according to the selections made in § 5.7.2.2.3.

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Off
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	» Select a setting from the dropdown menu. » Off » Analog Compensated Pressure » Analog Density » Current » Dew Point » Digital Compensated Pressure » Digital Density » Generic Pressure » Heater Monitor UPSM-241 » LenSense 2TC/105 » LenSense 2TC/106 » LenSense 2TC/108 » LenSense 2TC/115 » LenSense 2TC/117 » LenSense 2TC/118 » LenSense 2TC/822 » Temperature » Voltage
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off
☐ SF6		
☐ Gas Monitor	Units	» Select a setting from the dropdown menu.* » Pressure » Density
	Low Pressure Warning Alarm Limit	0.0 PSIG
	Low Pressure Danger Alarm Limit	0.0 PSIG
	Pressure Trend Alarm Limit	0.0 PSIG/day
	Forecast Planning Alarm	0 days
	Gas Fill Weight	0.0 lbs
	Fill Pressure	0.0 PSIG
	Fill Temperature	68.0° F
	Breaker Volume	0 L

6.1.2 Alarm Settings

The Optimizer3 continuously records SF_6 density and SF_6 pressure separately for every SF_6 sensor used (up to eight sensors maximum).

IMPORTANT: The Fill Pressure, Warning, and Danger alarm pressures should always correspond to what is written on the circuit breaker nameplate (see the following examples, 1 and 2).

Example 1 (Nameplate): Fill Pressure Setting

Rated Max Volts	145 Kv
Rated Continuous Current	3000 A
Frequency	60 Hz
Wt. of Breaker w/ Gas	8000 lbs
Weight of SF6 Gas	128 Lbs
Rated Operating Pressure at 68°F/20°C	87 PSIG
Minimum Operating Pressure at 68°F/20°C	72 PSIG
SF6 Alarm Pressure at 68°F/20°C	75 PSIG
SF6 Cutout Pressure at 68°F/20°C	72PSIG

→ *Weight of SF_6 Gas* = Gas Fill Weight (128 lbs)

→ *Rated Operating Pressure* = Fill Pressure (87 PSIG)

→ *SF_6 Alarm Pressure* = Low Pressure Warning Alarm Limit (75 PSIG)

→ *SF_6 Cutout Pressure* = Low Pressure Danger Alarm Limit (72 PSIG)

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Off
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Digital Compensated Pressure
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off
☐ SF6		
☐ Gas Monitor	Units	Pressure
	Low Pressure Warning Alarm Limit	75.0 PSIG
	Low Pressure Danger Alarm Limit	72.0 PSIG
	Pressure Trend Alarm Limit	0.5 PSIG/day
	Forecast Planning Alarm	45 days
	Gas Fill Weight	128.0 lbs
	Fill Pressure	87.0 PSIG
	Fill Temperature	68.0° F
	Breaker Volume	0 L

Example 2 (Nameplate): Fill Pressure Setting

SF6 PRESSURE (@ 20°C / 68°F) RELATIVE PRESSURE	
-NORMAL OPERATING PRESSURE	66.7 psig
-LOW PRESSURE ALARM	52.2 psig
-MINIMUM PRESSURE	47.9 psig
WEIGHT OF GAS	26.0 lbs
TOTAL WEIGHT	2738 lbs
MECHANISM TYPE	FK3-1/131 SPRING
CONTROL VOLTAGE -CLOSING	125VDC, 3.5A

→ *Normal Operating Pressure* = Fill Pressure (66.7 PSIG)

→ *Low Pressure Alarm* = Low Pressure Warning Alarm Limit (52.2 PSIG)

→ *Minimum Pressure* = Low Pressure Danger Alarm Limit (47.9 PSIG)

→ *Weight of SF_6 Gas* = Gas Fill Weight (26.0 lbs)

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Off
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Digital Compensated Pressure
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off
☐ SF6		
☐ Gas Monitor	Units	Pressure
	Low Pressure Warning Alarm Limit	52.2 PSIG
	Low Pressure Danger Alarm Limit	47.9 PSIG
	Pressure Trend Alarm Limit	0.5 PSIG/day
	Forecast Planning Alarm	45 days
	Gas Fill Weight	26.0 lbs
	Fill Pressure	66.7 PSIG
	Fill Temperature	68.0° F
	Breaker Volume	0 L

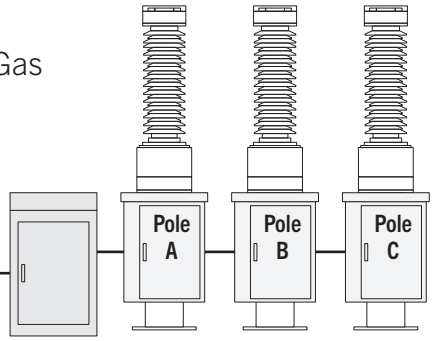
NOTE: *Users can choose "pressure" or "density" units when using a Density or Pressure sensor (the Optimizer3 will calculate the opposite measurement).* For example, when using a pressure sensor, it will calculate the density, or when using a density sensor, it will calculate the pressure (the user can choose what units are preferred). *It is common to use a density sensor, but do all the monitoring and alarms in pressure units.*

The previous two examples apply to circuit breakers with one common SF_6 system, using one density sensor. For circuit breakers having three independent SF_6 systems (one for each pole), the settings are slightly different.

The Fill, Warning, and Danger alarm pressures will be the same for each pole. For this type of circuit breaker, with separate SF_6 systems for each pole, one SF_6 density sensor must be installed on each pole. Each SF_6 density sensor works independently and leak

calculation for each pole uses the fill weight value programmed, as if it were for each individual pole.

In the case of three SF_6 pressure or density sensors used on three separate poles, the Total Weight of SF_6 Gas given on the nameplate must be divided by three. 360 ÷ 3 = 120 lbs (see example 3 below).



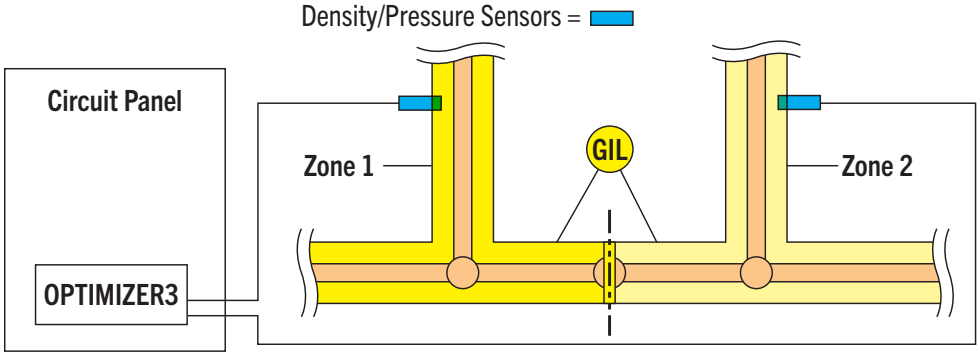
Example 3 (Nameplate): Fill Weight for IPO Breakers

Terminal to Terminal Circuit Breaker Open	1300 Kv	
Total Weight of Breaker w/Gas	29707 LBS	
Total Weight of SF6 Gas	360 LBS	→ *Total Weight of SF_6 Gas / 3* = Gas Fill Weight (120.0 LBS)
Normal SF6 Gas Pressure at 68°F/20°C	80.0 PSIG	→ *Normal SF_6 Gas Pressure* = Fill Pressure (80.0 PSIG)
SF6 Alarm Pressure at 68°F/20°C	75.5 PSIG	→ *SF_6 Alarm Pressure* = Low Pressure Warning Alarm Limit (75.5 PSIG)
Minimum SF6 Gas Pressure at 68°F/20°C	72.5 PSIG	→ *Minimum SF_6 Gas Pressure* = Low Pressure Danger Alarm Limit (72.5 PSIG)

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Off
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Digital Compensated Pressure
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off
☐ SF6		
☐ Gas Monitor	Units	Pressure
	Low Pressure Warning Alarm Limit	75.5 PSIG
	Low Pressure Danger Alarm Limit	72.5 PSIG
	Pressure Trend Alarm Limit	0.5 PSIG / day
	Forecast Planning Alarm	45 days
	Gas Fill Weight	120.0 lbs
	Fill Pressure	80.0 PSIG
	Fill Temperature	68.0° F
	Breaker Volume	0 L

6.1.3 Gas Insulated Line (GIL) Application

The Optimizer3 is a useful SF_6 gas monitoring system for gas insulated lines (GILs). Any of the eight sensor inputs may be used for SF_6 density or pressure measurement using analog Temperature-Compensated sensors.



In the example above, a three-pole GIL is being monitored, with each pole being comprised of two SF_6 gas zones. A SF_6 gas density sensor is installed on each riser, providing a total of six gas zones (compartments). The GIL manufacturer supplies the following information:

Gas Insulated Line Fill Weight

Compartment Gas Volume (ft³), Weight (lbs), and Length (ft)				
Circuit 1		Phase		
		A	B	C
Zone 1	Zone Volume	365.25	352.42	339.59
	Zone Weight	688.39	677.14	652.49
	Zone Length	341.67	329.67	317.67
Circuit 1		Phase		
		A	B	C
Zone 2	Zone Volume	365.25	378.07	390.90
	Zone Weight	715.19	726.44	751.09
	Zone Length	341.67	353.67	365.67

Example of GIL Settings

SF6 Gas System Specification: Compressed Gas Insulated Transmission Bus	
Total SF6 Gas Weight Per Zone	**LBS**
- Zone 1	688.39
- Zone 2	677.14
- Zone 3	652.49
- Zone 4	715.19
- Zone 5	726.44
- Zone 6	751.09
Total Weight of SF6 Gas	**4210.74**
Gas Fill Weight: 4210.74 / 6 = 701.79	
Nominal Gas Density	**1.92 lbs/ft³**
Nominal Gas Pressure at 68°F/20°C	55.0 PSIG
1st Alarm Gas Pressure at 68°F/20°C	50.0 PSIG
2nd Alarm Gas Pressure at 68°F/20°C	43.5 PSIG

NOTE: The Gas Fill Weight* is the average of all six gas zones (compartments).

SEE NEXT PAGE FOR VALUES APPLIED TO SETTINGS.

→ **The Sum Total Weight of SF_6 Gas (6 Zones) / 6* = Gas Fill Weight (701.79 LBS)*

→ *Normal SF_6 Gas Pressure* = Fill Pressure (55.0 PSIG)

→ *SF_6 Alarm Pressure* = Low Pressure Warning Alarm Limit (50.0 PSIG)

→ *Minimum SF_6 Gas Pressure* = Low Pressure Danger Alarm Limit (43.5 PSIG)

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	Mode	Analog Compensated Pressure
☐ Sensor 2	Mode	Analog Compensated Pressure
☐ Sensor 3	Mode	Analog Compensated Pressure
☐ Sensor 4	Mode	Analog Compensated Pressure
☐ Sensor 5	Mode	Analog Compensated Pressure
☐ Sensor A	Mode	Analog Compensated Pressure
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off
☐ SF6		
☐ Gas Monitor	Units	Pressure
	Low Pressure Warning Alarm Limit	50.0 PSIG
	Low Pressure Danger Alarm Limit	43.5 PSIG
	Pressure Trend Alarm Limit	0.5 PSIG/day
	Forecast Planning Alarm	45 days
	Gas Fill Weight	701.79 lbs
	Fill Pressure	55.0 PSIG
	Fill Temperature	68.0° F
	Breaker Volume	0 L

6.1.4 Pressure / Density Trend, Forecast Planning Alarms

If an SF_6 leak is detected in any of the SF_6 zones, and it exceeds the Pressure/Density Trend Alarm Limit (), the alarm relay can be asserted (if desired). The alarm status is available as a DNP SCADA point.

☐ Group	Parameter Name	Parameter Value
☐ SF6		
☐ Gas Monitor	Units	Pressure
	Low Pressure Warning Alarm Limit	0.0 PSIG
	Low Pressure Danger Alarm Limit	0.0 PSIG
	Pressure Trend Alarm Limit	0.5 PSIG/day
	Forecast Planning Alarm	0 days
	Gas Fill Weight	0.0 lbs
	Fill Pressure	0.0 PSIG
	Fill Temperature	0.0° F
	Breaker Volume	0 L

6.1.4.1 Low Gas Alarm Forecast & Forecast Planning Alarm

The Low Gas Alarm Forecast (📍) reports how many days until the Density/Pressure Danger Alarm will be reached. Based on this SF_6 leak trend, the number of days until this alarm is asserted is given on the Sensors Page and available via DNP. The maximum Forecast Planning Alarm(📍) limit is 180 days.

Group	Parameter Name	Parameter Value
☐ SF6		
☐ Gas Monitor	Units	Pressure
	Low Pressure Warning Alarm Limit	0.0 PSIG
	Low Pressure Danger Alarm Limit	0.0 PSIG
	Pressure Trend Alarm Limit	0.0 PSIG/day
	Forecast Planning Alarm	30 days
	Gas Fill Weight	0.0 lbs
	Fill Pressure	0.0 PSIG
	Fill Temperature	0.0° F
	Breaker Volume	0 L

The Forecast Planning Alarm (📍) adds a user-defined number of days to the Low Gas Alarm Forecast (📍) to allow for planning, equipment preparation, and outage scheduling. When the SF_6 gas pressure decreases so that the predicted number of days until the Danger Alarm is asserted is equal to or less than the Forecast Planning Alarm, the alarm relay can be asserted, if desired. The alarm status and the forecast value are available as DNP SCADA points.

Navigate to Monitor > Sensors for status information about senors.

- Density Trend (📍), Pressure Trend (📍), and their Trend Limit (📍)
- Low Gas Alarm Forecast (📍) and Forecast Limit (📍)

Sensors

	Sensor A
Average Mass (lbs)	
Mass Loss (lbs)	
Density (lb/ft³)	
Density Trend (lb/ft³/day)	
Low Gas Alarm Forecast (days)	
Pressure (PSIG)	
Average Pressure (PSIG)	
Pressure Trend (PSIG/day)	
Trend Confidence Level (%)	
Temperature (°F)	
Trend Limit	OK
Forecast Limit	OK
Low Gas Danger Limit	OK
Low Gas Warning Limit	OK
Erratic Signal	Alarm
Sensor Malfunction	Alarm

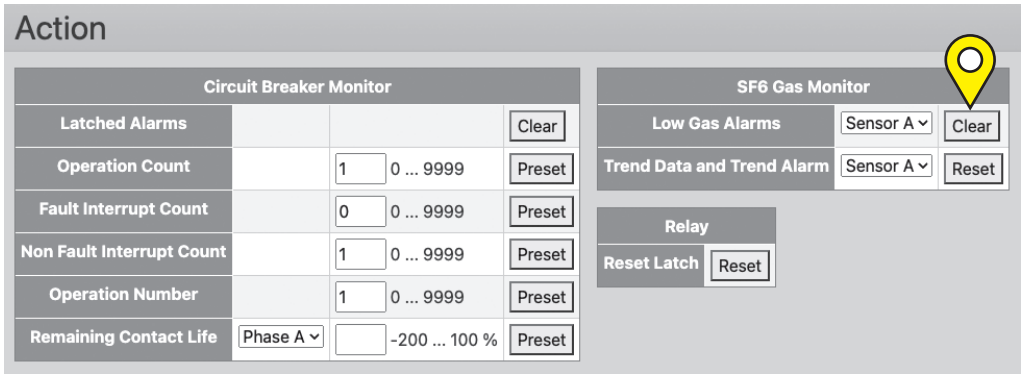
	Ambient
Temperature (°F)	98.8
Erratic Signal	OK
Sensor Malfunction	OK
Low Temperature Limit	OK
High Temperature Limit	OK

	Sensor 1
Heater	
Current (A)	
Low Current	

	Supply
Voltage (V)	116.6
Today's Average (V)	115.7
Today's Minimum (V)	113.6
Today's Maximum (V)	116.9
Sample Count	0

Clearing a Low-Gas Alarm

1. Add SF_6 to a value greater than 5% over the alarm limit that is set.
2. Manually clear the alarm (📍) by navigating to Monitor > Action.



6.2 Temperature Monitoring

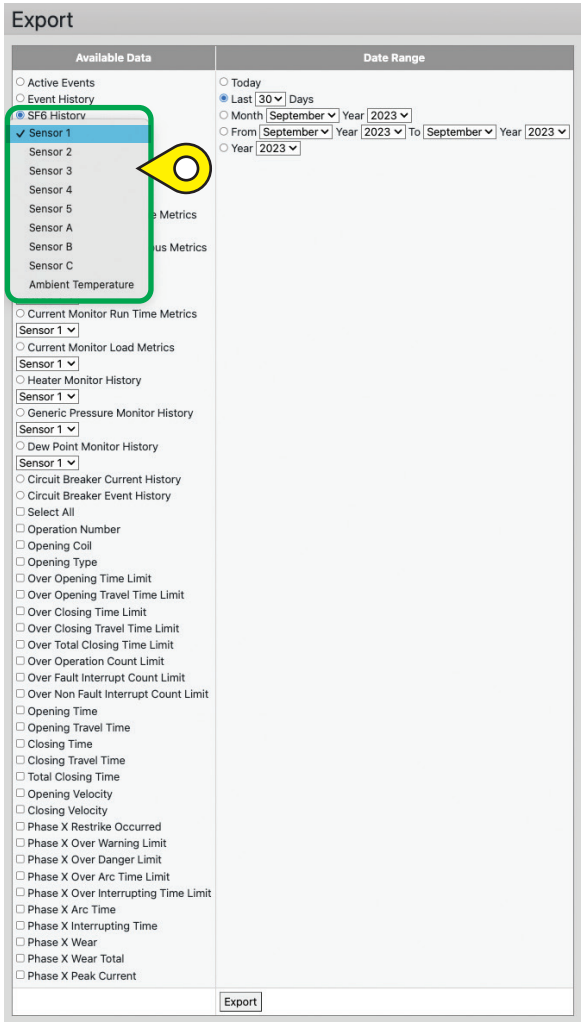
The Optimizer3 can record temperature from the internal Ambient sensor, from the temperature given by Digital (📍) Density or Pressure sensors, or from the Analog (📍) loop-powered 4–20 mA temperature transducers. A temperature transducer can be used to monitor cabinet temperature, interrupter heater blankets, etc.

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Temperature
	Signal Low	4.0 mA
	Signal Low Represents Temperature	-40.0 °F
	Signal High	20.0 mA
	Signal High Represents Temperature	147.2 °F
	Low Temperature Alarm Limit	-76.0 °F
	High Temperature Alarm Limit	-76.0 °F
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Digital Compensated Pressure
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off

NOTE:

- Although temperature measurements from the Ambient sensor and Digital Density or Pressure sensors are logged in the history, *there are no alarm limits associated with these temperature measurements.* Only the analog loop-powered 4–20 mA temperature transducers have associated programmable alarm limits.
- When the "Temperature" sensor mode is selected, scaling for the mA current range and temperature range appear. High and Low Temperature Alarm Limits appear.

- If an Alarm Limit is set to -60.0° C (-76.0° F), the alarm is disabled.
- The Low Temperature Alarm Limit is asserted if the measured temperature is less than or equal to the setting.
- The High Temperature Alarm Limit is asserted if the measured temperature is greater than or equal to the setting.
- A hysteresis of 3° is applied to an active alarm, to reduce nuisance toggling of the alarm. The alarms are non-latching and clear themselves when the measured temperature is between the alarm limits.
- The history log of the Ambient and Sensor temperatures can be downloaded from the Export Page, by selecting "SF_6 History" and then selecting the specific sensor from the pull-down menu (). Only the Temperature will be listed in the CSV file when the Ambient sensor or an analog loop-powered 4–20 mA temperature transducer is selected. Density and Pressure will be blank.



NOTE: There are DNP points for each temperature sensor type: Ambient (), Analog (), and Digital () sources.

☐ Group	Parameter Name	Parameter Value
☐ DNP3		
☐ Binary		
☐ Analog	Default static variation	Group 30 Variation 1 – 32-bit with flags
	Override defaults	No
	Number of measurements	3
☐ 1	Category	Other
	Source	Ambient Temperature
☐ 2	Category	Sensor 1
	Source	Sensor 1 Temperature
☐ 3	Category	Sensor A
	Source	Sensor A Temperature
☐ Counter		

6.3 Voltage Monitoring

The Optimizer3 monitors Voltage (📍) with loop-powered 4–20 mA Voltage transducers. The transducers can be used to monitor DC station battery voltage at the circuit breaker, AC station service voltage at the circuit breaker, or motor activity. *When Voltage is selected, scaling for the mA current range and voltage range appear as well as High and Low Voltage Alarm Limits.**

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Voltage
	Signal Low	4.0 mA
	Signal Low Represents Voltage	0.0 V
	Signal High	20.0 mA
	Signal High Represents Voltage	150.0 V
	Low Voltage Alarm Limit*	110.0 V
	High Voltage Alarm Limit*	135.0 V
	Run Time Metrics	Select “Yes” or “No”.
	Monitor Continuous Voltage	Select “Yes” or “No”.
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Off
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off

***NOTE**:

- If either High or Low Alarm Limits are set to zero, the alarm is disabled.
- The Low Voltage Alarm Limit is asserted if the measured voltage is less than or equal to the setting.
- The High Voltage Alarm Limit is asserted if the measured voltage is greater than or equal to the setting.
- A hysteresis of 3 V is applied to an active alarm to reduce nuisance toggling of the alarm. The alarm is non-latching and clears itself when the measured voltage is between the alarm limits.

NOTE:

- If Yes is selected for Run Time Metrics (📍), it is assumed the voltage sensor input is connected in parallel to a spring charging motor, air compressor motor, or hydraulic pump motor. The cumulative run-time, the number of runs per day, and average run duration are reported and logged. *See §6.5.1.1 for additional information regarding this setting.*
- If Yes is selected for Monitor Continuous Voltage (📍), the daily average, minimum, maximum, and sample count are reported and logged.

6.4 Current Monitoring

The Optimizer3 monitors Current (📍) with loop-powered 4–20 mA current transducers. The transducers can be used to monitor motor current, heater current, or the current of other accessory equipment. *When Current mode is selected, scaling for the mA current range and measured Current range appear, as well as High and Low Current Alarm Limits.**

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Current
	Signal Low	4.0 mA
	Signal Low Represents Current	0.0 V
	Signal High	20.0 mA
	Signal High Represents Current	30.0 A
	Low Current Alarm Limit*	0.0 A
	High Current Alarm Limit*	0.0 A
	Run Time Metrics	Select “Yes” or “No”.
	Monitor Load Metrics	Select “Yes” or “No”.
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Off
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off

***NOTE**:

- If either High or Low Alarm Limits are set to zero, the alarm is disabled.
- The Low Current Alarm Limit is asserted if the measured current is less than or equal to the setting.
- The High Current Alarm Limit is asserted if the measured current is greater than or equal to the setting.
- A hysteresis of 1 A is applied to an active alarm to reduce nuisance toggling of the alarm. The alarm is non-latching and clears itself when the measured current is between the alarm limits.

NOTE:

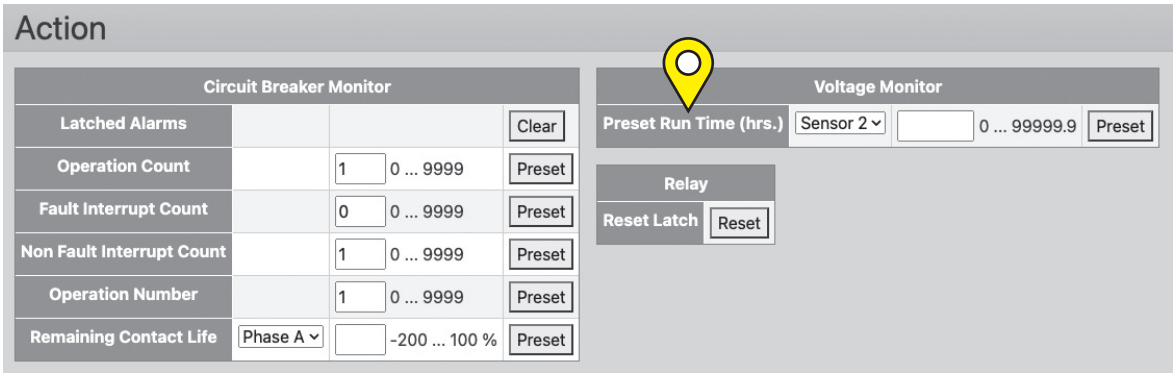
- If Yes is selected for Run Time Metrics (📍), it is assumed the current sensor input is connected around the input conductor to a spring charging motor, air compressor motor, or hydraulic pump motor. The cumulative run-time, the number of runs per day, and average run duration are reported and logged *See §6.5.2.1 for additional information regarding this setting.*
- If Yes is selected for Monitor Load Metrics (📍), the maximum current per run, run time, and I^2T for the run is reported and logged. *Load Metrics are useful for spring charging motors and Run Time Metrics are useful for air compressors or hydraulic pumps.*

6.5 Motor Run Time Metrics

6.5.1 Voltage Mode

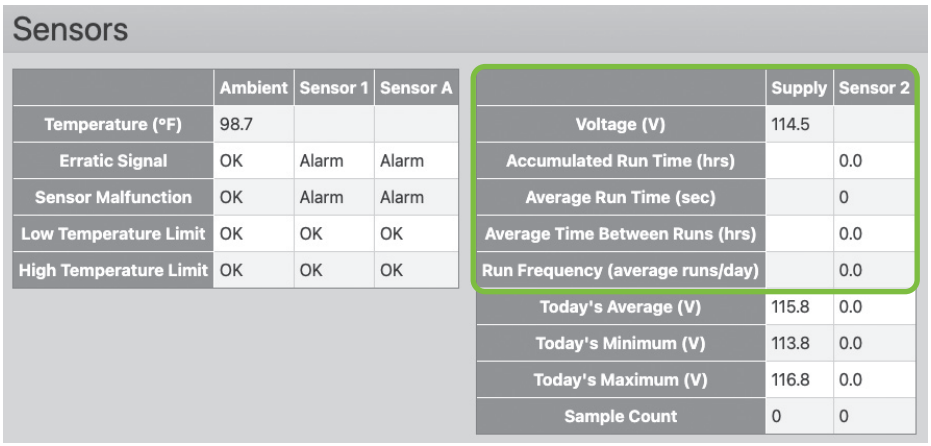
In Voltage sensor mode (see §6.3), the Run-Time Threshold is 3% of the programmed voltage range. Above this threshold the motor is considered running, below it, the motor is considered off.

The "Preset Run-Time (hrs.)" ( ) function, found by navigating to Monitor > Action screen, allows users to preset the Optimizer3 counter to match the mechanical Motor Run Hours counter on the breaker.



6.5.1.1 Monitor Run Metrics

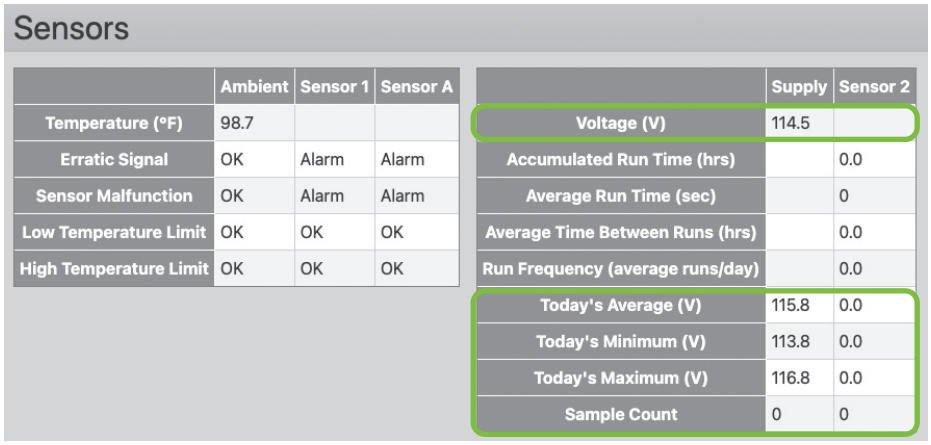
Navigate to Monitor > Sensors.



- Voltage – Present scaled input measurement.
- Accumulated Run-Time (hrs.) – Totalized running time for all starts (logged in database after each run).
- Average Run-Time (sec.) – Running time for the last 10 runs averaged (logged in database after each run).
- Average Time Between Runs (hrs.) – "OFF Times", measured from the end of one run to the beginning of the next, for the last 10 runs averaged (logged in database after each run).
- Run Frequency (avg. runs per day) – 30-day average number of starts (logged in database after each run).

6.5.1.2 Monitor Continuous Voltage

Navigate to Monitor > Sensors.

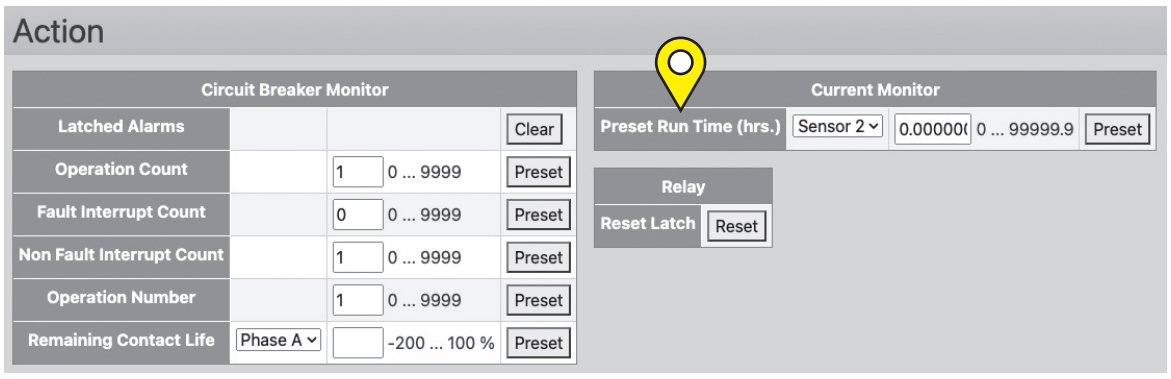


- Voltage – Present scaled input measurement.
- Today's Average – Average voltage since the previous midnight (logged in database once a day).
- Today's Minimum – Lowest measured voltage since the previous midnight (logged in database once a day – with date/time stamp when they occurred).
- Today's Maximum – Highest measured voltage since the previous midnight (logged in database once a day – with date/time stamp when they occurred).
- Sample Count – Number of voltage samples since the previous midnight

6.5.2 Current Mode

In Current sensor mode (see §6.4), the Run-Time Threshold is 3% of the programmed current range. Above this threshold the motor is considered running, below it, the motor is considered off.

The "Preset Run-Time (hrs.)" ( ) function, found by navigating to Monitor > Action screen, allows users to preset the Optimizer3 counter to match the mechanical Motor Run Hours counter on the breaker.



NOTE: Current is sampled at a high rate but averaged in roughly one second time intervals. These one second intervals are used in all calculations.

6.5.2.1 Monitor Run Metrics

Navigate to Monitor > Sensors.

Sensors

	Ambient	Sensor 1	Sensor A
Temperature (°F)	98.8		
Erratic Signal	OK	Alarm	Alarm
Sensor Malfunction	OK	Alarm	Alarm
Low Temperature Limit	OK	OK	OK
High Temperature Limit	OK	OK	OK

	Supply
Voltage (V)	115.0
Today's Average (V)	115.9
Today's Minimum (V)	114.1
Today's Maximum (V)	116.8
Sample Count	0

	Sensor 2
Current (A)	
Accumulated Run Time (hrs)	0.0
Average Run Time (sec)	0
Average Time Between Runs (hrs)	0.0
Run Frequency (average runs/day)	0.0
I×T (A × sec)	0
I²×T (A² × sec)	0
Maximum Current (A)	0.0

- Current (A) – Present scaled input measurement of the last one second time interval.
- Accumulated Run-Time (hrs.) – Totalized running time for all starts (logged in database after each run).
- Average Run-Time (sec.) – Running time for the last 10 runs averaged (logged in database after each run).
- Average Time Between Runs (hrs.) – "OFF Times", measured from the end of one run to the beginning of the next, for the last 10 runs averaged (logged in database after each run).
- Run Frequency (avg. runs per day) – 30-day average number of starts (logged in database after each run).

6.5.2.2 Monitor Load Metrics

Navigate to Monitor > Sensors.

Sensors

	Ambient	Sensor 1	Sensor A
Temperature (°F)	98.8		
Erratic Signal	OK	Alarm	Alarm
Sensor Malfunction	OK	Alarm	Alarm
Low Temperature Limit	OK	OK	OK
High Temperature Limit	OK	OK	OK

	Supply
Voltage (V)	115.0
Today's Average (V)	115.9
Today's Minimum (V)	114.1
Today's Maximum (V)	116.8
Sample Count	0

	Sensor 2
Current (A)	
Accumulated Run Time (hrs)	0.0
Average Run Time (sec)	0
Average Time Between Runs (hrs)	0.0
Run Frequency (average runs/day)	0.0
I×T (A × sec)	0
I²×T (A² × sec)	0
Maximum Current (A)	0.0

- IxT (A x sec.) – Sum of IxT calculations from the last run (logged in database after each run).
- I^2xT (A^2 x sec.) – Sum of I^2xT calculations from the last run (logged in database after each run).
- Maximum Current – Highest 1-second average current during the last run (logged in database after each run).

6.6 Heater Monitoring

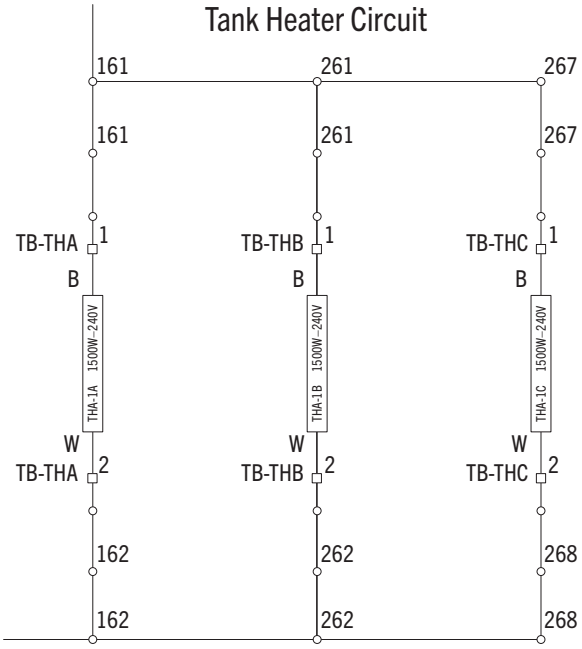
The “Universal Power Status Monitor (UPSM-241)” (📍) accessory detects when the thermostat is calling for heat and measures the current in the main heater circuit. The design assumes that all failures of electric heating elements are caused by open circuits.

- **Heater Low Current Alarm Limit** (📍) – Is asserted if the measured heater current is less than or equal to the setting. The alarm status is available as a DNP SCADA point.

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	…	…
☐ Sensor 2	Mode	Heater Monitor UPSM-241
	Current Range	0–40 A
	Low Current Alarm Limit	18.4 A
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Off
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off

The example to the right, is a circuit where a circuit breaker controls a 1500 W heater for each interrupter tank running at 240 VAC.

- There is a heater running at 240 VAC.
- The total current is 18.75 A.
- The loss of one cabinet heater is the lowest reduction that could occur. *This would reduce total current to 12.5 A.*
- For this example, the Low Current Alarm Limit should be set between 15–17 A.



A simpler alternate approach is to use the ambient temperature sensor and poll the temperature versus the current draw on the heater circuit. If ambient is colder than the thermostat setting, then there should be current associated with the heaters in the circuit. This analytic would be done in the SCADA environment as a “back office” application.

Sensors

	Ambient
Temperature (°F)	98.7
Erratic Signal	OK
Sensor Malfunction	OK
Low Temperature Limit	OK
High Temperature Limit	OK

	Sensor 1
Heater	
Current (A)	
Low Current	

	Supply
Voltage (V)	114.4
Today's Average (V)	115.9
Today's Minimum (V)	114.4
Today's Maximum (V)	116.8
Sample Count	0

6.7 Generic Pressure Monitoring

The Optimizer3 monitors Generic Pressure (📍) with loop-powered 4–20 mA Pressure transducers. The transducers can be used to monitor air pressure, hydraulic pressure, or any generic pressure at the circuit breaker. *When Generic Pressure is selected, scaling for the mA current range and pressure range appear, as well as High and Low Current Alarm Limits.**

☐ Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	Mode	Generic Pressure
	Signal Low	4.0 mA
	Signal Low Represents Generic Pressure	0.0 PSIG
	Signal High	20.0 mA
	Signal High Represents Generic Pressure	9,999.0 PSIG
	Low Generic Pressure Alarm Limit*	0.0 PSIG
	High Generic Pressure Alarm Limit*	0.0 PSIG
☐ Sensor 2	Mode	Off
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Off
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off

***NOTE**:

- If either High or Low Alarm Limits are set to -14.5 PSIG (-1 BAR), the alarm is disabled.
- The Low Pressure Alarm Limit is asserted if the measured pressure is less than or equal to the setting.
- The High Pressure Alarm Limit is asserted if the measured pressure is greater than or equal to the setting.
- A hysteresis of 3% of full range is applied to an active alarm to reduce nuisance toggling of the alarm. The alarm is non-latching and clears itself when the measured pressure is between the alarm limits.

6.8 Dew Point Monitoring

NOTE: See §4.3.1 for Dew Point Sensor mounting information.

The Optimizer3 monitors moisture with 4–20 mA Dew Point (📍) sensors. This moisture is expressed as a Dew Point Temperature, the temperature at which the water vapor will condense into a liquid. The Dew Point sensors can be used to monitor the moisture content of SF_6 gas when plumbed into the SF_6 gas system, typically alongside the density or pressure sensors.

The Optimizer3 calculates and records the Average Dew Point every two hours. This

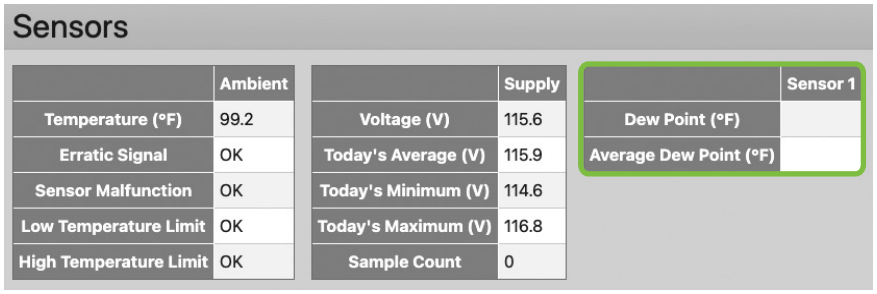
calculation uses the measured Dew Point values from the previous 30 days. *When Dew Point is selected, scaling for the mA current range and Dew Point range appear as well as the High Dew Point Alarm Limit.**

Group	Parameter Name	Parameter Value
☐ Sensors		
☐ Sensor 1	Mode	Dew Point
	Signal Low	4.0 mA
	Signal Low Represents Dew Point	-76.0 °F
	Signal High	20.0 mA
	Signal High Represents Dew Point	68.0 °F
	High Dew Point Alarm Limit*	-76.0 °F
☐ Sensor 2	Mode	Off
☐ Sensor 3	Mode	Off
☐ Sensor 4	Mode	Off
☐ Sensor 5	Mode	Off
☐ Sensor A	Mode	Off
☐ Sensor B	Mode	Off
☐ Sensor C	Mode	Off
☐ SF6		
☐ Gas Monitor	Units	Density
	Low Density Warning Alarm Limit	0.0 lb/ft³
	Low Density Danger Alarm Limit	0.0 lb/ft³
	Density Trend Alarm Limit	0.0 lb/ft³/day
	Forecast Planning Alarm	30 days
	Gas Fill Weight	0.0 lbs
	Fill Pressure	0.0 PSIG
	Fill Temperature	0.0° F
	Breaker Volume	0 L

***NOTE**:

- If the High Alarm Limit is set to -60° C (-76° F), the alarm is disabled.
- The High Dew Point Alarm Limit is asserted when the average Dew Point value is equal to or higher than the setting.
- A hysteresis of 0.2° C is applied to an active alarm to reduce nuisance toggling of the alarm. The alarm is non-latching and clears itself when the measured Dew Point is below the alarm limit.

Navigate to Monitor > Sensors.



6.9 Circuit Breaker Monitoring

See §5.7.2.10 additional information.

6.9.1 Overview

Circuit breakers are complex mechanical and electrical systems which require periodic maintenance. The need for maintenance is affected by:

- Number of fault operations
- Number of total operations
- SF_6 sealing system integrity
- Environmental conditions
- Time since last operation
- Time since installation (equipment age)

There are symptoms associated with the maintenance needs which the Optimizer3 detects:

- Longer-than-normal arcing times
- Occurrence of restrikes
- Longer-than-normal Opening (Trip Latch) Time
- Longer-than-normal Opening Travel Time
- Spring-Charging motor high peak current or longer-than-normal run times
- Trip Coil or Close Coil exhibiting high forward voltage drop (=open coil)

Extended arcing time can result from blast nozzles on puffer circuit breakers that have a high accumulated arcing duty. The exposure to hot arcs causes ablation of the Teflon nozzle material so the nozzle diameter gets larger and the velocity of the SF_6 blasted into the arc is reduced, with reduced effectiveness to extinguish the arc. *For Oil Circuit Breakers, extended arcing times may be the symptom of contaminated oil or fault currents in excess of its rating.*

Longer-than-normal Opening Travel Time is equivalent to slower-than-normal average velocity. In most cases, long measured Opening Travel Times are caused by poor lubrication or bearings that have seized with grease where liquids have evaporated and only the clay or other thickener remain.

The Optimizer3 will detect SF_6 gas leaks far earlier than the 63X pressure switch or SF_6 controller. Leaks are not only detected, but the day on which the low-gas alarm will assert is determined and made known to the maintenance planner. Beyond this, the Optimizer3 calculates how much SF_6 has leaked and when the circuit breaker is refilled and with how much SF_6 gas. Circuit breakers that have had leak problems over their life are likely to also have high moisture content in the SF_6 gas. These circuit breakers are good candidates for SF_6 Dew Point monitoring with an added OM-DPS sensor.

The Optimizer3 monitors the phase currents and calculates the I^2T during the arcing portion of the circuit interruption. I^2T is an abbreviation for $\int I^2T\,dt$ from contact part until the time when the arc is extinguished. This is done for each phase separately. By keeping track of the cumulative duty for each pole separately, a pole replacement

might be justified in certain circumstances compared with a full circuit breaker replacement, thereby reducing operating and maintenance expenses.

6.9.2 Operating Modes

The Optimizer3 has five pairs of control inputs which are connected to specific combinations of open coils, close coils, auxiliary switches, red light bulbs, green light bulbs, and other control circuit inputs as appropriate for a circuit breaker. The DC voltage levels (states) of these circuit nodes and their transitions are interpreted by the Optimizer3 to produce operating times, main contact state (OPEN/CLOSE), and other parameters.

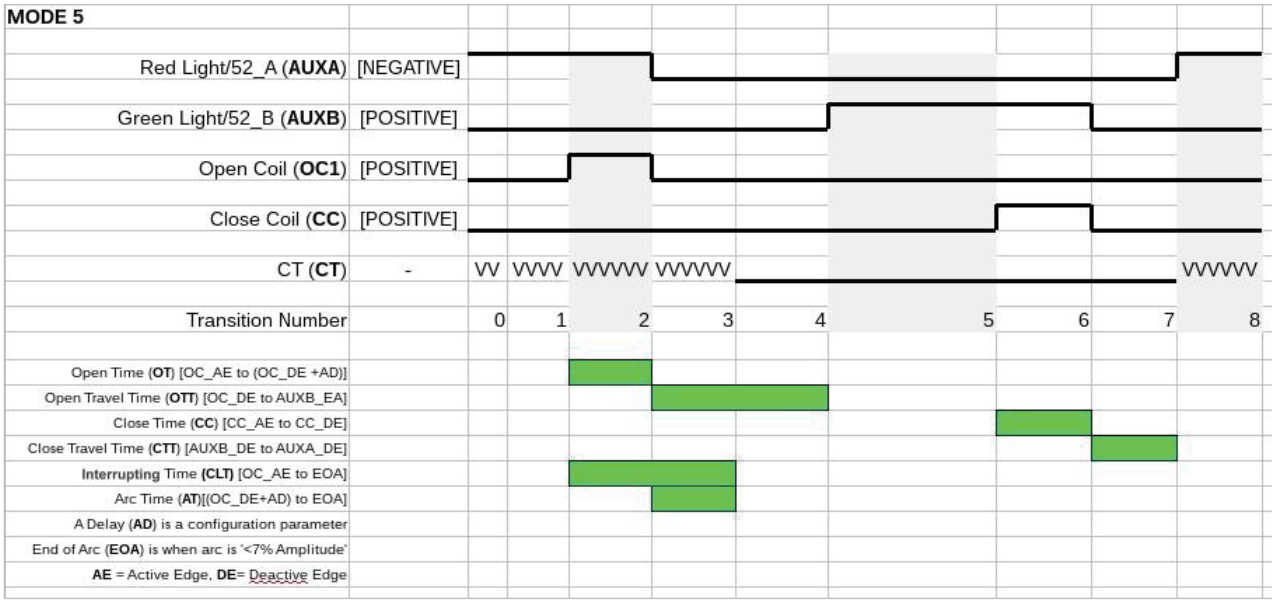
NOTE: AD represents "A Input Delay" the time skew between the control signal that begins the monitor recording (usually the assertion of the 52a auxiliary switch), and main breaker contact parting.

The only reference to breaker main contact parting is to the 52a auxiliary switch. *It is very important to accurately know the time difference between 52a assertion and the main contact parting on an OPEN breaker operation.* ***The quality of the arcing time and I^2T calculation of main contact duty depends on the accuracy of this parameter.***

Circuit Breaker Monitoring – Input Modes

		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7
		Continuuous A & B	Pulse Open Coil	Continuous A	Pulse Open Coil	Pulse Open Coil & Close Coil	Two Open Coils, No Close Coil	Two Open Coils, One Close Coil
			No B	No B	Continuous B	52a & 52b Input	52a & 52b Input	52a & 52b Input
Input Channels	Auxv 1	Red Light or 52a Switch	Open Coil	Red Light or 52a Switch	Open Coil	Open Coil	Open Coil 1	Open Coil 1
	Aux 2	Green Light or 52b Switch			Green Light or 52b Switch	Close Coil	Open Coil 2	Open Coil 2
	Aux 3					Red Light 52a Switch	Red Light 52a Switch	Close Coil
	Aux 4					Green Light 52b Switch	Green Light 52b Switch	Red Light 52a Switch
	Aux 5							Green Light 52b Switch
Timing Measurements	Open Trip Time Start	N/A	Open Coil Active Edge	N/A	Open Coil Active Edge	Open Coil Active Edge	1st Open Coil Active Edge	1st TC Active Edge
	Open Trip Time Stop	N/A	Open Coil Deactive Edge +AD	N/A	Open Coil Deactive Edge +AD	Open Coil Deactive Edge +AD	Open Coil Deactive Edge +AD	Last TC Deactive Edge +AD
	Interrupting Time Start Ø	N/A	Open Coil Active Edge	N/A	Open Coil Active Edge	Open Coil Active Edge	1st Open Coil Active Edge	1st TC Active Edge
	Arc Time Start Ø	Aux A Active Edge + AD	Open Coil Deactive Edge + AD	Aux A Active Edge + AD	Open Coil Deactive Edge + AD	Open Coil Deactive Edge +AD	Open Coil Deactive Edge +AD	TC Deactive Edge +AD
	Arc Time End Ø	<7% Amplitude	<7% Amplitude	<7% Amplitude	<7% Amplitude	<7% Amplitude	<7% Amplitude	<7% Amplitude
	Interrupting Time End Ø	N/A	<7% Amplitude	N/A	<7% Amplitude	<7% Amplitude	<7% Amplitude	<7% Amplitude
	Open Travel Time Start	Aux A Active Edge	N/A	N/A	Open Coil Deactive Edge	Open Coil Deactive Edge	Last Open Coil Deactive Edge or 52a Active Edge	Last Open Coil Deactive Edge or 52a Active Edge
	Open Travel Time Stop	Aux B Active Edge	N/A	N/A	Aux B Active Edge	52b Active Edge	52b Active Edge	52b Active Edge
	Close Time Start	Aux B Deactive Edge	N/A	N/A	N/A	Close Coil Active Edge	N/A	CC Active Edge
	Close Time Stop	Aux A Active Edge	N/A	N/A	N/A	Close Coil Deactive Edge	N/A	CC Deactive Edge
	Close Travel Time Start	N/A	N/A	N/A	N/A	52b Deactive Edge	52b Deactive Edge	52b Deactive Edge
	Close Travel Time Stop	N/A	N/A	N/A	N/A	52a Active Edge	52a Active Edge	52a Active Edge
	Velocity					Time duration between 52a & 52b	Time duration between 52a & 52b	Time duration between 52a & 52b
	A-B Input Logic Failure Modes	52a & 52b inputs are active at the same time	Open Coil input is active at the same time	N/A	Open Coil input is active continuously	Open Coil or Close Coil input is active continuously, or both 52a & 52b inputs are active at the same time	Open Coil or Close Coil input is active continuously, or both 52a & 52b inputs are active at the same time	Open Coil 1, Open Coil 2 or Close Coil input is active continuously, or Both 52a & 52b inputs are active at the same time

MODE 5

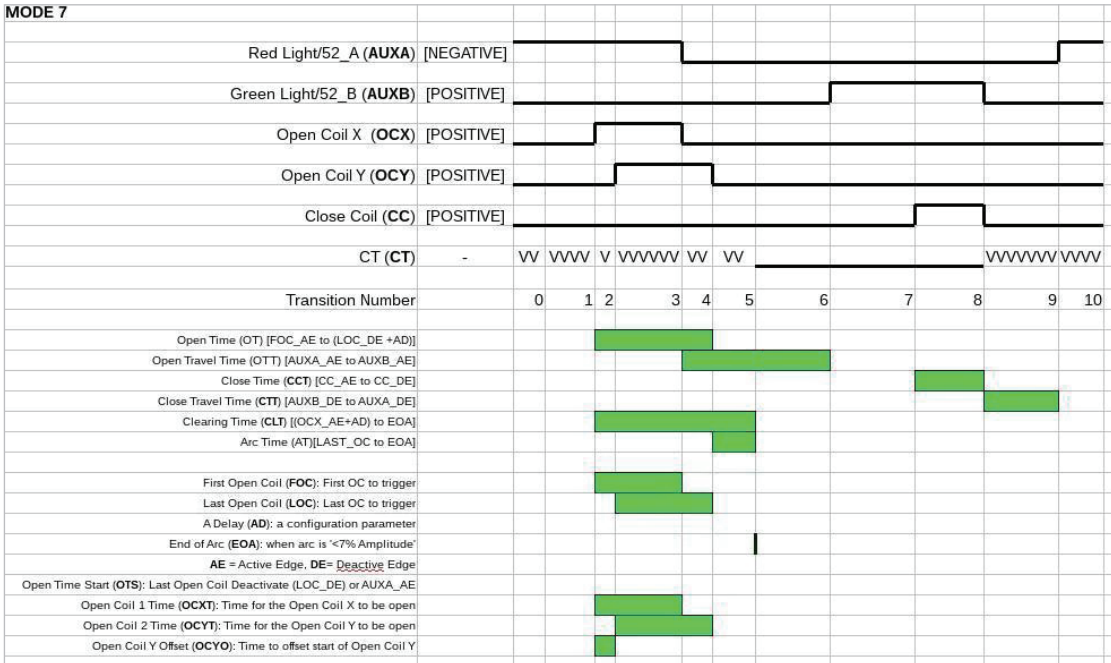


Transition Table

		D03	D05	D06	D09	D12
Transition	t (ms)	AUXA	AUXB	OC	CC	CT
0	0	1	0	0	0	1
1	1000	1	0	1	0	1
2	OT	1	0	0	0	1
3	AT	0	0	0	0	1
4	OTT-AT	0	1	0	0	0
5	500	0	1	0	1	0
6	CC	0	0	0	0	0
7	CTT	1	0	0	0	1
8	500	1	0	0	0	1

Input Mode 5 Logic Chart

MODE 7



Transition Table

		D03	D05	D06 or D09	D09 or D06	D10	D12
Transition	t (ms)	AUXA	AUXB	OCX	OCY	CC	CT
0	0	1	0	0	0	0	1
1	1000	1	0	1	0	0	1
2	OCYO	1	0	1	1	0	1
3	(OCXT-OCYO)	0	0	0	1	0	1
4	(OCYT+OCYO)-OCXT	0	0	0	0	0	0
5	AT						
6	OTT-AT-((OCYT+OCYO)-OCXT)	0	1	0	0	0	0
7	500	0	1	0	0	1	0
8	CCT	0	0	0	0	0	1
9	CTT	1	0	0	0	0	1
10	500	1	0	0	0	0	1

Input Mode 7 Logic Chart

NOTES:

* Open Coil 'X' (OCX) opens before Open Coil 'Y' (OCY).
* At runtime, the outputs of OCX and OCY are assigned to either OC1 or OC2 to simulate the operation of the redundant coil (FIRST_COIL=OC1 or FIRST_COIL=OC2)

6.9.3 Choosing An Operating Mode

For circuit breaker characteristic monitoring, there are seven operating modes to select from. *See §5.7.2.10, for the seven operating modes shown in this section listed under "Parameter Value" for "Input Mode".*

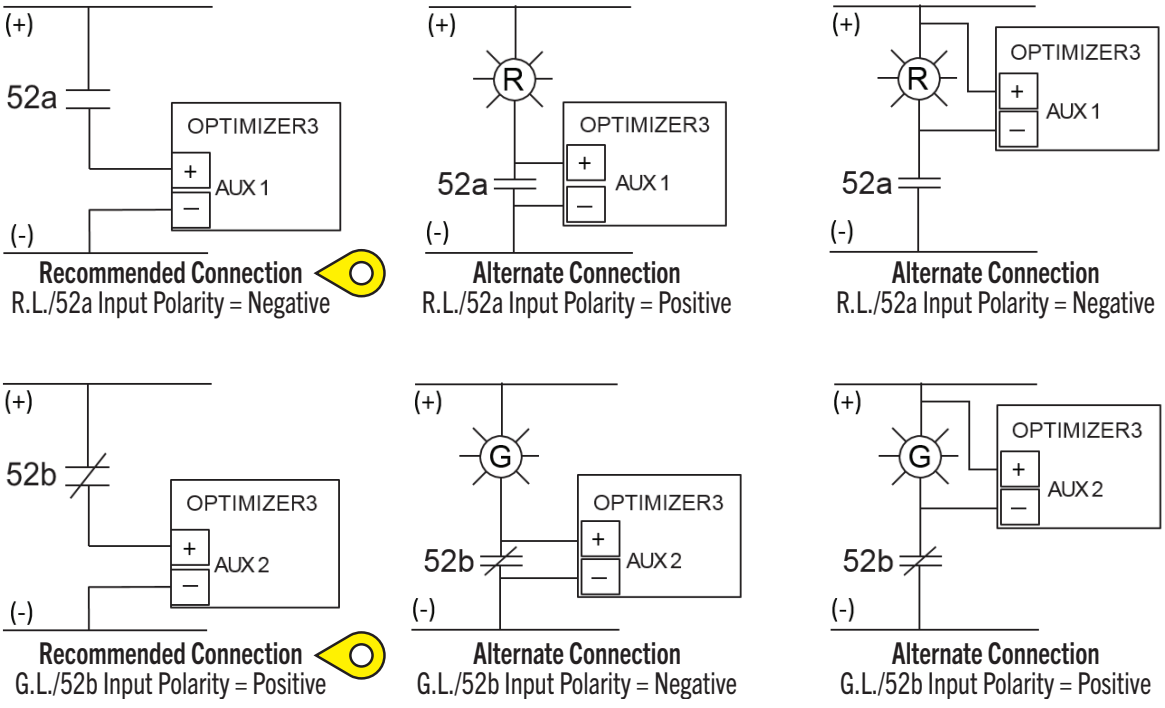
6.9.3.1 Mode 1 (Continuous A, w/ B Input)

This choice monitors the state of the 52a and 52b auxiliary switches for the circuit breaker. When the 52a changes state, the monitor registers an Open operation, modifies it by the A Input Delay setting to calculate Contact Duty and records the time duration until the 52b changes state. This time duration is called Opening Travel Time, given in milliseconds. Opening Travel Time is the actual measurement and is not modified by the A Input Delay.

When the 52b transitions from closed to open, the monitor registers a Close operation and records the time duration until the 52a closes. This time duration is called Closing Travel Time, given in milliseconds.

Optimizer3 pre-assigns the control inputs as a default, but they can be changed if desired. The AUX 1 input can be assigned to the 52a switch and the AUX 2 input can be assigned to 52b auxiliary switch. *The recommended connection* (📍). *is to spare 52a and 52b switches that are wetted by the station battery voltage.* An equivalent timing signal is to connect in parallel with the Red Light and Green light. In both cases, the Input Polarity for Red Light/52a is Negative because the voltage level transitions from high to low on the Open operation. Similarly, the Input Polarity for Green Light/52b is Positive because the voltage level transitions from low to high on the Open operation.

CONNECTION OPTIONS MODE 1

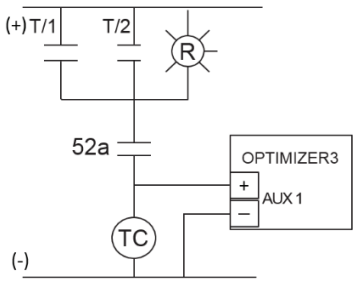


NOTE: All wiring diagrams are shown with circuit breaker in the OPEN position.

6.9.3.2 Mode 2 (Opening Coil, No B Input)

This choice monitors the state of a single Opening Coil only. When the Opening Coil is energized, the monitor registers an Open operation and records the time duration of the Opening Coil energization. The start is the protective relay closing the trip circuit. The end is the opening of the 52A auxiliary switch, modified by the A Input Delay, which begins the Contact Duty measurement. This time duration is called Opening Time, given in milliseconds. The Opening Time measurement is modified by the A Input Delay.

CONNECTION OPTIONS MODE 2



Opening Coil Input Polarity = Positive

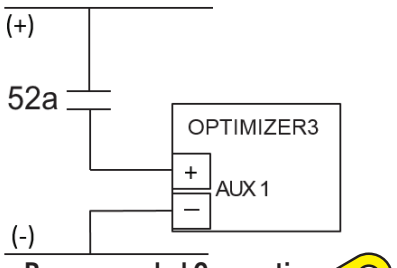
- Mode 2 is used on older field retrofits when there is no opportunity for connecting to 52b auxiliary switches or Green Light.
- Optimizer3 does not provide any Close operation data in Mode 2.
- Assign the Opening Coil connection to AUX 1.
- The Polarity set to Positive because the Opening Coil energization is a positive-going pulse.

6.9.3.3 Mode 3 (Continuous A, No B Input)

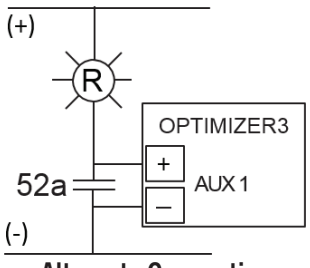
This choice monitors the state of the 52a auxiliary switch only. When the 52a changes state, the monitor registers an Open operation, modifies it by the A Input Delay setting, and calculates contact duty.

- Mode 3 is used on older field retrofits when the only connection that can be made is to the 52a auxiliary switch or Red Light.
- Assign the 52a auxiliary switch connection to AUX 1.
- *The recommended connection* (📍) *is in series with a wetted spare 52a auxiliary switch.* Alternate connection may be made in parallel to an in-service 52a auxiliary switch or in parallel with the red-light bulb.

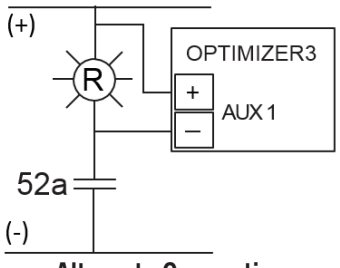
CONNECTIONS OPTIONS MODE 3



Recommended Connection
R.L./52a Input Polarity = Negative



Alternate Connection
R.L./52a Input Polarity = Positive



Alternate Connection
R.L./52a Input Polarity =

6.9.3.4 Mode 4 (Opening Coil, w/ B Input)

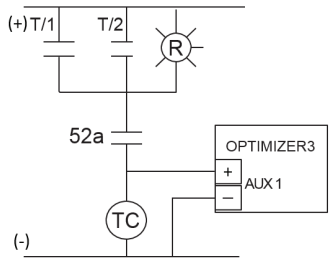
This choice monitors the state of a single Opening Coil and the 52b auxiliary switch. When the Opening Coil is energized, the Optimizer3 registers an Open operation and records the time duration of the Opening Coil pulse. The start is the protective relay closing the trip circuit. The end is the opening of the 52A auxiliary switch, modified by the A Input Delay, which begins the Contact Duty measurement. This time duration is named Opening Time, given in milliseconds. The Opening Time measurement is modified by the A Input Delay.

The Opening Travel Time is defined by the time duration beginning with the falling edge of the Opening Coil pulse (52a auxiliary switch opening) and ending with 52b auxiliary switch closing. This segment of time is recorded and reported as Opening Travel Time, given in milliseconds. Opening Travel Time is the actual measurement and is not modified by the A Input Delay.

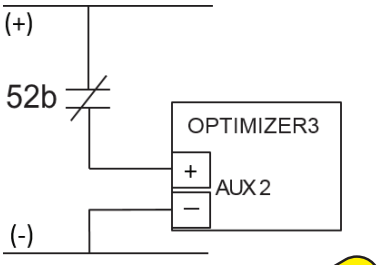
- Circuit breaker Close operations are detected from the 52b auxiliary switch transitioning from closed to open. *In Mode 4, no timing information is recorded for the Close operation other than a date and time stamp.*
- The Optimizer3 pre-assigns the control inputs as a default, but they can be changed if desired. *For example, the AUX 1 input can be assigned to the Opening Coil and the AUX 2 input can be assigned to 52b auxiliary switch.*
- *The recommended AUX 2 connection* (📍) *is to a spare 52b switch that is wetted by the station battery voltage*. There are other wiring connections which give an equivalent timing signal for AUX 2 - in parallel to an in service 52b auxiliary switch or connection in parallel with the green light bulb. The Green Light/52b Polarity setting is specific to the connection location.

NOTE: Recommended connection diagrams are shown in the following diagram (📍).

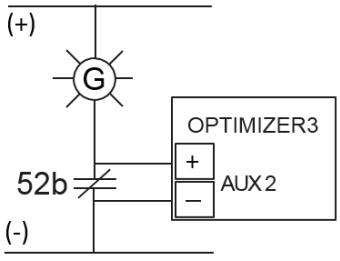
CONNECTION OPTIONS MODE 4



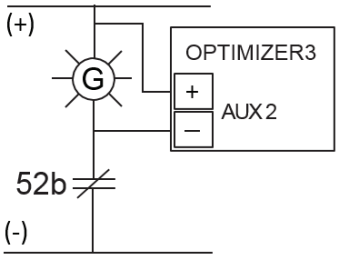
Opening Coil Input Polarity = Positive



Recommended Connection
G.L./52b Input Polarity = Positive



Alternate Connection
G.L./52b Input Polarity = Negative



Alternate Connection
G.L./52b Input Polarity = Positive

6.9.3.5 Mode 5 (Opening Coil, Closing Coil, w/ A & B Input)

This choice monitors the state of a single Opening Coil, the Closing Coil, the 52a and 52b auxiliary switches. When the Opening Coil is energized, the Optimizer3 registers an Open operation and records the time duration of the Opening Coil pulse. The start is the protective relay closing the trip circuit. The end is the opening of the 52A auxiliary switch, modified by the A Input Delay, which begins the Contact Duty measurement. This time duration is named Opening Time, given in milliseconds. The Opening Time measurement is modified by the A Input Delay.

The Opening Travel Time is defined by the time duration beginning with the falling edge of the Opening Coil pulse (52a auxiliary switch opening) and ending with 52b auxiliary switch closing. This segment of time is recorded and reported as Opening Travel Time, given in milliseconds. Opening Travel Time is the actual measurement and is not modified by the A Input Delay.

When the Closing Coil is energized, the monitor registers a Close operation. The time duration from Closing Coil energization to 52b auxiliary switch opening is reported as Closing Time, given in milliseconds. The time duration from 52b auxiliary switch opening to 52a auxiliary switch closing is reported as Closing Travel Time, given in milliseconds. Closing Travel Time is the actual measurement and is not modified by the A Input Delay. Total Closing Time is the sum of the Closing Time and Closing Travel Time measurements.

Optimizer3 pre-assigns default control inputs, but they can be changed if desired:

- AUX 1 input can be assigned to the Opening Coil
- AUX 2 input can be assigned to the Closing Coil.
- AUX 3 input can be assigned to the 52a auxiliary switch
- AUX 4 input can be assigned to the 52b auxiliary switch

The recommended AUX 3 connection (📍) *is to a spare 52a auxiliary switch that is wetted by the station battery voltage.* There are alternate wiring connections which give an equivalent timing signal for AUX 3- connection in parallel to an in service 52a auxiliary switch or connection in parallel with the Red Light bulb. The Red Light/52a Polarity setting is specific to the connection type.

Aux 3 Input Polarity

AUX 3 Input Wiring Connection	AUX 3 Polarity setting	Type
In series with wetted spare 52a auxiliary switch	Negative	*Recommended*
In parallel with in service 52a auxiliary switch	Positive	Alternate
In parallel with red light bulb	Negative	Alternate

NOTE: Wiring connections shown in diagrams on the following page.

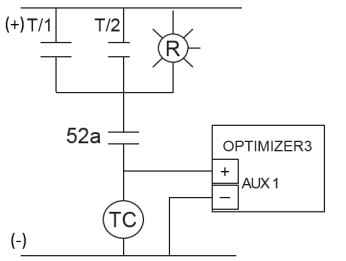
The recommended AUX 4 connection (📍) is to a spare 52b auxiliary switch that is wetted by the station battery voltage. There are other wiring connections which give an equivalent timing signal for AUX 4- connection in parallel to an in service 52b auxiliary switch or connection in parallel with the Green Light bulb. The Green Light/52b Polarity setting is specific to the connection location.

Aux 4 Input Polarity

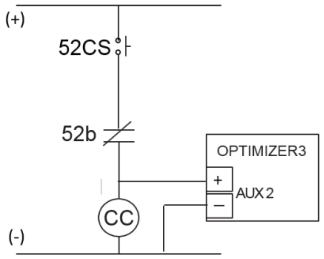
AUX 4 Input Wiring Connection	AUX 4 Polarity setting	Type
In series with wetted spare 52b auxiliary switch	Positive	*Recommended*
In parallel with in service 52b auxiliary switch	Negative	Alternate
In parallel with green light bulb	Positive	Alternate

NOTE: Wiring connections shown in the following diagrams.

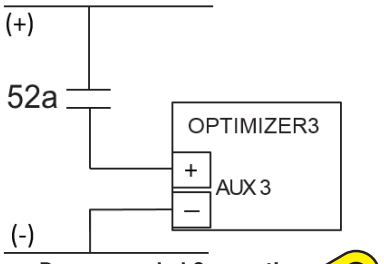
CONNECTION OPTIONS MODE 5



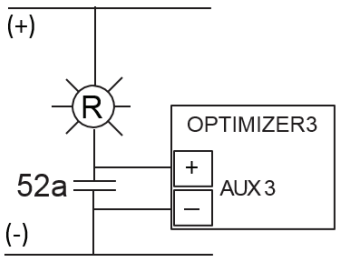
Opening Coil Input Polarity = Positive



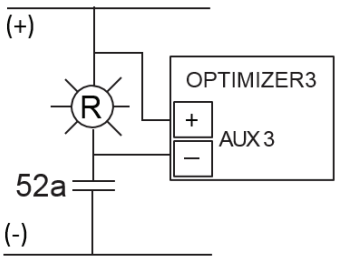
Closing Coil Input Polarity = Positive



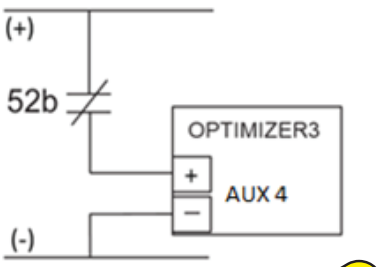
Recommended Connection
R.L./52a Input Polarity = Negative



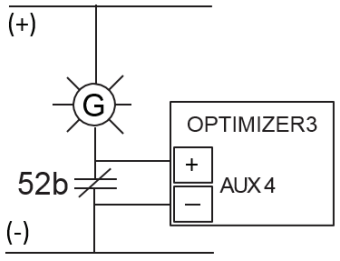
Alternate Connection
R.L./52a Input Polarity = Positive



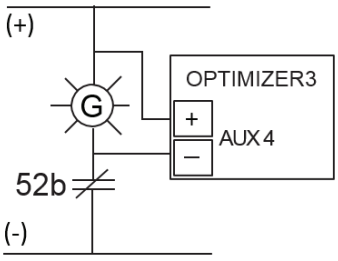
Alternate Connection
R.L./52a Input Polarity = Negative



Recommended Connection
G.L./52b Input Polarity = Positive



Alternate Connection
G.L./52b Input Polarity = Negative



Alternate Connection
G.L./52b Input Polarity = Positive

6.9.3.6 Mode 6 (2 Opening Coils, w/ A & B Input)

This choice monitors two Opening Coils, the 52a and 52b auxiliary switches. Mode 6 assumes that no connection to the Closing Coil is possible. Because of this, Closing Time is not measured.

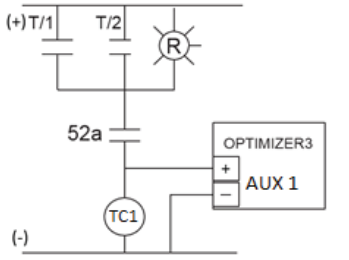
The first Opening Coil to be energized is identified. The Optimizer3 registers an Open operation and records the time duration of the Opening Coil pulse. The start is the protective relay closing the trip circuit. The end is the opening of the 52A auxiliary switch, modified by the A Input Delay, which begins the Contact Duty measurement. This time duration is named Opening Time, given in milliseconds. The Opening Time measurement is modified by the A Input Delay.

The Opening Travel Time is defined by the time duration beginning with the falling edge of the Opening coil pulse (52a auxiliary switch opening) and ending with 52b auxiliary switch closing. This segment of time is recorded and reported as Opening Travel Time, given in milliseconds. Opening Travel Time is the actual measurement and is not modified by the A Input Delay.

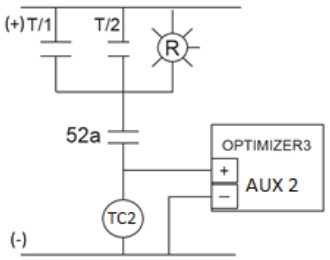
When the 52b transitions from closed to open, the monitor registers a Close operation and records the time duration until the 52a closes. This time duration is called Closing Travel Time, given in milliseconds.

NOTE: Examples shown in the following diagrams (recommended connections ( )).

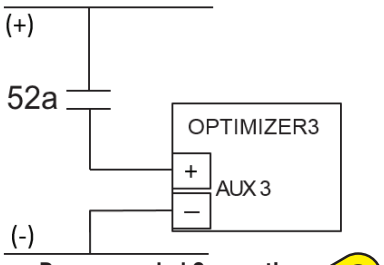
CONNECTION OPTIONS MODE 6



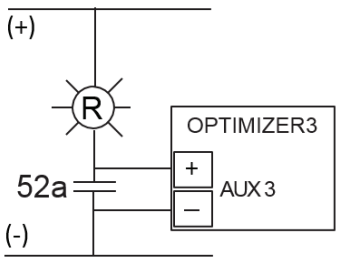
Opening Coil 1 Input Polarity = Positive



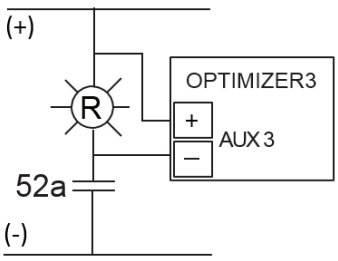
Closing Coil 2 Input Polarity = Positive



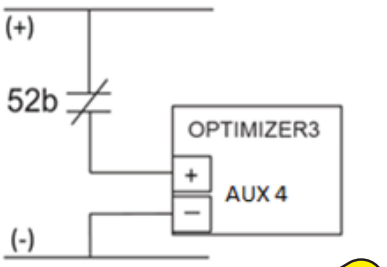
Recommended Connection
R.L./52a Input Polarity = Negative



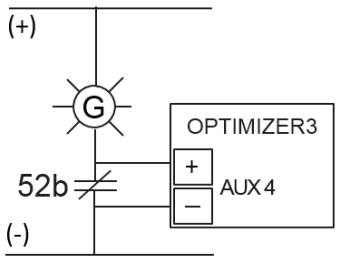
Alternate Connection
R.L./52a Input Polarity = Positive



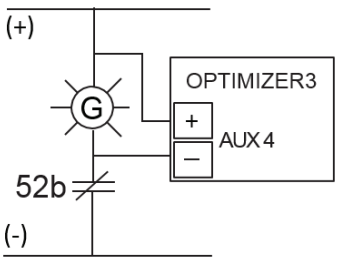
Alternate Connection
R.L./52a Input Polarity = Negative



Recommended Connection
G.L./52b Input Polarity = Positive



Alternate Connection
G.L./52b Input Polarity = Negative



Alternate Connection
G.L./52b Input Polarity = Positive

6.9.3.7 Mode 7 (2 Opening Coils, Closing Coil, w/ A & B Input)

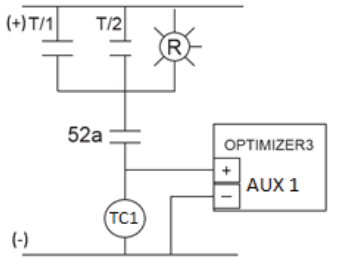
This choice monitors two Opening Coils, the Closing Coil, the 52a and 52b auxiliary switches. The first Opening Coil to be energized is identified. The Optimizer3 registers an Open operation and records the time duration of the Opening Coil pulse. The start is the protective relay closing the trip circuit. The end is the opening of the 52A auxiliary switch, modified by the A Input Delay, which begins the Contact Duty measurement. This time duration is named Opening Time, given in milliseconds. The Opening Time measurement is modified by the A Input Delay.

The time duration from 52a auxiliary switch opening to 52b auxiliary switch closing is reported as Opening Travel Time, given in milliseconds. Opening Travel Time is the actual measurement and is not modified by the A Input Delay.

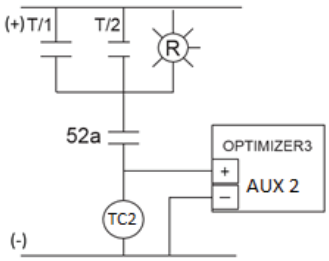
When the Closing Coil is energized, the monitor registers a Close operation. The time duration from Closing Coil energization to 52b auxiliary switch opening is reported as Closing Time, given in milliseconds. The time duration from 52b auxiliary switch opening to 52a auxiliary switch closing is reported as Closing Travel Time, given in milliseconds. Closing Travel Time is the actual measurement and is not modified by the A Input Delay. Total Closing Time is the sum of the Closing Time and Closing Travel Time measurements.

NOTE: Examples shown in the following diagrams (recommended connections ( )).

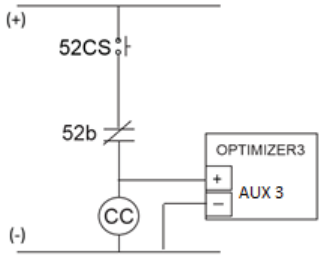
TRIP AND CLOSE COIL CONNECTIONS MODE 7



Opening Coil 1 Input Polarity = Positive

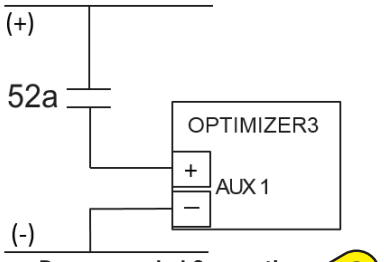


Opening Coil 2 Input Polarity = Positive

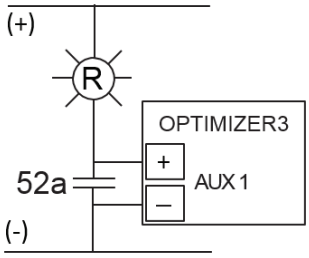


Closing Coil Input Polarity = Positive

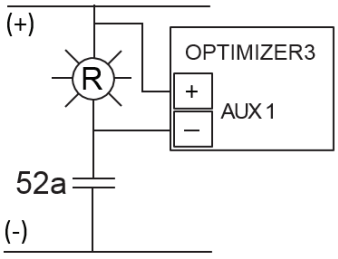
CONNECTION OPTION MODE 7



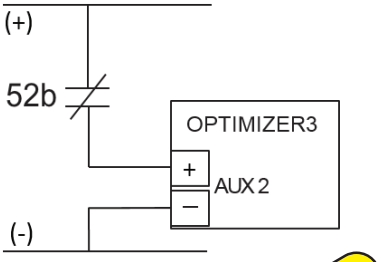
Recommended Connection
R.L./52a Input Polarity = Negative



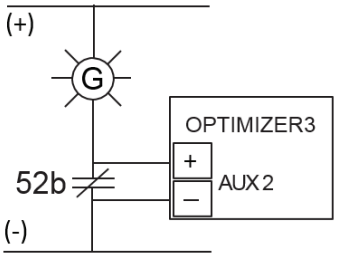
Alternate Connection
R.L./52a Input Polarity = Positive



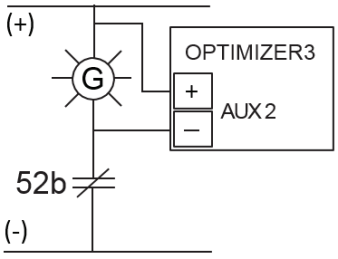
Alternate Connection
R.L./52a Input Polarity = Negative



Recommended Connection
G.L./52b Input Polarity = Positive



Alternate Connection
G.L./52b Input Polarity = Negative



Alternate Connection
G.L./52b Input Polarity = Positive

6.9.4 Velocity & Average Velocity Measurements

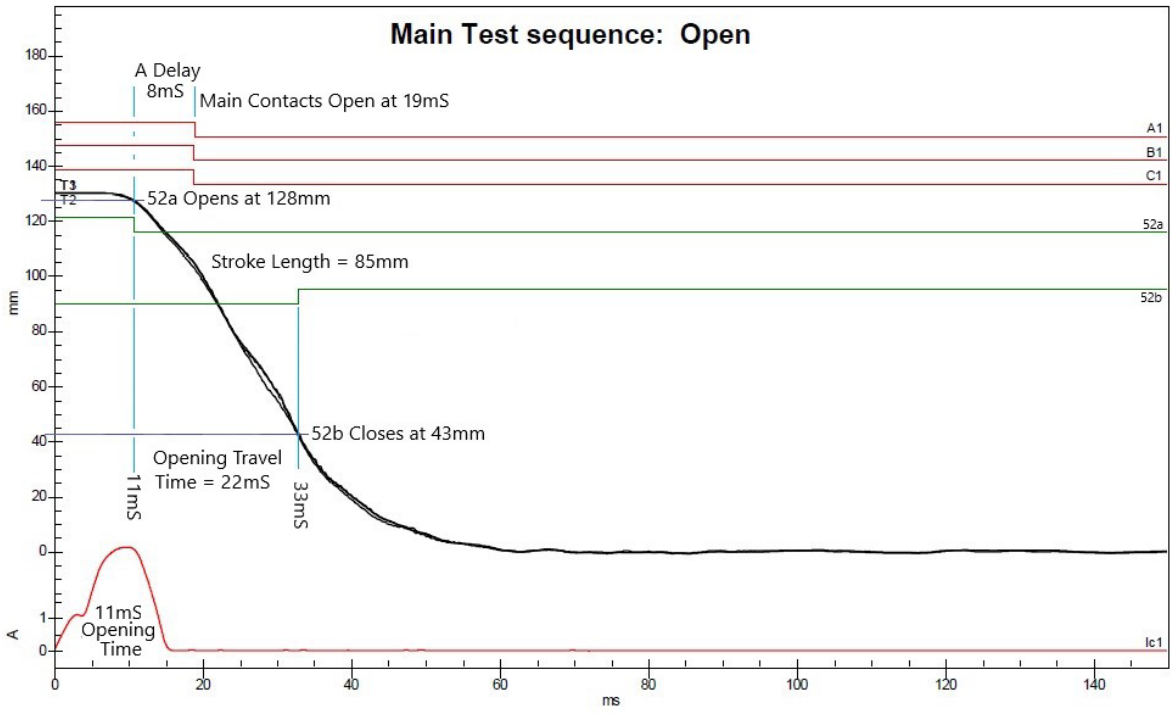
The Optimizer3 will report the Opening Velocity (modes 1,4,5,6,7) and Closing Velocity (modes 1,5,6,7) during Trip and Close operations. The Last 10 Opening and Closing Velocity measurements are averaged to provide the Average Opening Velocity and Average Closing Velocity.

During a Trip operation, the Opening Velocity measurement is calculated by dividing the main contact stroke distance by the Open Travel Time. During a Close operation, the Closing Velocity measurement is calculated by dividing the main contact stroke distance by the Close Travel Time.

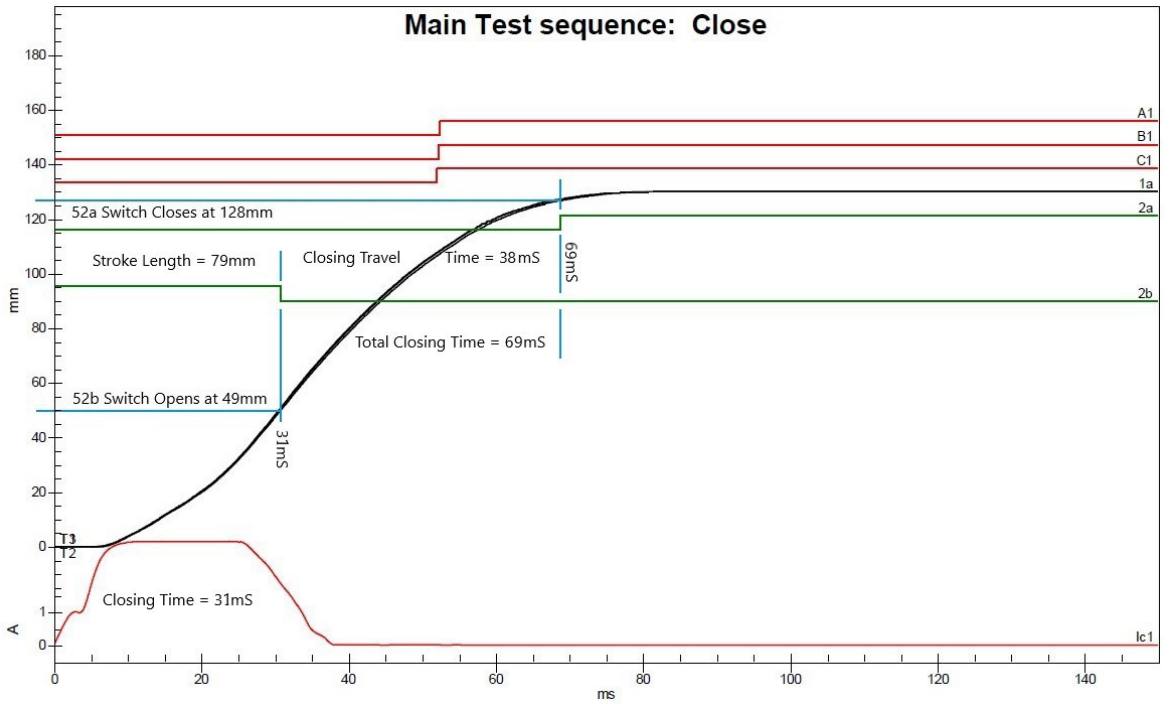
The average velocity is an important measurement from the standpoint of trend. The absolute value may not exactly agree with an off-line time-travel test. An off-line time-travel test will calculate the velocity as the main contact travels through the arcing zone. The arcing zone may be defined by different end points than are assumed by the Optimizer3. The Optimizer3 calculates the opening velocity from 52A assertion to 52B assertion. The velocity calculation can be manipulated slightly by adjusting the stroke distance. The breaker instruction book will have information on the timing of the breaker operations.

Careful study of the Open and Close Illustrations shows the total contact stroke of 85 mm. The Optimizer3 begins the timer at the start of the Opening Coil pulse. The 52a auxiliary switch opens at 11 mS. The 52b auxiliary switch closes at 33 mS. The approximate locations of 52A and 52B assertions are 128 mm and 43 mm, giving a stroke of 85 mm from 52A opening to 52B closing.

Opening Travel Chart



Close Travel Chart



For this breaker, the approximate value of 82 mm for stroke is used as a Configuration setting in the Optimizer3. This is the average of the strokes found in the Opening and Close Travel Charts (85 mm + 79 mm)/2 = 82 mm.

For some test operations, the following data is produced:

Open and Close Travel Data

Report ID	Date/Time	Type	Operation Number	Open Coil	Open Type	Open Time	Open Travel Time	Close Time	Close Travel Time	Total Closing Time	Open Velocity	Close Velocity
22	Mar 15, 2022, 5:01:35PM	Open	177	1	Non Fault	11	27				3.04	
21	Mar 15, 2022, 5:01:19PM	Close						30	38	68		2.16
20	Mar 15, 2022, 5:01:12PM	Open	176	2	Non Fault	12	26				3.15	
19	Mar 15, 2022, 5:00:57PM	Close						31	39	69		2.10
18	Mar 15, 2022, 5:00:48PM	Open	175	1	Non Fault	11	26				3.15	
17	Mar 15, 2022, 4:45:45PM	Close						31	38	69		2.16
16	Mar 15, 2022, 4:45:18PM	Open	174	1	Non Fault	11	26				3.15	
15	Mar 15, 2022, 4:44:45PM	Close						30	38	68		2.16

- The Optimizer3 divides 82 mm stroke by 26 mS Opening Travel Time to get 3.15 millimeters per millisecond (or meters per second).
- The Optimizer3 divides 82 mm stroke by 33 mS Closing Travel Time to get 2.16 millimeters per millisecond (or meters per second).

The breaker instruction book gives a calculation of 3 meters per second for an open operation and 2 meters per second for a close operation. The Optimizer3 gives a very good approximation of the Opening and Closing Velocities.

6.9.5 Current and Voltage Logging

The Optimizer3 continuously monitors its power supply voltage and phase currents:

- Every two hours, power supply voltage and phase currents are logged in the database.
- Each day, minimum, maximum and average power supply voltage and phase currents are calculated and logged in the database.
- As the Optimizer3 monitors the phase currents, while the breaker's main contacts are interrupting a fault, the highest measured current value for each phase is recorded as Peak Current (Ø A,B,C). The Peak Current is measured only during the Arc Time. The time duration of the Peak Current is not recorded – only its amplitude. This is a different measurement than the I^2T but occurs during the same (Arc) time period.

This data is available for download by going to Monitor > Export screen. Choose the items for download from the Available Data list, set the desired Date Range and then select the Export button at the bottom of the page (see §5.5.4).

- Average Power Supply Voltages are downloaded by clicking "Voltage Monitor Continuous Metrics" and selecting "Supply Voltage" instead of a sensor.
- Average Phase Currents are downloaded by clicking "Circuit Breaker Current History".
- Peak Phase Currents are downloaded by clicking "Phase X Peak Current".

6.9.6 AUX Inputs for Control Circuit Status Monitoring

AUX Inputs left unused for Modes 1–6 may be used for voltage on/off status monitoring of any DC control circuit node. High and Low voltage status may be monitored. After the Mode is saved, unused AUX inputs will be available in the Digital Input cell. They may be configured as active-high or active-low. The Off/On threshold is approximately 35 VDC.

The AUX Input can drive the relay output only. There is no visibility for the status of AUX Inputs used this way on web pages or through DNP. The relay status is visible as a DNP point so if no other parameter is configured to assert the relay, then the status of the AUX Input may be known by the status of the relay DNP point

For instance, if Mode 6 is selected and saved and AUX Inputs defined, the remaining unused AUX Inputs will show in the Digital Input cell.

Example 1: Programming Spare AUX Input for State Monitoring

☐ Group	Parameter Name	Parameter Value
☐ Digital Inputs		
☐ Channel 5	Active State	Select "High" or "Low".
☐ Relay	Enable	Yes
	Polarity	**Normal**
	Logic	**OR**
	Latch	No
☐ Input 1	Type	State
	Digital Input	**Channel 5**

NOTE: To configure a Binary DNP point to report the relay state:

- Category = "Other"
- Source = "Relay Activated"

Example 2: Programming a Binary DNP3 Point to Monitor Relay State:

☐ Group	Parameter Name	Parameter Value
☐ Binary	Default static variation	Group 1 Variation 2 - with flags
	Override defaults	**No**
	Number of measurements	1
☐ 1	Category	Other
	Source	**Relay Activated**

6.10 DNP3.0

See §5.7.2.13.

7 Appendix

7.1 Event Codes & Troubleshooting

Event/Alarm Code	Description	Proposed Action
Any	Includes all events.	N/A
Unknown	Unknown.	Upgrade the Optimizer3 unit to the latest firmware version and contact FE Technical Support if not resolved.
Power Down	The Optimizer3 unit was powered down.	N/A
Configuration changed	Changes have been made to the configuration.	N/A
Configuration error	There is a current error within the configuration programming.	Check configuration settings for errors and contact FE Technical Support if not resolved.
Power up	The Optimizer3 unit was powered up.	N/A
Reboot	The Optimizer3 unit was rebooted.	N/A
Watchdog reset	The system detected that the software had stopped responding and triggered a reboot.	If this happens repetitively, contact FE Technical Support.
Hardware reset	The hardware reset line to the processor was activated.	If this happens repetitively, contact FE Technical Support.
Unexpected reset	A reboot occurred unexpectedly.	If this happens repetitively, contact FE Technical Support.
Reboot requested	User requested reboot	N/A
Firmware upgraded	The firmware version of the Optimizer3 unit has been upgraded.	N/A
Transient power failure detected	Momentary loss of power detected.	If this happens repetitively, contact FE Technical Support.
Time zone changed	The time zone has been changed in configuration.	N/A
Time source error	System time source is in error.	Contact FE Technical Support.
Data storage error	Internal storage data error.	Contact FE Technical Support.
Web server error	Internal web server is in error.	Contact FE Technical Support.
Communication bus error	Internal communication bus is in error.	Contact FE Technical Support.
Firmware upgrade in progress	A firmware version upgrade is in progress.	N/A
Firmware upgrade has failed	The latest firmware version upgrade attempt has failed.	Check firmware file and retry. Contact FE Technical Support if not resolved.
Service failed	Part of the firmware system repeatedly failed to start.	Contact FE Technical Support.
System clock changed	The date and time have been changed in configuration.	N/A
System backup restore in progress	A full system backup restoration is in progress.	N/A
Firmware upgrade is available	Reserved for future use.	N/A

Event/Alarm Code	Description	Proposed Action
User changed	The user logged into the Web Browser Interface has changed.	N/A
User Web Session in Progress	A user web session has been initiated.	N/A
User Local Session in Progress	Reserved for future use.	N/A
Internal error – contact technical support	Internal error.	Contact FE Technical Support.
Invalid Registration	Reserved for future use.	N/A
Registration Changed	Reserved for future use.	N/A

7.2 Related Documents

Related documentation can be found at www.franklingrid.com.

Part Number	Description
000-0321	Optimizer3 DNP3.0 Device Profile Document

7.3 Notes

000-1533 r5

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