Entellisys 5.5 Low-Voltage Switchgear System User's Manual

DEH-551
July 18th, 2014

imagination at work

DEH-551

Warnings, Cautions, and Notes as used in this publication

Warnings

WARNING! Warning notices are used in this publication to emphasize that hazardous voltages, currents, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

Warning notices are also used for situations in which inattention or lack of equipment knowledge could cause either personal injury or damage to equipment.

Cautions

CAUTION: Caution notices are used for situations in which equipment might be damaged if care is not taken.

Notes

NOTE: Notes call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to ensure accuracy, the information contained herein does not cover all details or variations in hardware and software, nor does it provide for every possible contingency in connection with installation, operation, and maintenance. Features may be described in here that are not present in all hardware and software systems. GE Industrial Solutions assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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Third revision. Corresponds to Entellisys HMI version 5.5.

How to contact us

Please have your Entellisys System Summary # and Sub # ready when calling Post Sales Service. This information can be found on the Entellisys HMI on the **System Health** screen by clicking the **Job Info** button.

Post Sales Service
GE Switchgear
510 Agency Road
West Burlington, IA 52655

Phone (toll free): 1-888-437-3765

Additional information:
www.entellisys.com

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8 Reduced Energy Let-Thru Mode

9 Sequence of events, fault reports and waveform capture records

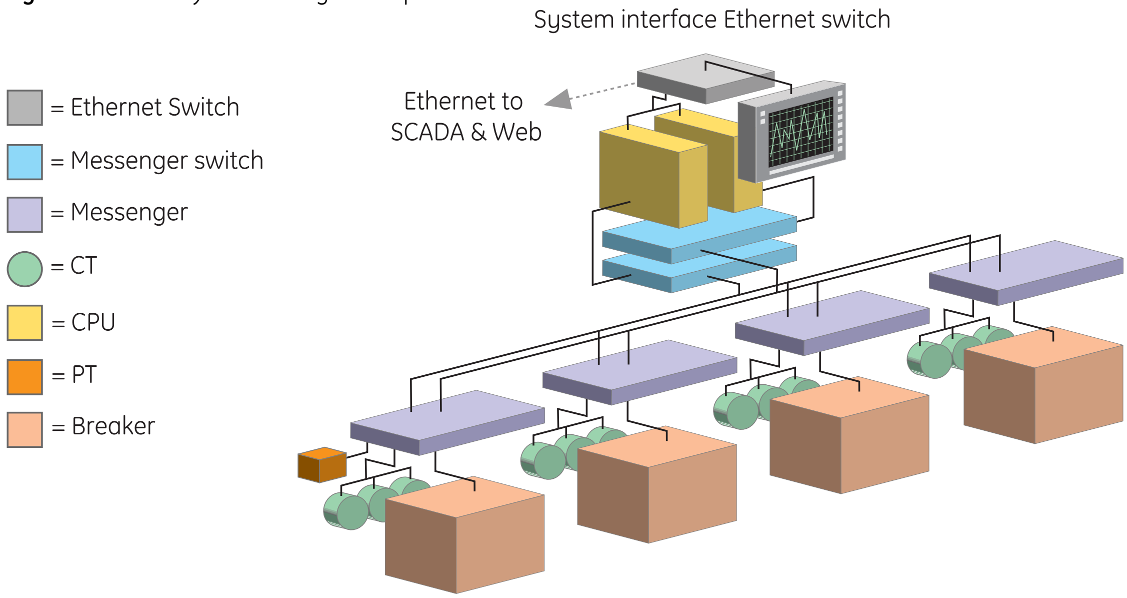
10 Discrete I/O

1 System architecture

The Entellisys™ Low-Voltage Switchgear provides protection, control and monitoring in a flexible package that will change the way you think about switchgear. The central processor unit (CPU) is the basis of this new protection-and-control architecture. The CPU provides protection and control functions over the entire low-voltage switchgear system.

The key advantage of this architecture is that the CPU has all the information from all circuit breakers simultaneously. The architecture also has built in redundancy to increase system availability.

Figure 1-1 Entellisys LV Switchgear simplified architecture



1.1 Description of operation

Current transformers (CTs) and potential transformers (PTs) measure current and voltage and transmit the analog information to the EntelliGuard™ messenger. The Messenger digitizes and sends the information over the Messenger communication network to two redundant CPUs.

The CPUs make protection decisions, capture events, process waveform data, and provide status information. For example, if the CPUs identify a trip condition at a circuit breaker, the CPU alerts the EntelliGuard Messenger at that circuit breaker, which then actuates the circuit breaker and returns the circuit breaker status to the CPU.

Modbus® communication, an open industry standard protocol, is provided as an interface to external components such as the Entellisys HMI, SCADA, or other Building Automation Systems.

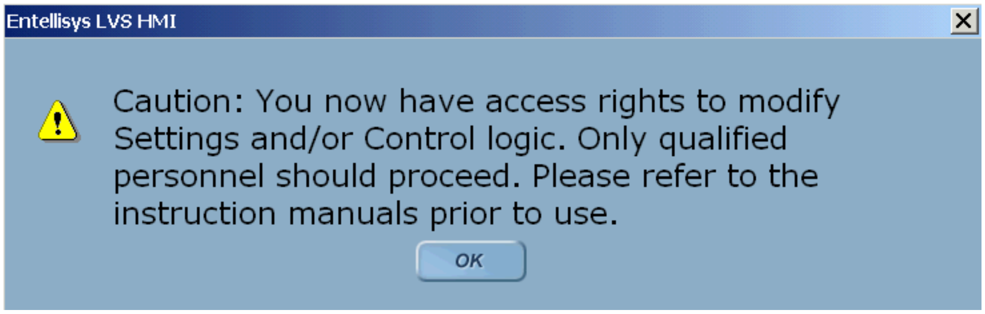
The Human Machine Interface (HMI) is the central user interface for the system. HMIs are touchscreen computers located in-gear or near-gear (see Touchscreen HMI on page 39) and Remote HMIs are available for desktop/laptop users who want to view the switchgear from remote locations.

Discrete I/O is provided for customer-specific inputs and outputs. This equipment is resident in the switchgear and is connected through the CPUs. Discrete I/O and custom control schemes will run in the CPUs if enabled.

In summary, Entellisys changes the protection paradigm from individual circuit protection to system protection.

CAUTION: Users that have been assigned Group Permissions by the System Administrator for features that allow the changing of settings and/or access to control functions must be established as qualified personnel only. See User Permissions on page 81 for more information about programming user permissions. As a reminder, users with such privileges will be presented with the following screen upon initial login:

Figure 1-2 Initial login Caution screen



1.2 Switchgear installations

There are two primary installation methods in the switchgear:

- Standard
- Split-redundant

With **standard** installation, redundant components such as the CPUs, Messenger switches, and UPSs are installed together in the equipment. This method optimizes footprint and convenience of maintenance.

With **split-redundant** installation, redundant components such as the CPUs, Messenger switches, and UPSs are split-up with at least one switchgear stack separating them. This method optimizes system availability.

For more information, see DEH-41472A Entellisys Low Voltage Switchgear Installation and Maintenance Instruction Guide.

1.3 Specifications

1.3.1 Environmental

Storage/shipping temperatures

–40 to 85° C

Operating temperatures

0 to 40° C ambient, indoor use

Humidity

5% to 95%, non-condensing, indoor use

1.3.2 Type tests

Tests are split into two categories:

- **EntelliGuard Messenger Tests** – the primary protection control element
- **Entellisys System Tests** – the complete system

Table 1-1 Type tests

Type	Name	EntelliGuard Messenger Tests	Entellisys System Tests
EMC/Transient	Harmonic Currents	IEC60947-2 sec.F.4.1.2	
EMC/Transient	Current Dips and Interruptions	IEC60947-2 sec. F.4.2	
EMC/Transient	Fast Transient Burst	IEC61000-4-4 ANSI C37.90.1	ANSI C37.90.1 ANSI C62.41 IEC61000-4-4
EMC/Transient	Voltage/Current Surge Immunity	IEC61000-4-5 IE255-22-5	ANSI C62.41 IEC61000-4-4
EMC/Transient	Electrostatic Discharge Immunity	IEC60947-2 sec. F.4.3 IEC60255-6	EN61000-4-2
EMC/Transient	1MHz Oscillatory SWC	IEC 60255-22-1 ANSI C37.90.1	ANSI C37.90.1
EM emission	Conducted		FCC part 15, subpart B, Class A
EM emission	Radiated		FCC part 15, subpart B, Class A
RFI	Electromagnetic Field Immunity	IEC60947-2 sec. F.4.4	

Table 1-1 Type tests

Type	Name	EntelliGuard Messenger Tests	Entellisys System Tests
RFI	RFI with portable transmitters	IEC60255-6	
RFI	ANSI Radiated Susceptibility	ANSI C37.90.2	ANSI C37.90.2
RFI	Conductive RF Immunity	IEC60255-22-6	
Environment	Dry Heat	IEC60947-2 sec. F.7	
Environment	Thermal Shock	IEC60947-2 sec. F.9 IEC60068-2-1 IEC60068-2-2	
Environment	Damp Heat	IEC60947-2 sec. F.8	
Environment	Humidity	IEC60947-1 IEC60947-2 sec. F.8	
Mechanical	Sinusoidal Vibration	IEC255-21-1	
Safety	Dielectric Strength	IEC60255-6	ANSI C37.20.2 Paragraph 5.3
Safety	Insulation Resistance	IEC60255-6	
Safety	Impulse Voltage Withstand	IEC60255-6	
Magnetic	Power Frequency Magnetic Field	IEC61000-4-8	
Magnetic	Power Magnetic Field Immunity	IEC61000-4-9	
Voltage	Overvoltage		ANSI C84.1 IEC 61000-4-11
Voltage	Undervoltage		ANSI C84.1
Voltage	Ramp voltage		ANSI C84.1
Voltage	Line Interruption		ANSI C84.1 IEC 61000-4-11

1.3.3 Approvals

UL Listed – Low Voltage AC Power Circuit Breaker Trip Unit - E-48428

FCC Class A listed

1.4 Remote HMI Software

Entellisys Remote HMI software allows users to access the switchgear system from any desktop/laptop computer.

There are two versions of Remote HMI software:

- **User Interactive version**: provides programmable permission levels for all users from full "Administrator" access to view-only "Guest" privileges.
- **Viewer version**: limited to view-only "Guest" privileges. Login name and passwords are fixed.

The following steps are required to install and configure the Entellisys Low Voltage Switchgear – Remote HMI software:

1.4.1 System Requirements

Please verify the target computer meets the requirements before Installing:

OS	Microsoft Windows 7 or 8, 32bit or 64bit OS
Processor	•1 GHz 32-bit or 64-bit processor
Memory	•1 GB of system memory
Storage device	Hard disk drive 20 GB, minimum
Screen resolution	1024x768 in 256 colors, preferred
USB port	One port required
Instances	Entellisys supports up to 4 simultaneous Remote HMI connections
Entellisys version support	Entellisys 4.5 to 5.5 lineups only

1.4.2 Installation

The IP addresses of the system's CPUs and the fixed IP for the Remote HMI station must be known before continuing.

Also, if the Remote HMI is connected to an open LAN, the Entellisys VPN must be installed in the gear and configured to allow the Remote HMI IP. (See Network security/VPN device on page 63)

Step 1: Set IP addresses, verify system communication

If the Remote HMI is being used to pre-configured gear using the HMI offline mode, then go to Step 2, otherwise,

Remote HMIs will need some addition consideration to establish communication to the CPUs. Typically, computers that are connected to a network are configured to establish a TCP/IP address dynamically. However, the Entellisys devices are all static and some manual record keeping is required to ensure all devices on the Entellisys network are communication properly - see Changing the local HMI IP address on page 61

Step 2: Install Software

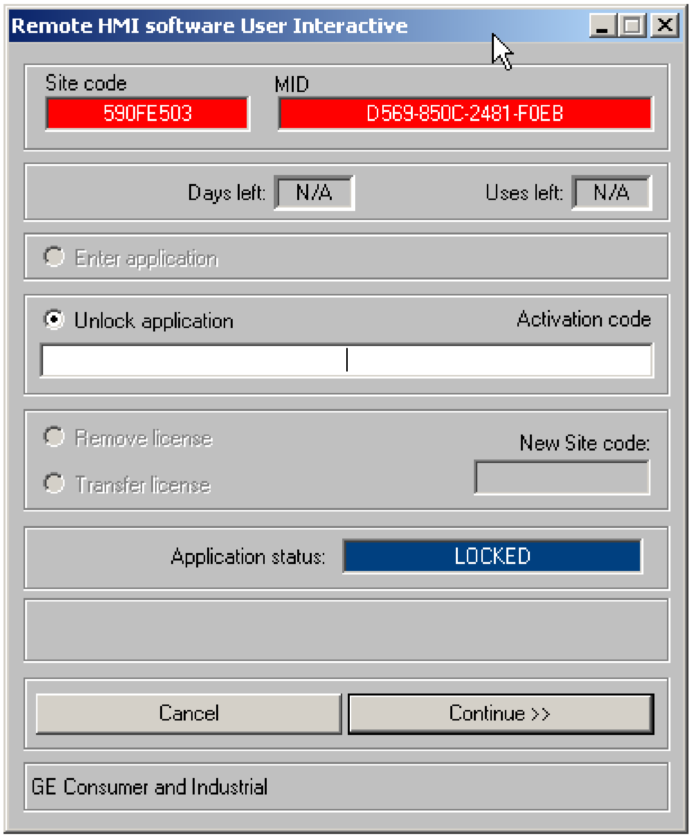
Insert the "Entellisys Remote HMI" CD and run the install program. Follow the on-screen installation wizard. Click **Finish** to complete the installation.

To start the Entellisys Remote HMI application, point to **Start**, select **Programs**, and then double-click **Entellisys LVS HMI**.

Step 3: License Software

The first time the Remote HMI program is launched, a window will display requesting an Activation code.

Figure 1-3 Remote HMI License Activation window



To obtain an Activation code, call GE at:

GE Switchgear – Post Sales Service
510 Agency Road, West Burlington, IA 52655
Phone (toll free): 1-888-437-3765

Please have the following information ready:

Entellisys System Identifier: Summary#, Sub#

- HMI Type: User Interactive or Viewer, on the blue title bar in Figure 1-3
- SITE CODE: from the activation window in Figure 1-3
- MID CODE: from the activation window in Figure 1-3

GE will verify that unused licenses of the desired version are available and will provide an Activation code for the software. Type in the Activation code and click **Continue**.

An example Activation code follows:

D11C8284-F54A0910-03D20031-B1ACADFA

Step 4: Configure Remote HMI to communicate to CPUs

After the software is licensed, the HMI will immediately open the HMI Preferences Screen. Click on **Config Lineup** and modify the "Default Lineup" with the IP addresses of the CPUs. (See Configuring Lineups on page 108 for details)

NOTE: When installing a Remote HMI prior to the switchgear arrival, this step cannot be performed. In this situation, a System Archive must be installed. See Restore an archive on page 52 for instructions.

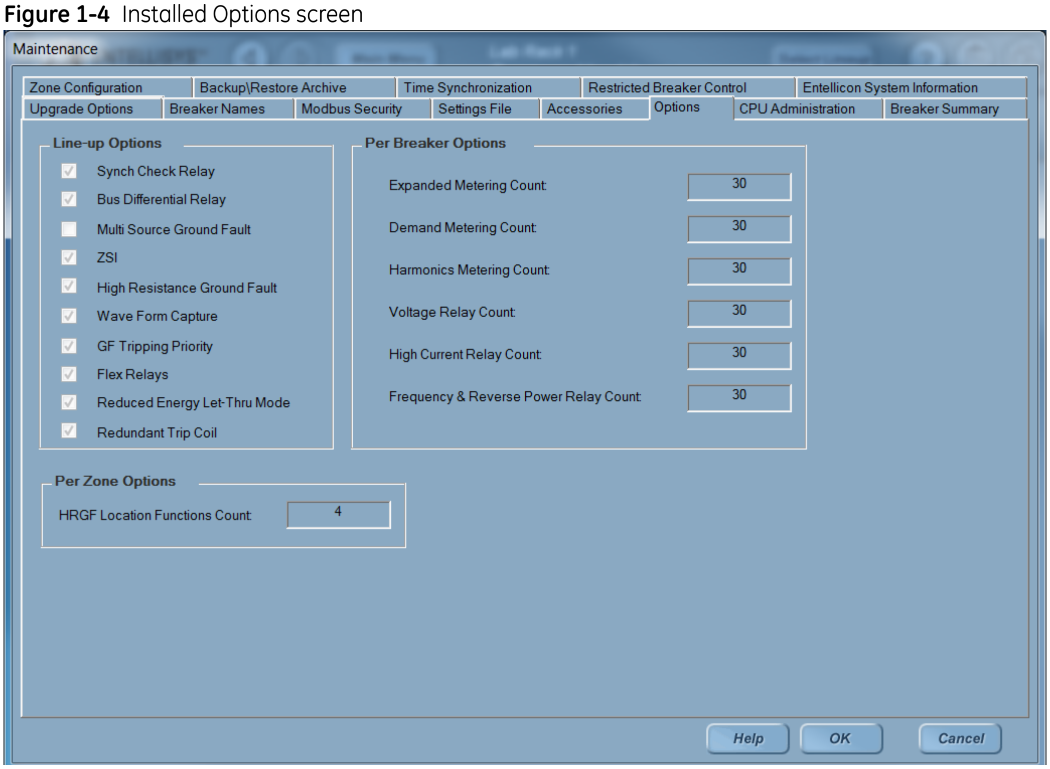
1.5 Feature options

The Entellisys Low Voltage Switchgear system has many features available through software upgrades.

1.5.1 View installed options

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Options** tab to view current installed software options as shown in Figure 1-4.

Figure 1-4 Installed Options screen



1.5.2 Upgrade options

The process for upgrading features is as follows:

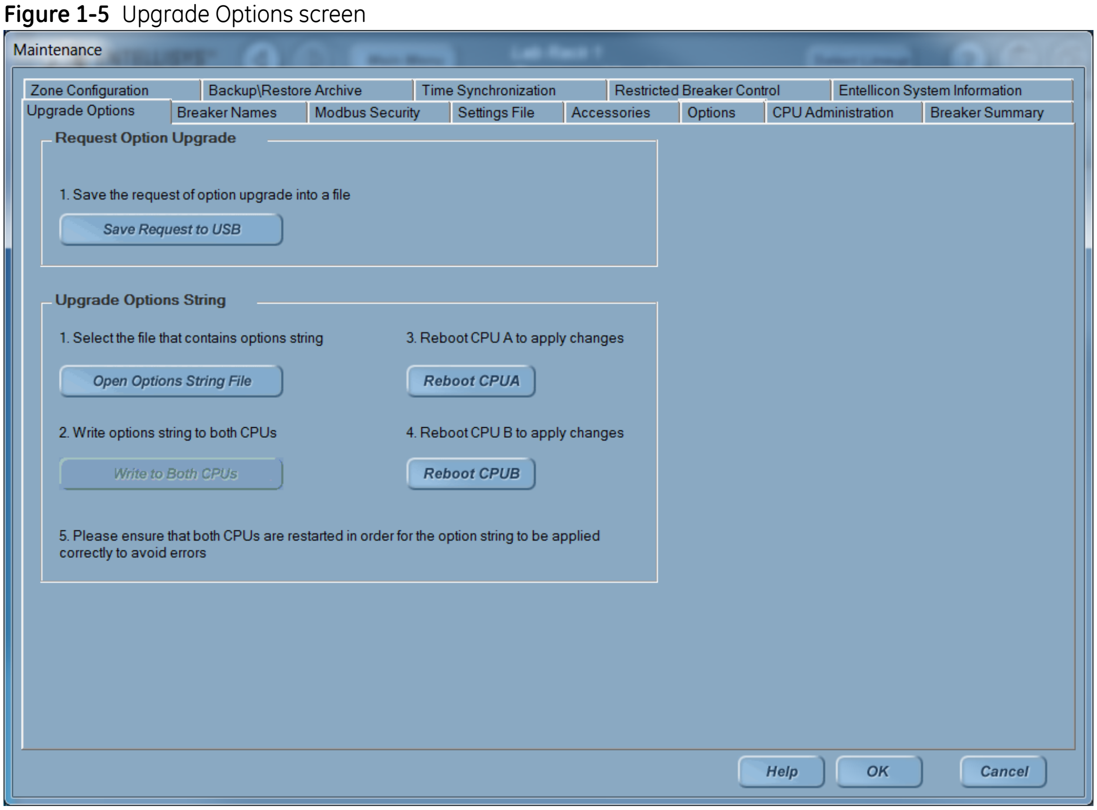
Step 1: Request an Upgrade through HMI

The Administrator must make a request at the HMI. The HMI saves required information (*.dat file) to a USB flash memory device and must be sent to GE for creating a new encrypted "option string" which contains all existing and newly purchased features.

To request an upgrade

1. Insert the USB device into the HMI USB port.
2. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
3. Click the **Upgrade Options** tab, as shown in Figure 1-4.

Figure 1-5 Upgrade Options screen



4. In the "Request Option Upgrade" group, click the **Save Request To USB** button.
5. Select a valid USB drive. Once a valid drive is selected, the Save button is automatically enabled.
6. Enter a File Name in the dialog box.
7. Click the **Save** button. A message will confirm the "Option String successfully saved into file (directory path)." Acknowledge the message dialog box.

Step 2: Send Request to GE with Data from the USB

To place order, contact GE Post Sales Support (see How to contact us on page 2).

GE will request the following information:

- Entellisys System Identifier: Summary#, Sub#
- HMI Upgrade request information saved on the USB flash memory device (*.dat file)
- New options requested

Some features are simple to add, and can be upgraded by the System Administrator. Other features require more programming and potentially onsite installation/testing to ensure system performance. This will be explained when the order is placed.

Step 3: Get new Option String from GE

GE will either mail or e-mail the new option string (*.dat file). Copy the new option string to a USB flash memory device.

Step 4: Install the Upgrade

Follow the procedure below to install the feature upgrade option string:

1. Insert the USB flash device into a USB port. For Touchscreen HMIs, this port is accessed from the front of the switchgear, behind the small door in the bottom right corner of the HMI.
2. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
3. Click the **Open Options String File** button in the **Upgrade Option String** group.
4. In the “Browse CPU Option File” dialog box, select the Option string file (extension is *.dat).
5. Click **Open**. A dialog box stating “Option String successfully read” will display. Acknowledge the dialog box.
6. After successful reading of the option string, the Write to Both CPUs and Reboot button will automatically be enabled. Click the **Write to Both CPUs and Reboot** button. A confirmation message will display stating that “After Option string loading started, you can't abort it. Are you sure you want to proceed it”.
7. Click **Yes** to proceed (or click **No** to cancel option upgrade). The “Loading Option String” status will display.
8. Verify the feature upgrades are installed. On the **Maintenance** screen, click the **Options** tab. Select the **Line-up Options** and **Per Breaker Options** items.

1.6 Control power and UPS configuration

Entellisys instrumentation and circuit breakers rely upon 120 Vac 50/60 Hz control power for operation. An integral double-redundant, UPS-protected control power system provides a highly reliable power source for the devices.

1.6.1 Bus & CPT

Control power transformers (CPTs) “A” and “B” typically connect to separate phases of the main switchgear bus. In systems with more than one main bus, CPTs “A” and “B” connect to separate main bus. The two power outputs (which are unsynchronized) are the sources for the two redundant control power circuits throughout the switchgear.

CPTs transform bus voltage (240 Vac, 480 Vac, or 600 Vac) to 120 Vac 50/60 Hz.

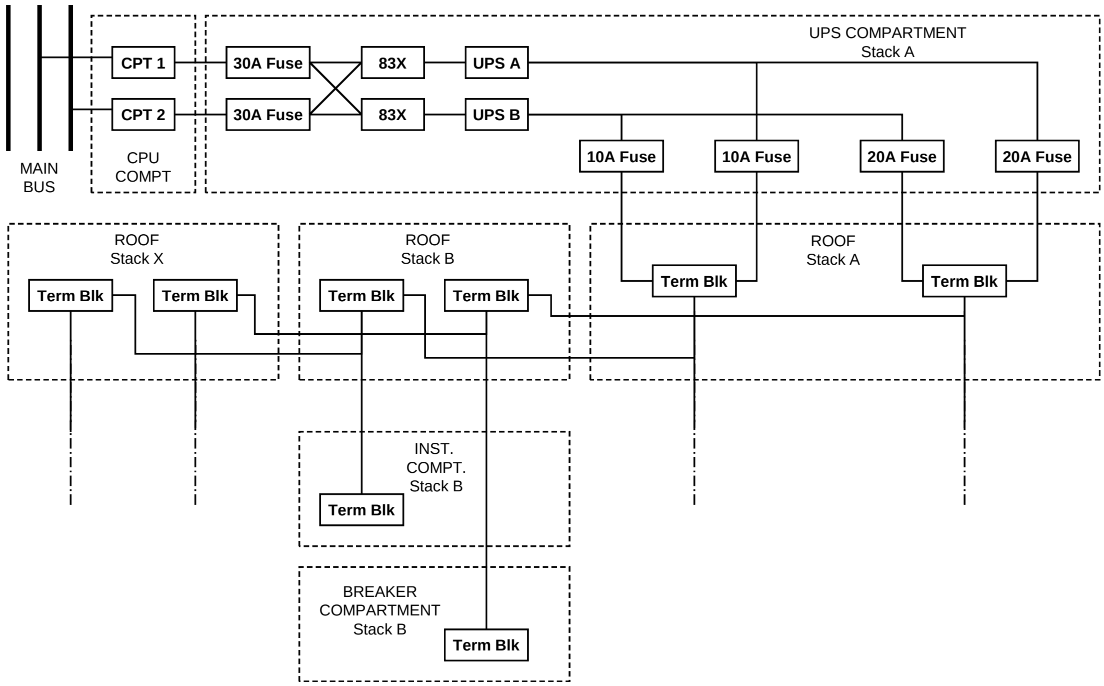
CPTs are typically located in their own compartments. CPTs are co-located in non-split systems when space allows, and they are always located in separate compartments in split systems.

Each CPT is rated at 5 kVA or more.

1.6.2 UPS compartment

Each of the two incoming power lines from CPT "A" and "B" connect directly to a 30 A fuse upon entering the UPS compartment (see Figure 1-6).

Figure 1-6 Control Power & UPS overview



The system uses two throwover devices to select and transfer between the two sources to provide power to the uninterruptible power supplies (UPSs). Each of the two lines serves as a preferred source for one throwover device. Devices transfer from their preferred source if its voltage drops below a specified level. Pickup and dropout voltages for the throwover devices are set at the factory to 85% and 90% of the line voltage, respectively.

The two outputs from the throwover system are fed into a pair of 3 kVA UPSs. The UPSs are of the on-line double-conversion type, with 120 Vac 50/60 Hz inputs and outputs. The UPSs protect the power to the Entellisys instrumentation and circuit breaker control circuits during normal operation, line disturbances, and complete control power source loss. The UPS system does not provide power to the main switchgear bus nor the motor operator accessory of electrically operated circuit breakers.

Each UPS output is split into two circuits: one for circuit breaker control circuits and the other for instrumentation. Each of these (four) UPS-protected control power circuits is then fused to provide protection for the downstream system. 20 A fuses protect the circuit breaker control circuits, while 10 A fuses protect those of the Entellisys instrumentation. This architecture protects the central Entellisys instrumentation in the event of an interruption in circuit breaker control power.

In non-split Entellisys systems, the control power devices described above are located in a single instrument compartment. In split systems, however, the two control power networks (A&B) and their devices are placed in separate compartments. Thus, one input power fuse, one UPS, one throwover device, and two output fuses are housed in each compartment.

1.6.3 Roof

To distribute control power to the gear, the four protected output circuits are typically brought to the roof(s) of the vertical stack(s) housing the UPSs. Power lines are then daisy-chained to terminal blocks on the roofs of the other switchgear stacks as necessary (see Figure 1-6). Circuit breaker and instrument control power is brought only to stacks having circuit breakers and instruments, respectively.

1.6.4 Instrument and circuit breaker compartments

From the roof, control power is brought to each compartment as its contents require (see Figure 1-6). Wires are daisy-chained when multiple compartments in the same stack require control power.

Apart from the input and output UPS fuses, instrument compartments contain no fuses. Compartments for manually operated circuit breakers have no fuses.

Compartments for electrically operated circuit breakers have up to five fuses accessible behind their doors. At the left of the compartment are fuses for the circuit breaker spring charge motor, close coil, and shunt trip. At the right of the compartment are fuses for the set and reset coils of the network interlock accessory. These two fuses are only present when the compartment is intended for a circuit breaker having the network interlock device.

The close coil, shunt trip, and network interlock circuits derive power from the EntelliGuard Messenger, which is powered by both of the UPS-protected control power circuits. Power to the spring charge motor, however, is not derived from the UPS protected control power system.

1.7 System components

Below are brief descriptions of each component in the Entellisys system.

1.7.1 EntelliGuard circuit breaker

EntelliGuard low-voltage power circuit breakers control and protect power circuits up to 600 volts. They will safely switch loads and automatically clear circuits when abnormal conditions occur. These include short circuits, sustained overloads, ground faults, and other programmable conditions.

The EntelliGuard circuit breakers are available in 800 ampere, 1,600 ampere, 2,000 ampere, 3,200 ampere, 4,000 ampere, and 5,000 ampere frame sizes. These values represent the maximum continuous-current rating of each frame.

Circuit breakers may be equipped with a combination of accessories and interlocking devices.

Figure 1-7 EntelliGuard small frame circuit breaker

- The **network interlock** accessory selectively prevents the closing of specific circuit breakers in the electrical distribution network. The CPU sets and resets network interlock devices remotely while continuously monitoring their status. For example, in a double-ended substation, these devices could be used to interlock the main and tie circuit breakers to prevent connecting two unsynchronized power sources.
- The **bell alarm lockout** accessory prevents a circuit breaker from closing after receiving a trip command from the EntelliGuard Messenger. Closing of the circuit breaker is permitted only after the lockout is reset manually at the front of the circuit breaker.

For more information, see the following EntelliGuard Circuit Breaker Instruction Books:

- DEH-201 EntelliGuard Power Circuit Breakers 800-2,000A Frames, 240-600Vac Users Guide
- DEH-202 EntelliGuard Power Circuit Breakers 3,200-5,000A Frames, 240-600Vac Users Guide

1.7.2 EntelliGuard E circuit breaker

EntelliGuard-E low-voltage power circuit breakers control and protect power circuits up to 600 volts. They will safely switch loads and automatically clear circuits when abnormal conditions occur. These include short circuits, sustained overloads, ground faults, and other programmable conditions.

The EntelliGuard-E circuit breakers are available in 800 ampere, 1,600 ampere, 2,000 ampere, 3,200 ampere, 4,000 ampere, and 5,000 ampere ratings. These values represent the maximum continuous-current rating of each frame.

Circuit breakers may be equipped with a combination of accessories and interlocking devices.

Figure 1-8 EntelliGuard E frame 2 circuit breaker

- The **network interlock** accessory selectively prevents the closing of specific circuit breakers in the electrical distribution network. The CPU sets and resets network interlock devices remotely while continuously monitoring their status. For example, in a double-ended substation, these devices could be used to interlock the main and tie circuit breakers to prevent connecting two unsynchronized power sources.
- The **bell alarm lockout** accessory prevents a circuit breaker from closing after receiving a trip command from the EntelliGuard Messenger. Closing of the circuit breaker is permitted only after the lockout is reset manually at the front of the circuit breaker.

For more information, see the following EntelliGuard-E Circuit Breaker Instruction Books:

- DEH-41526 EntelliGuard Power Circuit Breakers 800-5,000A Frames, 240-600Vac Users Guide

1.7.3 Current transformers

Current transformers (CTs) are sensors that measure current. Each circuit breaker requires input from three CTs (one per phase) and an optional neutral CT. Unlike traditional switchgear, this single set of CTs provides the necessary current sensing for all needs including protection, metering, and control.

The CTs are attached to the power bus behind the circuit breaker in the circuit breaker compartment. Only Entellisys CTs may be used with the Entellisys system.

CTs either come in a 3-pack (shown in Figure 1-9) or as single CTs.

Figure 1-9 CT 3-pack

1.7.4 Potential transformers

Potential or voltage transformers (PTs) are sensors that measure voltage. Unlike traditional switchgear, only the main (or source) circuit breakers in the system require PTs. This hardware and wiring reduction is possible because of the central processor architecture and the sampling synchronization maintained by the system.

Three PTs, one for each phase, are required on the main circuit breakers in the system. The remaining circuit breakers reference one circuit breaker with physical PTs and use that source's voltage readings for metering calculations. This source reference may change as the system topology changes.

The PTs are located outside the circuit breaker compartments in auxiliary compartments.

Figure 1-10 Entellisys PT

1.7.5 EntelliGuard Messenger

The EntelliGuard Messenger electronic device provides the interface between the circuit breakers and the CPUs in the Entellisys system.

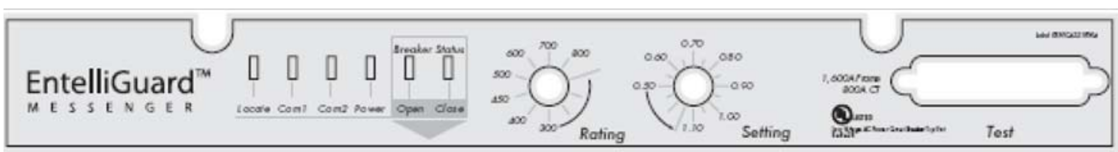
The following is a summary of the Messenger's functionality:

- Digitizes all switchgear signals
- Communicates the raw samples to CPUs via the Messenger network
- Controls the circuit breaker
- Performs independent backup trip capability at all times
- Powered by dual 120v control power sources or self-powered from the current sensors
- Provides LED illumination of circuit breaker status, power status, communication status, and GE "Locator" information
- Provides seal-able switches to set CT rating, and (long time) multiplier setting
- Provides a test connector for trip curve testing using the Entellisys System Test Kit

1.7.5.1 Messenger User Interface

The Messenger User Interface, as show in Figure 1-11, is described below.

Figure 1-11 Messenger front



LED Indicator Lights

- **Locate**: LED blinks for 10 or 30 seconds on command from the HMI to help operator physically locate a circuit breaker in the switchgear lineup.
- **Com1, Com2**: Illuminates when Ethernet communication is plugged in and ready to communicate.
- **Power**: Illuminates when either Control Power A or Control Power B sources are powering the messenger.
- **Circuit Breaker Status Open**: Illuminates when the circuit breaker is Open. This sensor is independent of the circuit breaker Close sensor.
- **Circuit Breaker Status Closed**: Illuminates when the circuit breaker is Closed. This sensor is independent of the circuit breaker Open sensor.

Switches

- **Rating**: Ampere rating of the circuit in use. Maximum value is the CT Rating.
- **Setting**: Multiplier setting for Long Time Overcurrent Protection, specified as X times the Rating switch value.

Rating Label

- **Frame**: Circuit breaker rating, in Amperes, represents the maximum continuous-current rating.
- **CT**: Maximum Ampere rating of the CTs.

Test Connector

Connection point between the Entellisys System Test Kit and the Messenger.

Figure 1-12 EntelliGuard Messenger

The Messenger is located directly above the circuit breaker compartment.

1.7.5.2 Active Health Monitoring

The Entellisys Messenger actively monitors critical internal circuits which is displayed on the HMI in the **System Health** screen. The HMI can also annunciate alarms on the following circuits:

- Communications channels A and B
- Control Power channels A and B
- Ibutton health
- Flux Shifter circuitry

Alarm Annunciation

User configured alarms can be configured at the HMI to annunciate locally, send auto-generated email or programmed to energize an annunciator light (discrete I/O required). (see Alarms on page 101).

The Messenger health alarms that can be configured are:

Flux Shifter Alarm

Messengers with hardware revision 5 and beyond, have a monitoring circuit which monitors the Flux Shifter circuitry to ensure that it is armed and capable of tripping the breaker.

NOTE: This circuitry does not monitor the Flux Shifter coil or the electrical/mechanical connections between the Messenger and the coil.

Compartment ID Button Missing

Indicates that the compartment ID button is either missing, damaged or not installed correctly. (See Compartment ID button on page 34).

Messenger Communication Lost

Each Messenger has redundant Ethernet channels (Ethernet channels 1 and 2). This alarm indicates that either comm 1, comm 2 or both channels have stopped communicating to the default CPU.

Redundant CPU Messenger Comm Lost

Similar to the Messenger Communication Lost alarm above except it monitors the comm on the redundant CPU.

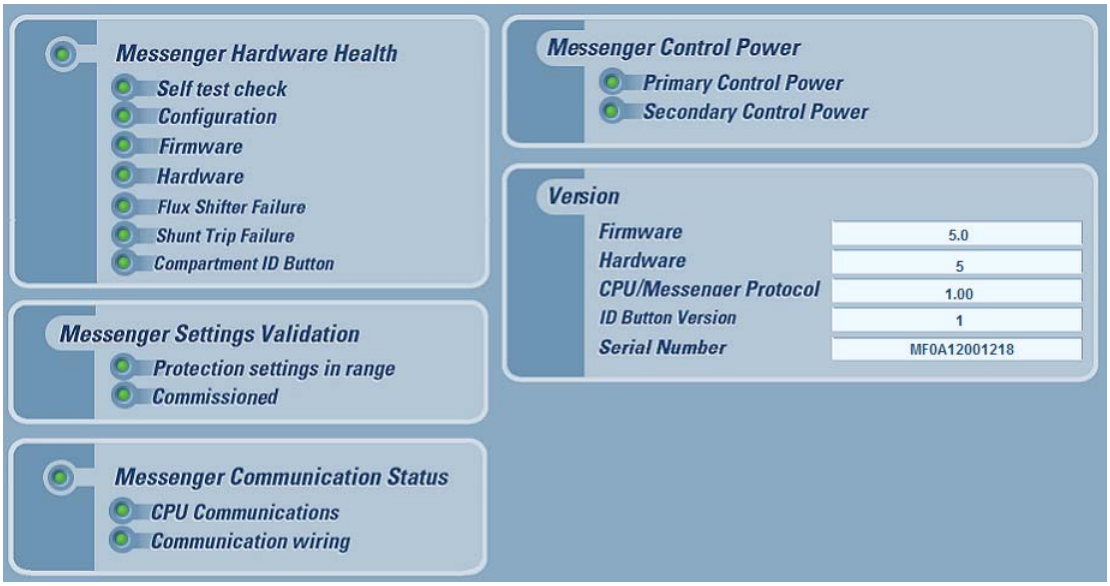
Messenger Control Power Lost

Each messenger is powered by redundant 120V sources. This alarm indicates that source A, source B or both sources are down.

Viewing the Breaker Health

At the HMI, the breaker health screen (Figure 1-13) can be selected by clicking on any breaker from the **System Health** screen.

Figure 1-13 EntelliGuard Messenger Health Screen



1.7.6 Compartment ID button

The Compartment ID button stores compartment configuration information in non-volatile memory. It informs the system about the circuit breaker residing in the cubicle.

The Compartment ID button is shipped inserted into the EntelliGuard Messenger, tethered to the equipment, and does not require any user interface during normal operation. It remains within the switchgear cubicle at all times.

WARNING! Compartment ID buttons are set at the factory and are not interchangeable between compartments. Failure to utilize the correct compartment ID button can result in personal injury and damage to equipment.

The ID button provides the system with necessary information such as circuit breaker frame size, CT size, and overcurrent protection capabilities as follows:

- Ground fault protection always on
- Ground fault protection always off
- Ground fault protection switchable (enabled/disabled) in the HMI

If the ground fault protection options need to change, a replacement ID button must be ordered (GE CAT# ETSCOMPID).

Figure 1-14 Compartment ID Button un-tethered from switchgear

1.7.7 Messenger communications network

The Messenger communications networks are closed, dedicated LANs for transmitting information between the Messengers and the CPUs in the system. The LANs are for the Entellisys system only and should never be connected to other networks.

CAUTION: Failure to maintain a dedicated LAN will result in the EntelliGuard Messenger reverting to back-up Overcurrent protection.

A Messenger switch is required to route information appropriately. The communication wiring required is 100BaseT, CAT5 cables.

Each CPU resides on a separate network, providing redundant communications.

1.7.8 Messenger switch

The Messenger switch enables the communication network between the Messengers and corresponding CPU. A Messenger switch is required for each of the two redundant networks. The number of ports provided is determined by the number of circuit breakers in the system. Each circuit breaker requires its own port in the switch.

The largest switch provides only 24 ports. If the number of circuit breakers in the system exceeds 22, a pyramid switch scheme, utilizing multiple switches, is required.

1.7.9 CPU

The CPU is a rack-mount industrial computer running a real-time operating system. The CPU provides the processing capability to support all switchgear functions. Two redundant CPUs (CPU A and CPU B) are used per lineup, supporting up to 30 circuit breakers.

The CPUs run simultaneously. If one CPU has an issue, the other continues to run providing redundancy. One CPU should be running at all times to maintain the highest level of protection. In the event that the Messenger-to-CPU communication network is down or power to the CPU is not available, the EntelliGuard Messenger will provide back-up overcurrent protection functionality.

The redundant CPUs are synchronized by a common connection to a synch clock. Each CPU has a slot for synch clock, although only one synch clock is used per system. The synch clock is programmed for either 60 Hertz or 50 Hertz frequency operation.

Each CPU has two slots for optional discrete I/O cards.

Figure 1-15 Redundant CPUs with synch clock connection

1.7.10 Synch clock

To maintain system synchronization, a mechanism exists to provide a single sampling time source. This time source is provided on a separate hardware card, called the Synch Clock. The Synch Clock sits in CPU A and has a connection to CPU B.

In the event of an issue with the Synch Clock or its connections, the CPUs fall-back to software synch functionality. When this occurs CPU A maintains full functionality. As time drifts, CPU B may suspend advanced multi-source protection and may not be able to provide metering information for the circuit breakers without PTs. If CPU A is powered down to provide maintenance, CPU B will continue to run all functions.

1.7.11 Discrete I/O

The discrete I/O equipment provides programmable input and output logic for customer-specific requirements.

Examples include the following:

- Sound a horn when a circuit breaker is open
- Trigger an output when voltage exceeds a value

The redundant discrete I/O option provides signal processing to/from either CPU. One CPU (the Master) processes the information and responds. The other provides a backup of the Master fails. Redundant discrete I/O is recommended if any of the signals are critical to the operation of the system. Critical I/O examples include the following:

- Inputs to automatic throw-over schemes
- Inputs that must trip circuit breaker (such as high transformer pressure)

For more information on discrete I/O, see Discrete I/O on page 257.

1.7.11.1 Discrete I/O cards

The input and output signals from the CPU are transferred through the discrete I/O cards. Each card supports 64 bi-directional points that range from 0 to 5 volts. A maximum of two cards may be inserted for a total of 128 I/O points. The cards come installed in the CPU upon purchase.

1.7.11.2 Discrete I/O cable

This cable connects the discrete I/O card to the terminal block. Each cable transmits 64 I/O points.

1.7.11.3 Terminal block

The terminal block accepts 64 I/O signals from the discrete I/O card through a single cable and breaks out the individual signals into 64 terminals for wiring.

1.7.11.4 “OR” boards

These boards are only required for redundant discrete I/O. The output signals from both CPUs must be “Horde” together, between the terminal blocks and the relay blocks, to prevent increased voltages from damaging the relays. Each “OR” board supports 16 output signals.

1.7.11.5 Relay blocks

The relay blocks hold solid state input and output relays (16 per block).

Relay blocks are configured as all inputs or all outputs. Unused discrete I/O points may have relays left off.

1.7.11.6 Relays

The input relays transform the customer input (120 Vac or 24-125 Vdc) to 5V inputs for the Entellisys system.

The output relays are either opened or closed based on programmable logic in the Entellisys system.

1.7.11.7 Discrete I/O customer interface wiring

The customer interface to the discrete I/O is provided at the I/O module relay blocks. These relay blocks and the customer wire termination points are mounted in the discrete I/O cubicle and are accessed from the front of the switchgear. Control conduits are terminated in the rear cable compartment and the discrete I/O wiring is routed to the front of the switchgear through an opening in the discrete I/O cubicle rear barrier.

1.7.12 System interface Ethernet communication network

The system interface Ethernet communication network is a 10/100 Mbps Ethernet LAN that provides an interface into the Entellisys system for systems such as the Entellisys HMI, SCADA systems, building automation, HVAC systems or other. The system interface Ethernet communication network provides information and control of all circuit breakers in the system. The external communications network will use 100BaseT (copper twisted pair) CAT5 or better cabling. A fiber optic connection is available as an option.

1.7.13 System interface Ethernet switch

The interface between the Entellisys system and the external world is through the system interface Ethernet switch, an industrial hardened 10/100 Mbps Ethernet switch. An 8-port copper model is standard. Optionally customers may choose a 9-port model with an additional fiber port for external gear communication. The fiber port supports 100FL connections only.

Figure 1-16 Ethernet switch, 8-port

1.7.14 Touchscreen HMI

The system interface for the Entellisys switchgear will be through one or more touchscreen computer displays. The display is driven by a separate computer and communicates to the CPUs through an Ethernet connection. The System Interface Ethernet Switch provides the physical interface.

The HMI communicates primarily with one of the CPUs but can switch to the other in event of a failure. Functionality provided by the HMI includes:

- Programmable user login to grant/deny access to specific features
- Animated one-line that shows the current status of the entire system
- Circuit breaker status, circuit breaker control
- Metering, demand logging, harmonics
- User settings for overcurrent protection, relay protection, advanced multi-source protection. This may be writable or read-only depending on permissions granted.
- Customer-specific discrete I/O programming and status
- Customer-specific control scheme programming and status
- Sequence of events
- System health – showing the health of the Entellisys equipment
- Alarm panel – setup, panel status, e-mail configuration for alarms

NOTE: The HMI is not critical to the protection functionality of the system. The HMI can be brought down for service with no loss of protection in the system.

1.7.14.1 In-gear HMI

Typically a touchscreen HMI is installed in the switchgear. This is deemed an “in-gear” HMI.

A redundant in-gear HMI is available as an option. The redundant HMI is also a touchscreen HMI located in the gear.

1.7.14.2 Near-gear HMI

Optionally, a touchscreen HMI may be installed near the switchgear equipment, but away from the hazardous arc flash zone. This can be in a separate stack or in a wall-mount box up to 250 feet from the switchgear. This is deemed a “near-gear” HMI.

1.7.15 Remote HMI

The Entellisys system offers remote access to the switchgear with the same HMI software installed in the gear. The remote HMI software can be installed on any Windows 7 or later computer and requires an Ethernet connection to the switchgear. The Ethernet connection is connected to the system interface Ethernet switch.

Two versions of remote HMI are offered:

- User Interactive

  Permissions are programmable and can be set for full Administrator access down to Guest access.

- Viewer

  Allows read-only access to the system.

1.7.16 VPN firewall device

Virtual Private Network (VPN) firewall device provides business-class network security providing Denial of Service (DoS) protection and intrusion detection using Stateful Packet Inspection (SPI), URL access and content filtering, logging, reporting, and real-time alerts. Up to eight users can access the system simultaneously.

It is strongly recommended that anytime an Entellisys system is connected to the Ethernet LAN, a VPN firewall be installed to protect the Entellisys system from network threats.

For more information, see Network security/VPN device on page 63.

1.7.17 Control power

Control Power is 120 Vac, 50 and 60 Hz only. Uninterruptible power is provided standard with each system. The control power scheme is specific to each installation and constructed from standard elements using defined practices for Entellisys control power distribution.

1.7.18 UPS

Two Universal Power Supplies are installed in the switchgear to provide backup power to the control power network. The UPSs are powered from the primary power buses (utility or generator) and are redundant.

The UPS serves all 120 Vac control power network devices. It does not power the charging motors of electrically operated circuit breakers.

For more information on the Control Power Network, see Control power and UPS configuration on page 25.

1.7.19 UPS to HMI connection

The Entellisys system provides event/alarm/e-mail information when the UPS A has gone on battery backup and when the batteries are low. When the batteries are low, the HMI safely shuts down to avoid abrupt power interruption. To enable this communication, a link between UPS A and the primary touchscreen HMI is established. This link is a serial connection between the DB-9 serial port connection on the UPS and a serial port connection on the HMI. Since distances between the HMI and UPS may exceed serial cable distances, a pair of RS-232 to RS-485 converters are installed at each end to accommodate the cabling distance through the switchgear.

1.7.20 RS-232 to RS-485 converter

This device converts RS-232 signals to RS-485 signals. This is required to support the cable lengths in the switchgear. RS-232 imposes a distance limitation of only 15 meters. RS-485 can transmit data over distances up to 1.2 km.

1.7.21 Entellisys System Test Kit

The Entellisys System Test Kit is a portable test instrument designed for field testing of the Entellisys Low-Voltage Switchgear system.

The test kit includes the following features:

- Simulate power-line characteristics for a single circuit breaker in the Entellisys Low-Voltage System
- Verify the function/operation of the protection system
- Overcurrent protection tests – long time, short time, instantaneous and ground fault protection tests
- Single-point relay protection tests (overvoltage, undervoltage, over frequency, under frequency, power reversal and phase loss, high current test)
- Verify the calibration of the trip time current curve
- Verify the operation of the circuit breaker actuation in “Trip mode”
- Perform tests without trips in “No Trip mode”
- Ground Fault Defeat function provides temporarily suspension of all ground fault protection in the system
- Automatically retrieves system configuration for increased productivity
- Displays a summary of all protection configuration
- Saves test results to be reviewed later
- Windows Interface for ease of use
- Operation from 120 Vac

For more information, see DEH-503 Entellisys Low Voltage Switchgear System Test Kit User Manual.

1.7.22 Clamp circuit

The clamp circuit is an intermediary device between the CTs with 150ampere and 400ampere ratings on EntelliGuard breakers only. The clamp circuit protects the Messenger from large current outputs from the CTs. The clamp circuit is installed in the circuit breaker compartment on the left-hand side sheet.

2 System Administration

2

2.1 System administrator roles and responsibilities

The Entellisys™ Low Voltage Switchgear system requires a System Administrator for oversight of critical functions. Those critical functions are described in this guide.

The following chapters describe how to perform the functions, in detail.

2.1.1 Security Champion

The most important role of the System Administrator is to control the access to the system. There are several forms of access:

- HMI Login Access: Entellisys provides programmable permissions and passwords. The System Administrator determines who needs what permissions and assigns login names and passwords.
- Modbus® Settings and Control Access.
- Remote Access to the Switchgear over a company network.

Security Reminders

- Limit the access level handed out to only the required permissions.
- Stress the importance of keeping passwords secret.
- If you believe passwords have been compromised, change them immediately.
- Always log out before leaving the local HMI, or leave the system logged in as Guest. Alternatively, the switchgear can be configured to automatically log out after a time period. (For details, on the **Main Menu**, click **User Settings**, and then click **HMI Preferences**.)

2.1.2 System Maintenance

The System Administrator is also responsible for system maintenance as described in this document.

2.2 View and update circuit breaker accessories

The HMI displays the circuit breaker status for each circuit breaker in the system. To display the proper circuit breaker status, the installed accessories must be known.

The following is affected by the installed accessories:

- Breaker Racking Position status is available only if the position switch accessory is installed.
- Electrically Locked Out status is available only if either the Bell-Alarm or Network Interlock accessory is present.
- Closing Spring Status is available only if the Electric Operated accessory is present.

Additionally, the Breaker Control relies on the electric operated circuit breaker accessory. The remote control functions will be limited by the presence of the electrically operated accessory.

The following functions in the HMI Breaker Control are affected:

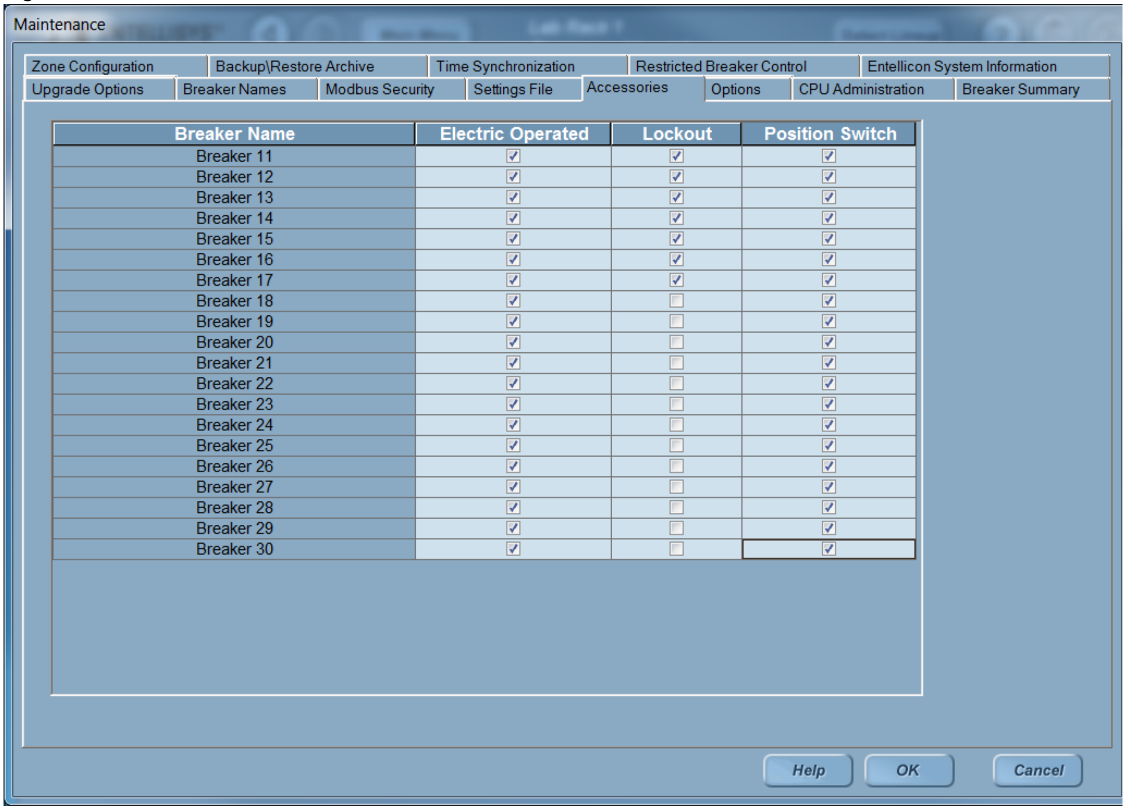
- Open Breaker function is displayed only if the electrical operated accessory is present.
- Close Breaker function is displayed only if the electrical operated accessory is present.
- Trip Breaker is NOT affected.

GE configures the proper circuit breaker accessories upon shipment of the switchgear. However, if the accessories change or if different circuit breakers are exchanged, the accessories must be updated, otherwise the status might not be correct.

To view or change the circuit breaker accessories

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Accessories** tab. A table will display as shown as in Figure 2-1.

Figure 2-1 Breaker Accessories screen



- **Breaker Name**: Unique name given to a circuit breaker.
- **Electric Operated**: Accessory allows the circuit breaker to be opened, closed, and charged remotely. The check box should be selected if this accessory is present.
- **Lockout**: Circuit breaker contains either a bell alarm lockout accessory to prevent reclosing after tripping, or a network interlock accessory to prevent closing during automatic throw over. The check box should be selected if this accessory is present.
- **Position Switch**: Circuit breaker contains an accessory that provides remote monitoring of the position of the circuit breaker during rack-in and rack-out. The check box should be selected if this accessory is present.

3. Click the **OK** button to keep changes (or click **Cancel** to exit the screen without saving).

2.3 Pre-programming settings prior to switchgear arrival

Entellisys provides a method for users to work on the system settings before the switchgear arrives. Once the gear is installed and control power is applied, the saved settings can be written to the system.

To pre-program Settings, the "Entellisys Remote HMI – User Interactive version" must be purchased. GE will ship the Remote HMI software, System Administrator Manual (this manual), and a System Archive when the switchgear ships from the factory.

The following steps should be performed to begin pre-programming:

- **Step 1**: Install the "Entellisys Remote HMI – User Interactive version" software.

  See Remote HMI Software on page 19 for instructions.

- **Step 2**: Install the System Archive provided by GE.

  See Restore an archive on page 52 for instructions.

- **Step 3**: Change to Offline Mode.

  See Offline mode on page 47 for instructions and for offline mode capabilities.

- **Step 4**: Set User Settings.

  See Overcurrent protection on page 135 for settings.

- **Step 5**: Install and Commission the Switchgear.

  See Commissioning the switchgear on page 46 for instructions.

- **Step 6**: Configure the System for Remote Communications.

  See Establishing communication to Remote HMIs on page 58 for instructions.

- **Step 7**: Write saved Settings to System.

  See Write settings to a live system on page 49 for instructions.

2.4 Commissioning the switchgear

Installing and starting up the switchgear is an important event for the System Administrator. The following steps must be followed when commissioning the switchgear.

- **Step 1**: Reset Passwords.

  See HMI Preferences on page 87.

- **Step 2**: Set User Settings.

  See Overcurrent protection on page 135 for settings.

- **Step 3**: Set Local HMI flags.

  See HMI Roles on page 112.

- **Step 4**: Set System Time Synchronization.

  See Time synchronization on page 95.

- **Step 5**: Configure System for Remote Communications.

See Establishing communication to Remote HMIs on page 58.

2.5 Settings files and offline system configuration

All system settings are recorded locally in “Settings” files. These files are updated each time a setting is modified and automatically updated every 30 minutes.

NOTE: Both CPUs must have the same configuration and settings at all times, otherwise unpredictable system behavior could occur. Every 30 minutes the system compares the settings between the CPUs. If a mismatch in settings between CPUs does occur, an event will be generated. A mismatch should be correctly immediately.

2.5.1 Offline mode

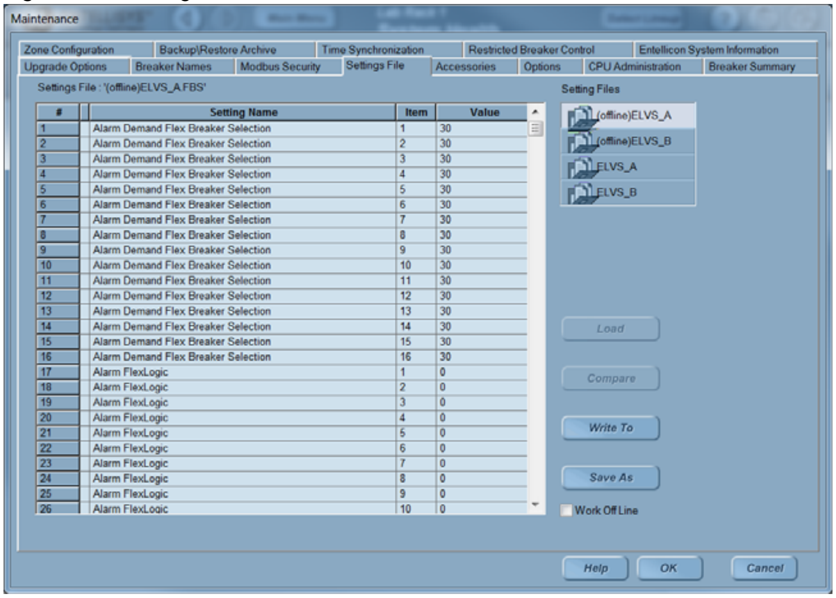
The HMI has a special offline mode. Offline mode disconnects the HMI from a live system and allows users to modify and save settings. Later, once reconnected to a live system, these saved settings can be written to the system.

The following operations are permitted in offline mode:

- User Settings activities
- Maintenance activities
- User Administration

Another convenience offline mode provides is the ability to work on protection settings prior to the arrival of the switchgear. See Commissioning the switchgear on page 46 for more details.

Figure 2-2 Settings File screen



To enable or disable offline mode

1. On the **Main Menu**, click the **Maintenance** button. The button will only display if Maintenance access is allowed with the current login permissions.
2. On the **Maintenance** screen, click the **Settings File** tab.
3. Select the **Work Offline** check box to change to offline mode. This can be found in the lower right-hand corner of the Settings tab, see Figure 2-2.
    - Checked: HMI will go into offline mode and disconnect from the live system.
    - Unchecked: HMI will connect to the live system.

   A message on the status bar will indicate that the application is in offline mode.

   The first time offline mode is enabled, a new set of settings files will be created as follows: **Offline(ELVS_A).fbs** and **Offline(ELVS_B).fbs**.
4. Click **Load** to ensure the desired files are loaded for offline work. If the Load button is grayed out, the highlighted file is already loaded.

NOTE: If the state of the offline settings files is unknown, it is recommended to reset the offline settings files to the current settings. See Reset the offline settings files to the current settings on page 50.

Changes made during offline mode

- User Settings and Maintenance changes are automatically saved to the active settings file loaded.
- User Administration changes can be viewed under User Administration only.

2.5.2 View and compare settings files

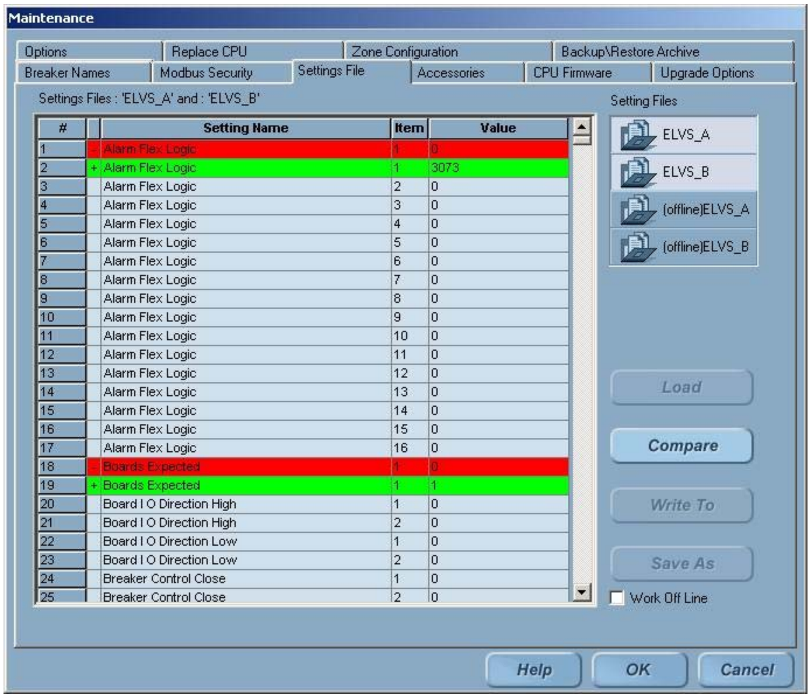
The HMI can display the settings associated with a particular settings file. To view any settings file, click the filename in the right-side pane, click **Load**, and the settings will display.

As mentioned in Chapter 2, it is important to keep the settings in both CPUs consistent. The HMI can compare two settings files and highlight differences.

To compare two settings files

1. On the **Main Menu**, click the **Maintenance** button. The button will only display if Maintenance access is allowed with the current login permissions.
2. On the **Maintenance** screen, click the **Settings File** tab.
3. Select two files to compare (e.g., **ELVS_A** and **ELVS_B**). To select two files, hold down the **Shift** key and click both file buttons. Once two files are selected the compare button will be enabled.
4. Click the **Compare** button. The differences between the two files will be highlighted.

Figure 2-3 Settings file compare screen



2.5.3 Write settings to a live system

To make the offline settings permanent in the live system

1. On the **Main Menu**, click the **Maintenance** button. The button will only display if access is allowed with the current login permissions.
2. On the **Maintenance** screen, click the **Settings File** tab.
3. Verify the HMI is connected to the system (clear the **Work Off Line** check box).
4. Select the offline settings to download. Once selected, the settings values will display on the screen.

5. Click **Write To**. The screen in Figure 2-4 will display.

Figure 2-4 Write Settings screen

6. Select the CPU name to and click download.

   A Red CPU indicates that it is not currently communicating and cannot be written.

NOTE: It is recommended that users only perform Write To when both CPUs are communicating to avoid a mismatch in settings when the second CPU starts communicating.

---

7. Click the **Write** button to send the settings to the selected CPU.
8. Repeat steps 5 to 7 for the second CPU.

2.5.4 Reset the offline settings files to the current settings

It may be desired to reset the offline settings files to the current settings.

To copy current settings to the offline settings files

1. On the **Maintenance** screen, click the **Settings File** tab, and then select the settings to copy.
2. Click the **Write To** button.
3. Select the offline files as the device to write to.
4. Click the **Write** button.

2.6 System archive

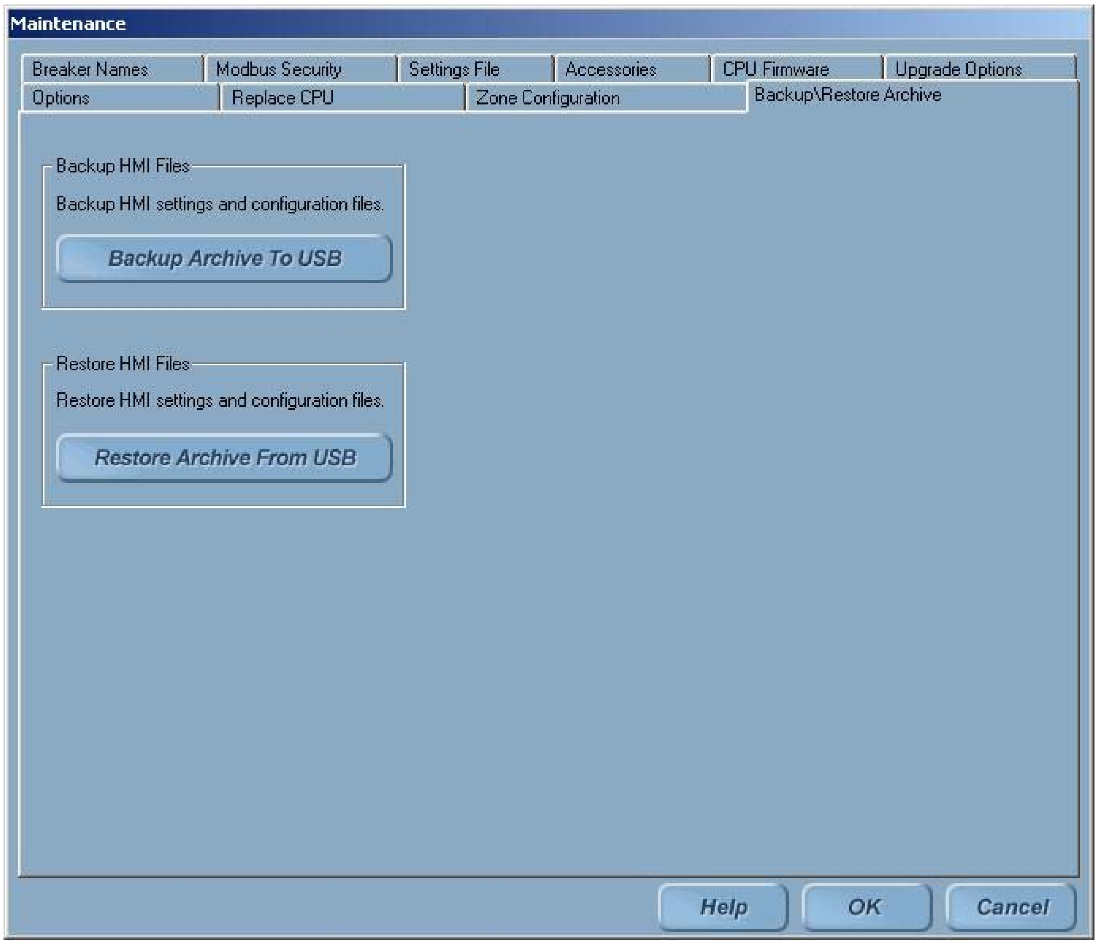
A System Archive is a snapshot of the system's custom screens, configuration, and optionally the event logs, fault reports, and waveforms. The archive is used to reconfigure a system, putting it back to a known state. It is important to have a valid System Archive at all times.

An archive is created and shipped to the System Administrator when the switchgear ships from the factory. The archive may be installed in a Remote HMI application allowing users to pre-program protection settings prior to the switchgear arrival.

Archives are recommended at the following events:

- At switchgear startup, once the system settings have been programmed and tested.
- Periodically throughout the life of the switchgear – for example prior to summer shutdown each year.

Figure 2-5 Archive screen



2.6.1 Restore an archive

To install or restore an archive from a USB flash memory device

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Backup/Restore Archive** tab.
3. Click **Restore Archive From USB**. The system will search for an active USB drive. If not found, a dialog box stating "Can't find any USB drive" will display.
4. Select the directory where the Archive is located. An example of an Archive Directory is as follows: ELVSArchive_12212004_180230. The directory name contains the date and time the archive was taken.
5. Once a valid Archive directory is selected, the Restore button will be enabled. Click the **Restore** button.
6. A confirmation dialog box will display. Click **Yes** to proceed.
7. The Archive is now restored. Click the **Close** button to exit. The system will automatically eject the USB device.
8. Click the "**Settings File"** tab and select "(offline)ELVS_A"
9. Click "Write **To"** button and select "CPU A" and finally click the "**Write**" button
10. Repeat for CPU B
11. Click on the **General** button (**Main Menu/User Settings/HMI Preferences**) and click update CPU and restart the HMI

The following files are restored in the process:

- Setting Files
- Multi-point Configuration and Breaker Settings
- One Line, Elevation Files, and Control Panel screen files
- Event Logs (optional)
- Fault Reports (optional)
- Waveforms (optional)

2.6.2 Create an archive

To create an archive and save it to a USB flash memory device

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Settings File** tab and select "ELVS_A" and click "Load"
3. After it's done, click "Write To" and select "(OFFLINE) BOTH CPUs" and click the "Write" button
4. Click the **Backup/Restore Archive** tab.
5. Click the **Backup Archive to USB** button.
6. Select the files to backup in the **Archive Files Selection** dialog box as in Figure 2-6.

NOTE: The log files may be very large in size and are not required to recreate a system. It is recommended to clear all three log files.

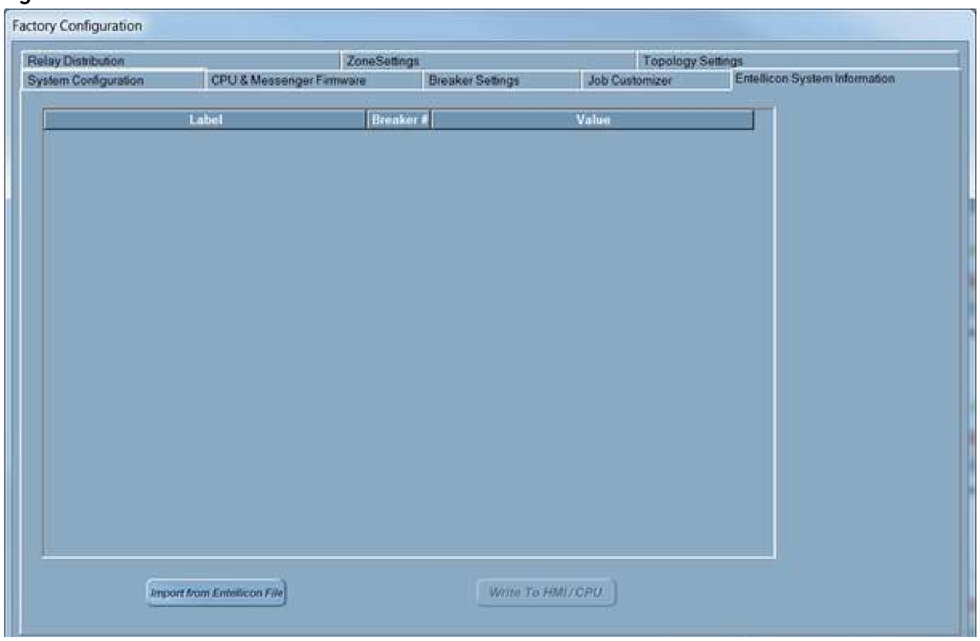
Figure 2-6 Archive File Selection screen

7. Once the desired files are selected, click **OK** to proceed (or click **Cancel** to exit).
8. Insert the USB flash memory device into the USB port.
9. Select the USB drive. Once a valid drive is selected, the Backup button is automatically enabled.
10. Select the folder where you want the archive to be created.
11. Click the **Backup** button. A subfolder with the current date and time stamp is automatically created. On successful completion of the backup, a message will display: "Backup has been taken in the following directory <subfolder name>. Please Close the dialog".

2.7 Entellicon Download

The Entellicon System Information is for use by an authorized GE field engineer to make changes to the configuration of the switchgear. Functionality on this tab is intended to be used by a trained GE field engineer or a trained Entellisys system administrator in conjunction with GE post sales service.

Figure 2-7 Entellicon Download screen



WARNING! Unauthorized changes might negatively affect normal operation of the Entellisys switchgear. Please call post sales service to request changes that are required.

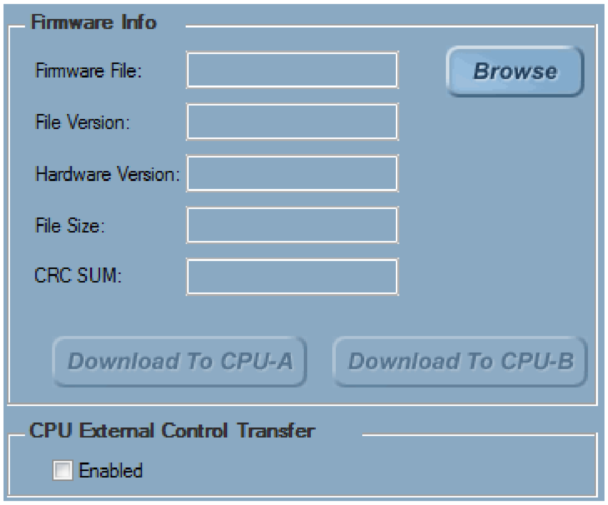
2.8 CPU Administration

The HMI provides a tool to change the CPU IP address and upgrade firmware. See CPU IP Address on page 59 for IP address configuration

CAUTION: Downloading new firmware to a CPU will erase all previous settings in the unit. See Write settings to a live system on page 49 for instructions on restoring CPU settings.

NOTE: Both CPUs must have the same firmware version loaded.

Figure 2-8 CPU Firmware Download screen



To download new firmware to the CPUs

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **CPU Administration** tab.
3. Click the **Browse** button to select a CPU firmware file.
4. Locate the CPU firmware (ELVS_CPU.BIN) file and click the **Open** button.
5. If the selected file is valid, the Firmware Info will display and **Download to CPU A** and **Download to CPU B** buttons will be enabled. Click the corresponding button for the CPU to download the firmware.

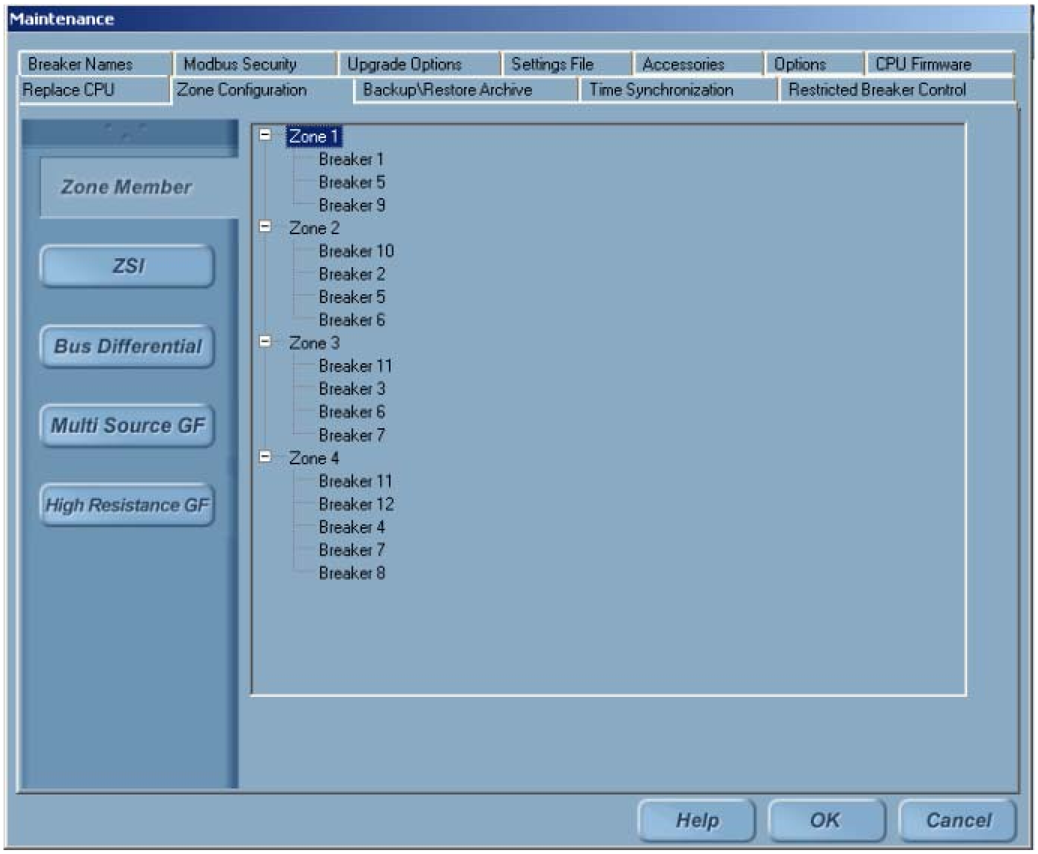
2.9 View zone configuration

The Zone Configuration screen gives an overview of the global zone configuration for each protection function (Multi-Source Ground-Fault Relay, Bus Differential Relay, Zone Selective Interlockand the PT Throw-Over function.

Zone configuration is typically done by a GE factory technician before the system is shipped, and no additional configuration is necessary unless the switchgear line-up changes (e.g., a new breaker is added).

See Zones, buses, and topologies on page 191 for details.

Figure 2-9 View Zone configuration



2.10 CPU Replacement

This procedure should be performed by GE factory services.

NOTE: At least one CPU must be working. Factory must generate a new option string with the serial number of the new CPU. The new option string must be present before starting this wizard - which can either emailed or a USB must be shipped from the factory.

If both CPUs are down, GE Factory services must be called to restore CPUs

Contact GE Post Sales Service (1-888-437-3765) at entellisys.lvs.pss@ge.com.

2.11 Establishing communication to Remote HMIs

The Entellisys system can be configured to communicate with up to 4 remote HMI PCs and 4 local HMI kiosked touchscreen computers. The HMIs and CPUs all communicate through TCP/IP, and by default, these devices are configured with IP addresses that work together on the local network but will not communicate over a building network.

In general there are two methods to configure a Remote HMI workstation

- **A separate dedicated network**: A second network card is installed in the Remote HMI PCs which are connected to and configured for the Entellisys Network
- **Utilize the building LAN**: The Entellisys system is configured to communicate on the building LAN

NOTE: In either case, VPNs must be installed to protect the Entellisys network from network traffic, unauthorized access and viruses. Failing to do so will put the entire system at risk!

2.12 Ethernet network addressing

The following procedure must be done at the dedicated Kiosked HMI either in or near the gear. The procedure must also be done before connecting to the building LAN. “Local” refers to Entellisys network in the gear which the HMIs or CPUs are connected.

Since Entellisys components are not DHCP-compatible, each device must be assigned a static IP addresses from the facility IT department.

The number of IP addresses required depends on the number of HMIs. The following number of IP addresses is required:

- 2 addresses for CPU A and CPU B
- Addresses for all In-Gear and Near-Gear HMIs
- 1 address for the VPN

Step 1: Reserve IP addresses.

Step 2: Re-configure the CPU IP addresses. See CPU IP Address on page 59

Step 3: Update the HMI with the new CPU IP Addresses (See Updating HMI with CPU IP address on page 61)

Step 4: Reset the local HMI IP Addresses (See Changing the local HMI IP address on page 61)

Step 5: Verify communication between the local HMIs and CPUs (See Verify local communication to CPU on page 62)

Step 6: Install and Configure a network security device such as a VPN/Firewall appliance (See Network security/VPN device on page 63)

2.12.1 Connect to the local network

Step 1: Connect the Entellisys system to the company network via the VPN/Firewall appliance in the switchgear

Step 2: Verify communication between local HMI(s) and CPUs (See Verify local communication to CPU on page 62)

Step 3: Install Remote HMIs (See Remote HMI Software on page 19)

Step 4: Verify communication between Remote HMI and CPUs

2.12.2 CPU IP Address

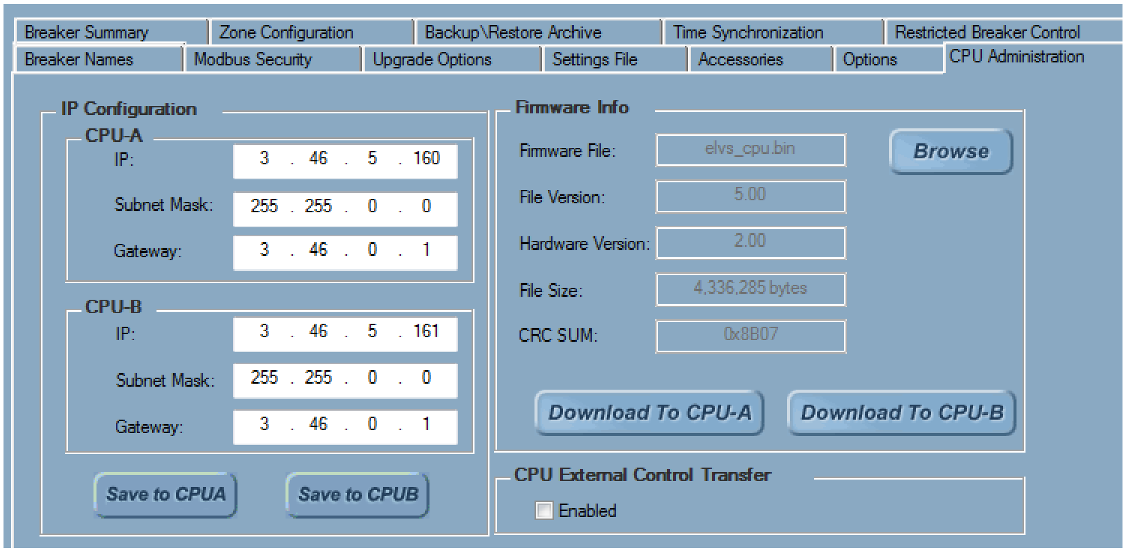
Administrator permissions are required to change the CPU IP address. Navigate to the “CPU Administration” tab from the Main menu, maintenance button. Update the IP, Subnet and Gateway fields and click “Save to CPUA or B.”

Subnet masks and Gateway addresses are required if communication is required to a different subnet. (A subnet refers to the left most digits in the address).

Care must be taken when changing the CPU IP address to avoid duplicate IPs or an incorrect IP address. Double check the IP address that you are changing before clicking “Save to CPU.” Make sure that it is on the correct subnet.

CAUTION: After changing the CPU IP address, the HMI will no longer communicate to the CPU and must be reconfigured for the new IP address. See Updating HMI with CPU IP address for more details.

Figure 2-10 CPU Administration screen



CPU IP address recovery

If, after the entire procedure above, the HMI communication to the CPU does not resume or is sporadic, then there is an addressing issue. To troubleshoot:

- Double check the IP address of the HMI: Is it on the same subnet as the CPUs?
- Disconnect any external connection - leaving only the HMI and CPUs connected: Does the HMI communicate?
- Login as an administrator to the Local HMI operating system and open attempt to ping the CPUs from a command prompt: Does the ping respond?

If the CPUs still don't respond then the IP address will need to be determined through CPU programming interface. Please contact post sales support to open a case. See How to contact us.

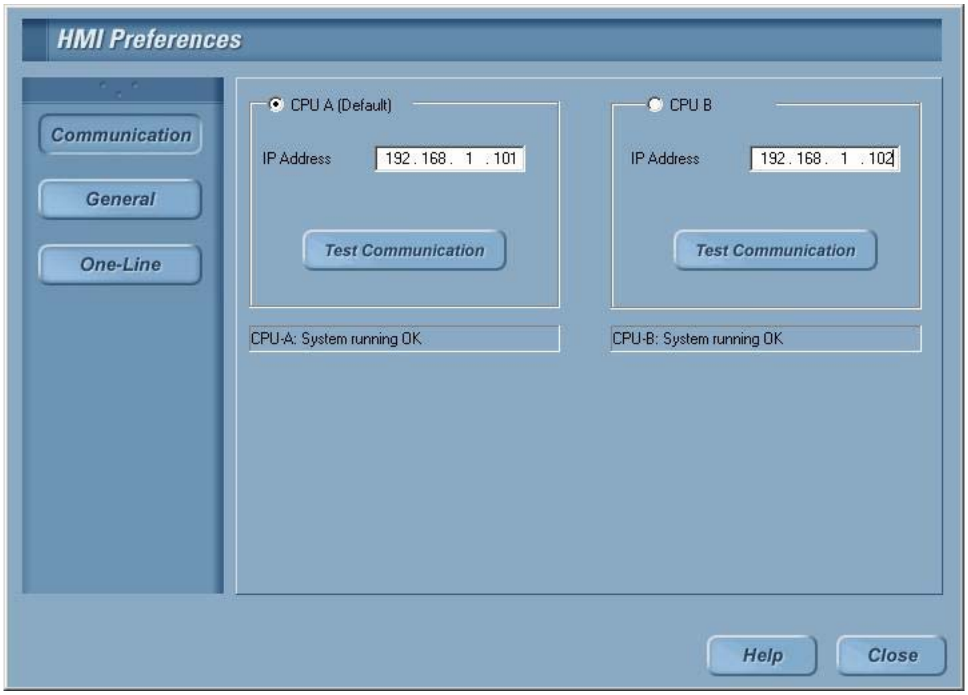
2.12.3 Updating HMI with CPU IP address

The IP address of the active CPUs must be configured in the HMI before the HMI can communicate.

To change the CPU IP addresses

1. Navigate to the **Communication tab** from the **Main Menu**, **User Settings, HMI Preferences**
2. Select either **CPU A** or **CPU B** by clicking the appropriate button.
3. Enter the new IP address. The IP address format is X.X.X.X where X is from 0 to 255.

Figure 2-11 CPU IP Address configuration screen on a Local HMI



NOTE: CPU IP address fields are read-only in the Remote HMI software. To configure Remote HMIs, see Configuring Lineups on page 108.

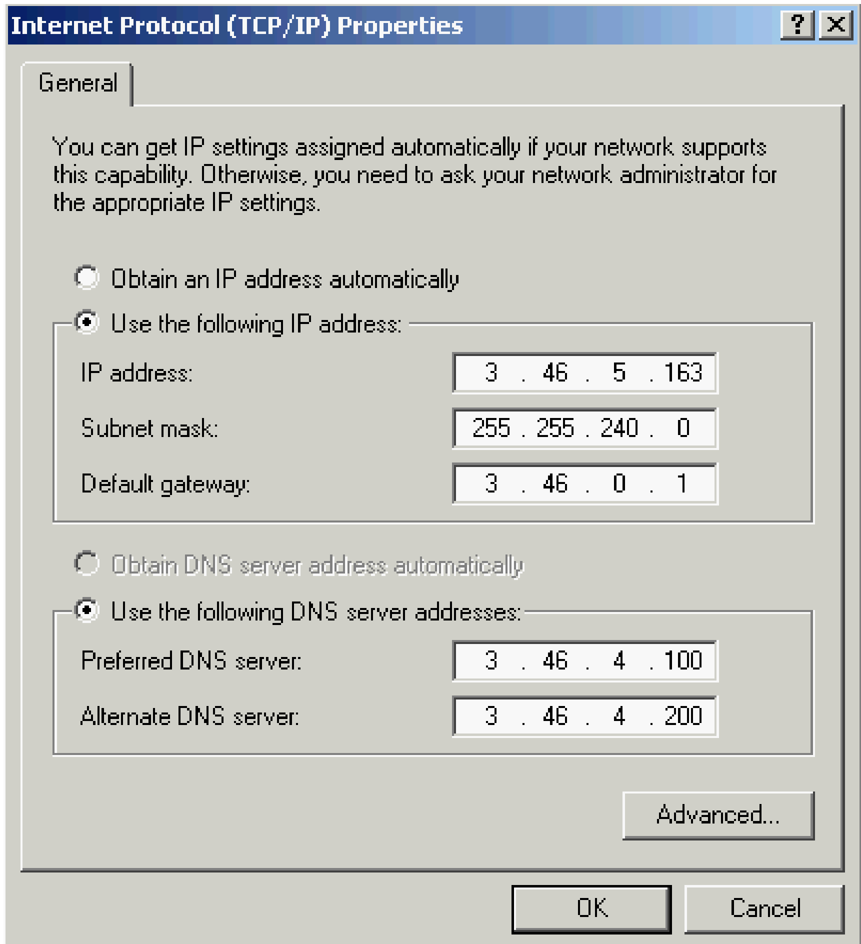
2.12.4 Changing the local HMI IP address

To change the HMI IP address

1. For the HMI touchscreen computer, login to the Operating System as Administrator. (See Administrator access to the operating system on page 64 for details)
2. Navigate to the "Change adapter settings" by opening Network and Sharing Center from within the control panel.
3. Double-click the **Local Area Connection**
4. In the **TCP/IP Properties** tab, set the new Local HMI IP address. Set the subnet mask to a value compatible with the segment on which it resides.

By default the subnet mask is set to 255.255.255.0. The default touchscreen HMI IP address is 192.168.1.1 as delivered (The default IP address for each additional touchscreen HMI is incriminated by 1 in the right-most address)

Figure 2-12 HMI TCP/IP Properties dialog box



The **subnet mask** must be compatible with the network segment on which each device resides

The **Gateway IP** depends on the company network and needs to be acquired from the Network Administrator.

2.12.5 Verify local communication to CPU

Through the HMI

1. Navigate to the **Communication tab** from the **Main Menu**, **User Settings, HMI Preferences**
2. Click the **Test Communication** button to verify the communication status with the new IP address. It will take a few seconds to establish communication with the CPU.
3. If unable to connect, a dialog box will display. Click the **Retry** button to test communication again or click **Cancel** to exit.
4. The Communication status with the new IP address will display below the IP address edit dialog box.

   For example: "CPU A: System Running OK" – Communication with new IP address is success.

"CPU B: System Unavailable" – Failed to communicate with new IP address.

Before installing the HMI

Generally, if the network and VPN/Firewall settings are correct, then the CPUs can be "pinged" utilizing the ping command that is installed with Windows.

1. Open a Dos Prompt: From the Windows Start menu, click on "Run" and type "CMD"
2. In the Dos window, type "Ping x.x.x.x" where x.x.x.x is the IP address of either CPU A
3. Repeat step 2 for CPU B

Figure 2-13 "Pinging a CPU'

```
Command Prompt

C:\>ping 3.46.5.161

Pinging 3.46.5.161 with 32 bytes of data:

Reply from 3.46.5.161: bytes=32 time=3ms TTL=63
Reply from 3.46.5.161: bytes=32 time=2ms TTL=63
Reply from 3.46.5.161: bytes=32 time=2ms TTL=63
Reply from 3.46.5.161: bytes=32 time=2ms TTL=63

Ping statistics for 3.46.5.161:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 3ms, Average = 2ms

C:\>_
```

2.12.6 Network security/VPN device

NOTE: GE requires that your Entellisys Low Voltage Switchgear system must be equipped with a VPN/Firewall device if it is connected to a LAN that is also used for other purposes or any of the Remote HMIs are also connected to a LAN. Failure to do so could result in virus attacks or unauthorized access to the control and settings functions of the circuit breakers.

In addition to the standard username and password administrative functions for Entellisys, accessibility to control functions and parameter settings must be considered from the network point of view. The provisions for securing the network on which Entellisys communicates to HMI Control Stations and other SCADA systems depends greatly on how the network over which they communicate is configured.

GE provides a mechanical mounting assembly compatible with a VPN/Firewall Appliance. Since configuration of the device is mostly dependent on the specific network architecture of the facility in which it is installed, please consult the VPN documentation for assistance in configuring this device, or contact your local IT department or network service provider.

GE recommends that the VPN/Firewall appliance be configured to only permit communications between the devices in the switchgear instrument compartment and the external devices that are intended to communicate with them.

Contact GE Post Sales Service for the latest VPN/Firewall appliance application and configuration guide. See How to contact us on page 2.

2.13 Administrator access to the operating system

Each Entellisys Touchscreen HMI computer has been configured to prevent direct access to the computer's operating system. Special user permissions are required to exit the HMI application. If exited, the only function allowed is to restart the computer.

For special cases when access to the computer is required, for the Entellisys System Administrator can login to the operating system as an Administrator. This will give the user full access to the computer. It is strongly recommended that the System Administrator limit knowledge of this ability to prevent unauthorized access.

Administrative access to the operating system of an HMI Touchscreen Computer

1. Press **Ctrl**+**Alt**+**Delete**. A Windows Security dialog box will display
2. Press the **Logoff** button
3. Constantly press the **Shift** key until the login dialog box "**Login On Windows as**" displays
4. Enter User Name as "Administrator"
5. Enter Password the Administrator password.
6. Press the **OK** button

Restarting the HMI

1. Press **Ctrl**+**Alt**+**Delete** and a Windows Security dialog box will display
2. Press the **Shutdown** button
3. Select **Restart** from the pull down and click **OK**

CAUTION: The system should never be left unattended in this state since unauthorized access could result in damage to the computer image requiring a new image to be loaded. Always restart the computer to revert to the default state.

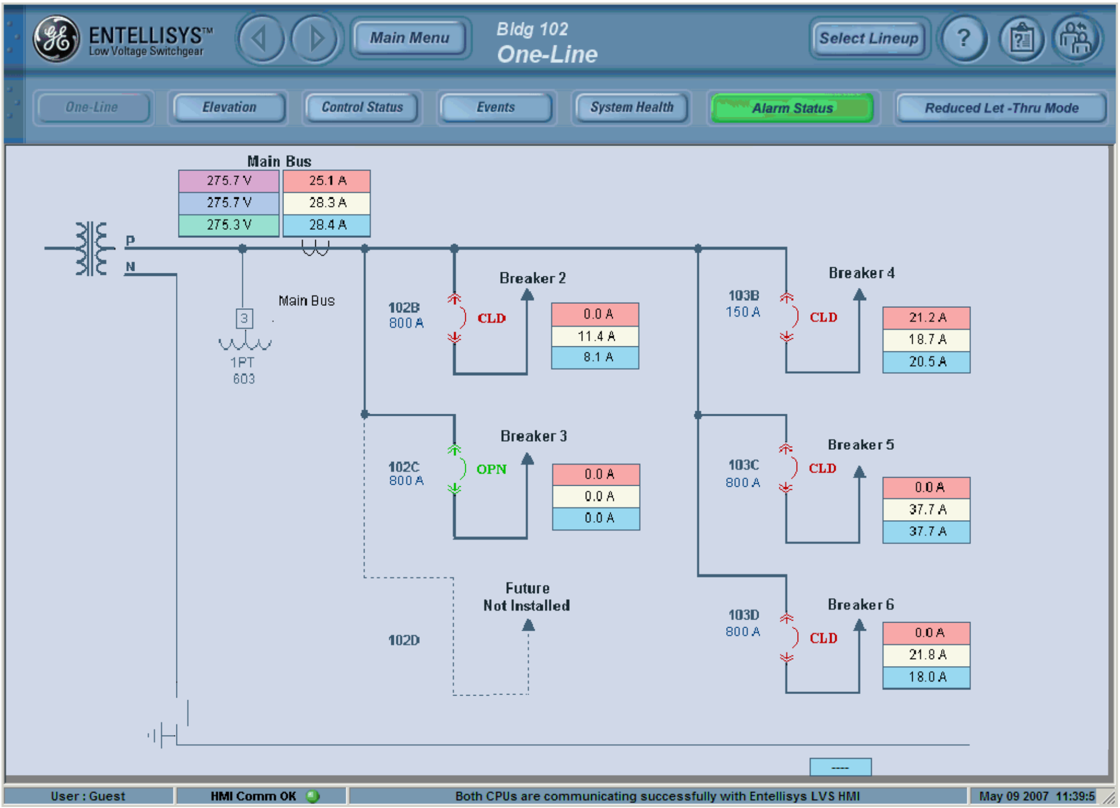
---

3 HMI Software

3.1 Entellisys HMI Overview

When the user approaches the HMI, the HMI is logged in as guest and the default screen will be displayed.

Figure 3-1 One-Line diagram



3.1.1 The Header Pane

Figure 3-2 The header pane

Navigation buttons

Forward and back buttons

Opens a dynamic floating menu. The menu options very depending on the current login credentials

On-line help

About - displays current HMI software revision

Login/Logout

Standard Display Screen buttons

Each of the status screens below are viewable before logging into the system.

- One-Line
- Elevation
- Control Status
- Events
- System Health
- Alarm Status

Enables/disables Reduced Energy Mode, see Reduced Energy Let-Thru Mode on page 225

3.1.2 The status bar

The status bar provides the user with important information about the status of the HMI

Figure 3-3 The header pane

User

Current user logged in the HMI (Max 20 characters)

Communication Status

Indicates that the communication with the CPUs are in one of 4 different states

- Green - HMI is communicating with both CPUs
- Yellow - HMI is communicating with one CPU
- Red - HMI is not communicating with either CPU
- Gray - HMI is in offline mode

Message Marquee

The message marquee will elaborate on the communication status or other pertinent user information.

Date and Time

The Date and time cell displays the computer time of the HMI PC

3.2 Login

Welcome to the Entellisys Human Machine Interface (HMI). Once you launch Entellisys, a read-only version of the One-Line diagram displays, and you are automatically logged in as a Guest user.

To log in to the Entellisys HMI, click the Login button  in the upper-right corner. The Login dialog displays. Enter your login ID and password and click the OK button.

Figure 3-4 Login dialog

Click the Login button to log out of the HMI. The default screen displays in read-only mode.

3.3 Main Menu

In addition to the standard display screens, depending on the user credentials, there will be additional buttons to administer the system. Guests and operators will be presented with the menu items in Figure 3-5

Figure 3-5 The main menu for guests and operators

Navigation

One-Line: One-Line Diagram of the gear.

Elevation: Elevation screen diagram of the gear

Sequence of Events: See Sequence of Events Viewer on page 243 for more details.

System Health: Displays the system health. See Breaker status screen on page 82 for more details.

User Settings: Used to navigate to Single-point functions, Metering, FlexLogic™, Preventive maintenance and HMI preferences.

Job Documentation: View imported job documents, see Job Documentation on page 76

User Administration: Update user permissions and credentials. See User Administration for more details.

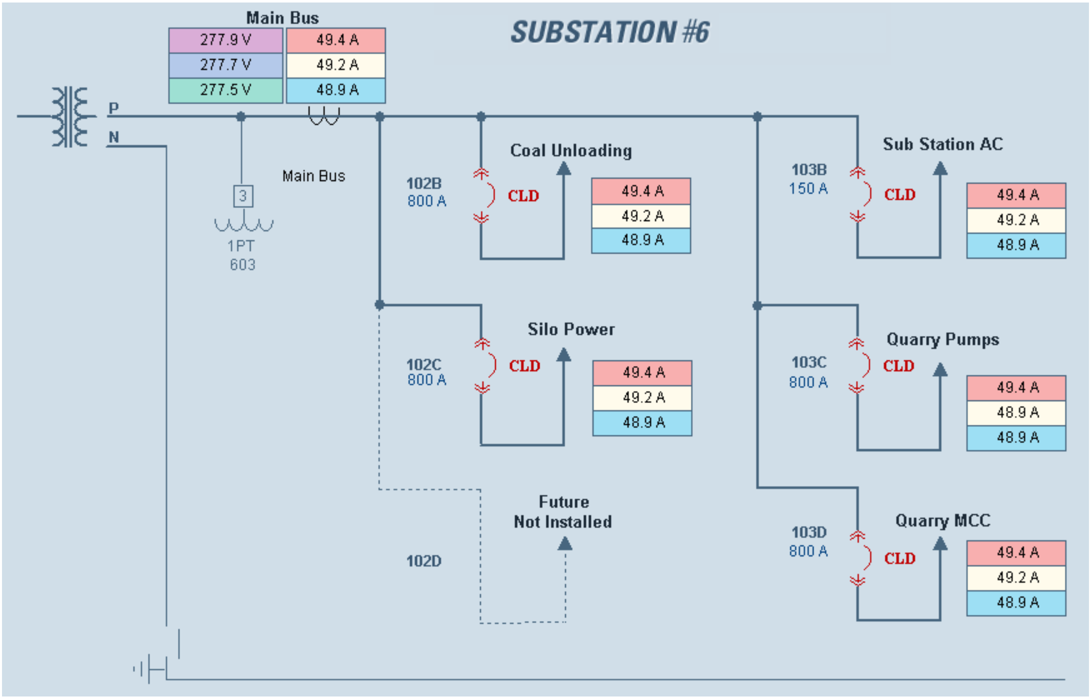
Maintenance: Update breaker names, backup\restore archive, Modbus Security, breaker names here. See Entellisys Maintenance on page 86 for more details.

3.3.1 One-Line Diagram

The One-Line window provides a diagram of your remote site configuration. You can use this diagram to view and control your breakers. Click the One-Line button in the Main Menu or click the One-Line button in the header to view the One-Line diagram.

The One-Line diagram will display the RMS currents at each breaker, and the RMS voltages at the main bus.

Figure 3-6 One-line diagram



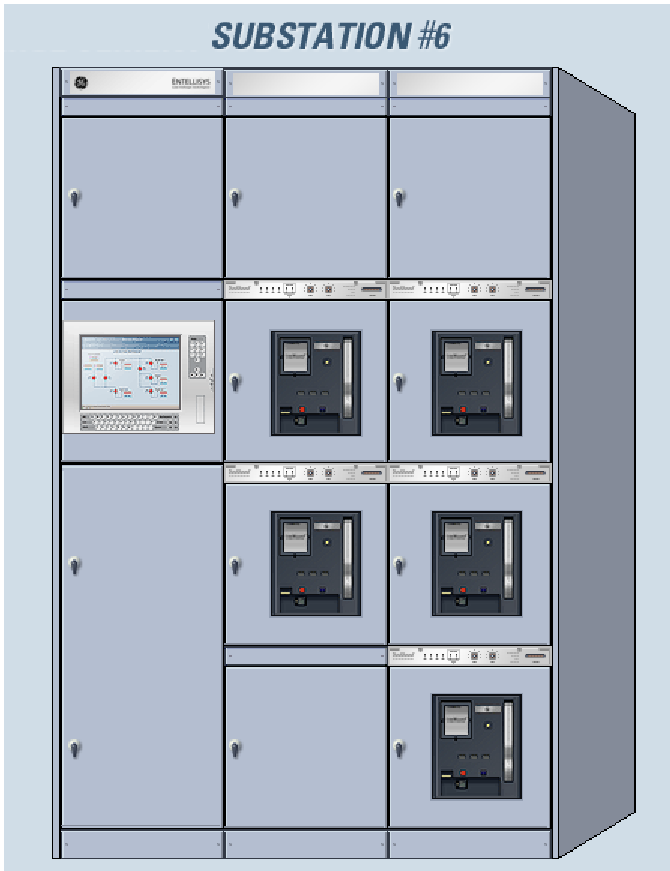
Click a breaker in the schema to view the Breaker status screen for the corresponding breaker

NOTE: The One-Line, as with all display screens can be edited by factory personnel. Breaker names can be modified via the Maintenance tab

3.3.2 Elevation screen

The Elevation window provides a physical representation of your nodes and breakers. You can use this diagram to view and control your breakers.

Figure 3-7 Elevation Diagram



Click a breaker in the schema to view the Breaker status screen for the corresponding breaker

NOTE: The One-Line, as with all display screens can be edited by factory personnel. Breaker names can be modified via the Maintenance tab

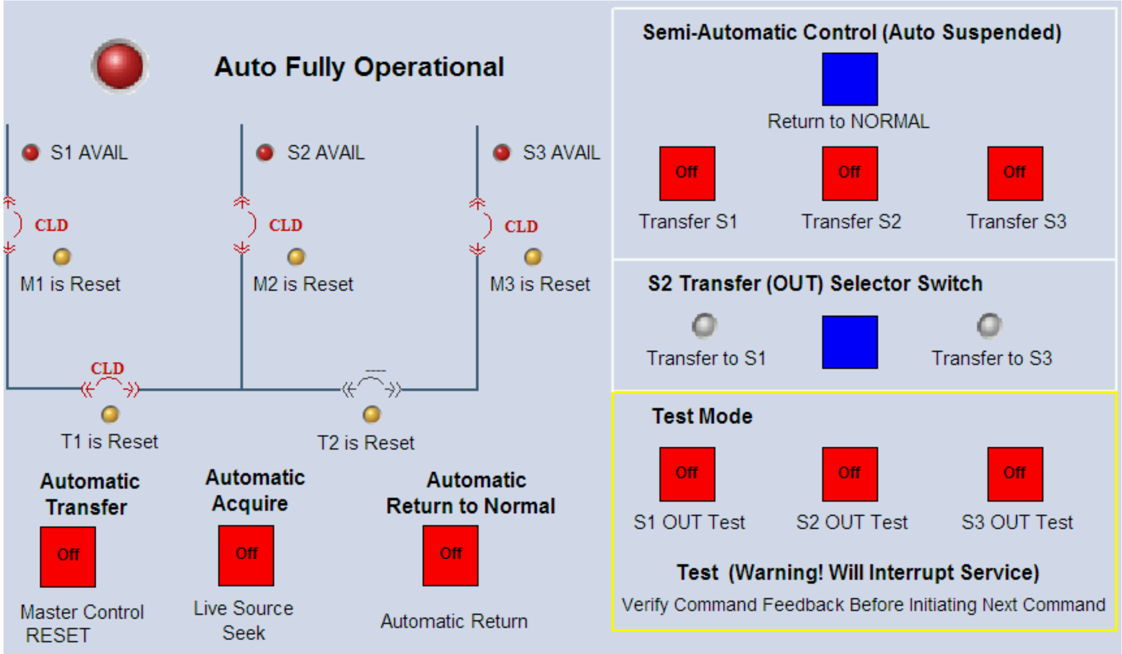
3.3.3 Control status screen

The Control Status window displays the user interface for the control scheme corresponding to the site configuration.

The LEDs are mapped to Virtual Outputs and display the current status of the Virtual Output.

When you open the Control Status window, Entellisys loads the control_status.sf schema file, which displays the control logic. The mapping of the buttons and LEDs depends on how the system is set up, using the One-Line Editor. Depending on the way the control logic is configured, the Virtual Output LEDs turn On or Off.

Figure 3-8 Control status screen



Click a breaker in the schema to view the Breaker status screen for the corresponding breaker

NOTE: The One-Line, as with all display screens can be edited by factory personnel. Breaker names can be modified via the Maintenance tab

3.3.4 System health

The System Health screen displays diagnostic information. Operators can quickly be alerted to any system maintenance or repairs that require attention, as well as troubleshoot startup issues.

Figure 3-9 System Health screen

The System Health screen shows the high level summary of the functional status of each device. Click on either of the CPU LED's to show the status for that device in greater detail. Click on the LED for an individual circuit breaker to view a greater level of detail of the status of the Messenger associated with that circuit breaker.

System health for hardware, firmware, communication and control power are monitored and their condition will propagate to the Health Button and will alert the user of the following conditions:

- **Loss of redundancy:** (Yellow) Lost redundancy but no loss in performance. In this case, the respective device and ultimately the System Health screen will annunciate yellow.
- **Hardware Error:** (Red) Loss of performance. Will annunciate on the failure of a critical subsystem or on the loss of a redundant subsystem and should be addressed immediately. For example if a Messenger is not commissioned or there is a hardware issue, the gear may not perform as expected. Will supersede yellow alerts.

The specific status information is outlined in Figure 3-10 and Figure 3-11. When a problem occurs within the system (red indication), a review of the Sequence of Events log is useful in determining the time of the failure and what may have led up to it. If the information still does not indicate the root cause of the issue, please call GE Post Sales Service for further assistance.

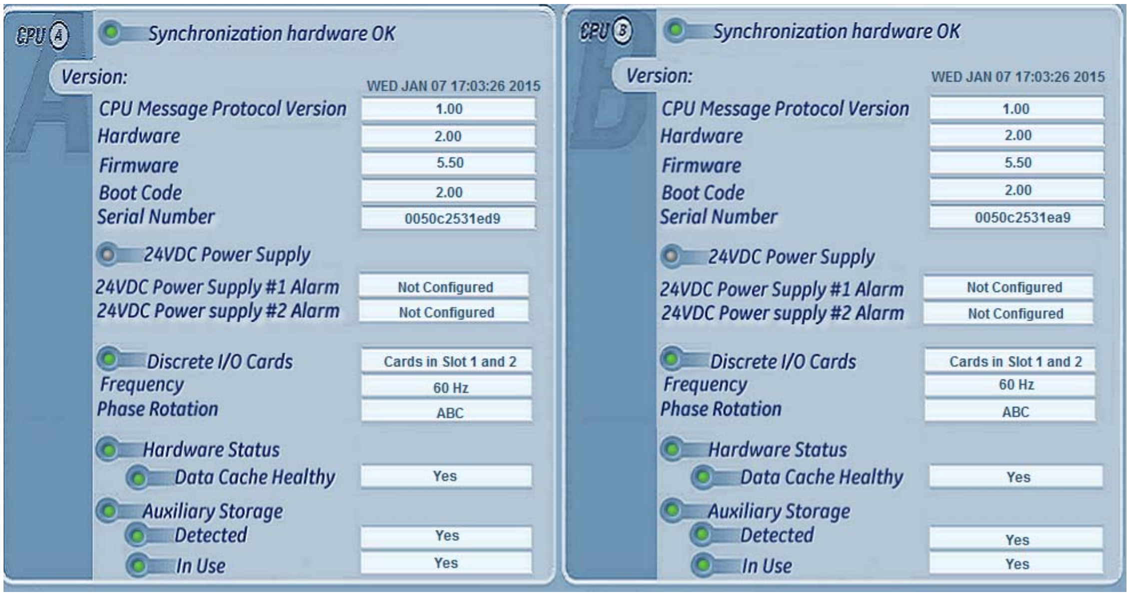
3.3.5 CPU Health Screen

CPU sync status, hardware and firmware are all continuously monitored.

For Entellisys with EntelliGuard E breakers, redundant 24 VDC power supplies are provided. Entellisys monitors these power supplies to ensure optimal performance. If installed, they will be configured at the factory.

Auxiliary storage continuously monitors a compact flash memory card installed in each CPU with CPU firmware version 5.50 and above.

Figure 3-10 CPU Health screen



3.3.6 Messenger Health Screen

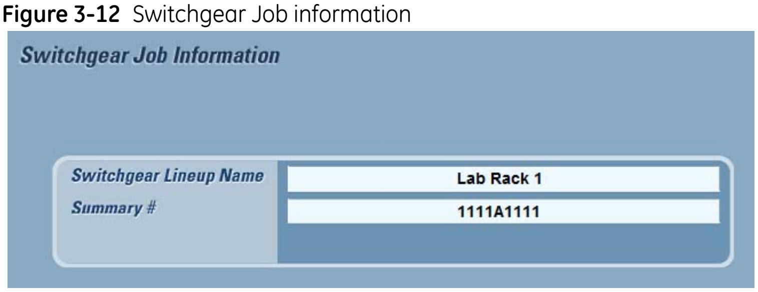
Monitors the Messenger's hardware and software critical to protection.

Figure 3-11 Messenger Health screen

3.3.7 Switchgear job information

Click the Job Info button on the System Health window to view the Switchgear Job Information window.

Figure 3-12 Switchgear Job information



The Switchgear Job Information window displays the job information for a particular lineup of Entellisys LV Switchgear. The Switchgear Lineup Name, Summary #, and Sub # fields uniquely identify the Entellisys LV lineup. These fields are read-only and cannot be modified.

Click the Back button to return to the System Health window.

3.3.8 User Settings

Click the User Settings button in the Main Menu to access the User Settings menu.

The User Settings menu lets you set your preferences for the following items:

Figure 3-13 User Settings

Overcurrent Protection: See Overcurrent protection on page 135

Relay Protection: See Additional Relay Protection Packages on page 147

Metering and Waveforms: See Metering on page 117

Discrete I/O: See Discrete I/O on page 257

Alarms: See Alarms on page 101

Advanced Protection: See Multi-point functions on page 195

Control: See FlexLogic™ on page 283

Preventative Maintenance: See Preventive maintenance on page 307

HMI Preferences: See User Administration screen in the HMI on page 86.

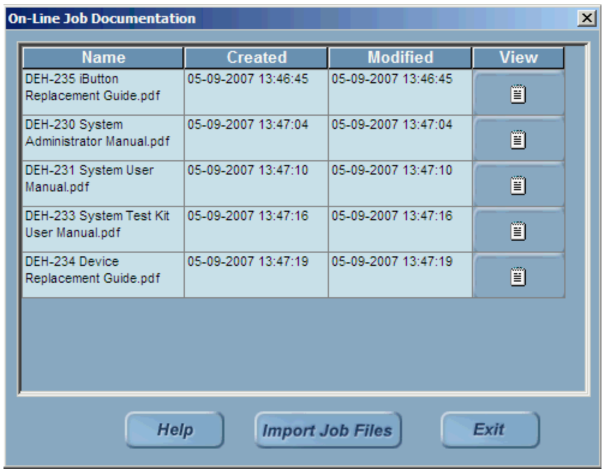
3.3.9 Job Documentation

The job documentation link allows all users access to the relevant job related documents. An Entellisys administrator may add job drawings and user manuals from a USB drive.

Documents are restricted to the following file types

- *.txt - plain text document
- *.pdf - Portable Document Format - Adobe Acrobat format
- *.tif - Targa Interchange File Format - graphic files

Figure 3-14 On-Line Job Documentation



To import documents, click on the **Import Job Files** and select the files from the USB stick (required). Import Job Files will be disabled if less than 15% of the disk space is remaining.

NOTE: Once imported, files can not be deleted

3.4 User Administration

The User Administration window lets an Administrator add, edit, or delete Access Groups and the users belonging to those Groups.

The Administrator, Operator, and Guest Access Groups are system groups and cannot be modified. The Administrator and Guest Groups also have a default user with the same name; you cannot delete this default user nor can you add another Administrator user. However, you can add additional Operator and Guest users, and you can create additional Groups with additional users.

Click the User Administration button in the Main Menu to access the User Administration window.

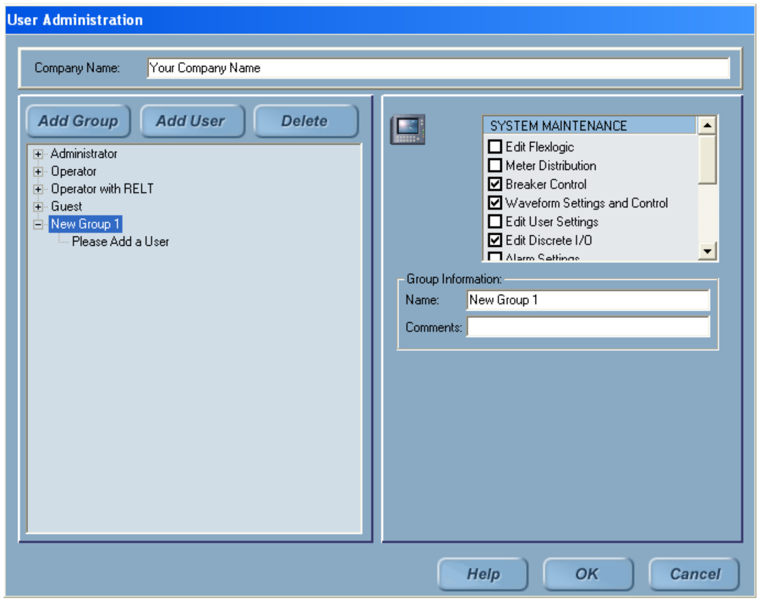
NOTE: Note: Only a user with an Administrator login can add, edit, or delete Access Groups. Other users do not have access to the User Administration window.

3.4.1 User groups

A **Group** defines the permission categories for a type or group of users. By default, there are 3 pre-configured groups - each with preset and fixed permissions. The Administrator and Guest user IDs are preset.

New user groups may be added to customize the permissions for a user.

Figure 3-15 Programmable permissions screen



New groups may be added and permissions may be assigned to the group or specific users in the group.

Add a group

1. On the **Main Menu**, click the **User Administration** button (Visible only by an Entellisys Administrator)
2. Click the desired user group to edit or click the **Add Group** button to define a new type of user.
3. Change the **permissions** by selecting the appropriate check boxes in the permission list.
   - Checked: User will be granted this permission.
   - Unchecked: User will not have this permission.

The changes are immediately saved in the HMI

3.4.2 Adding Users

Add users under the appropriate group at each HMI. (Administrative user rights are required) Each individual that is expected to operate the system should be given their own account. There are three default users.

Guest: The guest login allows read-only access to all status and settings screens. The system defaults to guest level access as soon as someone logs out.

Operator with RELT: Individuals that require access to control breakers, acknowledge alarms, modify breaker settings and can operate RELT. (See RELT Groups on page 230)

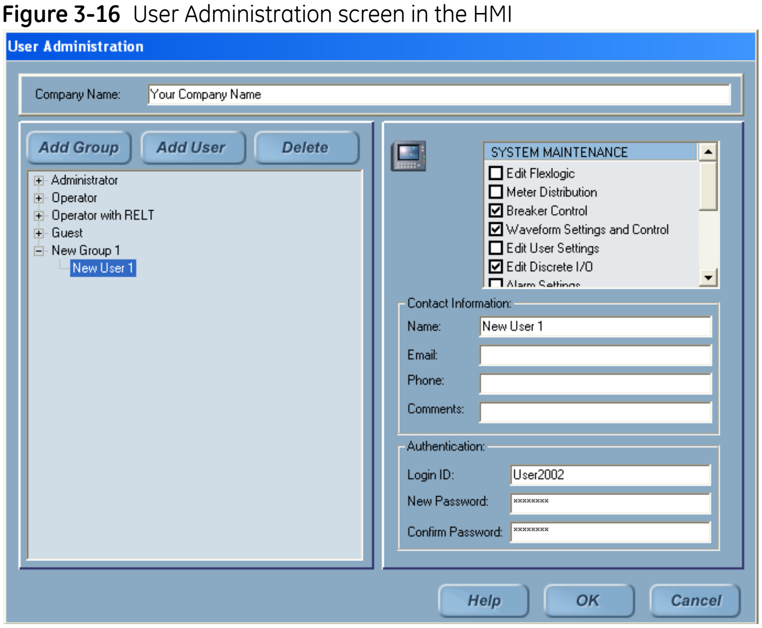
Operator: Individuals that require access to control breakers, acknowledge alarms, modify breaker settings but can **not** operate RELT.

Administrator: Operator permissions plus access can backup and restore settings, change CPUs, create users and other administrative tasks.

Changing user permissions

Permissions may be changed on a user basis for all users added to new user groups. Operator and Administrator user permissions are fixed and can not be changed.

Figure 3-16 User Administration screen in the HMI



Adding new users

1. On the **Main Menu**, click the **User Administration** button (Visible only by an Entellisys Administrator)
2. Click the user group which the user will be added and click "**Add User"**
3. Update the contact information
4. In the Authentication box, Enter their login ID and password
5. Modify permissions if required (must create a new user group)
6. The changes are immediately saved in the HMI

To change a password

1. On the **Main Menu**, click the **User Administration** button (Visible only by an Entellisys Administrator)
2. Select the desired **user group** on the left-side pane. Expand the group by clicking the **+** symbol and click a **user name**
3. Enter the new password in the **New Password** field
4. Confirm your password by re-entering the new password in the **Confirm Password** field. Click **OK** to save your new password (or click **Cancel** to exit)

To verify the password change:

1. Log out of the HMI by clicking the **Login/Logout** icon in upper right-hand corner

Figure 3-17 Login/Logout icon

2. Click once more to log back in and enter the new user name and password

3.4.3 User Permissions

- **Edit FlexLogic** – Edit FlexLogic control section.
- **Meter Distribution** – Modify Metering Distribution
- **Breaker Control** – Open/Close and Trip Breakers
- **Waveform Settings and Control** – Modify waveform settings
- **Edit User Settings** – Modify all Protection and Alarm relay settings
- **Edit Discrete I/O** – Modify rights to the Discrete I/O screen
- **Alarm Settings** – Modify rights to the Alarm settings configuration screen
- **Alarm Acknowledge** – Permissions to acknowledge alarms on the alarm screen
- **Reduced Let-Thru Mode** – Permissions to turn on and off RELT
- **Virtual Input Control** – Access to user push buttons on the control screen typically for Auto Throw-over
- **CPU & Messenger Maintenance** – Permissions to modify settings in the Predictive Maintenance screen.
- **Close HMI**
- **HRGF Location** – Permissions to run the Manual HRGF Location conductor

Permissions for Default Operators:

- Breaker Control
- Waveform Settings and Control
- Alarm Acknowledge
- Virtual Input Control
- HRGF Location Control

Administrator Permissions: Rights to all permissions.

3.4.4 Resetting forgotten HMI passwords

Administrators have access permission to change passwords for all users in all groups.

NOTE: It is very important for the System Administrator to keep the Administrator password in a safe location. If the Administrator password is lost, a GE Field Service visit is required to restore the password.

GE offers an optional service to store the Administrator password at the request of customers. In the event the password is lost, GE can provide the password to the customer over the phone, without requiring a site visit.

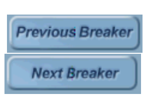
Contact GE Post Sales Service for help (see How to contact us on page 2).

3.4.5 Breaker status screen

The Breaker Status screen is opened after clicking on a breaker either on the oneline or the Elevation screens. The Breaker Status screen gives current and voltage information, breaker configuration and provides links to view settings, metering and control.

Figure 3-18 Breaker Status screen

Navigation buttons



Previous / Next Breaker: Cycles between breakers in order of breaker number

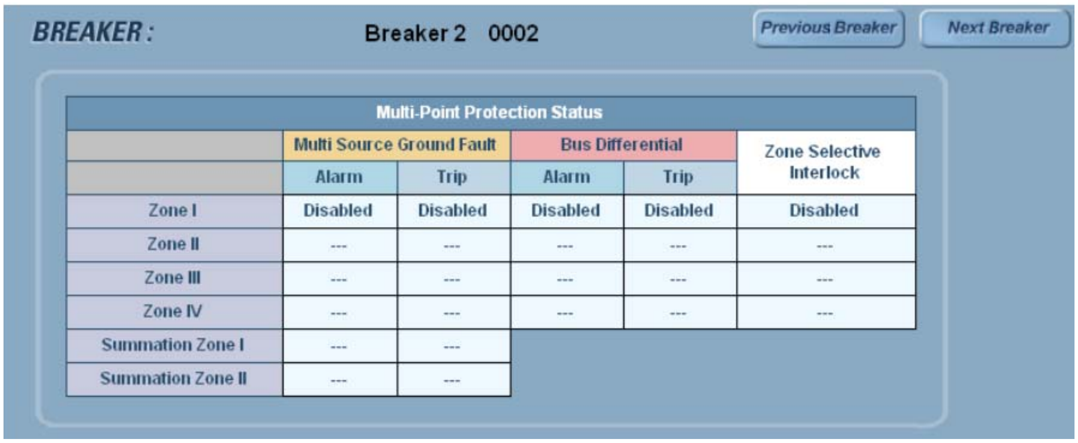
Test Mode: Active when the customer test cart is plugged into the messenger

3.4.6 Multi-Point protection status screen

When you click the Multipoint Protection button on the Breaker Status window, the Breaker Multi-point Protection Status window displays the name of the selected breaker and the status of the multipoint protection functions (Multi-Source Ground Fault, Bus Differential, Zone Selective Interlock) for all zones for a particular breaker.

If the breaker is configured as a member of a particular zone, the Multi-Point Protection Status (Enabled or Disabled) displays for that zone. If the breaker is not a member of a particular zone, the screen displays a dash (---) for that zone.

Figure 3-19 Multi-Point protection status screen



	Multi Source Ground Fault		Bus Differential		Zone Selective Interlock
	Alarm	Trip	Alarm	Trip	
Zone I	Disabled	Disabled	Disabled	Disabled	Disabled
Zone II	---	---	---	---	---
Zone III	---	---	---	---	---
Zone IV	---	---	---	---	---
Summation Zone I	---	---			
Summation Zone II	---	---			

Click the Previous Breaker or Next Breaker button to view Multi-Point Protection Status information about another breaker installed in the system without returning to the One-Line or Elevation diagram.

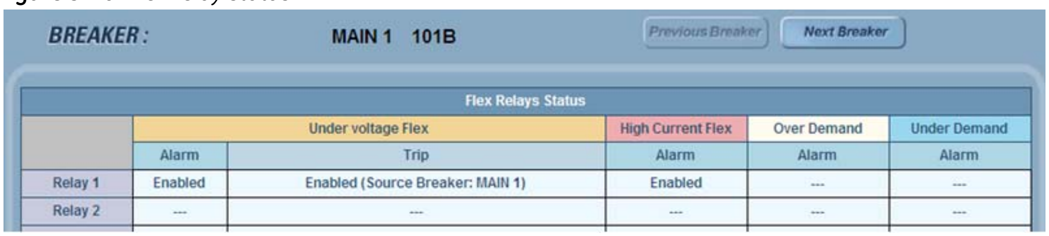
Click the Back button to return to the Breaker Status window.

3.4.7 Flex relay status

When you click the Flex Relays button on the Breaker Status window, the Flex Relays Status window displays the configured flex relays assigned to the selected breaker.

For example, the matrix below shows the relay configuration for Main 1. In this case, the Under Voltage Flex relay #1 is configured as Main 1 for both the Source Breaker and as the breaker that will trip if Under Voltage is triggered. The first High Current Flex relay is also configured for Main 1.

Figure 3-20 Flex relay status



	Under voltage Flex		High Current Flex	Over Demand	Under Demand
	Alarm	Trip	Alarm	Alarm	Alarm
Relay 1	Enabled	Enabled (Source Breaker: MAIN 1)	Enabled	---	---
Relay 2	---	---	---	---	---

Click the Previous Breaker or Next Breaker button to view Multi-Point Protection Status information about another breaker installed in the system without returning to the One-Line or Elevation diagram.

Click the Back button to return to the Breaker Status window.

3.4.8 HMI Administrator login

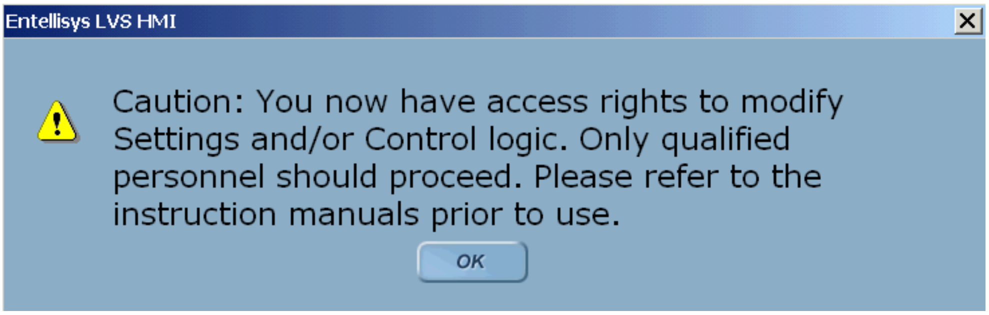
The Entellisys HMI requires a login name and password. This login sets the permissible actions for the session. Each user's permissions are programmable to provide flexibility. Only the Administrator can set permissions, login names, and passwords.

Since the HMI stores the user profiles locally, for systems with multiple HMIs, an individual user profile must be configured at each HMI.

Guest Login is the lowest level of access to the HMI and will assume the guest permissions at anytime a user has logged out. Guest is allowed “view only” access to all system status and breaker settings screens.

CAUTION: Enabling Group Permissions for features that allow the changing of settings and/or access to control functions must be restricted to accounts for qualified personnel only. As a reminder, users with such privileges will be presented with the following screen upon initial login:

Figure 3-21 Initial login Caution screen

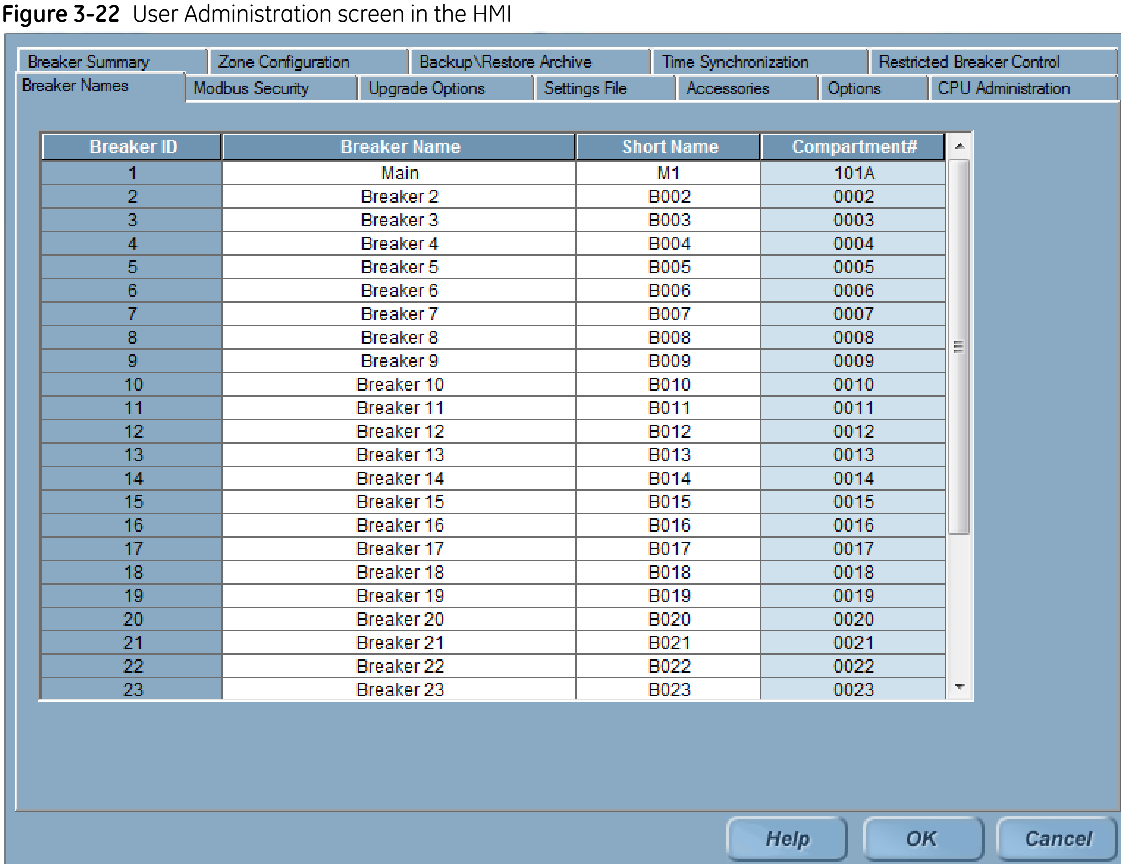


3.5 Entellisys Maintenance

The Maintenance window lets the Administrator configure and view various settings and connections of the CPUs, breakers, and nodes. From this tabbed dialog, the Administrator can:

- View and update circuit breaker names
- Modbus® security
- Upgrade options
- View and compare settings files
- View and update circuit breaker accessories
- View installed options
- CPU Administration
- Breaker summary
- View zone configuration
- Save or restore System archive
- Time synchronization
- Restricted Breaker Control

Figure 3-22 User Administration screen in the HMI



Breaker ID	Breaker Name	Short Name	Compartment#
1	Main	M1	101A
2	Breaker 2	B002	0002
3	Breaker 3	B003	0003
4	Breaker 4	B004	0004
5	Breaker 5	B005	0005
6	Breaker 6	B006	0006
7	Breaker 7	B007	0007
8	Breaker 8	B008	0008
9	Breaker 9	B009	0009
10	Breaker 10	B010	0010
11	Breaker 11	B011	0011
12	Breaker 12	B012	0012
13	Breaker 13	B013	0013
14	Breaker 14	B014	0014
15	Breaker 15	B015	0015
16	Breaker 16	B016	0016
17	Breaker 17	B017	0017
18	Breaker 18	B018	0018
19	Breaker 19	B019	0019
20	Breaker 20	B020	0020
21	Breaker 21	B021	0021
22	Breaker 22	B022	0022
23	Breaker 23	B023	0023

3.6 HMI Preferences

The HMI Preferences window lets you specify the Updating HMI with CPU IP address, General, One-Line and Lineup settings.

The HMI Preferences Communication window lets you view and change the Updating HMI with CPU IP address, test the communication between the HMI and each CPU, Publishing shared files.

To view the IP address of the configured CPUs:

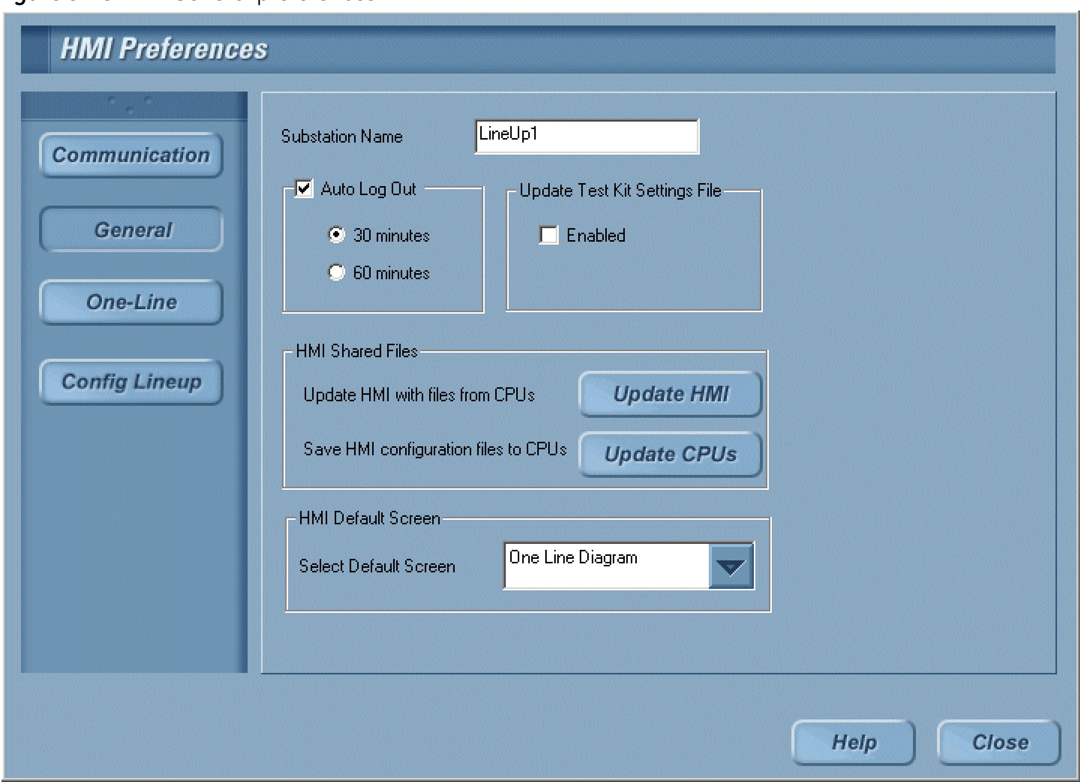
Click the User Settings button on the Main Menu. The User Settings menu displays.

Click the HMI Preferences button. The HMI Preferences window displays the Communication preferences, where you can specify the IP addresses of the two CPUs.

The IP address of each CPU displays. Select the appropriate CPU radio button to test the HMI's communication with that CPU.

Click the Close button when you've finished specifying HMI preferences and the changes are automatically saved.

Figure 3-23 HMI General preferences



Auto Logout

If the HMI is configured to logout a user after 30 or 60 minutes, the HMI will return to the default screen and login as a “guest” (Allowing view only access to the system). To configure or disable the auto logout, navigate to **User Settings**, then **HMI Preferences** and click on the **General** tab.

Update Test Kit Settings File

Default is checked. Will create test kit data files for use with the Entellisys test kit.

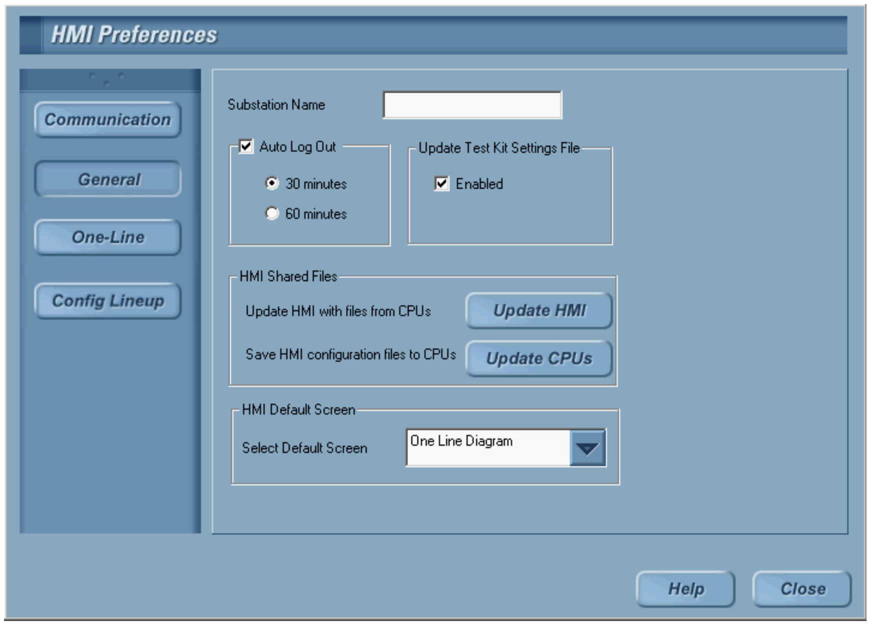
HMI Default Screen

Select the default power-on view for the HMI

3.6.1 Sharing files across HMIs

The HMI provides a tool for the System Administrator to distribute files across all HMIs.

Figure 3-24 HMI Shared Files screen



3.6.1.1 Publishing shared files

Publishing shared files should be done whenever the following changes are made. (Other HMIs must be updated manually, see Updating an HMI with shared files.

- Oneline, Elevation, or Control Panel screens
- Alarm configuration
- Circuit breakers are added to the system or circuit breaker maintenance is updated
- Advanced protection zones, tiers, or topologies change
- User configurations and passwords are not updated

To publish shared files for other HMIs to retrieve

1. On the **Main Menu**, click **User Settings**.
2. Click **HMI Preferences**.
3. In the **HMI Preferences** dialog box, click **General**.
4. In the **HMI Shared File** dialog box, click the **Update CPUs** button. Only the Administrator will have access perform this task. The button will be grayed out if the current session does not have Administrator permissions.

NOTE: The HMI will only update files which are newer than those on the CPU.

NOTE: Pop-up dialog boxes shall appear (one per CPU) confirming files are successfully written to each CPU. Should any file fail to publish, an appropriate pop-up dialog box shall appear identifying the file(s) and CPU to which the publish was not successful.

3.6.1.2 Updating an HMI with shared files

To obtain the custom files an Administrator has published

1. On the **Main Menu**, click **User Settings**.
2. Click **HMI Preferences**.
3. In the **HMI Preferences** dialog box, click **General**.
4. Click **Update HMI**.
5. Click **Yes** in the confirmation dialog box to proceed by loading the shared files. (Or click **No** to cancel the operation.)
6. Once the file transfer is complete, a list of transferred file names is displayed. Click **OK** to complete the process.

NOTE: On systems with more than one HMI, updating an HMI will change the file timestamps in the CPU and will cause the other HMIs to alert the user that there is a "HMI file mismatch" See figure 3-37 on page 109. On the other HMIs, select "Do Not Update."

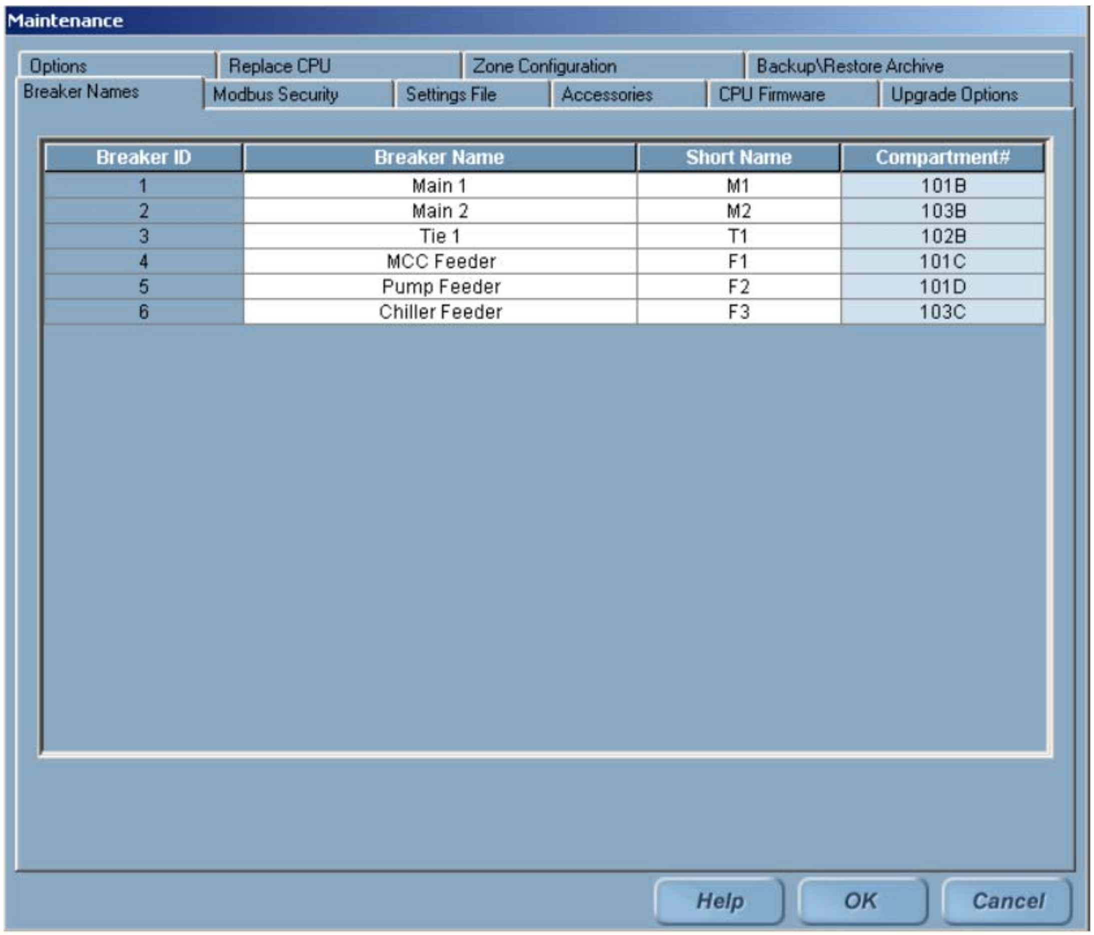
3.7 View and update circuit breaker names

The HMI provides a tool to change the circuit breaker names corresponding to their location in the switchgear.

To change the circuit breaker names

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Breaker Names** tab. A table will display as shown as in Figure 3-25.

Figure 3-25 Breaker Names screen



- **Breaker ID**: Unique identifier for the circuit breaker. This is set by GE and cannot be changed.
- **Breaker Name**: Unique name given to a circuit breaker (16 alphanumeric characters). This may be set in the factory if information is provided from the customer. Otherwise, it should be updated for ease of use with selection boxes.
- **Short Name**: Unique short name given to a circuit breaker (8 alphanumeric characters). This field is currently not used.
- **Compartment#**: Unique identifier for the location of the circuit breaker in the switchgear. The Compartment# is set by the factory upon shipment to the customer and cannot be changed. It is often included on nameplates on the switchgear.

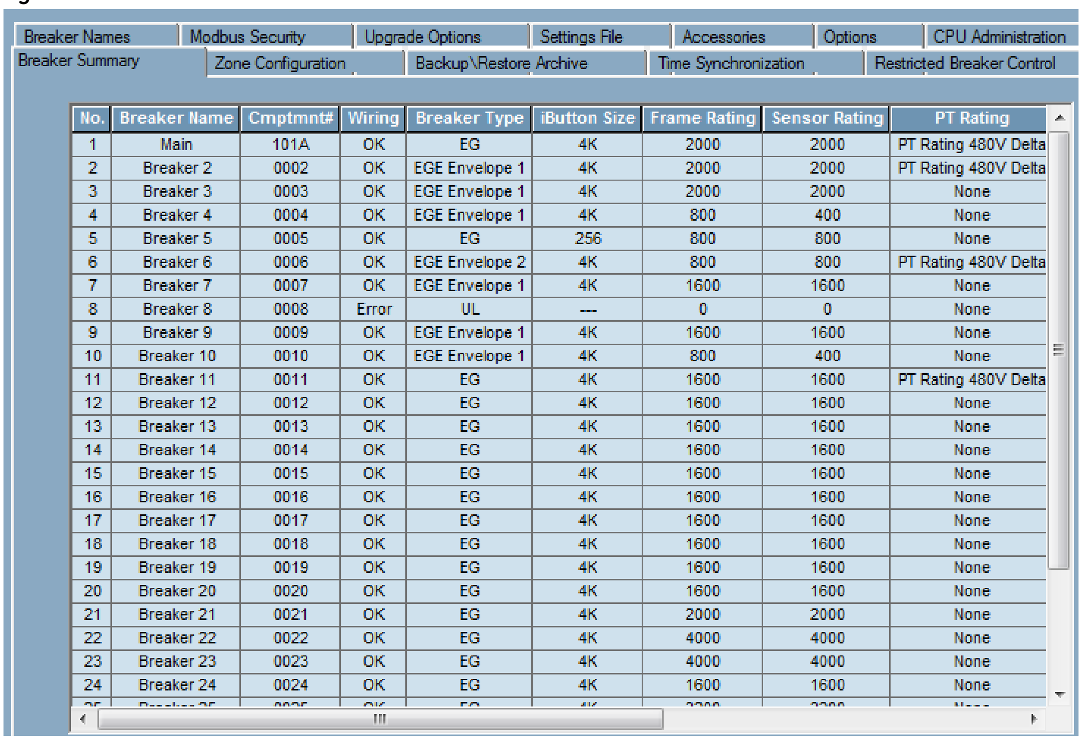
3. Click the **OK** button to keep changes (or click **Cancel** to exit the screen without saving).

NOTE: Changes to circuit breaker names will not be reflected on the custom Oneline screen. Contact GE Post Sales Support for details about updating to the Oneline screen (see How to contact us on page 2).

3.8 Breaker summary screen

The Breaker Summary screen provides an overview of the physical configuration of each breaker in the system.

Figure 3-26 Breaker Names screen



No.	Breaker Name	Cmptmnt#	Wiring	Breaker Type	iButton Size	Frame Rating	Sensor Rating	PT Rating
1	Main	101A	OK	EG	4K	2000	2000	PT Rating 480V Delta
2	Breaker 2	0002	OK	EGE Envelope 1	4K	2000	2000	PT Rating 480V Delta
3	Breaker 3	0003	OK	EGE Envelope 1	4K	2000	2000	None
4	Breaker 4	0004	OK	EGE Envelope 1	4K	800	400	None
5	Breaker 5	0005	OK	EG	256	800	800	None
6	Breaker 6	0006	OK	EGE Envelope 2	4K	800	800	PT Rating 480V Delta
7	Breaker 7	0007	OK	EGE Envelope 1	4K	1600	1600	None
8	Breaker 8	0008	Error	UL	---	0	0	None
9	Breaker 9	0009	OK	EGE Envelope 1	4K	1600	1600	None
10	Breaker 10	0010	OK	EGE Envelope 1	4K	800	400	None
11	Breaker 11	0011	OK	EG	4K	1600	1600	PT Rating 480V Delta
12	Breaker 12	0012	OK	EG	4K	1600	1600	None
13	Breaker 13	0013	OK	EG	4K	1600	1600	None
14	Breaker 14	0014	OK	EG	4K	1600	1600	None
15	Breaker 15	0015	OK	EG	4K	1600	1600	None
16	Breaker 16	0016	OK	EG	4K	1600	1600	None
17	Breaker 17	0017	OK	EG	4K	1600	1600	None
18	Breaker 18	0018	OK	EG	4K	1600	1600	None
19	Breaker 19	0019	OK	EG	4K	1600	1600	None
20	Breaker 20	0020	OK	EG	4K	1600	1600	None
21	Breaker 21	0021	OK	EG	4K	2000	2000	None
22	Breaker 22	0022	OK	EG	4K	4000	4000	None
23	Breaker 23	0023	OK	EG	4K	4000	4000	None
24	Breaker 24	0024	OK	EG	4K	1600	1600	None

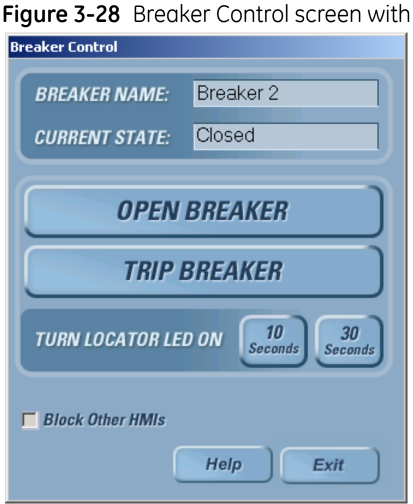
3.9 Controlling circuit breakers

Entellisys allows users to control EntelliGuard circuit breakers from the HMI. A circuit breaker may be commanded to open, close or trip. To locate or confirm the circuit breaker shown on the HMI screen matches the physical circuit breaker, the Locator LED on each EntelliGuard Messenger can be set to flash for 10 or 30 seconds.

To control a circuit breaker, navigate to the **Breaker Status** screen and click **Control** as shown in Figure 3-18. The **Breaker Control** screen appears. The Breaker Control screen resembles Figure 3-27 when the circuit breaker is open. The Breaker Control screen resembles Figure 3-28 when the circuit breaker is closed.

Figure 3-27 Breaker Control screen for open circuit breaker

Figure 3-28 Breaker Control screen with closed circuit breaker



3.9.1 Block other HMIs

Any HMI that is designated as a Local HMI can block other HMIs from operating circuit breakers. To designate an HMI as local, click the **Modbus Security** tab under the **Maintenance** menu. When the check box on that screen is checked, the HMI is the Local HMI.

To block other HMIs from the local HMI, click the **Control** button under the **Breaker Status** screen. In the **Breaker Control** screen there is a check box to **Block Other HMIs**.

Only Local HMIs have the ability to block other HMIs. If the Block Other HMIs check box is grayed out, it is not setup as a Local HMI.

CAUTION: When controlling circuit breakers through a local HMI it is recommended that users block all HMIs to prevent remote circuit breaker control. This step is in addition to normal lock-out tag-out procedures when applicable.

3.9.2 Open circuit breaker (electrically operated circuit breakers only)

To open a circuit breaker, click **OPEN BREAKER** on the **Breaker Control** screen. A dialog box appears for verification that the circuit breaker should be opened. Click **Yes** to open the circuit breaker. Once the open breaker command is verified, the EntelliGuard Messenger uses the Shunt Trip to actually open the circuit breaker.

If the open breaker command is successful, the circuit breaker opens and the **Current State** of the circuit breaker on the **Breaker Control** screen changes from **Closed** to **Open**. If the circuit breaker does not open, examine the Sequence of Events. One of the following events may be present:

- Attention Breaker Open Failed Shunt Trip
- Note Messngr Reports CPUA (or B) Command Timed Out

See Table A-7 for more information.

3.9.3 Close circuit breaker (electrically operated circuit breakers only)

To close a circuit breaker, click **CLOSE BREAKER** on the **Breaker Control** screen. A dialog box appears for verification that the circuit breaker should be closed. Click **Yes** to close the circuit breaker. Once the close breaker command is verified, the EntelliGuard Messenger uses the Close Coil to actually close the circuit breaker.

If the close breaker command is successful, the circuit breaker closes and the **Current State** of the circuit breaker on the **Breaker Control** screen changes from **Open** to **Closed**. If the circuit breaker does not close, examine the Sequence of Events. One of the following events may be present:

- Attention Breaker Close Failed
- Breaker Close Command Rejected Breaker Locked Out
- Note Messngr Arbitrated Command From CPUA (or B)
- Note Messngr Reports CPUA (or B) Command Timed Out

See Table A-7 for more information.

3

3.9.4 Trip circuit breaker

To trip a circuit breaker, click **TRIP BREAKER** on the **Breaker Control** screen. A dialog box appears for verification that the circuit breaker should be tripped. Click **Yes** to trip the circuit breaker. Once the trip breaker command is verified, the EntelliGuard Messenger uses the Flux Shifter to actually trip the circuit breaker.

If the trip breaker command is successful, the circuit breaker trips and is locked out, and the **Current State** of the circuit breaker on the **Breaker Control** screen changes from **Closed** to **Open-tripped**. If the circuit breaker does not trip, examine the Sequence of Events. One of the following events may be present: (See Table A-7 for more information)

- Attention Breaker Trip Failed Flux Shifter
- Note Messngr Reports CPUA (or B) Command Timed Out

3.9.5 Locator LED

To turn on the locator LED for 10 or 30 seconds, click **10 Seconds** or **30 Seconds** on the **Breaker Control** screen. The locator LED on the particular EntelliGuard Messenger blinks for the appropriate length, making identification easy.

3.9.6 Troubleshooting

Breaker Control screen only shows Trip option

- Open and close commands are only available for electrically operated circuit breakers.

Breaker Control screen shows Open, Close and Trip options at the same time

- Circuit breaker contact position is unknown.

Breaker control screen appears grayed out

- User does not have permissions to control circuit breakers.

Breaker does not open when command is issued

- Verify the remote racker is not inserted in the breaker.

3.10 Time synchronization

In the Entellisys System, events are generated by both the HMI and the CPU. When deciphering the event log, it is desirable that the date/time of all Entellisys devices are set from the same time reference. SNTP (Simple Network Time Protocol) is used to synchronize any number of Entellisys lineups. All systems must be networked together - either through the building LAN or through an isolated network.

Factory Default

Time Synchronization is not configured - See section 3.10.2 through 3.10.4 to configure

Synchronizing across multiple lineups

Additional lineups can be networked together and configured to reference the same time server. (See section 3.10.3)

It is possible to use another time server provided that:

- The Time Server supports passive SNTP
- The Time Server is connected to the HMI - CPU router

NOTE: If Entellisys is connected to the building LAN, a VPN must be used to prevent unwanted traffic on the Entellisys network.

Events

Time Server not Configured - logged when IP address of time source is set as 0 (initial condition).

Time Server Started - logged when time server is started at CPU and this CPU will be the synchronization point for all other devices.

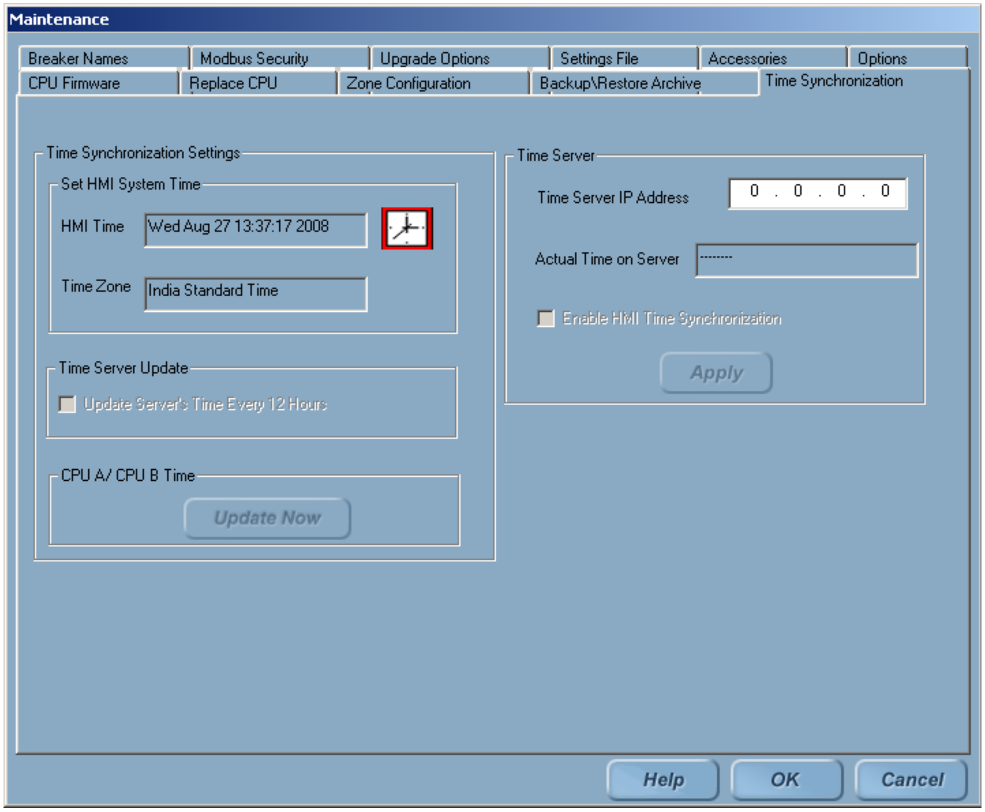
Time Server Stopped - logged when time server is stopped at CPU.

Time Server Synchronization Successful - logged when CPU or HMI received it's first synchronization message for the time server. It is logged only on the first successful reception of synchronization message from the time server. As long as there were no time synchronization issues, this event will not be logged again.

3.10.1 Time synchronization configuration screen

The configuration screen in Figure 3-29 can be accessed by an administrator by clicking on the Maintenance sub-menu

Figure 3-29 (Time Synchronization tab



Time Synchronization Settings group box

The clock icon opens the Windows™ Date and Time Properties Applet.

Time Server Update group box

Unavailable if the IP address in the “Time Server” group box does not reference one of the CPUs in the current lineup or if the Remote HMI software has been installed.

If the **Update Server’s Time Every 12 Hours** check box is checked then the HMI is considered the **“Master HMI**” (see Figure 3-30) and will set the time on the CPU designated in the “Time Server IP Address” according to the HMI’s date and time.

Update Now Button will immediately synchronize the CPUs time with the HMI PC.

Time Server Group Box

Time Server IP Address: (Defaulted to 0.0.0.0) Enter a SNTP time server IP address here.

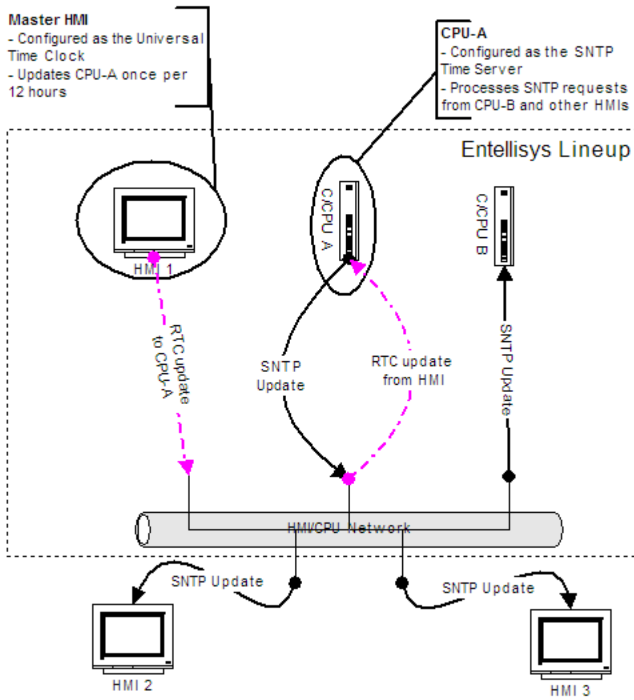
Enable HMI Time Synchronization: When checked, the PC clock on the HMI will be synchronized to the SNTP Timer Server designated in the “Time Server IP Address.”

Actual Time on Server: Only displayed when the “Time Server IP address” refers to a CPU in the current lineup.

3.10.2 Basic time sync configuration for stand-alone systems

The local HMI - generally located in the gear - is designated as the master HMI. The master HMI will update the CPUA Real Time Clock (RTC) once every 12 hours. CPUA is also set as the SNTP server and will send SNTP messages to CPUB and all additional HMIs

Figure 3-30 Time Synchronization factory configuration



Configure the Lineup as a stand-alone system

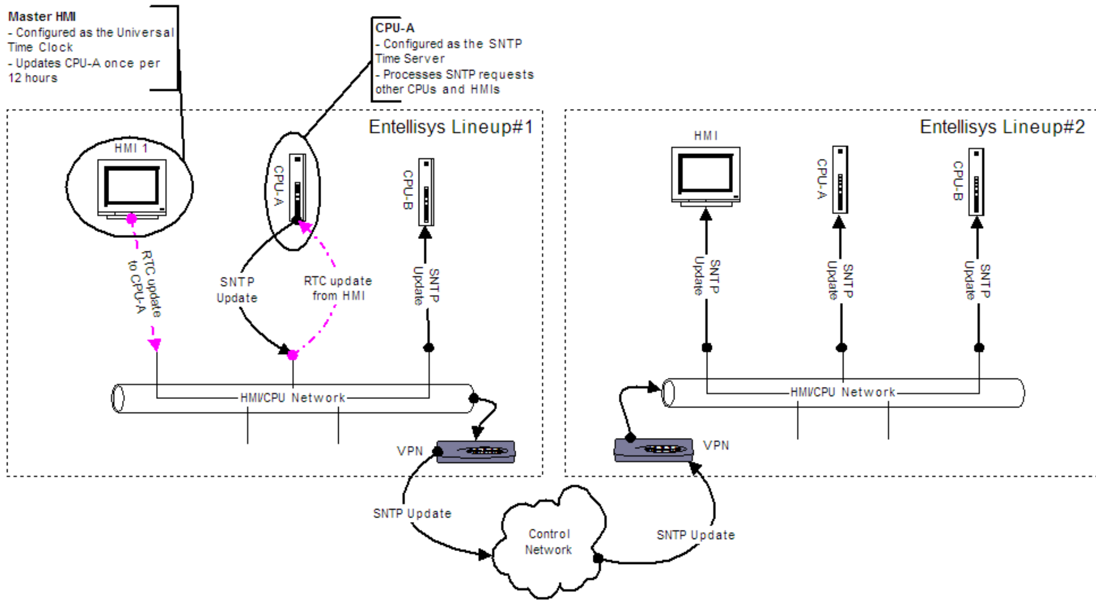
1. Identify the “Master HMI”. Go to the **Modbus Security** tab (**Main Menu, Maintenance**) and verify that “Master HMI” is checked
2. In the “Time Server” group box in the **Time Synchronization** tab (**Main Menu, Maintenance**), enter the IP address of CPU-A (The “Actual Time on Server” text box will update - see Figure 3-29)
3. At the master HMI, check “Update time server every 12 hours” and click the “Update Now” button
4. On all other Local HMIs, verify that the “Master HMI” check box is unchecked and “Enable HMI Time Synchronization” is checked and click the apply button (the apply button must be clicked to update the Windows Time Service with the new time server)

3.10.3 Time Sync configuration for multiple lineups

Additional lineups can be networked together and configured to reference the same time server.

Customers who have 2 or more complete Entellisys lineups may network systems together to synchronize all lineups to approximately 8ms of each other.

Figure 3-31 Time Synchronization for multiple lineups



NOTE: All networked Entellisys lineups and associated HMIs should be set to the same time zone.

Configure an Entellisys lineup to synchronize with another Entellisys lineup

1. A “Master Lineup” must be designated and setup according to section 5.2 (All other lineups are considered “Client Lineups”)
2. All “Client Lineups” must also be first setup according to section 5.2 (This step must be done to ensure time zone information is correctly written to the “Client Lineups”)
3. Network the lineups together (See Network considerations below)
4. On all client lineup HMIs, navigate to the **Time Synchronization** tab (**Main Menu, Maintenance**) and
   - Change, if necessary, the “Time Server IP Address” to match the Time Server IP address of the “Master Lineup” (The “Actual Time on Server” text box MAY NOT update)
   - Verify that the “Synchronize Server’s Time Every 12 hours” control is unchecked on all local HMI’s
   - Check the “Enable HMI Time Synchronization”
   - Click the apply button (the apply button must be clicked to update the Windows Time Service with the new time server)

Networking considerations

- HMI and CPU IP addresses on all additional lineups must be changed to provide unique IP addressing (see Establishing communication to Remote HMIs on page 58)
- To verify each device is communicating, ping each device using a laptop connected to the CPU/HMI LAN
- If the lineups are in close proximity of each other a network cable can be routed between them (300ft is the maximum recommended length for Cat 5E cable)
- If existing network infrastructure is used, VPNs must be installed at each lineup (see Network security/VPN device on page 63.). It is recommended that a dedicated Control LAN be used to ensure the highest degree of accuracy

- The VPN must be configured to allow port 123 (SNTP uses port 123 - which is normally blocked on the VPN)

NOTE: If Entellisys is connected to the building LAN, VPNs must be used to prevent unwanted traffic on the Entellisys network.

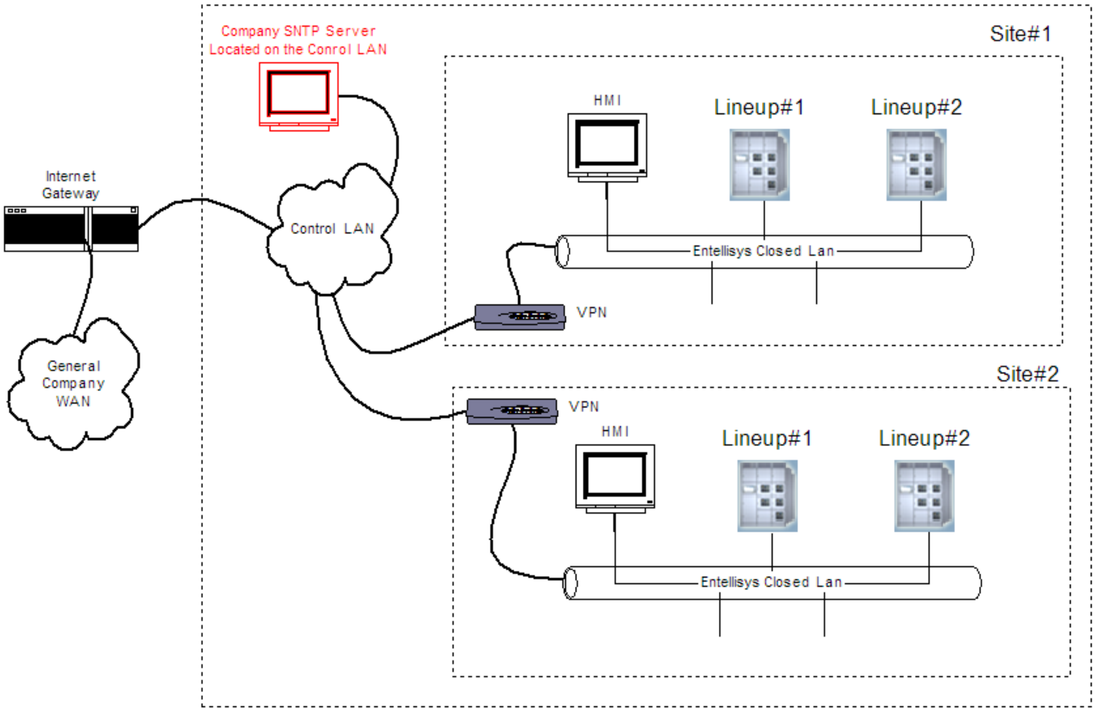
3.10.4 Using an external time server

If the time stamps on system events need to be synchronized to absolute time then a 3rd party time server may be used.

Time Server requirements:

- Time server that supports passive SNTP
- The time server is connected to the Entellisys VPN

Figure 3-32 Time Sync w/ external SNTP time server



NOTE: GE cannot make any guarantees regarding time accuracy if the user decides to use a 3rd party SNTP time server OR uses a WAN or internet to connect two Entellisys systems.

Configuring Entellisys lineups to synchronize with external time source

In this configuration, neither a master HMI or Lineup are designated. Instead, each lineup should configured as a "Client Lineup."

1. All lineups must first be setup according to section 5.2 (This step must be done to ensure time zone information is correctly written to lineup)
2. Network the lineups together (See Network considerations above)

3. At all lineups, verify that the "Synchronize Server's Time Every 12 hours" control is unchecked on all local HMIs
4. On all HMIs, navigate to the **Time Synchronization** tab (**Main Menu, Maintenance**) and
   - Change, if necessary, the "Time Server IP Address" to match the 3rd party time server IP address (The "Actual Time on Server" text box will NOT update)
   - Verify that the "Synchronize Server's Time Every 12 hours" control is unchecked on all local HMI's
   - Check the "Enable HMI Time Synchronization"
   - Click the apply button (the apply button must be clicked to update the Windows Time Service with the new time server)

3.10.5 Troubleshooting

Condition: After adding the time server IP address the actual address does not update with the current time

Problem: The time server is either not available or not communicating

Solution: There are many different reasons that this could occur.

For single lineups: Verify that the IP address for the time server matches one of the CPUs

For multiple lineups coupled with closed circuit networks without a VPN:

- Verify that the IP addresses for each CPU and HMI are unique
- Verify that CPUs or HMIs can be pinged from either lineup
- Verify that the IP address entered matches the IP address entered on the "Master HMI" on the "Master Lineup"

For multiple lineups coupled with closed circuit networks with a VPN:

- Follow the same checklist for closed circuit networks without a VPN (above)
- Verify that port 123 is allowed in all VPNs

Condition: The event log shows time differences between HMI and CPU events

Problem: The HMI and CPU time clocks are different

Solution:

- On all HMIs: Verify that the time zones are all correct
- On all HMIs (except the "Master HMI"): Verify that the "Enable HMI Time Synchronization" is checked
- Restart the "Master HMI" and navigate to the Time Synchronization tab (Main Menu, Maintenance) and click the "Update Now" button

Condition: An HMI is not synchronized with the time server

Problem: The Windows Service may not be configured with the correct time server

Solution: Go to the **Time Synchronization** tab (**Main Menu, Maintenance**) and verify the correct IP address and click the Apply button

3.11 Alarms

The Alarm Status function provides a convenient method for creating alerts for various conditions that may warrant immediate attention from operators. A single LED located at the top of the screen next to the Alarm Status button alerts the user to changes in the status of any configured alarms on a "most severe" basis, and provides navigation to the more detailed Alarm Status screen.

Each HMI instance (either remote or local) can have customized alarms, see Setup on page 103. However, if the user updates the HMI with files from the CPU it will overwrite the alarm configuration, see Sharing files across HMIs on page 88 for more details.

3.11.1 Use

During regular operation, Alarm Status is displayed as shown in Figure 3-33.

Figure 3-33 Alarm Status screen

Printing and Saving the Alarm Buttons

Use the **Print or Save to USB** buttons, to capture the alarm status. The print report includes the list of all configured alarms with their current state. Click the **Save to USB** button to export the data to a html file.

Note: The Print and Save to USB buttons are disabled when there are no alarms configured or the HMI is offline. The Print button is also disabled in Local HMI (Located in the gear).

Alarm Indication

The legend at the top of the Alarm Status screen shows the possible states for alarm conditions. The **Alarm Status** button located in the menu pane will reflect the highest alarm state of any of the configured alarms. For example, if an alarm is active and not acknowledged, the **Alarm Status** button will assume a red flashing state.

When an alarm first occurs, it transitions from a green state to a flashing red state. It remains in a flashing red state until it is acknowledged by an operator or the condition goes away (and transitions to solid red or yellow respectively). The alarm returns to a green state when the condition is normal and acknowledged.

Table 3-1 Alarm conditions

Alarm Color	Meaning
Green	Normal – The condition normal
Red (Flashing)	Active / Unacknowledged – The condition is currently persistent and has not been acknowledged by an operator
Red (Solid)	Active / Acknowledged – The condition is currently persistent but has been acknowledged by an operator
Yellow	Inactive / Unacknowledged – The condition was persistent and currently is not, but it has not been acknowledged by an operator
Gray	The alarm function is not currently communicating with the default CPU to obtain updates of the condition status.

NOTE: Transient events that occur quickly (such as an ST overcurrent trip) may appear to transition directly from green to yellow since the circuit breaker clears the fault in such a short period of time.

Acknowledge Alarms

Alarms can be acknowledged individually with the acknowledge button adjacent to each alarm, or all at once by clicking **Acknowledge All**. The alarm states are maintained by the CPU controller, so that the displayed state is consistent across both local and remote HMIs.

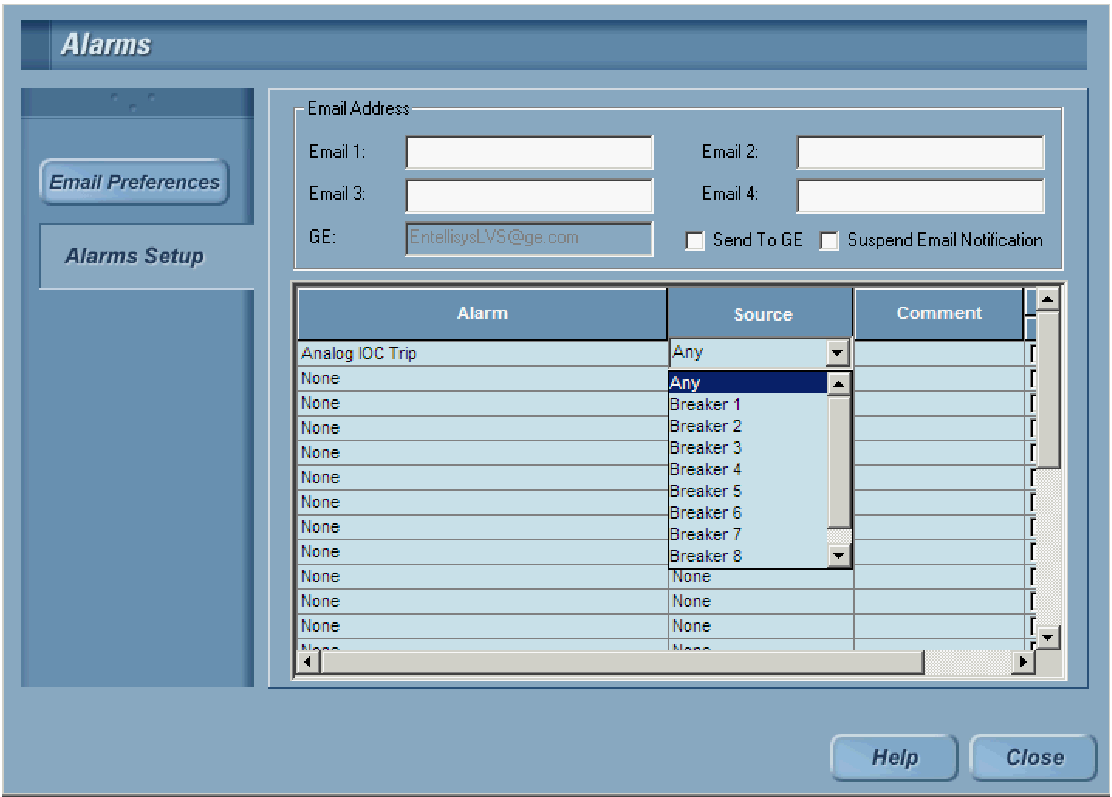
3.11.2 Setup

To set up an alarm

1. On the **Main Menu**, click **User Settings**, and then click **Alarms**
2. On the **Alarms** screen, click the **Alarms Setup** tab

The Alarms Setup tab of the Alarms screen is shown in Figure 3-34

Figure 3-34 Alarms Setup screen



To create an alarm, click a row in the **Alarms** list and select the condition to be monitored from the drop-down menu then select the source.

Up to 24 individual conditions may be selected, along with the desired e-mail notification recipients for that condition. As seen in the Alarms list, an Alarm can be a specific condition at a particular circuit breaker location or a general condition across any of the circuit breakers.

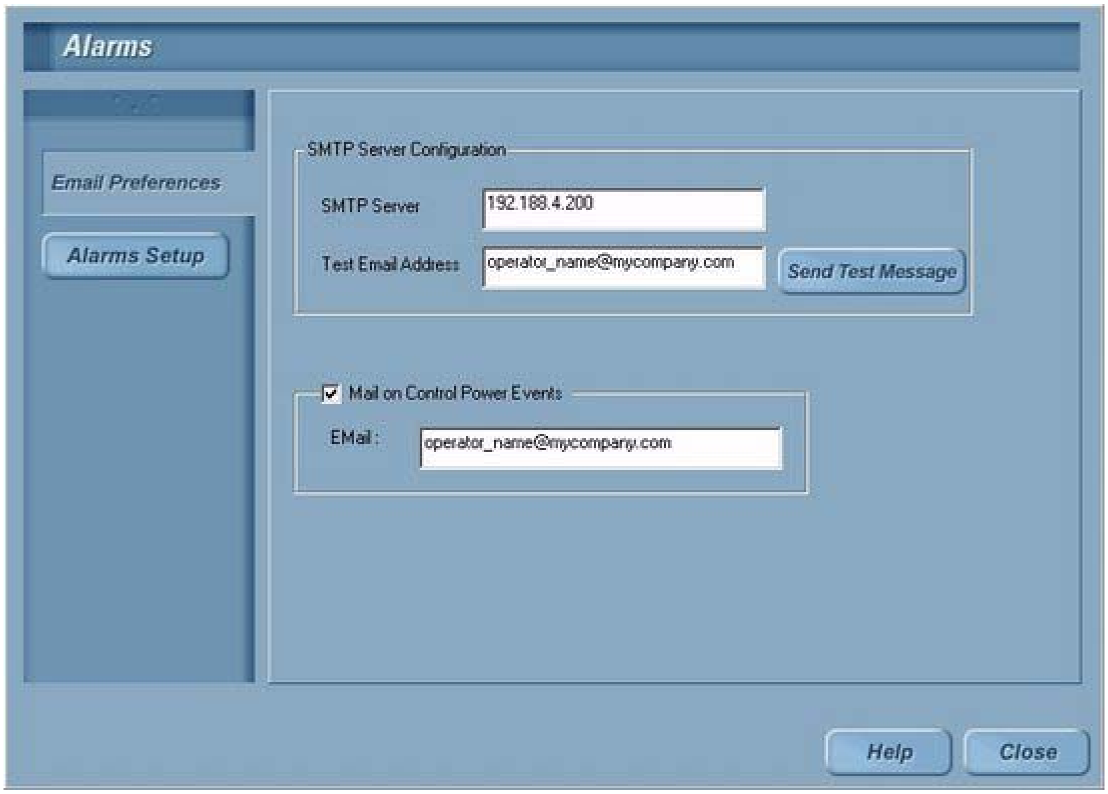
The **Send to GE** check box is used in conjunction with the optional service and maintenance contracts available through GE's Service Facilities. Please contact your local GE sales representative for more information about this service.

3.11.3 Alarm Emails

Emails can be sent when any of the 24 configurable alarms occur. The emails are sent using standard Simple Mail Transport Protocol (SMTP). Up to 4 recipients can be listed as email recipients and each alarm can be configured to email any of the 4 recipients.

Alarm emails can only be configured at a Local HMI (Kiosked) and if there are more than one local HMI, one must be designated as the master, see HMI Roles on page 112 for more details. The Lineup must also be configured to communicate on a LAN for email notifications to reach a SMTP server, see Ethernet network addressing on page 58 for more details.

Figure 3-35 Alarms Setup screen



To configure the SMTP server used for e-mail notifications, select the **Email Preferences** tab on the **Alarms** screen. Server information is typically available from an IT Systems Administrator at the plant location. A test e-mail address feature is provided to assist in testing e-mail functionality once it is set up.

The **Email Preferences** tab on the **Alarms** screen also includes a field for specifying **Email Notification on Control Power Events**. Control power events are associated with the uninterruptible power supplies that power the Entellisys Control Power Network, and may be used to warn of an extended outage of the Entellisys system.

3.11.4 Troubleshooting

Alarms are setup to send e-mail notifications, but notifications are not received

Make sure that the firewall is configured to allow communication between the specified e-mail server and the HMI.

Email can only be sent from a Local HMI which must be configured as a "Master."

Table 3-1 contains descriptions and recommended actions for abnormal states (Red or Yellow) on the Messenger Health screen. See Alarms and events on page 313 for additional information on the event descriptions. Contact information for GE Post Sales Service is located at the end of Alarms and events on page 313.

Table 3-1 descriptions and recommended actions for abnormal states

Status LED	Status	Description and Recommended Action
Messenger Hardware Health		
Self test check	Red	Call GE Post Sales Service (see How to contact us on page 2).
Configuration	Red	Call GE Post Sales Service (see How to contact us on page 2). NOTE: When this condition is detected, the following event is logged: *Caution Check Compartment ID Button Connection*
Firmware	Red	Call GE Post Sales Service (see How to contact us on page 2).
Hardware	Red	call GE Post Sales Service (see How to contact us on page 2). NOTE: When this condition is detected, one of the following events is logged: *Attention Messngr Error 3 Replace ASAP or Attention Messngr Error 4 Replace ASAP*
Compartment ID Button	Red	Call GE Post Sales Service (see How to contact us on page 2). NOTE: When this condition is detected, the following events will be logged: *Caution Check Compartment ID Button Connection and Note Messngr Error 5*
Compartment ID Button	Yellow	Call GE Post Sales Service (see How to contact us on page 2). NOTE: When this condition is detected, the following event will be logged: *Caution Check Compartment ID Button Connection*
Messenger Settings Validation		
Protection Settings in range	Red	This condition indicates that at least one of the settings in one of the CPUs is invalid. Look for any of the following events in the event log and verify the appropriate setting: *Attention Messngr Synch Disabld Bad Freq CPUA* *Attention Messngr Synch Disabld Bad Freq CPUB* *Invalid Setting IOC Mult CPUA Chng Rejected* *Invalid Setting IOC Mult CPUB Chng Rejected* *Invalid Setting ST From CPUA Change Rejected* *Invalid Setting ST From CPUB Change Rejected* *Invalid Setting GF From CPUA Change Rejected* *Invalid Setting GF From CPUB Change Rejected*

Table 3-1 descriptions and recommended actions for abnormal states

Status LED	Status	Description and Recommended Action
Messenger Communication Status		
CPU Communications	Red	This condition indicates a communications problem between the Messenger and one of the CPU's. One of the following events may appear in the event log: Caution Messngr Not Receiving From CPUA Caution Messngr Not Receiving From CPUB
Communication Wiring	Red	This condition indicates that a Messenger is reporting that there is no communication link between itself and one of the CPU's. One of the following events may appear in the event log: *Caution Enet Cable Disconnected Messngr CPUA* *Caution Enet Cable Disconnected Messngr CPUB*
Messenger Control Power		
Primary Control Power	Red	Power is not available to the Messenger from the primary control power source. See Alarms and events on page 313 under "Caution Messngr Control Power Lost" event for additional troubleshooting information.
Secondary Control Power	Red	Power is not available to the Messenger from the secondary control power source. See Alarms and events on page 313 under "Caution Messngr Control Power Lost" event for additional troubleshooting information.

3.11.5 Troubleshooting

One of the LEDs is red indicating a problem, but the Sequence of Events log does not provide any details about the condition

- Ensure that the event is not being filtered from the display. On the **Sequence of Events** screen, click **Preferences**, and then click **Filter Events** and review any unchecked events.

3.12 Multiple lineups

The Remote HMI software allows the user to quickly navigate between multiple Entellisys 4.0 Lineups. It is important to note that HMI can only annunciate alarms from the current Lineup which the HMI is connected. Alarms from all other configured lineups are not recognized until the user connects to that lineup.

Highlights

- Available only on remote interactive or remote view HMI software
- View, edit and control up to 25 lineups

User Permissions

All users have permissions to add, change or delete Lineups

Offline Mode

If the Entellisys HMI software is configured for offline mode for any of the lineups, none of the configured lineups will connect. (See Offline mode on page 47)

HMI Events

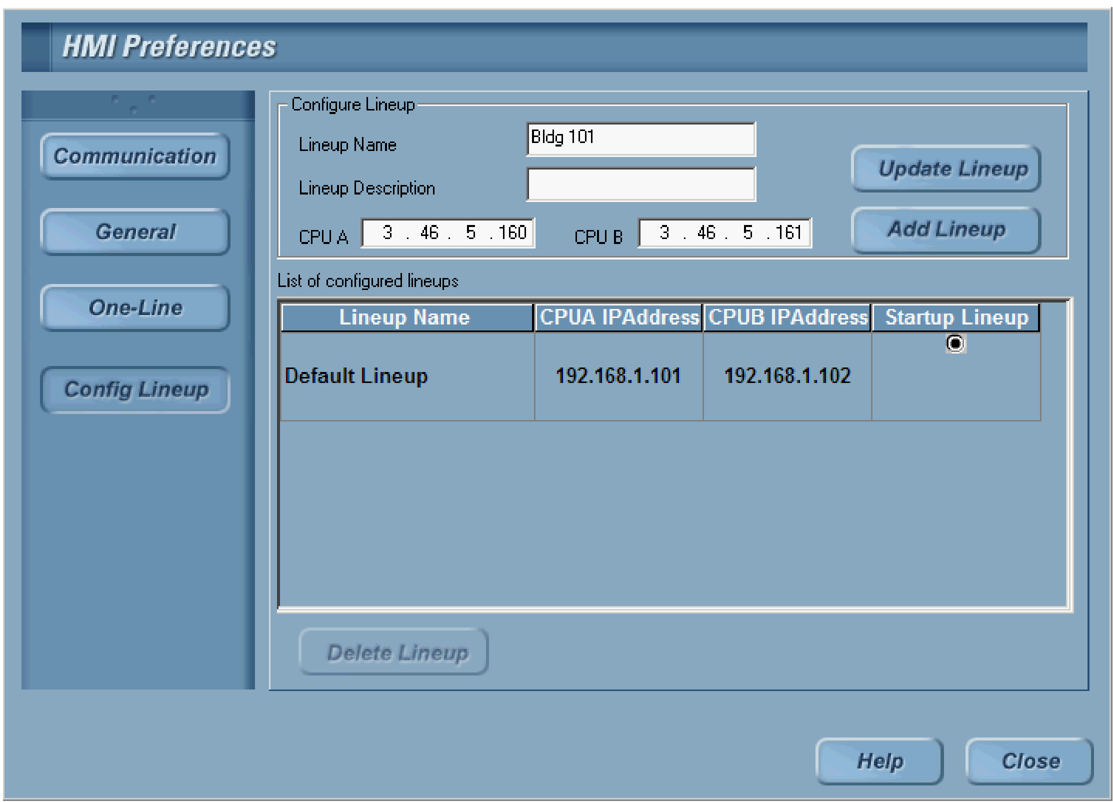
When logging into the system, the HMI will log an event “Switched to <Lineup Name>.” The HMI will also log current time zones of the user’s PC running the Remote HMI software and the lineup CPUs.

NOTE: Time zone differences between a remote HMI and the lineup will cause timestamp differences between CPU and any local HMI events. Will not affect events on CPU

3.12.1 Configuring Lineups

To configure a Lineup, login to the HMI and from the main menu, select “HMI Preferences.” Click on the “Config Lineup”

Figure 3-36 HMI Preferences



To add a lineup

1. Enter in the **Lineup name** (Must be unique and is limited to 30 characters)
2. Enter the Lineup Description (Limited to 250 characters)
3. Enter IP Addresses for both CPUA and CPUB (Must be unique)
4. Click the Startup Lineup to specify the default lineup

5. Click the **"Add Lineup"** button

To modify a lineup

1. Click on the desired lineup in the list and the Name, Description and IP addresses will populate with the lineup information - edit the information
2. Select "**Update Lineup**"

To Delete a lineup

1. Click on the desired lineup in the list and the Name, Description and IP addresses will populate with the lineup information
2. Select "Delete Lineup" (The current lineup and startup lineup cannot be deleted)

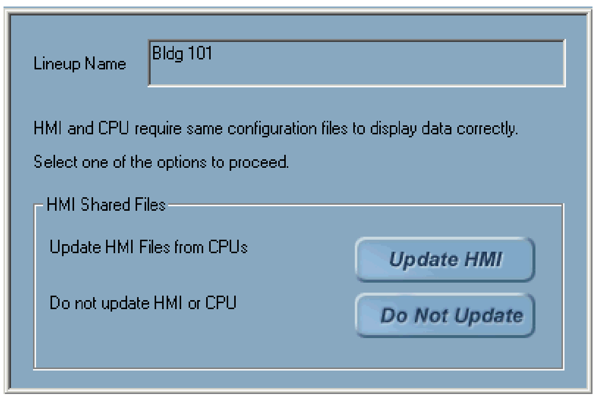
The Startup Lineup

The Startup Lineup is the default lineup which the HMI connects to each time the Remote HMI software is started

Configuration file upload

After either changing the default lineup or when connecting to an Entellisys Lineup for the first time, the HMI will attempt to connect and upload all HMI files from the CPUs of the respective lineup. (See figure 3-37) If the CPUs are unavailable, the lineup will still be entered and HMI will try again when the user selects the HMI from the **"Select Lineup"** screen. If there is a mismatch, the user will be prompted to either update the HMI or do nothing.

Figure 3-37 HMI file mismatch dialog



If the Entellisys system was configured in offline mode, do not select "Update HMI." See section Write settings to a live system on page 49 for details on uploading settings to the CPU.

NOTE: The order in which lineups appear in the "Select Lineup" screen is fixed to the order in which they were added into the HMI.

3.12.2 Switching between lineups

The Entellisys LVS Remote HMI lets you configure up to 25 lineups. Click on the select lineup button (in HMI title bar) to view the dashboard screen as shown below. The name of the lineup that the HMI is currently connected to will remain in the title bar until another lineup is selected.

Figure 3-38 Select Lineup Menu

The Dashboard displays all the configured lineups. To switch to a different lineup, simply click on the Lineup.

Connecting to a lineup for the first time

The HMI will prompt to download files from the CPU for selected lineup and will display the default HMI screen for that lineup. All subsequent connections to Lineup, the HMI will use the local files stored on the HMI. The HMI will also prompt for a download if the CPU has been updated from another HMI.

Offline HMIs

If the Remote HMI is offline (See Offline mode on page 47), lineup communication is not tested. However, the user can still add, edit, delete and switch between lineups. The HMI will use local HMI files if available.

Communication status LED

While in the “Select Lineup” screen, the communication is tested for each of the configured lineups and the status is indicated by the communication status LED according to colors below:

- **Green** - both CPUs are communicating with the HMI
- **Yellow** - only one of the CPUs is communicating with the HMI
- **Red** - neither CPU is communicating with the HMI
- **Grayed-out** - when the CPU is incompatible or the HMI as been set to offline by the user and does not attempt to establish communication to any of the lineups

3.13 Modbus® security

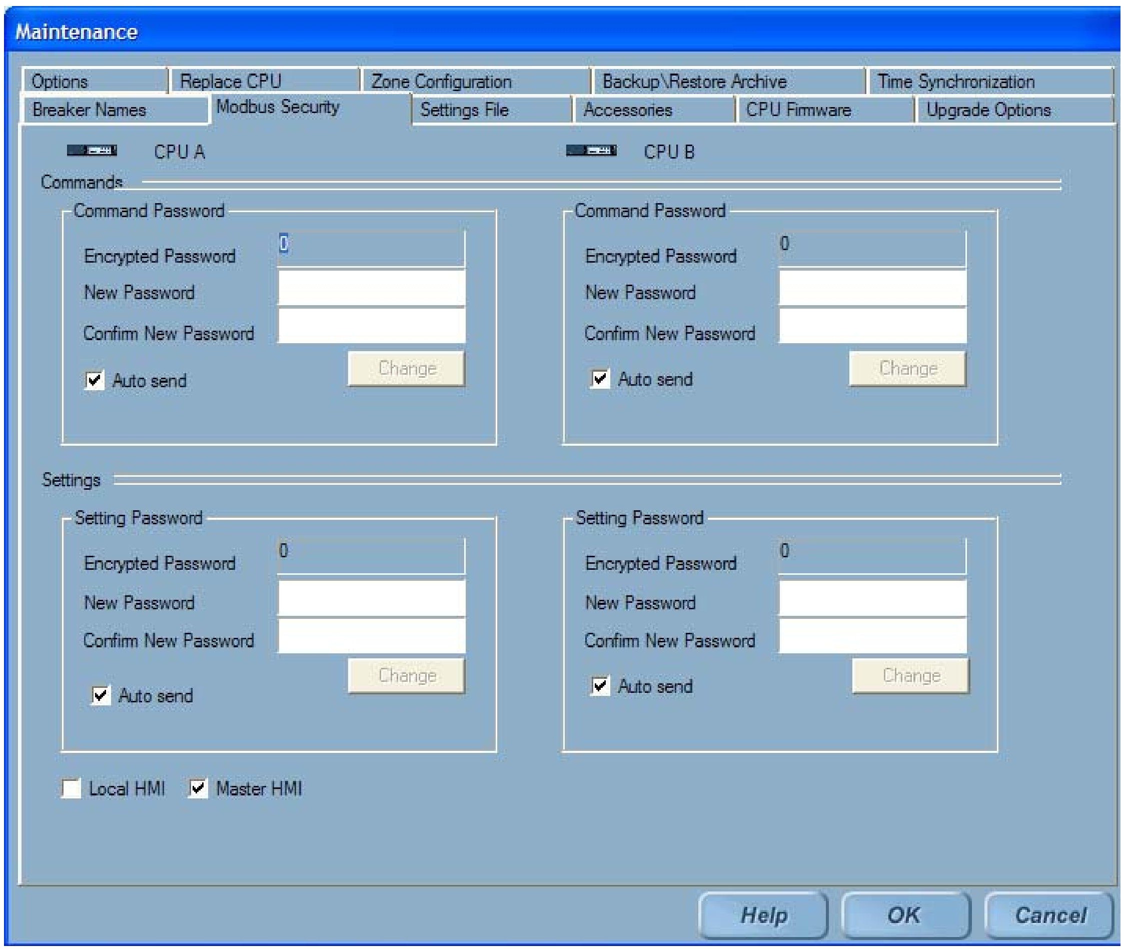
3.13.1 Control and settings passwords

The CPUs require extra passwords to change settings (i.e., Short Time pickup delay setting) and to send commands (i.e., Open Breaker command). These passwords apply to all clients that access the Entellisys system through Modbus communications including the Entellisys HMI, SCADA, or Building Automation, etc.

NOTE: The system ships with default CPU Modbus Settings and Command passwords. The System Administrator should change these passwords for added security.

The HMI can be configured to transparently send the passwords whenever needed or it can be configured to require all users to re-enter the password when the action is attempted.

Figure 3-39 Modbus Security screen in the HMI



To change the Settings and/or Command passwords

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Modbus Security** tab. The Modbus Security screen has options to change both CPU A and CPU B Command and Settings passwords.

NOTE: It is recommended that the passwords in CPU A and CPU B be set to the same value.

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3. Enter the new commands password in the **New Password** field - password must be a numeric number
4. Re-enter the password in the **Confirm Password** field
5. Click the **Change** button to download the password
6. Select the desired **Auto Send** option
    - Check indicates the Auto Send option will transparently send the password each time a command is sent to the CPU
    - Unchecked disables the Auto Send option.The user will be prompted to enter the password (for the CPU that is currently the default) each time a command is sent

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NOTE: For added security, it is recommended the Auto Send option be disabled. This will require an additional password to be entered each time a command is performed.

Clear Modbus passwords

1. Type “0” in both the **Password** and **Confirm Password** fields
2. Click **Change**
3. Enter the old password

3.13.2 HMI Roles

An Entellisys system may have multiple HMI stations running. There are three different roles that the HMI software will perform. There are some functions that should be performed by one HMI only.

The Kiosked touchscreen HMIs are considered **Local HMIs** and can be configured as a local or a master HMI.

The **“Local HMI”** check box designates the redundant HMI. When it is checked:

- The user can block breaker commands from other HMIs in the “Breaker Control” screen (See Controlling circuit breakers on page 92)
- HMI uses port 503 for Modbus TCP/IP communication with CPUs
- “Master HMI” check box is cleared
- HMI updates time zone bias information of CPUs that reside in the same lineup whenever that information is adjusted

The **"Master HMI"** check box designates the primary HMI. When it is checked:

- The HMI have the functions of the **"Local HMI"**
- Send alarm emails via SNTP
- Operate Reduced Energy Let - Thru Mode (RELT)

Remote HMI Role

The Remote HMI software which can be installed on a standard workstation or laptop. There are some minor differences between the Remote HMI and the Local HMI.

- The Local and Master HMI controls are disabled
- Does not send out email notifications for alarms
- Does not have ability to block breaker commands
- Uses port 502 for Modbus TCP/IP communication with CPUs
- Does not update time and time zone bias information of the CPUs

Communication restrictions

The CPUs can support up to 8 simultaneous communication ports for Modbus clients. Once the limit is exceeded, clients will be blocked until a port is free. The Local HMIs have special ports reserved for its use.

To set an Local HMI as a "Master"

1. On the **Main Menu**, click the **Maintenance** button. The button will only be displayed if access is allowed with the current login permissions.
2. Click the **Modbus Security** tab.
3. Select the **Master** check box as shown in Figure 3-39.
4. Click the **OK** button to save changes (or click **Cancel** to cancel changes).

3.14 Restricted Breaker Control

In systems with certain supervisory control schemes, such as a paralleling gear application, it may be necessary to deny breaker control from the user or from other Modbus TCP clients.

Using the Restricted Breaker Control feature, a code can be added for open, close and trip operations for selected breakers. Each function (open/close/trip) can be configured independently for a selected breaker.

Restricted Operation: (Restricted command enabled)

When Restricted Breaker Control is enabled for an operation on a particular breaker, all normal command avenues are disabled (except protective relays). The CPU will expect the pre-configured code to be written to a different register for the respective breaker for open, close or trip commands. The pre-configured code must match the code entered for the command and breaker in question in the "**Restricted Breaker Control"** setting screen. (See Setup on page 115)

For more information about operating breakers from a 3rd party Modbus TCP client, see DEH 502 System Integrator's guide.

NOTE: Restricted breaker control does NOT interfere with protective relays or FlexLogic and their ability to operate the breaker.

Enabling Restricted Breaker Control: Restricted Breaker Control is available but disabled by default. It must be enabled by the factory or a GE Field Service Engineer. Once enabled, the user controls shown in Figure 3-40 will be available.

Events:

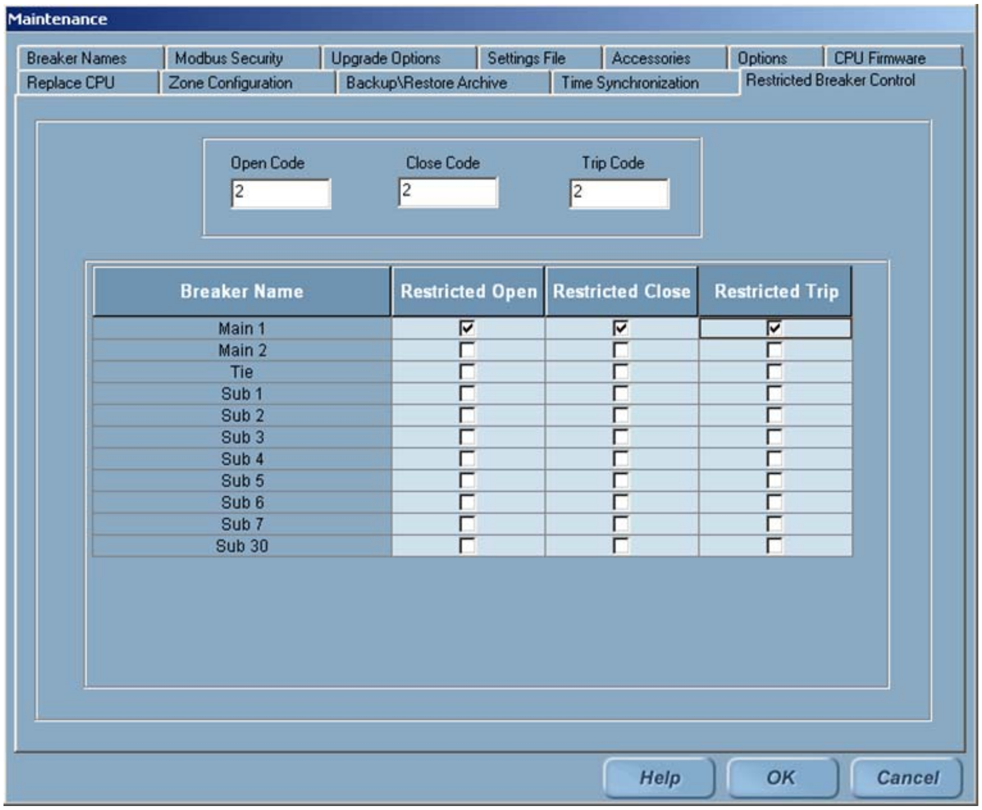
Following events are issued when a restricted breaker receives either a open, close or trip command.

- **Breaker Open/Close/Trip Command Restricted Control Received**: CPU acknowledged that the "SRC X Open/Close/Trip Breaker By Restricted Control" register received the correct command code.
- **Breaker Open/Close/Trip Cmd Restricted Cntrl Incorrect Code**: CPU reported that the "SRC X Open/Close/Trip Breaker By Restricted Control" register received the incorrect command code.
- **Breaker Open/Close/Trip Cmd Restricted Control Not Enabled**: CPU reported that the "SRC X Open/Close/Trip Breaker By Restricted Control" register received a command but the Restricted Breaker Control is disabled.
- **Breaker Open/Close/Trip Command Restricted Control Enabled**: CPU acknowledged that the normal Open/Close/Trip command was rejected because the associated command was restricted for the breaker. See Setup on page 115.

Setup

Navigate to the “Restricted Breaker Control” tab from the Main Menu, Maintenance screen - administrative login is required.

Figure 3-40 Restricted Breaker Control Setting Screen



Open / Close and Trip Code Text Boxes

Enter the code that is required to operate the associated breaker(s) in restricted mode. The default value for the Open/Close/Trip code is “2.” Allowable values are from 2 to 65535.

Breaker Operation Matrix

Check the operations per breaker which require restricted control.

NOTE: Restricting operations will prevent the HMI from sending said actions to the respective breaker(s).

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4 Metering

4

Entellisys provides a number of metering quantities, including RMS current and voltage, demands, energy values, power factors, and harmonic data. There are four levels of metering available: basic metering, expanded metering, demand metering, and harmonics metering.

The Metering & Waveforms window lets you specify metering, Meter distribution, Waveform capture, Demand metering and Demand Metering Alarms.

For Entellisys to correctly calculate all metering quantities that require voltage, it must know the potential transformer (PT) configuration (i.e., nominal voltage and whether it is a wye or delta) for the breaker that is supplying the voltage information. Entellisys does not require PTs at each breaker, so the voltage information supplied by one breaker can be used for calculations for other breakers. Entellisys also must know the current flow direction for each breaker.

NOTE: Note: Power flow direction is set by GE during factory configuration. It cannot be set by the user.

To specify metering settings:

1. Navigate to Metering & Waveforms.
2. Select the Breaker selection down arrow and select a breaker from the drop-down list. Entellisys displays rating information about the frame and sensor of the selected breaker.
3. Entellisys displays the PT Rating for the selected breaker. If this breaker does not have a PT attached, the Reference PT breaker is identified.
4. Entellisys displays the direction of the power flow – Forward or Reverse.
5. Click the Apply button to save your settings. (Click the Cancel button to close the window without saving your changes.)
6. When you've finished specifying Metering & Waveform settings, click the OK button to save all your settings, close the window, and return to the User Settings menu.

4.1 Basic configuration

Much of the basic configuration information necessary to ensure that metering operates correctly is required for other functions, such as overcurrent functions and relays, as well; this information is given in another section. It will be outlined here, however, as an introduction.

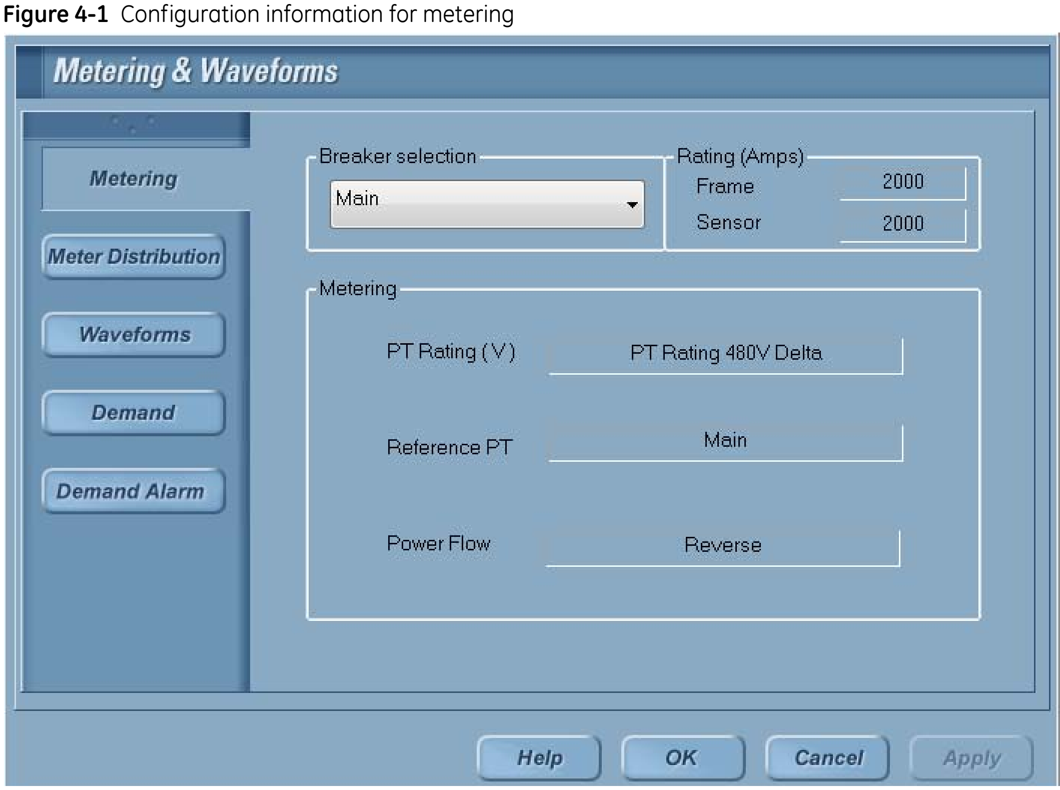
For Entellisys to correctly calculate all metering quantities that require current, it needs to know the sensor rating for each circuit breaker. This information is stored in the Compartment ID button that is connected to each Messenger. Entellisys also needs to have the current flow direction for each circuit breaker.

For Entellisys to correctly calculate all metering quantities that require voltage, it needs to know the potential transformer (PT) configuration (i.e., nominal voltage and whether it is a wye or delta) for the circuit breaker that is supplying the voltage information. Entellisys does not require PTs at each circuit breaker, so the voltage information supplied by one circuit breaker can be used for calculations for other circuit breakers. See PT Throw-Over on page 206 for more information.

To view the frame and CT ratings, power flow direction, PT configuration, and reference PT for each circuit breaker, click **Metering & Waveforms** on the the **User Settings** screen and then click **Metering**. The Metering options for the Metering & Waveforms screen are shown in Figure 4-1.

NOTE: Power flow direction is set by GE during factory configuration. It cannot be set by the user.

Figure 4-1 Configuration information for metering



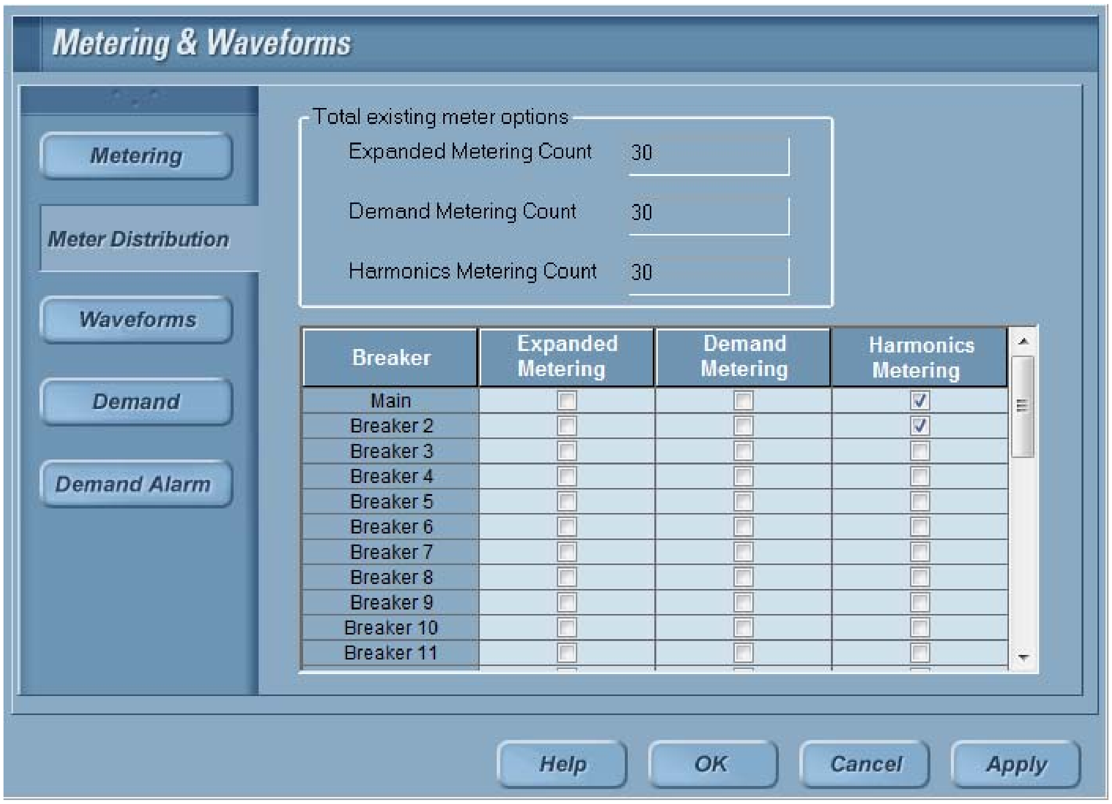
4.1.1 Meter distribution

One of the unique features of Entellisys is that meters can be moved from one circuit breaker to another with just a few clicks. To change the placement of meters, click **Metering & Waveforms** on the **User Settings** screen and then click **Meter Distribution**. The Meter Distribution parameters on the Metering & Waveforms screen are shown in Figure 4-2.

NOTE: When a meter is removed from a circuit breaker, all data accumulated at that circuit breaker (e.g., maximum demands, demand log information, and energy values) are cleared.

Because all metering information available with the expanded metering option is also available with the demand metering option, and all metering information available with the demand metering option is also available with the harmonics metering option, it does not make any sense to enable more than one meter type for a given circuit breaker. The HMI prevents the enabling of more than one meter type for a given circuit breaker. The HMI also prevents the enabling of more meters than the number of metering options purchased.

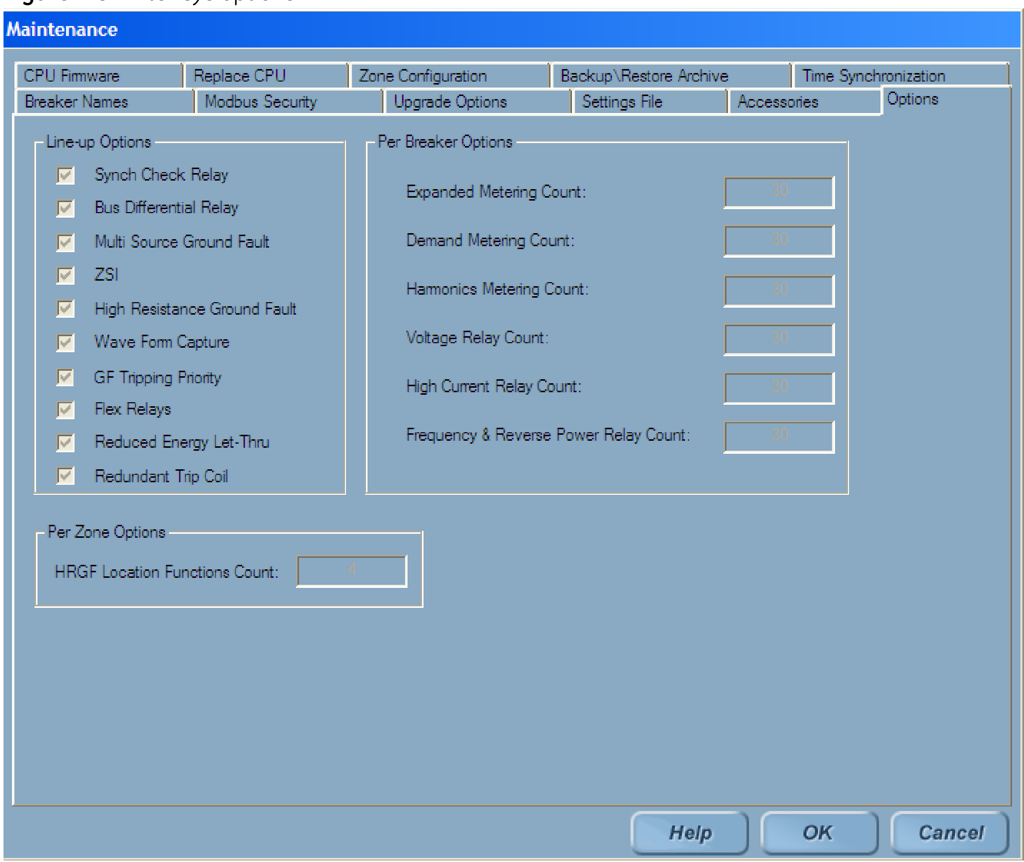
Figure 4-2 Meter distribution



4.2 Metering options

The three metering options (expanded, demand, and advanced) are described in the previous sections. The number of each type of metering option purchased is specified in the option string downloaded to the Entellisys CPU. To view the number of each type of option available, click the **Options** tab on the **Maintenance** screen. The Options tab of the Maintenance screen is shown in Figure 4-3.

Figure 4-3 Entellisys options



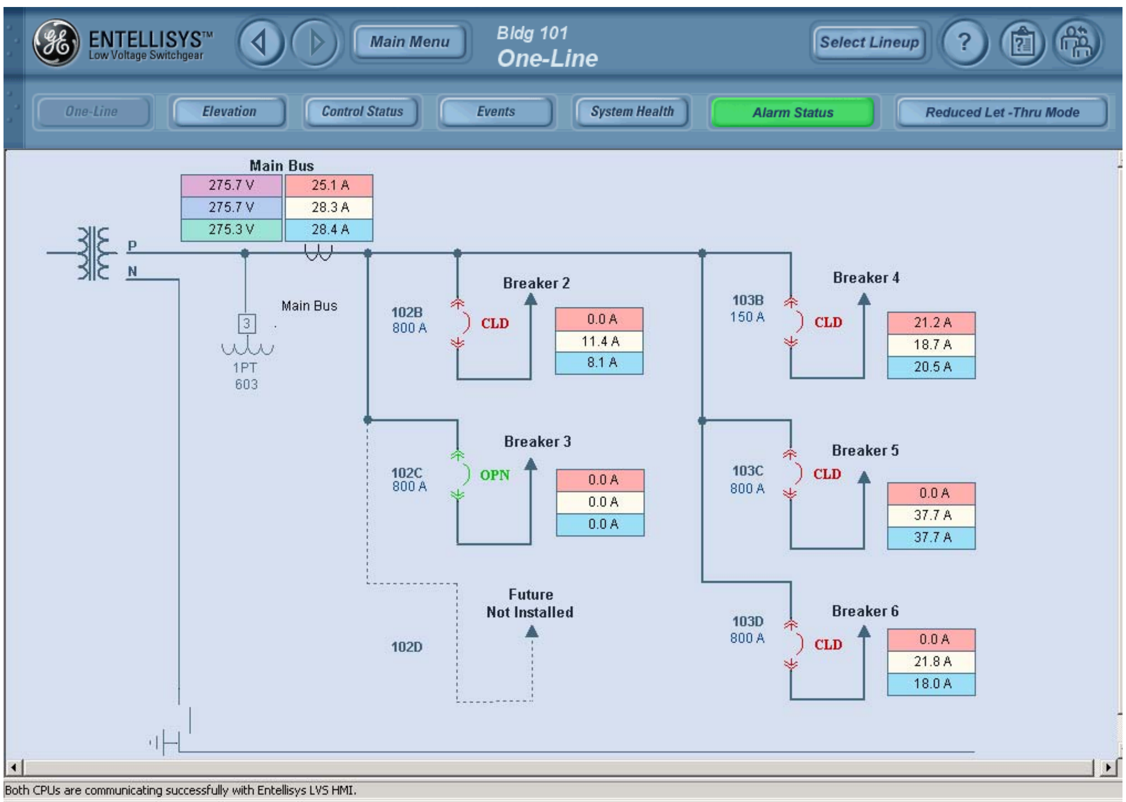
4.2.1 Basic metering

Basic metering is always available in Entellisys (i.e., it is not an optional feature). Basic metering includes RMS current per phase (I_A, I_B, I_C and I_N) and RMS voltage per phase. For wye PTs, Entellisys provides line-to-neutral (V_A, V_B and V_C) and line-to-line (V_{AB}, V_{BC} and V_{CA}) voltages. For delta PTs, Entellisys provides line-to-line voltages only.

The RMS voltages and currents are averages over one second (nominally 60 cycles of the fundamental power system frequency at 60 Hz) and include harmonics.

Basic metering quantities (i.e., RMS voltage and current) are typically available on the one-line diagram, although this depends on how the one-line diagram is configured. Figure 4-4 shows a one-line diagram that displays the RMS currents at each circuit breaker and the RMS voltages at the main bus.

Figure 4-4 One-Line diagram



To view all metering data, click the circuit breaker of interest in the one-line diagram. The **Breaker Status** screen appears, as shown in Figure 4-5.

The Breaker Status screen displays information about all aspects of the circuit breaker. However, in this section we are only concerned with metering data (i.e., the basic metering data [phase currents and phase voltages]) and the buttons for navigating to the screens that display optional metering data.

Figure 4-5 Breaker Status screen

4.2.2 Expanded metering

Expanded metering (also referred to as detailed metering) is an optional feature in Entellisys. Expanded metering can be enabled for each circuit breaker, up to the maximum number of purchased expanded metering options. With the expanded metering option enabled, Entellisys provides the following quantities:

- Positive watt-hours, per phase and total
- Negative watt-hours, per phase and total
- Positive var-hours, per phase and total
- Negative var-hours, per phase and total
- Apparent VA-hours, per phase and total
- Real power (watts) per phase and total
- Reactive power (vars) per phase and total
- Apparent power (VA) per phase and total
- Power factor per phase and total
- Minimum power factor, including date and time, per phase and total
- Maximum power factor, including date and time, per phase and total
- System Frequency

Figure 4-6 Detailed Metering screen

Per phase quantities are only available for wye connected systems.

Watt-hours, var-hours, and VA-hours are sums starting from when the option was last applied, or since the last time the values were reset through the HMI.

Real, reactive, and apparent power quantities are averages over one second (nominally 60 cycles of the fundamental power system frequency at 60 Hz) and include harmonics. Power factors are calculated by dividing real power by apparent power.

Watts and watt-hours are positive when the current is flowing from line to load and negative when the current is flowing from load to line. Vars and var-hours are positive when the current is lagging the voltage and negative when the current is leading the voltage.

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The power factor is positive (i.e., lagging) when watts and vars have the same sign and negative when watts and vars have the opposite sign. Minimum and maximum comparisons are done based on magnitudes (e.g., a power factor of –0.866 is greater than a power factor of 0.707).

System frequency is calculated using phase A to N in WYE systems and phase A to B in Delta systems. To view the Detailed Metering screen, click **Detailed Metering** on the **Breaker Status** screen. The Detailed Metering screen is shown in Figure 4-6.

NOTE: The Expanded Metering button is only active if the Expanded Metering option is enabled for that circuit breaker. A description of the quantities available in the Detailed Metering screen is given above.

The Clear Energy button resets the Real, Reactive, and Apparent energy values, as well as the Minimum and Maximum Power Factors, for the circuit breaker currently being viewed.

The Clear All Bkrs button resets the energy and power factor values for all the circuit breakers. Entellisys keeps track of how many times the energy values have been reset, as well as the date and time of the last resets.

4.2.3 Harmonics metering

Harmonics metering is an optional feature in Entellisys. Harmonics metering can be enabled for each circuit breaker, up to the maximum number of purchased harmonics metering options. When the harmonics metering option is enabled, Entellisys provides the following quantities:

- All quantities available with the demand metering option
- K factor for each current phase
- Voltage Total Harmonic Distortion (VTHD) for each phase
- Current Total Harmonic Distortion (ITHD) for each phase
- Frequency spectrum (magnitude only) for voltage and phase

Entellisys samples at 64 samples per cycle, so it will display the up to the 31^{st} harmonic.

To view the Harmonics Metering screen, click **Harmonics Metering** on the **Breaker Status** screen. The Harmonics Metering screen is shown in Figure 4-7.

Figure 4-7 Harmonics Metering screen

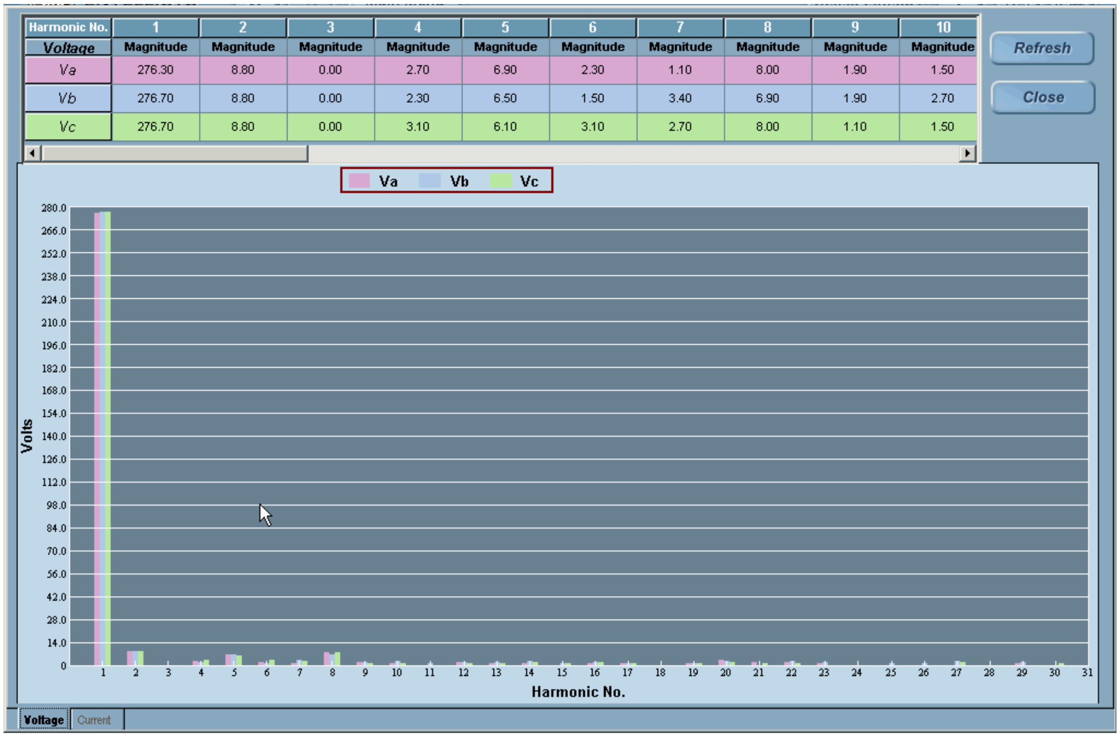
NOTE: The Harmonics Metering button is only active if the Harmonics Metering option is enabled for that circuit breaker.

4.2.4 Harmonic distortion analysis

To view the frequency spectra of the voltages and currents, click **Harmonics Analysis** on the **Harmonics Metering** screen shown in Figure 4-7. Sample frequency spectra are shown in Figure 4-8.

The graph will autoscale to the largest harmonic.

Figure 4-8 Frequency spectra for currents



4.3 Demand metering

The only programmable parameters for metering are the demand interval or subinterval length, and the number of subintervals per interval. To set these parameters, click **Metering & Waveforms** on the **User Settings** screen and then click **Demand**. The Demand parameters on the Metering & Waveforms screen are shown in Figure 4-12.

Demand metering is an optional feature in Entellisys. Demand metering can be enabled for each circuit breaker, up to the maximum number of purchased demand metering options. When the demand metering option is enabled, Entellisys provides the following quantities:

- All quantities available with the expanded metering option
- Previous interval kilowatt (kW) demand
- Maximum kW demand
- Previous interval kilovar (kvar) demand
- Maximum kvar demand

- Previous interval kVA demand
- Maximum kVA demand
- Demand logging – kWh, kvarh, kW demand, kvar demand, power factor

Per phase quantities are only available for wye connected systems.

To view the Demand Metering screen, click **Demand Metering** on the **Breaker Status** screen. The Demand Metering screen is shown in Figure 4-9.

The method for calculating previous interval and maximum demands and the function of the demand log are described above.

NOTE: The Demand Metering button is only active if the Demand Metering option is enabled at that circuit breaker.

In addition to viewing previous interval and maximum demands, demand log files can also be viewed. To view demand log files, click **View** on the **Demand Metering** screen. A demand log file is shown in Figure 4-10.

Figure 4-9 Demand Metering screen

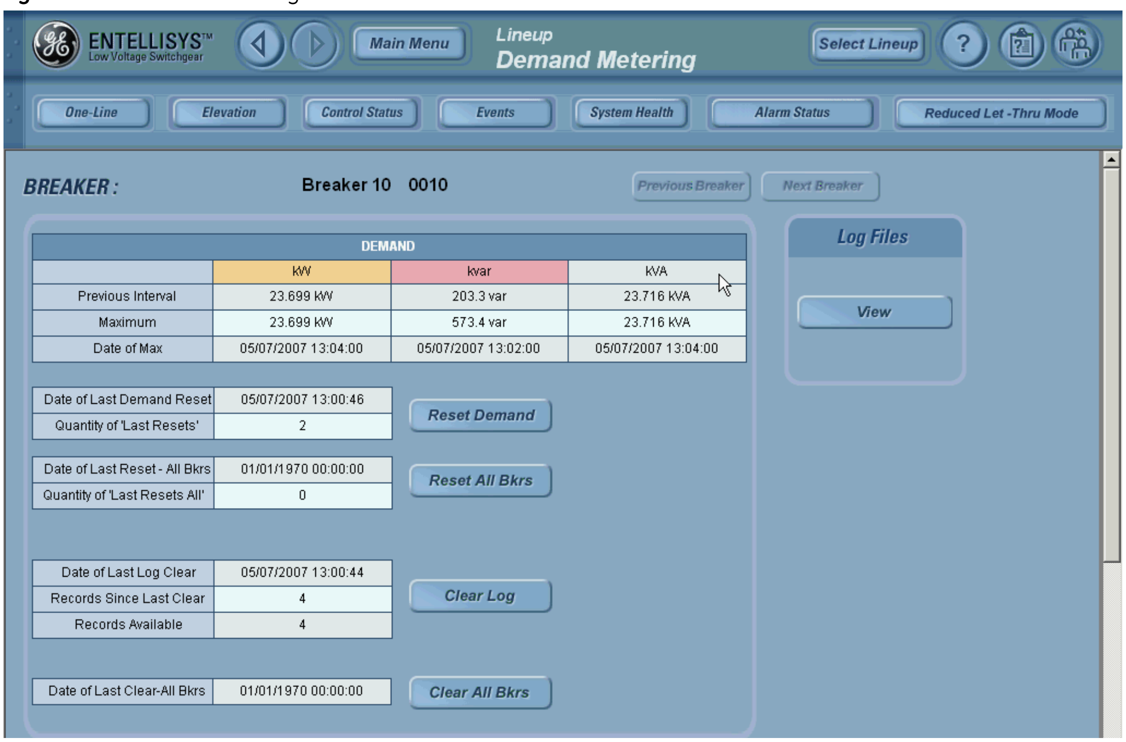
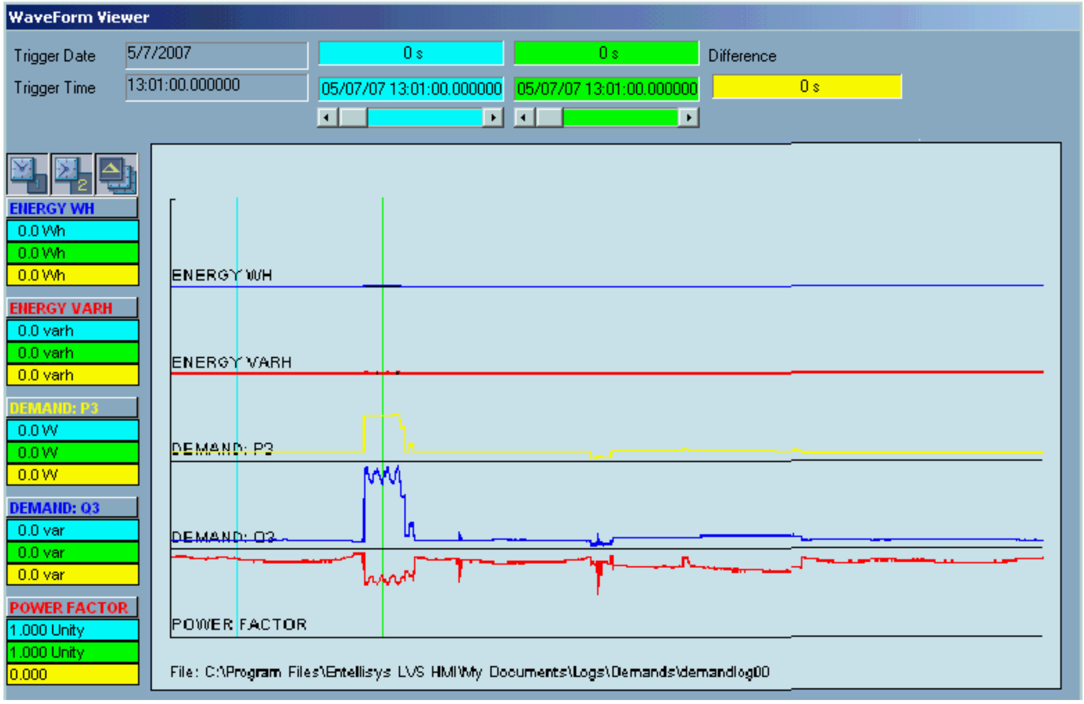


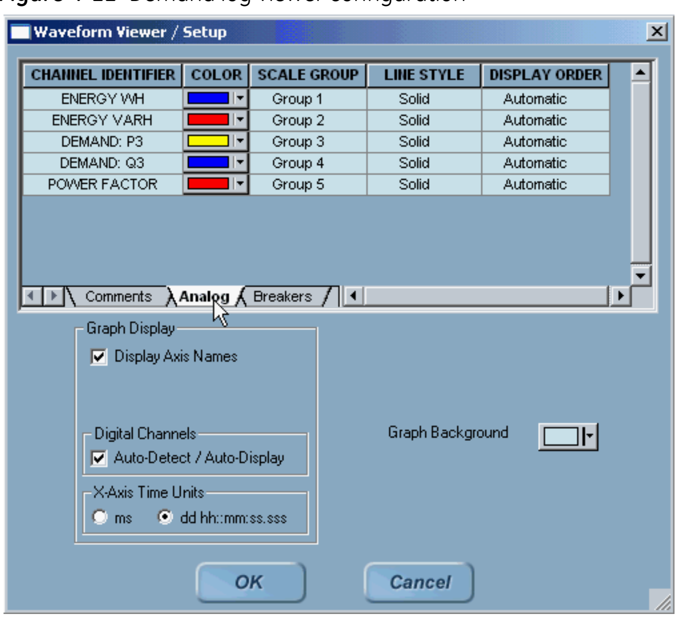
Figure 4-10 Demand log viewer



The demand log shows the demand, power factor, and energy used by the system over time. To view the details of the log (actual date and time at the top of the window and specific values at the far left of the window) at a given time move the cursors by dragging the sliding bars at the top of the window.

The Save to USB button saves the demand log file to the USB drive. The Config button provides setup information, such as the line colors and the order in which the data appear, for the demand log viewer. A demand log viewer configuration file is shown in Figure 4-11.

Figure 4-11 Demand log viewer configuration

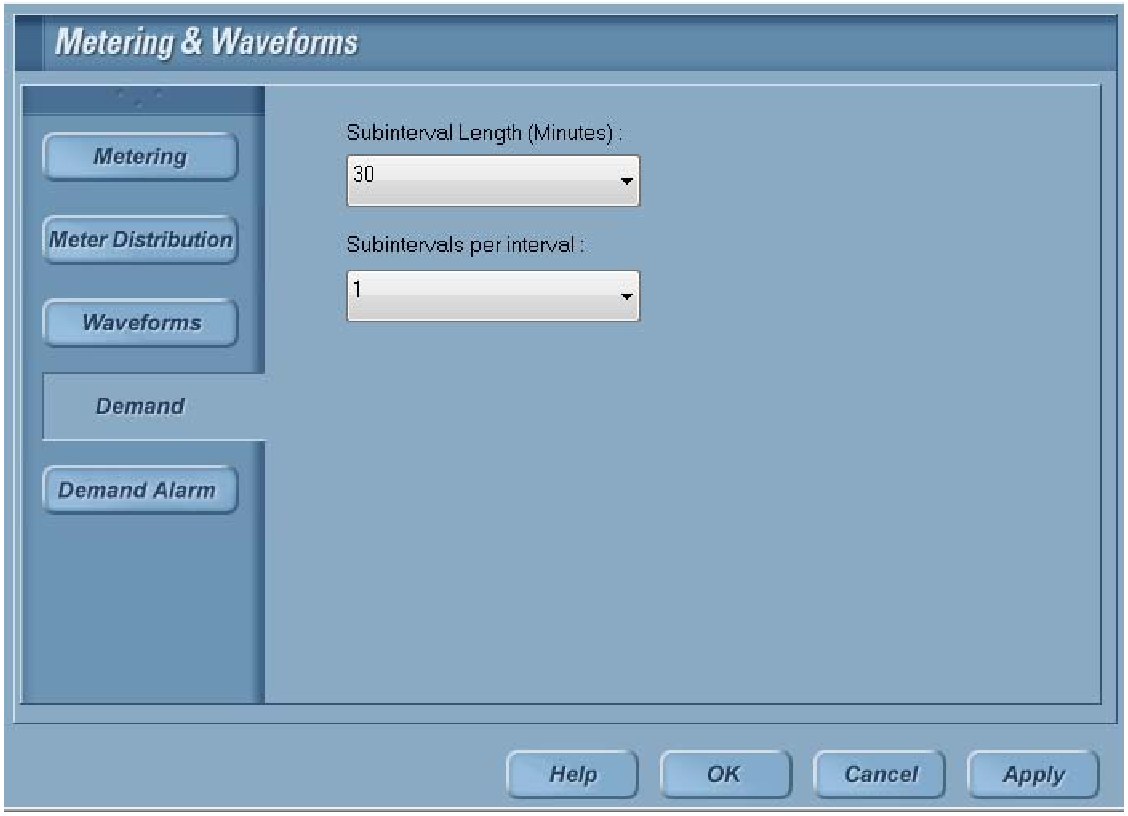


The Demand Metering screen provides buttons that reset the demand values and the demand logs.

The Reset Demand button resets the demand for the circuit breaker that is currently being viewed; the Reset All Bkrs button resets the demand for all circuit breakers.

The Clear Log button resets the demand log for the circuit breaker that is currently being viewed; the Clear All Bkrs button resets the demand logs for all circuit breakers. Entellisys keeps track of how many times the demands and the demand logs have been reset, as well as the date and time of the last resets.

Figure 4-12 Configuring demand calculations



Demands are averages over a demand interval. Entellisys supports both block and rolling demand intervals:

Table 4-1 Demand interval and subinterval combinations supported in Entellisys

Subintervals per interval	**Subinterval length, minutes**										
	1	2	3	4	5	6	10	15	20	30	60
1 (block demand)	x	x	x	x	x	x	x	x	x	x	x
2	x	x	x		x	x	x	x		x	
3	x	x		x	x		x		x		
4	x		x		x			x			
5	x	x	x	x		x					
6	x	x			x		x				

Table 4-1 Demand interval and subinterval combinations supported in Entellisys

Subintervals per interval	Subinterval length, minutes										
	1	2	3	4	5	6	10	15	20	30	60
10	x	x	x			x					
12	x				x						
	x	x		x							

For block demand, Entellisys calculates the average demand over the duration of the demand interval. For rolling demand, Entellisys calculates the average demand over the previous *N* subintervals, where *N* is the number of subintervals per demand interval. This is done at the end of each demand subinterval. Demand intervals are synchronized to the hour boundary. For example, if the demand interval or subinterval length is 15 minutes, the demand intervals end on the hour and at 15, 30, and 45 minutes past the hour.

The programmed interval length (block demand) or subinterval length and the number of subintervals per demand interval apply to all circuit breakers at which demand metering is enabled.

Demand log entries are added at the end of each demand interval or subinterval.

4.4 Metering accuracy

Table 4-2 shows the metering accuracy for Wh, varh, VAh, W, var, and VA under the following conditions:

- Nominal frequency
- Nominal voltage
- Power factor of 0.85 to 1.00 for Wh and VAh
- Power factor of 0.00 to 0.15 for varh

Table 4-2 Metering accuracy for Wh, varh, VAh, W, var, and VA

Current (percent of nominal CT rating)	Accuracy (percent of reading, includes current and voltage sensors)
10%	± 5.0%
30%	± 4.5%
50%	± 4.0%
75%	± 3.0%
85-100%	± 2.0%

Table 4-3 shows the voltage accuracy at nominal frequency:

Table 4-3 Voltage accuracy at nominal frequency

Current (percent of nominal PT rating)	Accuracy (percent of reading, includes voltage sensors)
50%	± 2.0%
75%	± 1.5%
85-100%	± 0.8%

Table 4-4 shows the current accuracy at nominal frequency:

Table 4-4 Current accuracy at nominal frequency

Current (percent of nominal CT rating)	Accuracy (percent of reading, includes current sensors)
10%	± 3.5%
30%	± 3.25%
50%	± 2.75%
75%	± 1.75%
85-100%	± 0.8%

4.5 Demand Metering Alarms

Demand alarms are designed to be used for demand indication and control and are only available with the Flex Relay option.

4.5.1 Operation

16 separate Demand Alarms are available. Each has an Under Demand and Over Demand set point. Each will generate different events and have separate control inputs in FlexLogic.

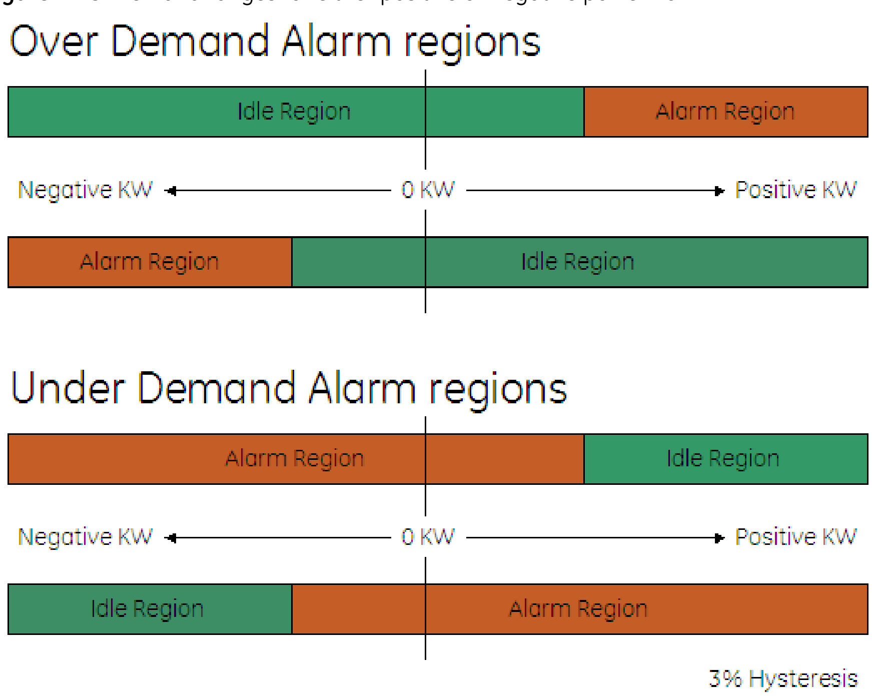
The demand is calculated on the three-phase sum for each relay using the sub-interval setting and will start as soon as the Demand Alarm is enabled.

The calculated demand must enter the desired demand range before the demand alarm is "armed." Once armed, the Demand Alarm will go into pickup as soon as a demand subinterval either exceeds the Over-Demand pickup or drops below the Under-Demand pickup setting. If it remains in pickup for the configured delay time, it will alarm.

Powerflow Direction

Powerflow will change the direction and how the set points should be configured. In figure 4-13, setpoint relationships are shown for both positive and negative power flow situations.

Figure 4-13 Demand ranges for either positive or negative power flow



FlexLogic

Pickup, Operate and Dropout elements for each relay are available in FlexLogic.

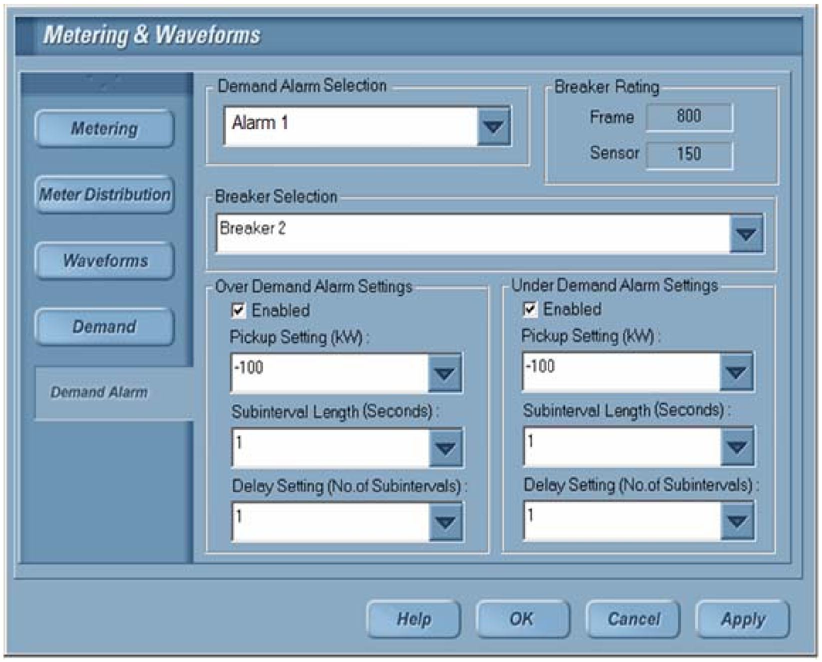
4.5.2 Setup

To set the settings for the Demand Alarm

1. On the **Main Menu**, click **User Settings**, and then select **Metering & Waveforms**.
2. Click the **Demand Alarm** tab.

Settings

Figure 4-14 Demand Alarm settings page



Demand Alarm Selection: Select the alarm instance 1 through 16

Breaker Selection: Lists all installed breakers.

Over Demand / Under Demand Alarm Settings groups

- **Enabled**: Enable the alarm
- **Pickup Setting**: Set the pickup threshold from -5000 to 5000 KW (excluding 0) in 100 KW increments.
- **Sub-Interval Length:** Set the subinterval length from 1 to 900 in increments of 1.
- **Delay Setting** (No of Subintervals): Configure the Interval length in terms of number of demand sub-intervals from 1 to 15 in increments of 1. The product of subinterval and interval setting cannot exceed 3600 seconds.

4.5.3 Events and Alarm

Events

The Demand Alarm Function generates the following events:

- Alarm Pickup Over-Demand Flex X: Logged when demand metering alarm goes into Over-Demand pickup state
- Alarm Over-Demand Flex X: Logged when demand metering over-demand alarm operates. Also available as in the HMI Alarm screen.
- Alarm Dropout Over-Demand Flex X: Logged when demand metering alarm drops out from over-demand pickup
- Alarm Pickup Under-Demand Flex X: Logged when demand metering alarm goes into Under-Demand pickup state
- Alarm Under-Demand Flex X: Logged when demand metering under-demand alarm operates. Also available as in the HMI Alarm screen.
- Alarm Dropout Under-Demand Flex X: Logged when demand metering alarm drops out from under-demand pickup

4.6 Troubleshooting

Current reads zero or dashes

- Verify that the Messenger is communicating to the CPU in the System Health screen. See System health on page 70 for more information.
- Verify that the frame and CT ratings are properly configured. This information is available on the Metering & Waveforms menu. See Basic configuration on page 118.
- Verify the current exceeds 1% of CT rating. The system will zero the current if below 1%. To verify this, trigger a waveform manually. The actual current will be displayed on the waveform.

Voltage reads zero

- Verify that the circuit breaker has a source for voltage data and that the source has a valid PT assigned to it by clicking **Metering** on the **Metering & Waveforms** screen. See Basic configuration on page 118. Also see PT Throw-Over on page 206 for more information.

Detailed, Demand, or Harmonics metering buttons are grayed out

- Verify that the corresponding option has been assigned to that circuit breaker. See Metering options on page 120.

5 Single-point functions

5

5.1 Overcurrent protection

The Entellisys Low-Voltage Switchgear system provides four different kinds of protection: Long Time Overcurrent protection, IOC/Short Time Overcurrent protection and Ground Fault protection. The system provides overcurrent protection by monitoring the phase currents at each circuit breaker. When an overcurrent condition is detected, the system opens the circuit breaker.

There are two levels of overcurrent protection in the Entellisys system. The first level is provided by the Entellisys CPU, and is based on phase-current data provided by each Messenger. The parameters for these functions are set by the customer through the HMI (except for long time pickup). The individual Messengers, based on local phase-current data, provide the second level. The parameters for these overcurrent functions are fixed according to the safe operating region for a given circuit breaker and are not programmable by the customer (except for long time pickup).

The system rejects any parameter input that is not valid or that places the system in an unsafe or inconsistent state. The system performs a range-checking operation on its programmed settings and does not allow a setting that exceeds the circuit breaker's design limit, safe operation, or the range specified by the applicable standard.

With the exception of Ground Fault Tripping Priority, each of the single-point functions supports up to 16 topologies, from 0 to 15. Topology 0 is the Reduced Let-Thru Mode topology and topology 1 is the default topology. If no topology circuit breakers are defined, Entellisys supports only topologies 0 and 1. See Zones, buses, and topologies on page 191 for more information.

NOTE: You can change the overcurrent settings for the Entellisys system while the breakers are carrying current – this will not cause a nuisance trip. The system will reject any parameter input that is not valid or that would put the system in an unsafe or inconsistent state. The system will also perform a range-checking operation on its programmed settings and will not let you specify a setting that exceeds the breaker’s design limit or safe operation, or the range specified by the applicable standard.

5.1.1 Long Time Overcurrent protection

There are two levels of Long Time (LT) Overcurrent Protection in the Entellisys system. The first level is provided by the Entellisys CPU. The second level is provided by the Messenger.

I^2T Long Time Overcurrent Protection curves

The equation for the I^2T Long Time function limit is:

$$\left(\frac{I_{RMS}}{C}\right)^2 \times T = K$$

The parameters in this equation are defined as:

T = Time to trip in seconds.

C = LT current setting in amps and is equal to the Rating Switch value times the LT pickup multiplier (see Table 5-1).

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K = LT delay band constant in seconds, user adjustable.

I_{RMS} = Value of the fault current in amps.

The Entellisys system provides four long time delay band settings. This selection defines the value of the constant K in the LT equation.

The following long time delay band selections are available:

- Band 1: K = 108 seconds
- Band 2: K = 216 seconds
- Band 3: K = 432 seconds
- Band 4: K = 900 seconds

The fixed LT Overcurrent Protection delay setting at the Messenger is Band 4 (K = 900 s).

5.1.1.1 Accuracy

Pickup accuracy is ±10% over the entire protection range.

5.1.1.2 Setup

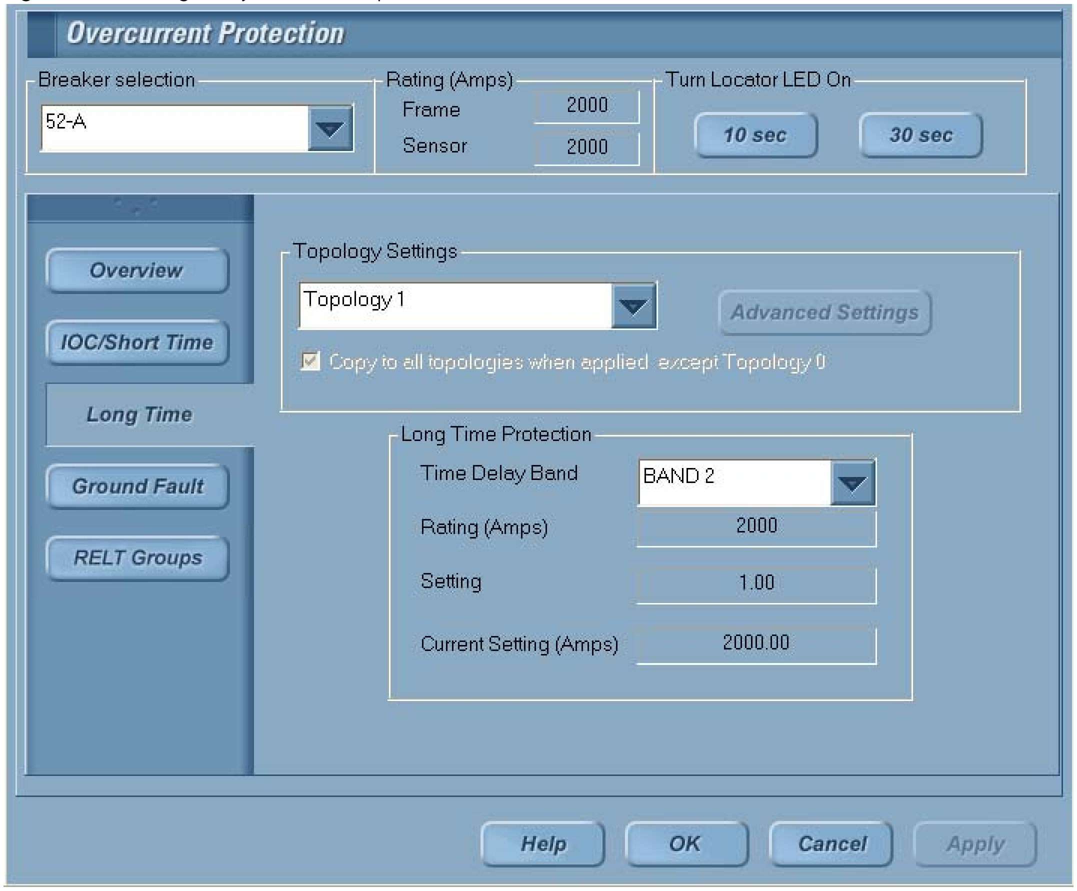
The LT Pickup setting is set with a rotary switch at the Messenger. This setting applies to the LT protection provided by the Messenger and the protection provided by the Entellisys CPU. The positions of the rotary switch and LT Pickup settings are shown in Table 5-1.

Table 5-1 Rotary switch positions and LT pickup settings

Position	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Setting	1.1	0.5	0.5	0.5	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1.0	1.05

The delay for the LT protection provided by the Messenger is not user-programmable; it is fixed according to the safe operating region for the circuit breaker controlled by the given Messenger. The delay for the LT protection provided by the Entellisys CPU is set in the HMI as shown in Figure 5-1.

Figure 5-1 Setting Delay Band for LT protection for Breaker 2



5.1.1.3 Usage

The LT Overcurrent Protection function picks up when the current value for any phase is above the LT Pickup setting.

LT pickup, trip, and dropout events are recorded in the Entellisys Sequence of Events log. Waveforms and fault reports are also captured on an LT trip event and can be viewed from the Sequence of Events log.

5.1.2 IOC/Short Time Overcurrent protection

There are two levels of Short Time (ST) Overcurrent Protection in the Entellisys system. The first level is provided by the Entellisys CPU and is based on phase-current data provided by each Messenger. The parameters for this function are user-adjustable through the HMI. The second level is provided by the Messenger. The parameters for this overcurrent function are not user-programmable; they are fixed based on the safe operating region for the circuit breaker controlled by the given Messenger.

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5.1.2.1 Short Time Overcurrent protection curves

There are seven ST delay bands available in Entellisys:

For 60 Hz systems

Band 1: 0.025 sec < T < 0.092 sec (see NOTE)

Band 2: 0.058 sec < T < 0.158 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.167 sec < T < 0.267 sec

Band 5: 0.217 sec < T < 0.317 sec

Band 6: 0.283 sec < T < 0.383 sec

Band 7: 0.400 sec < T < 0.500 sec.

For 50 Hz systems

Band 1: 0.030 sec < T < 0.095 sec (see NOTE)

Band 2: 0.060 sec < T < 0.160 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.170 sec < T < 0.270 sec

Band 5: 0.220 sec < T < 0.320 sec

Band 6: 0.280 sec < T < 0.380 sec

Band 7: 0.400 sec < T < 0.500 sec

NOTE: Band 1 is not intended to be selective with Band 3. The actual fault clearing time depends on the energy content of the fault current.

Entellisys also provides an I^2T curve option for ST, the equation for which is given below:

$$\left(\frac{I_{RMS}}{C}\right)^2 \times T = K$$

Where:

T = time to trip in seconds

K = 18 seconds

C = LT pickup setting, in amps

I_{RMS} = fault current, in amps

5.1.2.2 Accuracy

Pickup accuracy is ±10% over the entire protection range

5.1.2.3 Setup

The setup required for ST protection is done in the HMI and at the Messenger. There are three options configured at each Messenger that control the operation of Short Time and Instantaneous overcurrent protection:

- Short Time option
- Instantaneous option
- Switchable Short Time/Instantaneous option

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If the Short Time option or the Instantaneous option (or both) is enabled, the state of the Switchable ST/IOC option is ignored. The Messenger and Entellisys CPU perform the protection functions specified by the Short Time and Instantaneous options.

If the Short Time and Instantaneous options are disabled and the Switchable ST/IOC option is enabled, the Messenger defaults to performing Short Time and digital Instantaneous functions until instructed otherwise by the Entellisys CPU. In this case, the Messenger does not perform the analog Instantaneous function. The Entellisys CPU instructs the Messenger to turn on or off Short Time.

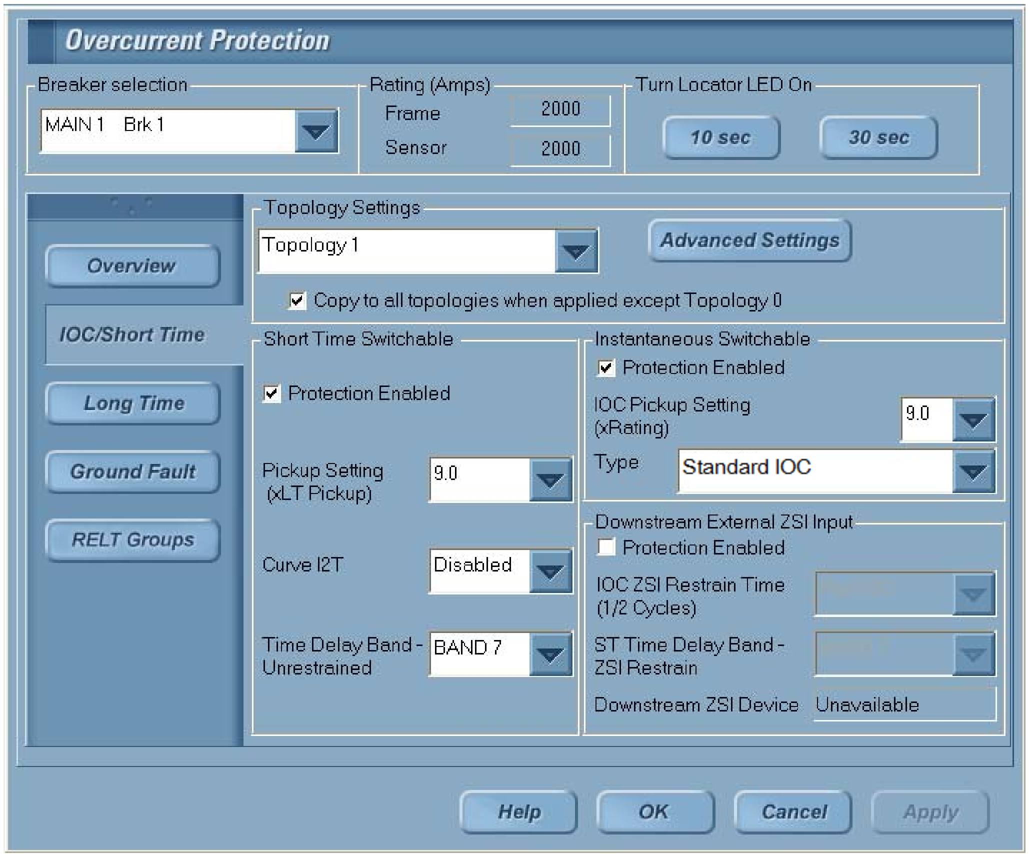
Entellisys limits the maximum Instantaneous Overcurrent Pickup Setting (P_{IOC}) Multiplier based on frame type and whether or not Short Time protection is enabled. This relationship is shown for EntelliGuard circuit breakers in Table 5-2 below:

Table 5-2 Maximum P_{IOC}

Breaker Frame Size	Maximum P_{IOC} with Short Time	Maximum P_{IOC} without Short Time
800	15	10
1600	15	10
2000	15	10
3200	13	10
4000	9	9
5000	7	7

Parameters such as IOC pickup, ST pickup, curve type and delay bands for Short Time protection are set in the HMI, as shown in Figure 5-2.

Figure 5-2 Setting parameters of IOC/ST protection for Breaker 2



IOC Type

Standard IOC

The Messenger's digital IOC (Standard IOC) function will trip after 5 consecutive samples are found to be above the pickup rating. This occurs within 1.3 milliseconds or within $1/10^{th}$ of a power cycle.

Adjustable Selective IOC (Waveform Recognition)

Instantaneous overcurrent has been expanded to provide waveform recognition further improving selectivity to GE current limiting breakers downstream of the Entellisys switchgear. Selective Discrimination will trip within the second 1/2 power cycle of fault current above the pickup setting.

Downstream External ZSI Input

Entellisys is capable of accepting a ZSI signal from a downstream overcurrent device. If a downstream device is detected, “**Downstream ZSI Device**” will read “Available.”

When a ZSI device is available then the messenger will respond to a restraint signal and will restrain Short Time and IOC to the “**IOC ZSI Restrain Time**” and “**ST Time Delay**” settings. Further more, the ZSI restraint signal will propagate to breakers up stream as defined by the Entellisys ZSI Zone configuration. (See section 7.5 Downstream Zone Selective Interlocking on page 217) for more details.

Curve I^2T

The I^2T option is available with each of the seven delay bands listed above. Note that the trip times will not be shorter than the values listed above for the delay bands, even when the I^2T curve is selected. For example, suppose ST band 6 (60 Hz) is selected and I^2T is enabled. On a fault where (I_{RMS}/C) is 4.0, the circuit breaker will trip according to the I^2T curve. In this case the system will initiate a trip after approximately 1.1 seconds. On a fault where (I_{RMS}/C) is 10.0, the system will not follow the I^2T curve and will instead initiate a trip according to the constant-time part of the trip curve (i.e., after 0.283 seconds). In this case, if the system followed the I^2T curve, the trip time would have been only 0.18 seconds.

Values:

- Disabled
- Enabled
- Max Slope

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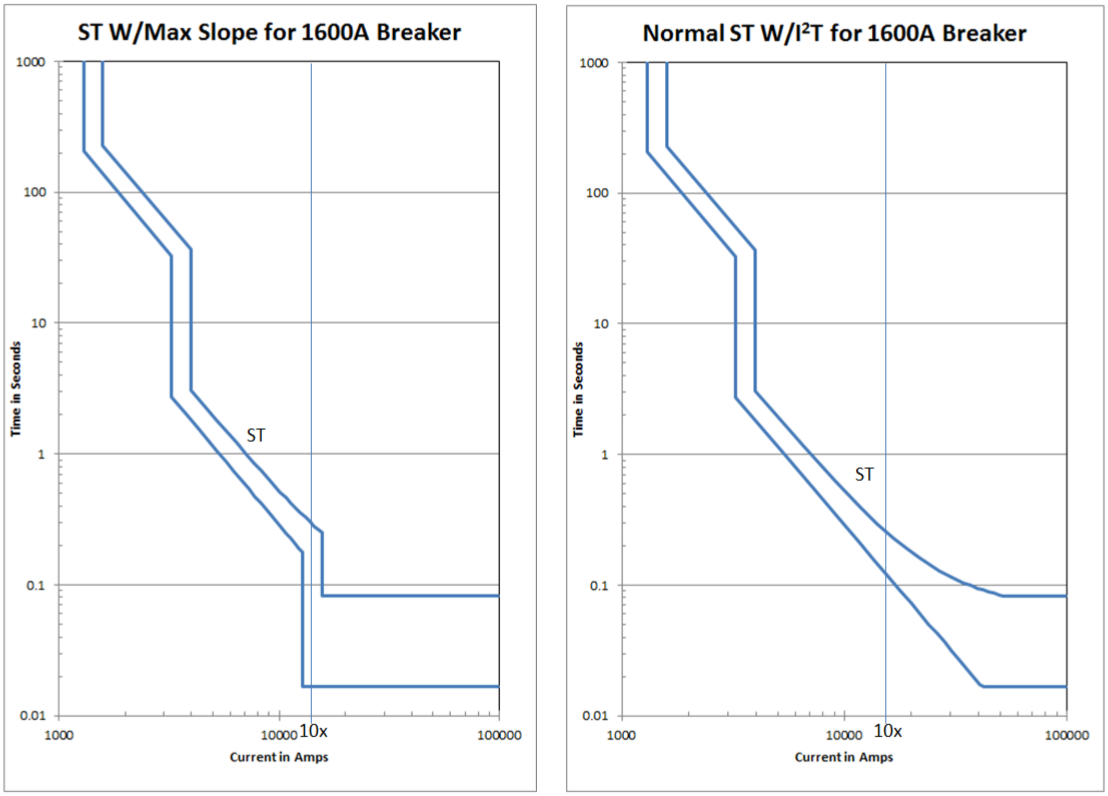
Max Slope

I^2T Max Slope limits the slope for ST delay band settings, transitioning from the I^2T slope to the definite time at 10x. Above 10X, the I^2T slope is typically no longer needed for selectivity with the I^2T slope of smaller downstream breakers or fuses. The truncated I^2T slope maintains selectivity while providing superior protection.

Figure 5-3 Typical I^2T Curves - Max slope vers normal I^2T



5.1.2.4 Operation

The operation of the Messenger and Entellisys CPU based on the state of the protection options is summarized in Table 5-3 below:

Table 5-3 Protection options and operation of Entellisys CPU and Messenger

ST Option (Messenger config)	IOC Option (Messenger config)	Switchable ST/IOC Option (Messenger config)	Options at Entellisys CPU	Notes
Enabled	Enabled	Don't care	NA – CPU will have ST will set Messenger IOC	CPU: performs ST and sets Messenger's IOC at user setting. Messenger: performs ST at max setting; Messenger has analog IOC at max, digital IOC at user setting. CPU cannot change Messenger protection options.
Enabled	Disabled	Don't care	NA – CPU has ST only	CPU: performs ST at user setting.; Messenger: performs ST at max setting. No analog or digital IOC. CPU cannot change Messenger protection options.
Disabled	Enabled	Don't care	NA – CPU sets Messenger IOC	CPU: sets Messenger's IOC at user setting. Messenger has analog IOC at max, digital IOC at user setting. CPU cannot change Messenger protection options.
Disabled	Disabled	Disabled	Not a valid state	CPU: performs ST at default setting or user settings if they have been changed. Messenger: performs ST at max setting, digital IOC at max setting. No analog IOC. CPU cannot change Messenger protection options.
Disabled	Disabled	Enabled	CPU not operating	Messenger: performs ST at max setting; Messenger performs digital IOC at max or previous user setting. No analog IOC.
			ST ON, IOC ON	CPU: performs ST and IOC at user setting. Messenger: performs ST at max setting, digital IOC at user setting. No analog IOC.
			ST ON, IOC OFF	CPU: performs ST at user setting. Messenger: performs ST at max setting. IOC can only be turned OFF if ST is ON.
			ST OFF, IOC ON	CPU: sets Messenger's IOC at user setting. Messenger: performs digital IOC at user setting. No analog IOC. ST can only be turned OFF if IOC is ON.
			ST OFF, IOC OFF Invalid command	Messenger: does not change protection functions; current ST and IOC options and settings continue to run.

5.1.2.5 Usage

ST Overcurrent Protection goes into pickup when the current in any phase is above the ST pickup setting. ST pickup, trip, and dropout events are recorded in the Entellisys Sequence of Events log. Waveforms and fault reports are also captured on a ST trip event, and can be viewed from the Sequence of Events log.

The Entellisys system provides instantaneous overcurrent protection by tripping the circuit breaker with no intentional delay when the sensed input current exceeds the programmed IOC threshold. IOC trip events are recorded in the Entellisys Sequence of Events log. Waveforms and fault reports are also captured on an IOC trip event, and can be viewed from the Sequence of Events log.

5.1.3 Ground Fault protection

There are two levels of Ground Fault (GF) Overcurrent Protection available in the Entellisys system. The first level is provided by the Entellisys CPU. This function is optional, and its parameters, including whether to trip the circuit breaker or activate an alarm on a fault, are user-programmable. The second level is provided by the individual Messenger. This function is also optional, but its parameters are not user-programmable; the pickup and delay are set to the maximum allowed for a given configuration. Also, the GF function performed at the Messenger only trips the circuit breaker.

A GF alarm-only option is always available.

5.1.3.1 Ground Fault protection curves

There are seven GF delay bands available in Entellisys:

For 60 Hz systems

Band 1: 0.025 sec < T < 0.092 sec (see NOTE)

Band 2: 0.058 sec < T < 0.158 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.167 sec < T < 0.267 sec

Band 5: 0.217 sec < T < 0.317 sec

Band 6: 0.283 sec < T < 0.383 sec

Band 7: 0.400 sec < T < 0.500 sec.

For 50 Hz systems

Band 1: 0.030 sec < T < 0.095 sec (see NOTE)

Band 2: 0.060 sec < T < 0.160 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.170 sec < T < 0.270 sec

Band 5: 0.220 sec < T < 0.320 sec

Band 6: 0.280 sec < T < 0.380 sec

Band 7: 0.400 sec < T < 0.500 sec

NOTE: Band 1 is not intended to be selective with Band 3. The actual fault clearing time depends on the energy content of the fault current.

Entellisys also provides an I^2T curve option for GF, the equation for which is given below:

$$\left(\frac{I_{RMS}}{P_{GF}}\right)^2 \times T = K$$

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Where:

T = time to trip in seconds

K = 18 seconds

PGF = GF pickup setting, in amps

I_{RMS} = ground fault current, in amps

The I^2T option is available with each of the seven delay bands listed above. Note that the trip times will not be shorter than the values listed above for the delay bands, even when the I^2T curve is selected. For example, suppose GF band 6 (60 Hz) is selected and I^2T is enabled. On a fault where (I_{RMS}/PGF) is 1.5, the circuit breaker will trip according to the I^2T curve. In this case the system will initiate a trip after approximately 0.9 seconds. On a fault where (I_{RMS}/PGF) is 5.0, the system will not follow the I^2T curve and will instead initiate a trip according to the constant-time part of the trip curve (i.e., after 0.283 seconds). In this case, if the system followed the I^2T curve, the trip time would have been only 0.08 seconds.

5.1.3.2 Accuracy

Pickup accuracy is ±10% over the entire protection range

5.1.3.3 Setup

Setup for GF protection is done in two places:

- GF option at the Messenger
- Delay Band trip options in the HMI

The Ground Fault Pickup Setting Multiplier is adjustable for each circuit breaker over the range of 0.20 to 0.60, but is limited by sensor rating as shown in Table 5-4:

Table 5-4 Maximum Ground Fault pickup threshold

WavePro™ breakers	
Sensor, I_{CT}	**Maximum Ground Fault Pickup Threshold (× I_{CT})**
150–2000	0.6
3200	0.37
4000	0.3
5000	0.24

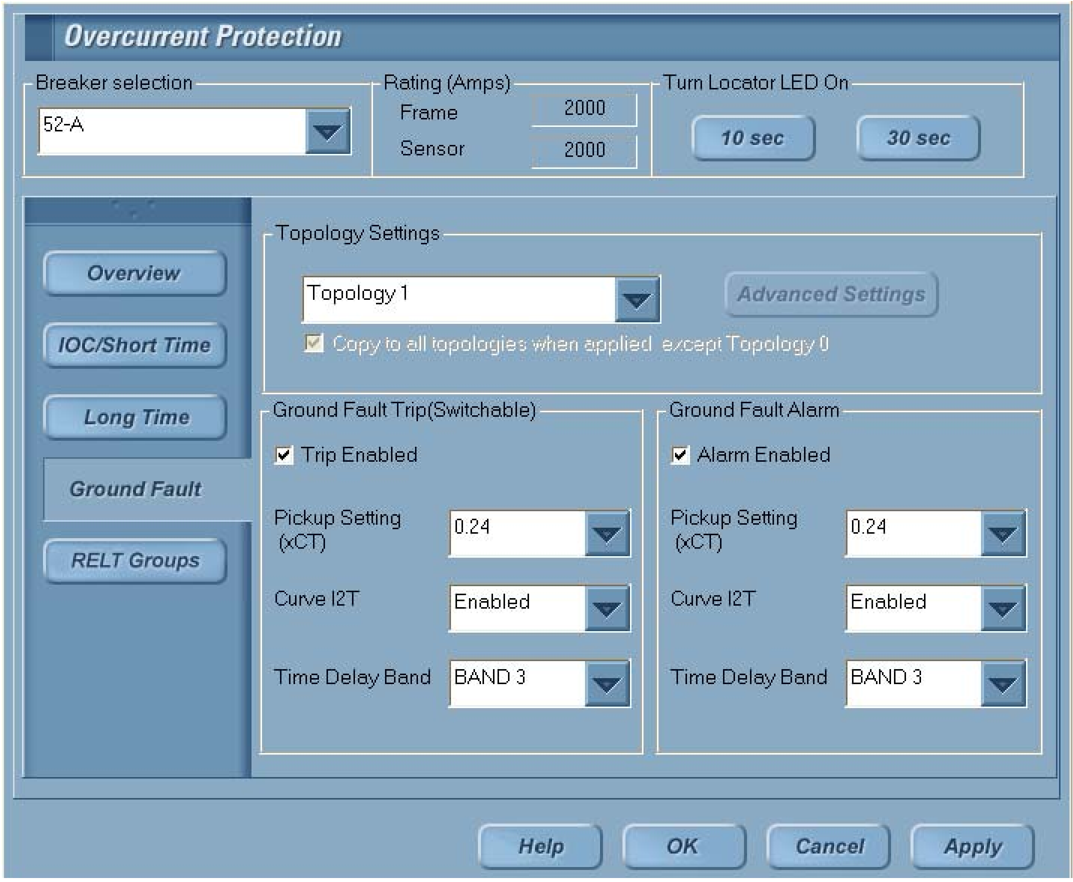
There are two options configured at each Messenger for Ground Fault. The combinations of Ground Fault options are listed in Table 5-5 below.

Table 5-5 Ground Fault options

GF Option at Messenger	Switchable GF Option at Messenger	GF Tripping Priority Optioned (HRG Systems)	GF Trip function available?	Notes
Enabled	N/A	No	Both CPU and Messenger	• Messenger and CPU perform GF • CPU at user setting, Messenger at max • GF Alarm is available • UL Listed as a GF Device
Disabled	Enabled	No	Both CPU and Messenger	• GF Trip must be enabled for GF trip to operate • If disabled, GF Trip will not operate at either the CPU or Messenger • If enabled, CPU will tell the Messenger to begin performing GF (at max setting) while the CPU performs GF Trip at user settings. • GF Alarm is available
N/A	N/A	Yes	CPU only	• GF protection is always disabled at messenger for HRG system • CPU does NOT set GF at the messenger when GF Tripping Priority function is optioned in the system
Disabled	Disabled	No	No	No GF at Messenger or CPU

The parameters for the GF protection provided by the Entellisys CPU can be set in the HMI as shown in Figure 5-4.

Figure 5-4 Ground Fault settings screen



5.1.3.4 Usage

The GF Protection function detects unintentional current flowing from a circuit to a conducting path to ground. These currents are usually of a lower magnitude than the current set by the LT pickup setting and would not normally be sensed by that protection function. GF protection is performed by calculating the vector sum of the three phase currents in a three-wire system or the vector sum of the three phase currents and the neutral in a four-wire, wye-system and comparing this sum to a pickup threshold.

GF pickup, trip, and dropout events are recorded for GF alarms and trip events in the Entellisys Sequence of Events log. Waveforms and fault reports are captured on a GF trip or alarm event, and can be viewed from the Sequence of Events log.

5.2 Additional Relay Protection Packages

Entellisys system provides Single-point Protection Relay functions in three optional packages: the Voltage Relays package, the Frequency and Reverse Power Relays package and the High Current Relay package.

The Voltage Relays package includes the following functions:

- Undervoltage Relay
- Overvoltage Relay
- Phase Loss Relay protection

The Frequency and Reverse Power Relays package includes the following functions:

- Under Frequency Relay
- Over Frequency Relay
- Reverse Power Relay

The High Current Relay package includes the following function:

- High Current Relay

NOTE: Removing a relay package from a Messenger can cause any control scheme that includes those relays to misoperate. See Metering options on page 120 for more details.

These protection relay functions run in addition to the standard overcurrent protection functions and are performed at the Entellisys CPU only. No protection relay functions are performed locally at the Messengers.

Each relay has two sets of pickup and delay settings, with the exception of the High Current and High Resistance GF. One set is for tripping the circuit breaker and the other is for activating an alarm. Therefore, a user can set one threshold for a trip condition and the other threshold for an alarm condition. It is possible to enable or disable each relay function individually; for example, it is possible to enable a relay alarm function but disable the trip function.

Users can set the relay trips to use either the OPEN command (flux shifter Open, without bell alarm activation) or the TRIP command (flux shifter Open, with bell alarm activation). The system will not perform a relay function requiring voltage if there is no valid PT source for that Messenger.

Entellisys handles the case where a breaker that has been opened by a voltage relay (UV, OV, UF, OF, or Phase Loss) is re-closed while the condition still exists. Because opening a breaker does not necessarily clear the fault condition, the breaker could remain closed with the fault still present. The system monitors the breaker status after a voltage relay has opened (or tripped, depending on how it is programmed). If, at any time after a delay of 180 cycles, the breaker status transitions to Not Open (note that this is not the same as Closed), and the relay drops out of pickup, the system re-opens the breaker.

Relay trips can be configured to use either the OPEN command (flux shifter open without bell alarm activation) or the TRIP command (flux shifter open with bell alarm activation). The system will not perform a relay function requiring voltage if there is no valid PT source for that Messenger.

If a circuit breaker is opened (either through a OPEN or TRIP command) by a voltage relay, and the circuit breaker is re-closed, Entellisys will re-open the circuit breaker within approximately three seconds if the condition is still present.

5.2.0.1 Enabling Single-point Relay packages

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Single-point Relay packages must be enabled for each circuit breaker before any relay can be used individually on that circuit breaker. This is done by GE.

5.2.1 Undervoltage Relay

Entellisys executes the Undervoltage Relay function by comparing the voltage in each phase to the nominal 1X value of the system voltage. For example, in a 120-V wye system, nominal 1X is defined to be 120-V phase to neutral.

The pickup range of the undervoltage relay allows this relay to be used as either an undervoltage or a residual voltage relay.

The relay can be in three states:

- **Pickup –** If the voltage in a set number of voltage phases (one, two or all three voltage phases) is less than the pickup set point, the relay goes into pickup, and is said to enter Pickup state
- **Operate** – If the relay stays in pickup state for a specified pick up delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state
- **Drop out** – The relay drops out of pickup when the voltage exceeds 103% of the programmed threshold. The relay is said to be in Drop out state.

For wye potential transformers, the Undervoltage Relay operates on line-to-neutral voltage. For open delta potential transformers, the Undervoltage Relay operates on line-line voltage. Entellisys uses RMS voltages in the calculations.

The Undervoltage Relay can function using both constant and inverse time curves.

Constant time function: If the constant time curve is selected, the system trips the appropriate circuit breaker or activates an alarm if the phase voltage is less than the set point for the specified time delay.

Trip time accuracy: Trip-time accuracy is ±0.1 second.

Inverse time function: If the inverse time curve is selected, the system trips the appropriate circuit breaker or activates an alarm according to the equation:

$$T = \frac{D}{\left(1 - V/V_{pickup}\right)}$$

The parameters in this equation are defined as:

T = operating time

D = delay setting

V = input voltage

V_{pickup} = pickup voltage = (set point) × (nominal voltage)

Trip time accuracy: Trip time accuracy depends on the value of V/V_{pickup}. The closer that ratio is to 1, the larger the trip time error is for a given pickup error. For V/V_{pickup} = 0.8, the trip time accuracy is ±10%. For V/V_{pickup} = 0.5, the trip time accuracy is ±4%.

Blocking voltage option: A 'blocking voltage' user-defined input option is provided. The Undervoltage Relay function is not performed if the blocking voltage option is enabled and the voltages on all three phases are less than the blocking voltage setting. If the Undervoltage Relay goes into pickup, and the voltages subsequently drop below the blocking voltage, the relay goes out of pickup and the delay is reset.

Accuracy: Pickup accuracy is ±2%.

5.2.1.1 Setup

To set the Trip and Alarm settings for the Undervoltage Relay function

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **Undervoltage**.

The remainder of this section discusses the relay parameters that can be set in the Undervoltage section of the Relay Protection screen as shown in Figure 5-5.

5.2.1.2 Trip settings

Relay Enabled: Select **Enabled** to enable the relay.

Curve Type: Select either **Constant time curve** or **Inverse time curve** from the **Curve Type** drop-down menu.

Pickup: Adjust the undervoltage pickup from 10% to 95% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the undervoltage delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Phase Requirement: Select from among the following options using the **Phase Requirement** drop-down menu:

- Operate if any one phase is below the pickup threshold
- Operate if any two phases are below the pickup threshold
- Operate if all three phases are below the pickup threshold

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage.

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Blocking Voltage Setting: Adjust the blocking voltage from 5% to 75% in increments of 1% using the **Setting** drop-down menu in the **Blocking Voltage** section.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.2.1.3 Alarm settings

Relay Enabled: Select **Enabled** to enable the alarm relay.

Curve Type: Select either **Constant time curve** or **Inverse time curve** from the **Curve Type** drop-down menu.

Pickup: Adjust the undervoltage pickup from 10% to 95% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the undervoltage delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

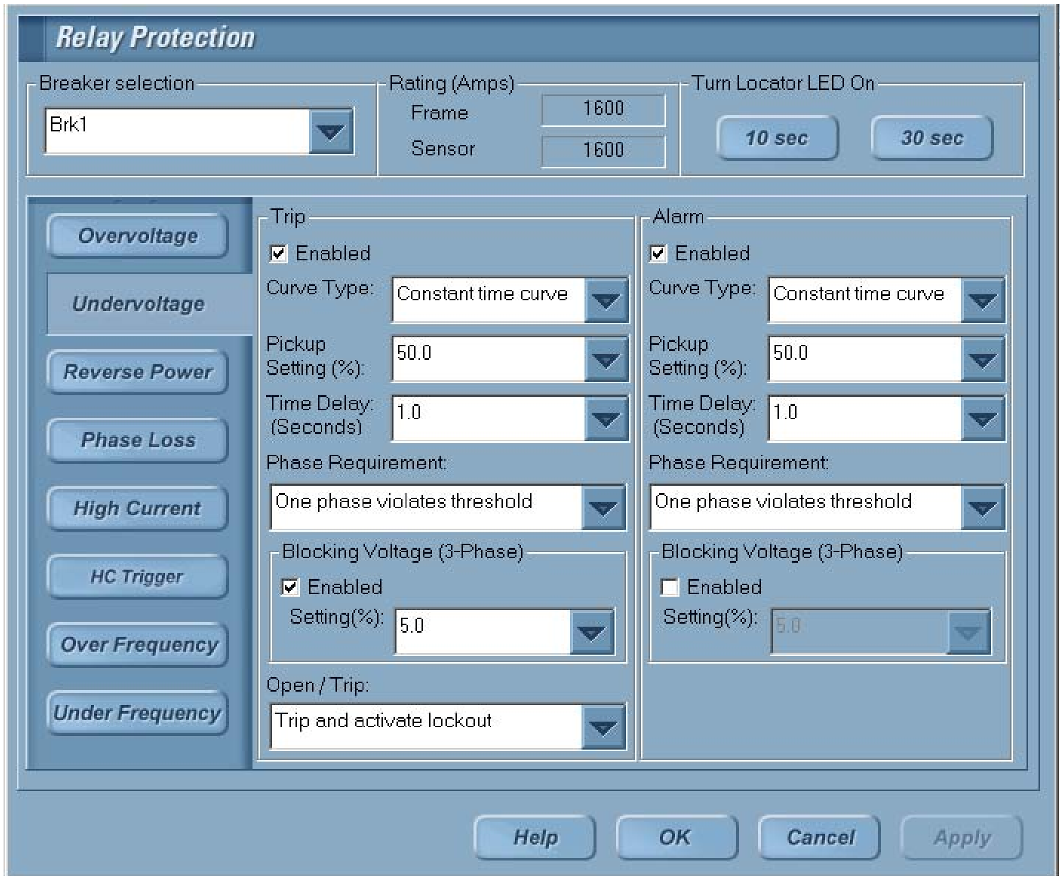
Phase Requirement: Select from among the following options using the **Phase Requirement** drop-down menu:

- Operate if any one phase is below the pickup threshold
- Operate if any two phases are below the pickup threshold
- Operate if all three phases are below the pickup threshold

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage.

Blocking Voltage Setting: Adjust the blocking voltage from 5% to 75% in increments of 1% using the **Setting** drop-down menu in the **Blocking Voltage** section.

Figure 5-5 Settings for Undervoltage Relay



5.2.1.4 Usage

Event logging

The following events are logged:

- Alarm Pickup Undervoltage – when the alarm function enters pickup
- Alarm Undervoltage – when the alarm function operates
- Alarm Dropout Undervoltage – when the alarm function drops out
- Pickup Undervoltage – when the trip function enters pickup
- Breaker Trip Undervoltage – when the trip function operates
- Dropout Undervoltage – when the trip function drops out
- Voltage Below Undervoltage Alarm Blocking Voltage – The voltages on all three phases have dropped below the alarm only undervoltage blocking voltage threshold.
- Voltage Above Undervoltage Alarm Blocking Voltage – The voltage on at least one of the three phases has exceeded the alarm only undervoltage blocking voltage threshold.
- Voltage Below Undervoltage Blocking Voltage – The voltages on all three phases have dropped below the undervoltage blocking voltage threshold.
- Voltage Above Undervoltage Blocking Voltage – The voltage on at least one of the three phases has exceeded the undervoltage blocking voltage threshold.

To view these events, click **Sequence of Events** on the **Main Menu**.

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5.2.2 Overvoltage Relay

The Entellisys system performs the Overvoltage Relay function by comparing the voltage in each phase to the nominal 1X value of the system voltage. For example, in a 120-V wye system, nominal 1X is defined to be 120-V phase to neutral.

The relay can be in three states:

- **Pickup –** If the voltage in a set number of voltage phases (one, two or all three voltage phases) is greater than the pickup set point, the relay goes into pickup, and is said to enter Pickup state
- **Operate** – If the relay stays in pickup state for a specified pick up delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state
- **Drop out** – The relay drops out of pickup when the voltage drops below 97% of the programmed threshold. The relay is said to be in Drop out state.

For wye potential transformers, the Overvoltage Relay operates on phase neutral voltage. For open delta potential transformers, the Overvoltage Relay operates on line-line voltage. Entellisys uses RMS voltages in the calculations.

The system trips the appropriate circuit breaker or activates an alarm if the voltage is greater than the pick up set point for the specified time delay.

5.2.2.1 Accuracy

Pickup accuracy is ±2%.

5.2.2.2 Setup

To set the Trip and Alarm settings for the Overvoltage Relay

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **Overvoltage**.

The remainder of this section discusses the relay parameters that can be set in the Overvoltage section of the Relay Protection screen as shown in Figure 5-6.

5.2.2.3 Trip settings

Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the overvoltage pickup from 105% to 125% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the overvoltage delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Phase Requirement: Select from among the following options using the **Phase Requirement** drop-down menu:

- Operate if any one phase is below the pickup threshold
- Operate if any two phases are below the pickup threshold
- Operate if all three phases are below the pickup threshold

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.2.2.4 Alarm settings

Relay Enabled: Select **Enabled** to enable the relay.

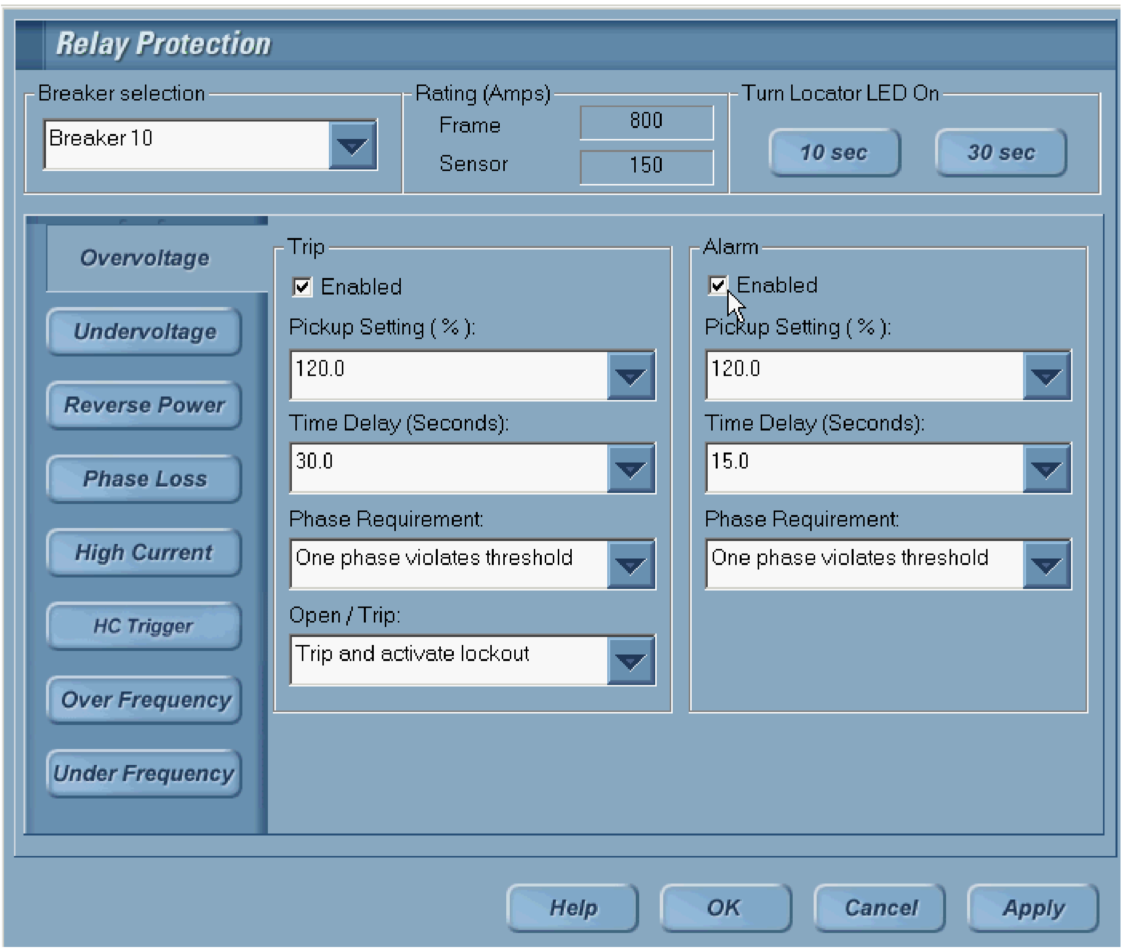
Pickup: Adjust the overvoltage pickup from 105% to 125% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the overvoltage delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Phase Requirement: Select from among the following options using the **Phase Requirement** drop-down menu:

- Operate if any one phase is below the pickup threshold
- Operate if any two phases are below the pickup threshold
- Operate if all three phases are below the pickup threshold

Figure 5-6 Settings for Overvoltage Relay



5.2.2.5 Usage

Event logging

The following events are logged for the Overvoltage relay in the Entellisys HMI:

- Alarm Pickup Overvoltage – Alarm only overvoltage relay has entered pickup
- Alarm Overvoltage – Alarm only overvoltage relay has operated
- Alarm Dropout Overvoltage – Alarm only overvoltage relay has dropped out of pickup
- Pickup Overvoltage – relay has entered pickup
- Breaker Trip Overvoltage – relay has operated
- Dropout Overvoltage – relay has dropped out of pickup

To view these events, click **Sequence of Events** on the **Main Menu**.

5.2.3 Over Frequency Relay

The Entellisys System executes the Over Frequency Relay function by comparing the *fundamental* frequency of the *phase A* voltage to the programmed pickup set point.

The relay can be in three states:

- **Pickup –** If the frequency of the phase A voltage is greater than the pickup set point, the relay goes into pickup, and is said to enter Pickup state
- **Operate** – If the relay stays in pickup state for a specified pickup delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state
- **Drop out** – The relay drops out of pickup when the frequency drops below 97% of the programmed threshold. The relay is said to be in Drop out state.

The system trips the appropriate circuit breaker or activates an alarm if the frequency is greater than the pickup set point for the specified time delay.

5.2.3.1 Accuracy

Pickup accuracy is less than ±0.1 Hz. Trip time accuracy is ±0.1 seconds.

Blocking voltage option: A 'blocking voltage' user-defined input option is provided. The over frequency relay function is not performed if the blocking voltage option is enabled and the voltage is less than the blocking voltage. If the Over Frequency Relay goes into pickup, and the voltages subsequently drop below the blocking voltage, the relay goes out of pickup and the delay is reset.

The accuracy of the blocking voltage depends on the frequency deviation and is listed in Table 5-6.

Table 5-6 Blocking voltage accuracy

Frequency Deviation	Blocking Voltage Accuracy
0 Hz	±2%
2 Hz	±5%
4 Hz	±7%
6 Hz	±10%
8 Hz	±13%
10 Hz	±15%

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5.2.3.2 Setup

To set the Trip and Alarm settings for the Over Frequency Relay

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **Over Frequency**.

The remainder of this section discusses the relay parameters that can be set in the Over Frequency section of the Relay Protection screen as shown in Figure 5-7.

5.2.3.3 Trip settings

Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the over frequency pickup from 50 to 70 Hz in increments of 0.1 Hz from the **Pickup Setting** drop-down menu.

Delay: Adjust the over frequency delay from 0.1 to 600 seconds in increments of 0.1 seconds from the **Time Delay** drop-down menu.

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage. If the option is enabled, the blocking voltage setting is 10% of the nominal voltage.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.2.3.4 Alarm settings

Relay Enabled: Select **Enabled** to enable the relay.

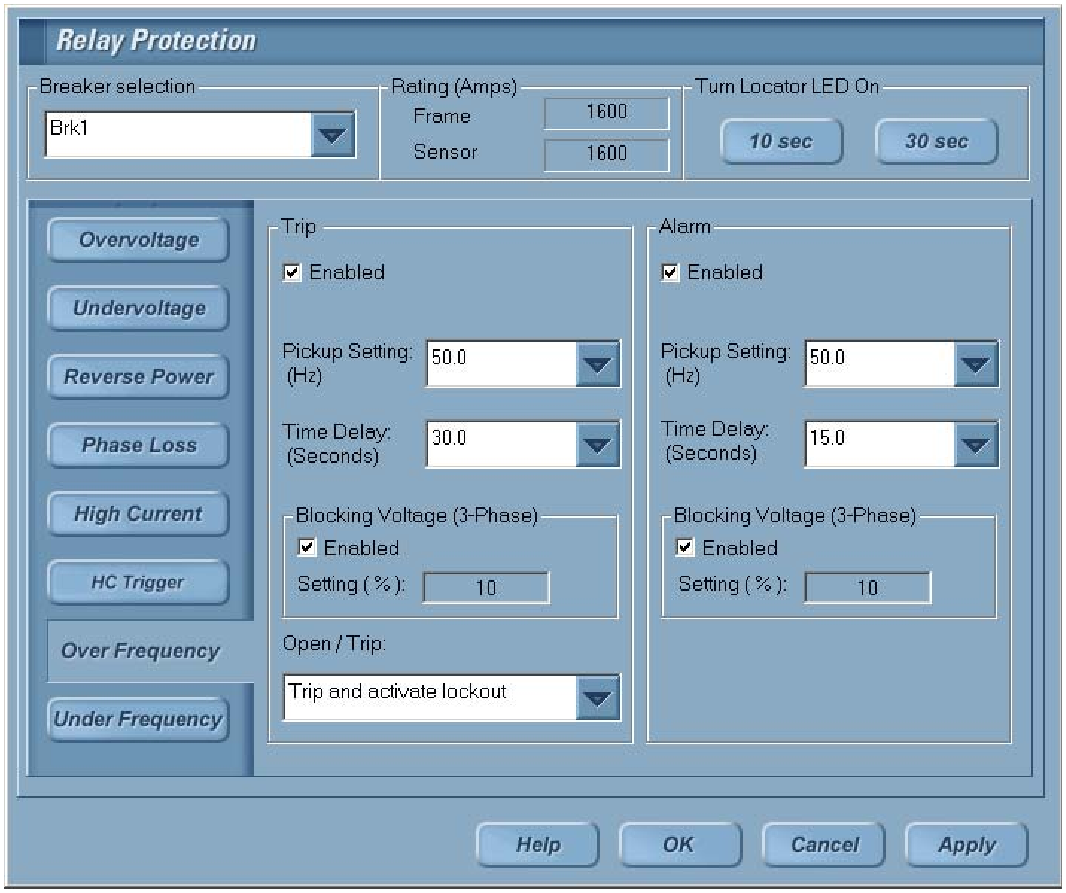
Pickup: Adjust the over frequency pickup from 50 to 70 Hz in increments of 0.1 Hz from the **Pickup Setting** drop-down menu.

Delay: Adjust the over frequency delay from 0.1 to 600 seconds in increments of 0.1 seconds from the **Time Delay** drop-down menu.

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage. If the option is enabled, the blocking voltage setting is 10% of the nominal voltage.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

Figure 5-7 Settings for Over Frequency Relay



5.2.3.5 Usage

Event logging

The following events are logged for the over frequency relay in the Entellisys HMI:

- Alarm Pickup Over Frequency – Alarm only over frequency relay has entered pickup.
- Alarm Over Frequency – Alarm only over frequency relay has operated.
- Alarm Dropout Over Frequency – Alarm only over frequency relay has dropped out of pickup.
- Voltage Below Overfreq Alarm Blocking Voltage – The voltage has dropped below the alarm only over frequency blocking voltage threshold.
- Voltage Above Overfreq Alarm Blocking Voltage – The voltage has exceeded the alarm only over frequency blocking voltage threshold.
- Pickup Over Frequency – Over frequency relay has entered pickup.
- Breaker Trip Over Frequency – Over frequency relay has operated.
- Dropout Over Frequency – Over frequency relay has dropped out of pickup.
- Voltage Below Over Frequency Blocking Voltage – The voltage has dropped below the over frequency blocking voltage threshold.

- Voltage Above Over Frequency Blocking Voltage – The voltage has exceeded the over frequency blocking voltage threshold.

To view these events, click **Sequence of Events** on the **Main Menu**.

5.2.4 Under Frequency Relay

The Entellisys System executes the Under Frequency Relay function by comparing the *fundamental* frequency of the *phase A* voltage to the programmed pickup set point.

The relay can be in three states:

- **Pickup –** If the frequency of the phase A voltage is less than the pickup set point, the relay goes into pickup, and is said to enter Pickup state
- **Operate** – If the relay stays in pickup state for a specified pick up delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state
- **Drop out** – The relay drops out of pickup when the frequency exceeds 103% of the programmed threshold. The relay is said to be in Drop out state.

The system trips the appropriate circuit breaker or activates an alarm if the frequency is less than the pickup set point for the specified time delay.

5.2.4.1 Accuracy

Pickup accuracy is less than ±0.1 Hz. Trip time accuracy is ±0.1 seconds.

Blocking voltage option: A 'blocking voltage' user-defined input option is provided. The under frequency relay function is not performed if the blocking voltage option is enabled and the voltage is less than the blocking voltage. If the Under Frequency Relay goes into pickup, and the voltages subsequently drop below the blocking voltage, the relay goes out of pickup and the delay is reset.

The accuracy of the blocking voltage depends on the frequency deviation and is listed in Table 5-7.

Table 5-7 Blocking voltage accuracy

Frequency Deviation	Blocking Voltage Accuracy
0 Hz	±2%
2 Hz	±5%
4 Hz	±7%
6 Hz	±10%
8 Hz	±13%
10 Hz	±15%

5.2.4.2 Setup

To set the Trip and Alarm settings for the Under Frequency Relay

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **Under Frequency**.

The remainder of this section discusses the relay parameters that can be set in the Under Frequency section of the Relay Protection screen as shown in Figure 5-8.

5.2.4.3 Trip settings

Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the under frequency pickup from 45 to 60 Hz in increments of 0.1 Hz from the **Pickup Setting** drop-down menu.

Delay: Adjust the under frequency delay from 0.1 to 600 seconds in increments of 0.1 seconds from the **Time Delay** drop-down menu.

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage. If the option is enabled, the blocking voltage setting is 10% of the nominal voltage.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.2.4.4 Alarm settings

Relay Enabled: Select **Enabled** to enable the relay.

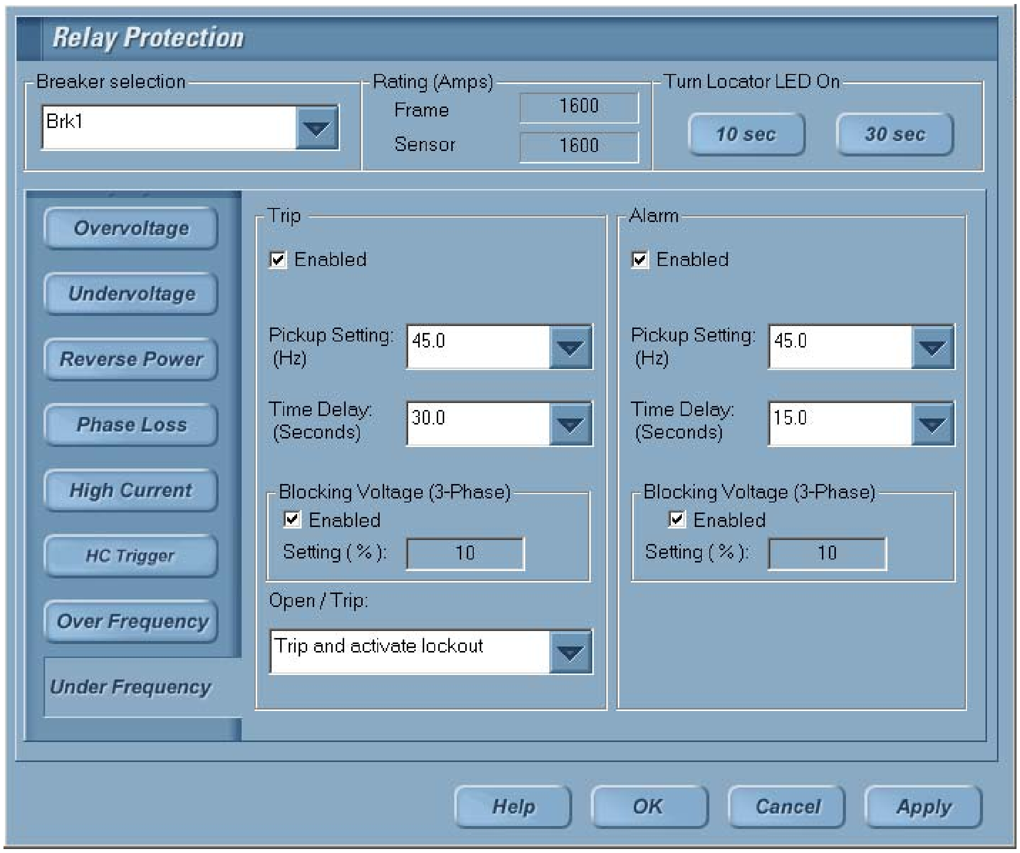
Pickup: Adjust the under frequency pickup from 45 to 60 Hz in increments of 0.1 Hz from the **Pickup Setting** drop-down menu.

Delay: Adjust the under frequency delay from 0.1 to 600 seconds in increments of 0.1 seconds from the **Time Delay** drop-down menu.

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage. If the option is enabled, the blocking voltage setting is 10% of the nominal voltage.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

Figure 5-8 Settings for Under Frequency Relay



5.2.4.5 Usage

Event logging

While the relay is functional, the following events are logged for the under frequency relay in the Entellisys CPU:

- Alarm Pickup Under Frequency – Alarm only under frequency relay has entered pickup.
- Alarm Under Frequency – Alarm only under frequency relay has operated.
- Alarm Dropout Under Frequency – Alarm only under frequency relay has dropped out of pickup.
- Voltage Below Underfreq Alarm Blocking Voltage – The voltage has dropped below the alarm only under frequency blocking voltage threshold.
- Voltage Above Underfreq Alarm Blocking Voltage – The voltage has exceeded the alarm only under frequency blocking voltage threshold.
- Pickup Under Frequency – Under frequency relay has entered pickup.
- Breaker Trip Under Frequency – Under frequency relay has operated.
- Dropout Under Frequency – Under frequency relay has dropped out of pickup.
- Voltage Below Under Frequency Blocking Voltage – The voltage has dropped below the under frequency blocking voltage threshold.
- Voltage Above Under Frequency Blocking Voltage – The voltage has exceeded the under frequency blocking voltage threshold.

To view these events, click **Sequence of Events** on the **Main Menu**.

5.2.5 Phase Loss Relay protection

Phase Loss is an optional relay that is part of the voltage relay package. The Entellisys system performs Phase Loss Relay Protection by comparing the negative-phase sequence voltage to the nominal 1X value of the system voltage.

For example, in a 120-V wye system, nominal 1X is defined as 120-V phase to neutral. The negative-phase sequence voltage for the phase-to-phase voltages is used regardless of PT configuration (i.e., delta or wye). The negative-phase sequence voltage for line-to-line is calculated as follows:

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$$V_N = \frac{1}{3}\left(V_1 + a^2 V_2 + aV_3\right)$$

The parameters in these equations are defined as:

V_N = negative phase sequence voltage

$a = 1\angle 120^\circ$

$a^2 = 1\angle 240^\circ$

For ABC phase rotation, $V_1 = V_{ab}$, $V_2 = V_{bc}$, $V_3 = V_{ca}$
For ACB phase rotation, $V_1 = V_{ab}$, $V_2 = V_{ca}$, $V_3 = V_{bc}$

The negative-phase sequence voltages are calculated for the fundamental (60 or 50 Hz) component only.

The relay can be in three states:

- **Pickup –** If the negative-phase sequence voltage is more than the pickup set point, the relay goes into pickup, and is said to enter Pickup state.
- **Operate** – If the relay stays in Pickup state for a specified pickup delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state.
- **Drop out** – The relay drops out of pickup when the negative-phase sequence voltage drops below 97% of the programmed threshold. The relay is said to be in Drop out state.

The phase loss pickup setting can be adjusted from 8% to 50% in increments of 1%. The phase loss delay setting can be adjusted from 0.5 second to 600 seconds in increments of 0.5 seconds.

Blocking voltage option: An optional blocking voltage is provided and, if enabled, is 5%. The phase loss relay function is not performed if Blocking Voltage is enabled and the voltage on all phases is less than the blocking voltage, in which case the system logs an event. If the phase loss relay goes into pickup, and the voltage subsequently drops below the blocking voltage, the relay goes out of pickup and the delay is reset. It is possible to suspend the relay through FlexLogic.

5.2.5.1 Accuracy

Pickup accuracy is ±4%. Trip time accuracy is ±0.1 seconds.

5.2.5.2 Setup

To set the Trip and Alarm settings for the Phase Loss relay

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **Phase Loss**.

The remainder of this section discusses the relay parameters that can be set in the Phase Loss section of the Relay Protection screen as shown in Figure 5-9.

5.2.5.3 Trip settings

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Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the phase loss pickup from 8% to 50% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the phase loss delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage. If the option is enabled, the blocking voltage setting is 5% of the nominal voltage.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.2.5.4 Alarm settings

Relay Enabled: Select **Enabled** to enable the relay.

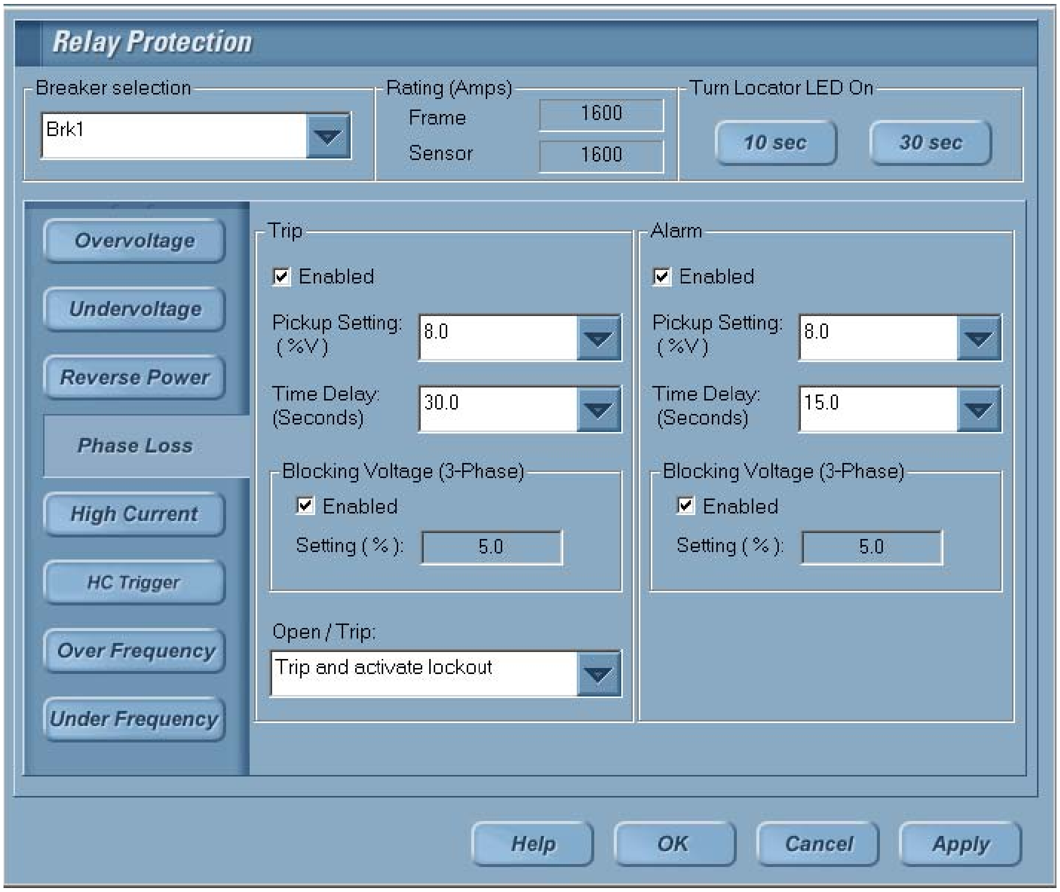
Pickup: Adjust the phase loss pickup from 8% to 50% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the phase loss delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage. If the option is enabled, the blocking voltage setting is 5% of the nominal voltage.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

Figure 5-9 Phase Loss Relay settings



The phase rotation is set at the factory and cannot be changed by the user.

5.2.5.5 Usage

Phase Loss goes into pickup whenever the negative-phase sequence voltage is greater than the pickup threshold set by the user. The Phase Loss Relay trips or sets off the alarm with the time delay set by the user.

Event logging

The events generated by a Phase Loss Relay are:

- Alarm Pickup Phase Loss – Alarm only phase loss relay has entered pickup.
- Alarm Phase Loss – Alarm only phase loss relay has operated.
- Alarm Dropout Phase Loss – Alarm only phase loss relay has dropped out of pickup.
- Voltage Below Phase Loss Alarm Blocking Voltage – The voltages on all three phases have dropped below the alarm only phase loss blocking voltage threshold.
- Voltage Above Phase Loss Alarm Blocking Voltage – The voltage on at least one of the three phases has exceeded the alarm only phase loss blocking voltage threshold.
- Pickup Phase Loss – Phase loss relay has entered pickup.
- Breaker Trip Phase Loss – Phase loss relay has operated.
- Dropout Phase Loss – Phase loss relay has dropped out of pickup.
- Voltage Below Phase Loss Blocking Voltage – The voltages on all three phases have dropped below the phase loss blocking voltage threshold.

- Voltage Above Phase Loss Blocking Voltage – The voltage on at least one of the three phases has exceeded the phase loss blocking voltage threshold.

To view these events, click **Sequence of Events** on the **Main Menu**.

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5.2.6 Reverse Power Relay

The Entellisys system provides a Reverse Power Relay that prevents an open primary on a transformer from back-feeding the magnetizing current. The system performs this function by comparing the magnitude and direction of the power in each phase to the set point. If, on any phase, the direction of the power is reversed and the magnitude of the power is greater than the set point for the specified time delay, the system opens or trips the circuit breaker or activates an alarm.

The relay can be in three states:

- **Pickup –** If the reverse power is more than the pickup set point, the relay goes into pickup, and is said to enter Pickup state.
- **Operate** – If the relay stays in Pickup state for a specified pick up delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state.
- **Drop out** – The relay drops out of pickup when the reverse power drops below 97% of the programmed threshold. The relay is said to be in Drop out state.

The power reversal pickup setting can be adjusted from 10 to 990 kW, in steps of 10 kW. The power reversal delay setting can be adjusted from 0.5 second to 600 seconds in increments of 0.5 seconds.

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5.2.6.1 Accuracy

Pickup accuracy is ±4%. Trip time accuracy is ±0.5 seconds.

5.2.6.2 Setup

To set the Trip and Alarm settings for the Reverse Power Relay

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **Reverse Power**.

The remainder of this section discusses the relay parameters that can be set in the Reverse Power section of the Relay Protection screen as shown in Figure 5-10.

5.2.6.3 Trip settings

Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the reverse power pickup from 10 to 990kW in increments of 10kW from the **Pickup Setting** drop-down menu.

Delay: Adjust the reverse power delay from 0.1 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.2.6.4 Alarm settings

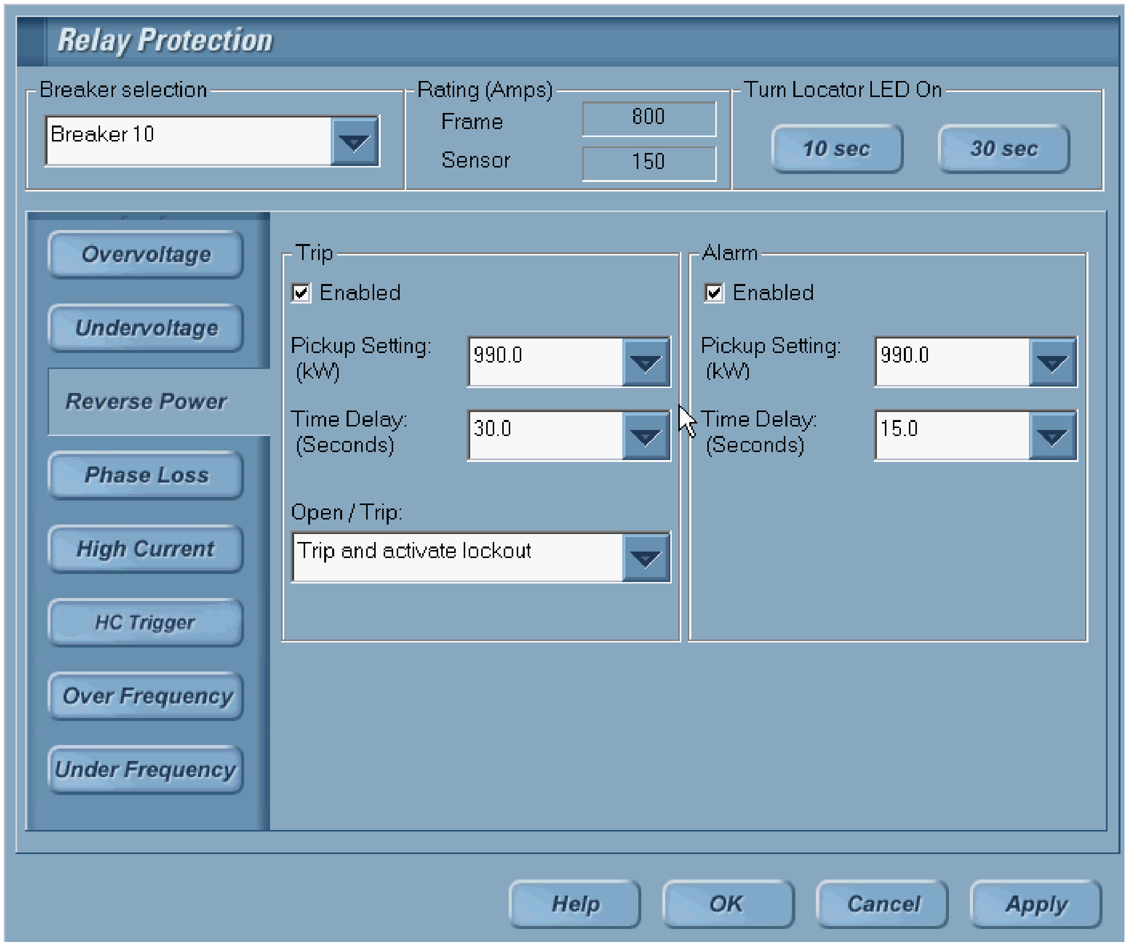
Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the reverse power pickup from 10 to 990kW in increments of 10kW from the **Pickup Setting** drop-down menu.

Delay: Adjust the reverse power delay from 0.1 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

Figure 5-10 Reverse Power Relay settings



5.2.6.5 Usage

The Reverse Power Relay goes into pickup whenever the direction of power, on any phase, is reversed and the magnitude of the power is greater than the pickup threshold set by the user. The Reverse Power Relay trips or sets off the alarm with the time delay set by the user.

Event logging

The following events are generated by the Reverse Power Relay:

- Alarm Pickup Reverse Power – Alarm only reverse power relay has entered pickup
- Alarm Reverse Power – Alarm only reverse power relay has operated
- Alarm Dropout Reverse Power – Alarm only reverse power relay has dropped out of pickup
- Pickup Reverse Power – Reverse power relay has entered pickup
- Breaker Trip Reverse Power – Reverse power relay has operated
- Dropout Reverse Power – Reverse power relay has dropped out of pickup

To view these events, click **Sequence of Events** on the **Main Menu**.

5.2.7 High Current Relay

The Entellisys system provides a High Current Relay. The system performs this function by comparing each of the current phases to the programmed threshold. If any of the currents are above the programmed threshold for more than the programmed delay, the system activates an alarm. The High Current Relay cannot trip a circuit breaker.

The relay can be in three states:

- **Pickup –** If the current in any phase is more than the pickup set point, the relay goes into pickup, and is said to enter Pickup state
- **Operate** – If the relay stays in pickup state for a specified pick up delay time, the system trips the appropriate circuit breaker or activates an alarm, and the relay is said to be in Operate state
- **Drop out** – The relay drops out of pickup when the current drops below 97% of the programmed threshold. The relay is said to be in Drop out state.

The high current pickup relay can be adjusted from 50% to 200% of the Long Time Protection pickup setting, in increments of 5%. The high current delay setting can be adjusted from 1 to 15 seconds in steps of 1 second. The relay can be suspended through FlexLogic.

5.2.7.1 Accuracy

Pickup accuracy is ±10%. Trip time accuracy is ±1 second.

5.2.7.2 Setup

To set the Alarm settings for the high current relay

1. On the **Main Menu**, click **User Settings**, and then select **Relay Protection**.
2. On the **Relay Protection** screen, choose the circuit breaker number from the drop-down menu and click **High Current**.

The remainder of this section discusses the relay parameters that can be set in the High Current section of the Relay Protection screen as shown in Figure 5-11.

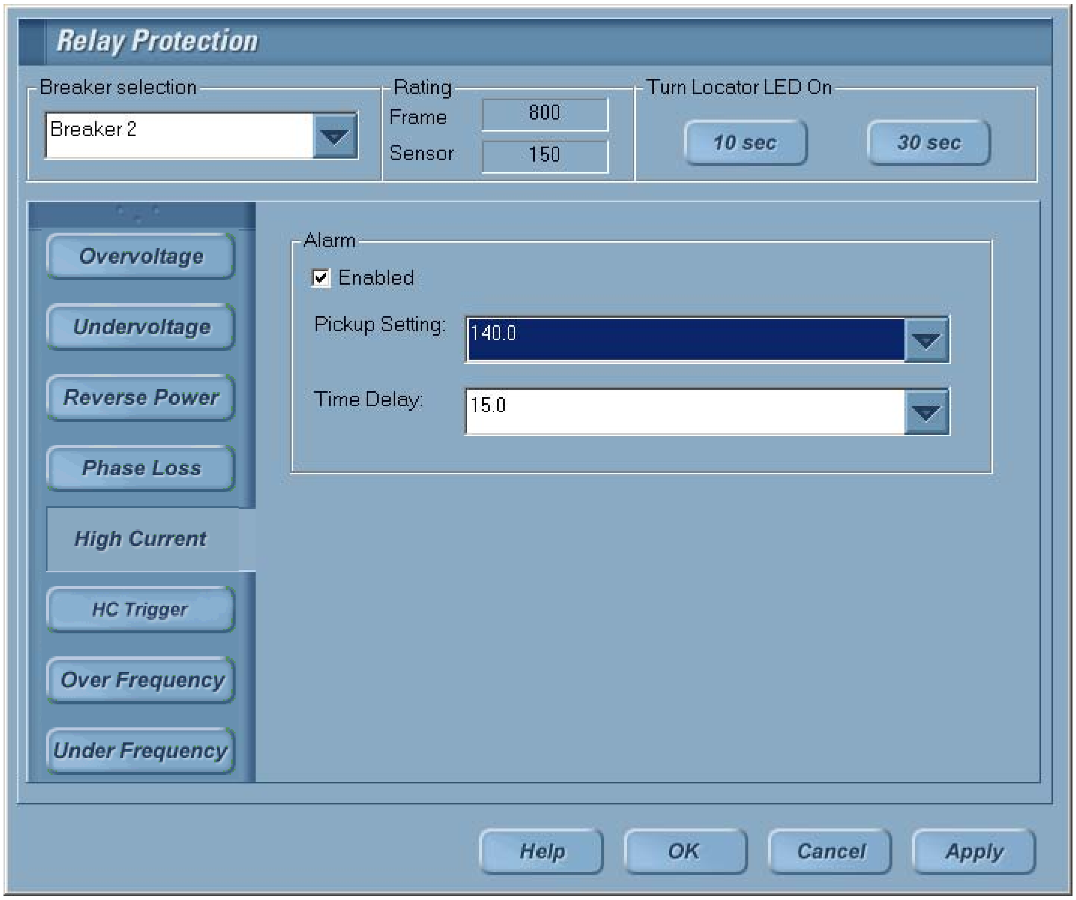
5.2.7.3 Alarm settings

Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the high current pickup from 50% to 200% in increments of 5% from the **Pickup Setting** drop-down menu.

Delay: Adjust the high current delay from 1 to 15 seconds in increments of 1 second from the **Time Delay** drop-down menu.

Figure 5-11 High Current Relay settings



5.2.7.4 Usage

The High Current Relay goes into pickup when any of the currents are greater than the programmed threshold. The high current relay sets off the alarm with the time delay set by the user.

5.2.7.5 Event logging

The High Current Relay generates the following events:

- Alarm Pickup High Current – High current relay has entered pickup
- Alarm High Current – High current relay has operated
- Alarm Dropout High Current – High current relay has dropped out of pickup

To view these events, click **Sequence of Events** on the **Main Menu**.

5.3 Advanced Protection Relays

5.3.1 High Resistance Ground Fault Detection Relay

The Entellisys system provides an optional High Resistance Ground Fault Detection (HRGF) Function that is an alarm-only function that does not trip the circuit breaker. The relay requires an additional 10A ground CT and will detect a fault by measuring the current through the resistance ground circuit of the substation transformer.

The system will indicate that a ground fault event occurred and on which phase. See High Resistance Ground Fault Location Relay on page 171 to locate the specific feeder.

The relay can be in three states:

- **Pickup –** If the ground current in any phase is more than the pickup set point, the relay goes into pickup, and is said to enter Pickup state.
- **Operate** – If the relay stays in pickup state for a specified pick up delay time, the system activates an alarm, and the relay is said to be in Operate state.
- **Drop out** – The relay drops out of pickup when the ground current drops below 97% of the programmed threshold. The relay is said to be in Drop out state.

The HRGF pickup is programmable from 0.1 amps to 10.0 amps of ground current in increments of 0.1 amps. The delay setting is programmable from 0.5 to 5 seconds in increments of 0.1 second. A constant time curve is used for HRGF. If the ground current is above the pickup threshold, the system logs an event. If the ground current remains above the threshold for longer than the delay setting, the system logs an event and activates an alarm.

NOTE: Multi-Source Ground Fault is not available in High Resistance Systems

5.3.1.1 Accuracy

Pickup accuracy is ±10%. For 1 Amp and below, the accuracy is ± 10% of 1 Amp

5.3.1.2 Setup

The HRGF relay is a per line-up option.

To set the Alarm settings for the HRGF relay

1. On the **Main Menu**, click **User Settings**, and then select **Advanced Protection**.
2. On the **High Resistance GF tab** (**User Settings**, **Advanced Protection** screen), choose the circuit breaker number from the drop-down menu and click **High Resistance GF**.

The remainder of this section discusses the relay parameters that can be set in the High Resistance GF section of the Relay Protection screen as shown in Figure 5-12.

NOTE: High Resistance Detection and Location Relays are only available on breakers which have a ground CT.

5.3.1.3 Alarm settings

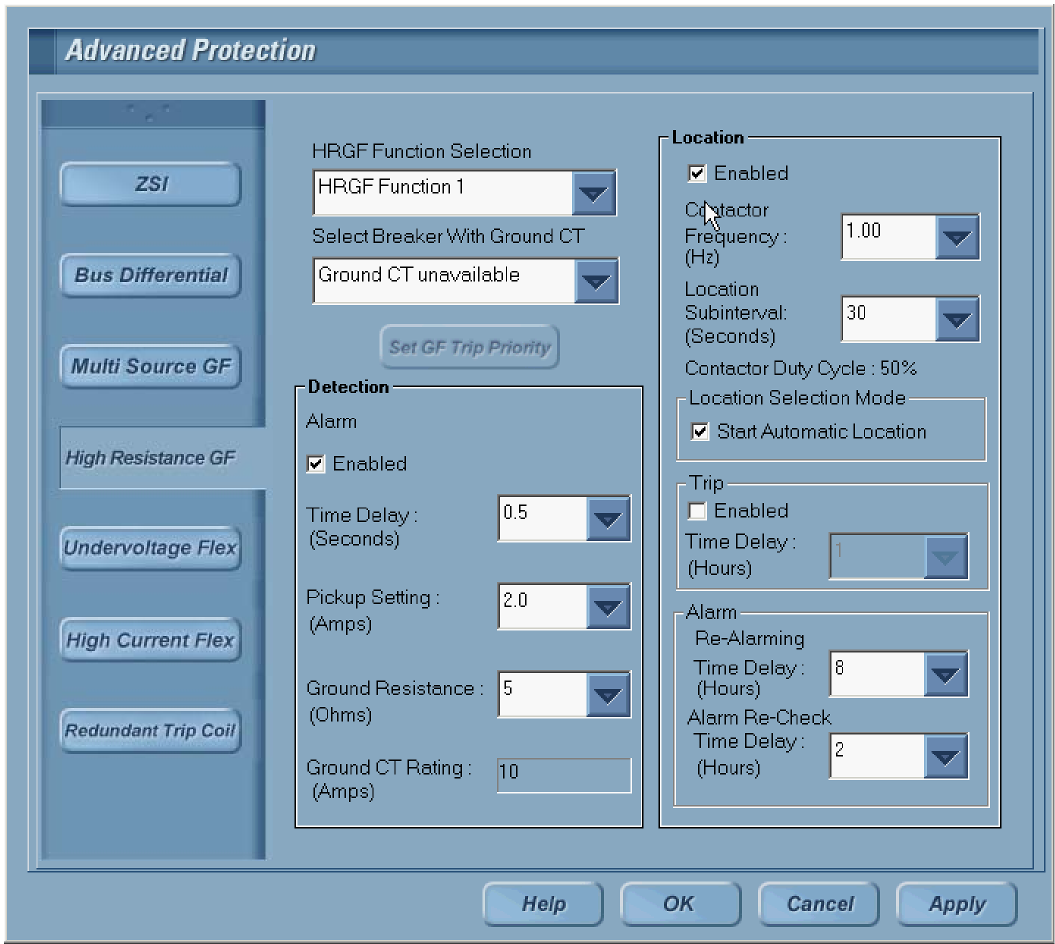
Relay Enabled: Select **Enabled** to enable the relay.

Pickup: Adjust the HRGF pickup from 0.1 Amps to 10 Amps in increments of 0.1 Amp from the **Pickup Setting** drop-down menu.

Delay: Adjust the HRGF delay from 0.5 to 5 seconds in increments of 0.1 second from the **Time Delay** drop-down menu.

Ground Resistance: Enter the untapped system ground resistance from 5 to 500 ohms in increments of 1 ohm.

Figure 5-12 High Resistance GF settings



5.3.1.4 Usage

The High Resistance Ground Fault Relay goes into pickup if the ground current is above the pickup threshold and generates an alarm if the ground current remains above the threshold for longer than the delay setting.

5.3.1.5 Event logging

The HRGF relay generates the following events:

- Pickup High Resistance GF – when the alarm function enters pickup
- Alarm High Resistance GF – when the alarm function operates

- Drop out High Resistance GF – when the alarm function drops out

To view these events, click **Sequence of Events** on the **Main Menu**.

5.3.2 High Resistance Ground Fault Location Relay

The Entellisys system provides High Resistance Ground Fault Location (HRGF Location) for up to 4 mains which locates a fault by analyzing system currents while operating the ground resistor pulsing contactor.

For example, in a typical High Resistance system, a phase to ground fault will be limited to 5-15 Amps allowing the breaker to remain closed. To locate, a ground contactor will short some of the resistor effectively reducing the ground resistance and increasing the ground current at a periodic rate. Location systems will use this amperage modulation to locate the fault to the specific breaker(s) affected.

Unlike traditional systems, Entellisys does not require additional sensors to locate a ground fault, rather it utilizes a signal processing algorithm to detect the low magnitude ground signal in the presence of large phase currents. Entellisys then reports all breakers that are seeing the modulated current - including mains and ties.

Highlights

Manual Mode will pulse the contactor indefinitely until stopped by the user.

Tripping Option: When a ground fault occurs and has been successfully located, the relay will begin timing to trip the faulted breaker. If the fault continued uninterrupted for the specified number of hours, the feeder breakers reported by this function will be tripped.

Tripping Priority: If a breaker faults to ground while a HR fault already exists there will be what amounts to a phase to phase fault through ground. In High Resistance systems, only one breaker needs to be tripped. Entellisys allows the user to configure a tripping priority to each breaker. (See Ground Fault Tripping priority on page 221)

Operation

the location relay can be set to automatically operate when a fault is detected. Once the detection relay is in pickup, the location relay automatically starts to locate the fault by pulsing the grounding contactor through the discrete I/O for 1 minute.

The CPU locates the ground fault by creating a tracing signal in the ground current using a pulsing contactor toggled by a FlexLogic contact output "HRGF Pulse contactor output 1-4" routed to an appropriate discrete output to pulse the contactor.

When the contactor is ON, the resistance value will be lowered and the ground current will be increased, thus creating a tracing pulse current through the ground resistor. Only one contactor among of the available contactors (maximum of 4) will be operating at any point of time. The contactor pulsing can be manually initiated under any condition.

The pulsing contactor connected to the discrete I/O must have a coil current less than 1 Ampere of 120VAC current when closed. The contact ratings must be at least 10A @ 600VAC when closed and while opening.

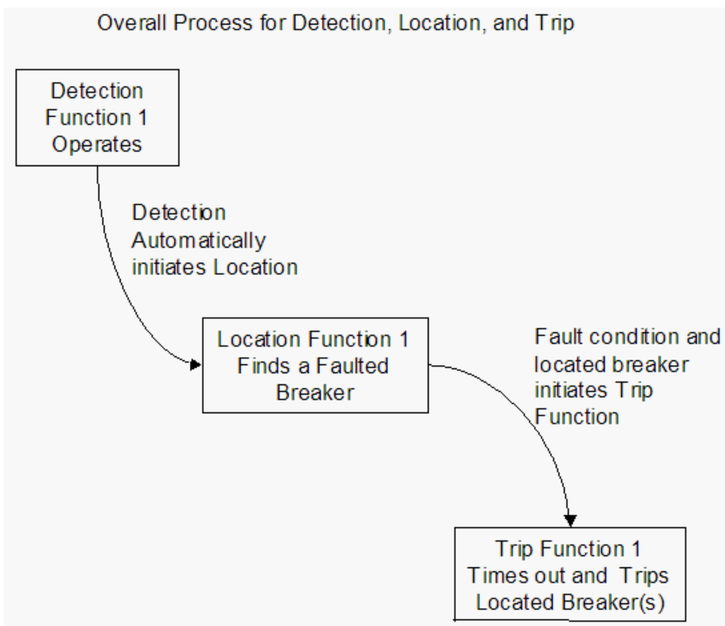
The user must go to the **Event** screen to view the results of the HRGF location relay. From the HRGF events, the user will be able to determine that a ground fault has occurred and if the system has located the responsible feeder. There are also several alarms to help alert the user. (See Events and Alarms on page 177)

Operational limitations

Location may not find the faulted feeder under the following conditions:

- Load Currents above 1X (Overload)
- High Z fault (insufficient pulse current)
- Multiple feeders faulted
- Other rapid transient currents (i.e. motors starting every fraction of a second)
- Network (parallel) applications may not locate for mains and ties
- Minimum pulse current not met
- Breaker is in a reverse power condition

Figure 5-13 HRGF Detection and Location process - w/ optional trip enabled



5.3.2.1 Hardware Requirements

The system must be a High Resistance grounded system with HRGF detection and have either redundant or non-redundant discrete I/O

5.3.2.2 Accuracy

The location relay is dependant on the CT size and differential current between the pulsing contactor's on and off state. The minimum differential pulse current will, in turn, depend on fault impedance and the size of the grounding resistors.

Table 5-8 CT accuracy in terms of detectable fault currents

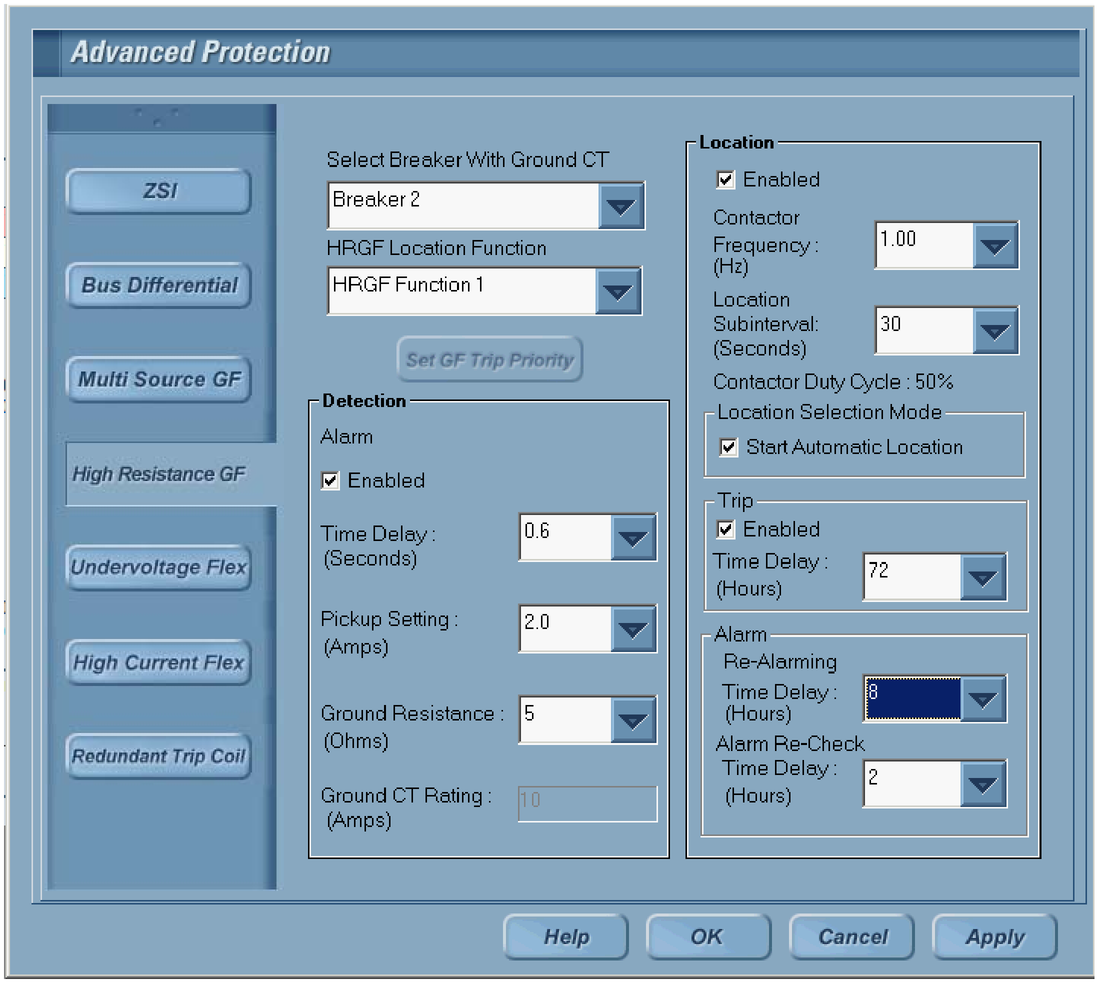
CT Rating (Amps)	Minimum detectable differential current (Differential amps)
150	1.0
400	1.0
800	1.0
1,600	1.0
2,000	1.2
3,200	1.5
4,000	2.0
5,000	3.0

5.3.2.3 Setup

The HRGF Location functionality is an extension to the HRGF Detection relay. Since the location process starts after a fault has been detected by HRGF Detection, the configuration parameters specified for the HRGF Detection functionality must be set for the feature to work.

The High Resistance Detection and Location Relays are only available on breakers which have a ground CT installed by the factory. To navigate to the setup screen login as an administrator to the HMI and open the **Advanced Protection** (Main Menu, User Settings)

Figure 5-14 High Resistance GF Location settings



Select Breaker With Ground CT - Lists only breakers with ground CT's assigned to them from the factory

HRGF Location Function: Lists the available location relays - if optioned. Typically will reflect the number of mains in the system equipped with HR equipment.

Detection Function: See Setup on page 169

Location Relay Group box

> **Contactor Frequency**: (0.5 - 2 Hz or 30 - 120 pulses per minute) Frequency at which the contactor will pulse. User can adjust depending on the sensitivity of hand held amp meters used to locate the fault downstream of Entellisys.

Location Subinterval: (20-60 seconds, default 30) defines the minimum duration of pulsing required before initiating a location event.

Start Automatic Location: Default checked - starts location automatically after a fault is detected.

Trip group box

Time Delay: (0 to 999 hr in 1 hr increments, 0 will trip immediately) Time the system will wait before issuing a trip command to a feeder. Note: Only available for feeders.

Alarm Settings group box

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Re-Alarming Time Delay: (0 to 99 hr in 1 hr increments, 0 is disabled) Turns the acknowledged alarm back to un-acknowledged (blinking) and logs a single event.

Alarm Re-Check Time Delay: 0 to 99 hr in 1 hr increments0 is disabled) Logs event every interval only after re-alarm if fault still exists. Does not change the fault alarm acknowledge state.

5.3.2.4 Tripping

Once a fault has been detected and located, the trip timer will begin timing only on breakers classified as feeders. Once the trip timer times out, the faulted feeder will only trip after the location relay verifies that it is still faulted by re-running the location routine.

If, before the breaker is tripped, the detection relay drops out then the system will wait for up to 30 seconds before resetting the trip timer. If the fault reoccurs within 30 seconds, the trip timer will continue timing.

While timing out, if the located breaker is opened and the detection drops out then the function is reset. If detection does not drop out then locate will find and restart timing for a new faulted breaker.

Lastly, if the detection relay is still active but the fault originally located is not verified by the system, the system will attempt 10 times to locate the breaker every 30 minutes or until the detection relay drops out. If the location verification identifies a different faulted breaker, trip timing will be restarted for the newly faulted breaker.

The system will only trip a breaker if the following conditions are met

- The breaker has been designated as a feeder (factory configuration)
- Location trip has been enabled
- Trip timer has timed out
- The location function has verified that the breaker is still faulted

If the Trip Time Delay is set to 0, then the location verification and retry attempts will occur immediately without the 30 minute delay and immediately trip the breaker after location verification.

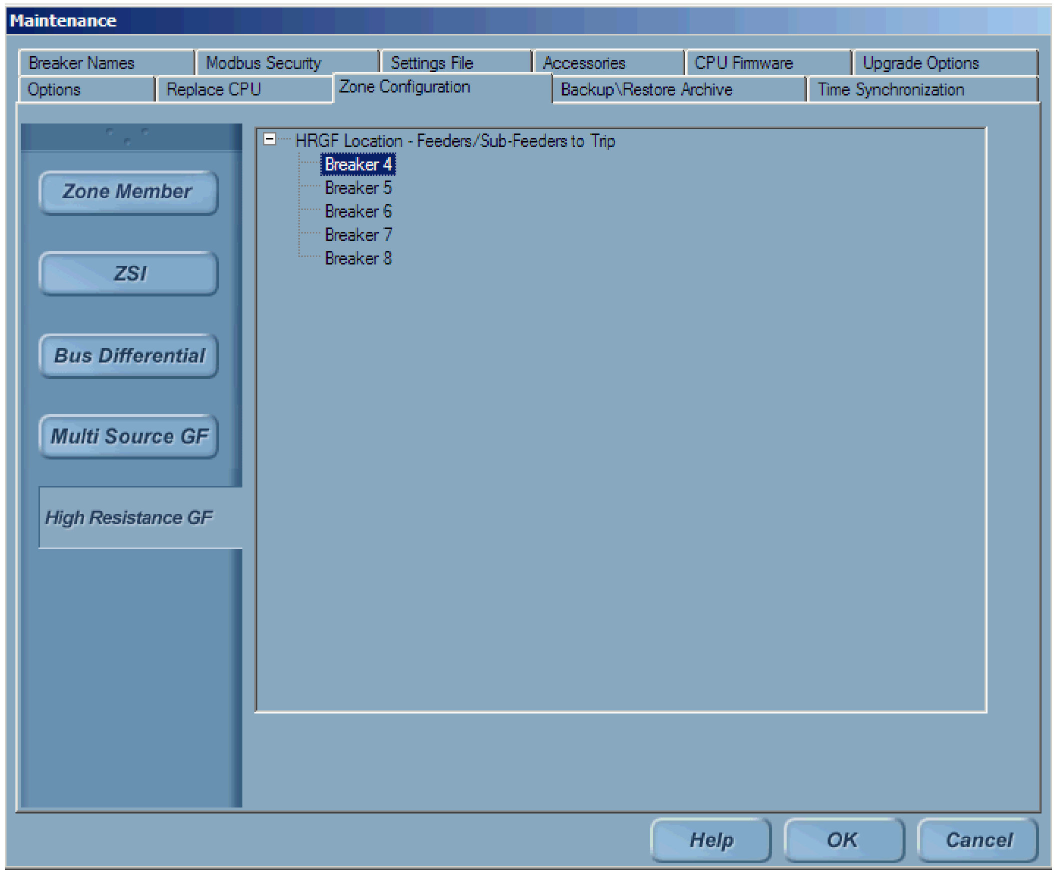
How to determine if a breaker is configured to trip:

1. Login to the HMI as an administrator and navigate to the **Maintenance** screen
2. Select the “Zone Configuration” tab
3. Select the High Resistance GF button - See Figure 5-15

To modify the breaker list, contact GE Post Sales Service. See How to contact us on page 2

NOTE: Once a breaker is tripped, a ground fault may still exist. The fault could still be present because there is a second, higher impedance fault that was masked by the first fault.

Figure 5-15 List of HRGF Location breakers configured to trip



5.3.2.5 Manual Mode

Entellisys provides the ability to manually pulse the contactor either for testing purposes or to locate the fault downstream of Entellisys. When the location function is started manually, the location relay will attempt to locate the feeder and continue to pulse the contactor until the time it is stopped by the user.

To place the HRGF Location in manual mode, click on the **HRGF Location** button from the **Events** screen.

To Start, wait until automatic mode is idle and choose the function (if more than one function is enabled) and click start or stop. The contactor will begin pulsing indefinitely.

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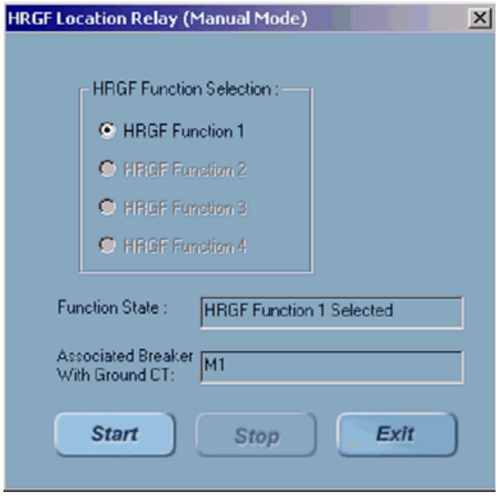
After initiating the manual mode, the screen may be closed and the contactor will continue to pulse. Return to the Manual Mode to stop the contactor pulsing.

Figure 5-16 HRGF Location manual mode screen



5.3.2.6 Events and Alarms

Events

Start and Stop events: Each location relay will log an event when HRGF is started and stopped either automatically or manually.

Location Events: Upon location of the ground fault, the CPU will log an event listing the name of the located feeder breakers

Trip events: An event is logged when the Location Relay is in pickup, dropout or trips the feeder breaker with the ground fault

Alarms

The CPU provides the following alarm functionality for the HRGF Location feature, irrespective of the fault being located by either automatic or manual mode:

The **High Resistance GF Location Alarm** will activate the alarm upon location of the ground fault. The alarm, if acknowledged, will return to an un-acknowledged state if the fault is not cleared before the re-alarming delay or recheck delay.

The **Trip Alarm** will alarm when the HRGF Location relay issues a trip command.

Contactor Pulsing Alarm is provided to alert the user that the contactor is actively being pulsed by Entellisys - either manually or automatically.

5.3.3 UnderVoltage Flex Relay

The UnderVoltage Flex Relay is a collection of 16 breaker independent UnderVoltage relays. See Undervoltage Relay on page 148 for operational details.

Any one of the 16 relays can be configured to monitor the voltage on any of the breakers. Also, unlike the fixed undervoltage relays, the undervoltage flex relays allows the same or a different breaker to be tripped.

5.3.3.1 Setup

To set the Alarm settings for the Undervoltage Flex relay

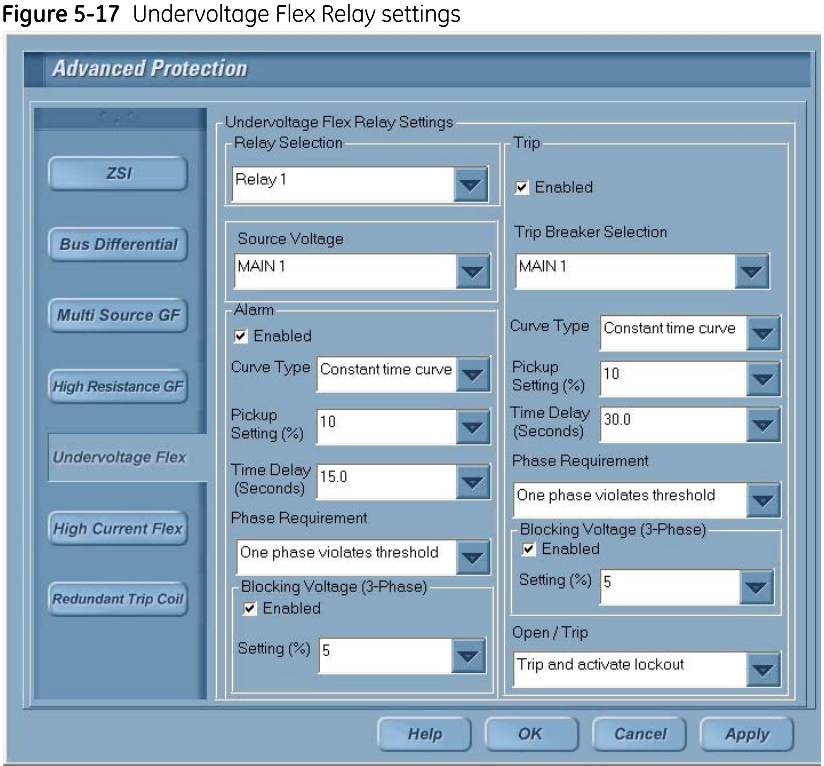
1. On the **Main Menu**, click **User Settings**, and then select **Advanced Protection**.
2. Click on **Undervoltage Flex** and choose the relay number from the drop-down menu.

Relay Selection: Select the relay instance (1 - 16)

Source Voltage: Select the breaker with the voltage source that will be associated with the relay shown in the Relay Selection pull-down.

Trip Breaker Selection: Select the breaker which will trip when the relay operates.

Figure 5-17 Undervoltage Flex Relay settings



5.3.3.2 Trip settings

Relay Enabled: Select **Enabled** to enable the relay.

Curve Type: Select either **Constant time curve** or **Inverse time curve** from the **Curve Type** drop-down menu.

Pickup: Adjust the undervoltage pickup from 10% to 95% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the undervoltage delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Phase Requirement: Select from among the following options using the **Phase Requirement** drop-down menu:

- Operate if any one phase is below the pickup threshold
- Operate if any two phases are below the pickup threshold
- Operate if all three phases are below the pickup threshold

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage.

Blocking Voltage Setting: Adjust the blocking voltage from 5% to 75% in increments of 1% using the **Setting** drop-down menu in the **Blocking Voltage** section.

Open Trip: Select the command issued when the relay operates from the **Open Trip** drop-down menu. Options are **Open and don't activate lockout** and **Trip and activate lockout**.

5.3.3.3 Alarm settings

Relay Enabled: Select **Enabled** to enable the alarm relay.

Curve Type: Select either **Constant time curve** or **Inverse time curve** from the **Curve Type** drop-down menu.

Pickup: Adjust the undervoltage pickup from 10% to 95% in increments of 1% from the **Pickup Setting** drop-down menu.

Delay: Adjust the undervoltage delay from 0.5 to 600 seconds in increments of 0.5 seconds from the **Time Delay** drop-down menu.

Phase Requirement: Select from among the following options using the **Phase Requirement** drop-down menu:

- Operate if any one phase is below the pickup threshold
- Operate if any two phases are below the pickup threshold
- Operate if all three phases are below the pickup threshold

Blocking Voltage Enabled: Select **Enabled** in the **Blocking Voltage** section to enable the blocking voltage.

Blocking Voltage Setting: Adjust the blocking voltage from 5% to 75% in increments of 1% using the **Setting** drop-down menu in the **Blocking Voltage** section.

5.3.3.4 Events and Alarms

Events

The Undervoltage Flex relay generates the following events:

- Alarm Pickup Undervoltage Flex Relay X – when the alarm function enters pickup
- Alarm Undervoltage Flex Relay X – when the alarm function operates
- Alarm Dropout Undervoltage Flex Relay X – when the alarm function drops out
- Pickup Undervoltage Flex Relay X – when the trip function enters pickup
- Breaker Trip Undervoltage Flex Relay X – when the trip function operates
- Dropout Undervoltage Flex Relay X – when the trip function drops out
- Voltage Below UV Flx Rly X Alarm Blocking Voltage – The voltages on all three phases have dropped below the alarm only undervoltage blocking voltage threshold.
- Voltage Above UV Flx Rly X Alarm Blocking Voltage – The voltage on at least one of the three phases has exceeded the alarm only undervoltage blocking voltage threshold.
- Voltage Below UV Flx Rly X Blocking Voltage – The voltages on all three phases have dropped below the undervoltage blocking voltage threshold.
- Voltage Above UV Flx Rly X Blocking Voltage – The voltage on at least one of the three phases has exceeded the undervoltage blocking voltage threshold.

To view these events, click **Sequence of Events** on the **Main Menu**.

Alarms

An **Undervoltage Flex Alarm** and an **Undervoltage Flex Trip** alarm can be configured through the Alarm configuration. The Alarm can be configured to annunciate on **Any** relay or for a specific relay.

5.3.4 High Current Flex Relay

The High Current Flex Relay is a collection of 16 breaker independent relays. The High Current Flex Relay is very similar to the High Current Relay (see High Current Relay on page 167).

As with the High Current Relay, the flex relay compares each of the phase currents and if any of the currents exceed the pickup for more than the programmed delay, the system activates an alarm. The alarm can be read by FlexLogic or on the HMI Alarm Screen.

The alarm can be in three states:

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- **Pickup –** If the current in any phase is more than the pickup set point, the alarm goes into pickup.
- **Operate** – If the alarm stays in pickup state for the selected pick up delay time, the system activates an alarm.
- **Drop out** – The alarm drops out of pickup when the current drops below 97% of the programmed threshold.

The High Current Flex Relay can be adjusted from 10% to 200% of the Long Time Protection pickup setting, in increments of 5%. The high current delay setting can be adjusted from 1 to 15 seconds in steps of 1 second. The relay can be suspended through FlexLogic.

5.3.4.1 Accuracy

Pickup accuracy is ±10%.

5.3.4.2 Setup

To set the alarm settings for the High Current Flex Relay

1. On the **Main Menu**, click **User Settings**, and then select **Advanced Protection**.
2. Click on **High Current Flex** and choose the relay number from the drop-down menu.

5.3.4.3 Settings

Relay Selection: Select the relay instance (1 - 16)

Enabled: Select **Enabled** to enable the alarm.

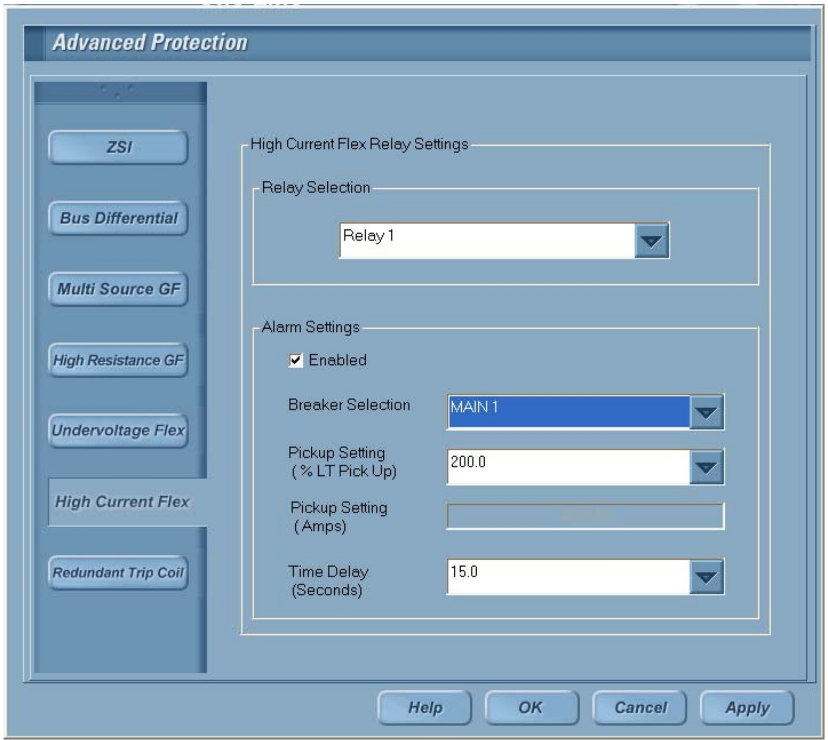
Breaker Selection: Select the breaker which will be associated with the alarm shown in the Relay Selection.

Pickup Setting: Adjust the high current pickup from 10% to 200% in increments of 5% of the long time setting.

Time Delay: Adjust the high current delay from 1 to 15 seconds in increments of 1 second.

NOTE: The High Current Flex Relay cannot trip a breaker directly. It is a protection element in FlexLogic and can be programmed to trip a breaker.

Figure 5-18 High Current Flex Relay settings



5.3.4.4 Events and Alarms

Events

The High Current Flex Relay generates the following events:

- Alarm Pickup High Current Flex X– High current relay has entered pickup
- Alarm High Current Flex X – High Current Flex relay has operated
- Alarm Dropout High Current Flex X – High Current Flex relay has dropped out of pickup

To view these events, click **Sequence of Events** on the **Main Menu**.

Alarms

The High Current Relay will trigger a **High Current Flex Alarm** which can be configured through the Alarm configuration. The Alarm can be configured to annunciate on **Any** breakers or breaker 1 to 30 can be specified.

5.3.5 Redundant Trip Coil

Each electrically operated EntelliGuard circuit breaker has two means to actuate the breaker: the Trip and the Open coil. Manually operated breakers only have a Trip coil.

Normally, in an overcurrent condition, the Trip coil will open the breaker, whereas the Open and Close coils are used to electrically actuate the breaker without engaging the network interlock or bell alarm (if equipped).

The Redundant Trip Coil feature will utilize the Open coil as a redundant trip mechanism to open an electrically operated breaker in the event of a trip signal. When a trip event occurs, the CPU will send a command to both the Trip and Open coils simultaneously.

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5.3.5.1 Operation

To maintain UPS control power stability, the Open coil command will only be issued to three breakers at any instance in time. In an event which involves more than 3 breakers simultaneously, the CPU will issue trip commands to all relevant breakers and will que Open coil commands as necessary in order of breaker number. Lower breaker numbers have first priority since, in Entellisys, Main and Tie breakers are always numbered starting with 1.

In the event of a high IOC fault condition, the Messenger will actuate the Trip coil first. The Trip and Open commands from the CPU will occur shortly after.

5.3.5.2 Event Logging

There are no events which are specifically related to the Redundant Trip Coil, however, operation of the Redundant Trip Coil can be validated in the event log. In the event of a Trip signal from either a protection relay or a manual HMI trip command, both Open and Trip command events will be seen in the event log as shown in figure 5-19.

Figure 5-19 Redundant Trip Coil events

Date & Time	Source	Description	Fault
Sep 28 2009 16:26:10.	Breaker 26	Breaker Tripped	N/A
Sep 28 2009 16:26:10.	Breaker 26	Breaker Lockout	N/A
Sep 28 2009 16:26:10.	Breaker 26	Breaker Open Command Received	Available
Sep 28 2009 16:26:10.	Breaker 26	Breaker Trip Command Received	Available

NOTE: Electric operated breakers are required as the open coil is actuated in unison with the Trip coil.

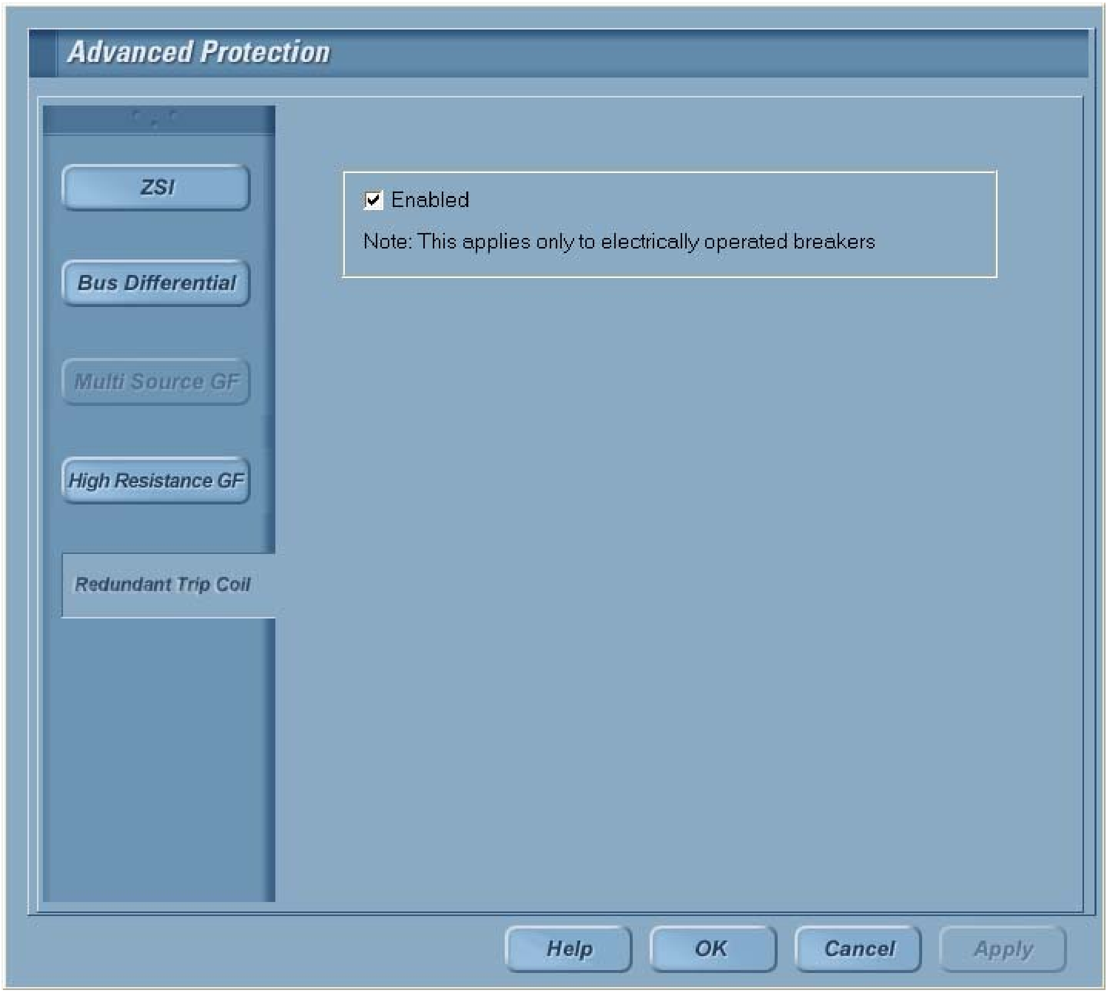
5.3.5.3 Setup

The Redundant Trip Coil settings tab is located under User Settings/Advanced Protection.

Enabled: Select Enabled to turn on the Redundant Trip Coil feature.

No other settings are needed for this feature.

Figure 5-20 Redundant Trip Coil



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5.3.5.4 Alarming

The Redundant Trip Coil settings tab is located under User Settings/Advanced Protection.

Enabled: Select Enabled to turn on the Redundant Trip Coil feature.

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5.4 Synch Check relay

The Synch Check function is used as a permissive for closed-transition automatic throw-over control schemes.

Entellisys performs the synch check relay function by comparing the amplitude, phase and frequency of the voltages in each of the three phases of the two selected source circuit breakers.

NOTE: The Synch Check Relay function is not a per messenger option, but a per line up option. Entellisys provides up to six synch check functions.

The following thresholds are used by the Synch Check relay:

Dead Bus Threshold: This user-programmable value represents the voltage for source 1 below which a phase is considered dead.

Live Bus Threshold: This user-programmable value represents the voltage for source 1 above which a phase is considered live.

5.4.1 Synch check status

Each synch check function provides the following status information:

Synchronous Live: Set to true if all three phases at both sources are above the live bus threshold and are in synch (i.e., all three phases satisfy the programmed voltage, frequency, and phase differential criteria) and is set to false otherwise.

Dead Source: If one or both sources are de-energized, the dead source selection permits closing of the circuit breaker to by-pass the synch check measurements. The following Dead Source criteria selections are available:

- None – Dead source function is disabled
- LV1 and DV2 – Voltage source 1 live and voltage source 2 dead
- DV1 and LV2 – Voltage source 1 dead and voltage source 2 live
- DV1 or DV2 – Voltage source 1 dead or voltage source 2 dead
- DV1 xor DV2 – One voltage source is dead, the other is live
- DV1 and DV2 – Both sources are dead

The Dead Source status is shown as true if the programmed dead bus configuration condition is true.

Close: This status is set to true if Synchronous Live is true or Dead Source is true.

Each synch check function verifies that the two sources have the same PT primary voltage and configuration (delta or wye). If both parameters are not the same for both sources, the CPU logs an event and disables the synch check function.

5.4.2 Setup

To set the settings for the Synch Check Relay

1. On the **Main Menu**, click **User Settings**, and then select **Control**.
2. On the **Control** screen, click **Synch Check**.

The remainder of this section discusses the parameters that can be set in the Synch Check section of the Control screen as shown in Figure 5-21.

The following settings must be set for the Synch Check Relay:

Synch Check Function: Choose the synch check relay number from the **Synch Check Function** drop-down menu.

Relay Name: Assign a name for identifying the relay.

Relay Enabled: Select **Enable** to enable the relay.

5

5.4.2.1 Source voltages

First: Select the circuit breaker number that provides the voltage for source 1 from the **First** drop-down menu in the **Source Voltages** menu group.

Second: Select the circuit breaker number that provides the voltage for source 2 from the **Second** drop-down menu in the **Source Voltages** menu group.

5.4.2.2 Maximum differentials

Voltage: Adjust the maximum voltage differential allowed between source voltages for the synch check function to operate from 0 to 90 V in steps of 0.5 V from the **Voltage** drop-down menu in the **Maximum Differentials** menu group.

Frequency: Adjust the maximum frequency differential allowed between source voltages for the synch check function to operate from 0 to 2 Hz in steps of 0.1 Hz from the **Frequency** drop-down menu.

Phase: Adjust the maximum phase differential allowed between source voltages for the synch check function to operate from 0 to 60 degrees in steps of 1 degree from the **Phase** drop-down menu.

The Synch Check function applies a 3% hysteresis factor to the voltage, frequency, phase, live bus and dead bus thresholds.

5.4.2.3 Source 1

Dead Bus Threshold: Adjust the threshold below which a phase is considered dead from 5 to 50% of the nominal voltage (line-neutral for wyes, line-line for deltas) in steps of 1% from the **Dead Bus Threshold** drop-down menu in the **Source 1** menu group.

Live Bus Threshold: Adjust the threshold above which a phase is considered live from 50% to 100% of the nominal voltage (i.e., the PT rating, line-neutral for wyes, line-line for deltas) in steps of 1% from the **Live Bus Threshold** drop-down menu in the **Source 1** menu group.

5.4.2.4 Source 2

Dead Bus Threshold: Adjust the threshold below which a phase is considered dead from 5 to 50% of the nominal voltage (line-neutral for wyes, line-line for deltas) in steps of 1% from the **Dead Bus Threshold** drop-down menu in the **Source 2** menu group.

Live Bus Threshold: Adjust the threshold above which a phase is considered live from 50% to 100% of the nominal voltage (i.e., the PT rating, line-neutral for wyes, line-line for deltas) in steps of 1% from the **Live Bus Threshold** drop-down menu in the **Source 2**menu group.

5.4.2.5 Configuration

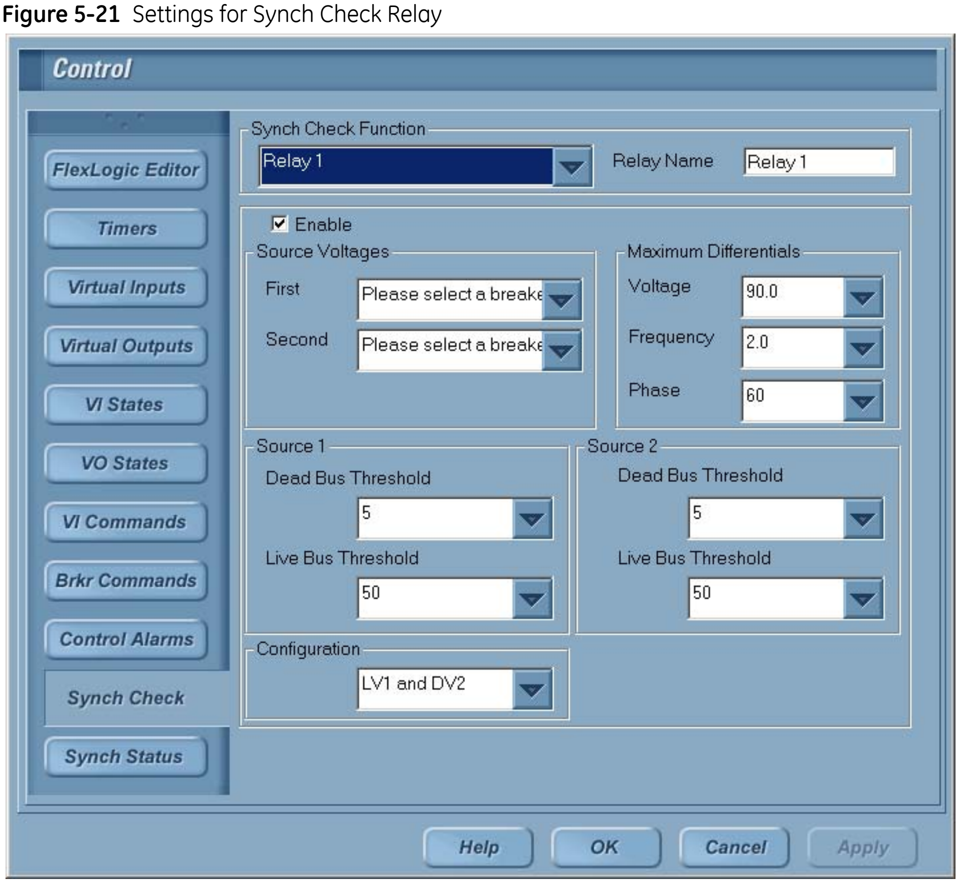
5

Select the condition under which the “Dead Source” status output is true from the following options in the **Configuration** drop-down menu:

- None – Dead source function is disabled
- LV1 and DV2 – Voltage source 1 live and voltage source 2 dead
- DV1 and LV2 – Voltage source 1 dead and voltage source 2 live
- DV1 or DV2 – Voltage source 1 dead or voltage source 2 dead
- DV1 xor DV2 – One voltage source is dead, the other is live
- DV1 and DV2 – Both sources are dead

NOTE: A source is considered dead when all voltage phases are below the dead bus threshold. A source is considered live when all voltage phases are above the live bus threshold.

Figure 5-21 Settings for Synch Check Relay

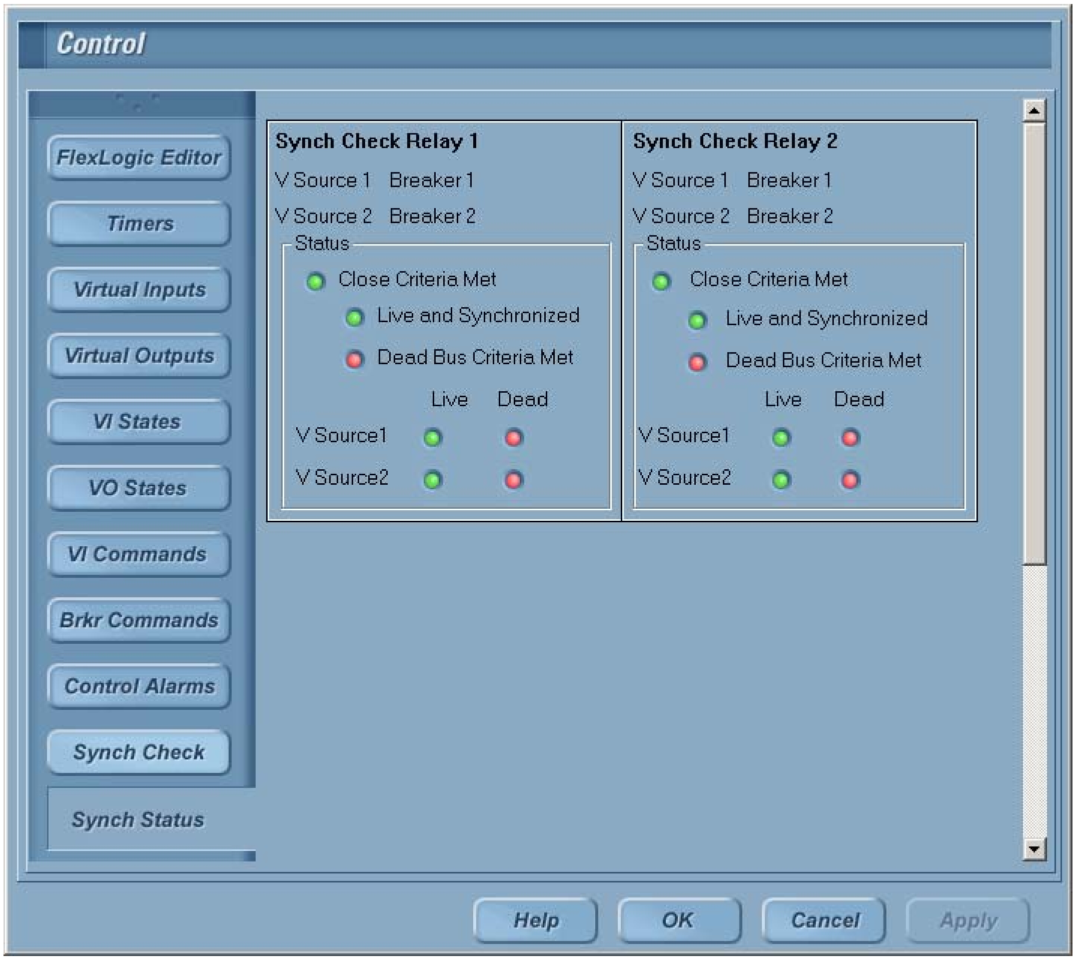


5.4.3 Usage

When two voltage source circuit breakers are selected as the two sources for synch check relay, if the differences in their magnitude, phase and frequency are within the set limits, the synch check shows the synch status as Live and Synchronized. The Dead Source status is also shown depending on whether the selected criterion for the dead source is met.

Figure 5-22 shows the status of a typical Synch Check Relay.

Figure 5-22 Synch Check status



5

5.4.3.1 Event logging

The following events are logged for the Synch Check relay:

- Synch Check Control Enabled 1…12 – Synch check relay 1…12 has been enabled
- Synch Check Control Disabled 1…12 – Synch check relay 1…12 has been disabled
- Synch Check 1…12 Sources Not Synchronized – Messengers that are providing voltage information for synch check relay are not synchronized, so Entellisys is unable to check for synchronization between voltage sources.
- Synch Check 1…12 Sources Not Compatible – Voltage sources for synch check relay 1…12 are not compatible; i.e. they have different PT configurations or ratings
- Synch Check 1…12 Dead Source Operate – Dead source criteria for synch check relay 1…12 have been met
- Synch Check 1…12 Dead Source Drop Out – Dead source criteria for synch check relay 1…12 have been met
- Synch Check 1…12 V1 Above Minimum – Voltage source 1 for synch check relay 1…12 is above the live source threshold
- Synch Check 1…12 V1 Below Maximum – Voltage source 1 for synch check relay 1…12 is below the dead source threshold
- Synch Check 1…12 V2 Above Minimum – Voltage source 2 for synch check relay 1…12 is above the live source threshold
- Synch Check 1…12 V2 Below Maximum – Voltage source 2 for synch check relay 1…12 is below the dead source threshold

To view these events, click **Sequence of Events** on the **Main Menu**.

6 Zones, buses, and topologies

6.0.1 Overview

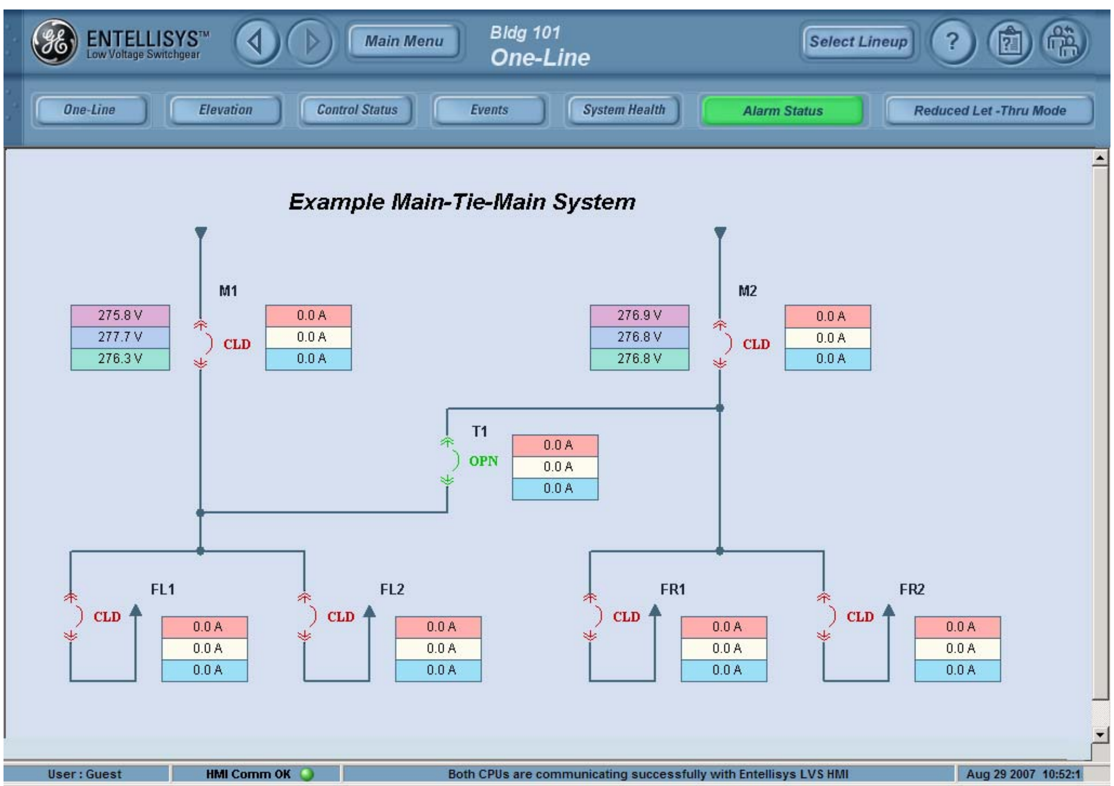
6.0.1.1 Zones and buses

Entellisys implements Multi-Source Ground Fault (MSGF), Bus Differential (BD), and Zone Selective Interlock (ZSI) as zone functions. In Entellisys, a zone is a set of circuit breakers connected to a common bus. The circuit breakers in a zone may control the power to that bus (e.g., a main circuit breaker), or the circuit breakers may be fed by that bus (e.g., a feeder or sub-feeder).

The system is divided into zones to provide better performance and simplify the configuration. MSGF, BD and ZSI will respond to faults that are within their zone and ignore faults outside the zone. This allows the zones to be inherently selective with the other zones and individual circuit breaker protection functions.

The system in Figure 6-1 contains two zones: Zone 1 is made up of Main 1 (M1), Tie 1 (T1), Feeder Left 1 (FL1) and Feeder Left 2 (FL2). Zone 2 is made up of Main 2 (M2), Tie 1 (T1), Feeder Right 1 (FR1) and Feeder Right 2 (FR2). It also contains two buses, Bus 1 and Bus 2, separated by a tie circuit breaker.

Figure 6-1 One-Line diagram for a main-tie-main system



The main-tie-main is a common configuration, but the concept of buses and zones is not limited to a main-tie-main configuration. Entellisys only requires that the number of zones is between one and four, and the number of circuit breakers per zone is between one and thirty (or zero if a zone is not used).

6.0.1.2 Topologies

In Figure 6-1 the bus to which the member circuit breakers of a given zone are connected can be powered in several different ways (this assumes that the main circuit breakers M1 and M2 are each connected to a source, e.g., a utility or generator). For example, Bus 1 can be powered from the source at M1, it can be powered from the source at M2, or it can be powered by both sources in parallel (it can also be unpowered). The same options are available for Bus 2. How the buses are powered depends on the state of the mains and the tie.

Circuit breakers that control the flow of power to a bus, such as M1, M2, and T1 in the example above, are referred to in Entellisys as topology circuit breakers. For example, if M1 is open, M2 is closed, and T1 is closed, then M2 powers both Bus 1 and Bus 2. Entellisys allows up to eight topology circuit breakers to be specified. The state of the topology circuit breakers defines how a given bus is powered, and each state is referred to as a topology.

6

Entellisys allows the user to select different settings for the multi-point functions based on each zone's topology. For example, a user might want different pickup settings for the zone 1 bus differential function based on whether the bus is powered by the source at M2 versus the source at M1.

For a system with *B* buses, Entellisys provides 2^B Topologies numbered 0 to $2^B - 1$. Each topology can have its own settings associated with it for each multi-point function. (See Bus Differential Relay on page 196, Multi-Source Ground-Fault Relay on page 200, and Zone Selective Interlock on page 210 for more details). In the example above, there are two buses, so there are four topologies, numbered 0 through 3. In this case, the user can select settings for topologies 1–3. Entellisys reserves topology 0 settings for the Reduced Let-Through Mode settings (see Reduced Energy Let-Thru Mode on page 225 for more information).

6.0.2 Setup

The setup of the zones and topologies is done by GE before the switchgear is shipped to the customer. It is not done by the customer.

6.0.2.1 Zones

Entellisys provides a maximum of four zones. The example above only has two zones, however, so Zone 3 and Zone 4 do not contain any member circuit breakers. The zone definitions for the example one-line in Figure 6-1 are shown below:

Zone 1 Member Circuit Breakers

M1

T1

FL1

FL2

Zone 2 Member Circuit Breakers

M2

T1

FR1

FR2

6.0.2.2 Buses, topologies and the Association Matrix

In the system in Figure 6-1, circuit breakers M1, M2, and T1 are topology circuit breakers, since their state (i.e., open or closed) determines how the buses are powered. In the system shown in Figure 6-1, there are three different ways in which a bus can be powered, so there are three topologies for each zone:

Zone 1

- Topology 1: Bus 1 powered by source at M1 (or not powered)
- Topology 2: Bus 1 powered by source at M2
- Topology 3: Bus 1 powered by sources at M1 and M2

Zone 2

- Topology 1: Bus 2 powered by source at M2 (or not powered)
- Topology 2: Bus 2 powered by source at M1
- Topology 3: Bus 2 powered by sources at M1 and M2

This topology definition is summarized in the Table 6-1 below. Entellisys refers to this table as the Association Matrix.

Table 6-1 Association Matrix

T1	M2	M1	Zone 1 Topology	Zone 2 Topology
Open	Open	Open	1	1
Open	Open	Closed	1	1
Open	Closed	Open	1	1
Open	Closed	Closed	1	1
Closed	Open	Open	1	1
Closed	Open	Closed	1	2
Closed	Closed	Open	2	1
Closed	Closed	Closed	3	3

NOTE: Bus 1 in Zone 1 is always powered by the source connected to circuit breaker M1 (or is unpowered), except for the following two cases:

Case 1: The circuit breaker M1 (Topology Circuit Breaker 1) is open and circuit breakers M2 (Topology Circuit Breaker 2) and T1 (Topology Circuit Breaker 3) are closed. In this case Bus 1 is powered by the source connected to M2. For that row in the Association Matrix, the Topology for Zone 1 is therefore 2.

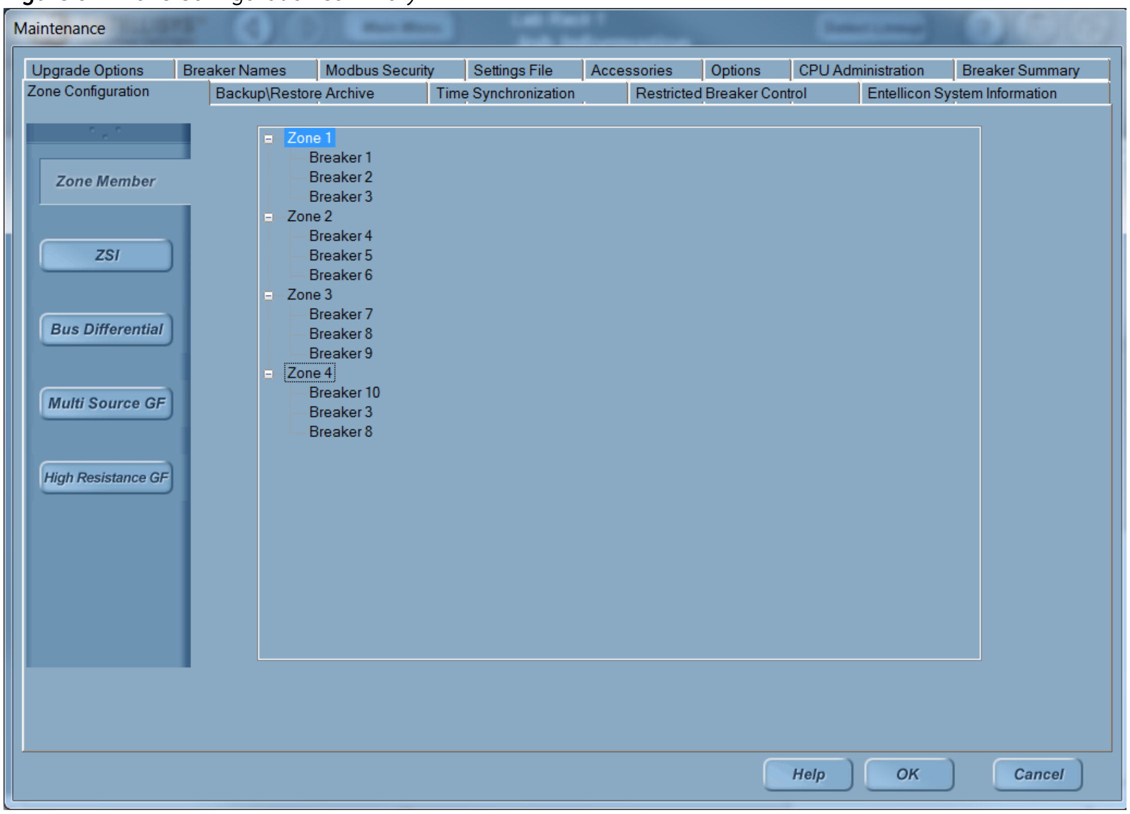
Case 2: All three topology circuit breakers are closed, in which case Bus 1 is powered by the sources connected to M1 and M2, in parallel. For that row in the Association Matrix, the Topology for Zone 1 is therefore 3. For Zone 1, all other rows in the Association Matrix are set to 1. A similar analysis applies to Zone 2.

6.0.3 Usage

The purpose of configuring the zones, buses, and topologies is to define the system properties for the multi-point functions (BD, MSGF, and ZSI), which, as noted above, operate on zones. This information is also used by the PT Throwover function (see PT Throw-Over on page 206 for details). Once this setup is completed (typically by GE before shipping) no further action is required unless the switchgear line-up changes (e.g., a new circuit breaker is added).

To view a summary of the zone configuration, on the **Maintenance** screen click the **Zone Configuration** tab as shown in Figure 6-2.

Figure 6-2 Zone Configuration summary



7 Multi-point functions

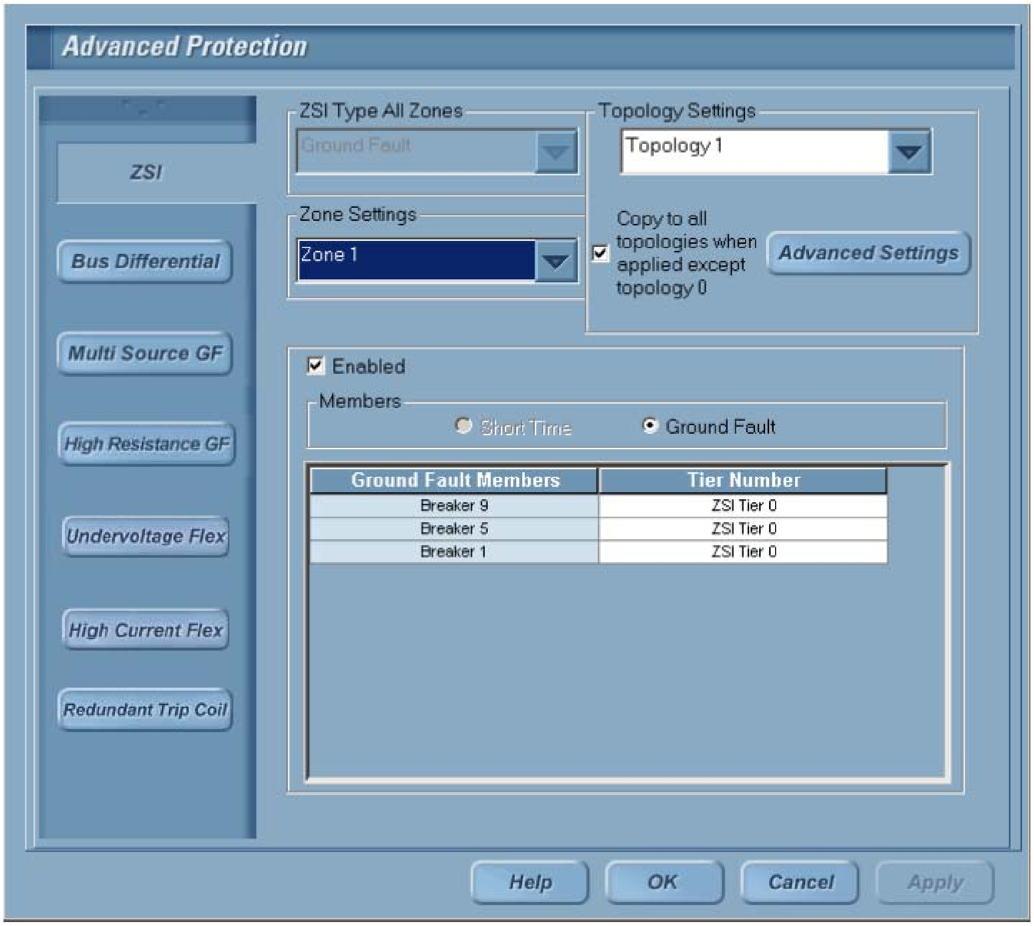
Entellisys implements Multi-Source Ground-Fault Relay, Bus Differential Relay and Zone Selective Interlock as zone functions. In Entellisys, a zone is a set of breakers connected to a common bus. The breakers in a zone may control the power to that bus (e.g., a main breaker), or the breakers may be fed by that bus (e.g., a feeder or sub-feeder).

The system is divided into zones to provide better performance and to simplify the configuration. MSGF, BD, and ZSI respond to faults that are within their zone and ignore faults outside their zone. This configuration allows the zones to be inherently selective with the other zones and individual breaker protection functions.

The Undervoltage Relay and High Current Flex Relay are collections of 16 breaker-independent relays.

The Redundant Trip Coil feature utilizes the Open coil as a redundant trip mechanism to open a breaker in the event of a trip. When a trip event occurs, the CPU sends a command to both the Flux Shifter and Open coils simultaneously. You can also configure High Resistance Ground Fault Detection Relay.

Figure 7-1 Advanced protection



7.1 Bus Differential Relay

Entellisys offers optional Bus Differential Relay Protection. The bus differential relay monitors the currents on each phase entering and leaving a zone (refer to section on zones and topologies for more information). If a fault occurs within the zone, the bus differential relay will detect this.

Because Bus Differential can discriminate between in zone and out of zone faults, the pickup settings of the Bus Differential relay can be set independent of the settings needed to serve the load. For example, if the 3,200A main Short Time pickup is set at 6X to start all loads than the minimum in zone fault the main will detect is 19,200A. Bus Differential can be set to levels similar to ground fault (1200A or less), offering far more sensitivity to detect bus and circuit breaker faults.

Bus Differential Protection has two types of relays to select from: an alarm-only relay and a trip relay. The trip relay also has an optional backup function. If the backup function is enabled, the Bus Differential function will open additional circuit breakers in the event that opening the circuit breakers that feed the zone does not clear the fault. This can happen, for example, when the fault is in a tie circuit breaker that only has one set of CTs. The backup function can be configured to operate with no additional delay, or after 100 msec of operation of the primary relay.

The alarm-only relay activates an alarm if the fault is above the specified limit for the specified duration of time. The trip relay opens/trips the trip and/or backup targets and also activates an alarm if the fault is above the specified limit for the specified duration of time.

7.1.1 Setup

7.1.1.1 Configuring Bus Differential zones

The Bus Differential configuration, namely the member circuit breakers for each zone, the current flow direction, and the circuit breakers to trip, is set up by GE.

7.1.1.2 User settings

Entellisys supports up to 16 topologies, from 0 to 15. Topology 0 is the Reduced Let-Thru Mode topology and topology 1 is the default topology. If no topology circuit breakers are defined, Entellisys supports only topologies 0 and 1. See Zones, buses, and topologies on page 191 for more information.

Each Bus Differential Relay (Alarm-Only and Trip) can be enabled or disabled in each zone for each topology. Bus Differential has two pickup settings and two time delay settings for each relay (i.e., Alarm-Only and Trip) in each zone and for each topology. The backup function of the Trip relay can be enabled to operate along with the Trip relay or after a delay of 100 msec by selecting **Trip Immediately** or **Trip After 100msec** from the **Backup Time Delta** drop-down menu on the **Topology Settings** tab as shown in Figure 7-2. These two settings are also topology-specific.

The only setting that is not topology specific on the Topology Settings tab is the Trip/Open setting that determines whether the Trip relay just opens the circuit breakers (either trip-targets or backup-trip-targets) or opens the circuit breaker and activates the lockout too.

7.1.1.3 Setting Bus Differential pickups/delays

To configure pickup and delay settings

1. On the **Main Menu**, click **User Settings.**
2. Click **Advanced Protection**, and then click **Bus Differential** as shown in Figure 7-2.
3. Select the zone number and topology number, and then select the appropriate settings for pickup setting 1, pickup setting 2, etc.

Pickup setting 1 must always be less than pickup setting 2. A similar constraint is enforced for time delay settings; time delay setting 1 must always be greater than time delay setting 2. A second constraint for pickup settings is that the pickup setting (1 or 2) cannot be less than the minimum pickup of its bus differential zone. A bus differential zone's minimum pickup is computed as 20% of the CT rating of the largest circuit breaker of that zone. So, although the allowed pickup setting range for the Bus Differential Relay is 100 to 22,000 Amps, the actual allowed range is only from “zone-minimum-pickup” to 22,000 Amps.

There are seven delay bands available:

7

For 60 Hz systems

Band 1: 0.025 sec < T < 0.092 sec (**Note:** The actual fault clearing time depends on the energy content of the current at the circuit breaker.)

Band 2: 0.058 sec < T < 0.158 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.167 sec < T < 0.267 sec

Band 5: 0.217 sec < T < 0.317 sec

Band 6: 0.283 sec < T < 0.383 sec

Band 7: 0.400 sec < T < 0.500 sec

For 50 Hz systems

Band 1: 0.030 sec < T < 0.095 sec (**Note:** The actual fault clearing time depends on the energy content of the current at the circuit breaker.)

Band 2: 0.060 sec < T < 0.160 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.170 sec < T < 0.270 sec

Band 5: 0.220 sec < T < 0.320 sec

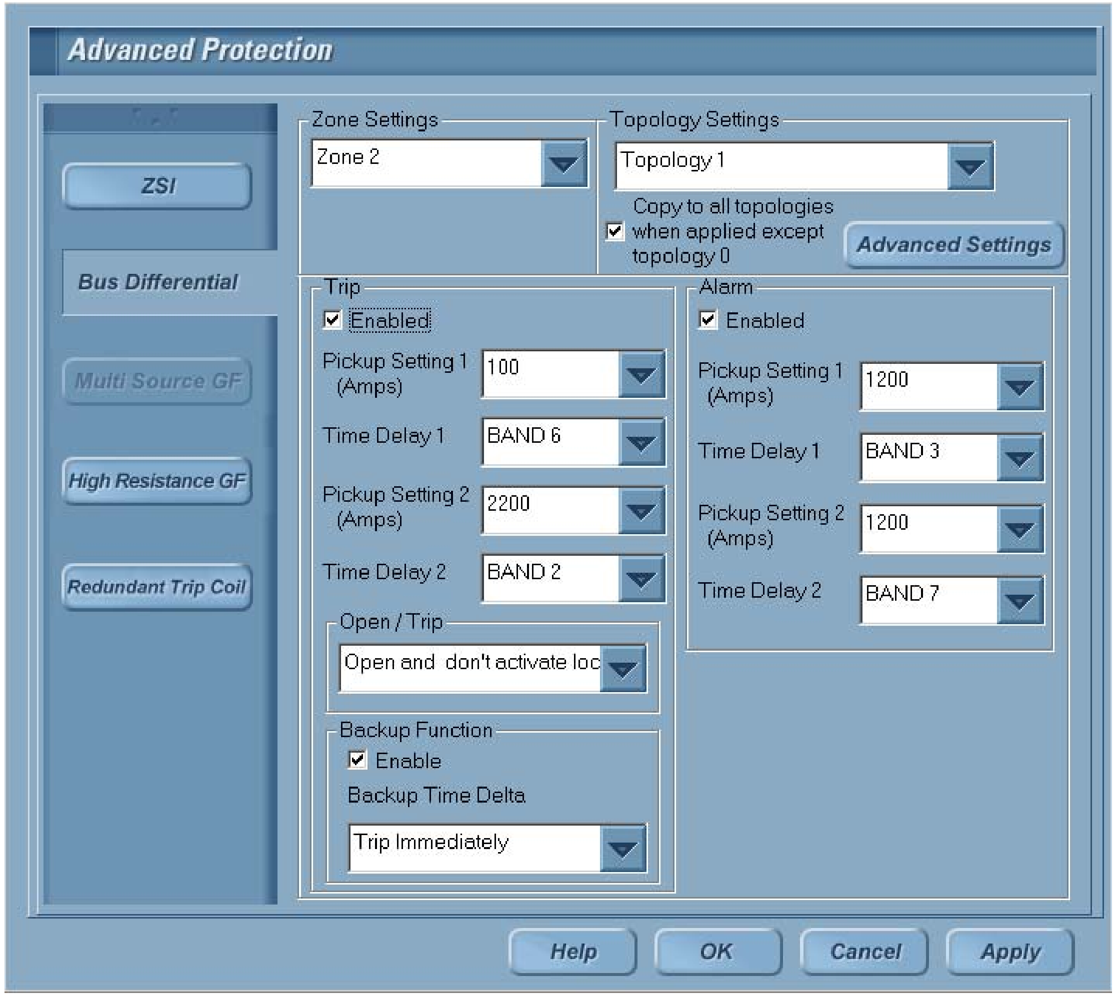
Band 6: 0.280 sec < T < 0.380 sec

Band 7: 0.400 sec < T < 0.500 sec

The pickup default is 1200 Amps and the time delay default is BAND 3.

If **Topology Settings** is set to **Topology 1** and **Apply to all Topologies** is selected, then the settings of topology 1 are applied to all topologies from 1 to $2^{(\text{num of buses})} - 1$. To apply different settings to different topologies, click **Advanced Settings** and select the desired topology and settings as shown in Figure 7-2. For topology 0, settings are selected separately and these settings are used when the Reduced Let-Thru Mode is enabled.

Figure 7-2 Bus differential user settings



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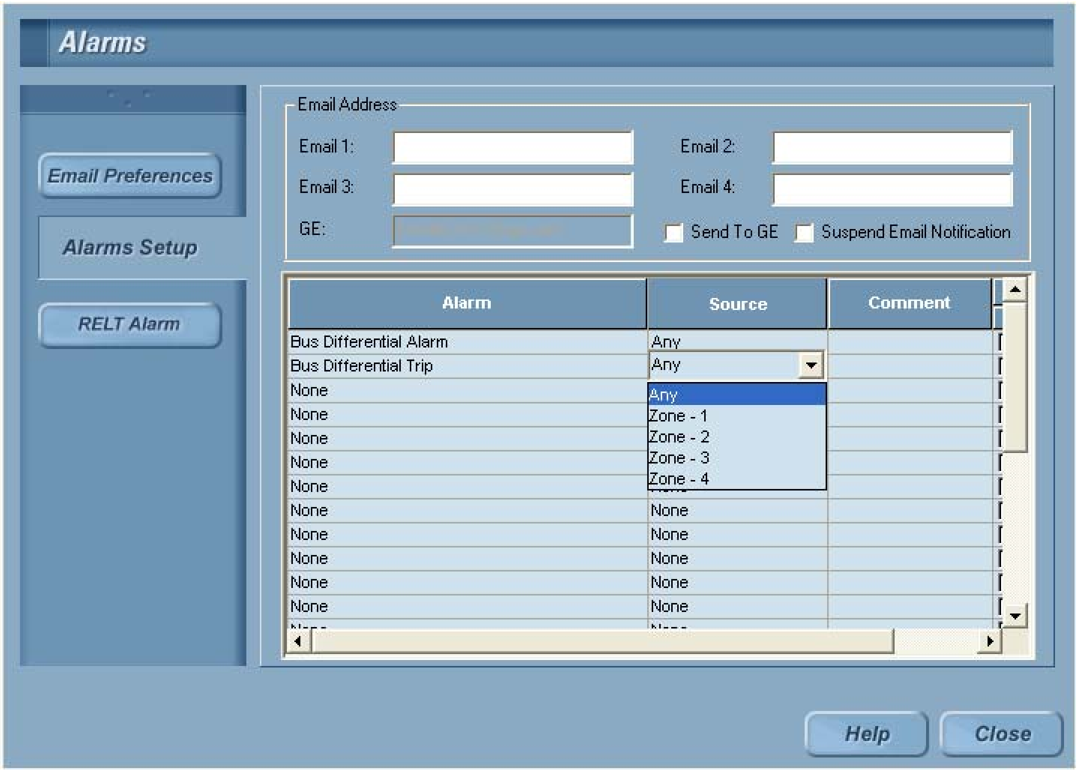
7.1.1.4 Alarms and Events

Bus Differential Alarm and Trip functions have a configurable alarm for each zone. To configure a Bus Differential alarm on the HMI:

1. On the **Main Menu**, click **User Settings**, and then select **Alarms**.
2. On the **Alarms** screen, click **Alarms Setup** as shown in Figure 7-3.
3. Select the Bus Differential Alarm or Trip Alarm and enter a comment in the **Comment** text box.

Figure 7-3 Bus differential alarms setup



Events

To view a table of the events generated by the Bus Differential Relay, see Bus Differential Events on page 359.

7.1.2 Troubleshooting

Bus Differential Setting Change Rejected events are observed in the Sequence of Events log

- Verify that the pickup setting is within the valid range. Valid range is from "Zone Minimum Pickup" to 22,000 Amps. (See Setting Bus Differential pickups/delays on page 197.)

Frequent suspended/resumed events are seen

- Verify that both CPUs are operating with the hardware clock. This can be done from the System Health screen. The Synchronization hardware OK indicator lights should be green for both CPUs.

7.2 Multi-Source Ground-Fault Relay

Entellisys offers optional Multi-Source Ground-Fault Relay Protection. Multi-source Ground Fault is needed in systems where there is a parallel path for the neutral current, for example, in a double-ended substation with two mains and a tie circuit breaker. In that case, the neutral current from either side can return through both the neutral bus at the tie and the ground bus. Therefore, a ground fault algorithm cannot just look at the currents in one main circuit breaker or just the tie circuit breaker. MSGF is implemented on a per-zone basis (see Zones, buses, and topologies on page 191 for more information on this topic). The zone functions measure the total ground fault current into the zone, not the ground fault current from the source. The zone function trips all circuit breakers that feed that zone.

MSGF also has a summation function that measures the total ground current from all sources. The summation function and the zone functions interact. If a zone function is in pickup, the summation function is suspended until the zone drops out of pickup. If no zone is in pickup, the summation function trips the ties when it times out. The summation function can also be set to open the mains. This allows the zone to clear the fault without unnecessarily tripping tie circuit breakers in systems with three or four main circuit breakers.

Multi-Source Ground-Fault Relay has two types of relays to select from: an alarm-only relay and a trip relay. The trip relay has a built-in backup function. MSGF also includes an optional backup function. If the backup function is enabled, the MSGF function will open additional circuit breakers in the event that opening the circuit breakers that feed the zone does not clear the fault. This can happen, for example, when the fault is in a tie circuit breaker that only has one set of CTs. The backup function can be configured to operate with no additional delay, or after 100 msec of operation of the primary relay.

Each relay comes with a set of pickup and delay settings. Each relay can have either a constant time or an inverse time. The alarm-only relay activates an alarm if the fault is above the specified limit for the specified duration of time. The trip relay opens/trips the trip and/or backup targets and also activates an alarm if the fault is above the specified limit for the specified duration of time.

7.2.0.1 Interoperation with Zone Selective Interlock function

Each MSGF zone can be configured as a member of a ZSI Ground Fault zone. See Zone Selective Interlock on page 210 for more information.

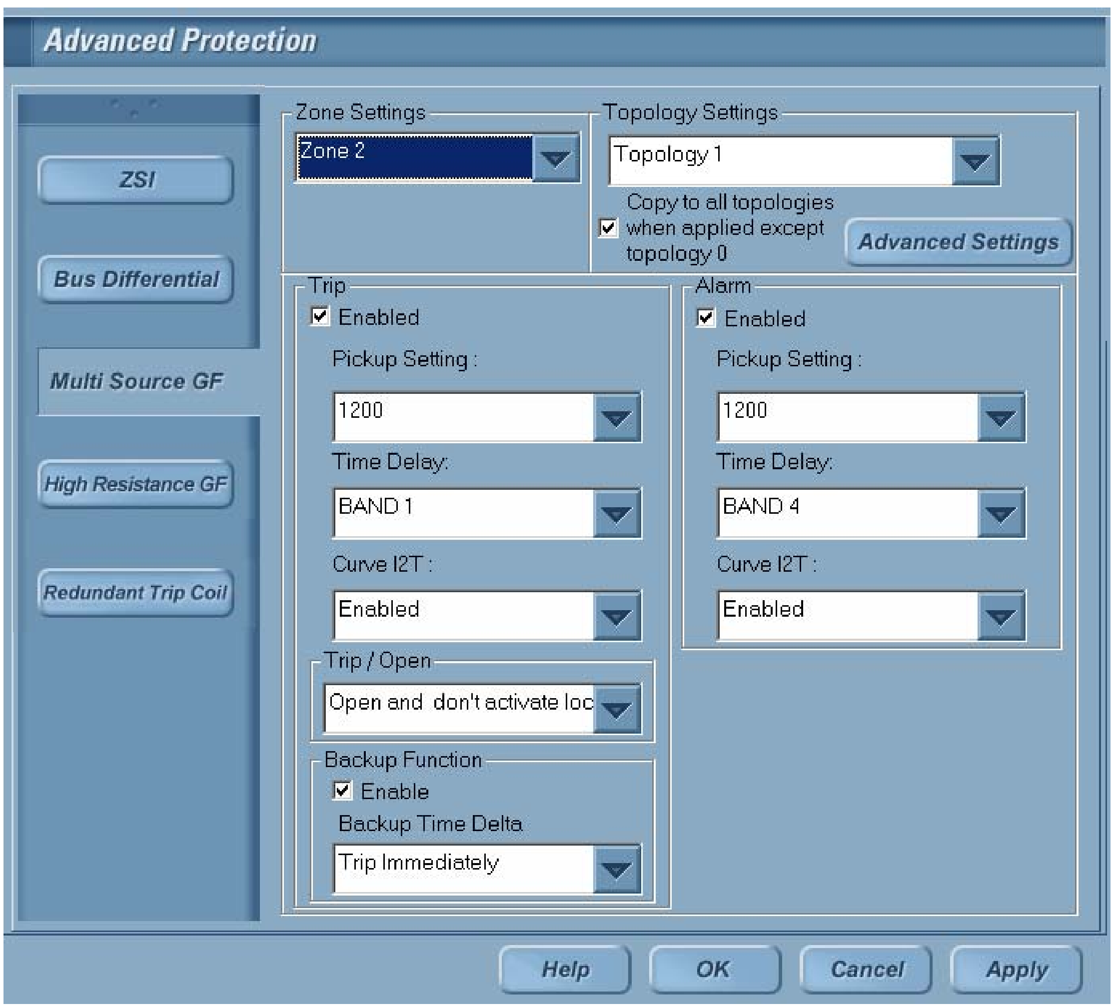
7.2.1 Setup

7.2.1.1 User settings

Each Multi-Source Ground-Fault relay (Alarm-Only and Trip) can be enabled or disabled in each zone for each topology (see Figure 7-4). Multi-Source Ground-Fault has one pickup setting, one time delay setting and one Curve I^2T setting for each relay (i.e., Alarm-Only and Trip) in each zone and for each topology. The backup function of the Trip relay (zones 1-4) can be enabled to operate along with the Trip relay or after a delay of 100 msec by selecting **Trip Immediately** or **Trip After 100msec** from the **Backup Time Delta** drop-down menu on the Topology Settings tab as shown in Figure 7-2. These two settings are also topology-specific.

The only setting that is not topology specific on the Topology Settings tab is the Trip/Open setting that determines whether the Trip relay just opens the circuit breakers (either trip-targets or backup-trip-targets) or opens and activates the lockout too.

Figure 7-4 Multi-Source GF user settings



7.2.1.2 Setting Multi-Source Ground-Fault pickup/delay

To configure pickup and delay settings

1. On the **Main Menu**, click **User Settings**.
2. Click **Advanced Protection**, and then click **Multi Source GF**.
3. Select the zone number and topology number, and then select the appropriate settings for pickup settings, time delay and Curve I^2T, etc.

The pickup setting cannot be less than the minimum pickup for that MSGF zone. An MSGF zone's minimum pickup is computed as 20% of the CT rating of the largest circuit breaker of that zone. So, although the allowed pickup setting range for the MSGF Relay is 30 to 1200 Amps, the actual allowed range is only from "zone-minimum-pickup" to 1200 Amps.

There are seven delay bands available:

For 60 Hz systems

Band 1: 0.025 sec < T < 0.092 sec (**Note:** The actual fault clearing time depends on the energy content of the current at the circuit breaker.)

Band 2: 0.058 sec < T < 0.158 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.167 sec < T < 0.267 sec

Band 5: 0.217 sec < T < 0.317 sec

Band 6: 0.283 sec < T < 0.383 sec

Band 7: 0.400 sec < T < 0.500 sec

For 50 Hz systems

Band 1: 0.030 sec < T < 0.095 sec (**Note:** The actual fault clearing time depends on the energy content of the current at the circuit breaker.)

Band 2: 0.060 sec < T < 0.160 sec

Band 3: 0.100 sec < T < 0.200 sec

Band 4: 0.170 sec < T < 0.270 sec

Band 5: 0.220 sec < T < 0.320 sec

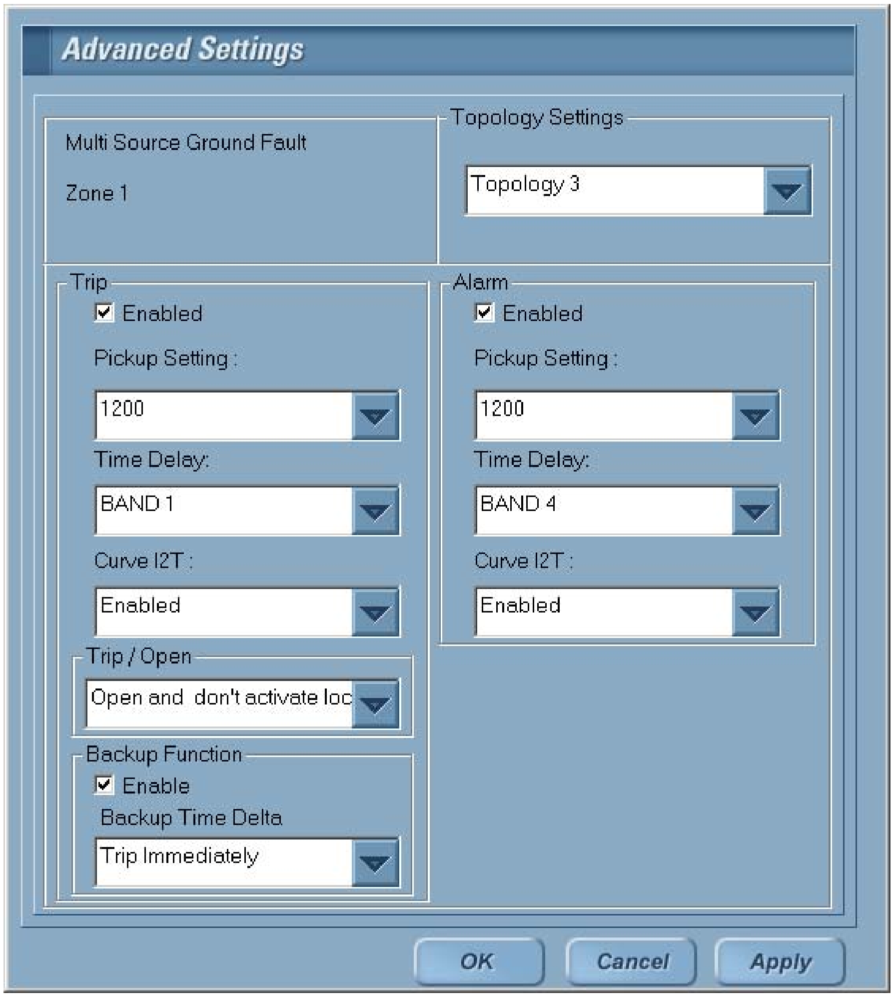
Band 6: 0.280 sec < T < 0.380 sec

Band 7: 0.400 sec < T < 0.500 sec

The pickup default is 1200 Amps and the time delay default is BAND 3 and the Curve I2T default is "disabled."

If **Topology Settings** is set to **Topology 1** and **Apply to all Topologies** is selected, then the settings of topology 1 are applied to all topologies from 1 to $2^{(\text{num of buses})} - 1$. To apply different settings to different topologies, click **Advanced Settings** and select the desired topology and settings as shown in Figure 7-5. For topology 0, settings are selected separately and these settings are used when the Reduced Let-Thru Mode is enabled.

Figure 7-5 Multi-Source GF user settings for different topologies



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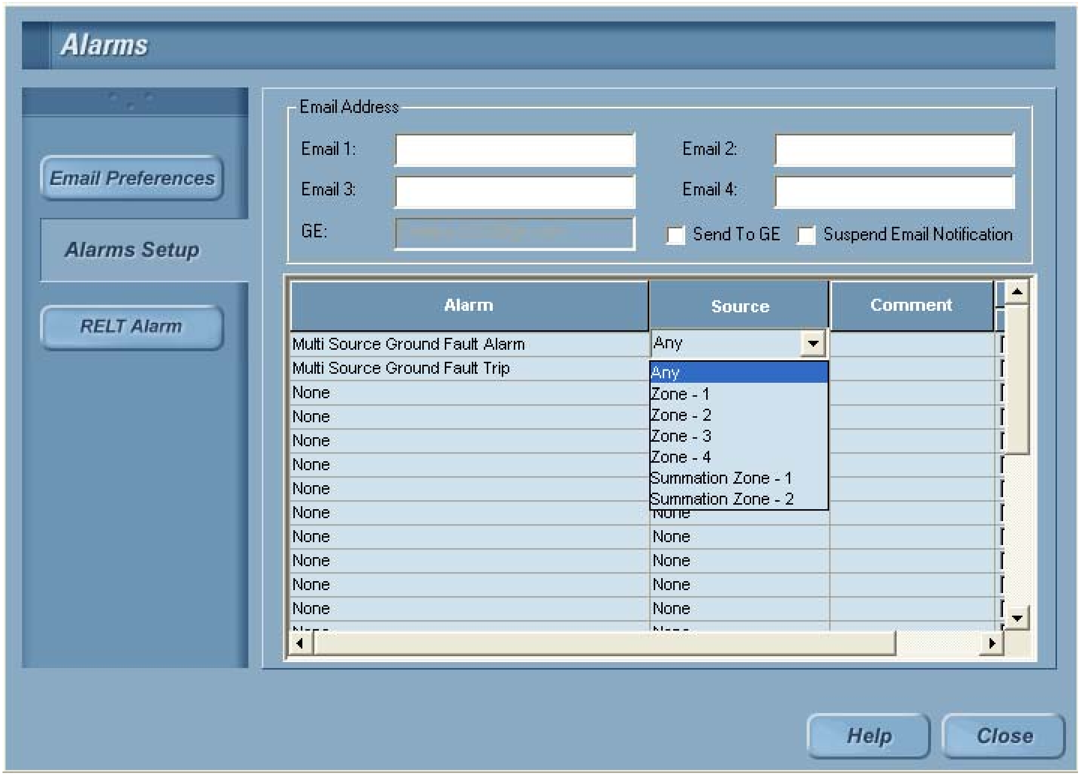
7.2.1.3 Alarms and Events

Multi-Source GF Alarm and Trip functions have a configurable alarm for each zone. To configure a MSFG Alarm on the HMI:

1. On the **Main Menu**, click **User Settings**, and then select **Alarms**.
2. On the **Alarms** screen, click **Alarms Setup** as shown in Figure 7-6.
3. Select the Multi-Source Ground Fault Alarm or Trip Alarm and enter a comment in the **Comment** text box.

Figure 7-6 Setting up Multi-Source GF alarms



Events

To view a table of the events generated by the Bus Differential Relay, see Multi-Source Ground Fault Events on page 361.

7.2.2 Troubleshooting

Multi-Source Ground Fault Setting Change Rejected events are observed in the Sequence of Events log

- Verify that the pickup setting is within the valid range. Valid range is from “Zone Minimum Pickup” to 1200 Amps. (See Setting Multi-Source Ground-Fault pickup/delay on page 202.)

Backup relay is not working

- Verify that the backup function is enabled for the concerned zone in the concerned topology.

Frequent suspended/resumed events are seen

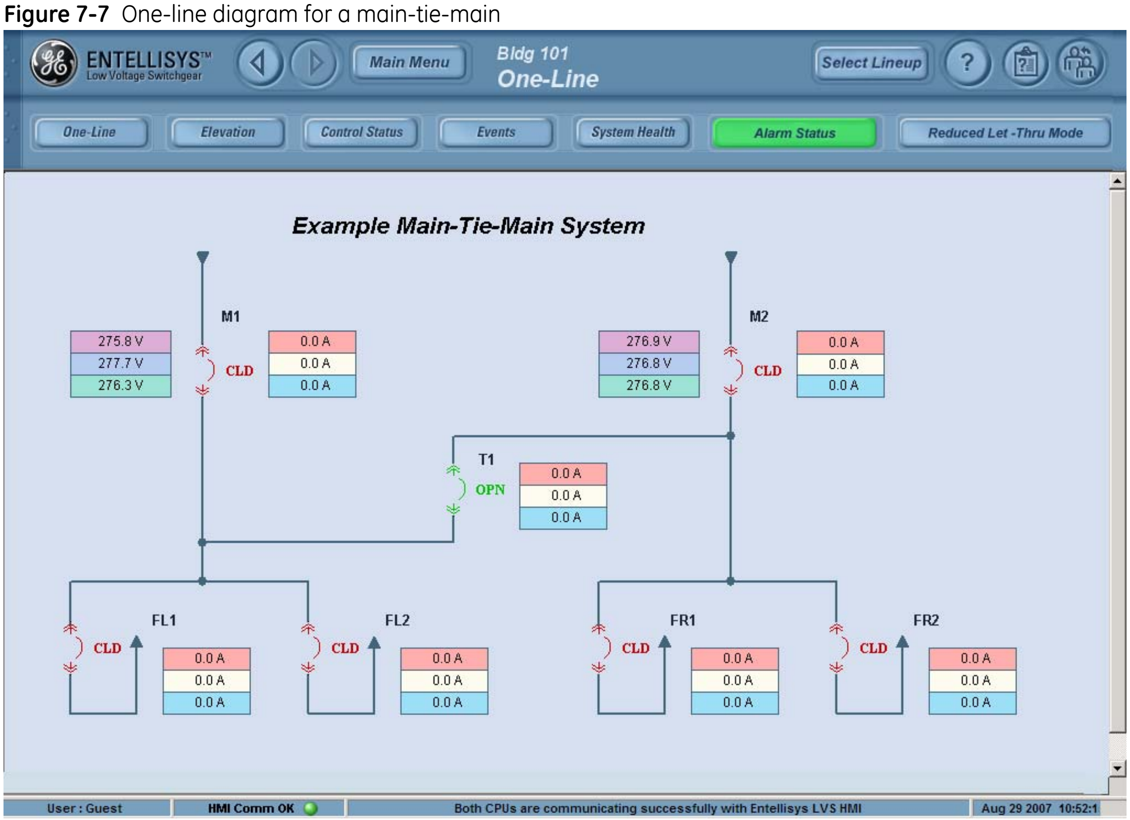
- Verify that both CPUs are operating with the hardware clock. This can be done from the System Health screen. The Synchronization hardware OK indicator lights should be green for both CPUs.

7.3 PT Throw-Over

The PT Throw-Over changes the voltage source for the metering and relay functions for a circuit breaker, based on how a bus is powered. It is recommended that you review the chapter on Zones and Topologies (see Zones, buses, and topologies on page 191) before continuing, since many of the terms and concepts used here are defined more thoroughly in that chapter.

Consider the main-tie-main system shown in Figure 7-7. Typically there is a power source, such as a utility source or generator, connected to each main (circuit breakers M1 and M2) and a set of potential transformers (PTs) at each main that step down the primary voltage so that it can be measured by the EntelliGuard Messenger at the circuit breaker.

Figure 7-7 One-line diagram for a main-tie-main



One of the advantages of Entellisys is that voltage information measured at one circuit breaker can be used for metering and relaying functions at another circuit breaker. In the system shown in Figure 7-7, what voltage information should be used for the feeder circuit breakers (FL1, FL2, FR1, and FR2)?

The answer, of course, depends on the state of the topology circuit breakers M1, M2, and T1 (see Zones, buses, and topologies on page 191 for more information). For example, if the source at circuit breaker M1 is powering Bus 1 (i.e., M1 is closed, T1 is open) then the metering and relaying functions at FL1 and FL2 should use the voltage data from M1. If M2 is powering Bus 1, then the metering and relaying functions at FL1 and FL2 should use the voltage data from M2.

NOTE: Although the main-tie-main is a common configuration, this feature is not limited to that configuration.

7.3.1 Setup

The setup of the PT sources is done by GE before the switchgear is shipped to the customer, rather than by the customer.

Before showing how the PT sources are defined for this case, review the definition of each zone and the meaning of the topologies for each zone.

Zone 1 Member Circuit Breakers

- M1
- T1
- FL1
- FL2

Zone 1 Topologies

- Topology 1: Bus 1 powered by source at M1 (or not powered)
- Topology 2: Bus 1 powered by source at M2
- Topology 3: Bus 1 powered by sources at M1 and M2 in parallel

Zone 2 Member Circuit Breakers

- M2
- T1
- FR1
- FR2

Zone 2 Topologies

- Topology 1: Bus 2 powered by source at M2 (or not powered)
- Topology 2: Bus 2 powered by source at M1
- Topology 3: Bus 2 powered by sources at M1 and M2 in parallel

The completed PT source table for this example is shown in Table 7-1.

Note in Table 7-1 that M1 and M2 always use their own voltage information, regardless of topology. The reason is that, in the example, these two circuit breakers have PTs attached and therefore do not need to use voltage information from another circuit breaker.

For the circuit breakers in Zone 1, Topology 1 indicates that the bus (Bus 1) is powered by the source at circuit breaker M1. Therefore, FL1 and FL2 use M1 as the voltage source. For the circuit breakers in Zone 2, Topology 1 indicates that the bus (Bus 2) is powered by the source at circuit breaker M2. Therefore, FR1 and FR2 use M2 as the voltage source.

For the circuit breakers in Zone 2, Topology 1 indicates that the bus is powered by the source at circuit breaker M2. For the circuit breakers in Zone 2, Topology 2 indicates that the bus is powered by the source at circuit breaker M1. The Topology 2 settings are filled in to reflect this.

Table 7-1 PT Throwover matrix

Circuit Breaker Names	PT Source Topology 1	PT Source Topology 3	PT Source Topology 4
M1	M1	M1	M1

7

Table 7-1 PT Throwover matrix

Circuit Breaker Names	PT Source Topology 1	PT Source Topology 3	PT Source Topology 4
M2	M2	M2	M2
T1	M1	M2	M1
FL1	M1	M2	M1
FL2	M1	M2	M1
FR1	M2	M1	M2
FR2	M2	M1	M2

In Topology 3, all three topology circuit breakers are closed, so the sources at M1 and M2 are operating in parallel. In this case, the feeder circuit breakers can use either circuit breaker as a voltage source. For simplicity, the sources are defined exactly as they are for Topology 1.

The tie circuit breaker T1 is a special case, because it is a member of both zones. The way Entellisys handles this case, for the purposes of PT Throwover only, is to treat it as a member of the lowest-numbered zone of which it is a member. In the example above, T1 is treated as a member of Zone 1 only.

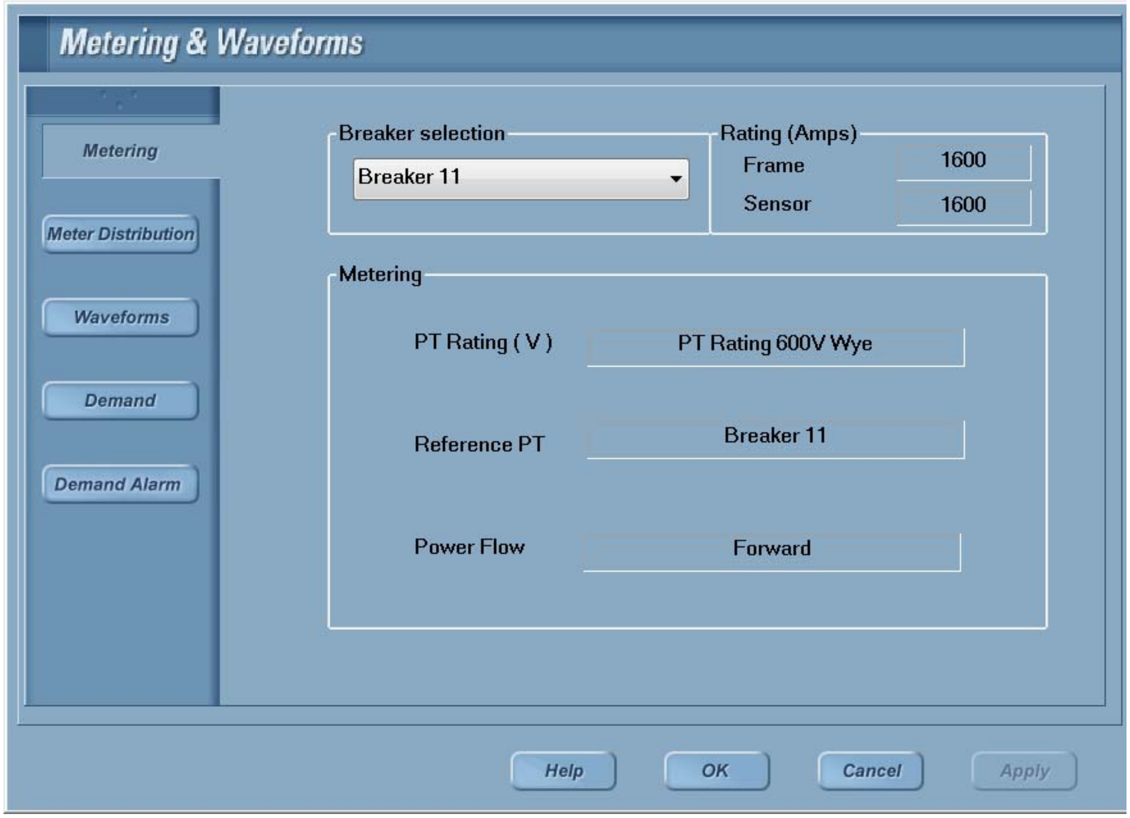
7.3.2 Usage

To view the PT source in use by a given circuit breaker

1. On the **User Settings** screen, click **Metering & Waveforms**.
2. On the **Metering & Waveforms** screen, click **Metering**.

In Figure 7-8, the metering information is shown for circuit breaker FL1. It does not have a PT attached and it uses circuit breaker M1 for voltage information.

Figure 7-8 Metering information for circuit breaker FL1



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7.4 Zone Selective Interlock

Entellisys provides support for Zone Selective Interlock (also referred to as ZSI). ZSI enables selectivity of the power system within a zone. Entellisys can support up to four ZSI zones and is able to dynamically respond to topology changes. Successful completion of ZSI setup requires knowledge of power protection field concepts. The essential concepts are described in sections that follow.

7.4.1 Zones

Entellisys can support up to four zones. Zones divide the topology of the system and group topology circuit breakers with single power source with feeder and sub-feeder circuit breakers. Topology circuit breakers are circuit breakers that control the source from which a load is powered.

7.4.2 ZSI zones

ZSI zones are a subset of topology zones. Each ZSI zone can be a subset of one topology zone. Hence the total number of ZSI zones is four. Each of the ZSI zones can support up to 30 circuit breakers with Ground Fault (GF), four Multi-Source Ground-Fault (MSGF) groups, and 30 circuit breakers with Short Time (ST) protection. Any of the circuit breakers may support both of the protection types. However, in this case ZSI treats such a circuit breaker, as if it were two separate circuit breakers.

Zones can be defined as independent or interdependent. Independent zones are ones where there are no common circuit breakers for the selected operation mode, while interdependent zones occur when two zones share at least one circuit breaker for a selected operation mode. For more information on Multi-Source Ground-Fault relay and protection offered by them, see Multi-Source Ground-Fault Relay on page 200.

7.4.3 Protection types

ZSI operation can be configured to perform one of three protection types: ground fault protection, short time protection, and ground fault and short time protection.

Ground fault protection includes multi-source ground-fault groups. Once a protection type is selected, it applies to all ZSI zones. Also, if a ZSI zone is configured with circuit breakers supporting ST and GF type protection and only GF protection is enabled, ZSI does not analyze data from and takes no actions to perform ST protection. The same rule applies in the opposite case.

7.4.4 Topologies

A topology is the state of the circuit breakers that control the system's power flow. Such circuit breakers are also referred to as topology circuit breakers. Since the Entellisys system is for main-tie-main (M-T-M) topologies and is limited to 4 buses, the total possible number of different topologies is 16. The mathematical formula for the total number of topologies is 2^B, where B is the number of buses in the system. The number of topologies affects the number of tiers values that each member circuit breaker needs to be configured with.

7.4.5 Tiers

In order for the ZSI to manage the hierarchy in a dynamic power system, it has to keep track of the current topology that the system is in. Whenever the system changes topology, ZSI reacts by using new tier settings for all member circuit breakers of the affected zones.

Each member circuit breaker can have up to 16 different tier values. The user is responsible for providing tier information for the ZSI. Entellisys allows four different tier values from 0 through 3. Tier 0 indicates that the circuit breaker is the highest in the hierarchy and Tier 3 indicates that it is the lowest. Multiple circuit breakers within a zone may have the same tier values, if it makes sense from the system hierarchy standpoint.

7

7.4.6 Algorithm

When enabled, the ZSI zone tracks all its member circuit breakers for any GF/MSGF or/and ST fault conditions. If a member circuit breaker goes into pickup, ZSI reacts. Based on the current topology's tier settings for member circuit breakers, ZSI adjusts the time delays of upstream member circuit breakers. It starts from one tier higher than the circuit breaker in the detected pickup condition. The time delay of the circuit breaker in pickup is not adjusted. However it is used as the starting point for calculating new time delays for circuit breakers positioned higher in the hierarchy. Upstream circuit breakers are updated with new time delays regardless of their current state (whether they are open or closed or whether they are in pickup or not). The new delay value is a function of the time delay of the member circuit breaker that is immediately downstream and the difference between the current tier value of that circuit breaker and the circuit breaker that new time delay is being calculated for. The mathematical formula for this is:

Equation 7-1 Mathematical formula for time delay calculation

$$d = d_d + (t - t_d) * 100$$

where:

d = the new time delay of circuit breaker

d_d = the current time delay of the immediately downstream circuit breaker

t = the current tier value of the circuit breaker that the time delay is calculated for

t_d = the current tier value of the immediate downstream circuit breaker.

The new time delay is calculated in milliseconds.

There are a couple of restrictions in place for this calculation. The newly calculated time delay cannot exceed 400 ms. If new time delay is longer than 400 ms, the circuit breaker is assigned a delay of 400 ms. The other restriction is if the newly calculated time delay is shorter than the current time delay of the circuit breaker, no delay adjustment is performed. However, that unchanged time delay becomes the basis for the calculation of the time delays of the rest of the upstream circuit breakers.

Once the circuit breaker clears the fault, the algorithm begins the process of restoring the time delays of all involved circuit breakers to their original values. As soon as a circuit breaker's accumulator is cooled and the accumulators of all downstream circuit breakers are also cooled, the time delay for the circuit breaker is restored to its original setting.

Each member circuit breaker can have up to 16 different tier values that correspond to 16 possible different topologies. The actual number of tier values that a circuit breaker needs to be configured with depends on the system size and layout. ZSI reacts to dynamic changes in the current topology by switching to corresponding pre-configured tier values for member circuit breakers of affected zones.

NOTE: When a topology change occurs while ZSI is operating and before it is able to restore time delays of member circuit breakers to their original values, ZSI postpones switching until the zone is idle. Only after the accumulators of all member circuit breakers in the zone are cooled, does the ZSI switch to the corresponding new topology tier set for member circuit breakers.

7.4.7 Setup

ZSI setup is done in three steps. Briefly, the steps are:

1. Set tiers for member circuit breakers
2. Enable zones
3. Set ZSI protection type

Each of these steps is described in greater detail below.

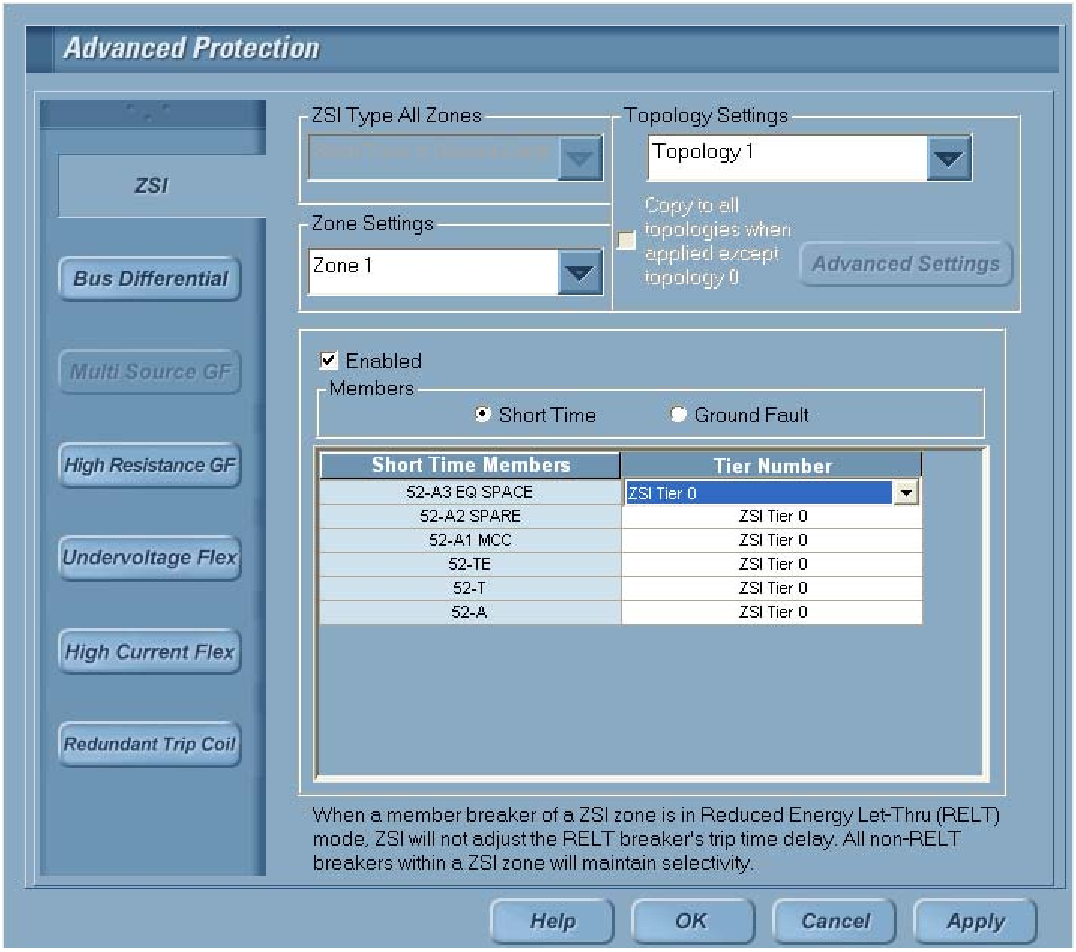
7.4.7.1 Configuring ZSI parameters

To perform the ZSI configuration, a user must be logged in with administrator privileges. Before ZSI zones can function properly, electrical hierarchy of each zone must be configured. This is done by assigning tier values for every member circuit breaker.

To set the tiers

1. On the **Main Menu**, click **User Settings**, and then click **Advanced Protection.**
2. On the **Advanced Protection** screen, click **ZSI**.

Figure 7-9 Tier settings and ZSI type



To select the ZSI type for all zones, choose from the following options in the **ZSI Type All Zones** drop-down menu: **Short Time**, **Ground Fault** and **Short Time & Ground Fault**. The ZSI Type All Zones drop-down menu is only enabled when the Zone Settings drop-down menu displays **Please select a zone** as the current selection.

The list contains all member circuit breakers configured for the zone selected in Zone Settings. The left column displays the circuit breakers and the right one contains the circuit breaker's tier setting. Each circuit breaker can be assigned one of four tier values (0-3). Tier 0 indicates that the circuit breaker is the highest in the hierarchy and Tier 3 indicates that it is the lowest.

To change the type of circuit breakers displayed in the list, select the **Short Time** or **Ground Fault** radio button. A circuit breaker's tier setting for short time protection is independent of its tier settings for ground fault protection. To view tier settings for Topology 0 or Topology 1 for member circuit breakers in the list, select the desired topology from the **Topology Settings** drop-down menu. Topology 1 is the default topology of the system. Topology 0 is for Reduced Let-Thru Mode. See Reduced Energy Let-Thru Mode on page 225 for more information.

If other topologies are to be used by the system, click **Advance Settings** to configure the tier settings for member circuit breakers for these topologies. A dialog box similar to the one described above for topologies 0 and 1 displays for the user to configure. If all topologies in the system have the same configuration as topologies 0 and 1, select **Copy to all topologies when applied** and click **OK** or **Apply**.

Each ZSI zone can be enabled or disabled independently by checking **Enabled** where appropriate.

To send changes to the CPU, click **OK** or **Apply**. Once changes are sent to the CPU, the ZSI is running on the CPUs.

NOTE: If changes made to the tier settings of member circuit breakers are committed to the CPUs while the affected ZSI zones are not idle, the changes are accepted but do not take effect until the ZSI zones enter idle states and can switch to using the new tier values.

NOTE: If some of the member circuit breakers do not communicate with CPUs, the ZSI zones that these circuit breakers are members of switch to the new tier values until communication is restored and it is confirmed that these circuit breakers are not in pickup state. On normally functioning systems, if ZSI zones are not idle they switch to new tier values within several seconds after changes were committed.

7.4.7.2 Operation

If a ZSI zone is enabled, every half cycle, ZSI evaluates the state of its member circuit breakers. If ZSI detects that a member circuit breaker is in pickup state, it attempts to update all upstream circuit breakers with new time delays and it logs the update as an event as shown in Figure 7-10. This event log is the only indication that ZSI is working.

After a fault is cleared, ZSI restores all original time delays and no corresponding event is logged.

NOTE: If the system loses communication with a member circuit breaker, for safety reasons, ZSI assumes that the non-communicating circuit breaker is in pickup state and performs protection tasks. As soon as the non-communicating circuit breaker starts communicating again with the system, ZSI verifies whether circuit breaker is actually in pickup condition. If it is not, ZSI restores all original time delays.

Figure 7-10 ZSI events

7.4.7.3 Events

Events logged by the ZSI can be grouped into three categories: configuration, confirmation, and operation events. These events are described below.

7.4.7.4 Configuration events

This category has only one event.

- **Protection Suspended ZSI File Error**. This event is logged when there is any problem with the ZSI configuration file. This file is stored internally in CPUs by the HMI during the ZSI configuration process.

7.4.7.5 Confirmation events

This category consists of eight events. "**X**" in the descriptions below stands for zone number and it can assume values of 1 to 4.

- **ZSI Zone X Enabled**. This event is logged when the ZSI zone is enabled from the HMI. There can be a total of 4 variants of this event, one for each zone.
- **ZSI Zone X Disabled**. This event is logged when the ZSI zone is disabled from the HMI. There can be a total of 4 variants of this event, one for each zone.

7.4.7.6 Operation events

This category includes four events. "**X**" in the descriptions below stands for zone number and it can assume values of 1 to 4.

- **ZSI Zone X Operation**. This event is logged when the ZSI zone detects that at least one of the member circuit breakers is in pickup condition and it updates all upstream circuit breakers with new time delays. There can be a total of 4 variants of this event, one for each zone.

7.4.8 Troubleshooting

7

ZSI operation event is logged while no circuit breaker is in pickup condition

- There is no communication with at least one EntelliGuard Messenger corresponding to the ZSI zone member circuit breaker. Verify that all Messengers corresponding to zone's member circuit breakers are communicating. This information is available in the System Health screen (see System health on page 295).

ZSI operation events are logged very frequently

- Communication with EntelliGuard Messenger is intermittent. Verify that all Messengers for the ZSI zone's member circuit breakers are communicating without problems. This information is available in System Health screen (see System health on page 295).

No ZSI operation events are logged but are expected

- Zone is disabled. Verify whether ZSI zone is enabled. This information is available in the Advanced Protection screen (see Configuring ZSI parameters on page 212).
- ZSI configuration file is corrupted. Verify the event log for the corresponding event.
- ZSI protection is not optioned. Check if current option string enables ZSI protection. This information is available in the Options tab of the Maintenance screen.

7.5 Downstream Zone Selective Interlocking

For Entellisys feeders, downstream Zone Selective Interlocking (ZSI) is available to further improve the selectivity with a wide range of equipment. When a protection device with ZSI output is enabled and physically wired to the messenger, the Messenger will respond to a restraint signal and will restrain Short Time and IOC to the “**IOC ZSI Restrain Time**” and “**ST Time Delay**” settings.

If Entellisys ZSI option is available, the ZSI restraint signal will propagate to breakers up stream and restrain Short Time Overcurrent as defined by the Entellisys ZSI Zone configuration. (See section 7.4 Zone Selective Interlock on page 210)

NOTE: Entellisys Ground Fault is not restrained during a downstream ZSI signal and thus must be adjusted above downstream equipment to avoid nuisance tripping.

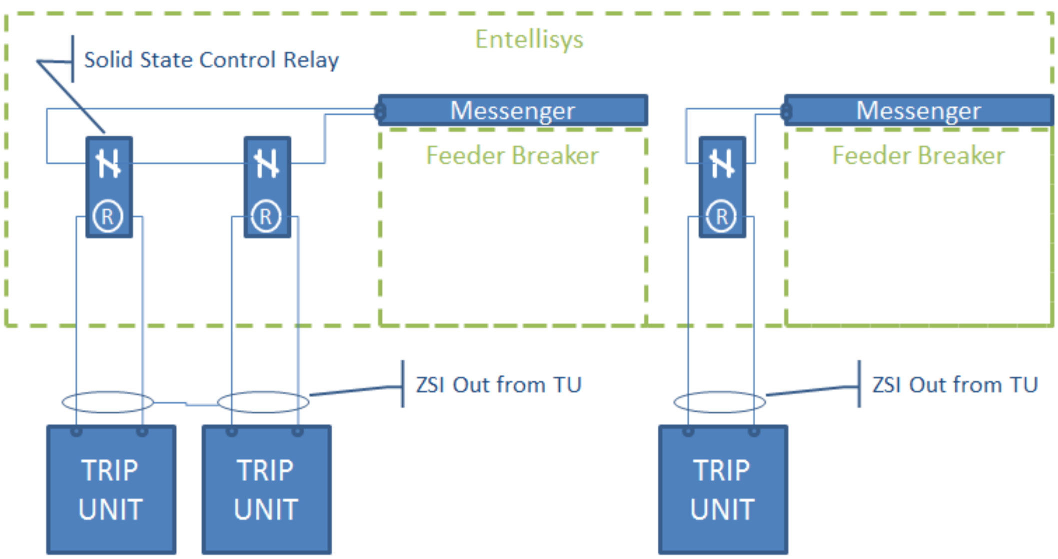
Entellisys Downstream ZSI is applicable to the ZSI output from GE MicroVersa Trip, EntelliGuard TU and Micro EntelliGuard trip units.

7.5.1 Installation

Entellisys expects a reverse logic dry contact input from a downstream overcurrent device. The Entellisys messenger will wait for an “Arming signal” or closed set of contacts to detect the presence of a downstream device and will then restrain on the negative transition - from closed to open.

Entellisys version 5.0 or later ships with EntelliGuard-E breakers and ZSI Inputs wired out to terminal blocks. Interposing relays and wiring are not supplied.

Figure 7-11 Typical Downstream ZSI wiring diagram



ZSI inputs from downstream trip units shall be wired to solid state control relays with normally closed contacts. Relays shall be selected to work with the downstream trip units.

Entellisys feeder breakers that supply more than one downstream breaker may use multiple ZSI interface relays wired in series.

Downstream ZSI "Armed"

The Entellisys Messenger will consider a ZSI downstream device "Armed" when the ZSI input is shorted to common through an interposing relay. The Armed status is stored in volatile memory will re-arm if control power on the messenger is cycled.

7.5.2 Setup

Downstream ZSI restraint settings are configured in the "**Downstream External ZSI Input"** control group located in the **Overcurrent Protection** settings screen of the respective breaker.

IOC Restraint

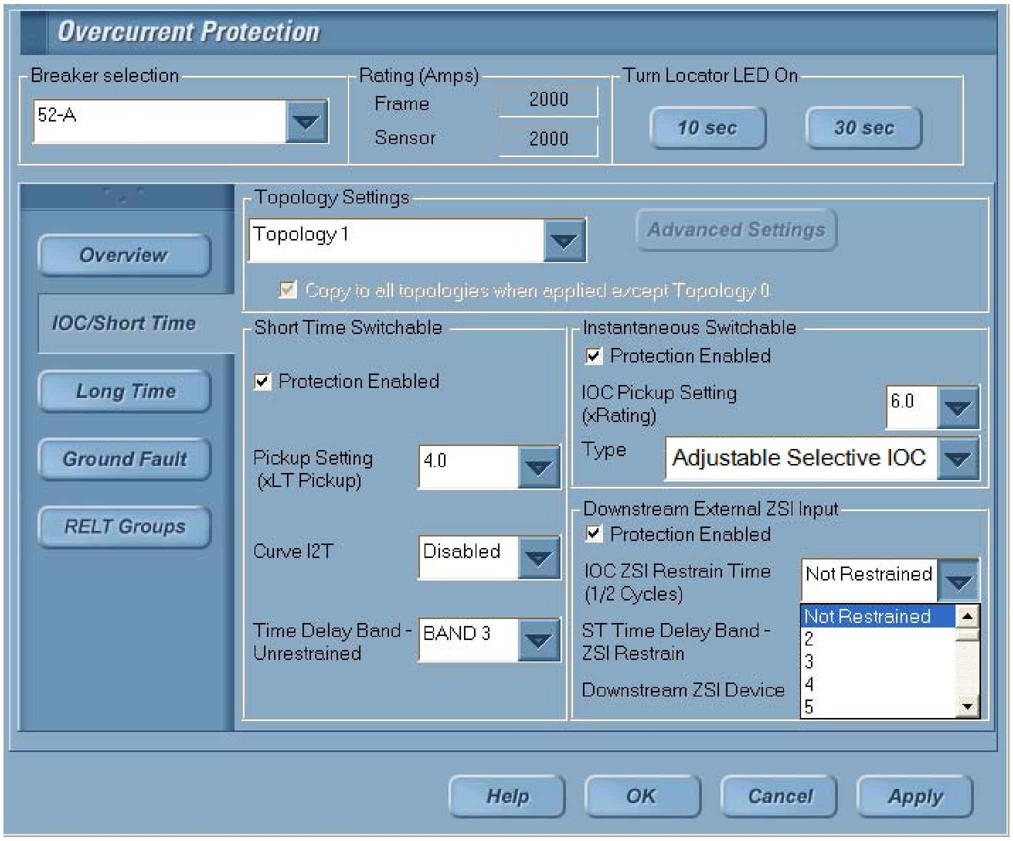
When the Instantaneous Overcurrent type is set to "**Adjustable Selective IOC**", the "**IOC ZSI Restrain Time"** will be sent to the messenger and restrain the IOC algorithm by the selected number of half cycles ONLY when both conditions are true:

- A downstream device is detected (the input circuit is wired and completed through the normally closed interposing relay)
- A negative transition is detected (from closed to open)

When the restraint signal is active, **IOC ZSI Restraint Time** and **ST Delay Band ZSI Restraint** settings will be active.

NOTE: At no time will the downstream ZSI restraint be enabled if the system was not previously "Armed."

Figure 7-12 Downstream ZSI Restraint Settings



7.5.3 Test

To confirm that the Downstream ZSI inputs are wired correctly and the Downstream trip unit is correctly restraining the Entellisys feeder breaker, the downstream trip unit must be forced into pickup using primary injection or through a test kit purposed for use with the downstream trip unit. The Entellisys system will record the following events; "*Downstream ZSI Operated*" and "*Downstream ZSI Dropout*" if correctly configured.

Downstream external ZSI delay settings should be verified that they are longer than the downstream device.

"*Downstream External ZSI Operated*" and "*Downstream External ZSI Dropout*" events acknowledges the downstream ZSI signal. If these events are received during a test of the downstream trip unit, no further testing is required to ensure the correct operation of Downstream ZSI.

Figure 7-13 Event log during a downstream ZSI event.

Sep 27 2012 13:04:02.670531	End Room Left	C-7C71	Downstream External ZSI Dropout
Sep 27 2012 13:04:02.660896	End Room Left	C-7C12	Dropout LT Overcurrent
Sep 27 2012 13:04:02.644231	Main 1 (TS3)	C-7C12	Dropout LT Overcurrent
Sep 27 2012 13:04:02.645013	End Room Left	C-7C70	Downstream External ZSI Operated
Sep 27 2012 13:04:02.627566	End Room Left	C-7C11	Pickup LT Overcurrent
Sep 27 2012 13:04:02.627566	Main 1 (TS3)	C-7C11	Pickup LT Overcurrent

7.6 Ground Fault Tripping priority

7

The Ground Fault Tripping Priority (GFTP) function (optional) provides additional control to High Resistance Systems with HRGF Location configured.

In High Resistance systems, a breaker may be faulted to ground but remain closed until repaired. If another breaker faults to ground on another phase, an over current condition will occur on both breakers and both breakers may trip on ground fault or over current - depending on the settings. In this case however, the system need only trip one breaker.

This function prioritizes which circuit breaker is tripped first to clear over current condition leaving one ground fault. This allows critical loads to be maintained.

Operation

The pickup of only the highest priority breaker in pickup will be delayed by 100ms. It does not cascade the delays up the priority list.

GF Tripping Priority will update the time delay of a breaker that is in ground fault pickup and has the highest priority assigned.

For systems with GF Tripping priority and GF ZSI are both used two functions interact as follows:

- GF Tripping Priority will update the time delay of a breaker if it is a member of a GF ZSI zone
- ZSI will not update the delays of a breaker with a priority assigned.

Time delays are limited to 400ms maximum.

Delays in the I2t region are not modified.

Prerequisites

HRGF Detection must be optioned, see High Resistance Ground Fault Detection Relay on page 169

MSGF must not be optioned, see Multi-Source Ground-Fault Relay on page 200

Switchable GF must be enabled and set at each breaker which will be assigned a tripping priority, see Ground Fault protection on page 143

ZSI must be optioned, see Zone Selective Interlock on page 210

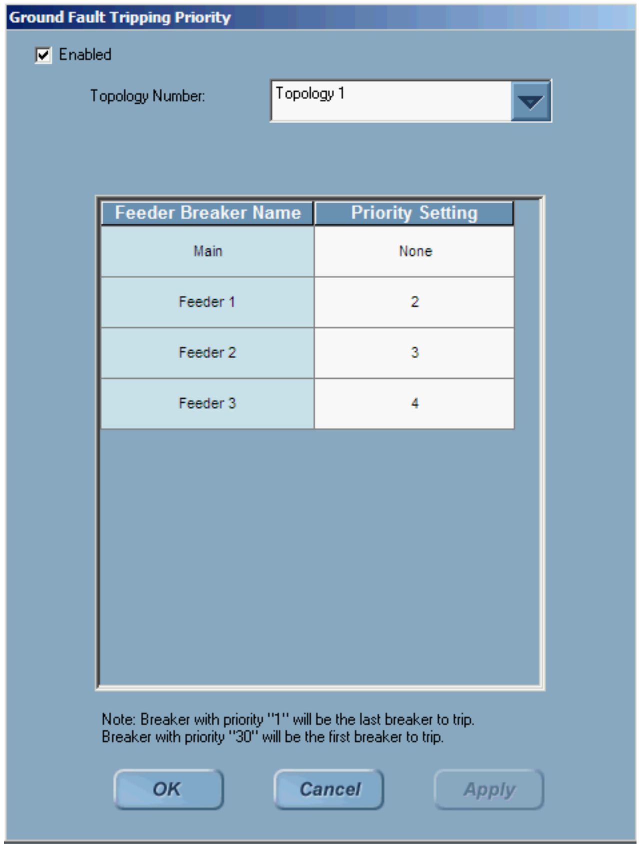
Events

"GF Trip priority operated" – logged when a breaker either picks up or drops out of GF, GF Tripping Priority operates to modify the delay values.

7.6.1 Setup

To set breaker priorities, navigate to the **High Resistance GF** settings screen (Main Menu, Advanced Protection) and click **Set GF Tripping Priority** button to assign priorities.

Figure 7-14 Ground Fault tripping priority settings screen



Select **Enabled** to enable the Ground Fault Tripping Priority.

Topology Number: Lists only topology 1 and 0 and defaults to topology 1. Topology 1 will always be used if there are more than one topology configured.

Priority Setting: Allows user to determine the priority between 1 and 30 to each breaker. Priority 1 is the highest priority. Thus, the breaker with priority 1 will be tripped last. Entellisys does not allow two breakers to be assigned the same priority. If a breaker is set to **None,** then it will not be considered - essentially disabling tripping priority for that breaker.

7.6.2 Usage

This function can be configured in many different permutations. It is possible to configure Priority Tripping function where in some situations, it may delay a breaker in such a manner that selectivity is undermined. Below are recommended configurations:

If the mains and ties have GF enabled, then GF ZSI should be used for selectivity between the prioritized feeders and tiered mains, ties, and feeders.

If GF is not enabled on the mains and ties then priorities should only be assigned to feeders.

7

If the mains and ties have GF enabled, then they should always be assigned a higher priority than the feeders.

All feeders should have the same pickup setting - in Amps

Although it is possible to set priorities for topology 0 (reserved for Reduced Energy Mode), the priority should always be set to “NONE” so no delays are imposed on breakers while in the Reduced Energy Mode.

7

8 Reduced Energy Let-Thru Mode

Reduced energy let-thru (RELT) is an optional feature which provides the ability for a user to quickly adjust the system to temporary settings (usually more sensitive) while in close proximity to the Entellisys switchgear or downstream equipment.

Topology 0 stores RELT settings for each relay (see below). Topology 0 settings will take precedence over any topologies until the system is returned to normal.

Highlights

- **Reduces potential arc flash energy** - Increases the sensitivity of the breaker, potentially lowering the HRC category.
- **Dynamic ZSI Automatic Adjustment** - Breakers in RELT mode will use their RELT settings. ZSI delays will dynamically adjust all upstream breakers.
- **Security** - Individual user software “keys” are used to track RELT commands per user.
- **Easy to use** - Quickly enable, disable and view RELT with clear graphics on an intuitive HMI touchscreen interface.
- **Programmable** - RELT can be turned on and off via Modbus TCP, FlexLogic or from an external device through Discrete I/O.
- **Flexibility** - RELT for a single breaker, group of breakers or the entire lineup can be executed by a single user input.
- **Alarming** - A Reduced Energy Let-Thru Mode alarm is available for visual and email notification.

Relays with RELT Settings

Single-point Relays

- Overcurrent relays - IOC, ST, LT and GF

Multi-point Relays

- Bus Differential (BD)
- Multi-Source Ground Fault (MSGF)
- Dynamic Zone Selective Interlock (ZSI)
- High Resistance Ground Fault (HRGF) Priority Tripping

Reduced Energy Let - Thru Modes

- **Single Breaker RELT** - Switches overcurrent relay settings to RELT (Topology 0) for a single breaker as well as any associated breakers as a group. (See RELT Groups on page 230)
- **Multi-point RELT** - This will add a “Multi-point” key and switch all multi-point relays to RELT (Topology 0) settings as a group.
- **System Wide RELT** - This will add a “System Wide” key and switch settings for all current relays on all breakers as well as all multi-point relays to RELT (Topology 0) settings.

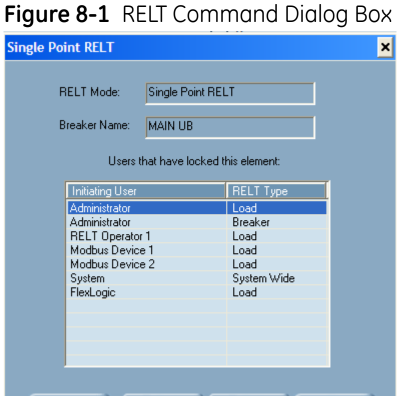
8.1 Operation

The user will initiate RELT by adding a “key” to a RELT element. An element is an individual breaker, a group of breakers, Multi-point relays or the entire system. A RELT “key” can be initiated by a user, FlexLogic or an external Modbus device.

These keys are cumulative. Up to 8 user keys can be added to each RELT element. There can be any combination of Single-point, Multi-point and System Wide keys. They can be added to each RELT instance simultaneously and in any configuration. (See figure 8-1).

If FlexLogic has initiated RELT, then the FlexLogic program must check that the state of the associated Virtual Output is low (off) before RELT can be turned off. (See FlexLogic™ Configuration on page 239)

Figure 8-1 RELT Command Dialog Box



NOTE: If more than one user initiated RELT, then each user must individually **Turn Off** RELT before the element is returned to normal.

8.1.1 HMI Control

Point of Access

RELT is only controllable (on/off) from the **Master HMI** in a system. This HMI will be one of the in-gear/near-gear HMIs. (See HMI Roles on page 112)

All other HMIs can view RELT status and can change RELT (Topology 0) settings but can not toggle the RELT state.

To determine the interactive level allowed on a particular HMI, click on the **Reduced Let - Thru Mode** button and the floating window which appears will indicate the level. See below:

The **Master HMI** text indicates that the HMI will accept RELT mode commands.

The **Non-Master HMI** text indicates that the HMI will not accept RELT mode commands and will be displayed on all other HMIs - both Local HMIs and PCs with Remote Interactive software.

CAUTION: RELT will not turn off if there is more than one HMI configured as a “Master” in the system.

HMI Indication

The Entellisys HMI will provide positive feedback through local indication that one or more of the RELT elements are operating with RELT (Topology 0) settings. The HMI will constantly monitor and update the Reduced Let - Thru Mode, One-Line and Elevation screens with the system state.

States of RELT

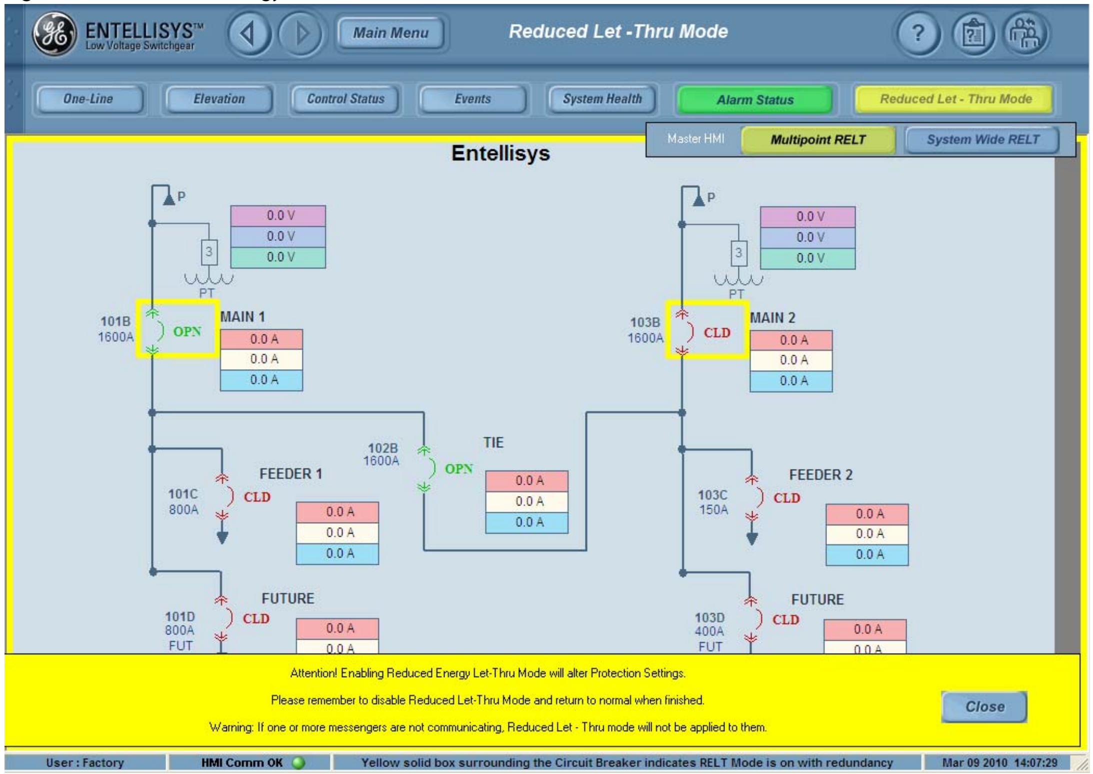
RELT state is indicated by the color of the **Reduced Let - Thru Mode** button for all modes and a colored box surrounding the breaker icon (See Figure 8-2). The color of the annunciation also provides information about the state of the system:

- **Solid Yellow** - Indicates that both CPUs are operating on RELT (Topology 0) settings.
- **Flashing Yellow** - Indicates that only one CPU is operating on the new RELT (Topology 0) settings. Although there is no redundancy, the system is still operating on the adjusted settings.
- **Flashing Red** - Indicates either a loss of communication between the HMI and both CPUs while RELT mode is turned on or that there was an error and neither CPU are operating with RELT (Topology 0) settings and RELT Mode it is not in effect.

Breaker Indication

The blue location LED will blink at 2Hz on the breaker while it is operating in RELT (Topology 0) settings (See Messenger User Interface on page 32).

Figure 8-2 Reduced Energy Let-Thru Mode



User Permissions

Only users with “Reduced Let-Thru Mode” permission enabled shall be able to operate RELT. (See User Permissions on page 79)

Default user groups and their RELT permissions:

- **Factory:** Reserved for factory trained service engineers. Can set and remove keys as well as remove keys set by others.
- **Administrator:** Can set and remove RELT keys as well as remove keys set by others.
- **Operator with RELT**: Can set and remove RELT keys.
- **Operator:** Denied the ability set or remove RELT keys.
- **Guest:** Denied the ability set or remove RELT keys.

Additional groups can be defined with unique permissions.

8.1.2 Enabling Reduced Energy Let-Thru Mode

To enable RELT, On the **Master HMI** (See HMI Roles on page 112):

1. Click on the Reduced Energy Let-Thru button on the menu bar

   The HMI will enter a “**RELT Interactive**” mode and the one-line screen with a yellow border will be displayed. From here, there are three different modes of operation.

2. Choose the type of RELT to initiate:

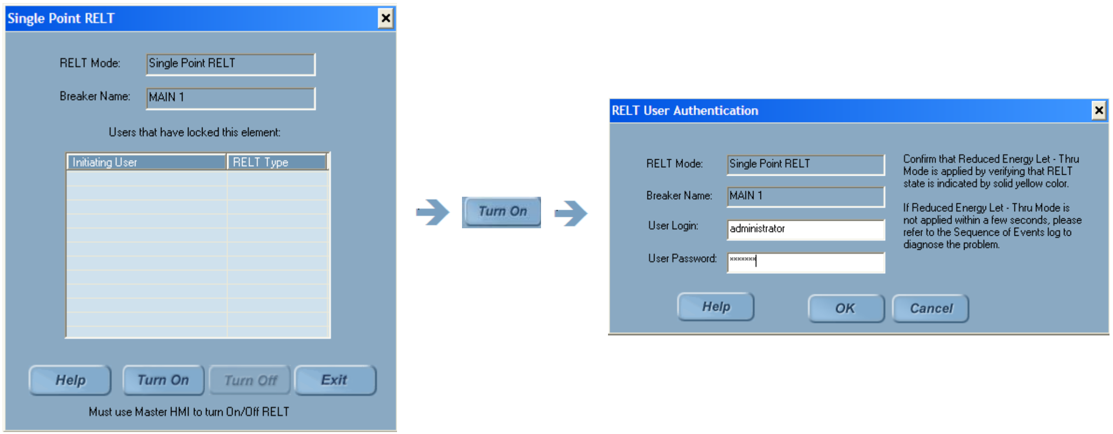
Single Breaker - Click on an individual breaker and while in “RELT Interactive mode,” the RELT “Key” dialog box will pop up. When enabled, RELT will change IOC, ST, LT and GF settings for the breaker to RELT (Topology 0).

Multi-point RELT - Will change all Multi-point Relays to RELT (Topology 0).

System Wide RELT - Will change all breakers AND Multi-point Relays to RELT (Topology 0)

3. For any type of RELT selected, the RELT “Key” dialog box will appear. Click the **Turn on** button.

Figure 8-3 The RELT “Key” dialog box



4. Type in the user id and password to initiate RELT

Once the system has accepted the RELT command, the HMI will annunciate its state by changing the color of the Reduced Let - Thru Mode button. It will also annunciate its state by the highlight around the breaker icon for Single-point and System Wide modes. The Multi-point button will illuminate when that mode is enabled.

NOTE: A breaker’s settings can not change to topology 0 (RELT) settings until all relays are idle. Because of the long pickup times for the LT relay, a delay in System Wide RELT could occur.

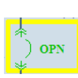
8.1.3 Disabling Reduced Energy Let-Thru Mode

To disable RELT, On the **Master HMI** (HMI Roles on page 112)

1. Click on the Reduced Energy Let-Thru button on the menu bar

The display will be changed to the RELT interactive One-Line screen. From here, there are three different modes of operation.

2. Choose the type of RELT to disable:



Single Breaker - Will return the IOC, ST, LT and GF settings for the breaker and its associated breakers to normal.

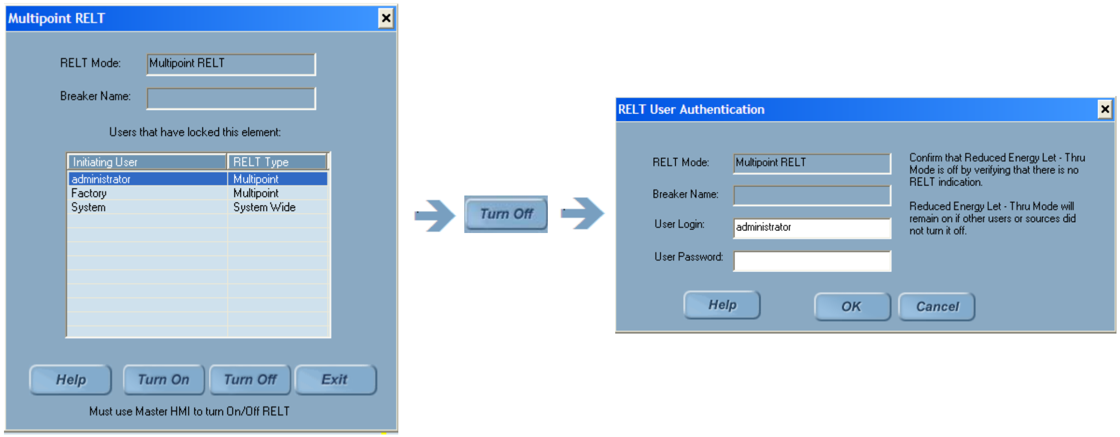
Multi-point RELT - Will return all Multi-point Relays to normal.

System Wide RELT - Will return all breakers AND Multi-point Relays to normal.

3. The RELT “Key” dialog box will appear. Click the **Turn off** button.

NOTE: The Administrator login can clear keys from any initiating user except FlexLogic. The Administrator login can not clear breakers whose initiating user was a RELT group. (See RELT Groups on page 230

Figure 8-4 Reduced Energy Let-Thru Logon Dialog



4. Type in the user ID and password to disable RELT

8.1.4 RELT Groups

RELT Groups are designed to offer protection options to the user. RELT Groups is a method by which the administrator can setup breaker associations. This enables users, when selecting a single breaker, the option of automatically selecting all other associated breakers.

When a user requests Single-point RELT on a breaker configured as an “initiating” breaker, the user is offered a choice between **Load Protection** and **Breaker Protection**.

Initiating Breaker: The breaker which, when issued a Single-point RELT command, will give the user the option of also changing the settings on the Member Breakers to RELT settings.

Member Breaker: Breakers associated with the Initiating Breaker.

Load Protection

When a user enables/disables Single-point RELT on a specific breaker AND selects **Load Protection** only the selected breaker will use RELT settings.

Breaker Protection

When a user enables/disables Single-point RELT on a specific breaker AND selects **Breaker Protection**, all grouped breakers will also be enabled/disabled at the same time. (See Setup of RELT Groups below)

NOTE: In order to turn off the entire group, the RELT “key” must be removed from the initiating breaker.

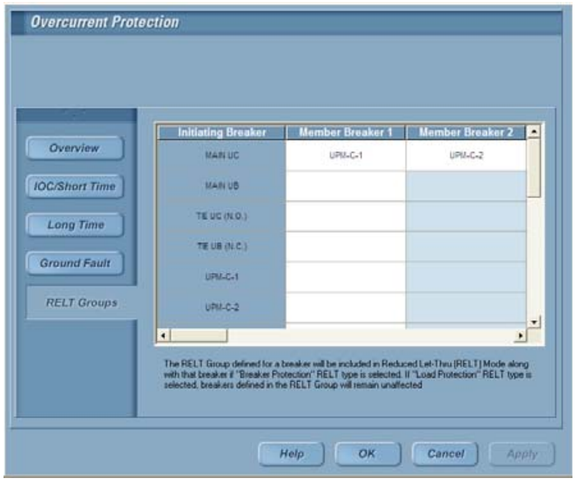
Examples

- In a lineup where a breaker is feeding downstream equipment, an operator can select **Load Protection** on the feeder breaker before approaching the downstream equipment. Only the feeder breaker will be operating on RELT settings.
- In a double ended substation, the administrator may group the tie (the initiating breaker) and both main breakers (the member breakers) together. This may be useful when the operator is racking the tie breaker, the associated source breakers on either side of the tie will operate on RELT settings. In this case the operator, when putting the tie into RELT, would select **Breaker Protection**.

Setup of RELT Groups

1. On the **Main Menu**, click **User Settings**.
2. Click **Overcurrent Protection**, and then click **RELT Groups**.
3. Configure **Member Breakers**. For each “Initiating Breaker,” add select the Member Breakers from the list of installed breakers.

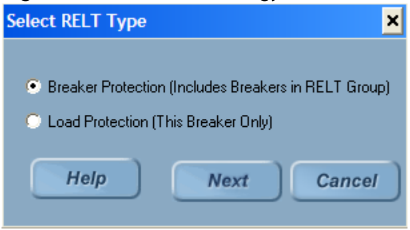
Figure 8-5 RELT Groups



Operation

When turning on Single-point RELT for any breaker which has been configured as an **Initiating Breaker**, the system will offer a choice: **Breaker Protection** or **Load Protection**. (See Enabling Reduced Energy Let-Thru Mode)

Figure 8-6 Reduced Energy Let-Thru Mode message



8.2 Administration

When enabled on a breaker or group of breakers, Reduced Energy Let-Through mode uses an independent set of over current protection settings. The RELT mode is usually turned ON when people will be near the energized equipment or near downstream equipment. The RELT settings are typically set at more sensitive levels than what is used in normal operation. These more sensitive settings can pick-up and operate faster than the normal settings and therefore minimize the incident arc energy during an arcing fault.

To place breakers into RELT mode an operator must meet the following criteria:

- Have a user ID that allows RELT on/off access
- Enter the corresponding password to the User ID each time he enables or disables RELT

Therefore, the administrator of the Entellisys system must consider how they want to set up User Ids and related permissions. It is recommended that each individual have their own User ID and related password instead of a group User ID and password that a number of people use. This is so each individual can enable/disable RELT "keys" independent of each other.

For example, if Ted places a breaker in RELT and an hour later Joe wants to place the breaker in RELT, each can do so independently. Then, when each is finished (at different times) they will turn their RELT off, and RELT will remain in effect until the last person is finished. In contrast, if a group User ID and password is used, Ted would turn it on, Joe would see that it was on and not put it on. Ted could turn RELT off not knowing that Joe still wanted it on. The User ID permissions and set-up is the responsibility of the site's Entellisys administrator and care should be taken in determining what suits the site.

The site administrator must also consider what RELT (topology 0) settings to select. Typically the settings are more sensitive than 'normal' protection settings. When RELT is used with Entellisys dynamic zone selective interlocking and bus differential, selectivity with upstream breakers can be achieved while providing faster than 'normal' settings response times to arcing faults.

Although the RELT (Topology 0) settings are user-adjustable, the values described in the following sections are examples of the most sensitive settings and minimum delay bands.

8.2.1 Single-point Overcurrent Settings

Breakers must have ST, IOC or Switchable ST/IOC for single-point RELT to function. RELT (Topology 0) settings should be reviewed to provide an acceptable level of increased protection while the system is in Reduced Energy Let - thru mode. See Section 5: Single-point functions on page 135 for more information.:

The minimum settings for overcurrent relays for Topology 0 are:

Setting	Value
IOC Enabled	Enabled
IOC Pickup Setting Multiplier	1.5
ST Protection Switch	Enabled
ST Pickup Setting	1.5
ST I2T Curve	Enabled
ST Delay Band Setting	0
LT Delay Band Setting	0
GF Protection Switch	Enabled
GF Trip Priority	0
GF Alarm Enable	Enabled
GF Trip/Alarm Pickup Setting	0.2
GF Trip/Alarm I2T Curve	Enabled
GF Trip/Alarm Delay Band Setting	0

8.2.2 RELT Settings for Bus Differential

Bus Diff will operate using Topology 0 settings while in **Multi-point RELT** or **System Wide RELT**. See Section 7.1: Bus Differential Relay on page 196 for more information.

The minimum settings for Bus Differential zones for both Alarm-Only and Trip Relays for Topology 0 are:

Setting	Value
Pickup Setting 1 & Pickup Setting 2	100A
Time Delay 1 & Time Delay 2	BAND 1
Backup Function (For Trip Relay only)	Enabled
Backup Time Delta (For Trip Relay only)	Trip Immediately

NOTE: Although the Pickup is set to 100 Amps, Entellisys automatically enforces a "Zone Minimum Pickup Setting" for Bus Differential. The "Zone Minimum Pickup Setting" is 20% of the largest CT rating in the corresponding zone.

8.2.3 RELT Settings for Multi-Source Ground-Fault

Multi-Source Ground-Fault will operate on Topology 0 settings while in **Multi-point RELT** or **System Wide RELT**. See Section 7.2: Multi-Source Ground-Fault Relay on page 200 for more information.

The minimum settings for Multi-Source Ground-Fault zones for both Alarm-Only and Trip Relays for Topology 0 are:

Setting	Value
Pickup Setting	30 Amps
Time Delay	BAND 1
Curve I^2T	DISABLED
Backup Function (For Trip Relay only)	Trip Immediately
Backup Time Delta (For Trip Relay only)	Trip Immediately

For all MSGF summation zones for both Alarm-Only & Trip Relays for Topology 0

Setting	Value
Pickup Setting	30 Amps
Time Delay	BAND 1
Curve I^2T	DISABLED

NOTE: Although the Pickup is set to 30 Amps, Entellisys automatically enforces a “Zone Minimum Pickup Setting” for Multi-Source Ground-Fault. The “Zone Minimum Pickup Setting” is 20% of the largest CT rating in the corresponding zone.

8.2.4 Ground Fault Trip Priority

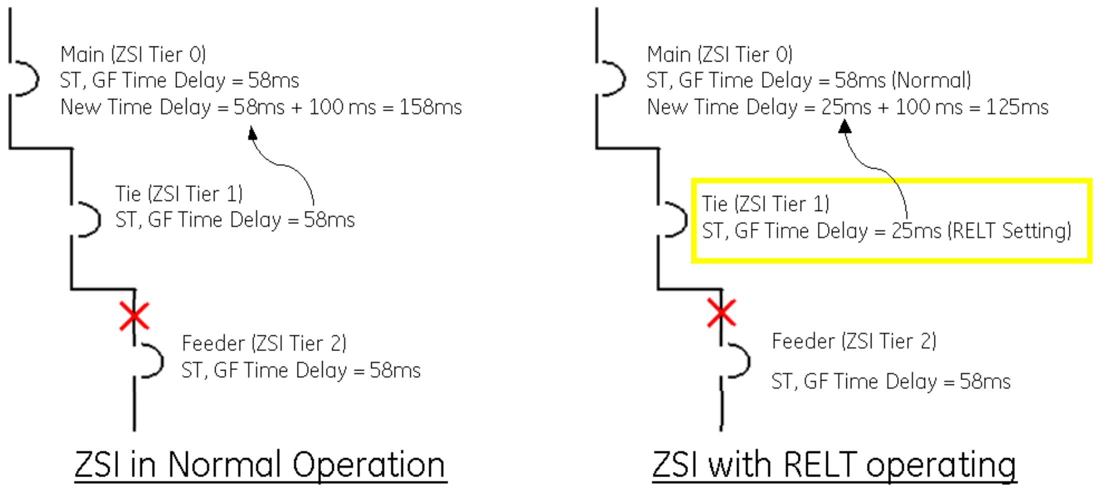
By default, each breaker will be excluded from the High Resistance GF Trip Priority scheme while operating with RELT (topology 0) settings.

8.2.5 RELT Settings for Zone Selective Interlock

A ZSI zone is made of one or more MSGF zones, main, tie, and feeder circuit breakers. A ZSI zone can be either a ZSI-Short Time zone, ZSI-Ground Fault zone or both.

ZSI delays will be ignored by any breaker operating with RELT (Topology 0) settings. The delay will propagate upstream preserving selectivity on all breakers that are NOT operating with RELT (Topology 0) settings (see figure 8-7). Multi-point RELT effectively disables ZSI altogether. (see Configuring ZSI parameters on page 212)

Figure 8-7 ZSI Operation



In Figure 8-7, demonstrates the interaction between ZSI and RELT. In this case, the gear has both buses fed from a single main and the user has placed the tie in RELT while they are working near the feeder.

NOTE: If a ZSI zone member is offline and another member enters RELT mode, the system will select the safest time delay to prevent equipment damage.

8.3 RELT Events

When Reduced Energy Let-Thru Mode is enabled/disabled, an event is displayed in the HMI Events Log as follows:

HMI Events

- RELT - ON Request For [breaker name] By [User name] - Logged when user requests to turn ON single point RELT mode for a breaker
- RELT - OFF Request For [breaker name] By [User name] - Logged when user requests to turn off single point RELT mode for a breaker
- RELT-Factory Request Reset For [breaker name];[user name] - Logged when factory user requests to override a lock on a breaker
- RELT - Factory Request Reset [breaker name] - Logged when factory user requests to override all locks for a breaker from Non-Master HMI
- RELT - Admin Request Reset For [breaker name];[user name] - Logged when administrator user requests to override lock on a breaker
- RELT - Factory Request Reset For [breaker name]; Modbus Device - Logged when factory user requests to override lock(s) (either one or all) for single point RELT mode that was set by a Modbus device
- RELT - Admin Request Reset For [breaker name]; Modbus Device - Logged when administrator user requests to override a lock for single point RELT mode that was set by a Modbus device
- RELT - Factory Request Reset For [breaker name]; RELT Grp - Logged when factory user requests to override lock(s) for single point RELT mode that was set by RELT Group

Single-point Events

- RELT Mode - ON Request From User
- RELT Mode - OFF Request From User
- RELT Mode - ON Request From FlexLogic
- RELT Mode - OFF Request From FlexLogic
- RELT Mode - ON Request From Initiating Breaker
- RELT Mode - OFF Request From Initiating Breaker
- RELT Mode - ON Request From Modbus Device
- RELT Mode - OFF Request From Modbus Device
- RELT Mode ON
- RELT Mode OFF

Multi-point Events

- RELT Mode Multipoint - ON Request From User

- RELT Mode Multipoint - OFF Request From User
- RELT Mode Multipoint - ON Request From FlexLogic
- RELT Mode Multipoint - OFF Request From FlexLogic
- RELT Mode Multipoint - ON Request From Modbus Dvc
- RELT Mode Multipoint - OFF Request From Modbus Dvc
- RELT Mode Multipoint ON
- RELT Mode Multipoint OFF

System Wide RELT

- RELT Mode System Wide - ON Request From User
- RELT Mode System Wide - OFF Request From User
- RELT Mode System Wide - ON Request From FlexLogic
- RELT Mode System Wide - OFF Request From FlexLogic
- RELT Mode System Wide - ON Request From Modbus Dvc
- RELT Mode System Wide - OFF Request From Modbus Dvc
- RELT Mode System Wide ON
- RELT Mode System Wide OFF

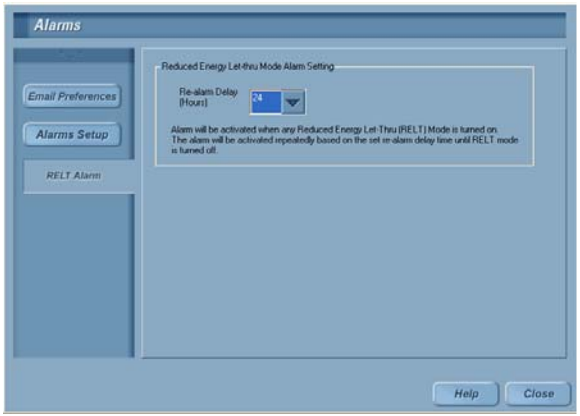
8.4 RELT Alarm

The **Reduced Let Thru On Alarm** is annunciated anytime either a user, Modbus or FlexLogic turns on any Reduced Energy Let Thru mode (Single-point, Multi-point or System Wide) regardless of the Reduced Energy status. If acknowledged, the HMI will re-alarm every X (adjustable from 1 -24) hours until the system is returned to normal.

RELT Alarm Re-Alarm delay

To adjust the Re-alarm delay, On the **Main Menu**, click the **User Settings** button and click on **Alarms.** From the Alarms screen click on **RELT Alarm.** The Re-alarm delay is adjustable from 1 to 24 hours.

Figure 8-8 RELT Re-Alarm



8.5 FlexLogic™ Configuration

Reduced Energy Let-Thru Mode can be controlled (through FlexLogic and Discrete I/O) by a 3rd party device.

FlexLogic and Modbus TCP can turn RELT on for individual breakers (Load protection) as well as enable Multi-point and System Wide RELT.

Operation

Reduced Energy Let-Thru can be controlled with designated Virtual Outputs. FlexLogic can then be programmed to control these designated Virtual Outputs through either logic or discrete inputs.

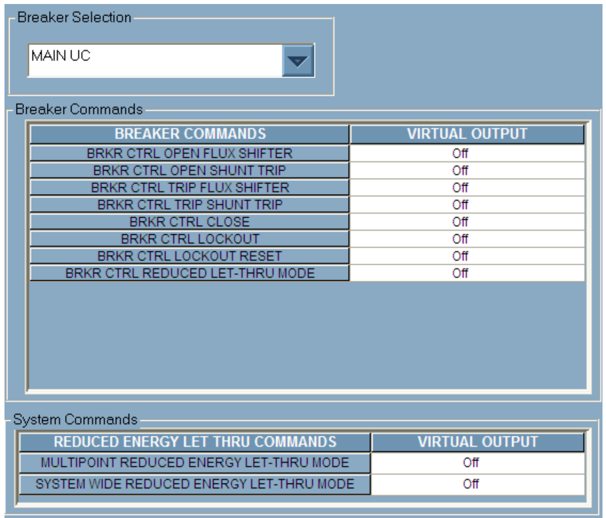
FlexLogic will work in conjunction with other user initiated keys. FlexLogic commands cannot be overridden. In other words, RELT will remain active as long as FlexLogic evaluates the VO high.

8.5.1 FlexLogic Programming

FlexLogic can command individual breakers into RELT. To program:

1. **Find and reserve a Virtual Output:** Navigate to the **Virtual Outputs** screen (Main Menu, User Settings, Control) and enable and rename a spare Virtual Output for Reduced Energy Let-Through and apply changes.
2. **Configure Breaker Commands**: Navigate to the **Brkr Commands** screen (from (User Setting, Control) and assign the Virtual Output to one of 3 RELT commands:
    - **Brkr Ctrl Reduced Let-Thru Mode**: Can be found in the **Breaker Commands** group. There is a unique breaker command for each breaker installed in the system.
    - **Multipoint Reduced Energy Let-Thru Mode**: Can be found in the **System Commands** group. This is a system command and will initiate Multi-point RELT.
    - **System Wide Reduced Energy let-Thru Mode**: Can be found in the **System Commands** group. This is a system command and will change single-point and multi-point RELT settings on all installed breakers.

Figure 8-9 Breaker Commands



CAUTION: **In many cases, FlexLogic will be factory programmed with an automatic transfer scheme or other control logic. It is extremely important not to, in any way, tamper with factory programming. Verify that the Virtual Outputs and Contact Inputs used are spares. If there is any doubt, contact GE Post Sales Service.**

8.5.2 Configure a Discrete Input to enable RELT

In this example, a discrete input will be setup to turn on RELT.

1. **Reserve a spare contact input**: Navigate to the **Contact Inputs** (User Settings, Discrete I/O) and assign and rename a spare contact input “Reduced Energy Let-Thru”. Enable **Debounce Time**.
2. **Reserve spare Virtual Outputs**: Navigate to **Virtual Outputs** (User Settings, Control) and find a spare VO and rename.
3. **Assign breaker Commands**: Navigate to **Brkr Commands** (User Settings, Control) and assign the VO to one of the RELT elements (see FlexLogic Programming on page 239)
4. **Program FlexLogic**: Navigate to the **FlexLogic editor** (User Settings, Control) and scroll down and find the first empty lines of FlexLogic and program the FlexLogic shown in Figure 8-10.

Figure 8-10 FlexLogic Example

Flex Logic Entry	Type	Syntax	Instance
Flex Entry 1	Contact Inputs On	RELT Digital Input On	NONE
Flex Entry 2	Write Virtual Output[Assign	= RELT VO (VO1)	NONE

8.5.3 FlexLogic testing procedure

1. **Force the Discrete Input On**: Navigate to the **Force Contact I/O** screen (Main Menu, User Settings, Discrete I/O) and enable test mode. On the same screen, select “Input” from the “Contact I/O Selection,” find the Reduced Energy discrete input and force closed
2. **Validate RELT Operation**: Navigate back to the one-line and click on **Reduced Let - Thru Mode** and verify that RELT Instance programmed in section 8.5.1 is highlighted in yellow.

Click on the RELT Instance and validate that FlexLogic is listed as an Initiating User. (See figure 8-11)

Figure 8-11 Initiating User - FlexLogic

3. Return to normal by reversing step 1.

4. Test again using the physical input.

8.6 Troubleshooting

Condition: "The Reduced Let-Thru" button is grayed out

- RELT is not optioned. See Section 11.2 in DEH 500 System Administrators Manual.
- HMI, on initial startup, was not communicating to either CPU.

Condition: Multi-point RELT is grayed out

- Verify that at least one of the Multi-point relays are optioned. (BD, MSGF and ZSI)

Condition: Multi-point RELT is enabled but Multi-point RELT status is off

- Verify that all of the Multi-point relays are not suspended.
- Verify that all zone member circuit breakers are commissioned.
- Verify that all zone member circuit breakers are communicating with the CPU.
- Verify that the CT ratings are valid for breaker frame.
- Configured zones are disabled.

Condition: A breaker has a blinking red highlight after RELT was enabled.

- Verify that the breaker is communicating to the CPU.
- Verify that the HMI is communicating with the CPUs.

Condition: After turning off RELT, the RELT status remains on.

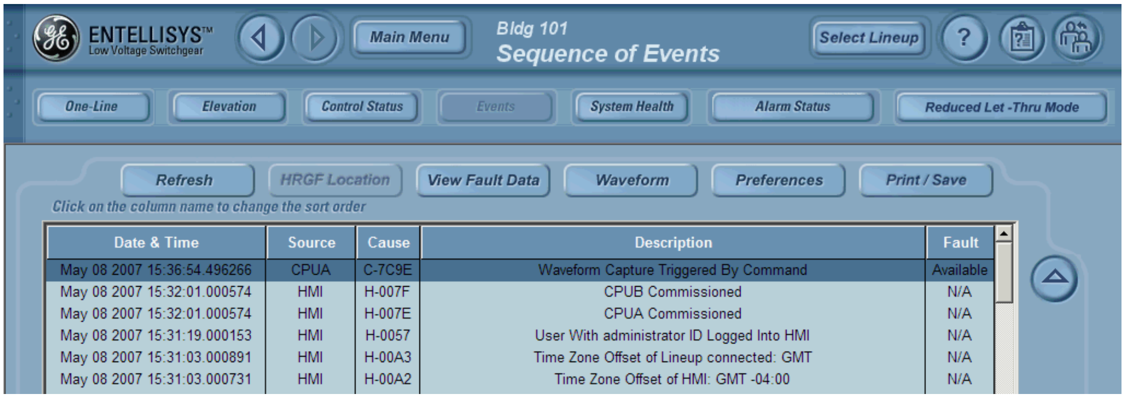
- On each RELT element, verify that neither Modbus Devices nor FlexLogic are still enabled.
- On individual breakers, verify that RELT groups are not enabled.

9 Sequence of events, fault reports and waveform capture records

9.1 Sequence of Events Viewer

The Sequence of Events (SOE) record in Entellisys Low-Voltage switchgear is intended to provide a detailed chronology of all system phenomena. This includes events related to enabled protective and control functions as well as the monitoring system itself.

Figure 9-1 SOE Viewer



Operation:

Each CPU buffers and maintains the last 1024 events it records. These event buffers are backed up in non-volatile memory in the event of a system reset. The Entellisys local and remote HMIs continuously poll each CPU and retrieve this information automatically as new events are generated. Additionally, the HMI logs events related to it (e.g., operator logon, time synchronization, etc.) and adds them to the locally stored record.

Some events result in the triggering of a waveform capture and fault report. These include protection related alarms and events as well as commands issued to activate the opening or closing of a circuit breaker. An association is maintained between each type of record to make it easy to recall the relevant information when viewing a given event. Like event data, fault report data is stored in non-volatile memory. Waveform records are stored only in volatile memory within the CPU due to the volume of data in relation to available flash memory. The HMI retains all retrieved records on its local hard drive. To maintain system performance, the HMI does not automatically retrieve every waveform, only those that are requested for viewing by the user at the time the request is made. It is possible to configure a SCADA system to perform automatic retrieval for backup purposes.

The Sequence of Events window lets you view and track the alarms and events generated by the default CPU. These events are also stored in two local log files, one maintained by each CPU. Entellisys generates a new event log file once per day, whenever the first event occurs. The naming convention for a log file is: YYYYMMDD-X-Z.lge, where X is a sequential value and Z represents the source of the log data: 0 for CPU A and 1 for CPU B.

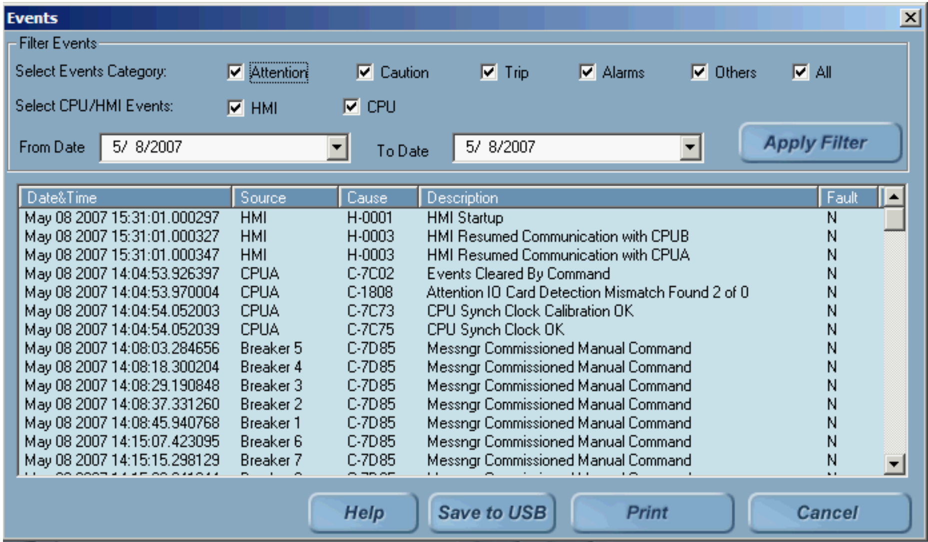
For a complete listing of available events, descriptions, and tips for analyzing and troubleshooting them, see Alarms and events on page 313.

9

9.1.1 Event Printing

The List of events can be filtered and either be printed or saved to a USB drive. Click on the **Print/Save** button on the events screen, see Figure 9-1. Configure the event filters and date range then either print or save to an USB drive as a HTML file.

Figure 9-2 Event Printing



Select Events Category: Click on the check boxes to select that group of events

Select CPU/HMI Events: Click on either the HMI or the CPU. HMI events are generally related to user activities where as CPU events are generally system related events

Apply Filter: After clicking, the event list will rebuild with new selections

Printing on Local HMIs

On kiosked touchscreen HMIs, the print function is disabled. When saving to a USB, the USB will be ejected and must be removed and re-inserted to save another event report.

9.1.2 Viewing the SOE

The default SOE view displays events of the default CPU in the order in which they were logged. In this mode, it is possible for events to be slightly out of chronological order due to the relative locations of devices within the system that may be generating them. To sort the events in another order, click on the heading of any column to sort them accordingly. Navigation buttons are provided on the screen to move between pages of events. The screen is not refreshed automatically so as not to interrupt navigation through the list. Instead, a refresh button is provided at the top of the screen to update the list at the user's discretion.

If a protection or circuit breaker operation event occurs, a Fault Report and Waveform Capture associated with the event are available. To view either of these, highlight the event and click either the **View Fault Data** or **Waveform** button located at the top of the screen, see Figure 9-1

The fault report consists of a table of all circuit breakers in the system. For each circuit breaker, the report shows the RMS current recorded by the circuit breaker's Messenger over the course of the half cycle just prior to the occurrence of the event.

9.1.3 Event configuration

The SOE configuration is located under **Preferences** at the top of the SOE window. The following options are available:

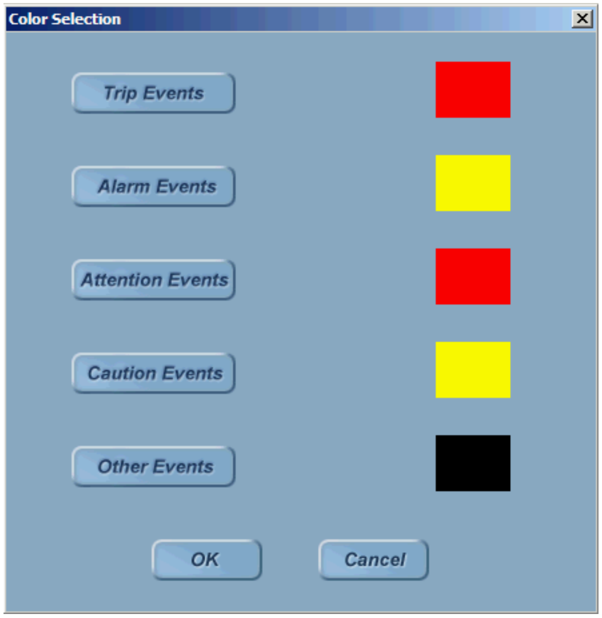
Figure 9-3 SOE Preferences

- **Filter Events** – Makes it possible to select which events are displayed in the SOE. This affects only the immediate display properties. Events that are not selected for display are still maintained in the local record files, and may be viewed at any time by selecting the specific type of event in the filtering list.

Figure 9-4 Filter events

- **Events Color** - Changes the default colors of event categories. The color of the event text helps the user quickly identify specific types of events. To see the list of events and the categories, see Alarms and events on page 313.

Figure 9-5 Event Category Colors



The categories are defined as follows:

Attention - An Entellisys issue that may potentially cause a future problem that should be addressed at the next service interval

Caution - An Entellisys issue that is causing an immediate problem and should be addressed immediately

Trip - A relay operation that tripped a breaker

Alarm - A power system event that caused a relay to exceed the alarm setting thresholds

Others - Conditions that occur during normal operation that are informative in nature

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- **Protect/Overwrite** – In Protect mode, the event logger stops recording events when the maximum size of the daily log is reached. In Overwrite mode, the oldest events are overwritten on a FIFO basis.
- **Event Log Size** – Specifies the maximum size of the daily log.
- **Maximum Fault Reports** – Specifies the point at which the HMI should stop automatically retrieving Fault Reports in a given day.
- **Retention Days** – Specifies the number of days to retain event records before they should be automatically deleted to conserve disk space.

9.2 Waveform capture

Waveform capture is an optional feature which, when triggered, saves waveforms for all phases on all breakers in the system simultaneously. The following channels are recorded from each EntelliGuard Messenger:

- Analog – Ia, Ib, Ic, In, Va, Vb, Vc (or Vba, Vbc, Vca for delta PT configurations)
- Discrete Command Transitions – Open, Close, and Trip
- Discrete Status Transitions – Open, Closed, Spring Charge, Analog IOC, Backup Trip

All channels for the entire system are time-synchronized to within 5us of each other. The number of system-wide waveforms held in memory is dependent on the number of Messengers in the system. The capacity can be calculated as the integer quotient of 1000/n, where n represents the total number of Messengers in the system. Other specifications for waveforms are:

- Sampling Rate – 64 samples / cycle
- Duration – 1 second (60-Hz systems); 1.2 second (50-Hz systems)
- File Format – COMTRADE (IEEE Std. C37-111-1999)

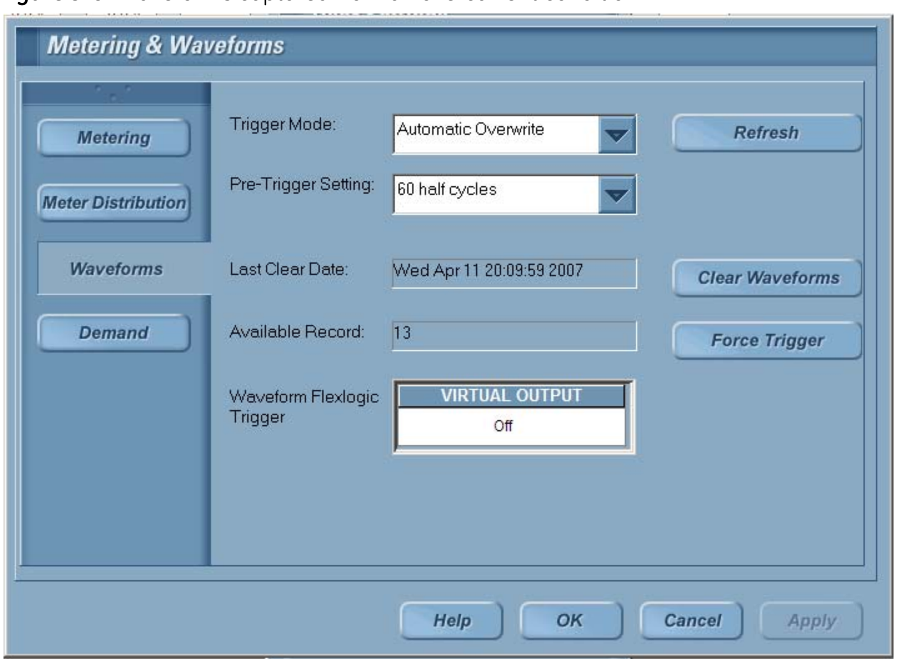
Because of the large memory capacity of the CPU, these parameters are fixed for all captures.

9

9.2.1 Waveform capture configuration

Use the Waveform Capture configuration utility (from the **User Settings** menu, click **Metering & Waveforms**) to set the following parameters:

Figure 9-6 Waveforms captured from an overcurrent condition



- **Trigger Mode** – In the default Automatic Overwrite mode, waveforms are overwritten in the CPU memory on a FIFO basis. In Protected mode, waveforms stop being captured once the waveform buffer capacity has been reached, as discussed below. It is necessary to manually clear the waveforms from memory using the **Clear Waveforms** button on this screen to resume capture in this mode.

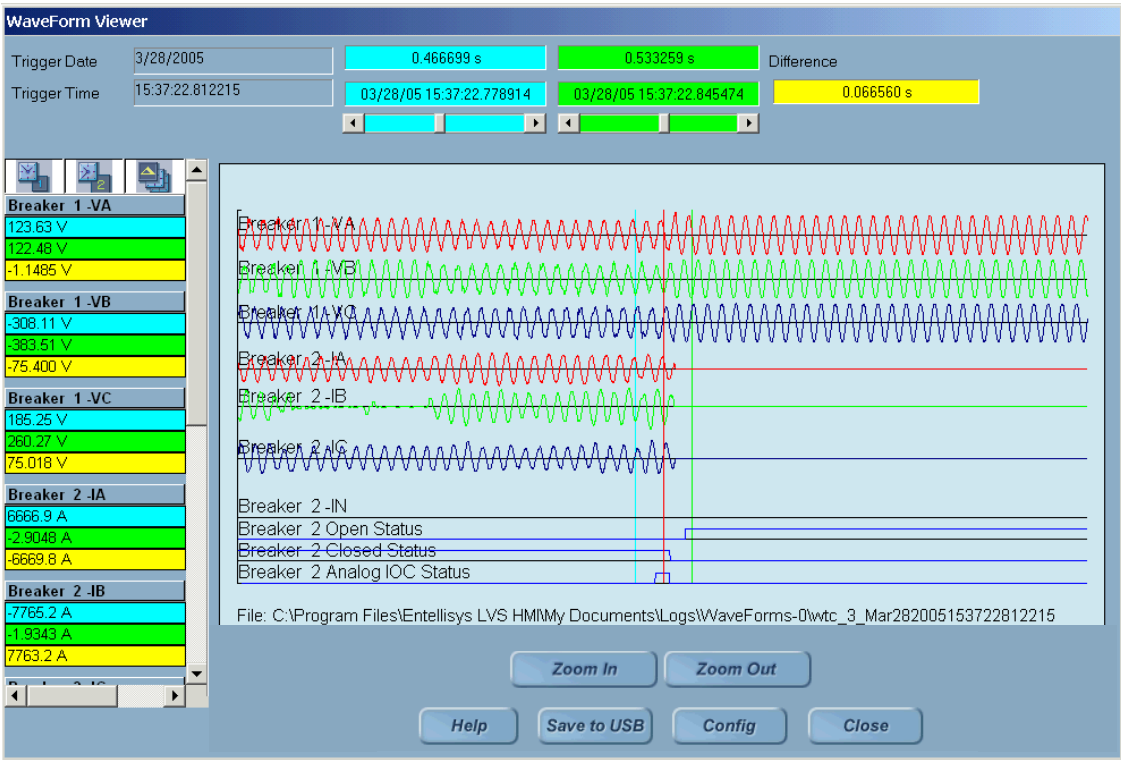
- **Pre-Trigger Setting** – Selects the amount of pre-trigger information contained in each waveform, from 0 to 119 half-cycles worth of data.
- **Force Trigger** – Forces a waveform capture to occur. It is necessary to press the Refresh button to update the information on the screen to reflect the new capture.
- **Waveform FlexLogic Trigger**– Waveform capture is triggered when the assigned FlexLogic Virtual Output transitions from low to high. To view the waveform, find the "Waveform Capture Triggered By FlexLogic" event and click on the associated waveform icon (See section 9.2.2).

9.2.2 Waveform viewer

To view a waveform capture on the HMI screen, highlight the event in the SOE listing with which the waveform is associated and click the **Waveform** button.

The waveforms in Figure 9-7 were captured from an overcurrent condition. At the left of each time line, magnitude data or operation status are shown for the displayed waveform trace.

Figure 9-7 Waveforms captured from an overcurrent condition



At the top of the window, the Trigger Date (D/M/Y) and time of triggering (to nearest microsecond) are displayed.

The Cursor 1, Cursor 2 numeric values indicate the position of the corresponding cursor from the start of the record. The Delta numeric value displays the time difference between Cursor 1 and Cursor 2.

The **cursors** can be moved in one of two ways: either by clicking and dragging them left and right across the duration period of the signal, or by using the Cursor 1 and Cursor 2 scroll bars at the top of the window. The red line is the trigger position, which cannot be moved across the captured waveforms.

The numeric amount listed in the corresponding colored box to the left of the signal indicates the magnitude of the signal at the point where the cursor is located. There are also **Cursor 1**, **Cursor 2**, and **Delta** boxes at the top of the window, which indicate the exact point in time for that cursor position.

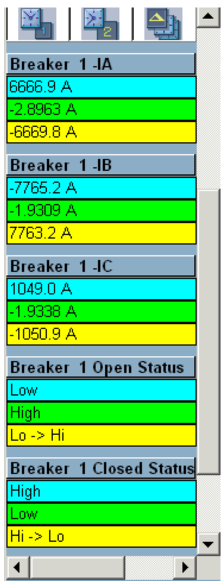
Zooming - To zoom in on a selected section of waveform(s), right-click or click the Zoom In button and drag the outline box over the desired area. Multiple zooms are possible. To zoom out, right-click or click Zoom Out.

Save to USB - Will save the waveform as a comtrade file to a USB memory stick.

To superimpose waveforms, select the waveform to be moved by left-clicking on the X-axis and dragging it to the desired position.

Displayed on the left side of the window are parameter fields, as shown in Figure 9-8:

Figure 9-8 Parameter fields

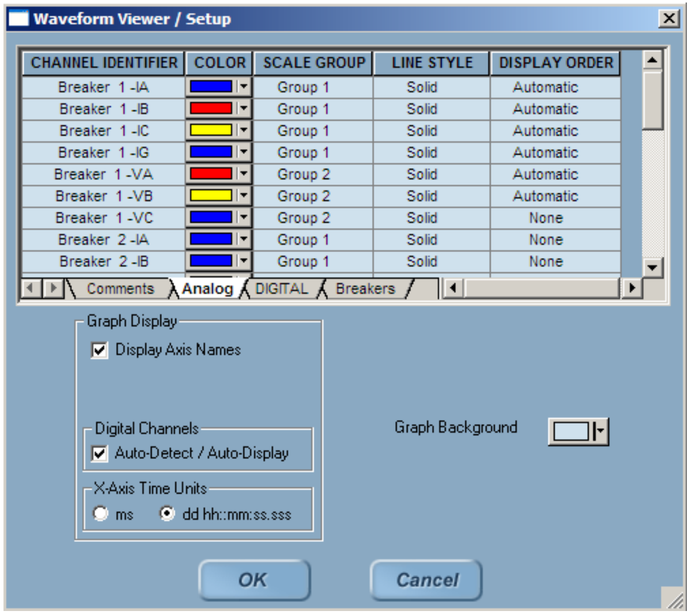


- The blue field displays the parameter value at the blue Cursor 1 position.
- The green field displays the parameter value at the green Cursor 2 position.
- The yellow field indicates the relative parameter difference between the two cursor amplitude values.
- The vertical red line indicates the trigger position (%) of the data capture.
- Located just above the Parameter fields on the right are three buttons. These three buttons corresponds to the Cursor 1, Cursor 2 and the delta values being displayed. When turned off, the corresponding values are not displayed in the numerical chart. All three switches are on by default.

9.2.3 Configuring the waveform viewer

Click the **Config** button to display the waveform viewer setup window, as shown in Figure 9-9.

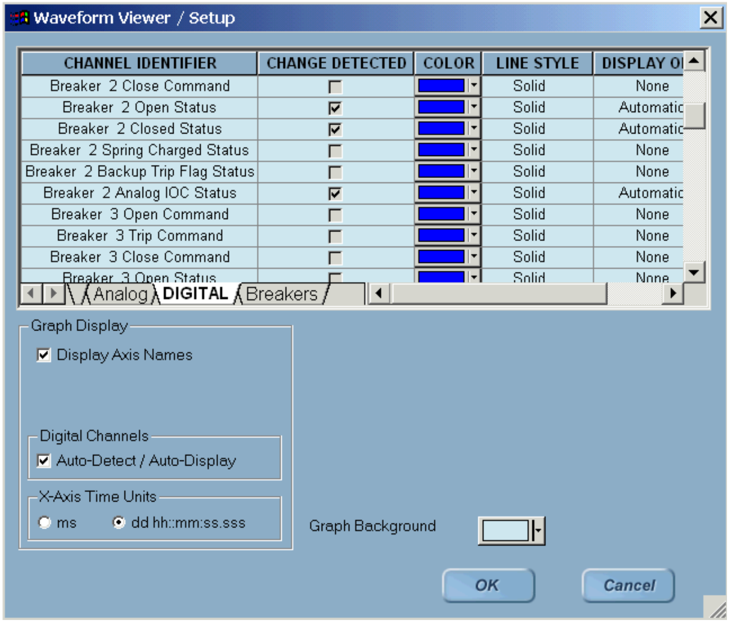
Figure 9-9 Waveform viewer setup window



This window enables the selection of channels to be plotted in various colors, line styles, and groups for simultaneous display. These channels can be a combination of Analog and Digital channels.

Click the **Digital** tab, as shown in Figure 9-10. When a change of state is detected within the record, a check mark appears beside the corresponding operand in the **Change Detected** column.

Figure 9-10 Digital Channel Setup tab



Display axis names

- Check box hides/displays the Y-axis parameter names.

Auto-detect / auto-display

- Check box automatically displays preset, digital channel outputs if a change of state occurred during triggering.

Change background color

- Change the background color of the graphs. The default is light blue. Changing this option effects the background of waveform capture display.

9.2.4 Grouping waveform signals

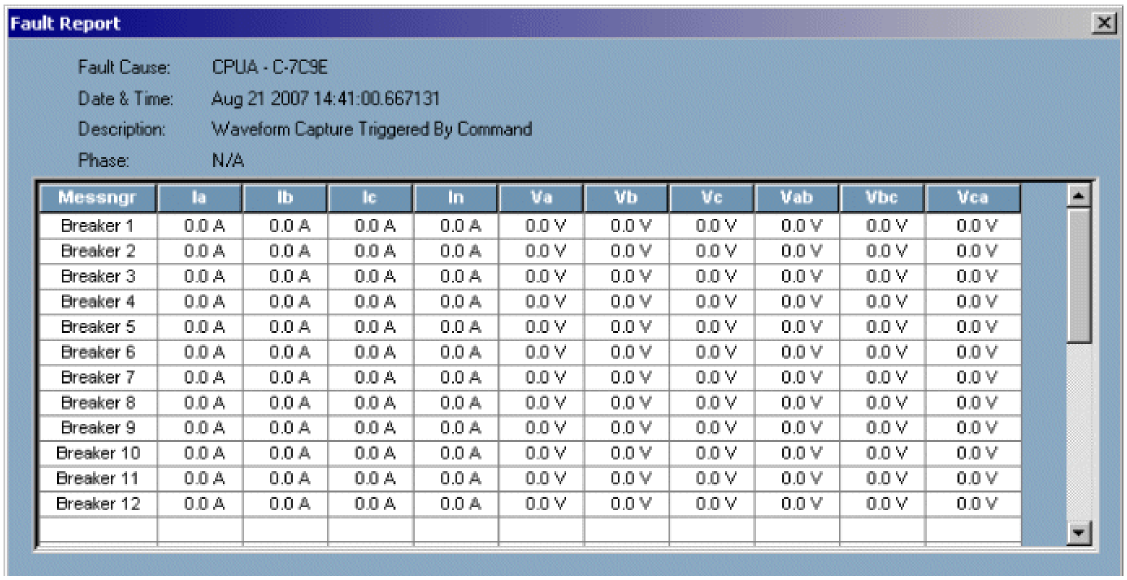
The ability to group waveform signals together in order to view them with respect to a common scale is available. Phase waveform magnitudes that are grouped within the same group heading are displayed in relation to each of the other signals in their group. The waveform with the largest amplitude is taken as the reference scale, and other waveforms are displayed in their proper ratios with respect to this signal.

9.3 Fault reports

If a protection or circuit breaker operation event occurs, Entellisys generates a fault report, which consists of a table of all circuit breakers in the system. For each circuit breaker, the report shows the RMS currents and voltages recorded by the circuit breaker's Messenger over the course of the half cycle just prior to the occurrence of the event.

Select an event in the Sequence of Events window and click the View Fault Data button to display the fault report for the selected event.

Fault Report



Fault Report

Fault Cause: CPUA - C-7C9E

Date & Time: Aug 21 2007 14:41:00.667131

Description: Waveform Capture Triggered By Command

Phase: N/A

Messngr	Ia	Ib	Ic	In	Va	Vb	Vc	Vab	Vbc	Vca
Breaker 1	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 2	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 3	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 4	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 5	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 6	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 7	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 8	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 9	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 10	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 11	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V
Breaker 12	0.0 A	0.0 A	0.0 A	0.0 A	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V	0.0 V

Entellisys generates a new event log file, and the associated fault log file, once per day, and saves the fault log file on the local machine.

The naming convention for a fault log file is: YYYYMMDD-X-Z.lgf, where X is a sequential value and Z represents the source of the log data: 0 for CPU A and 1 for CPU B.

Note: The event log file uses the same naming convention with a *.lge extension, while the fault log file has a *.lgf extension.

The Fault Type and Operated Element fields vary depending on the type of event. For example, a settings change event should indicate information about the setting and value that was changed. Voltage and Current data is present regardless of the event type.

Click the Close button to return to the Sequence of Events window.

9.4 High Current Trigger relay

The High Current Trigger relay is included in the Waveform Capture option and is designed to automatically trigger a waveform capture in the event of a sudden change in the steady state load.

By setting current thresholds as low as 10% of the breaker rating, Entellisys can capture waveforms of every phase from all circuit breakers in the system on a wide variety of normal events. This is useful to characterize system dynamics such as a motor starting or to diagnose and improve power system dynamics.

Operation

Once current is above a relative pickup level for the specified duration, the relay will alarm and trigger waveform capture. Waveforms are captured per the settings in "Waveforms" tab of "Metering & Waveforms" screen (See section 9.2.1).

If waveform capture option is not enabled or the maximum number of waveforms has been reached, the High Current Trigger Relay will no longer record waveforms but still log alarm events.

NOTE: If the High Current Trigger relay operates (in the same half cycle) at more than one breaker, each generates an event but only one waveform is captured.

Events

This relay logs the following events:

"Alarm Pickup High Current Trigger" - logged when current at the breaker goes above the pickup level

"Alarm Dropout High Current Trigger" - logged when current at the breaker goes below the dropout level

"Alarm High Current Trigger" - logged when function operated (i.e. current stayed above pickup level for the duration of the set time delay)

"HCTR Waveforms Max Count Reached" - logged when maximum set number of waveforms has been triggered by the function

"HCTR Waveforms Counter Reset" - logged when user resets waveform count

Alarms

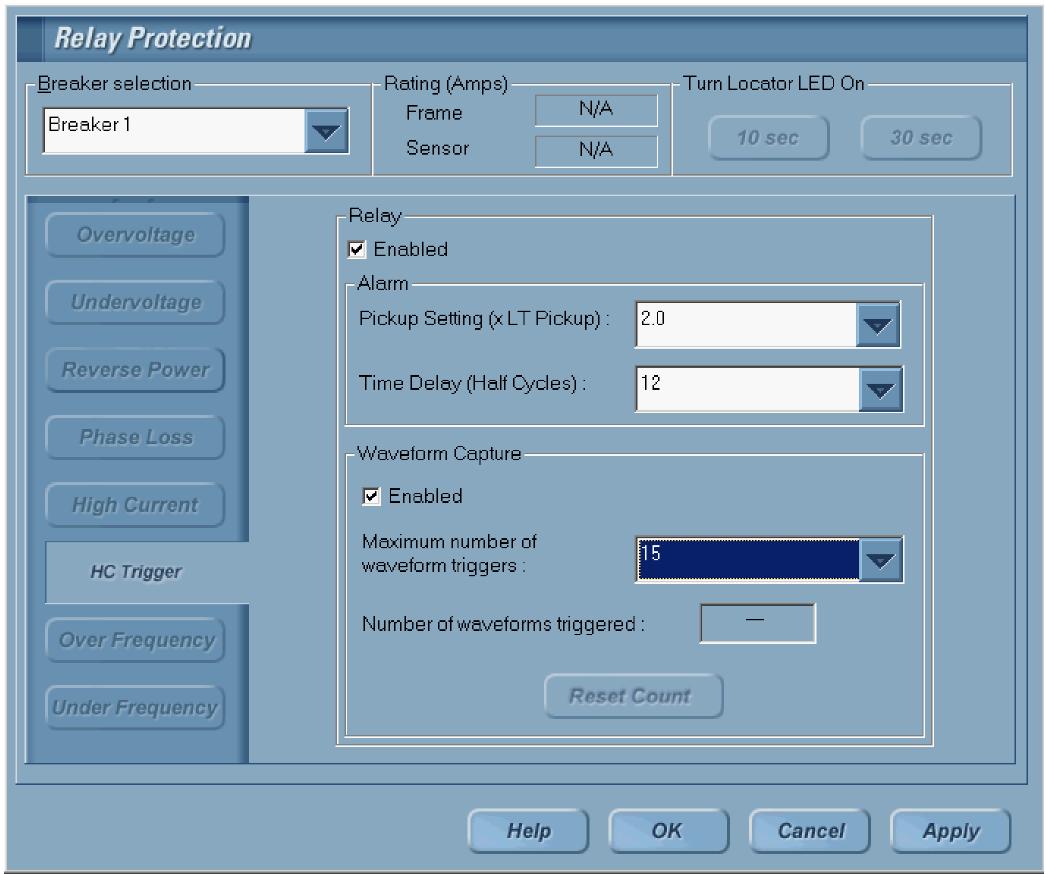
"High Current Trigger - Any"

"High Current Trigger - Breaker X" - where X stands for breaker number from 1 thru 30

9.4.1 Configuration

The High Current Trigger relay is associated to a specific breaker. From the **User Setting** sub-menu, click on **Relay Protection**, select the appropriate breaker and click on the **HC Trigger** button.

Figure 9-11 High Current Trigger Settings



Function settings are grouped into two groups. One is dedicated to the alarm settings and the other group allows user to set waveform trigger limit.

Alarm Group Box

Pickup (x LT Pickup) - 0.1 to 9 in steps of 0.1

Delay (Half cycles) - 1 to 120 in steps of 1 (Half cycle refers to the AC Power signal and thus for a 60Hz system, 1 half cycle = 8.333ms)

Waveform Group Box

Maximum number of waveform triggers - 0 to 30, 0 disables waveform capture

Reset Count - Resets the number of waveforms triggered (Does not affect the stored waveforms)

9.4.2 Troubleshooting

Condition: The event logs shows where the High Current Trigger Relay triggered but there are no waveforms

Solution: The waveforms will not be recorded if:

- “The Waveform Capture Enable” checkbox is unchecked
- The Waveform buffers are full and waveform protection is enabled

10 Discrete I/O

10.1 Discrete inputs/outputs

Entellisys provides support for up to 128 discrete I/O points that can be configured as either inputs or outputs. Purchase of separate hardware is required. Discrete I/Os are controlled by the FlexLogic™ program (see FlexLogic™ on page 283).

Contact input states can be used as input data for a FlexLogic equation, and the results of FlexLogic execution can operate contact outputs. Therefore Discrete I/O boards are serviced in a synchronous manner, with the reading states of contact inputs and writing states to contact outputs interleaved with the processing of FlexLogic equations. This sequence is executed every half cycle, which corresponds to 8.333 ms and 10.000 ms for 60- and 50-Hz systems respectively. The response times of Discrete I/Os are up to 12 ms and 14 ms for 60- and 50-Hz systems respectively, with the assumption that input debouncing is disabled.

The Discrete I/O window displays the number of boards available and the number of Discrete I/O points available. These are read from the Modbus interface when the Discrete I/O window opens.

The window also displays a grid containing a list of all available I/O points, where you can configure the direction for each point. The I/O points are used in blocks of 8: from 1-48 for Board1 and from 65-128 for Board 2, if available. You can configure the other I/Os points on a one-by-one basis

Software

During CPU start up, the presence of discrete I/O boards is automatically detected. Support of discrete I/Os does not occur through the option string. The only requirement for this feature is that the hardware is correctly installed in the CPUs' PMC slots. If a CPU is to be equipped with a single discrete I/O card, it must be plugged into slot PMC0, otherwise the CPU ignores the board, execution of FlexLogic program is disabled, and the CPU logs an error event.

10.1.0.1 Redundancy

Software is not affected by whether the discrete I/Os are wired in redundant or non-redundant configuration.

10.1.0.2 Test mode

Test mode of discrete I/Os enables overriding the states of discrete inputs and outputs. Once the test mode is turned on, the behavior of each I/O channel is determined separately by test mode related channel settings. Channels can be set to ignore test mode and act normally, as if the test mode was not actually turned on, or they can be preset to a high or low state, which overrides a channel's actual state. Once the test mode is disabled, all channels function normally. Test mode can be exited at any time. As a precaution, test mode is automatically disabled when the CPU is restarted.

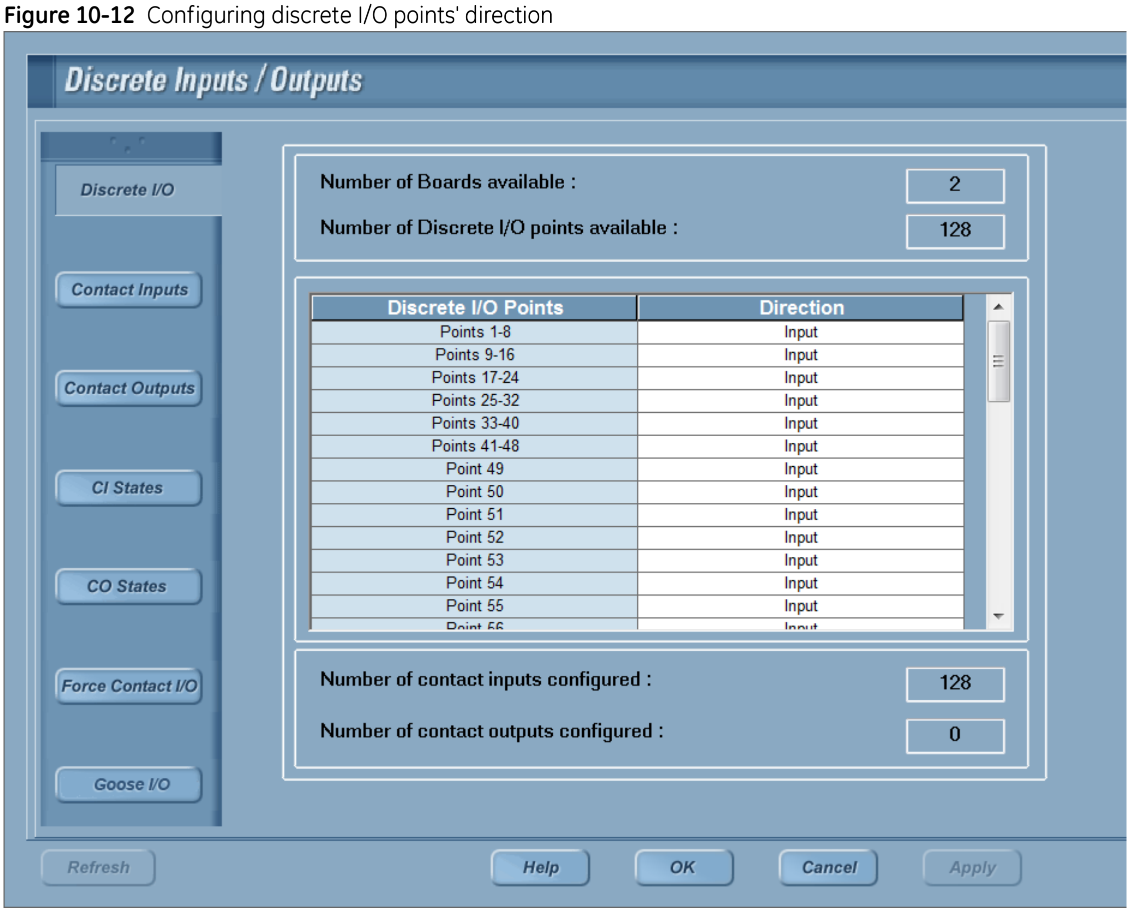
10.1.1 Setup

Preparing CPUs to use discrete I/Os takes place in two independent steps: hardware installation and software configuration. Discrete I/O cards must be installed in a CPU's PMC slots in the correct order, starting with slot PMC0, otherwise discrete I/Os do not function and FlexLogic is disabled. If there is a single card per CPU, it must be installed in slot PMC0. All the cards must be secured to the CPU's main board using screws that are provided by cards' manufacturer. Other hardware installation requirements and software configuration steps are specified in the corresponding sections below.

10.1.1.1 I/O points direction

Before discrete I/Os can be used, their direction must be configured. When discrete I/O cards are installed, all I/O points are by default treated as inputs. Change the necessary I/O directions from Discrete Inputs/Outputs dialog box. To do so, click the **User Settings** button and then click the **Discrete I/O** button to access the Discrete Inputs/Outputs dialog box. A column of buttons appears on the left side of the dialog box. These buttons behave similarly to tabs. Click a button to view the associated content in the right side of the dialog box. By default, information associated with Discrete I/O is displayed.

Figure 10-12 Configuring discrete I/O points' direction



The list displayed in the middle of the dialog box contains two columns. The left column contains ranges of discrete I/O points while the right column contains the corresponding direction. A limitation of discrete I/O card hardware is that the direction of I/O points from 1 through 48 must be configured in groups of eight while the remaining 16 I/O points can be configured separately.

The I/O points served by the card in the PMC0 slot are numbered from 1 through 64. The I/O points associated with the second card are numbered from 65 through 128. As soon as a direction is changed, the current number of inputs and outputs are updated in the boxes below the table.

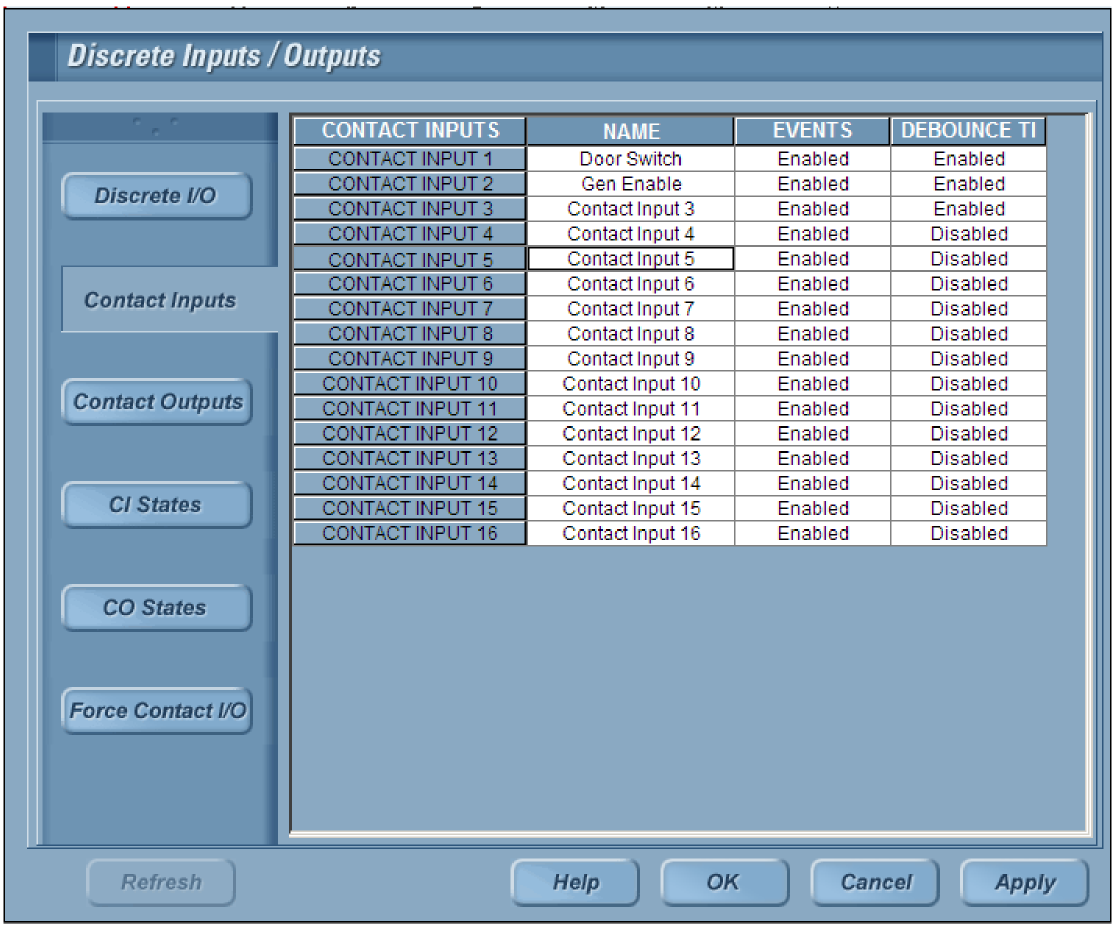
The Discrete Inputs/Outputs dialog box also displays the number of boards and total number of discrete I/O points available in CPUs. These boxes are not configurable. The displayed number of boards available in the dialog box may be different from the number of boards actually plugged in the CPUs if there are problems with the cards themselves, or when a single card is used and the card was plugged into the incorrect slot.

When all I/O points are assigned the intended direction, click **Apply** to transfer the points' direction assignments to the CPUs. New point direction assignments do not take effect until the CPUs are restarted. Before continuing with the remainder of the configuration process, restart. The next step in the configuration is to set discrete inputs and outputs as appropriate.

10.1.1.2 Input configuration

To configure discrete I/O inputs, click the **Contact Inputs** button in the Discrete Inputs/Outputs dialog box. The dialog box presents a list of configured inputs and a set of three adjustable parameters.

Figure 10-13 Inputs configuration



The list contains an entry for each input-configured I/O point. Each contact input can be assigned a user-friendly name that appears in the Contact Inputs column. The Events column specifies whether an event should be logged whenever the input's state transitions. The last

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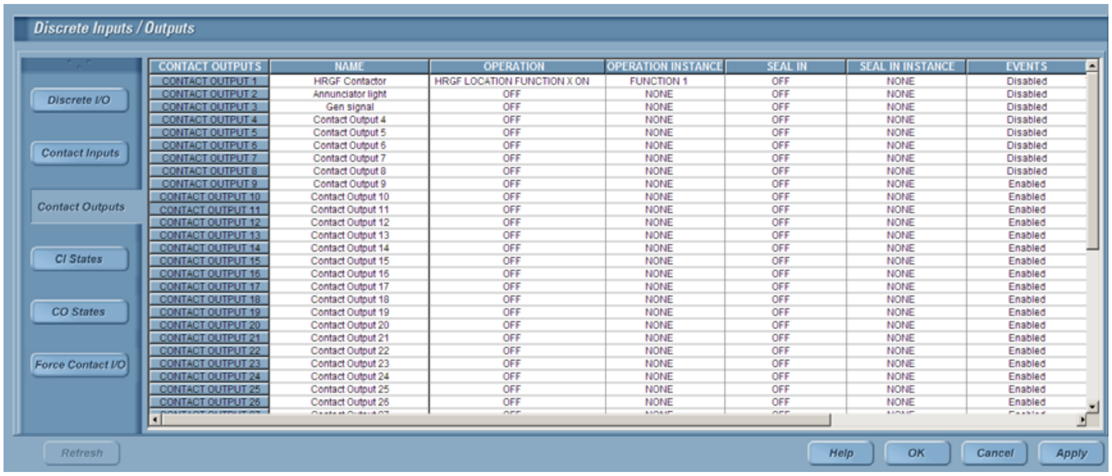
column, if enabled, will the debounce the contact input. After alterations are completed, click **Apply** to commit the changes to the CPUs before moving to the next step of the configuration process.

10.1.1.3 Output configuration

To configure discrete I/O outputs, click **Contact Outputs** in the Discrete Inputs/Outputs dialog box. The dialog box lists the configured outputs and a set of four adjustable parameters.

Figure 10-14 Output configuration



The list contains an entry for each output-configured I/O points. Each contact output can have a user-friendly name. Two next parameters control the behavior of the contact output. The column labeled **Operation** and **Operation Instance** controls when the contact output is energized (asserted high) or de-energized (asserted low). Click a cell to view a combo box with available FlexLogic operands. Whenever the state of the operand evaluates to true, the contact output is energized. Otherwise it is de-energized.

The column labeled **Seal In** and **Seal In Instance** controls when the contact output's state can be de-energized after the operand selected in Operation column is evaluated to false. This parameter can be set to any available FlexLogic operand. As long as the FlexLogic operand in the Seal In column evaluates to true, the contact output remains energized even if the Operation FlexLogic operand evaluates to false. When both FlexLogic operands evaluate to false, contact output is de-energized. For more information about FlexLogic operands, see FlexLogic™ on page 283. The last column controls whether or not an event should be logged when the contact output changes its state. Configuration of discrete I/Os is completed with completion of this step.

10.1.1.4 Operation

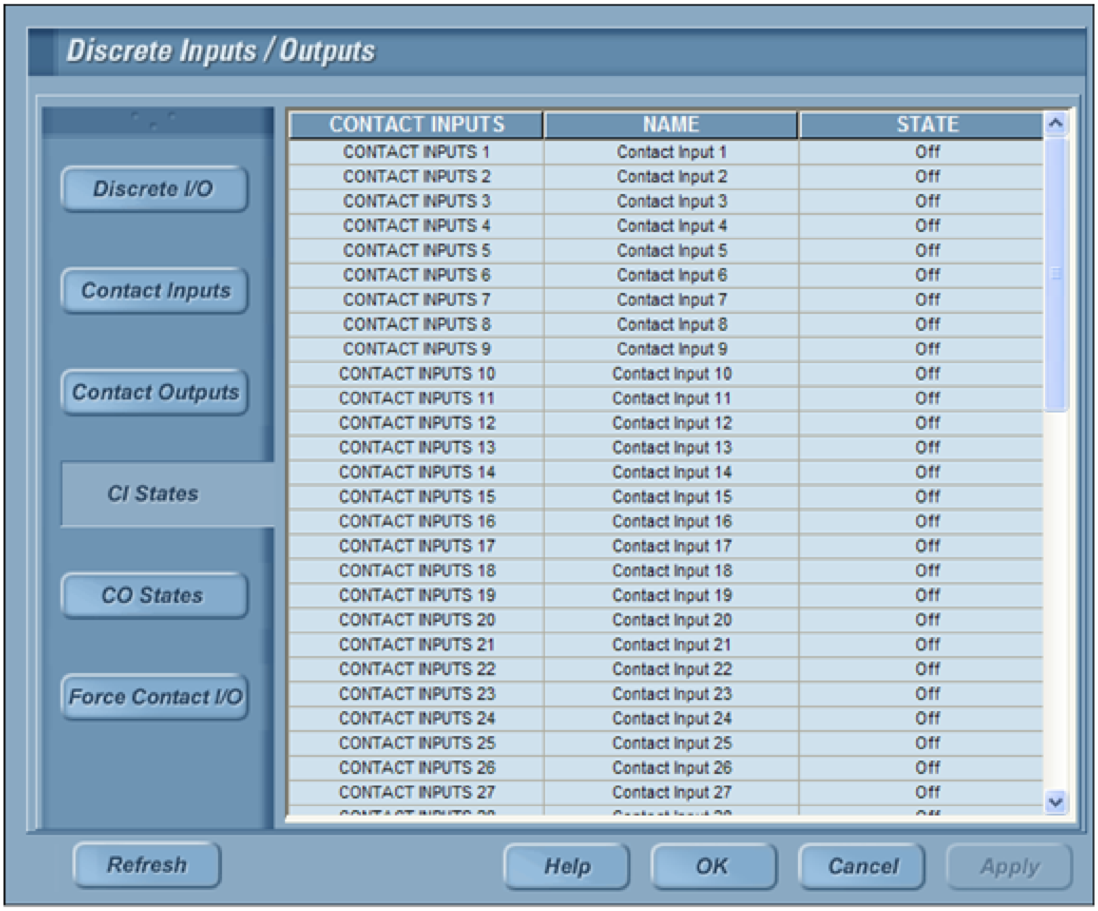
Discrete I/Os are closely tied with FlexLogic. Contact input states can be used as input data for a FlexLogic equation and the results of FlexLogic execution can operate contact outputs. Therefore discrete I/O boards are serviced in a synchronous manner, with the reading states of contact inputs and writing states to contact outputs interleaved with the processing of FlexLogic equations. This sequence is executed every half cycle, which corresponds to 8.333 ms and 10.000 ms for 60- and 50-Hz systems respectively. The response times of discrete I/Os are up to 12 ms and 14 ms for 60- and 50-Hz systems respectively, with the assumption that input debouncing is disabled.

10.1.1.5 Contact input states

While CPUs are running they provide the current states of discrete inputs. To view this information, click **CI States** in the Discrete Inputs/Outputs dialog box. The list contains all configured discrete inputs with its corresponding user-friendly name and current state. The information on the screen is a snapshot of the discrete inputs' states taken at the time the dialog box was opened.

Click the **Refresh** button to refresh the screen

Figure 10-15 Contact input states

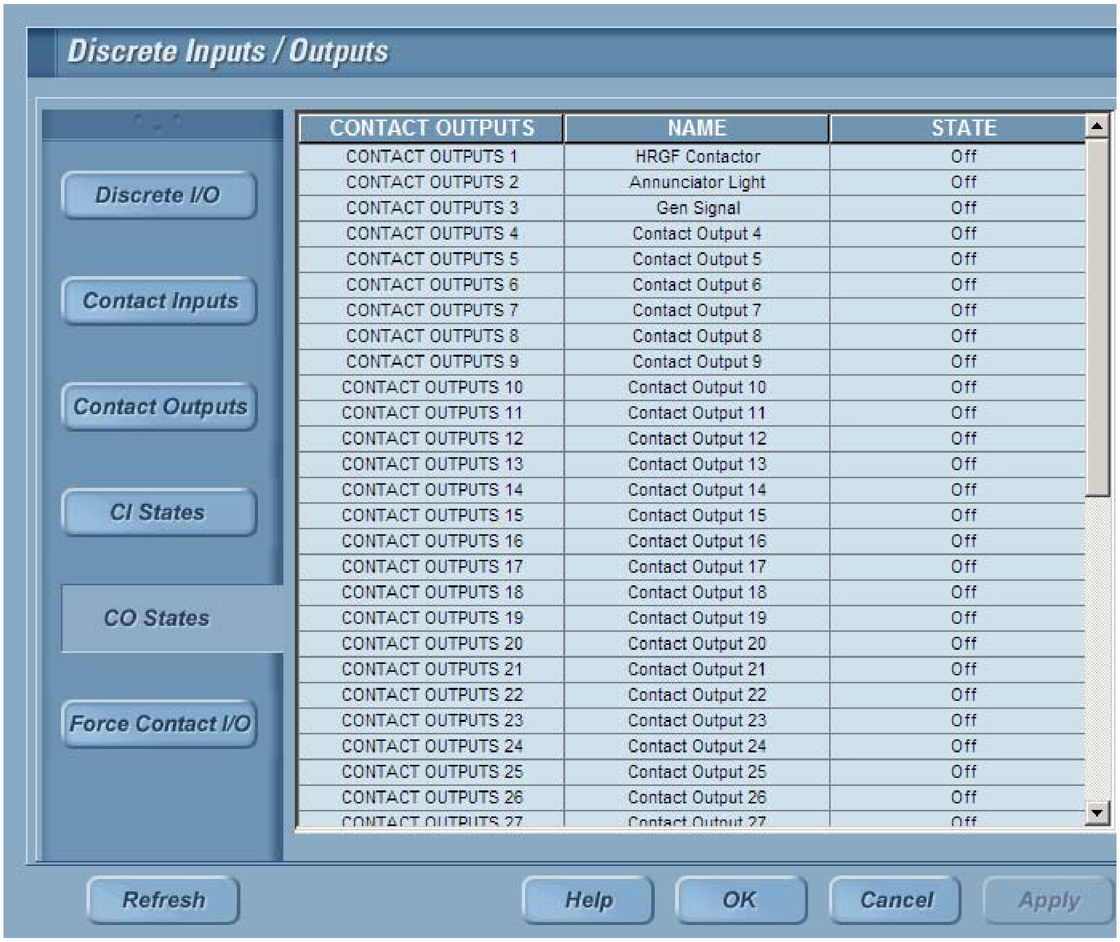


10.1.1.6 Contact output states

While CPUs are running they provide the current states of discrete outputs. To view this information, click **CO States** in the Discrete Inputs/Outputs dialog box. The list contains all configured discrete outputs with its corresponding user-friendly name and current state. The information on the screen is a snapshot of the states taken at the time the dialog box was opened.

Click the **Refresh** button to refresh the screen

Figure 10-16 Contact output states



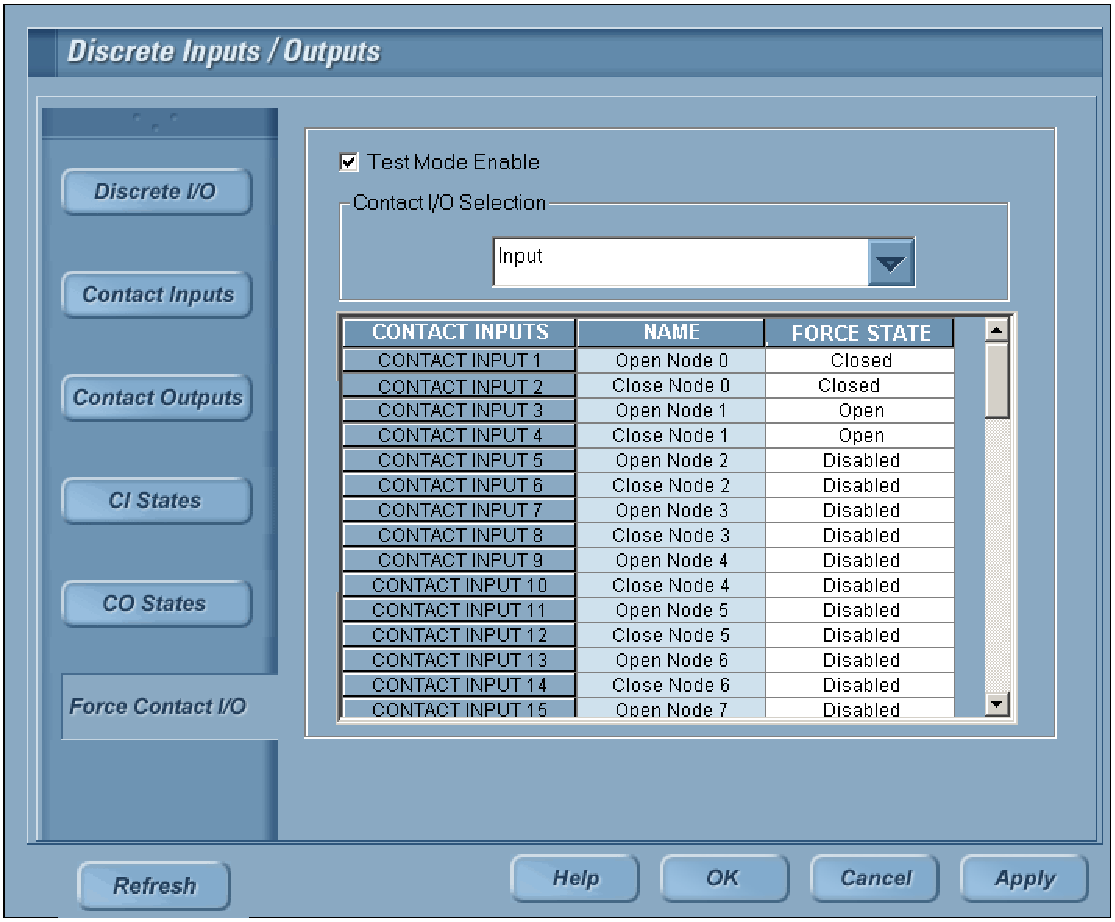
10.1.1.7 Test mode

Discrete I/Os can be placed into test mode which enables the states of the I/Os that are read or assigned during normal system operation to be overridden. To enter test mode, click **Force Contact I/O** in the Discrete Inputs/Outputs dialog box and click to select the **Test Mode Enable** check box. Choose which type of I/O points are displayed by selecting an option in the Contact I/O box. When the test mode is enabled, it is active for both inputs and outputs until it is either turned off or the CPUs are restarted.

10.1.1.8 Input test mode

To operate on inputs, choose **Input** in the Contact I/O Selection drop-down menu. Each input can be placed into one of three states. Disabled causes the input to ignore test mode and to act as if test mode was not active. Open and Closed override the input state and set it to low and high respectively. Click **Apply** to assign new input states. Inputs remain overridden until they are changed again, until test mode is turned off, or the CPUs are restarted.

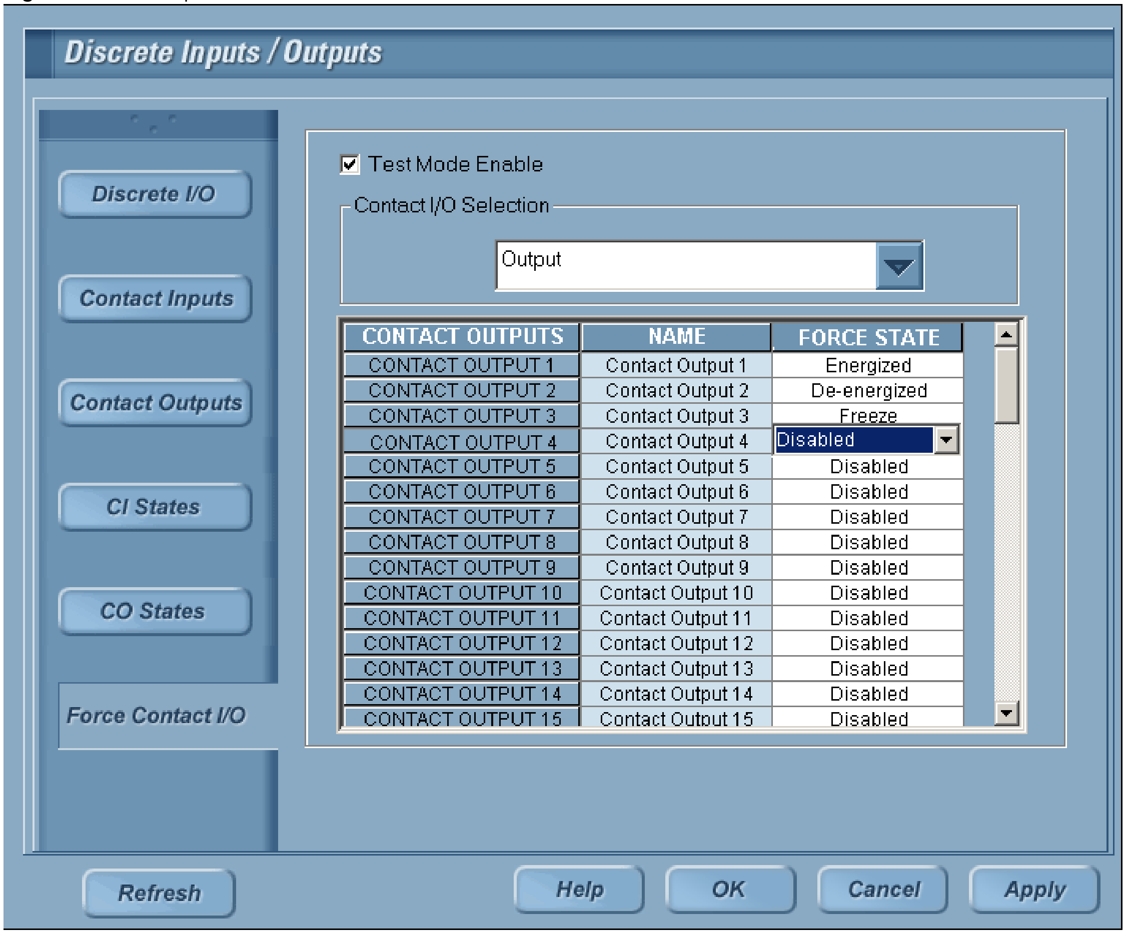
Figure 10-17 Inputs test mode



10.1.1.9 Output test mode

To operate on outputs, select **Output** in the **Contact I/O Selection** drop-down menu. Each output can be placed into one of four states: Disabled causes the output to ignore test mode and to act as if test mode was turned off; Energized and De-energized override the output state and set it to high and low state respectively; Freeze causes the output to remain in its current state, overriding any other state that the output may transition into. Click **Apply** to assign new states. Outputs remain in the assigned states until they are changed, until test mode is turned off, or the CPUs are restarted.

Figure 10-18 Output test mode



10.1.1.10 Events

CPUs can log several events related to the discrete I/Os. Events can be grouped into three categories: configuration, confirmation, and operation events. All events falling within these categories are described in sections that follow.

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10.1.1.11 Configuration events

This category has 9 events.

- **Discrete IO Disabled Invalid Cfg Card 1**. This event is logged when Entellisys had problems configuring the direction of discrete I/O points on the discrete I/O card plugged into PMC0 slot.
- **Discrete IO Disabled Invalid Cfg Card 2**. This event is logged when Entellisys had problems configuring the direction of discrete I/O points on the discrete I/O card plugged into PMC1 slot.
- **Discrete IO Disabled Card In Wrong Slot**. This event is logged when there is only a single discrete I/O board plugged into the CPU and it is plugged into slot PMC1 instead of the required PMC0.
- **Attention IO Card Detection Mismatch Found X of Y**. This event is logged when the actual number of discrete I/O cards installed in the CPU is different than number of discrete I/O cards expected as specified by user through the HMI during discrete I/O configuration process. X and Y stand for a number from 0 through 2 with a restriction that the event cannot have X and Y equal. There are six (6) possible variants of this event.

NOTE: The number of expected discrete I/O boards is set before the system is shipped to the customer. Customer is in no position to adjust it on its own.

10.1.1.12 Confirmation events

This category consists of 2 events.

- **Discrete IO Test Mode Initiated**. This event is logged when the user enables discrete I/O test mode from the HMI.
- **Discrete IO Test Mode Ended**. This event is logged when the user disables discrete I/O test mode from the HMI.

10.1.1.13 Operation events

This category of events includes 1024 events.

- **Contact Input X On**. This event is logged when input X transitions from state off to on. X stands for the discrete input number. There are 128 possible variants of this event. This event can look completely different if the user decides to modify default user-friendly input name. If that happens, default Contact Input X text of the event is replaced with whatever custom name the user assigned to the input during discrete I/O configuration.
- **Contact Input X Off**. This event is logged when input X transitions from state on to off. X stands for a discrete input number. All remarks about the Contact Input X On event are also valid for this event.
- **Contact Output X On**. This event is logged when output X transitions from state de-energized or off to energized or on. X stands for a discrete output number. There are 128 possible variants of this event. This event can look completely different if user decides to modify default user-friendly output name. If that happens, default Contact Output X text of the event is replaced with whatever custom name the user assigned to the output during discrete I/O configuration.
- **Contact Output X Off**. This event is logged when output X transitions from state energized or on to de-energized or off. X stands for a discrete output number. All remarks about the Contact Output X On event are also valid for this event.

10.1.2 Troubleshooting

Discrete input status does not change despite toggling corresponding input relay

- Discrete I/O point was configured as an input but the CPUs were not restarted and new configuration did not take effect. Restart CPUs and verify that discrete input responds to relay toggling.
- Discrete I/Os are in test mode and the input in question has a forced state set to something other than Disabled. Verify if the discrete I/O test mode is turned on by accessing the Discrete Inputs/Outputs dialog box and clicking the **Force Contact I/O** button.
- Toggling time is too short for configured input debounce settings. Verify that debounce time setting is shorter than the time that the input relay stays in one state.
- There is no continuity in the circuit connecting the discrete I/O board with input relays. Verify that there is continuity.
- Discrete I/O board that the discrete I/O input is serviced by is defective. Replace the board with a new one.

Discrete output status does not change while it is expected to do so

- Discrete I/O point was configured as an output but the CPUs were not restarted and the new configuration did not take effect. Restart CPUs and verify that discrete output changes its state according to the expectations.
- Make sure that the Operation parameter of the output's configuration refers to the correct FlexLogic operand and that the operand evaluates to the expected value.
- Discrete I/Os are in test mode and the output in question has its forced state set to something different than Disabled. Verify if the discrete I/O test mode is turned on by accessing the Discrete Inputs/Outputs dialog box and clicking the **Force Contact I/O** button.
- There is no continuity in the circuit connecting the discrete I/O board with output relays. Verify that the continuity exists.
- Discrete I/O board that the discrete I/O output is serviced by is defective. Replace the board with a new one.

Discrete output status does not change to de-energized or off

- FlexLogic operand configured in Operation parameter of the discrete output does not evaluate to false. Verify that Operation parameter associated with the output refers to a correct FlexLogic operand and the operand evaluates to false.
- FlexLogic operand configured in Seal In parameter of the discrete output does not evaluate to false. Verify that Seal In parameter associated with the output refers to the correct FlexLogic operand and that the operand evaluates to false.
- Discrete I/Os are in test mode and the output in question has its forced state set to something different than Disabled. Verify if the discrete I/O test mode is turned on by accessing the Discrete Inputs/Outputs dialog box and clicking the **Force Contact I/O** button.
- Discrete I/O board that the discrete I/O output is serviced by is defective. Replace the board with a new one.

Discrete I/Os behave inconsistently after FlexLogic file was loaded

- Loading the FlexLogic files may rearrange assignments of discrete I/O point direction. Restart CPUs for the new assignments to take effect.

10.1.3 Hardware

Slots PMC0 and PMC1 on the CPU board each accommodate one discrete I/O board. Hardware requirements also include an "OR" board, relays and relay blocks, described in detail in the corresponding sections. Discrete I/Os can be wired in two distinct configurations. One configuration allows for redundancy of discrete I/Os and the other that is non-redundant. The latter configuration can be used when uptime and reliability is not as important. These configurations are described in corresponding sections below.

10.1.3.1 Wiring

This section describes rules to properly wire the system. Wiring rules are divided into four sections corresponding to the four major hardware components of the system.

CAUTION: Wiring rules need to be followed very strictly. Any deviation from them might damage the equipment.

Input relay blocks

- GND
  - Connects directly to common on power terminal strip
  - No daisy-chaining GND to other relay blocks or "OR" boards
  - Inputs from the PMC464 must have a common connection from the PMC464 (pin 17) running inside cable bundle
    - This common connection from the PMC464 must connect to the relay board's GND
- +5V
  - One connection directly to +5V power terminal strip
  - All additional 5V connections on a single relay input block are daisy-chained within its own individual input relay block

Output relay blocks

- GND
  - Redundant output
    - GND connected to GND point on the "OR" board
    - All additional GND connections on a single relay output block are daisy-chained within its own individual output relay block
    - No daisy-chaining GND to other relay blocks or "OR" boards
  - Non-redundant output
    - GND connected to common on power terminal strip
    - No daisy-chaining GND to other relay blocks
    - Outputs from the PMC464 must have a common connection from the PMC464 (pin 17) running inside cable bundle
      - Common connection from PMC464 card should connect to its corresponding output relay block
      - Connect PMC464 common to output relay block GND
- +5V
  - N/A

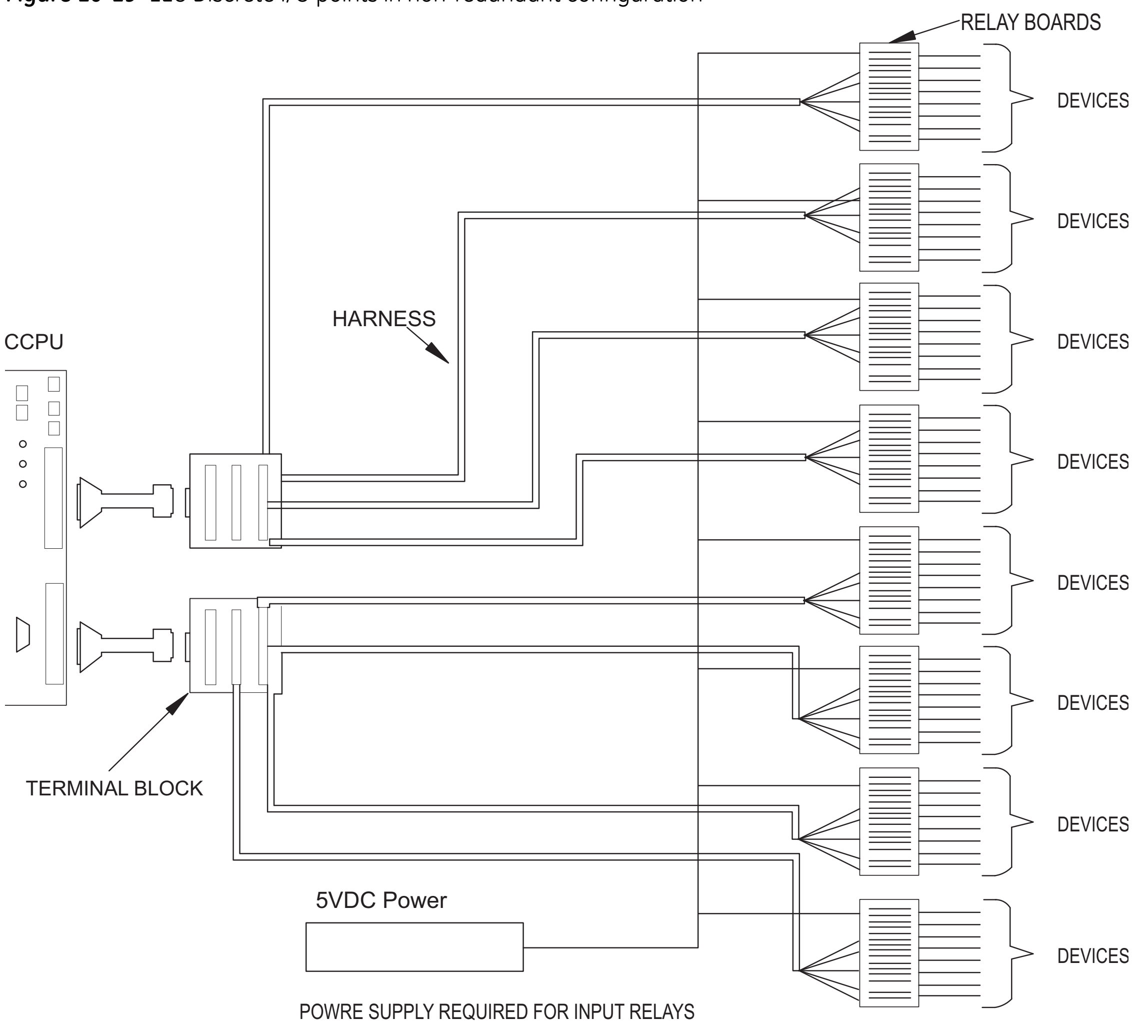
"OR" board

- +5V
  - Connect directly to +5V on power terminal strip
- GND
  - Connect directly to common on power terminal strip
  - No daisy-chaining GND to other "OR" boards or relay blocks
  - Output from PMC464 must have a common connection (pin 17) running inside the cable bundle
  - Common connection from PMC464 connects to its corresponding "OR" Board
- Twist 5V and GND cables together before connecting to power terminal strip

Power supply

- +5V
  - Connect directly to +5V on power terminal strip
- GND
  - Connect directly to GND on power terminal strip

Figure 10-19 128 Discrete I/O points in non-redundant configuration



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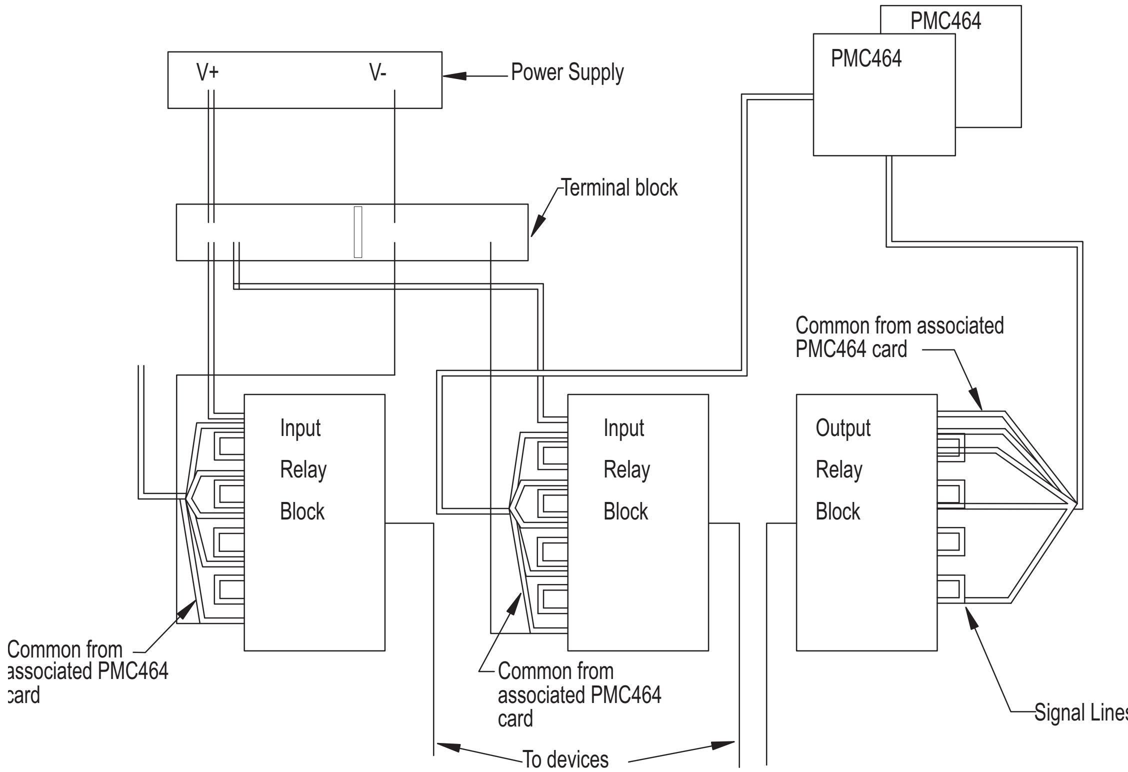
10.1.3.2 Non-redundant discrete I/O

Discrete I/Os can be wired in two configurations: non-redundant and redundant. Non-redundant configurations allow one CPU to manage up to 128 discrete I/O points. In this configuration, a second CPU can have no installed discrete boards.

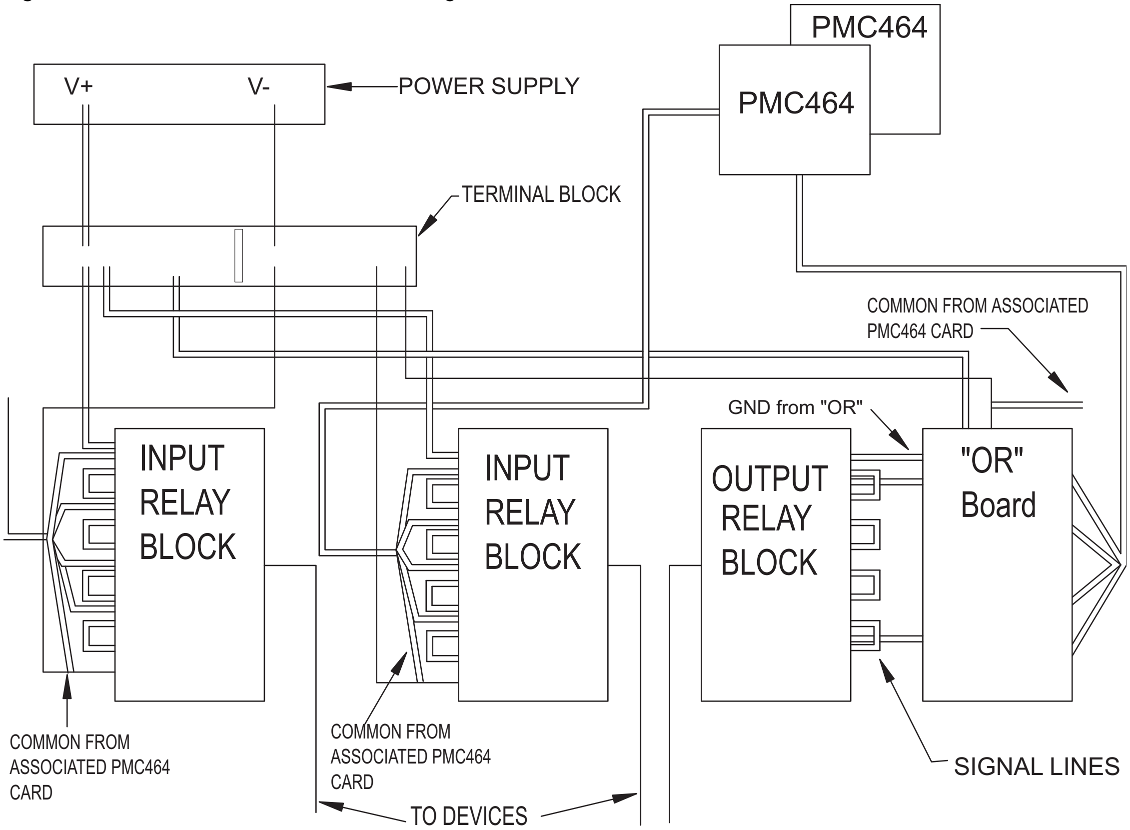
Figure 10-1 Discrete I/O in non-redundant configuration



10.1.3.3 Redundant discrete I/O

Redundant discrete I/O configurations require both CPUs to have same number of discrete I/O boards. Discrete I/O boards connect to terminal boards using a 68-pin SCSI cable. Connections from output terminals are wired to the “OR” board and then to the output relays. Input terminal connections are wired directly from relay blocks. Presence of the “OR” board and same number of discrete I/O boards in both CPUs are indicators of redundant configuration.

Figure 10-2 Discrete I/O in redundant configuration



10.1.3.4 Discrete I/O boards

Discrete I/O boards supported by and certified for the Entellisys systems are PMC464 from Acromag Inc. This board supports 64 discrete I/O points with TTL logic (+5 V).

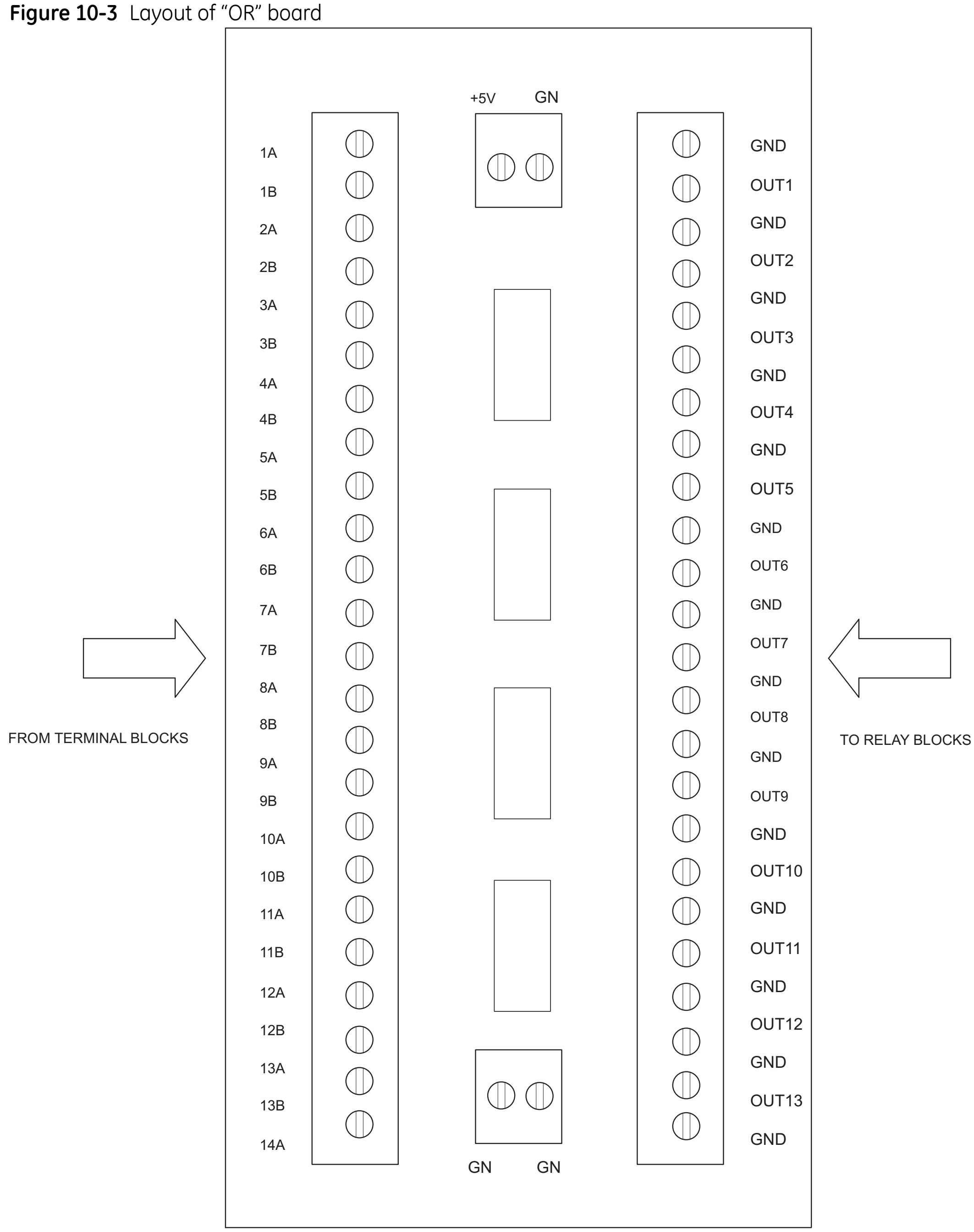
CAUTION: Applying higher voltage may damage the board.

For support of 128 points, two such boards are required. Points on the board can be configured as inputs or outputs. By default on power up all points are configured as inputs, however during the booting process CPUs reconfigure boards according to the configuration specified by the HMI. Discrete I/O points from 1 through 48 can be configured as inputs or outputs in clusters of eight. The first eight I/O points can be configured as either inputs or outputs. The next eight I/O points can be configured as inputs or outputs, etc. Set the direction of discrete I/O points from 49 through 64 on a one-by-one basis; the eight-point cluster rule does not apply to them. Each input can be set independently to one of five debounce settings: one value disables debouncing or sets it to 0, and the other four set the debouncing to 1.4us, 10.4us, 408.8us, and 3.276ms. All configurable parameters of the boards mentioned here are set through the HMI. For more detailed information on the board's specifications please refer to the board’s user manual.

10.1.3.5 “OR” board

The “OR” board is used only in redundant configurations of discrete I/Os. In redundant configurations, outputs on two or four discrete I/O boards (installed in two CPUs) control the states of output relays. The “OR” board is used to electrically isolate outputs on boards. Only outputs are connected to the “OR” board. The board logically “ORs” the signals from the outputs of two CPUs, and the resulting signal controls output relays. There is no need to “OR” signals from input relays. Each board can handle up to 16 outputs from each CPU. Screw terminals with letter A designate discrete outputs from CPU A, and those with letter B designate discrete outputs from CPU B. Connections from the outputs on terminal blocks are made in pairs. The “OR” board takes the “OR” of each pair and outputs a single result for each pair. Depending on the number of discrete outputs in the systems, more “OR” boards can be used.

Figure 10-3 Layout of “OR” board



10.1.3.6 Relays

Entellisys uses two types of relays: input and output. Both are optically isolated, solid state relays. Recommended relays are 70G-IDC5 and 70G-IAC5 for inputs and 70G-ODC5R for outputs. 70G-IDC5 is DC driven relay and it can accept from 3 to 32 Vdc of input voltage. The other input relay, 70G-IAC5 is an AC driven relay and it can accept from 90 to 140 Vac of input voltage. All of the relays are manufactured by Grayhill. Input relays support negative logic, such as when a relay is closed or on, the LED indicator is "ON", but the signal that it feeds discrete input is low, and vice versa. To make sure that LED "ON" corresponds to the "ON" state in the CPUs' logic, they reverse or negate the input states. Output relays can accept 100 Vdc or 120 Vac with logic voltage ranging from 4.8 to 6 Volts.

NOTE: If an input relay is "ON" and voltage measurement is taken on the control side of the relay, low voltage is indicated on the measuring device. The voltage is high when the relay is "OFF".

For more detailed information about the relays or if any other type of relays is used, please see the manufacturer's specifications.

10.1.3.7 Relay blocks

Relays are screwed to a relay block. Each relay block can accept up to 16 relays. Different relay types (inputs vs. outputs) cannot be mixed on the same relay block. These restrictions, along with number of inputs and outputs in the system, determine how many relay blocks are necessary. The recommended relay block for use with inputs and outputs is 70GRCK16I-DIN from Grayhill. This is a DIN rail-mounted version that allows for greater installation flexibility. For more details about the relay block, please refer to manufacturer's specification.

10.1.3.8 Terminal block

Entellisys requires up to four 68-pin terminal blocks, one for every discrete I/O board in the system. Terminal blocks provide a 68-pin SCSI connector so it can easily be connected to discrete boards with a straight 68-pin SCSI cable. The recommended terminal block is CIO-MINI68 from Measurement Computing. For more detailed information about the terminal block, please refer to manufacturer's specification. Figure 10-4 represents pin assignment on the terminal block.

Figure 10-4 Terminal block pin assignment

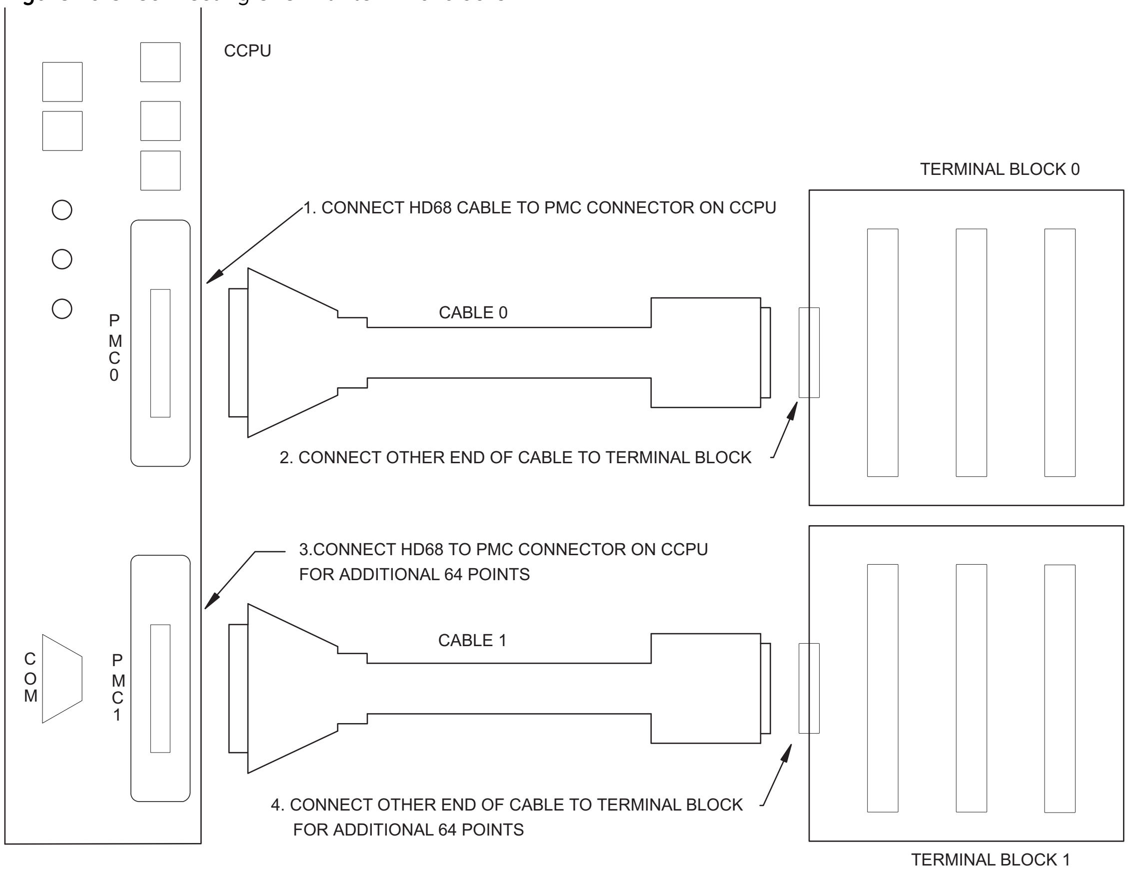
Pin Description	Pin	Pin Description	Pin
Digital Channel 0	1	COMMON	35
Digital Channel 1	2	COMMON	36
Digital Channel 2	3	Digital Channel 24	37
Digital Channel 3	4	Digital Channel 25	38
Digital Channel 4	5	Digital Channel 26	39
Digital Channel 5	6	Digital Channel 27	40
Digital Channel 6	7	Digital Channel 28	41
Digital Channel 7	8	Digital Channel 29	42
Digital Channel 8	9	Digital Channel 30	43
Digital Channel 9	10	Digital Channel 31	44
Digital Channel 10	11	Digital Channel 32	45
Digital Channel 11	12	Digital Channel 33	46
Digital Channel 12	13	Digital Channel 34	47
Digital Channel 13	14	Digital Channel 35	48
Digital Channel 14	15	Digital Channel 36	49
Digital Channel 15	16	Digital Channel 37	50
COMMON	17	Digital Channel 38	51
COMMON	18	Digital Channel 39	52
Digital Channel 16	19	Digital Channel 40	53
Digital Channel 17	20	Digital Channel 41	54
Digital Channel 18	21	Digital Channel 42	55
Digital Channel 19	22	Digital Channel 43	56
Digital Channel 20	23	Digital Channel 44	57
Digital Channel 21	24	Digital Channel 45	58
Digital Channel 22	25	Digital Channel 46	59
Digital Channel 23	26	Digital Channel 47	60
Digital Channel 48	27	Digital Channel 56	61
Digital Channel 49	28	Digital Channel 57	62
Digital Channel 50	29	Digital Channel 58	63
Digital Channel 51	30	Digital Channel 59	64
Digital Channel 52	31	Digital Channel 60	65
Digital Channel 53	32	Digital Channel 61	66
Digital Channel 54	33	Digital Channel 62	67
Digital Channel 55	34	Digital Channel 63	68

10.1.3.9 Cable

Discrete I/O boards connect with terminal blocks by a 68-pin SCSI cable. The cable is shielded and provides one-to-one connection. Discrete I/O boards include four common connections in addition to the 64 I/O points provided. Entellisys system requires as many cables as there are boards installed in two CPUs. The recommended cable is CBCC166035 from Black Box. No off-the-shelf cable could fulfill length and shielding requirements, and GE has an arrangement with Black Box to make a special 11 ft. shielded cable.

Figure 10-5 illustrates the correct way to connect discrete I/O boards with terminal blocks.

Figure 10-5 Connecting CPU with terminal blocks



10.1.3.10 Power supply

Input and output relays in the discrete I/O subsystems require +5V control power. This power is supplied by +5Vdc general-purpose power supply. The recommended power supply is SWS50-5 manufactured by Lambda Americas.

10.2 IEC 61850 - GOOSE I/O

GOOSE is a subset of the IEC 61850 standard and is used to transmit and receive discrete and analog information between devices. In Entellisys, GOOSE is implemented to communicate discrete bits of information only – status or commands – to other IEC 61850 GOOSE compliant devices.

Networking considerations

GOOSE messages are broadcast from an IEC 61850 compliant publisher as multicast ethernet packets. Multicast packets do not have a destination IP address and therefore are transmitted throughout the network. Typically routers and firewalls will prevent the propagation of multicast packets in either direction. Care must be given to the implementation of control networks to ensure transmission of GOOSE multicast packets reach the intended devices and do not add unnecessary traffic to wide area networks.

Virtual LAN Technology

Virtual LAN technology permits the existence of a multicast-based control protocol and a Building Control Network on existing network infrastructure without compromising security or degrading the overall network performance. Networks are logically or virtually separated by configuration on each network switch involved. Usually VLAN tags are added to ethernet packets as they travel from switch to switch depending on the port assignment. In the case of GOOSE, publishers will add the VLAN tag as it prepares the Ethernet packet.

GOOSE Publishers must be assigned a specific VLAN number which is added to the Multicast ethernet message. By default, almost all switches are configured to allow the propagation of VLAN ID 1 traffic to all ports. If a VLAN ID other than 1 is used, all ethernet switches between the publisher and intended recipients must then be configured to propagate that VLAN number.

10.2.1 Goose Inputs

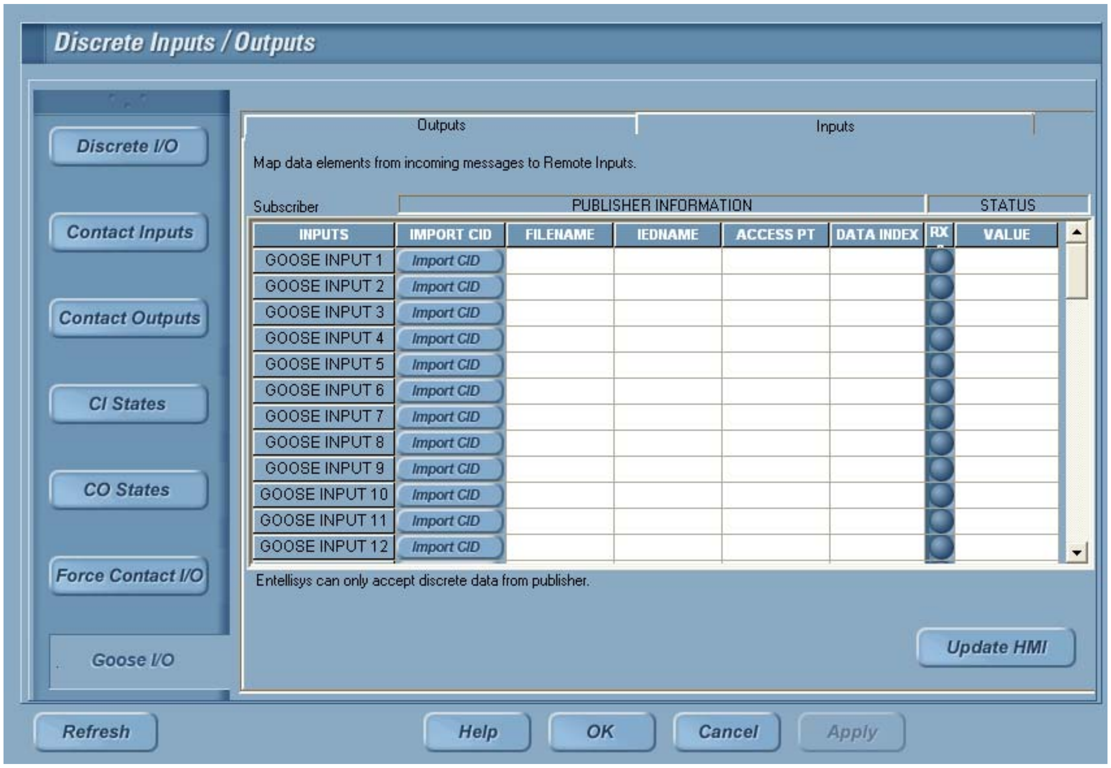
Configure Entellisys as a subscriber to 3rd party GOOSE publishers. When correctly configured, the CPU will listen to incoming GOOSE messages and update GOOSE inputs 1- 64. These inputs will then be available in Flexlogic and can be integrated into an overall control scheme.

Moreover, each GOOSE input can be setup to listen to a unique publisher.

Applying changes: When applying settings, both CPUs will be required to reboot. A dialog box will prompt the user to continue through the Reboot process.

NOTE: Analog information points such as current and voltage are not supported through IEC 61850 but is available through Modbus TCP.

Figure 10-6 GOOSE Inputs



Controls

Update HMI button: Before configuring GOOSE, you must download the current configuration from the CPU.

GOOSE Input parameters:

Import CID button: Import or select a IEC 61850 compliant CID file. This CID file must be generated by the publisher device. It must contain the exact data definition of the GOOSE message broadcasted by the publisher to be configured.

IED name, Access PT and **Data Index** are the fields in the publisher's CID file and are used to assign the data element in the GOOSE message to an Entellisys GOOSE Input.

The IED Name: The IED name or GO ID specified by the publisher's CID file.

Access PT: Publisher's CID file may contain a number of "Configurations" - only one of which can be pushed out onto the network. This information should be contained within the CID file itself.

Data Index: In the GOOSE message (as defined by the CID file) there is a specified number of data items. These items could be any type. The Data Index is the index of the data item of interest in the CID file.

Status: Once the reboot has finished, the active CPU will be listening for input messages. The health status and Value will indicate both if the CPU is receiving data from the configured publisher, what the value is and the error type if it is failing.

RX indicator: Green when the Goose inputs are correctly configured. Red if there is a failure.

Value: When RX Is green, this will indicate the value (0 or 1) of the goose input. If RX is red, it will contain the relevant error message.

Table 10-2 GOOSE Input troubleshooting

Message	Explanation	Solution
Input Time to Live Expired	The GOOSE message is periodically refreshed by the publisher. This message indicates that the subscriber function in Entellisys is no longer receiving GOOSE messaging from the subscriber.	Check network connectivity and GOOSE configuration on the subscriber device.
Input Out of Sequence Detected	GOOSE message retransmission from publisher is out of sequence.	Check network connectivity and GOOSE configuration on the publisher device.
Input Configuration Revision Mismatch	Configuration Revision mismatch between publisher GOOSE message and its cid/icd file.	Check publisher cid/icd file "confRev" tag and GOOSE configuration on the publisher device.
Input Need Commissioning	Commission in GOOSE message is not set.	Check GOOSE configuration on the publisher device.
Input Test Mode	Test Mode in GOOSE message is enabled.	Check GOOSE configuration on the publisher device.
Input Goose Control Block Reference Mismatch	Control Block Reference mismatch between publisher GOOSE message and its cid/icd file.	Check publisher cid/icd file "GoCBRef" tag and GOOSE configuration on the publisher device.
Input App ID Mismatch	App ID mismatch between publisher GOOSE message and its cid/icd file.	Check publisher cid/icd file "GoID" or "AppID" tag and GOOSE configuration on the publisher device.
GOOSE Control Block Initialization Failure	Data Set mismatch between publisher GOOSE message and its cid/icd file.	Check publisher cid/icd file "DatSet" tag and GOOSE configuration on the publisher device.
Input Incorrect Data Type	Entellisys subscriber only recognize discrete inputs with Boolean type.	Configure GGIO Boolean output at publisher.
Input Data Item Not Configured Data Index Mapping Error Input Data Set Mismatch	Publisher data item either not configured correctly or missing.	Check HMI GOOSE I/O screen "DATA INDEX" field and verify the data index is available at publisher and its cid/icd file.
OSI File Configuration Failure	OSI file not resided at Entellisys CPU.	Close Entellisys HMI and reapply GOOSE Input setting from HMI.
File Read Failure	Entellisys HMI fails to configure Entellisys subscriber configuration files.	Check HMI GOOSE Input setting and reapply GOOSE Input setting.

Table 10-2 GOOSE Input troubleshooting

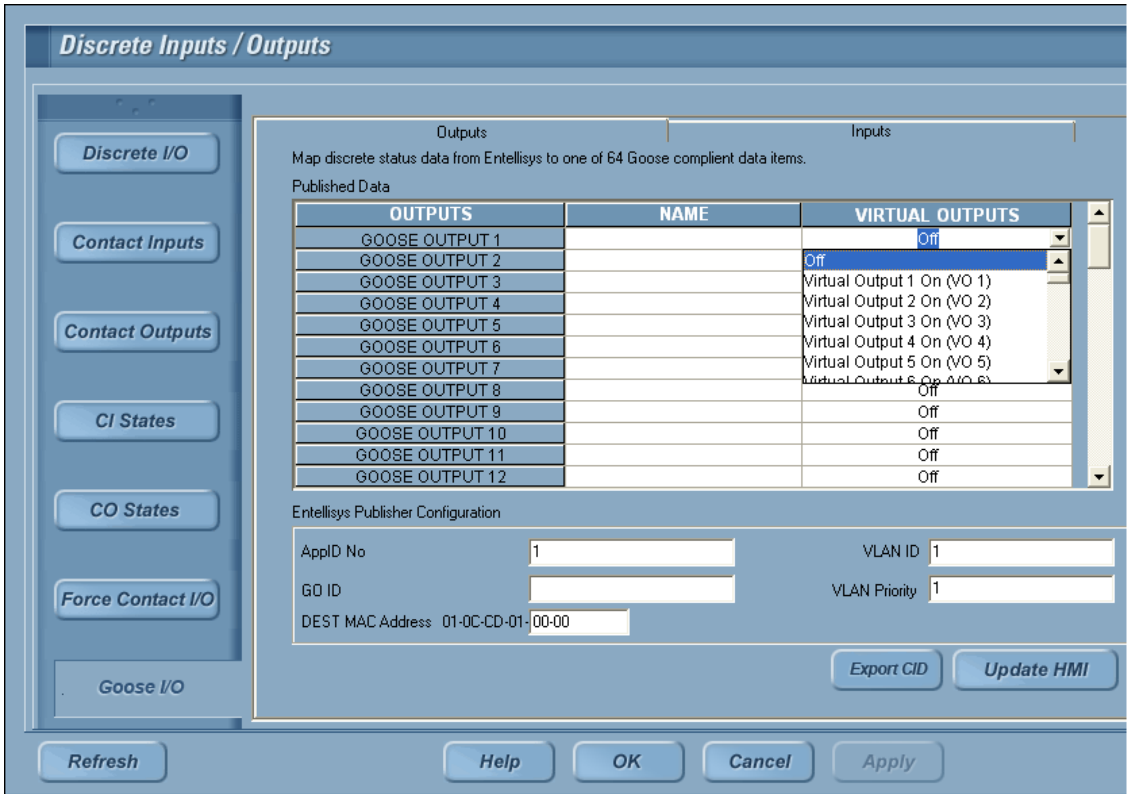
Message	Explanation	Solution
File Parse Failure	Invalid "File name"/"IED name"/"AccessPoint name" or Publisher cid/icd file format not supported by Entellisys.	1.Check HMI GOOSE I/O screen "FILENAME", "IEDNAME", "ACCESS PT" fields and reapply GOOSE Input setting. 2.Verify publisher "APPID" is in range: 0 to 0xFFFF. 3.Verify publisher "orCat" <Val> is 1. May need to modify publisher cid/icd file directly. 4.Verify "DataSet" is available and valid at publisher and its cid/icd file. Entellisys only supports GGIO data item (set) and Boolean data type.
Data Type/Item Creation Failure	Data type/Item not supported by Entellisys. Entellisys only supports GGIO data item and Boolean data type.	Check GOOSE configuration on the publisher device.
MAC Address Initialization Failure Destination MAC Address Mismatch	Invalid or incorrect publisher destination MAC address.	Check GOOSE configuration on the publisher device and use Entellisys HMI to load new publisher cid/icd files to Entellisys subscriber components.
VLAN Priority Parse Failure VLAN ID Parse Failure	Publisher cid/icd file contains invalid VLAN priority / VLAN ID.	Check GOOSE configuration on the publisher device.
All other error code	Entellisys internal error.	Record error code and contact GE support.

10.2.2 Goose Outputs

Configure Entellisys to publisher Virtual Outputs for 3rd party GOOSE compliant subscribers.

Applying changes: To apply settings, both CPUs will be required to reboot. A dialog box will prompt the user to continue through the Reboot process.

Figure 10-7 GOOSE Outputs



Controls:

Goose Outputs 1- 64: Enter a descriptive name and assign the Goose output to an Entellisys Virtual Output (VO).

Update HMI button: Before configuring GOOSE, you must download the current configuration from the CPU.

Export CID: Will export a CID file based on the GOOSE outputs defined in the table. If new outputs are added, then previously configured subscribers may need to be updated with the new CID file.

Entellisys Publisher Configuration

The publisher fields define the exported Entellisys CID file. To setup 3rd party 61850 GOOSE compliant devices as publishers to Entellisys, the exported Entellisys CID file must be imported into the device configuration software.

AppID No: Refers to the “APPID” field in the subnetwork section of the CID.

GOID: Describes the appID field defined in the S1 Access Point Name

```
</Substation>
<Communication>
        <SubNetwork name="N-Tron" type="8-MMS">
                <Text>Station bus</Text>
                <BitRate unit="b/s">100</BitRate>

                <ConnectedAP iedName="GE_ELVS" apName="S1">
                        <GSE ldInst="CPU" cbName="RemoteIO">
                                <Address>
                                        <P type="MAC-Address">[DST MAC Address]</P>
                                        <P type="VLAN-ID">[VLANID]</P>
                                        <P type="VLAN-PRIORITY">[VLAN Priority]</P>
                                        <P type="APPID">[APPID_NO]</P>
                                </Address>
                        </GSE>
                </ConnectedAP>
        </SubNetwork>
</Communication>
```

DEST MAC Address: In the 61850 standard, the Destination mac address is used to both define the type ethernet packet, (GOOSE multicast) and the device which sent the original packet. The first 4 octets (01-0C-CD-01) define the type of ethernet packet and the last 2 are reserved for the identification of the Publisher. Valid values are 00-00 to 01-FF.

VLAN ID: (Default 1). Used by VLAN enabled switches and routers to limit the ethernet ports to which Goose traffic may propagate. Valid range is 0-FFF in Hex.

Valid VLAN Priority: 0-7

Additional Publisher Information

Additionally, the subscriber may need the following:

- **IEDName =** “GE_ELVS”
- **Access PT Name** = “S1”
- **GSEControl name** = “RemoteIO”

11 FlexLogic™

The Control window lets you specify settings for:

- FlexLogic Equation Editor
- FlexLogic timers
- FlexLogic virtual inputs
- FlexLogic virtual outputs
- FlexLogic circuit breaker commands
- FlexLogic control alarms
- Synch Check relay

11.1 Introduction to FlexLogic

To provide maximum flexibility to the user, the arrangement of internal digital logic combines fixed and user-programmed parameters. Logic upon which individual features are designed is fixed, and all other logic, from discrete input signals through elements or combinations of elements to discrete outputs, is variable. The user has complete control of all variable logic through FlexLogic™. In general, the system receives discrete inputs, which it uses to produce discrete outputs.

The states of all discrete signals used in Entellisys are represented by flags (or FlexLogic operands, which are described later in this section). A digital “1” is represented by a “set” flag. Any external-contact change-of-state can be used as an input to a control feature in a FlexLogic equation or to operate a contact output. The state of the contact input can be viewed remotely via the HMI. If more complex logic than presented above is required, it is implemented via FlexLogic.

Traditionally, protective relay logic has been relatively limited. Any unusual applications involving interlocks, blocking, or supervisory functions had to be hard-wired using contact inputs and outputs. FlexLogic minimizes the requirement for auxiliary components and wiring while making more complex schemes possible. The logic that determines the interaction of inputs, elements, schemes and outputs is field programmable through the use of logic equations that are sequentially processed.

FlexLogic allows users to customize Entellisys through a series of equations that consist of operators and operands. The operands are the states of inputs, elements, schemes and outputs. The operators are logic gates, timers, and latches (with set and reset inputs). A system of sequential operations allows any combination of specified operands to be assigned as inputs to specified operators to create an output. The final output of an equation is a numbered register called a virtual output. Virtual outputs can be used as an input operand in any equation, including the equation that generates the output, or as a seal-in or other type of feedback.

A FlexLogic equation consists of parameters that are either operands or operators. Operands have a logic state of 1 or 0. Operators provide a defined function, such as an AND gate or a Timer. Each equation defines the combinations of parameters to be used to set a Virtual Output flag. Evaluation of an equation results in either a 1 (=ON, i.e., flag set) or 0 (=OFF, i.e., flag not set). Each equation is evaluated twice every power system cycle.

The characteristics of the different types of operands are listed in Table 11-1.

Table 11-1 FlexLogic operand types

Operand type	State	Example format	Characteristics [Input is '1' (= ON) if...]
Contact Input	On	Contact Input On	Voltage is presently applied to the input (external contact closed).
	Off	Contact Input Off	Voltage is presently not applied to the input (external contact open).
Element (Analog)	Pickup	LONG TIME 1 PKP	The tested parameter is presently above the pickup setting of an element, which responds to rising values, or below the pickup setting of an element, which responds to falling values.
	Dropout	LONG TIME 1 DPO	This operand is the logical inverse of the above PKP operand.
	Operate	LONG TIME 1 OP	The tested parameter has been above/below the pickup setting of the element for the programmed delay time, or has been at logic 1 and is now at logic 0 but the reset timer has not finished timing.
Fixed	On	On	Logic 1
	Off	Off	Logic 0
Virtual Input	On	Virtual Input 1 On	The virtual input is presently in the ON state.
Virtual Output	On	Virtual Output 1 On	The virtual output is presently in the set state (i.e., evaluation of the equation which produces this virtual output results in a "1").
PLC Input	On	PLC Input 1	The PLC input is presently in the ON state.

Table 11-2 describes all available operands available for all Entellisys relays and are listed alphabetically by operand type.

NOTE: While all relay elements and operands are available in FlexLogic, relays that are optionable will not function unless properly optioned and configured.

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
ELEMENT: Breaker Control	BREAKER 1 OPENED BREAKER 1 CLOSED BREAKER 1 LOCKED OUT BREAKER 1 CLOSED SPRING CHRGD BREAKER 1 PRIMARY CONNECTED BREAKER 1 PRIMARY DISCONNECTED BREAKER 1 SECONDARY CONNECTED	Breaker 1 open Breaker 1 closed Breaker 1 locked out Breaker 1 closing spring charged Breaker 1 primary connected Breaker 1 primary disconnected Breaker 1 secondary connected
	BREAKER 1 AVAILABLE	TRUE when both the primary and secondary disconnects are connected.
	BREAKER 1 READY	TRUE when the breaker is closed and both primary and secondary are connected.
	BREAKER 1 OPEN FAILED	TRUE when open operation failed for the breaker. The result is set until breaker opened. Applies to all open and trip commands: shunt trip open, shunt trip, flux shifter open, flux shifter trip.
	BREAKER 1 CLOSE FAILED	TRUE when close operation failed for the breaker. The result is set until breaker closed.
	BREAKER 1 FAULT	TRUE when LT, ST, GF, multi-point relays or single-point relays operated on a fault. The result is set until the fault is cleared. Breaker x Fault is returned to false when the breaker is opened or open time-out (550ms).
	BREAKER 2...30	Same set of operands as shown for BREAKER 1

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
ELEMENT: Bus Differential	BD ZONE 1 TRIP DPO	Bus Differential Zone 1 trip function not in pickup
	BD ZONE 1 ALARM DPO	Bus Differential Zone 1 alarm function not in pickup
	BD ZONE 1 TRIP PKP	Bus Differential Zone 1 trip function in pickup
	BD ZONE 1 ALARM PKP	Bus Differential Zone 1 alarm function in pickup
	BD ZONE 1 TRIP OP	Bus Differential Zone 1 trip function has tripped breakers
	BD ZONE 1 ALARM OP	Bus Differential Zone 1 alarm activated
	BD ZONE 1 TRIP BACKUP OP	Bus Differential Zone 1 trip backup function has tripped backup breakers
	BD ZONE 2...4	Same set of operands as shown for BD ZONE 1
ELEMENT: Ground Fault	GROUND FAULT 1 TRIP PKP	Ground Fault 1 trip in pickup
	GROUND FAULT 1 ALARM PKP	Ground Fault 1 alarm in pickup
	GROUND FAULT 1 TRIP OP	Ground Fault 1 tripped breaker
	GROUND FAULT 1 ALARM OP	Ground Fault 1 activated an alarm
	GROUND FAULT 1 TRIP DPO	Ground Fault 1 trip not in pickup
	GROUND FAULT 1 ALARM DPO	Ground Fault 1 alarm not in pickup
	GROUND FAULT 2...30	Same set of operands as shown for GROUND FAULT 1
ELEMENT: High Current Relay	HIGH CURRENT 1 PKP	High Current 1 in pickup
	HIGH CURRENT 1 OP	High Current 1 activated alarm
	HIGH CURRENT 1 DPO	High Current 1 not in pickup
	HIGH CURRENT 2...30	Same set of operands as shown for HIGH CURRENT 1
ELEMENT: High Current Trigger	HIGH CURRENT 1 TRIGGER PKP	High Current 1 Trigger in pickup
	HIGH CURRENT 1 TRIGGER OP	High Current 1 Trigger activated alarm
	HIGH CURRENT 1 TRIGGER DPO	High Current 1 Trigger not in pickup
	HIGH CURRENT Trigger 2...30	Same set of operands as shown for HIGH CURRENT Trigger 1
ELEMENT: High Resistance Ground Fault Detection	HRGF 1 PKP	HRGF 1 in pickup
	HRGF 1 OP	HRGF 1 activated alarm
	HRGF 1 DPO	HRGF 1 not in pickup
	HRGF 2...30	Same set of operands as shown for HRGF 1

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
ELEMENT: High Resistance Ground Fault Location	HRGF LOCATION FUNCTION 1 OFF HRGF LOCATION FUNCTION 1 ON	HRGF Location Function 1 On pulses for the contactor output - positive logic HRGF Location Function 1 Off pulses for the contactor output - negative logic
	HRGF LOCATION 2…4	Same set of operands as shown for HRGF Location 1
ELEMENT: Instantaneous Overcurrent	IOC 1 OP IOC 1 DPO	Instantaneous Overcurrent 1 activated Instantaneous Overcurrent 1 deactivated
	IOC 2…30	Same set of operands as shown for IOC 1
ELEMENT: Long Time Overcurrent	LONG TIME 1 PKP LONG TIME 1 OP LONG TIME 1 DPO	Long Time Overcurrent 1 in pickup Long Time Overcurrent 1 tripped breaker Long Time Overcurrent 1 not in pickup
	LONG TIME 2…30	Same set of operands as shown for LONG TIME 1
ELEMENT: Multi-Source Ground Fault	MSGF ZONE 1 TRIP DPO	Multi-Source GF Zone 1 trip function not in pickup
	MSGF ZONE 1 ALARM DPO	Multi-Source GF Zone 1 alarm function not in pickup
	MSGF ZONE 1 TRIP PKP	Multi-Source GF Zone 1 trip function in pickup
	MSGF ZONE 1 ALARM PKP	Multi-Source GF Zone 1alarm function in pickup
	MSGF ZONE 1 TRIP OP	Multi-Source GF Zone 1 trip function has tripped breakers
	MSGF ZONE 1 ALARM OP	Multi-Source GF Zone 1 alarm activated
	MSGF ZONE 1 TRIP BACKUP OP	Multi-Source GF Zone 1 trip backup function has tripped backup breakers
	MSGF ZONE 2…4	Same set of operands as shown for MSGF ZONE 1

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
ELEMENT: Multi-Source Ground Fault Summation Zone	MSGF SUMMATION ZONE 1 TRIP DPO	Multi-Source GF Summation Zone 1 trip function not in pickup
	MSGF SUMMATION ZONE 1 ALARM DPO	Multi-Source GF Summation Zone 1 alarm function not in pickup
	MSGF SUMMATION ZONE 1 TRIP PKP	Multi-Source GF Summation Zone 1 trip function in pickup
	MSGF SUMMATION ZONE 1 ALARM PKP	Multi-Source GF Summation Zone 1 alarm function in pickup
	MSGF SUMMATION ZONE 1 TRIP OP	Multi-Source GF Summation Zone 1 trip function has tripped breakers
	MSGF SUMMATION ZONE 1 ALARM OP	Multi-Source GF Summation Zone 1 alarm activated
	MSGF SUMMATION ZONE 1 TRIP RESTRAINED	Multi-Source GF Summation Zone 1 trip function restrained
	MSGF SUMMATION ZONE 1 ALARM RESTRAINED	Multi-Source GF Summation Zone 1 alarm function restrained
	MSGF SUMMATION ZONE 2	Same set of operands as show above for MSGF SUMMATION ZONE 1
ELEMENT: Overvoltage	MULTIPOINT REDUCED LET THRU INITIATED	System is operating in Reduced Energy mode (topology 0)
ELEMENT: Over frequency	OVERFREQUENCY 1 ALARM PKP	Overfrequency 1 alarm function in pickup
	OVERFREQUENCY 1 ALARM OP	Overfrequency 1 alarm activated
	OVERFREQUENCY 1 ALARM DPO	Overfrequency 1 alarm function not in pickup
	OVERFREQUENCY 1 TRIP PKP	Overfrequency 1 trip function in pickup
	OVERFREQUENCY 1 TRIP OP	Overfrequency 1 relay function tripped breaker
	OVERFREQUENCY 1 TRIP DPO	Overfrequency 1 trip function not in pickup
	OVERFREQUENCY 2…30	Same set of operands as shown for OVERFREQUENCY 1
ELEMENT: Overvoltage	OVERVOLTAGE 1 ALARM PKP	Overvoltage 1 alarm function in pickup
	OVERVOLTAGE 1 ALARM OP	Overvoltage 1 alarm activated
	OVERVOLTAGE 1 ALARM DPO	Overvoltage 1 alarm function not in pickup
	OVERVOLTAGE 1 TRIP PKP	Overvoltage 1 trip function in pickup
	OVERVOLTAGE 1 TRIP OP	Overvoltage 1 relay function tripped breaker
	OVERVOLTAGE 1 TRIP DPO	Overvoltage 1 trip function not in pickup
	OVERVOLTAGE 2…30	Same set of operands as shown for OVERVOLTAGE 1
ELEMENT: Phase Loss	PHASE LOSS 1 ALARM PKP	Phase Loss 1 alarm function in pickup
	PHASE LOSS 1 ALARM OP	Phase Loss 1 alarm activated
	PHASE LOSS 1 ALARM DPO	Phase Loss 1 alarm function not in pickup
	PHASE LOSS 1 TRIP PKP	Phase Loss 1 trip function in pickup
	PHASE LOSS 1 TRIP OP	Phase Loss 1 relay function tripped breaker
	PHASE LOSS 1 TRIP DPO	Phase Loss 1 trip function not in pickup

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
	PHASE LOSS 2...30	Same set of operands as shown for PHASE LOSS 1
ELEMENT: PLC Inputs	PLC INPUT 1...256	PLC Input x register is equal to 1
ELEMENT: Power Reversal	POWER REVERSAL 1 ALARM PKP	Reverse Power 1 alarm function in pickup
	POWER REVERSAL 1 ALARM OP	Reverse Power 1 alarm activated
	POWER REVERSAL 1 ALARM DPO	Reverse Power 1 alarm function not in pickup
	POWER REVERSAL 1 TRIP PKP	Reverse Power 1 trip function in pickup
	POWER REVERSAL 1 TRIP OP	Reverse Power 1 relay function tripped breaker
	POWER REVERSAL 1 TRIP DPO	Reverse Power 1 trip function not in pickup
	POWER REVERSAL 2...30	Same set of operands as shown for POWER REVERSAL 1
ELEMENT: Short Time Overcurrent	SHORT TIME 1 PKP	Short Time Overcurrent 1 in pickup
	SHORT TIME 1 OP	Short Time Overcurrent 1 tripped breaker
	SHORT TIME 1 DPO	Short Time Overcurrent 1 not in pickup
	SHORT TIME 2...30	Same set of operands as shown for SHORT TIME 1
ELEMENT: Synch Check	SYNC CHECK 1 DEAD S OP	Synch Check 1 dead source has operated
	SYNC CHECK 1 DEAD S DPO	Synch Check 1 dead source has dropped out
	SYNC CHECK 1 SYNC OP	Synch Check 1 in synchronization has operated
	SYNC CHECK 1 SYNC DPO	Synch Check 1 in synchronization has dropped out
	SYNC CHECK 1 CLS OP	Synch Check 1 close has operated
	SYNC CHECK 1 CLS DPO	Synch Check 1 close has dropped out
	SYNC CHECK 1 V1 ABOVE MIN	Synch Check 1 V1 is above the minimum live voltage
	SYNC CHECK 1 V1 BELOW MAX	Synch Check 1 V1 is below the maximum dead voltage
	SYNC CHECK 1 V2 ABOVE MIN	Synch Check 1 V2 is above the minimum live voltage
	SYNC CHECK 1 V2 BELOW MAX	Synch Check 1 V2 is below the maximum dead voltage
	SYNC 2...12	Same set of operands as show above for SYNC CHECK 1

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
ELEMENT: Under frequency	UNDERFREQUENCY 1 ALARM PKP	Underfrequency 1 alarm function in pickup
	UNDERFREQUENCY 1 ALARM OP	Underfrequency 1 alarm activated
	UNDERFREQUENCY 1 ALARM DPO	Underfrequency 1 alarm function not in pickup
	UNDERFREQUENCY 1 TRIP PKP	Underfrequency 1 trip function in pickup
	UNDERFREQUENCY 1 TRIP OP	Underfrequency 1 relay function tripped breaker
	UNDERFREQUENCY 1 TRIP DPO	Underfrequency 1 trip function not in pickup
	UNDERFREQUENCY 2...30	Same set of operands as shown for UNDERFREQUENCY 1
ELEMENT: Undervoltage	UNDERVOLTAGE 1 ALARM PKP	Undervoltage 1 alarm function in pickup
	UNDERVOLTAGE 1 ALARM OP	Undervoltage 1 alarm activated
	UNDERVOLTAGE 1 ALARM DPO	Undervoltage 1 alarm function not in pickup
	UNDERVOLTAGE 1 TRIP PKP	Undervoltage 1 trip function in pickup
	UNDERVOLTAGE 1 TRIP OP	Undervoltage 1 relay function tripped breaker
	UNDERVOLTAGE 1 TRIP DPO	Undervoltage 1 trip function not in pickup
	UNDERVOLTAGE 2...30	Same set of operands as shown for UNDERVOLTAGE 1
FIXED OPERANDS	Off	Logic = 0. Does nothing and may be used as a delimiter in an equation list; used as 'Disable' by other features.
	On	Logic = 1. Can be used as a test setting.
INPUTS/OUTPUTS: Contact Inputs (Note: total contact inputs + total contact outputs <= 128)	Contact Input 1 On ↓ Contact Input 128 On	External contact input 1 activated ↓ External contact input 128 activated
	Contact Input 1 Off ↓ Contact Input 128 Off	External contact input 1 deactivated ↓ External contact input 128 deactivated
INPUTS/OUTPUTS: Virtual Inputs	Virtual Input 1 On ↓ Virtual Input 32 On	Flag is set, logic = 1 ↓ Flag is set, logic = 1
INPUTS/OUTPUTS: PLC Inputs	PLC Input 1 ↓ PLC Input 256	Flag is set, logic = 1 ↓ Flag is set, logic = 1

Table 11-2 Entellisys FlexLogic operands

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
INPUTS/OUTPUTS: Virtual Outputs	Virtual Output 1 On ↓ Virtual Output 480 On	Flag is set, logic = 1 ↓ Flag is set, logic = 1
	Breaker Control commands available as virtual outputs: Open Flux Shifter Open Shunt Trip Trip Flux Shifter Trip Shunt Trip Close Network Interlock Lockout Network Interlock Lockout Reset	

Some operands can be renamed by the user. The operands that can be renamed are the names of contact inputs/outputs and virtual inputs/outputs. If the user changes the default name of any of these operands, the assigned name appears in the relay list of operands. The default names are shown in the FlexLogic operands table (Table 11-2).

The operators available in FlexLogic are listed in Table 11-3.

Table 11-3 FlexLogic operators

Type	Syntax	Descriptions	Notes
Editor	Copy	Copy a parameter from an equation list.	
	Paste	Paste a parameter in an equation list.	
	Insert	Insert a parameter in an equation list.	
	Delete	Delete a parameter from an equation list.	
End	END	The first END encountered signifies the last entry in the list of processed FlexLogic parameters.	
One Shot	POSITIVE ONE SHOT	One shot that responds to a positive going edge.	A 'one shot' refers to a single input gate that generates a pulse in response to an edge on the input. The output from a 'one shot' is True (positive) for only one pass through the FlexLogic equation. There is a maximum of 64 'one shots'.
	NEGATIVE ONE SHOT	One shot that responds to a negative going edge.	
	DUAL ONE SHOT	One shot that responds to both the positive and negative going edges.	

Table 11-3 FlexLogic operators

Type	Syntax	Descriptions	Notes
Logic Gate	NOT	Logic Not	Operates on the previous parameter.
	OR (2) ↓ OR (16)	2 input OR gate ↓ 16 input OR gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	AND (2) ↓ AND (16)	2 input AND gate ↓ 16 input AND gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	NOR (2) ↓ NOR (16)	2 input NOR gate ↓ 16 input NOR gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	NAND (2) ↓ NAND (16)	2 input NAND gate ↓ 16 input NAND gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	XOR (2)	2 input Exclusive OR gate	Operates on the 2 previous parameters.
	LATCH (S, R)	Latch (Set, Reset) - reset-dominant	The parameter preceding LATCH (S, R) is the Reset input. The parameter preceding the Reset input is the Set input. 512 available
Timer	TIMER 1 ↓ TIMER 160	Timer set with FlexLogic Timer 1 setting. ↓ Timer set with FlexLogic Timer 160 settings.	The timer is started by the preceding parameter. The output of the timer is TIMER #.
Assign Virtual Output	= Virtual Output 1 ↓ = Virtual Output 480	Assigns previous FlexLogic parameter to Virtual Output 1. ↓ Assigns previous FlexLogic parameter to Virtual Output 480.	The virtual output is set by the preceding parameter.

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The characteristics of the logic gates are found in Table 11-4.

Table 11-4 Gate characteristics

GATES	NUMBER OF INPUTS	OUTPUT IS '1' (= ON) IF...
NOT	1	input is '0'
OR	2 to 16	any input is '1'
AND	2 to 16	all inputs are '1'
NOR	2 to 16	all inputs are '0'
NAND	2 to 16	any input is '0'
XOR	2	only one input is '1'

The latch logic operation is described in Table 11-5.

Table 11-5 Latch operation table

LATCH TYPE	LATCH SET	LATCH RESET	LATCH OUTPUT
Reset Dominant	ON	OFF	ON
	OFF	OFF	Previous State
	ON	ON	OFF
	OFF	ON	OFF

11.2 FlexLogic rules

When forming a FlexLogic equation, the sequence in the linear array of parameters must follow these general rules:

1. Operands must precede the operator that uses the operands as inputs.
2. Operators have only one output. The output of an operator must be used to create a virtual output if it is to be used as an input to two or more operators.
3. Assigning the output of an operator to a virtual output terminates the equation.
4. A timer operator (e.g., “TIMER 1”) or virtual output assignment (e.g., “= Virtual Output 1”) may only be used once. If this rule is broken, a syntax error is declared.

11.3 FlexLogic evaluation

Each equation is evaluated in the order in which the parameters are entered.

CAUTION: FlexLogic provides latches, which by definition have a memory action, and remain in the set state after the set input has been asserted. However, latches are volatile (i.e., they reset on the re-application of control power).

When making changes to an equation entry, all FlexLogic equations are re-compiled and all latches and timers are automatically reset. If it is necessary to re-initialize FlexLogic during testing, it is recommended that the CPUs be powered down and back up.

11.4 FlexLogic Equation Editor

To access the FlexLogic Equation Editor

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, and then select **FlexLogic Editor**.

There are 4096 FlexLogic entries available, numbered from 1 to 4096, with default "END" entry settings. If a "Disabled" element is selected as a FlexLogic entry, the associated state flag will never be set to "1".

Once an equation is edited, click **Apply** to store and activate the new equation. To erase all equations and replace them with default "END" settings, click **Default**. To replace all FlexLogic equation entries with the last saved values, click **Restore**.

To access copy, paste, insert and delete commands, right-click on a FlexLogic equation entry.

NOTE: If flexlogic code does not appear in the editor, check the CPU communication and reopen the FlexLogic editor.

11.5 FlexLogic equation viewer

To view FlexLogic equations

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, select **FlexLogic Editor**, and then click **View**.

FlexLogic equations can be viewed graphically as logic diagrams. To print a FlexLogic equation logic diagram, while in the graphical view screen, click **Print**.

11.6 FlexLogic timers

To view FlexLogic timers

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, and then select **Timers**.

There are 160 identical FlexLogic timers available. These timers can be used as operators for FlexLogic equations.

- **TIMER 1 TYPE**: This setting is used to select the time measuring unit.
- **TIMER 1 PICKUP DELAY**: Sets the time delay to pickup. If a pickup delay is not required, set this function to “0”.
- **TIMER 1 DROPOUT DELAY**: Sets the time delay to dropout. If a dropout delay is not required, set this function to “0”.

11.7 FlexLogic virtual inputs

To view FlexLogic virtual inputs

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, and then click **Virtual Inputs**.

There are 32 virtual inputs that can be individually programmed to respond to input signals from the HMI. A custom name (up to 40 characters) can be assigned to each virtual input. All virtual input operands are defaulted to OFF = 0 unless the appropriate input signal is received. **Virtual input states are preserved through a control power loss**. Any change of state of a virtual input can be logged as an event if programmed to do so.

If the “VIRTUAL INPUT x FUNCTION” is set to “Disabled”, the input is forced to “OFF” (Logic 0) regardless of any attempt to alter the input. If the “VIRTUAL INPUT x FUNCTION” is set to “Enabled”, the output of the virtual input is based on received input signal and the applied setting.

There are two types of operations: Self-Reset and Latched. If “VIRTUAL INPUT x TYPE” is set to “Self-Reset”, when the input signal transits from OFF = 0 to ON = 1, the output operand is set to ON = 1 for only one evaluation of the FlexLogic equations and then returns to OFF = 0. If set to “Latched”, the virtual input sets the state of the output operand to the same state as the most recent received input, ON =1 or OFF = 0.

NOTE: The “Self-Reset” operating mode generates the output operand for a single evaluation of the FlexLogic equations. If the operand is to be used anywhere other than internally in a FlexLogic equation, it will likely have to be lengthened in time. A FlexLogic timer with a delayed reset can perform this function.

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11.8 FlexLogic virtual outputs

To view FlexLogic virtual outputs

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, and then click **Virtual Outputs**.

There are 480 virtual outputs that can be assigned via FlexLogic. If not assigned, the output is forced to "OFF" (Logic 0). A custom name (up to 40 characters) can be assigned to each virtual output. Virtual outputs are resolved in each pass through the evaluation of the FlexLogic equations. Any change of state of a virtual output can be logged as an event if programmed to do so.

11.9 FlexLogic circuit breaker commands

To view FlexLogic circuit breaker commands

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, and then click **BRKR Commands**.

FlexLogic equation output can open, trip, close, lockout, and reset lockout a circuit breaker. A virtual output must be mapped to a FlexLogic circuit breaker control command to perform the desired circuit breaker command. Each virtual output can be mapped to only one FlexLogic circuit breaker control command. The following FlexLogic circuit breaker control commands are available:

Open Flux Shifter

Open Shunt Trip

Trip Flux Shifter

Trip Shunt Trip

Close

Network Interlock Lockout

Network Interlock Lockout Reset

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CAUTION: **1.** When a virtual output mapped to a circuit breaker open/trip/close command changes its state to ON, the FlexLogic circuit breaker control command continues triggering for only 3 power cycles. If circuit breaker status feedback is needed, "BREAKER X OPENED" or "BREAKER X CLOSED" protection elements can be used to monitor the circuit breaker status.

2. The FlexLogic circuit breaker network interlock lockout/reset command continues firing as long as its state is ON. The network interlock reset command is valid only when the lockout command is in the OFF state.

11.10 FlexLogic control alarms

To view FlexLogic control alarms

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, and then click **Control Alarms**.

FlexLogic equation output can trigger a system alarm. A virtual output must be mapped to a FlexLogic control alarm and proper system alarm setup is required. There are 30 control alarms.

11.11 Load FlexLogic equation

To load a FlexLogic equation

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, click **FlexLogic Editor**, and then click **Load**.

If a previously saved FlexLogic equation is desired, click **Load** to select a desired file from the USB drive (USB drive required). In the HMI and CPU, all current settings including virtual inputs/outputs, contact inputs/outputs, timers, circuit breaker commands, and control alarms are lost and replaced by the saved settings. If the HMI is in offline mode, only the HMI is affected.

11.12 Save FlexLogic equation

To save a FlexLogic equation

1. On the **Main Menu**, click **User Settings**.
2. Click **Control**, click **FlexLogic Editor**, and then click **Save As**.

FlexLogic equation and settings can be saved to a USB drive (USB drive required). Settings to be saved are virtual inputs/outputs, contact inputs/outputs, timers, circuit breaker commands, and control alarms. A mismatch between the HMI and CPU equation can occur if the equation is modified and the user chooses not to apply the changes to the CPU.

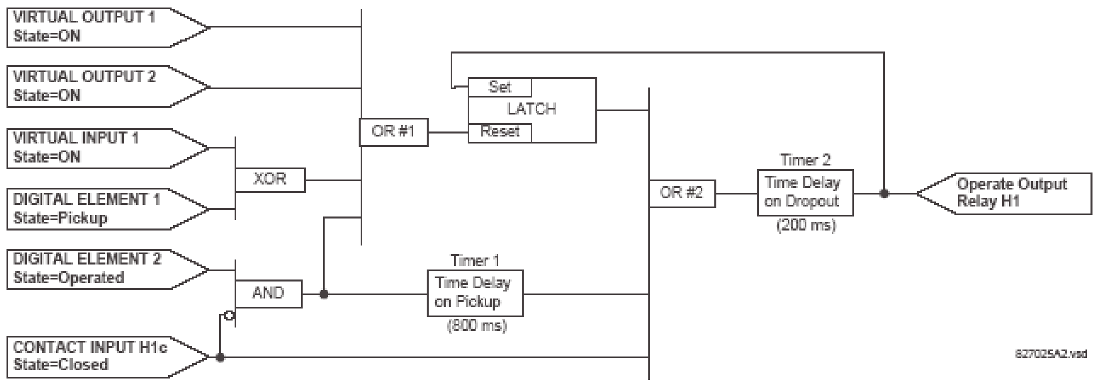
11.13 FlexLogic example

This section provides an example of implementing logic for a typical application. The sequence of the steps is quite important and is designed to minimize the work necessary to develop the relay settings.

NOTE: The example presented in Figure 11-1 is intended to demonstrate the procedure, not to solve a specific application situation.

In the example below, it is assumed that logic has already been programmed to produce Virtual Outputs 1 and 2, and is only a part of the full set of equations used. When using FlexLogic, it is important to make a note of each virtual output used—a virtual output designation (1 to 480) can only be properly assigned once.

Figure 11-1 Example logic scheme

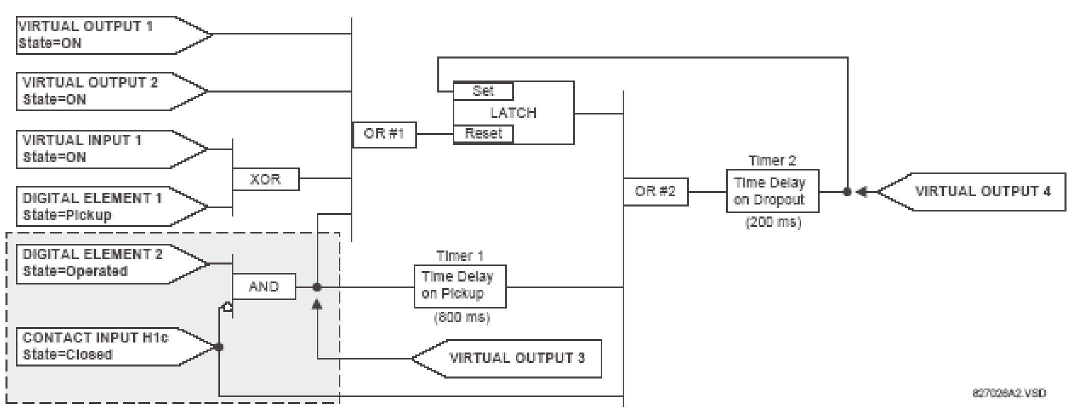


1. Inspect the logic diagram to determine if the required logic can be implemented with the FlexLogic operators. If this is not possible, the logic must be altered until this condition is satisfied.
   a. Count the inputs to each gate to verify that the number of inputs does not exceed the FlexLogic limits, which is unlikely but possible. If the number of inputs is too high, subdivide the inputs into multiple gates to produce an equivalent. For example, if 25 inputs to an AND gate are required: connect Inputs 1 through 16 to AND (16); 17 through 25 to AND (9); and the outputs from these two gates to AND (2).
   b. Inspect each operator between the initial operands and final virtual outputs to determine if the output from the operator is used as an input to more than one subsequent operator. If so, the operator output must be assigned as a virtual output.

      For example, in Figure 11-1, the output of the AND gate is used as an input to both OR#1 and Timer 1, and must therefore be made a virtual output and assigned the next available number (i.e., Virtual Output 3). The final output must also be assigned to a virtual output (Virtual Output 4), which will be programmed in the contact output section to operate relay H1 (i.e., Output Contact H1).

      Therefore, the required logic can be implemented with two FlexLogic equations with outputs of Virtual Output 3 and Virtual Output 4 as shown below in Figure 11-2.

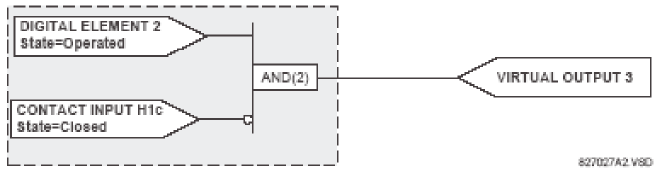
Figure 11-2 Logic example with Virtual Outputs



2. Prepare a logic diagram for the equation to produce Virtual Output 3, as this output will be used as an operand in the Virtual Output 4 equation (create the equation for every output

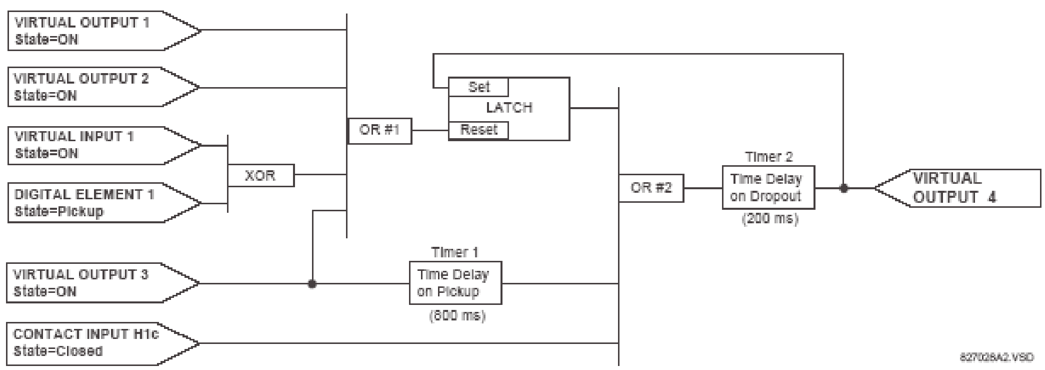
that will be used as an operand first, so that when these operands are required they have already have been evaluated and assigned to a specific virtual output). The logic for Virtual Output 3 is shown with the final output assigned in Figure 11-3.

Figure 11-3 Logic for Virtual Output 3



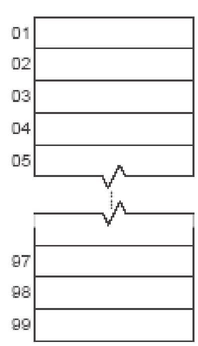
3. Prepare a logic diagram for Virtual Output 4, replacing the logic ahead of Virtual Output 3 with a symbol identified as Virtual Output 3, as shown in Figure 11-4.

Figure 11-4 Logic for Virtual Output 4



4. Program the FlexLogic equation for Virtual Output 3 by translating the logic into available FlexLogic parameters. The equation is formed one parameter at a time until the required logic is complete. It is generally easier to start at the output end of the equation and work back towards the input, as shown in the following steps. It is also recommended to list operator inputs from bottom to top. For demonstration, the final output will be arbitrarily identified as parameter 99, and each preceding parameter decremented by one in turn. Until accustomed to using FlexLogic, it is suggested that a worksheet with a series of cells marked with the arbitrary parameter numbers be prepared, as shown in Figure 11-5.

Figure 11-5 FlexLogic worksheet



a. Following the procedure outlined, start with parameter 99, as follows:

99: The final output of the equation is Virtual Output 3, which is created by the operator "= Virt Op n". This parameter is therefore "= Virt Op 3".

98: The gate preceding the output is an AND, which in this case requires two inputs. The operator for this gate is a 2-input AND so the parameter is "AND (2)".

NOTE: FlexLogic rules require that the number of inputs to most types of operators must be specified to identify the operands for the gate. As the 2-input AND will operate on the two operands preceding it, these inputs must be specified, starting with the lower.

97: This lower input to the AND gate must be passed through an inverter (the NOT operator) so the next parameter is "NOT". The NOT operator acts upon the operand immediately preceding it, so specify the inverter input next.

96: The input to the NOT gate is to be contact input H1c. The operand is therefore "Cont Ip H1c On".

95: The last step in the procedure is to specify the upper input to the AND gate, the operated state of digital element 2. This operand is "DIG ELEM 2 OP".

b. Write the parameters in numerical order to now form the equation for VIRTUAL OUTPUT 3:

[95] DIG ELEM 2 OP

[96] Cont Ip H1c On

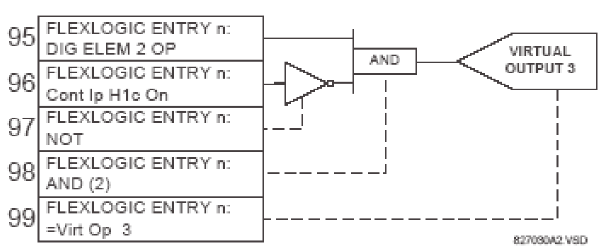
[97] NOT

[98] AND (2)

[99] = Virt Op 3

c. It is now possible to check that this selection of parameters will produce the required logic by converting the set of parameters into a logic diagram. The result of this process is shown in Figure 11-6, which can be compared to the "Logic for Virtual Output 3" diagram (Figure 11-3) as a check.

Figure 11-6 FlexLogic equation for Virtual Output 3



5. Repeating the process described for VIRTUAL OUTPUT 3, select the FlexLogic parameters for Virtual Output 4.

a. Start with parameter 99 as follows:

99: The final output of the equation is VIRTUAL OUTPUT 4 which is parameter "= Virt Op 4".

98: The operator preceding the output is Timer 2, which is operand "TIMER 2".

NOTE: The settings required for the timer are established in FlexLogic timers on page 295.

97: The operator preceding Timer 2 is OR #2, a 3-input OR, which is parameter “OR (3)”.

96: The lowest input to OR #2 is operand “Cont Ip H1c On”.

95: The center input to OR #2 is operand “TIMER 1”.

94: The input to Timer 1 is operand “Virt Op 3 On”.

93: The upper input to OR #2 is operand “LATCH (S, R)”.

92: There are two inputs to a latch, and the input immediately preceding the latch reset is OR #1, a 4-input OR, which is parameter “OR (4)”.

91: The lowest input to OR #1 is operand “Virt Op 3 On”.

90: The input just above the lowest input to OR #1 is operand “XOR (2)”.

89: The lower input to the XOR is operand “DIG ELEM 1 PKP”.

88: The upper input to the XOR is operand “Virt Ip 1 On”.

87: The input just below the upper input to OR #1 is operand “Virt Op 2 On”.

86: The upper input to OR #1 is operand “Virt Op 1 On”.

85: The last parameter is used to set the latch, and is operand “Virt Op 4 On”.

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b. Write the parameters in numerical order to now form the equation for VIRTUAL OUTPUT 4:

[85] Virt Op 4 On

[86] Virt Op 1 On

[87] Virt Op 2 On

[88] Virt Ip 1 On

[89] DIG ELEM 1 PKP

[90] XOR (2)

[91] Virt Op 3 On

[92] OR (4)

[93] LATCH (S, R)

[94] Virt Op 3 On

[95] TIMER 1

[96] Cont Ip H1c On

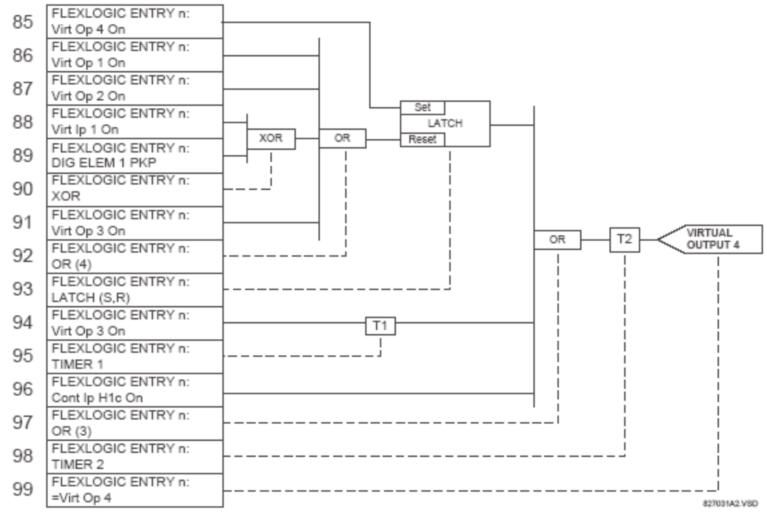
[97] OR (3)

[98] TIMER 2

[99] = Virt Op 4

c. It is now possible to check that the selection of parameters will produce the required logic by converting the set of parameters into a logic diagram. The result of this process is shown below in Figure 11-7 and can be compared to the “Logic for Virtual Output 4” diagram (Figure 11-4) as a check.

Figure 11-7 FlexLogic equation for Virtual Output 4



6. Now write the complete FlexLogic expression required to implement the logic, making an effort to assemble the equation in an order where virtual outputs that are used as inputs to operators are created before needed. In cases where a lot of processing is required to perform logic, this may be difficult to achieve, but in most cases this does not cause problems as all logic is calculated twice per power frequency cycle. The possibility of a problem caused by sequential processing emphasizes the necessity of testing the performance of FlexLogic before it is placed in service.

   In the following equation, Virtual Output 3 is used as an input to both Latch 1 and Timer 1 as arranged in the order shown below:

   DIG ELEM 2 OP

   Cont Ip H1c On

   NOT

   AND (2)

   = Virt Op 3

   Virt Op 4 On

   Virt Op 1 On

   Virt Op 2 On

   Virt Ip 1 On

   DIG ELEM 1 PKP

   XOR (2)

   Virt Op 3 On

   OR (4)

   LATCH (S, R)

   Virt Op 3 On

   TIMER 1

   Cont Ip H1c On

   OR (3)

   TIMER 2

   = Virt Op 4

   END

   In the expression above, the Virtual Output 4 input to the 4-input OR is listed before it is created. This is typical of a form of feedback used to create a seal-in effect with the latch and is correct.

7. The logic should always be tested after it is loaded into the system. Testing can be simplified by placing an "END" operator within the overall set of FlexLogic equations. The equations is then only evaluated up to the first "END" operator.

   The "On" and "Off" operands can be placed in an equation to establish a known set of conditions for test purposes, and the "Copy", "Paste", "Insert", and "Delete" commands can be used to modify equations.

11.14 FlexLogic redundancy

11.14.1 Overview

CPU control redundancy scheme utilizes primary/hot backup redundancy approach. CPU A is the primary and CPU B is the backup. By default, the primary runs as the active CPU and the backup runs as the inactive CPU. The active CPU has contact outputs and circuit breaker control commands actuated, and the inactive CPU has contact outputs and circuit breaker control commands blocked. Only one CPU can be active at any given time. Modbus register “FlexLogic Active”, address 0x0034, holds 1 when the CPU is active and holds 0 when the CPU is inactive.

11.14.2 Throw-over and throwback

The primary throws over to the backup when one of the following conditions occurs:

1. Primary physical discrete I/O card count is different than the configured discrete I/O card count (observed from **Factory Configuration**, **CPU Settings** screen).
2. During CPU startup, at least one installed messenger is not commissioned in primary or communicating with primary.
3. During system steady state, the primary CPU loses commission or communication with any of the messengers and the backup CPU is commissioned and communicating with all of the messengers.
4. During system steady state, primary loses commission or communication with its entire installed messengers.
5. Primary is down.

The backup throws back to the primary when all of the following conditions are met:

1. Primary is running.
2. Primary physical discrete I/O card count matches with the configured discrete I/O card count.
3. All installed messengers are commissioned in primary and communicating with primary.

Transition time for the throw-over and throwback is within 100 to 200 milliseconds. During the transition time, all contact outputs and circuit breaker control commands are blocked in both CPUs.

Throw-over and throwback events are shown below:

- CPUA Assumes Control Logic
- CPUB Assumes Control Logic
- CPUA Relinquishes Control Logic
- CPUB Relinquishes Control Logic

11.14.3 Failure mode

Both CPUs become inactive when one of the following conditions occurs.

1. Both CPUs have the same CPU ID. Event, "Attention Duplicate CPU IDs Found", can be observed in the Sequence of Events screen.
2. Two points failure. The primary throws over to the backup but the backup cannot become active because one of the following conditions occurs:
   a. Backup physical discrete I/O card count is different than the configured discrete I/O card count.
   b. Backup is down.
   c. All installed messengers are not commissioned in backup or communicating with backup.
   d. None of the messengers are communicating with both CPUs.

11.14.4 Discrete I/O card redundancy

In a discrete I/O card redundancy system (both CPUs have discrete I/O cards and identical configuration), the active CPU has discrete I/O card contact outputs actuated, and the inactive CPU has discrete I/O card contact outputs blocked. During the throw-over or throwback transition, both discrete I/O card contact outputs are blocked (all contact outputs stay low) for 100 to 200 milliseconds.

In a discrete I/O card non-redundancy system (only CPU A has a discrete I/O card), the system does not actuate any contact output when the backup is active. The backup CPU (CPU B) does not have a discrete I/O card installed.

12 Preventive maintenance

Entellisys provides data to enable users to manage preventive maintenance (PM) items. Circuit breaker transition counters, life calculations, run hours of operations, and last operation date stamping are all values that aid in maintaining and servicing the Entellisys system. Transition counters can trigger alarms after a certain number of transitions have occurred.

To view preventive maintenance data, select a circuit breaker from the one-line drawing. Maintenance data is shown in Figure 12-1.

Figure 12-1 Maintenance data

BREAKER : Breaker 1

MAINTENANCE DATA	
Total Operations	1
Total No Load Operations	0
Total Load Operations	1
Total Fault Operations	1

Percent Load Life	8.13
Percent Mechanical Life	0.02
Last Breaker Operation	04/02/2005 15:12:21
Initial Energization	01/01/1970 00:00:00

12.1 PM data elements

12.1.1 Total operations

Entellisys keeps a count of the total number of transitions of each EntelliGuard or EntelliGuard-E circuit breaker. When the circuit breaker transitions from the closed state to the open state, regardless of load, this counter is incremented by 1 count.

12.1.2 Total no-load operations

Entellisys keeps a count of the total number of transitions that occur with no-load on each circuit breaker. When a circuit breaker transitions from closed to open, if during the transition there is less than 1% of the rated current flowing through the circuit breaker, this counter is incremented by 1 count.

12.1.3 Total load operations

Entellisys keeps a count of the total number of transitions that occur with load on each circuit breaker. When an EntelliGuard circuit breaker transitions from closed to open, if during the transition there is greater than or equal to 1% of the rated current flowing through the circuit breaker, this counter is incremented by 1 count.

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12.1.4 Total fault operations

Entellisys keeps a count of the total number of transitions that occur due to a fault on each circuit breaker. When an circuit breaker transitions from closed to open as a result of a protection feature issuing a trip (i.e., Short time trip, Long time trip, Instantaneous over-current etc.), this counter is incremented by 1 count.

12.1.5 Percent load life

Entellisys keeps track of the percentage of the total load life used of each EntelliGuard circuit breaker. When an EntelliGuard circuit breaker transitions from closed to open, the percentage load life used is updated and stored. The equation used to calculate load life used (Equation 12-1) incorporates frame size, current flowing through the circuit breaker at the time of transition, and the constant K for that circuit breaker's frame size (see Table 12-1).

Equation 12-1 Load life equation

$$\%\text{ of Load Life} = \sum\left((I_{rms}/I_{frame})^2 / K_{frame}\right)$$

If the current flowing through the circuit breaker at the time of transition exceeds the maximum current threshold (Table 12-2), exactly 45% of the circuit breaker life is added to the total load life used value.

Table 12-1 K values for various frame sizes

Frame Size	K_{frame}
800	2800
1600	1200
2000	1000
3200	600
4000	500
5000	400

Table 12-2 Maximum Current Thresholds for various frame ratings, expressed in multiples of CT rating

Frame Size	Max current threshold
800	15
1600	15
2000	15
3200	13
4000	9
5000	7

12.1.6 Percent mechanical life

Entellisys calculates the percentage of mechanical life used on each EntelliGuard circuit breaker. This percentage is updated every time an EntelliGuard circuit breaker transitions from closed to open, and is calculated by dividing the total number of operations recorded by the counter by the number of rated operations. (See Equation 12-2 and Table 12-3.)

Equation 12-2 Percentage of mechanical life calculation

$$\%\ \text{of Mechanical Life} = Operations_{Total} / Operations_{Rated}$$

Table 12-3 Number of rated operations for various frame sizes

Frame Size	$\text{Operations}_{\text{Rated}}$
800	12500
1600	4000
2000	4000
3200	1500
4000	1500
5000	1500

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12.1.7 Last circuit breaker operation

Entellisys maintains the date and time of the last operation for each EntelliGuard circuit breaker. This is defined as any transition from closed to open or from open to closed.

12.2 Adjusting preventive maintenance values

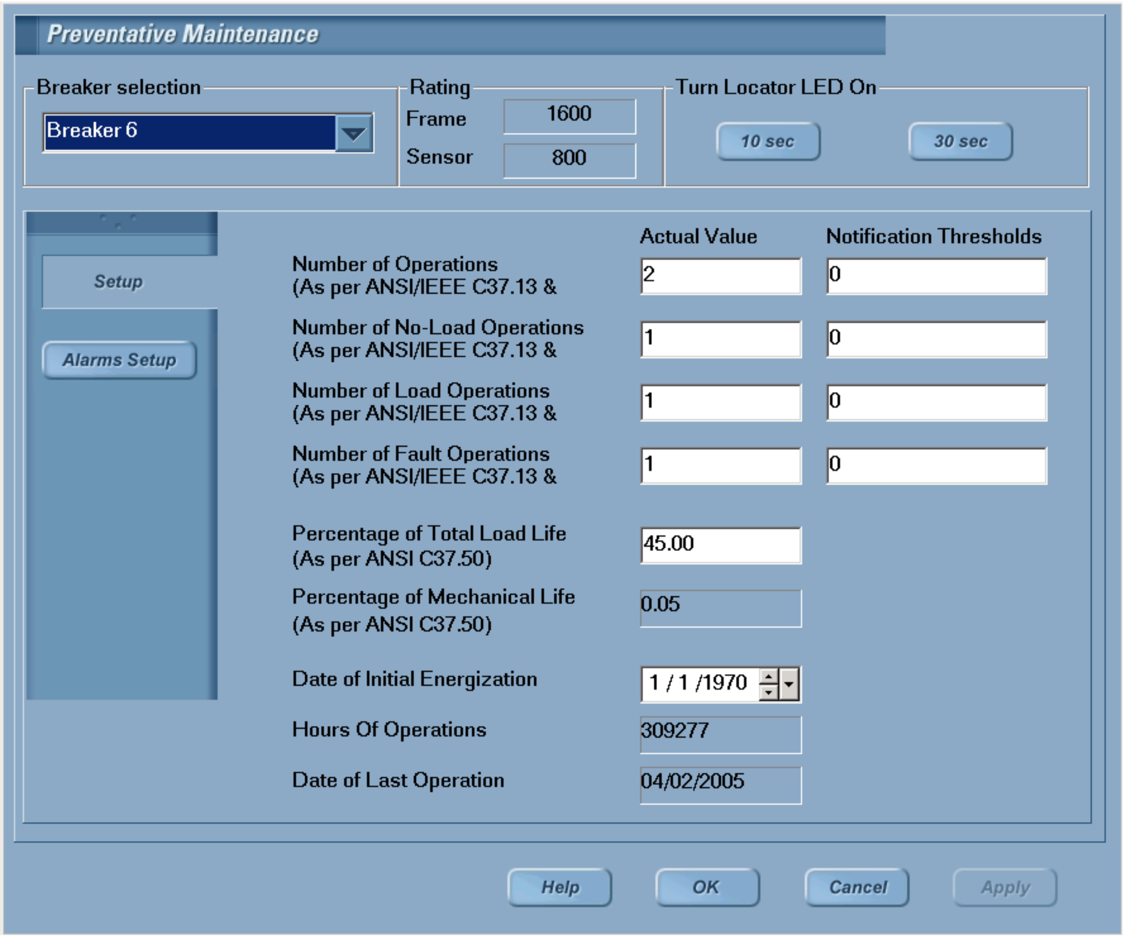
All the values above, except for accumulated service hours and percentage total load life (which are purely calculated values) can be adjusted through the HMI. To adjust these values, on the **Main Menu**, click **User Settings**, and then click **Preventative Maintenance**.

The Setup tab on the Preventative Maintenance screen shown in Figure 12-2 displays current values and allows the user to change fields that are adjustable. When a component of the Entellisys system is commissioned, replaced or moved, adjustments have to be made to all these values. When replacing a CPU component it is important to manually record all PM values, so they can be reentered at a later time.

Notification Thresholds are the values at which a Preventative Maintenance alarm report will be generated, as discussed in the next section.

A description of the adjustable fields on the Preventative Maintenance screen is given in the following sections.

Figure 12-2 Setup tab of Preventative Maintenance screen



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12.2.1 Notification thresholds

To enable a threshold alarm for an operation counter, enter a value in the appropriate **Notification Thresholds** text box. When the count equals the threshold value, an e-mail is sent.

Note that this functionality is distinct from the Alarms Setup located within the Alarms settings screen. The e-mail addresses for the PM report are entered here by clicking the **Alarms Setup** button shown in Figure 12-2. These reports are only generated and sent once every 24 hours for any threshold that may have been exceeded, whereas the conventional alarms are e-mailed as they occur. Also, both remote and local HMIs may be configured to send these reports, whereas the conventional alarms are only sent by the local HMI.

12.2.2 Hours of operation

Entellisys keeps track of the date and time of initial energization and displays the number of hours that have elapsed since that time. These hours are a purely calculated value and are only as accurate as the current system time.

A Alarms and events

A.1 Sequence of events cause code cross reference index

The following table lists the sequence of events cause codes. To view a description of these events and a troubleshooting guide, see Alarms and events description and system troubleshooting guide on page 342.

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
H-0001	HMI Startup	Others	A-1
H-0002	HMI Shutdown	Others	A-1
H-0003	HMI Resumed Communication with [CPUA/B]	Others	A-4
H-0004	Caution: HMI Lost Communication with [CPUA/B]	Caution	A-4
H-0005	Caution: HMI couldn't Establish Communication with [CPUA/B]	Caution	A-4
H-0006	Default CPU set to CPUA	Others	A-5
H-0007	Default CPU set to CPUB	Others	A-5
H-0008	Messnger Commission Command Sent for Breaker [Name]	Others	A-5
H-0009	Messnger Decommission Command Sent for Breaker [Name]	Others	A-5'
H-000A	IP Address for CPUA Set To [n.n.n.n] From [n.n.n.n]	Others	A-4
H-000B	IP Address for CPUB Set To [n.n.n.n] From [n.n.n.n]	Others	A-4
H-000C	Frequency Set To [50/60]Hz for [CPUA/B]	Others	A-5
H-000D	Caution: Settings Failed Writing Frequency to [CPUA/B]	Caution	A-5
H-000E	Caution: Settings Failed Writing Commission Status To [CPUA/B]	Others	A-5
H-0015	HMI System Date & Time set Successfully to Time Server	Others	
H-0016	Setting HMI System Date & Time to Time Server Failed	Others	
H-0018	Caution: Firmware Download Failed for [CPU A/B/Messngr].Unable to Enable Flash Pgm Mode. Replace CPU.	Caution	A-4
H-001C	Caution: Firmware Download Failed for [CPU A/B/Messngr].Cannot Erase Firmware.Replace CPU.	Caution	A-4
H-001D	Firmware Downloaded OK To [CPU A/B/Messngr]	Others	A-4
H-001E	Firmware Download Failed For CPU[A/B/MESSNGR]	Others	A-4

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Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
H-0020	Caution: Firmware Download to [CPU A/B/Messngr] Cannot be Verified	Caution	A-4
H-0022	Attention: Flash File Error in [CPU A/B/Messngr].Replace CPU.Unable to disable Flash Pgm Mode.	Attention	A-4
H-0024	Caution: Firmware Dwnld Failed.Err Reading Messnger Status for [Breaker(s)]	Caution	A-4
H-0025	Caution: Firmware Dwnld Failed-Err Reading Messenger Status during Switch for [Breaker(s)]	Caution	A-4
H-0026	Attention: System Freq [50/60]Hz While CPU Synch Clock Freq [60/50]Hz	Attention	
H-0027	Caution: CPUA and CPUB have duplicate IDs	Caution	A-5
H-0028	Caution: Invalid ID for CPUA. Expecting ID 0	Caution	A-5
H-0029	Caution: Invalid ID for CPUB. Expecting ID 1	Caution	A-5
H-002A	Attn: Settings Discrepancy btwn CPUA & CPUB.Updt in Maintenance-Settings Menu.	Attention	A-5
H-002B	Caution: Settings Update Failed.Retry will Occur in 30 minutes	Caution	A-4
H-002C	Caution: IP Error 1 For IP Address [n.n.n]	Caution	
H-002D	Caution: Event Log size reached Max Limit for [CPU A/B].Event retrieval stopped	Caution	A-2
H-002E	Event Log Read Resumed for [CPU A/B]	Others	A-2
H-0030	Note: FTP Error 1	Others	A-4
H-0031	Note: FTP Error 2	Others	A-4
H-0032	Note: FTP Error 3	Others	A-4
H-0033	Note: FTP Error 4	Others	A-4
H-0034	Note: FTP Error 5	Others	A-4
H-0035	Note: FTP Error 6	Others	A-4
H-0036	Note: FTP Error 7	Others	A-4
H-0037	Note: FTP Error 8	Others	A-4
H-0038	Note: FTP Error 9	Others	A-4
H-0039	Note: FTP Error 10	Others	A-4
H-003A	Note: FTP Error 11	Others	A-4
H-003B	Note: FTP Error 12	Others	A-4
H-003C	Note: FTP Error 13	Others	A-4
H-003D	Note: FTP Error 14	Others	A-4

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
H-003E	Note: FTP Error 15	Others	A-4
H-003F	Note: FTP Error 16	Others	A-4
H-0040	Note: FTP Error 17	Others	A-4
H-0041	Note: FTP Error 18	Others	A-4
H-0042	Note: FTP Error 19	Others	A-4
H-0043	Note: TFTP Error 1	Others	A-4
H-0044	Note: TFTP Error 2	Others	A-4
H-0045	Note: TFTP Error 3	Others	A-4
H-0046	Note: TFTP Error 4	Others	A-4
H-0047	Note: TFTP Error 5	Others	A-4
H-0048	Note: TFTP Error 6	Others	A-4
H-0049	Note: TFTP Error 7	Others	A-4
H-004A	Note: Event Log File for [CPU A/B] Exceeds [n]MB.New File Created	Others	A-2
H-004B	Caution: Event Log File Overwrite Attempt Failed for [CPU A/B].New Log Created	Caution	A-2
H-004C	Note: Event Log for [CPU A/B] Overwritten OK	Others	A-2
H-004D	Note: Deleting All Event Log,Fault Report and Waveform Files Older than [nn] Days	Others	A-2
H-004E	Caution: Daylight Savings Time Error 1	Caution	A-4
H-004F	Caution: Daylight Savings Time Error 2	Caution	A-4
H-0050	Daylight Savings Time in Effect, Time Synchronized.	Others	A-4
H-0051	Standard Time in Effect, Time Synchronized.	Others	A-4
H-0056	Invalid Login Attempt By Login ID[user ID]	Others	A-2
H-0057	User With [USER ID] ID Logged Into HMI	Others	A-2
H-0058	User With [USER ID] ID Logged Off HMI	Others	A-2
H-0059	Caution: Email Attempt Failed.SMTP Error 1	Caution	A-4
H-005A	Breaker Close Command Issued from HMI For [Breaker Name]	Others	A-7
H-005B	Breaker Open Command Issued from HMI For [Breaker Name]	Others	A-7
H-005C	Breaker Trip Command Issued from HMI For [Breaker Name]	Others	A-7
H-005D	HMI File [Name] Published OK	Others	A-4

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
H-005E	HMI File [Name] Retrieved OK	Others	A-4
H-005F	Caution: Error Publishing File [Name].Retry	Caution	A-4
H-0060	Caution: Error Retrieving File [Name].Retry	Caution	A-4
H-0064	Caution: Email Attempt Failed.SMTR Error 2	Caution	A-4
H-0066	Email for Alarm Notification Mail Sent OK	Others	A-4
H-0067	Email for Preventative Maintenance Notification Sent Out OK	Others	A-4
H-006B	Upgrades Downloaded to CPU OK	Others	A-4
H-006C	Caution: Upgrades Download Failed.Unable to Download to CPU	Caution	A-4
H-006D	Caution: Option Mismatch between CPUA and CPUB.Retry	Caution	A-5
H-006E	Attention: CPU Firmware Version Mismatch between CPUA and CPUB	Attention	A-5
H-0074	Caution: Unable to Read HMI Config File(elvs_config.bcf).Defaults Loaded.	Caution	A-2
H-0075	HMI Config File Loaded OK	Others	A-2
H-0076	Caution: Error Saving HMI Config File	Caution	A-2
H-0077	HMI Config File Saved OK	Others	A-2
H-007E	CPUA Commissioned	Others	A-4
H-007F	CPUB Commissioned	Others	A-2
H-0080	CPUA Decommissioned	Others	A-2
H-0081	CPUB Decommissioned	Others	A-2
H-0088	Caution: Email Attempt Failed.SMTP Error 3	Caution	A-4
H-0089	Attention: Control Power 1 Outage Detected On Battery Backup	Attention	A-7
H-008A	Attention: Control Power 1 Low Battery Detected Shutdown in 2 mins	Attention	A-7
H-008B	Control Power 1 Power Restored	Others	A-7
H-0091	Setting File Updated for CPU[A/B]	Others	A-4
H-0092	Can't Update Setting File for CPU[A/B]	Others	A-4
H-0096	IP Address in CPUA Written As [n.n.n.n] From [n.n.n.n]	Others	A-4
H-0097	IP Address in CPUB Written As [n.n.n.n] From [n.n.n.n]	Others	A-4
H-0098	HMI is restarted for Periodic maintenance.	Others	A-2
H-0099	Switched to Entellisys LV Lineup <LineupName>	Others	A-2

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
H-009A	Time Synchronization Successful	Others	A-4
H-009B	Time Server Not Responding Or Not Reachable	Others	A-4
H-009E	<USER ID> Requested Multipoint RELT	Others	A-7
H-009F	Unable to start Windows Time Service	Others	A-4
H-00A0	Unable to stop Windows Time Service	Others	A-4
H-00A1	<USER ID> Requested To End Multipoint RELT	Others	A-7
H-00A2	Time Zone offset of HMI:GMT xx:xx	Others	
H-00A3	Time Zone offset of Lineup Connected:GMT xx:xx	Others	
H-00A4	Cannot Connect to CPU Incompatible Firmware Version	Others	
H-00A6	RELT - ON request for [breaker name] by [User name]	Others	
H-00A7	RELT - OFF request for [breaker name] by [User name]	Others	
H-00A8	RELT-Factory request reset for [breaker name],[user name]	Others	
H-00A9	RELT - Factory request reset [breaker name]	Others	
H-00AA	RELT - Admin request reset for [breaker name],[user name]	Others	
H-00AB	RELT - Factory request reset for [breaker name], Modbus Device	Others	
H-00AC	RELT - Admin request reset for [breaker name], Modbus Device	Others	
H-00AD	RELT - Factory request reset for [breaker name], RELT Grp	Others	
H-00AE	RELT Multipoint - ON request from [user name]	Others	
H-00AF	RELT Multipoint - OFF request from [user name]	Others	
H-00B0	RELT Multipoint - Admin request reset for [user name]	Others	
H-00B1	RELT Multipoint - Factory request reset for [user name]	Others	
H-00B2	RELT Multipoint - Factory request reset	Others	
H-00B3	RELT Multipoint - Admin request reset for Modbus Device	Others	
H-00B4	RELT Multipoint - Factory request reset for Modbus Device	Others	
H-00B5	RELT System Wide - ON request by [User name]	Others	

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
H-00B6	RELT System Wide - OFF request by [User name]	Others	
H-00B7	RELT System Wide - Admin request reset for [user name]	Others	
H-00B8	RELT System Wide - Factory request reset for [user name]	Others	
H-00B9	RELT System Wide - Factory request reset	Others	
H-00BA	RELT System Wide - Factory request reset for Modbus Device	Others	
H-00BB	RELT System Wide - Admin request reset for Modbus Device	Others	
C-7C01	Upgrade Successful	Others	A-6
C-7C02	Events Cleared By Command	Others	A-3
C-7C03	CPU Reinitialized Issued	Others	A-3
C-7C04	Date Time Updated	Others	A-3
C-7C04	Caution Flux Shifter Failure Reported	Caution	A-10
C-7C06	Attention Breaker Open Failed Shunt Trip	Attention	A-8
C-7C07	Attention Breaker Close Failed	Attention	A-8
C-7C08	CPU Firmware Download Started	Others	A-6
C-7C09	CPU Firmware Download Complete	Others	A-6
C-7C0A	Attention Breaker Trip Failed Shunt Trip	Attention	A-8
C-7C0B	Discrete IO Test Mode Initiated	Others	A-6
C-7C0C	Pickup ST Overcurrent	Others	A-9
C-7C0D	Dropout ST Overcurrent	Others	A-9
C-7C0E	Discrete IO Test Mode Ended	Others	A-6
C-7C0F	Upgrade Failure Option String Corrupt	Attention	A-6
C-7C10	Breaker Trip ST Overcurrent	Trip	A-9
C-7C11	Pickup LT Overcurrent	Others	A-9
C-7C12	Dropout LT Overcurrent	Others	A-9
C-7C13	Breaker Trip LT Overcurrent	Trip	A-9
C-7C14	Pickup Ground Fault	Others	A-9
C-7C15	Dropout Ground Fault	Others	A-9

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Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7C16	Attention Breaker Open Failed Flux Shifter	Attention	A-8
C-7C17	Attention Breaker Trip Failed Flux Shifter	Attention	A-8
C-7C18	Breaker Trip Ground Fault	Trip	A-9
C-7C19	All Metering and Protection Disabled	Others	A-6
C-7C1A	Note CPU Internal Error 2	Others	A-9
C-7C1B	Alarm Ground Fault	Alarm	A-9
C-7C1C	Caution Messngr Control Power 1 Lost	Caution	A-10
C-7C1D	Caution Messngr Control Power 2 Lost	Caution	A-10
C-7C1E	Messngr Control Power 1 OK	Others	A-10
C-7C1F	Messngr Control Power 2 OK	Others	A-10
C-7C20	Note CPU Internal Error 1	Others	A-6
C-7C21	Upgrade Failure Internal Error 4	Others	A-6
C-7C22	Demand Log Cleared All By Command	Others	A-3
C-7C23	Demand Log Cleared By Command	Others	A-3
C-7C24	Note Invalid Breaker Type	Others	A-10
C-7C25	Protection Defaulted Invalid Frame Rating	Others	A-10
C-7C26	Protection Defaulted Invalid CT Rating	Others	A-10
C-7C27	Protection Defaulted Frame And CT Mismatch	Others	A-10
C-7C28	Attention Invalid PT Rating Volts Suspended	Attention	A-6
C-7C29	Protection Defaulted Invalid Rating Switch	Others	A-10
C-7C2A	Attention Check Switch Invald LT Overcurrent Set	Attention	A-10
C-7C2B	GF Trip Priority Disabled ZSI Not Optioned	Others	A-9
C-7C2C	Alarm Pickup Ground Fault	Others	A-9
C-7C2D	Alarm Dropout Ground Fault	Others	A-9
C-7C2F	Caution Check Compartment ID Button Connection	Caution	A-10
C-7C31	Caution Messngr Not Receiving From CPUA	Caution	A-10
C-7C32	Caution Messngr Not Receiving From CPUB	Caution	A-10
C-7C33	Caution Enet Cable Disconnected Messngr CPUA	Caution	A-10

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7C34	Caution Enet Cable Disconnected Messngr CPUB	Caution	A-10
C-7C35	Attention Messngr Synch Disabld Bad Freq CPUA	Attention	A-10
C-7C36	Attention Messngr Synch Disabld Bad Freq CPUB	Attention	A-10
C-7C37	Invalid Setting IOC Mult CPUA Chng Rejected	Others	A-10
C-7C38	Invalid Setting IOC Mult CPUB Chng Rejected	Others	A-10
C-7C39	Invalid Setting ST From CPUA Change Rejected	Others	A-10
C-7C3A	Invalid Setting ST From CPUB Change Rejected	Others	A-10
C-7C3B	Invalid Setting GF From CPUA Change Rejected	Others	A-10
C-7C3C	Invalid Setting GF From CPUB Change Rejected	Others	A-10
C-7C3D	Note Messngr Ignored Invalid Command CPUA	Others	A-10
C-7C3E	Note Messngr Ignored Invalid Command CPUB	Others	A-10
C-7C3F	Note Messngr Arbitrated Command From CPUA	Others	A-10
C-7C40	Note Messngr Arbitrated Command From CPUB	Others	A-10
C-7C41	Note Messngr Reports CPUA Command Timed Out	Others	A-10
C-7C42	Note Messngr Reports CPUB Command Timed Out	Others	A-10
C-7C43	Messngr Synch Not Locked	Others	A-10
C-7C48	Attention Messngr Error 3 Replace ASAP	Attention	A-10
C-7C49	Attention Messngr Error 4 Replace ASAP	Attention	A-10
C-7C4C	CPUA Synch Clock OK	Others	A-10
C-7C4D	Caution CPUA Synch Clock Err Backup Clock On	Caution	A-10
C-7C4E	Caution CPUA Not Rcv From 1 Or More Messngrs	Caution	A-10
C-7C4F	CPUB Synch Clock OK	Others	A-10
C-7C50	Caution CPUB Synch Clock Err Backup Clock On	Caution	A-10
C-7C51	Caution CPUB Not Rcv From 1 Or More Messngrs	Caution	A-10
C-7C52	Breaker Opened	Others	A-8
C-7C53	Breaker Closed	Others	A-8
C-7C54	Breaker Lockout	Others	A-8
C-7C55	Breaker Closing Spring Charged	Others	A-8

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Cause	Event Text	Category	Section
C-7C56	Breaker Primary Connected	Others	A-8
C-7C57	Breaker Primary Disconnected	Others	A-8
C-7C58	Breaker Secondary Connected	Others	A-8
C-7C59	Breaker Secondary Disconnected	Others	A-8
C-7C5A	Breaker Tripped	Trip	A-8
C-7C5B	Breaker Tripped Analog IOC	Trip	A-10
C-7C5C	Test Mode Initiated From Test Kit	Others	A-10
C-7C5D	Test Mode Ended From Test Kit	Others	A-10
C-7C5E	Protection Suspended GF From Test Kit	Others	A-10
C-7C5F	Protection Resumed GF From Test Kit	Others	A-10
C-7C61	Breaker Trip Backup ST Overcurrent	Trip	A-10
C-7C62	Breaker Trip Backup LT Overcurrent	Trip	A-10
C-7C63	Breaker Trip Backup Ground Fault	Trip	A-10
C-7C64	Breaker Trip Instantaneous Overcurrent	Trip	A-10
C-7C65	Breaker Topology State Change	Others	A-6
C-7C66	Alarm Pickup Undervoltage	Others	A-9
C-7C67	Alarm Undervoltage	Alarm	A-9
C-7C68	Alarm Dropout Undervoltage	Others	A-9
C-7C69	Pickup Undervoltage	Others	A-9
C-7C6A	Breaker Trip Undervoltage	Trip	A-9
C-7C6B	Dropout Undervoltage	Others	A-9
C-7C6C	Attention Messngr Error 1 Replace ASAP	Attention	A-10
C-7C6D	Attention Messngr Error 2 Replace ASAP	Attention	A-10
C-7C6E	Attention Compartment ID Button Missing	Attention	A-10
C-7C6F	Note Messngr Error 5	Others	A-10
C-7C72	Fault Report Triggered By Command	Others	A-3
C-7C73	CPU Synch Clock Calibration OK	others	A-6
C-7C74	Caution CPU Synch Clock Error Backup Clock On	Caution	A-6

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Cause	Event Text	Category	Section
C-7C75	CPU Synch Clock OK	Others	A-6
C-7C76	CPU Synch Clock Freq Mismatch	Attention	A-6
C-7C77	Alarm Pickup High Current	Others	A-9
C-7C78	Alarm High Current	Alarm	A-9
C-7C79	Alarm Dropout High Current	Others	A-9
C-7C7C	Note CPU Internal Error 4	Others	A-6
C-7C7E	Breaker Open Command Received	Others	A-3
C-7C7F	Breaker Close Command Received	Others	A-3
C-7C80	Breaker Trip Command Received	Others	A-3
C-7C83	Demand Reset By Command	Others	A-3
C-7C84	Demand Reset All By Command	Others	A-3
C-7C85	Alarm Pickup Overvoltage	Others	A-9
C-7C86	Alarm Overvoltage	Alarm	A-9
C-7C87	Alarm Dropout Overvoltage	Others	A-9
C-7C88	Pickup Overvoltage	Others	A-9
C-7C89	Breaker Trip Overvoltage	Trip	A-9
C-7C8A	Dropout Overvoltage	Others	A-9
C-7C8B	Alarm Pickup Phase Loss	Others	A-9
C-7C8C	Alarm Phase Loss	Alarm	A-9
C-7C8D	Alarm Dropout Phase Loss	Others	A-9
C-7C8E	Pickup Phase Loss	Others	A-9
C-7C8F	Breaker Trip Phase Loss	Trip	A-9
C-7C90	Dropout Phase Loss	Others	A-9
C-7C91	Alarm Pickup Reverse Power	Others	A-9
C-7C92	Alarm Reverse Power	Alarm	A-9
C-7C93	Alarm Dropout Reverse Power	Others	A-9
C-7C94	Pickup Reverse Power	Others	A-9
C-7C95	Breaker Trip Reverse Power	Trip	A-9

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Cause	Event Text	Category	Section
C-7C96	Dropout Reverse Power	Others	A-9
C-7C97	Upgrade Failure Unable To Decrypt	Others	A-6
C-7C98	Upgrade Failure Due To Bad CRC	Others	A-6
C-7C99	Upgrade Request Received	Others	
C-7C9A	Attention New Messngr Options Deficient	Attention	A-6
C-7C9B	Upgrade Failure Internal Error 2	Others	A-6
C-7C9C	Upgrade Failure Internal Error 3	Others	A-6
C-7C9D	Upgrade Failure Hardware Mismatch	Others	A-6
C-7C9E	Waveform Capture Triggered By Command	Others	A-3
C-7C9F	Waveforms Cleared By Command	Others	A-3
C-7CA0	Waveform Capture Triggered By FlexLogic	Others	A-6
C-7CA1	Waveform Capture Ignored Check Messngr Status	Others	A-6
C-7CA2	Waveform Capture Ignored Buffer Protection On	Others	A-6
C-7CA7	Note Ethernet Err Port1 Receive Invalid Frame	Others	A-6
C-7CA8	Note Ethernet Err Port1 Receive	Others	A-6
C-7CA9	CPU Power Down By Command	Others	
C-7CAA	CPU Load Defaults By Command	Others	
C-7CAB	CPU Reinitialize By Command	Others	A-3
C-7CAD	Multipoint Relays Topology State Change	Others	A-6
C-7CAE	HRGF Location Trip Function 1-Could Not Issue Trip	Others	A-9
C-7CAF	HRGF Location Trip Function 2-Could Not Issue Trip	Others	A-9
C-7CB0	HRGF Location Trip Function 3-Could Not Issue Trip	Others	A-9
C-7CB1	HRGF Location Trip Function 4-Could Not Issue Trip	Others	A-9
C-7CB2	HRGF Location Trip Function 1-In Pick Up	Others	A-9
C-7CB3	HRGF Location Trip Function 2-In Pick Up	Others	A-9
C-7CB4	HRGF Location Trip Function 3-In Pick Up	Others	A-9
C-7CB5	HRGF Location Trip Function 4-In Pick Up	Others	A-9
C-7CB6	HRGF Location Trip Function 1-Drop Out	Others	A-9

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Cause	Event Text	Category	Section
C-7CB7	HRGF Location Trip Function 2-Drop Out	Others	A-9
C-7CB8	HRGF Location Trip Function 3-Drop Out	Others	A-9
C-7CB9	HRGF Location Trip Function 4-Drop Out	Others	A-9
C-7CBA	Bad HRGF Location Trip Config File	Others	A-9
C-7CBB	RELT Mode ON	Others	A-9
C-7CBC	RELT Mode OFF	Others	A-9
C-7CBD	RELT Mode Multipoint ON	Others	A-9
C-7CBE	RELT Mode Multipoint OFF	Others	A-9
C-7CBF	RELT Mode System Wide ON	Others	A-9
C-7CC0	RELT Mode System Wide OFF	Others	A-9
C-7CC1	Power On	Others	A-6
C-7CC2	Note Ethernet Err Port1 Send	Others	A-6
C-7CC4	Attention Messngr Decommssned Msg Proto Ver	Attention	A-6
C-7CC5	Attention Messngr Decommssned Dupe IDs Seqs	Attention	A-6
C-7CC6	Attention Messngr Decommssned Dupe IDs	Attention	A-6
C-7CC7	Breaker Load Life At 90 Percent	Others	A-11
C-7CC8	Breaker In Service Anniversary	Others	A-11
C-7CC9	Breaker Mechanical Life At 12 Percent	Others	A-11
C-7CCA	Breaker Mechanical Life At 25 Percent	Others	A-11
C-7CCB	Breaker Mechanical Life At 37 Percent	Others	A-11
C-7CCC	Breaker Mechanical Life At 50 Percent	Others	A-11
C-7CCD	Breaker Mechanical Life At 62 Percent	Others	A-11
C-7CCE	Breaker Mechanical Life At 75 Percent	Others	A-11
C-7CCF	Breaker Mechanical Life At 87 Percent	Others	A-11
C-7CD0	Breaker Mechanical Life At 100 Percent	Others	A-11
C-7CD1	Breaker Load Life At 50 Percent	Others	A-11
C-7CD2	Breaker Load Life At 75 Percent	Others	A-11
C-7CD5	Breaker Close Command Rejected Breaker Locked Out	Others	A-8

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Cause	Event Text	Category	Section
C-7CD6	CPU Firmware Failure Previous Version In Use	Others	A-6
C-7CD9	Alarm Pickup Underfrequency	Others	A-9
C-7CDA	Alarm Underfrequency	Alarm	A-9
C-7CDB	Alarm Dropout Underfrequency	Others	A-9
C-7CDC	Pickup Underfrequency	Others	A-9
C-7CDD	Breaker Trip Underfrequency	Trip	A-9
C-7CDE	Dropout Underfrequency	Others	A-9
C-7CDF	Alarm Pickup Overfrequency	Others	A-9
C-7CE0	Alarm Overfrequency	Alarm	A-9
C-7CE1	Alarm Dropout Overfrequency	Others	A-9
C-7CE2	Pickup Overfrequency	Others	A-9
C-7CE3	Breaker Trip Overfrequency	Trip	A-9
C-7CE4	Dropout Overfrequency	Others	A-9
C-7CE5	Pickup Multi Source GF Zone 1	Others	A-9
C-7CE6	Dropout Multi Source GF Zone 1	Others	A-9
C-7CE7	Breakers Trip Multi Source GF Zone 1	Trip	A-9
C-7CE8	Breakers Trip Backup Multi Source GF Zone 1	Trip	A-9
C-7CE9	Alarm Pickup Multi Source GF Zone 1	Others	A-9
C-7CEA	Alarm Dropout Multi Source GF Zone 1	Others	A-9
C-7CEB	Alarm Multi Source GF Zone 1z	Alarm	A-9
C-7CEC	Pickup Multi Source GF Zone 2	Others	A-9
C-7CED	Dropout Multi Source GF Zone 2	Others	A-9
C-7CEE	Breakers Trip Multi Source GF Zone 2	Trip	A-9
C-7CEF	Breakers Trip Backup Multi Source GF Zone 2	Trip	A-9
C-7CF0	Alarm Pickup Multi Source GF Zone 2	Others	A-9
C-7CF1	Alarm Dropout Multi Source GF Zone 2	Alarm	A-9
C-7CF2	Alarm Multi Source GF Zone 2	Others	A-9
C-7CF3	Pickup Multi Source GF Zone 3	Others	A-9

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Cause	Event Text	Category	Section
C-7CF4	Dropout Multi Source GF Zone 3	Others	A-9
C-7CF5	Breakers Trip Multi Source GF Zone 3	Trip	A-9
C-7CF6	Breakers Trip Backup Multi Source GF Zone 3	Trip	A-9
C-7CF7	Alarm Pickup Multi Source GF Zone 3	Others	A-9
C-7CF8	Alarm Dropout Multi Source GF Zone 3	Others	A-9
C-7CF9	Alarm Multi Source GF Zone 3	Alarm	A-9
C-7CFA	Pickup Multi Source GF Zone 4	Others	A-9
C-7CFB	Dropout Multi Source GF Zone 4	Others	A-9
C-7CFC	Breakers Trip Multi Source GF Zone 4	Trip	A-9
C-7CFD	Breakers Trip Backup Multi Source GF Zone 4	Trip	A-9
C-7CFE	Alarm Pickup Multi Source GF Zone 4	Others	A-9
C-7CFF	Alarm Dropout Multi Source GF Zone 4	Others	A-9
C-7D00	Alarm Multi Source GF Zone 4	Alarm	A-9
C-7D01	RELT Mode - ON request from Initiating Breaker	Others	A-9
C-7D02	RELT Mode - OFF request from Initiating Breaker	Others	A-9
C-7D03	RELT Mode - ON request from Modbus Device	Others	A-9
C-7D04	RELT Mode - OFF request from Modbus Device	Others	A-9
C-7D05	Pickup Multi Source GF Sum Zone 1	Others	A-9
C-7D06	Dropout Multi Source GF Sum Zone 1	Others	A-9
C-7D07	Breaker Trip Multi Source GF Sum Zone 1	Trip	A-9
C-7D08	Alarm Pickup Multi Source GF Sum Zone 1	Others	A-9
C-7D09	Alarm Dropout Multi Source GF Sum Zone 1	Others	A-9
C-7D0A	Alarm Multi Source GF Sum Zone 1	Alarm	A-9
C-7D0B	Pickup Multi Source GF Sum Zone 2	Others	A-9
C-7D0C	Dropout Multi Source GF Sum Zone 2	Others	A-9
C-7D0D	Breaker Trip Multi Source GF Sum Zone 2	Trip	A-9
C-7D0E	Alarm Pickup Multi Source GF Sum Zone 2	Others	A-9
C-7D0F	Alarm Dropout Multi Source GF Sum Zone 2	Others	A-9

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Cause	Event Text	Category	Section
C-7D10	Alarm Multi Source GF Sum Zone 2	Alarm	A-9
C-7D13	Pickup Bus Diff Zone 1 Settings 1	Others	A-9
C-7D14	Dropout Bus Diff Zone 1 Settings 1	Others	A-9
C-7D15	Breakers Trip Bus Diff Zone 1 Settings 1	Trip	A-9
C-7D16	Breakers Trip Backup Bus Diff Zone 1 Settings1	Trip	A-9
C-7D17	Pickup Bus Diff Zone 1 Settings 2	Others	A-9
C-7D18	Dropout Bus Diff Zone 1 Settings 2	Others	A-9
C-7D19	Breakers Trip Bus Diff Zone 1 Settings 2	Trip	A-9
C-7D1A	Breakers Trip Backup Bus Diff Zone 1 Settings2	Trip	A-9
C-7D1B	Alarm Pickup Bus Diff Zone 1 Settings 1	Others	A-9
C-7D1C	Alarm Dropout Bus Diff Zone 1 Settings 1	Others	A-9
C-7D1D	Alarm Bus Diff Zone 1 Settings 1	Alarm	A-9
C-7D1E	Alarm Pickup Bus Diff Zone 1 Settings 2	Others	A-9
C-7D1F	Alarm Dropout Bus Diff Zone 1 Settings 2	Others	A-9
C-7D20	Alarm Bus Diff Zone 1 Settings 2	Alarm	A-9
C-7D21	Pickup Bus Diff Zone 2 Settings 1	Others	A-9
C-7D22	Dropout Bus Diff Zone 2 Settings 1	Others	A-9
C-7D23	Breakers Trip Bus Diff Zone 2 Settings 1	Trip	A-9
C-7D24	Breakers Trip Backup Bus Diff Zone 2 Settings1	Trip	A-9
C-7D25	Pickup Bus Diff Zone 2 Settings 2	Others	A-9
C-7D26	Dropout Bus Diff Zone 2 Settings 2	Others	A-9
C-7D27	Breakers Trip Bus Diff Zone 2 Settings 2	Trip	A-9
C-7D28	Breakers Trip Backup Bus Diff Zone 2 Settings2	Trip	A-9
C-7D29	Alarm Pickup Bus Diff Zone 2 Settings 1	Others	A-9
C-7D2A	Alarm Dropout Bus Diff Zone 2 Settings 1	Others	A-9
C-7D2B	Alarm Bus Diff Zone 2 Settings 1	Alarm	A-9
C-7D2C	Alarm Pickup Bus Diff Zone 2 Settings 2	Others	A-9
C-7D2D	Alarm Dropout Bus Diff Zone 2 Settings 2	Others	A-9

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Cause	Event Text	Category	Section
C-7D2E	Alarm Bus Diff Zone 2 Settings 2	Alarm	A-9
C-7D2F	Pickup Bus Diff Zone 3 Settings 1	Others	A-9
C-7D30	Dropout Bus Diff Zone 3 Settings 1	Others	A-9
C-7D31	Breakers Trip Bus Diff Zone 3 Settings 1	Trip	A-9
C-7D32	Breakers Trip Backup Bus Diff Zone 3 Settings1	Trip	A-9
C-7D33	Pickup Bus Diff Zone 3 Settings 2	Others	A-9
C-7D34	Dropout Bus Diff Zone 3 Settings 2	Others	A-9
C-7D35	Breakers Trip Bus Diff Zone 3 Settings 2	Trip	A-9
C-7D36	Breakers Trip Backup Bus Diff Zone 3 Settings2	Trip	A-9
C-7D37	Alarm Pickup Bus Diff Zone 3 Settings 1	Others	A-9
C-7D38	Alarm Dropout Bus Diff Zone 3 Settings 1	Others	A-9
C-7D39	Alarm Bus Diff Zone 3 Settings 1	Alarm	A-9
C-7D3A	Alarm Pickup Bus Diff Zone 3 Settings 2	Others	A-9
C-7D3B	Alarm Dropout Bus Diff Zone 3 Settings 2	Others	A-9
C-7D3C	Alarm Bus Diff Zone 3 Settings 2	Alarm	A-9
C-7D3D	Pickup Bus Diff Zone 4 Settings 1	Others	A-9
C-7D3E	Dropout Bus Diff Zone 4 Settings 1	Others	A-9
C-7D3F	Breakers Trip Bus Diff Zone 4 Settings 1	Trip	A-9
C-7D40	Breakers Trip Backup Bus Diff Zone 4 Settings1	Trip	A-9
C-7D41	Pickup Bus Diff Zone 4 Settings 2	Others	A-9
C-7D42	Dropout Bus Diff Zone 4 Settings 2	Others	A-9
C-7D43	Breakers Trip Bus Diff Zone 4 Settings 2	Trip	A-9
C-7D44	Breakers Trip Backup Bus Diff Zone 4 Settings2	Trip	A-9
C-7D45	Alarm Pickup Bus Diff Zone 4 Settings 1	Others	A-9
C-7D46	Alarm Dropout Bus Diff Zone 4 Settings 1	Others	A-9
C-7D47	Alarm Bus Diff Zone 4 Settings 1	Alarm	A-9
C-7D48	Alarm Pickup Bus Diff Zone 4 Settings 2	Others	A-9
C-7D49	Alarm Dropout Bus Diff Zone 4 Settings 2	Others	A-9

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Cause	Event Text	Category	Section
C-7D4A	Alarm Bus Diff Zone 4 Settings 2	Alarm	A-9
C-7D4B	Protection Disabled Invalid Cfg Multi Src GF	Others	A-9
C-7D4C	Protection Disabled Invalid Cfg Bus Diff	Others	A-9
C-7D4D	ZSI Zone 1 Operation	Alarm	A-9
C-7D4E	ZSI Zone 2 Operation	Alarm	A-9
C-7D4F	ZSI Zone 3 Operation	Alarm	A-9
C-7D50	ZSI Zone 4 Operation	Alarm	A-9
C-7D51	Note Ethernet Err Port1 Send Restart	Others	A-6
C-7D52	Note Ethernet Err Port1 Send Queue Full	Others	A-6
C-7D53	RELT Mode Multipoint - ON request from User	Others	A-9
C-7D54	RELT Mode Multipoint - OFF request from User	Others	A-9
C-7D55	RELT Mode - ON request from User	Others	A-9
C-7D56	RELT Mode - OFF request from User	Others	A-9
C-7D59	Pickup High Resistance GF	Others	A-9
C-7D5A	Dropout High Resistance GF	Others	A-9
C-7D5B	Alarm High Resistance GF	Alarm	A-9
C-7D5C	Invalid Settings HRGF Unable To Detect Phase	Others	A-9
C-7D5D	Adv Protection Default To Bus Cfg 1 Brkr Err	Others	A-6
C-7D5F	Adv Protection Default To Bus Cfg 1 File Err	Others	A-6
C-7D60	Discrete IO Disabled Invalid Cfg Card 1	Others	A-6
C-7D61	Discrete IO Disabled Invalid Cfg Card 2	Others	A-6
C-7D62	Discrete IO Disabled Card In Wrong Slot	Others	A-6
C-7D63	Invalid Setting IOC Change Rejected	Others	A-9
C-7D64	Invalid Setting IOC Pickup Change Rejected	Others	A-9
C-7D65	Invalid Setting GF Change Rejected	Others	A-9
C-7D66	Invalid Setting GF Pickup Change Rejected	Others	A-9
C-7D67	Invalid Setting ST Change Rejected	Others	A-9
C-7D68	Invalid Setting ST Pickup Change Rejected	Others	A-9

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Cause	Event Text	Category	Section
C-7D69	System OK Receiving Broadcast From CPUA	Others	A-10
C-7D6A	System OK Receiving Broadcast From CPUB	Others	A-10
C-7D6B	Protection Suspended Zone 1 Bus Diff	Others	A-9
C-7D6C	Protection Suspended Zone 2 Bus Diff	Others	A-9
C-7D6D	Protection Suspended Zone 3 Bus Diff	Others	A-9
C-7D6E	Protection Suspended Zone 4 Bus Diff	Others	A-9
C-7D6F	Protection Resumed Zone 1 Bus Diff	Others	A-9
C-7D70	Protection Resumed Zone 2 Bus Diff	Others	A-9
C-7D71	Protection Resumed Zone 3 Bus Diff	Others	A-9
C-7D72	Protection Resumed Zone 4 Bus Diff	Others	A-9
C-7D73	Protection Suspended Zone 1 Multi Source GF	Others	A-9
C-7D74	Protection Suspended Zone 2 Multi Source GF	Others	A-9
C-7D75	Protection Suspended Zone 3 Multi Source GF	Others	A-9
C-7D76	Protection Suspended Zone 4 Multi Source GF	Others	A-9
C-7D77	Protection Resumed Zone 1 Multi Source GF	Others	A-9
C-7D78	Protection Resumed Zone 2 Multi Source GF	Others	A-9
C-7D79	Protection Resumed Zone 3 Multi Source GF	Others	A-9
C-7D7A	Protection Resumed Zone 4 Multi Source GF	Others	A-9
C-7D7B	Protection Suspended Zone 1 Sum Multi Src GF	Others	A-9
C-7D7C	Protection Suspended Zone 2 Sum Multi Src GF	Others	A-9
C-7D7D	Protection Resumed Zone 1 Sum Multi Src GF	Others	A-9
C-7D7E	Protection Resumed Zone 2 Sum Multi Src GF	Others	A-9
C-7D7F	Caution System Topology Defaulted	Caution	A-6
C-7D80	Attentn PT Sources Defaulted Invalid Cfg File	Attention	A-6
C-7D81	PT Throwover Has Occurred	Others	A-6
C-7D84	Messngr Decommissioned Manual Command	Others	A-6
C-7D85	Messngr Commissioned Manual Command	Others	A-6
C-7D86	ZSI Zone 1 Enabled	Others	A-9

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Cause	Event Text	Category	Section
C-7D87	ZSI Zone 2 Enabled	Others	A-9
C-7D88	ZSI Zone 3 Enabled	Others	A-9
C-7D89	ZSI Zone 4 Enabled	Others	A-9
C-7D8A	ZSI Zone 1 Disabled	Others	A-9
C-7D8B	ZSI Zone 2 Disabled	Others	A-9
C-7D8C	ZSI Zone 3 Disabled	Others	A-9
C-7D8D	ZSI Zone 4 Disabled	Others	A-9
C-7D8E	Protection Suspended ZSI File Error	Others	A-6
C-7D8F	Synch Check Control Enabled 1	Others	A-9
C-7D90	Synch Check Control Disabled 1	Others	A-9
C-7D91	Synch Check 1 Sources Not Synchronized	Others	A-9
C-7D92	Synch Check 1 Sources Not Compatible	Others	A-9
C-7D93	Synch Check 1 Dead Source Operate	Others	A-9
C-7D94	Synch Check 1 Dead Source Drop Out	Others	A-9
C-7D99	Synch Check 1 V1 Above Minimum	Others	A-9
C-7D9A	Synch Check 1 V1 Below Maximum	Others	A-9
C-7D9B	Synch Check 1 V2 Above Minimum	Others	A-9
C-7D9C	Synch Check 1 V2 Below Maximum	Others	A-9
C-7D9D	Synch Check Control Enabled 2	Others	A-9
C-7D9E	Synch Check Control Disabled 2	Others	A-9
C-7D9F	Synch Check 2 Sources Not Synchronized	Others	A-9
C-7DA0	Synch Check 2 Sources Not Compatible	Others	A-9
C-7DA1	Synch Check 2 Dead Source Operate	Others	A-9
C-7DA2	Synch Check 2 Dead Source Drop Out	Others	A-9
C-7DA3	RELT Mode System Wide - ON request from User	Others	A-9
C-7DA4	RELT Mode System Wide - OFF request from User	Others	A-9
C-7DA5	RELT Mode System Wide - ON request from FlexLogic	Others	A-9
C-7DA6	RELT Mode System Wide - OFF request from FlexLogic	Others	A-9

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Cause	Event Text	Category	Section
C-7DA7	Synch Check 2 V1 Above Minimum	Others	A-9
C-7DA8	Synch Check 2 V1 Below Maximum	Others	A-9
C-7DA9	Synch Check 2 V2 Above Minimum	Others	A-9
C-7DAA	Synch Check 2 V2 Below Maximum	Others	A-9
C-7DAB	Synch Check Control Enabled 3	Others	A-9
C-7DAC	Synch Check Control Disabled 3	Others	A-9
C-7DAD	Synch Check 3 Sources Not Synchronized	Others	A-9
C-7DAE	Synch Check 3 Sources Not Compatible	Others	A-9
C-7DAF	Synch Check 3 Dead Source Operate	Others	A-9
C-7DB0	Synch Check 3 Dead Source Drop Out	Others	A-9
C-7DB1	RELT Mode Multipoint - ON request from Modbus Dvc	Others	A-9
C-7DB2	RELT Mode Multipoint - OFF request from Modbus Dvc	Others	A-9
C-7DB3	RELT Mode System Wide - ON request from Modbus Dvc	Others	A-9
C-7DB4	RELT Mode System Wide - OFF request from Modbus Dvc	Others	A-9
C-7DB5	Synch Check 3 V1 Above Minimum	Others	A-9
C-7DB6	Synch Check 3 V1 Below Maximum	Others	A-9
C-7DB7	Synch Check 3 V2 Above Minimum	Others	A-9
C-7DB8	Synch Check 3 V2 Below Maximum	Others	A-9
C-7DB9	Synch Check Control Enabled 4	Others	A-9
C-7DBA	Synch Check Control Disabled 4	Others	A-9
C-7DBB	Synch Check 4 Sources Not Synchronized	Others	A-9
C-7DBC	Synch Check 4 Sources Not Compatible	Others	A-9
C-7DBD	Synch Check 4 Dead Source Operate	Others	A-9
C-7DBE	Synch Check 4 Dead Source Drop Out	Others	A-9
C-7DBF	Attention: RELT lock limit reached - Modbus Device	Attention	A-9
C-7DC0	Attention: RELT Multipt lock limit reached-Modbus	Attention	A-9
C-7DC1	Attention: RELT Sys Wide lock limit reached-Modbus	Attention	A-9
C-7DC3	Synch Check 4 V1 Above Minimum	Others	A-9

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Cause	Event Text	Category	Section
C-7DC4	Synch Check 4 V1 Below Maximum	Others	A-9
C-7DC5	Synch Check 4 V2 Above Minimum	Others	A-9
C-7DC6	Synch Check 4 V2 Below Maximum	Others	A-9
C-7DC7	Synch Check Control Enabled 5	Others	A-9
C-7DC8	Synch Check Control Disabled 5	Others	A-9
C-7DC9	Synch Check 5 Sources Not Synchronized	Others	A-9
C-7DCA	Synch Check 5 Sources Not Compatible	Others	A-9
C-7DCB	Synch Check 5 Dead Source Operate	Others	A-9
C-7DCC	Synch Check 5 Dead Source Drop Out	Others	A-9
C-7DCD	Attention: RELT failed to initiate - iButn cfg err	Attention	A-9
C-7DCE	Attention: RELT failed to initiate - Comm Loss	Attention	A-9
C-7DCF	Attention: RELT failed to initiate - LT Pickup	Attention	A-9
C-7DD0	Attn: RELT MPt failed to initiate-missing options	Attention	A-9
C-7DD1	Synch Check 5 V1 Above Minimum	Others	A-9
C-7DD2	Synch Check 5 V1 Below Maximum	Others	A-9
C-7DD3	Synch Check 5 V2 Above Minimum	Others	A-9
C-7DD4	Synch Check 5 V2 Below Maximum	Others	A-9
C-7DD5	Synch Check Control Enabled 6	Others	A-9
C-7DD6	Synch Check Control Disabled 6	Others	A-9
C-7DD7	Synch Check 6 Sources Not Synchronized	Others	A-9
C-7DD8	Synch Check 6 Sources Not Compatible	Others	A-9
C-7DD9	Synch Check 6 Dead Source Operate	Others	A-9
C-7DDA	Synch Check 6 Dead Source Drop Out	Others	A-9
C-7DDF	Synch Check 6 V1 Above Minimum	Others	A-9
C-7DE0	Synch Check 6 V1 Below Maximum	Others	A-9
C-7DE1	Synch Check 6 V2 Above Minimum	Others	A-9
C-7DE2	Synch Check 6 V2 Below Maximum	Others	A-9
C-7DE5	Messngr Synchronization OK	Others	A-10

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Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7DE6	Invalid Set MSGF Zone1 Pkup Chng Rejctd	Others	A-9
C-7DE7	Invalid Set MSGF Zone2 Pkup Chng Rejctd	Others	A-9
C-7DE8	Invalid Set MSGF Zone3 Pkup Chng Rejctd	Others	A-9
C-7DE9	Invalid Set MSGF Zone4 Pkup Chng Rejctd	Others	A-9
C-7DEA	Invalid Set MSGF Zone1 Alrm Pkup Chng Rejctd	Others	A-9
C-7DEB	Invalid Set MSGF Zone2 Alrm Pkup Chng Rejctd	Others	A-9
C-7DEC	Invalid Set MSGF Zone3 Alrm Pkup Chng Rejctd	Others	A-9
C-7DED	Invalid Set MSGF Zone 4Alrm Pkup Chng Rejctd	Others	A-9
C-7DEE	Invalid Set MSGF Zone1 Pkup Min Used	Others	A-9
C-7DEF	Invalid Set MSGF Zone2 Pkup Min Used	Others	A-9
C-7DF0	Invalid Set MSGF Zone3 Pkup Min Used	Others	A-9
C-7DF1	Invalid Set MSGF Zone4 Pkup Min Used	Others	A-9
C-7DF2	Invalid Set MSGF Zone1 Alrm Pkup Min Used	Others	A-9
C-7DF3	Invalid Set MSGF Zone2 Alrm Pkup Min Used	Others	A-9
C-7DF4	Invalid Set MSGF Zone3 Alrm Pkup Min Used	Others	A-9
C-7DF5	Invalid Set MSGF Zone4 Alrm Pkup Min Used	Others	A-9
C-7DF6	Invalid MSGF Sum Zone1 Pkup Chng Rejctd	Others	A-9
C-7DF7	Invalid MSGF Sum Zone2 Pkup Chng Rejctd	Others	A-9
C-7DF8	Invalid MSGF Sum Zone1 Alrm Pkup Chng Rejctd	Others	A-9
C-7DF9	Invalid MSGF Sum Zone2 Alrm Pkup Chng Rejctd	Others	A-9
C-7DFA	Invalid MSGF Sum Zone1 Pkup Min Used	Others	A-9
C-7DFB	Invalid MSGF Sum Zone2 Pkup Min Used	Others	A-9
C-7DFC	Invalid MSGF Sum Zone1 Alrm Pkup Min Used	Others	A-9
C-7DFD	Invalid MSGF Sum Zone2 Alrm Pkup Min Used	Others	A-9
C-7DFE	Invalid BusDiff Zone1 Set1 Pkup Chng Rejctd	Others	A-9
C-7DFF	Invalid BusDiff Zone2 Set1 Pkup Chng Rejctd	Others	A-9
C-7E00	Invalid BusDiff Zone3 Set1 Pkup Chng Rejctd	Others	A-9
C-7E01	Invalid BusDiff Zone4 Set1 Pkup Chng Rejctd	Others	A-9

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7E02	Invalid BDiff Zone1 Set1 Alm Pkup Chng Rejctd	Others	A-9
C-7E03	Invalid BDiff Zone2 Set1 Alm Pkup Chng Rejctd	Others	A-9
C-7E04	Invalid BDiff Zone3 Set1 Alm Pkup Chng Rejctd	Others	A-9
C-7E05	Invalid BDiff Zone4 Set1 Alm Pkup Chng Rejctd	Others	A-9
C-7E06	Invalid BusDiff Zone1 Set2 Pkup Chng Rejctd	Others	A-9
C-7E07	Invalid BusDiff Zone2 Set2 Pkup Chng Rejctd	Others	A-9
C-7E08	Invalid BusDiff Zone3 Set2 Pkup Chng Rejctd	Others	A-9
C-7E09	Invalid BusDiff Zone4 Set2 Pkup Chng Rejctd	Others	A-9
C-7E0A	Invalid BDiff Zone1 Set2 Alm Pkup Chng Rejctd	Others	A-9
C-7E0B	Invalid BDiff Zone2 Set2 Alm Pkup Chng Rejctd	Others	A-9
C-7E0C	Invalid BDiff Zone3 Set2 Alm Pkup Chng Rejctd	Others	A-9
C-7E0D	Invalid BDiff Zone4 Set2 Alm Pkup Chng Rejctd	Others	A-9
C-7E0E	Invalid BusDiff Zone1 Set1 Pkup Min Used	Others	A-9
C-7E0F	Invalid BusDiff Zone2 Set1 Pkup Min Used	Others	A-9
C-7E10	Invalid BusDiff Zone3 Set1 Pkup Min Used	Others	A-9
C-7E11	Invalid BusDiff Zone4 Set1 Pkup Min Used	Others	A-9
C-7E12	Invalid BDiff Zone1 Set1 Alm Pkup Min Used	Others	A-9
C-7E13	Invalid BDiff Zone2 Set1 Alm Pkup Min Used	Others	A-9
C-7E14	Invalid BDiff Zone3 Set1 Alm Pkup Min Used	Others	A-9
C-7E15	Invalid BDiff Zone4 Set1 Alm Pkup Min Used	Others	A-9
C-7E16	Invalid BusDiff Zone1 Set2 Pkup Min Used	Others	A-9
C-7E17	Invalid BusDiff Zone2 Set2 Pkup Min Used	Others	A-9
C-7E18	Invalid BusDiff Zone3 Set2 Pkup Min Used	Others	A-9
C-7E19	Invalid BusDiff Zone4 Set2 Pkup Min Used	Others	A-9
C-7E1A	Invalid BDiff Zone1 Set2 Alm Pkup Min Used	Others	A-9
C-7E1B	Invalid BDiff Zone2 Set2 Alm Pkup Min Used	Others	A-9
C-7E1C	Invalid BDiff Zone3 Set2 Alm Pkup Min Used	Others	A-9
C-7E1D	Invalid BDiff Zone4 Set2 Alm Pkup Min Used	Others	A-9

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Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7E1E	Caution CPU Not Rcv From Messngr	Caution	A-6
C-7E1F	CPU Receiving From Messngr	Others	A-6
C-7E20	Attention Discrete IO Error FlexLogic Disabled	Attention	A-6
C-7E21	Attention Memory CRC Error Replace CPU	Attention	A-6
C-7E22	CPUA Assumes Control Logic	Others	A-6
C-7E23	CPUA Relinquishes Control Logic	Others	A-6
C-7E24	CPUB Assumes Control Logic	Others	A-6
C-7E25	CPUB Relinquishes Control Logic	Others	A-6
C-7E26	Attention Duplicate CPU IDs Found	Attention	A-6
C-7E27	Voltage Below Undervoltage Blocking Voltage	Others	A-9
C-7E28	Voltage Above Undervoltage Blocking Voltage	Others	A-9
C-7E29	Voltage Below Phase Loss Blocking Voltage	Others	A-9
C-7E2A	Voltage Above Phase Loss Blocking Voltage	Others	A-9
C-7E2B	Voltage Below Underfrequency Blocking Voltage	Others	A-9
C-7E2C	Voltage Above Underfrequency Blocking Voltage	Others	A-9
C-7E2D	Voltage Below Overfrequency Blocking Voltage	Others	A-9
C-7E2E	Voltage Above Overfrequency Blocking Voltage	Others	A-9
C-7E2F	Voltage Below Undervoltage Alarm Blocking Voltage	Others	A-9
C-7E30	Voltage Above Undervoltage Alarm Blocking Voltage	Others	A-9
C-7E31	Voltage Below Phase Loss Alarm Blocking Voltage	Others	A-9
C-7E32	Voltage Above Phase Loss Alarm Blocking Voltage	Others	A-9
C-7E33	Voltage Below Underfreq Alarm Blocking Voltage	Others	A-9
C-7E34	Voltage Above Underfreq Alarm Blocking Voltage	Others	A-9
C-7E35	Voltage Below Overfreq Alarm Blocking Voltage	Others	A-9
C-7E36	Voltage Above Overfreq Alarm Blocking Voltage	Others	A-9
C-7E37	Alarm Pickup Over-Demand Flex XX	Others	A-9
C-7E50	HRGF Location - Fault Located Function 1	Others	A-9
C-7E51	HRGF Location - Fault Located Function 2	Others	A-9

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7E52	HRGF Location - Fault Located Function 3	Others	A-9
C-7E53	HRGF Location - Fault Located Function 4	Others	A-9
C-7E54	HRGF Location - Automatic Mode Started Function 1	Others	A-9
C-7E55	HRGF Location - Automatic Mode Started Function 2	Others	A-9
C-7E56	HRGF Location - Automatic Mode Started Function 3	Others	A-9
C-7E57	HRGF Location - Automatic Mode Started Function 4	Others	A-9
C-7E58	HRGF Location - Automatic Mode Ended Function 1	Others	A-9
C-7E59	HRGF Location - Automatic Mode Ended Function 2	Others	A-9
C-7E5A	HRGF Location - Automatic Mode Ended Function 3	Others	A-9
C-7E5B	HRGF Location - Automatic Mode Ended Function 4	Others	A-9
C-7E5C	HRGF Location - Manual Mode Started Function 1	Others	A-9
C-7E5D	HRGF Location - Manual Mode Started Function 2	Others	A-9
C-7E5E	HRGF Location - Manual Mode Started Function 3	Others	A-9
C-7E5F	HRGF Location - Manual Mode Started Function 4	Others	A-9
C-7E60	HRGF Location - Manual Mode Stopped Function 1	Others	A-9
C-7E61	HRGF Location - Manual Mode Stopped Function 2	Others	A-9
C-7E62	HRGF Location - Manual Mode Stopped Function 3	Others	A-9
C-7E63	HRGF Location - Manual Mode Stopped Function 4	Others	A-9
C-7E64	Alarm HRGF Location Function 1	Alarm	A-9
C-7E65	Alarm HRGF Location Function 2	Alarm	A-9
C-7E66	Alarm HRGF Location Function 3	Alarm	A-9
C-7E67	Alarm HRGF Location Function 4	Alarm	A-9
C-7E68	HRGF Location - Breaker Trip Function 1	Trip	A-9
C-7E69	HRGF Location - Breaker Trip Function 2	Trip	A-9
C-7E6A	HRGF Location - Breaker Trip Function 3	Trip	A-9
C-7E6B	HRGF Location - Breaker Trip Function 4	Trip	A-9
C-7E6C	HRGF Location - Discrete Output Unavail Function 1	Others	A-9
C-7E6D	HRGF Location - Discrete Output Unavail Function 2	Others	A-9

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Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7E6E	HRGF Location - Discrete Output Unavail Function 3	Others	A-9
C-7E6F	HRGF Location - Discrete Output Unavail Function 4	Others	A-9
C-7E70	HRGF Location - Detection Not Optioned Function 1	Others	A-9
C-7E71	HRGF Location - Detection Not Optioned Function 2	Others	A-9
C-7E72	HRGF Location - Detection Not Optioned Function 3	Others	A-9
C-7E73	HRGF Location - Detection Not Optioned Function 4	Others	A-9
C-7F5E	RELT Mode Multipoint - ON Request From FlexLogic	Others	A-9
C-7F5F	RELT Mode Multipoint - OFF Request From FlexLogic	Others	A-9
C-7F60	RELT Mode - ON Request From FlexLogic	Others	A-9
C-7F61	RELT Mode - OFF Request From FlexLogic	Others	A-9
C-7F6B	HRGF Location Incomplete Missing Data Function1	Attention	A-9
C-7F6C	HRGF Location Incomplete Missing Data Function 2	Attention	A-9
C-7F6D	HRGF Location Incomplete Missing Data Function 3	Attention	A-9
C-7F6E	HRGF Location Incomplete Missing Data Function 4	Attention	A-9
C-7F6F	Alarm Pickup Under-Demand Flex XX	Others	A-9
C-7F7F	Alarm Dropout Under-Demand Flex XX	Others	A-9
C-7F8F	Alarm Under-Demand Flex XX	Alarm	A-9
C-7F9F	Synch Check Control Enabled 7	Others	A-9
C-7FA0	Synch Check Control Disabled 7	Others	A-9
C-7FA1	Synch Check 7 Sources Not Synchronized	Others	A-9
C-7FA2	Synch Check 7 Sources Not Compatible	Others	A-9
C-7FA3	Synch Check 7 Dead Source Operate	Others	A-9
C-7FA4	Synch Check 7 Dead Source Drop Out	Others	A-9
C-7FA5	Synch Check 7 V1 Above Minimum	Others	A-9
C-7FA6	Synch Check 7 V1 Below Maximum	Others	A-9
C-7FA7	Synch Check 7 V2 Above Minimum	Others	A-9
C-7FA8	Synch Check 7 V2 Below Maximum	Others	A-9
C-7FA9	Synch Check Control Enabled 8	Others	A-9

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7FAA	Synch Check Control Disabled 8	Others	A-9
C-7FAB	Synch Check 8 Sources Not Synchronized	Others	A-9
C-7FAC	Synch Check 8 Sources Not Compatible	Others	A-9
C-7FAD	Synch Check 8 Dead Source Operate	Others	A-9
C-7FAE	Synch Check 8 Dead Source Drop Out	Others	A-9
C-7FAF	Synch Check 8 V1 Above Minimum	Others	A-9
C-7FB0	Synch Check 8 V1 Below Maximum	Others	A-9
C-7FB1	Synch Check 8 V2 Above Minimum	Others	A-9
C-7FB2	Synch Check 8 V2 Below Maximum	Others	A-9
C-7FB3	Synch Check Control Enabled 9	Others	A-9
C-7FB4	Synch Check Control Disabled 9	Others	A-9
C-7FB5	Synch Check 9 Sources Not Synchronized	Others	A-9
C-7FB6	Synch Check 9 Sources Not Compatible	Others	A-9
C-7FB7	Synch Check 9 Dead Source Operate	Others	A-9
C-7FB8	Synch Check 9 Dead Source Drop Out	Others	A-9
C-7FB9	Synch Check 9 V1 Above Minimum	Others	A-9
C-7FBA	Synch Check 9 V1 Below Maximum	Others	A-9
C-7FBB	Synch Check 9 V2 Above Minimum	Others	A-9
C-7FBC	Synch Check 9 V2 Below Maximum	Others	A-9
C-7FBD	Synch Check Control Enabled 10	Others	A-9
C-7FBE	Synch Check Control Disabled 10	Others	A-9
C-7FBF	Synch Check 10 Sources Not Synchronized	Others	A-9
C-7FC0	Synch Check 10 Sources Not Compatible	Others	A-9
C-7FC1	Synch Check 10 Dead Source Operate	Others	A-9
C-7FC2	Synch Check 10 Dead Source Drop Out	Others	A-9
C-7FC3	Synch Check 10 V1 Above Minimum	Others	A-9
C-7FC4	Synch Check 10 V1 Below Maximum	Others	A-9
C-7FC5	Synch Check 10 V2 Above Minimum	Others	A-9

Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7FC6	Synch Check 10 V2 Below Maximum	Others	A-9
C-7FC7	Synch Check Control Enabled 11	Others	A-9
C-7FC8	Synch Check Control Disabled 11	Others	A-9
C-7FC9	Synch Check 11 Sources Not Synchronized	Others	A-9
C-7FCA	Synch Check 11 Sources Not Compatible	Others	A-9
C-7FCB	Synch Check 11 Dead Source Operate	Others	A-9
C-7FCC	Synch Check 11 Dead Source Drop Out	Others	A-9
C-7FCD	Synch Check 11 V1 Above Minimum	Others	A-9
C-7FCE	Synch Check 11 V1 Below Maximum	Others	A-9
C-7FCF	Synch Check 11 V2 Above Minimum	Others	A-9
C-7FD0	Synch Check 11 V2 Below Maximum	Others	A-9
C-7FD1	Synch Check Control Enabled 12	Others	A-9
C-7FD2	Synch Check Control Disabled 12	Others	A-9
C-7FD3	Synch Check 12 Sources Not Synchronized	Others	A-9
C-7FD4	Synch Check 12 Sources Not Compatible	Others	A-9
C-7FD5	Synch Check 12 Dead Source Operate	Others	A-9
C-7FD6	Synch Check 12 Dead Source Drop Out	Others	A-9
C-7FD7	Synch Check 12 V1 Above Minimum	Others	A-9
C-7FD8	Synch Check 12 V1 Below Maximum	Others	A-9
C-7FD9	Synch Check 12 V2 Above Minimum	Others	A-9
C-7FDA	Synch Check 12 V2 Below Maximum	Others	A-9
C-7FDB	Alarm Over-Demand Flex XX	Alarm	A-9
C-7FEB	GF Trip Priority Disabled MSGF Optioned	Others	A-9
C-7FEC	GF Trip Priority Disabled No HRGF Detection Option	Others	
C-7FED	GF Trip priority operated	Alarm	A-9
C-7FF6	HCTR Waveforms Max Count Reached	Others	A-9
C-7FF7	HCTR Waveforms Counter Reset	Others	A-9
C-7FF8	Alarm Pickup High Current Trigger	Others	A-9

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Table A-1 Sequence of events cause code cross reference index

Cause	Event Text	Category	Section
C-7FF9	Alarm Dropout High Current Trigger	Others	A-9
C-7FFA	Alarm High Current Trigger	Alarm	A-9
C-7FFB	Time Server Started	Others	A-10
C-7FFC	Time Server Stopped	Others	A-10
C-7FFD	Time Synchronization Successful	Others	A-4
C-7FFE	Time Server Not Responding Or Not Reachable	Others	A-4
C-7FFF	Time Server Not Configured	Others	A-10
C-08xx	Virtual Input x On	Others	11-1
C-0Axx	Virtual Input x Off	Others	11-1
C-0Cxx	Virtual Output x On	Others	11-1
C-0Exx	Virtual Output x Off	Others	11-1
C-04xx	Contact Input x On	Others	11-1
C-06xx	Contact Input x Off	Others	11-1
C-10xx	Contact Output x On	Others	11-1
C-12xx	Contact Output x Off	Others	11-1
C-14xx	PLC Input x On	Others	11-1
C-16xx	PLC Input x Off	Others	11-1
C-1801	Attention IO Card Detection Mismatch Found 0 of 1	Attention	A-8
C-1802	Attention IO Card Detection Mismatch Found 0 of 2	Attention	A-8
C-1804	Attention IO Card Detection Mismatch Found 1 of 0	Attention	A-8
C-1806	Attention IO Card Detection Mismatch Found 1 of 2	Attention	A-8
C-1808	Attention IO Card Detection Mismatch Found 2 of 0	Attention	A-8
C-1809	Attention IO Card Detection Mismatch Found 2 of 1	Attention	A-8

A.2 Alarms and events description and system troubleshooting guide

– Indicates a waveform capture is performed when the option is available.

Attention or Attn: An issue has been identified that must be addressed immediately.

A.2.1 HMI Internal Operations

Table A-2 HMI Internal Operations

Event	Description	Notes and Troubleshooting tips
HMI Internal Operations		
HMI Startup	Logged whenever the HMI application is started	
HMI Shutdown	Logged whenever the HMI application is exited	
Caution: Event Log size reached Max Limit for [CPU A/B]. Event retrieval stopped	The maximum local storage limit for events has been exceeded for the day.	The maximum size of the daily event log is typically much greater than what one would see in a typical healthy system. The maximum size can be set in the SOE preferences window. When this event occurs, it is best to see what type of events are filling the log and diagnose that area of the system. If the events are legitimate, it is possible to set the log to overwrite mode which will retain only the more recent events for any given day.
Event Log Read Resumed for [CPU A/B]	If event logging had been stopped for any reason, it has now resumed due to user interaction or transition to a new day.	
Note: Event Log File for [CPU A/B] Exceeds [n]MB.New File Created	Individual Event Log files are limited to the maximum size specified in the settings to keep them more manageable. New files are created once existing ones reach a certain size.	
Caution: Event Log File Overwrite Attempt Failed for [CPU A/B].New Log Created	When event logs are set to overwrite mode, an error writing to the file will result in the creation of a new.	Contact GE Post Sales Service (see How to contact us on page 2).
Note: Event Log for [CPU A/B] Overwritten OK	No problems were encountered overwriting an existing log file.	
Note: Deleting All Event Log, Fault Report and Waveform Files Older than [nn] Days	Logged when the HMI deletes older logs as specified in the event log settings.	
Invalid Login Attempt By Login ID [USER ID]	Logged when an invalid or mismatched username and password combination is used to attempt a log in.	Contact the System Administrator for the correct username and password, or contact GE Post Sales Service if it has been lost or forgotten.

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Table A-2 HMI Internal Operations

Event	Description	Notes and Troubleshooting tips
User With [USER ID] ID Logged Into HMI	Indicates that the specified operator has logged into the HMI application	
User With [USER ID] ID Logged Off HMI	Indicates that the specified operator has logged out of the HMI application	
Caution: Unable to Read HMI Config File(elvs_config.bcf). Defaults Loaded	The HMI was unable to load the local configuration file from disk.	Contact GE Post Sales Service (see How to contact us on page 2).
HMI Config File Loaded OK	The HMI successfully loaded the local configuration file from disk.	
Caution: Error Saving HMI Config File	The HMI was unable to successfully store the local configuration file to disk.	Contact GE Post Sales Service (see How to contact us on page 2).
HMI Config File Saved OK	The HMI successfully loaded the local configuration file from disk.	
Switched to Entellisys LV Lineup <LineupName>	Logged on switching to another lineup	
HMI is restarted for Periodic maintenance	The HMI has restarted itself as part of its periodic self-maintenance routine.	

A.2.2 Commands from HMI

Table A-3 Commands from HMI

Event	Description	Notes and Troubleshooting tips
CPU Reinitialized Issued	CPU is going to reboot, either because of a Modbus command, or an internal issue.	The reason for the CPU reboot should be in the event log. It will be one of the following: CPU Reinitialize By Command, Note CPU Internal Error 1, Note CPU Internal Error 2, Note CPU Internal Error 3
CPU Reinitialize By Command	CPU rebooted by Modbus reset relay command	The reset relay command is issued after new firmware or a new option string is downloaded to the CPU.
Breaker Open Command Received	CPU received a command via Modbus to open a breaker	
Breaker Close Command Received	CPU received a command via Modbus to close a breaker	
Breaker Trip Command Received	CPU received a command via Modbus to trip a breaker	
Events Cleared By Command	CPU received (via Modbus) and executed a command to clear its event log	

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Table A-3 Commands from HMI

Event	Description	Notes and Troubleshooting tips
Waveforms Cleared By Command	CPU received (via Modbus) and executed a command to clear its waveform capture buffers	
Waveform Capture Triggered By Command	CPU received (via Modbus) and executed a command to trigger a waveform capture	
Fault Report Triggered By Command	CPU received (via Modbus) and executed a command to trigger a fault report	
Date Time Updated	CPU date and time changed	
Demand Log Cleared All By Command	CPU received (via Modbus) and executed a command to reset the demand log for a single breaker	
Demand Log Cleared By Command	CPU received (via Modbus) and executed a command to reset the demand logs for all breakers	
Demand Reset By Command	CPU received (via Modbus) and executed a command to reset the demand values for a single breaker	
Demand Reset All By Command	CPU received (via Modbus) and executed a command to reset the demand values for all breakers	

A.2.3 HMI/CPU Communications Events

Troubleshooting communications between an HMI and a CPU:

- Check power to System Interface Ethernet Switch.
- Check power and status of CPU.
- Check communications link status. LEDs at the Ethernet ports on the HMI, switch, and CPU should be green.
- Check communications with redundant CPU by establishing it as the Primary (default) unit.
- Verify that the IP address, subnet mask, and gateway address (if applicable) are compatible between the CPU and HMI.

If this does not reveal the source of the problem, contact GE Service.

Table A-4 HMI/CPU Communications Related Events

Event	Description	Notes and Troubleshooting tips
HMI Internal Operations		
HMI Resumed Communication with [CPUA/B]	Logged when HMI establishes communications with a CPU	
HMI Lost Communication with [CPUA/B]	Logged when HMI can no longer communicate with a CPU	
HMI couldn't Establish Communication with [CPUA/B]	Logged when HMI cannot establish a communications session with a CPU	
IP Address for CPUA Set To [n.n.n.n] From [n.n.n.n]	Logged to record a change in the IP address for the given CPU	
IP Address for CPUB Set To [n.n.n.n] From [n.n.n.n]	Logged to record a change in the IP address for the given CPU	
Caution: Firmware Download Failed for [CPU A/B/Messngr]. Unable to Enable Flash Pgm Mode. Replace CPU	Contact GE Service for CPU replacement	Contact GE Post Sales Service (see How to contact us on page 2).
Caution: Firmware Download Failed for [CPU A/B/Messngr]. Cannot Erase Firmware.Replace CPU	Contact GE Service for CPU replacement	Contact GE Post Sales Service (see How to contact us on page 2).
Firmware Downloaded OK To [CPU A/B/Messngr]	Logged upon successful completion of a CPU firmware upgrade	
Firmware Download Failed for [CPU A/B/Messngr]	Contact GE Service for CPU replacement	Contact GE Post Sales Service (see How to contact us on page 2).
Caution: Firmware Download to [CPU A/B/Messngr] Cannot be Verified	Contact GE Service for CPU replacement	Contact GE Post Sales Service (see How to contact us on page 2).

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Table A-4 HMI/CPU Communications Related Events

Event	Description	Notes and Troubleshooting tips
Attention: Flash File Error in [CPU A/B/Messngr]. Unable to disable Flash Pgm Mode.Replace CPU	Contact GE Service for CPU replacement	Contact GE Post Sales Service (see How to contact us on page 2).
Caution: Firmware Dwnld Failed. Err Reading Messnger Status for [Breaker(s)]	An error was detected in confirming the status of a Messenger prior to upgrading its firmware.	Contact GE Post Sales Service (see How to contact us on page 2).
Caution: Firmware Dwnld Failed. Err Reading Messnger Status during Switch for [Breaker(s)]	An error was detected in confirming the status of a Messenger after its firmware has been updated.	Contact GE Post Sales Service (see How to contact us on page 2).
Caution: Settings Update Failed.Retry will Occur in 30 minutes	An attempt to update the local settings file was unsuccessful and a retry will be attempted in the specified time period.	If this error is repeated, Contact GE Post Sales Service (see How to contact us on page 2).
Caution: IP Error X For IP Address [n.n.n.n]	The HMI encountered an error in establishing a TFTP session with a CPU.	
Note: FTP Error X	An error has occurred during FTP protocol transfer with a CPU. Contact GE Service.	Contact GE Post Sales Service (see How to contact us on page 2).
Note: TFTP Error X	An error has occurred during TFTP protocol transfer with a CPU. Contact GE Service.	Contact GE Post Sales Service (see How to contact us on page 2).
HMI File [Name] Published OK	The HMI successfully updated the specified file in the CPU	
HMI File [Name] Retrieved OK	The HMI successfully retrieved the specified file from the CPU	
Caution: Error Publishing File [Name]. Retry	An error has occurred attempting to update the specified file and a retry will be attempted	
Caution: Error Retrieving File [Name]. Retry	An error has occurred attempting to retrieve the specified file and a retry will be attempted	
Upgrades Downloaded to CPU OK	The HMI successfully updated the available option programming for the CPU.	
Caution: Upgrades Download Failed.Unable to Download to CPU	The HMI was unable to update the available option programming for the CPU.	Contact GE Post Sales Service if repeated attempts fail (see How to contact us on page 2).
Setting File Updated for CPU[A/B]	The settings file has been successfully updated for the specified CPU.	
Can't Update Setting File for CPU[A/B]	The settings file for the specified CPU could not be updated.	
IP Address in CPUA Written As [n.n.n.n] From [n.n.n.n]	The IP address in CPU A has been changed as specified.	

Table A-4 HMI/CPU Communications Related Events

Event	Description	Notes and Troubleshooting tips
IP Address in CPUB Written As [n.n.n.n] From [n.n.n.n]	The IP address in CPU B has been changed as specified.	
Communications (other) related		
Caution: Email Attempt Failed.SMTP Error X	Indicates a problem reaching the specified e-mail server.	For e-mail specific issues, in addition to the general communications troubleshooting tips above (HMI/CPU Communications Events on page 345): • Verify that the specified e-mail server is available and online. • Verify that the Firewall/VPN appliance (if installed) is configured to permit this type of traffic.
Email for Alarm Notification Mail Sent OK	An attempt to send an alarm e-mail notification was successful.	
Email for Preventative Maintenance Notification Sent Out OK	An attempt to send a PM e-mail notification was successful.	
Clock and Time Synchronization Related		
Time Synchronization Disabled	Logged to record that the HMI is no longer synchronizing the real-time clock on each CPU	
Time Synchronization Enabled	Logged to record that the HMI is now synchronizing the real-time clock on each CPU	
Time Synchronization Frequency Set To [NN] Hours	Logged to record a change in the setting which determines how often the HMI synchronizes the real-time clock on each CPU	
Time Synchronization Successful	Logged each time the HMI synchronizes the real-time clock on each CPU	
Caution: Time Synchronization Failed with [CPU A/B]	Logged when the HMI is unable to synchronize the real-time clock of a given CPU	See the communications troubleshooting tips above (HMI/CPU Communications Events on page 345).
Caution: Daylight Savings Time Error X	The HMI was unable to resolve the time zone settings	Contact GE Post Sales Service (see How to contact us on page 2).
Daylight Savings Time in Effect, Time Synchronized	Logged when a daylight savings transition and resynchronization occurs	
Standard Time in Effect, Time Synchronized	Logged when a return to standard time and resynchronization occurs	
Time Synchronization Successful	Logged the first time or first time since last failure when HMI time sychronization is successful	
Time Server Not Responding Or Not Reachable	Logged once if time synch fails	See Troubleshooting on page 100 for troubleshooting

Table A-4 HMI/CPU Communications Related Events

Event	Description	Notes and Troubleshooting tips
Unable to start Windows Time Service. Time Synchronization Failed	Logged by HMI on startup if it is not able to start the Windows Time Service during initialization of the time service routines. This impacts only HMI synchronization, CPUs may be correctly synchronized.	May be due to the operating system permissions on the HMI. Login to the computer as an administrator, navigate to the time sync screen and toggle the Sync HMI checkbox. See Troubleshooting on page 100 for troubleshooting
Caution: Unable to stop Windows Time Service	Logged by HMI on shutdown if it is not able to stop the Windows Time Service. Attempt to stop Time service is performed only if it was not running previously before starting HMI	

A.2.4 CPU Settings Related Events

Table A-5 CPU Settings Related Events

Event	Description	Notes and Troubleshooting tips
Default CPU set to CPUA	The default view for the HMI has been set to CPU A	
Default CPU set to CPUB	The default view for the HMI has been set to CPU A	
Messnger Commission Command Sent for Breaker [Name]	Logged when a command to commission an EntelliGuard Messenger is issued to a CPU	
Messnger Decommission Command Sent for Breaker [Name]	Logged when a command to decommission an EntelliGuard Messenger is issued to a CPU	
Frequency Set To [50/60]Hz for [CPUA/B]	Logged to record a change in the frequency setting for a given CPU	
Caution: Settings Failed Writing Frequency to [CPUA/B]	Logged to indicate that a request to change the system frequency of a given CPU was rejected	Also check the event log for communication errors within the general time frame in which this event occurred. See the communications troubleshooting tips above if this is the case (HMI/CPU Communications Events on page 345).
Caution: Settings Failed Writing Commission Status To [CPUA/B]	Logged to indicate that a request to change the commissioning status of a given CPU was rejected	Also check the event log for communication errors within the general time frame in which this event occurred. See the communications troubleshooting tips above if this is the case (HMI/CPU Communications Events on page 345).
Attention: System Freq [50/60]Hz While CPU Synch Clock Freq [60/50]Hz	Indicates a discrepancy between the frequency jumper setting on the Hardware CPU sync clock in the CPU chassis and the firmware setting in the HMI / CPU	Verify that the jumper on the CPU synch clock is set to the same system frequency as the software setting.

Table A-5 CPU Settings Related Events

Event	Description	Notes and Troubleshooting tips
Caution: CPUA and CPUB have duplicate IDs	Both CPUs are given the same designation (A and or B).	Contact GE Post Sales Service immediately (see How to contact us on page 2). Certain control schemes and advanced features of Entellisys will not function in this state.
Caution: Invalid ID for CPUA. Expecting ID 0	The designation in the CPU firmware does not match the designation assigned to that CPU in the HMI.	Verify that the IP addresses for each CPU are not reversed with respect to their A and B designations.
Caution: Invalid ID for CPUB. Expecting ID 1	The designation in the CPU firmware does not match the designation assigned to that CPU in the HMI.	Verify that the IP addresses for each CPU are not reversed with respect to their A and B designations.
Attn:Settings Discrepancy btwn CPUA & CPUB. Updt in Maintenance-Settings Menu	The settings are not consistent between the primary and redundant CPUs and require synchronization.	Open the Settings File tab under the Maintenance dialog box to synchronize the settings files. Note that a sufficient privilege level is required to perform this action.
Caution: Option Mismatch between CPUA and CPUB. Retry	The available options programming is not consistent between the primary and redundant CPUs.	Contact GE Post Sales Service (see How to contact us on page 2).
Attention: CPU Firmware Version Mismatch between CPUA and CPUB	The firmware revisions are not consistent between the primary and redundant CPUs.	Check the CPU Firmware tab under the maintenance menu, or contact GE Post Sales Service (see How to contact us on page 2). Note that a sufficient privilege level is required to perform this operation.
CPUA Commissioned	CPU A transitioned from the decommissioned state to the commissioned state.	
CPUB Commissioned	CPU B transitioned from the decommissioned state to the commissioned state.	
CPUA Decommissioned	CPU A transitioned from the commissioned state to the decommissioned state.	Contact GE Post Sales Service if this occurs when not expected (see How to contact us on page 2).
CPUB Decommissioned	CPU B transitioned from the commissioned state to the decommissioned state.	Contact GE Post Sales Service if this occurs when not expected (see How to contact us on page 2).

A.2.5 CPU Status Events

Table A-6 CPU Status Events

Event	Description	Notes and Troubleshooting tips
Power On	CPU has powered on	
Discrete IO Test Mode Initiated	Test mode for discrete I/O has been initiated	
Discrete IO Test Mode Ended	Test mode for discrete I/O has ended	
All Metering and Protection Disabled	CPU is not performing any metering or protection, either because it does not have a valid option string or the firmware download is invalid	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Invalid PT Rating Volts Suspended	Programmed PT rating is not valid, no voltage relays or metering will be done for Messengers that use that Messenger as a voltage source	Contact GE Post Sales Service (see How to contact us on page 2).
CPU Synch Clock Calibration OK	Periodicity of CPU Synch Clock is within spec limits	
Caution CPU Synch Clock Error Backup Clock On	CPU cannot use CPU Synch Clock (Synch Clock is missing or calibration failed) and is running from the software backup clock	Verify that CPU Synch Clock is present and powered. If it is, contact GE Post Sales Service (see How to contact us on page 2).
CPU Synch Clock OK	CPU is running from the CPU Synch Clock	
CPU Synch Clock Freq Mismatch	CPU Synch Clock is interrupting at 50 Hz and CPU is programmed for 60 Hz, or vice versa	Contact GE Post Sales Service (see How to contact us on page 2).
Waveform Capture Ignored Check Messngr Status	All Messengers either decommissioned or are not communicating, so no waveform data was captured	Contact GE Post Sales Service (see How to contact us on page 2).
Waveform Capture Ignored Buffer Protection On	Waveform buffer is full and write protection is on, so waveform was not captured.	Clear waveforms, or allow Automatic Overwrite of waveforms.
Waveform Capture Triggered By FlexLogic	Logged when FlexLogic triggers a waveform capture	
Note Ethernet Err Port1 Receive Invalid Frame	CPU received an invalid frame on Ethernet port 1 (e.g., invalid MAC address or size, invalid data size)	Verify that no devices other than the Messengers and CPU are plugged into the switch that connects the Messengers and CPU.
Note Ethernet Err Port1 Receive	CPU detected an error on ethernet port 1	Contact GE Post Sales Service (see How to contact us on page 2).
Note Ethernet Err Port1 Send	CPU failed to send an Ethernet packet from port 1.	Contact GE Post Sales Service (see How to contact us on page 2).
Note Ethernet Err Port1 Send Restart	CPU restarted Ethernet port 1 transmit-driver.	Contact GE Post Sales Service (see How to contact us on page 2).
Note Ethernet Err Port1 Send Queue Full	CPU failed to send an Ethernet packet from port 1 because Ethernet driver transmit-buffer is full.	Contact GE Post Sales Service (see How to contact us on page 2).

Table A-6 CPU Status Events

Event	Description	Notes and Troubleshooting tips
Attention Messngr Decommssned Msg Proto Ver	Message protocol version sent by Messenger does not match what is expected, Messenger decommissioned	Messenger and CPU are incompatible, contact GE Post Sales Service (see How to contact us on page 2).
Attention Messngr Decommssned Dupe IDs Seqs	Two Messengers with the same ID have been detected	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Messngr Decommssned Dupe Ids	Two Messengers with the same ID have been detected	Contact GE Post Sales Service (see How to contact us on page 2).
Adv Protection Default To Bus Cfg 1 Brkr Err	Topology breaker is in an undefined state (i.e. not open and not closed), therefore system topology cannot be determined and CPU has defaulted to bus configuration 1	Breaker service issue, contact GE Post Sales Service (see How to contact us on page 2).
Breaker Topology State Change	Breaker topology has changed	
Multipoint Relays Topology State Change	Logged when system topology changes	
Adv Protection Default To Bus Cfg 1 File Err	Configuration files that define the system topology states is bad or missing, and the CPU has defaulted to bus configuration 1	Contact GE Post Sales Service (see How to contact us on page 2).
Discrete IO Disabled Invalid Cfg Card 1	CPU is unable to configure I/O for Card 1	Contact GE Post Sales Service (see How to contact us on page 2).
Discrete IO Disabled Invalid Cfg Card 2	CPU is unable to configure I/O for Card 2	Contact GE Post Sales Service (see How to contact us on page 2).
Discrete IO Disabled Card In Wrong Slot	Only one I/O card detected, and it is plugged into PMC1 instead of PMC0	Contact GE Post Sales Service (see How to contact us on page 2).
Caution System Topology Defaulted	The system has reverted to the default topology (topology 1). This occurs when the CPU is unable to determine the state of one or more of the topology breakers.	Breaker service issue, contact GE Post Sales Service (see How to contact us on page 2).
Attentn PT Sources Defaulted Invalid Cfg File	The file that describes the PT sources for each breaker for each topology is invalid. Each breaker is now using its own voltage information, if any (this is the default state).	Contact GE Post Sales Service (see How to contact us on page 2).
PT Throwover Has Occurred	Something has caused the system topology to change (typically a topology breaker has opened or closed), and the PT sources for some breakers may have changed.	
Messngr Decommissioned Manual Command	Messenger was decommissioned by a command received over Modbus	
Messngr Commissioned Manual Command	Messenger was commissioned	
ZSI Zone 1...4 Operation	ZSI has udpated the delay times for functions in zone 1...4	

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Table A-6 CPU Status Events

Event	Description	Notes and Troubleshooting tips
ZSI Zone 1...4 Enabled	ZSI functionality for zone 1...4 has been enabled	
ZSI Zone 1...4 Disabled	ZSI functionality for zone 1...4 has been disabled	
Protection Suspended ZSI File Error	Bad or missing ZSI configuration file, functionality is suspended	Contact GE Post Sales Service (see How to contact us on page 2).
Caution CPU Not Rcv From Messngr	The CPU is not receiving data from a Messenger	Check Ethernet connection between the Entellisys Messenger and switch, and the connection between the switch and CPU. Verify that Messenger is powered on and operating.
CPU Receiving From Messngr	The CPU is receiving data from a Messenger	
Attention Discrete IO Error FlexLogic Disabled	Number of discrete I/O cards detected by CPU does not match number that it has been programmed to expect	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Memory CRC Error Replace CPU	CRC error has been detected in the CPU memory, CPU should be replaced	Contact GE Post Sales Service (see How to contact us on page 2).
CPUA Assumes Control Logic	CPUA is running the control scheme	
CPUA Relinquishes Control Logic	CPUA is no longer running the control scheme	
CPUB Assumes Control Logic	CPUB is running the control scheme	
CPUB Relinquishes Control Logic	CPUB is no longer running the control scheme	
Attention Duplicate CPU IDs Found	Both CPUs have the same ID	Contact GE Post Sales Service (see How to contact us on page 2).
Note CPU Internal Error 1	CPU detected an internal error	Contact GE Post Sales Service (see How to contact us on page 2).
Note CPU Internal Error 2	CPU detected an internal error	Contact GE Post Sales Service (see How to contact us on page 2).
Note CPU Internal Error 4	CPU detected an internal error	Contact GE Post Sales Service (see How to contact us on page 2).

Table A-6 CPU Status Events

Event	Description	Notes and Troubleshooting tips
CPU Updates (firmware & options)		
CPU Firmware Download Started	CPU firmware download process started	
CPU Firmware Download Complete	New firmware has been downloaded to CPU	
Upgrade Successful	New option string successfully downloaded to CPU	
Upgrade Failure Internal Error 2	CPU detected an internal error during the option upgrade process	Contact GE Post Sales Service (see How to contact us on page 2).
Upgrade Failure Internal Error 3	CPU detected an internal error during the option upgrade process	Contact GE Post Sales Service (see How to contact us on page 2).
Upgrade Failure Internal Error 4	CPU detected an internal error during the option upgrade process	Contact GE Post Sales Service (see How to contact us on page 2).
Upgrade Failure Option String Corrupt	Invalid or corrupted option string: incorrect option string format	Contact GE Post Sales Service (see How to contact us on page 2).
Upgrade Failure Unable To Decrypt	Invalid or corrupted option string: decryption failure or bad digital signature	Contact GE Post Sales Service (see How to contact us on page 2).
Upgrade Failure Due To Bad CRC	Invalid or corrupted option string: bad CRC	Contact GE Post Sales Service (see How to contact us on page 2).
Upgrade Failure Hardware Mismatch	Invalid or corrupted option string: MAC address mismatch	Contact GE Post Sales Service (see How to contact us on page 2).
CPU Firmware Failure Previous Version In Use	CPU firmware upgrade operation failed; CPU is using previous firmware version	Contact GE Post Sales Service (see How to contact us on page 2).
Attention New Messngr Options Deficient	More per-breaker options are enabled then the number available per the option string. This can occur when a new option string is loaded that contains fewer per-breaker options than the original option string.	The CPU will allocate the options to the lowest numbered breakers that have the option specified. For metering options, allocate the available meters to the desired breakers. For relaying options, contact GE Post Sales Service (see How to contact us on page 2).

A.2.6 Breaker Command and Control Events

Table A-7 Breaker Command and Control Events

Event	Description	Notes and Troubleshooting tips
Breaker Close Command Issued from HMI For [Breaker Name]	Logged when an operator issues a close command for a given breaker	
Breaker Open Command Issued from HMI For [Breaker Name]	Logged when an operator issues an open command for the specified breaker	
Breaker Trip Command Issued from HMI For [Breaker Name]	Logged when an operator issues a trip command for the specified breaker	
[Alarm Name] Is In Alarm Condition	The specified alarm has entered the active condition.	
Attention: Control Power 1 Outage Detected On Battery Backup	The primary control power source has experienced an outage and is now operating from the UPS battery backup.	
Attention: Control Power 1 Low Battery Detected Shutdown in 2 mins	The HMI will shutdown in the specified amount of time due to impending outage of the UPS battery backup.	
Control Power 1 Power Restored	Power has been restored to the primary control power bus.	
<USER ID> Requested Multipoint RELT	Logged by HMI when user initiates RELT	
<USER ID> Requested To End Multipoint RELT	Logged by HMI when user turns off RELT	

A.2.7 Breaker Status Events

Table A-8 Breaker Status Events

Event	Description	Notes and Troubleshooting tips
Attention Breaker Open Failed Shunt Trip	CPU sent an open with shunt trip command to Messenger, but data sent by Messenger indicates that breaker did not open	• Verify that breaker is in the Test or Connect position. • Check shunt trip fuse. • Contact GE Post Sales Service (see How to contact us on page 2).

Table A-8 Breaker Status Events

Event	Description	Notes and Troubleshooting tips
Attention Breaker Close Failed	CPU sent a close command to Messenger, but data sent by Messenger indicates that breaker did not close	• Verify that breaker is in the Test or Connect position. • Verify that breaker is an electric breaker. If it is, verify that closing spring is charged, also check the fuse for the charging motor. • Contact GE Post Sales Service (see How to contact us on page 2).
Attention Breaker Trip Failed Shunt Trip	CPU sent a trip with shunt trip command to Messenger, but data sent by Messenger indicates that breaker did not open	• Verify that breaker is in the Test or Connect position. • Check shunt trip fuse. • Contact GE Post Sales Service (see How to contact us on page 2).
Attention Breaker Open Failed Flux Shifter	CPU sent an open with flux shifter command to Messenger, but data sent by Messenger indicates that breaker did not open	• Verify that the breaker is in the Test or Connect position. • Contact GE Post Sales Service (see How to contact us on page 2).
Attention Breaker Trip Failed Flux Shifter	CPU sent a trip with flux shifter command to Messenger, but data sent by Messenger indicates that breaker did not open	• Verify that the breaker is in the Test or Connect position. • Contact GE Post Sales Service (see How to contact us on page 2).
Breaker Opened	Breaker has opened	
Breaker Closed	Breaker has closed	
Breaker Lockout	Breaker is locked out	
Breaker Closing Spring Charged	Breaker closing spring is charged	
Breaker Primary Connected	Breaker primary is connected	
Breaker Primary Disconnected	Breaker primary is disconnected	
Breaker Secondary Connected	Breaker secondary is connected	
Breaker Secondary Disconnected	Breaker secondary is disconnected	
Breaker Tripped	Breaker has tripped	
Breaker Close Command Rejected Breaker Locked Out	Breaker is locked out, so CPU has rejected the close command	• If breaker has a manual lockout, verify that the lockout has been reset. • If the breaker has a network interlock, the control logic is likely causing the breaker to reject the close command. • Contact GE Post Sales Service (see How to contact us on page 2).
Attention IO Card Detection Mismatch Found 0 of 1	CPU expected 1 discrete I/O card, but detected none	Contact GE Post Sales Service (see How to contact us on page 2).

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Table A-8 Breaker Status Events

Event	Description	Notes and Troubleshooting tips
Attention IO Card Detection Mismatch Found 0 of 2	CPU expected 2 discrete I/O cards, but detected none	Contact GE Post Sales Service (see How to contact us on page 2).
Attention IO Card Detection Mismatch Found 1 of 0	CPU expected no discrete I/O cards, but detected 1	Contact GE Post Sales Service (see How to contact us on page 2).
Attention IO Card Detection Mismatch Found 1 of 2	CPU expected 2 discrete I/O cards, but detected 1	Contact GE Post Sales Service (see How to contact us on page 2).
Attention IO Card Detection Mismatch Found 2 of 0	CPU expected no discrete I/O cards, but detected 2	Contact GE Post Sales Service (see How to contact us on page 2).
Attention IO Card Detection Mismatch Found 2 of 1	CPU expected 1 discrete I/O card, but detected 2	Contact GE Post Sales Service (see How to contact us on page 2).

A.2.8 Protection Relay Events

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Alarm Pickup Undervoltage	Alarm only undervoltage relay has entered pickup	
Alarm Undervoltage	Alarm only undervoltage relay has operated	
Alarm Dropout Undervoltage	Alarm only undervoltage relay has dropped out of pickup	
Voltage Below Undervoltage Alarm Blocking Voltage	The voltages on all three phases have dropped below the alarm only undervoltage blocking voltage threshold.	
Voltage Above Undervoltage Alarm Blocking Voltage	The voltage on at least one of the three phases has exceeded the alarm only undervoltage blocking voltage threshold.	
Pickup Undervoltage	Undervoltage relay has entered pickup	
Breaker Trip Undervoltage	Undervoltage relay has operated	
Dropout Undervoltage	Undervoltage relay has dropped out of pickup	
Voltage Below Undervoltage Blocking Voltage	The voltages on all three phases have dropped below the undervoltage blocking voltage threshold.	
Voltage Above Undervoltage Blocking Voltage	The voltage on at least one of the three phases has exceeded the undervoltage blocking voltage threshold.	
Alarm Pickup Overvoltage	Alarm only overvoltage relay has entered pickup	
Alarm Overvoltage	Alarm only overvoltage relay has operated	

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Relays - Overvoltage and Phase Loss		
Alarm Dropout Overvoltage	Alarm only overvoltage relay has dropped out of pickup	
Pickup Overvoltage	Overvoltage relay has entered pickup	
Breaker Trip Overvoltage	Overvoltage relay has operated	
Dropout Overvoltage	Overvoltage relay has dropped out of pickup	
Alarm Pickup Phase Loss	Alarm only phase loss relay has entered pickup	
Alarm Phase Loss	Alarm only phase loss relay has operated	
Alarm Dropout Phase Loss	Alarm only phase loss relay has dropped out of pickup	
Voltage Below Phase Loss Alarm Blocking Voltage	The voltages on all three phases have dropped below the alarm only phase loss blocking voltage threshold.	
Voltage Above Phase Loss Alarm Blocking Voltage	The voltage on at least one of the three phases has exceeded the alarm only phase loss blocking voltage threshold.	
Pickup Phase Loss	Phase loss relay has entered pickup	
Breaker Trip Phase Loss	Phase loss relay has operated	
Dropout Phase Loss	Phase loss relay has dropped out of pickup	
Voltage Below Phase Loss Blocking Voltage	The voltages on all three phases have dropped below the phase loss blocking voltage threshold.	
Voltage Above Phase Loss Blocking Voltage	The voltage on at least one of the three phases has exceeded the phase loss blocking voltage threshold.	
Relays - High Current		
Alarm Pickup High Current	High current relay has entered pickup	
Alarm High Current	High current relay has operated	
Alarm Dropout High Current	High current relay has dropped out of pickup	
Relays - Frequency and Reverse Power		
Alarm Pickup Reverse Power	Alarm only reverse power relay has entered pickup	
Alarm Reverse Power	Alarm only reverse power relay has operated	
Alarm Dropout Reverse Power	Alarm only reverse power relay has dropped out of pickup	

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Pickup Reverse Power	Reverse power relay has entered pickup	
Breaker Trip Reverse Power	Reverse power relay has operated	
Dropout Reverse Power	Reverse power relay has dropped out of pickup	
Alarm Pickup Underfrequency	Alarm only underfrequency relay has entered pickup	
Alarm Underfrequency	Alarm only underfrequency relay has operated	
Alarm Dropout Underfrequency	Alarm only underfrequency relay has dropped out of pickup	
Voltage Below Underfreq Alarm Blocking Voltage	The voltages on all three phases have dropped below the alarm only underfrequency blocking voltage threshold.	
Voltage Above Underfreq Alarm Blocking Voltage	The voltage on at least one of the three phases has exceeded the alarm only underfrequency blocking voltage threshold.	
Pickup Underfrequency	Underfrequency relay has entered pickup	
Breaker Trip Underfrequency	Underfrequency relay has operated	
Dropout Underfrequency	Underfrequency relay has dropped out of pickup	
Voltage Below Underfrequency Blocking Voltage	The voltages on all three phases have dropped below the underfrequency blocking voltage threshold.	
Voltage Above Underfrequency Blocking Voltage	The voltage on at least one of the three phases has exceeded the underfrequency blocking voltage threshold.	
Alarm Pickup Overfrequency	Alarm only overfrequency relay has entered pickup	
Alarm Overfrequency	Alarm only overfrequency relay has operated	
Alarm Dropout Overfrequency	Alarm only overfrequency relay has dropped out of pickup	
Voltage Below Overfreq Alarm Blocking Voltage	The voltages on all three phases have dropped below the alarm only overfrequency blocking voltage threshold.	
Voltage Above Overfreq Alarm Blocking Voltage	The voltage on at least one of the three phases has exceeded the alarm only overfrequency blocking voltage threshold.	
Pickup Overfrequency	Overfrequency relay has entered pickup	
Breaker Trip Overfrequency	Overfrequency relay has operated	

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Dropout Overfrequency	Overfrequency relay has dropped out of pickup	
Voltage Below Overfrequency Blocking Voltage	The voltages on all three phases have dropped below the overfrequency blocking voltage threshold.	
Voltage Above Overfrequency Blocking Voltage	The voltage on at least one of the three phases has exceeded the overfrequency blocking voltage threshold.	
Bus Differential Events		
Pickup Bus Diff Zone 1...4 Settings 1	Bus differential for zone 1...4, settings 1 has entered pickup	
Dropout Bus Diff Zone 1...4 Settings 1	Bus differential for zone 1...4, settings 1 has dropped out of pickup	
Breakers Trip Bus Diff Zone 1...4 Settings 1	Bus differential for zone 1...4, settings 1 has operated and tripped the breakers	
Breakers Trip Backup Bus Diff Zone 1...4 Settings1	Bus differential backup for zone 1...4, settings 1 has operated and tripped the breakers	
Pickup Bus Diff Zone 1...4 Settings 2	Bus differential for zone 1...4, settings 2 has entered pickup	
Dropout Bus Diff Zone 1...4 Settings 2	Bus differential for zone 1...4, settings 2 has dropped out of pickup	
Breakers Trip Bus Diff Zone 1...4 Settings 2	Bus differential for zone 1...4, settings 2 has operated and tripped the breakers	
Breakers Trip Backup Bus Diff Zone 1...4 Settings2	Bus differential backup for zone 1...4, settings 2 has operated and tripped the breakers	
Alarm Pickup Bus Diff Zone 1...4 Settings 1	Alarm only bus differential for zone 1...4, settings 1 has entered pickup	
Alarm Dropout Bus Diff Zone 1...4 Settings 1	Alarm only bus differential for zone 1...4, settings 1 has dropped out of pickup	
Alarm Bus Diff Zone 1...4 Settings 1	Alarm only bus differential for zone 1...4, settings 1 has operated	
Alarm Pickup Bus Diff Zone 1...4 Settings 2	Alarm only bus differential for zone 1...4, settings 2 has entered pickup	
Alarm Dropout Bus Diff Zone 1...4 Settings 2	Alarm only bus differential for zone 1...4, settings 2 has dropped out of pickup	
Alarm Bus Diff Zone 1...4 Settings 2	Alarm only bus differential for zone 1...4, settings 2 has operated	

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Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Protection Disabled Invalid Cfg Bus Diff	File that contains configuration information for bus differential is bad or missing, all bus differential functions are disabled	Contact GE Post Sales Service (see How to contact us on page 2).
Protection Suspended Zone 1...4 Bus Diff	Bus differential (trip and alarm only) for zone 1...4 has been suspended	Examine Sequence of Events for cause. It can be any one of the following: • Current on one or more phases exceeded 10X (overcurrent pickup/trip event) • Messenger at a breaker in the zone is not communicating (Caution CPU Not Rcv From Messngr) • Messenger at a breaker in the zone has been decommissioned (Attention Messngr Decommssned Msg Proto Ver, Attention Messngr Decommssned Dupe IDs Seqs, or Attention Messngr Decommssned Dupe Ids) • A Compartment ID button at a breaker in the zone has been misconfigured • At least one of the breakers in the zone has been put into test mode (Test Mode Initiated from Test Kit)
Protection Resumed Zone 1...4 Bus Diff	Bus differential (trip and alarm only) for zone 1...4 has resumed	
Invalid BusDiff Zone1...4 Set1 Pkup Chng Rejctd	Pickup setting 1 for bus differential for zone 1...4 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid BDiff Zone1...4 Set1 Alm Pkup Chng Rejctd	Pickup setting 1 for alarm only bus differential for zone 1...4 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid BusDiff Zone1...4 Set2 Pkup Chng Rejctd	Pickup setting 2 for bus differential for zone 1...4 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid BDiff Zone1...4 Set2 Alm Pkup Chng Rejctd	Pickup setting 2 for alarm only bus differential for zone 1...4 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid BusDiff Zone1...4 Set1 Pkup Min Used	Pickup setting 1 for bus differential for zone 1...4 has been set to the minimum allowable (current setting is too low)	Check pickup setting for BD zone. Value can be set higher if desired.
Invalid BDiff Zone1...4 Set1 Alm Pkup Min Used	Pickup setting 1 for alarm only bus differential for zone 1...4 has been set to the minimum allowable (current setting is too low)	Check pickup setting for BD zone. Value can be set higher if desired.
Invalid BusDiff Zone1...4 Set2 Pkup Min Used	Pickup setting 2 for bus differential for zone 1...4 has been set to the minimum allowable (current setting is too low)	Check pickup setting for BD zone. Value can be set higher if desired.

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Invalid BDiff Zone1...4 Set2 Alm Pkup Min Used	Pickup setting 2 for alarm only bus differential for zone 1...4 has been set to the minimum allowable (current setting is too low)	Check pickup setting for BD zone. Value can be set higher if desired.
Multi-Source Ground Fault Events		
Pickup Multi Source GF Zone 1...4	Multi source ground fault for zone 1...4 has entered pickup	
Dropout Multi Source GF Zone 1...4	Multi source ground fault for zone 1...4 has dropped out of pickup	
Breakers Trip Multi Source GF Zone 1...4	Multi source ground fault for zone 1...4 has operated and tripped the breakers	
Breakers Trip Backup Multi Source GF Zone 1...4	Multi source ground fault backup for zone 1...4 has operated and tripped the breakers	
Alarm Pickup Multi Source GF Zone 1...4	Alarm only multi source ground fault for zone 1...4 has entered pickup	
Alarm Dropout Multi Source GF Zone 1...4	Alarm only multi source ground fault for zone 1...4 has dropped out of pickup	
Alarm Multi Source GF Zone 1...4	Alarm only multi source ground fault for zone 1...4 has operated	
Pickup Multi Source GF Sum Zone 1...2	Multi source ground fault for summation zone 1...2 has entered pickup	
Dropout Multi Source GF Sum Zone 1...2	Multi source ground fault for summation zone 1...2 has dropped out of pickup	
Breaker Trip Multi Source GF Sum Zone 1...2	Multi source ground fault for summation zone 1...2 has operated and tripped the breakers	
Alarm Pickup Multi Source GF Sum Zone 1...2	Alarm only multi source ground fault for summation zone 1...2 has entered pickup	
Alarm Dropout Multi Source GF Sum Zone 1...2	Alarm only multi source ground fault for summation zone 1...2 has dropped out of pickup	
Alarm Multi Source GF Sum Zone 1...2	Alarm only multi source ground fault for summation zone 1...2 has operated and tripped the breakers	
Protection Disabled Invalid Cfg Multi Src GF	File that contains configuration information for multi source ground fault is bad or missing, all multi source ground fault functions are disabled	Contact GE Post Sales Service (see How to contact us on page 2).

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Protection Suspended Zone 1…4 Multi Source GF	Multi source ground fault (trip and alarm only) for zone 1…4 has been suspended	Examine Sequence of Events for cause. It can be any one of the following: • Current on one or more phases exceeded 10X (overcurrent pickup/trip event) • Messenger at a breaker in the zone is not communicating (Caution CPU Not Rcv From Messngr) • Messenger at a breaker in the zone has been decommissioned (Attention Messngr Decommssned Msg Proto Ver, Attention Messngr Decommssned Dupe IDs Seqs, or Attention Messngr Decommssned Dupe Ids) • A Compartment ID button at a breaker in the zone has been misconfigured • At least one of the breakers in the zone has been put into test mode (Test Mode Initiated From Test Kit)
Protection Resumed Zone 1…4 Multi Source GF	Multi source ground fault (trip and alarm only) for zone 1…4 has resumed	
Protection Suspended Zone 1…2 Sum Multi Src GF	Multi source ground fault (trip and alarm only) for summation zone 1…2 has been suspended	Same as Protection Suspended Zone 1…4 Multi Source GF
Protection Resumed Zone 1…2 Sum Multi Src GF	Multi source ground fault (trip and alarm only) for summation zone 1…4 has resumed	
Invalid Set MSGF Zone1…4 Pkup Chng Rejctd	Pickup setting for multi source ground fault for zone 1…4 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid Set MSGF Zone1…4 Alrm Pkup Chng Rejctd	Pickup setting for alarm only multi source ground fault for zone 1…4 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid Set MSGF Zone1…4 Pkup Min Used	Pickup setting for multi source ground fault for zone 1…4 has been set to the minimum allowable (current setting is too low)	Check pickup setting for MSGF zone. Value can be set higher if desired.
Invalid Set MSGF Zone1…4 Alrm Pkup Min Used	Pickup setting 1 for alarm only multi source ground fault for zone 1…4 has been set to the minimum allowable (current setting is too low)	Check pickup setting for MSGF zone. Value can be set higher if desired.
Invalid MSGF Sum Zone1…2 Pkup Chng Rejctd	Pickup setting for multi source ground fault for summation zone 1…2 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid MSGF Sum Zone1…2 Alrm Pkup Chng Rejctd	Pickup setting for alarm only multi source ground fault for summation zone 1…2 is too low, change is rejected	Set pickup value above the minimum allowed (20% of the smallest CT rating in the zone); CPU sets value to minimum in this case.
Invalid MSGF Sum Zone1…2 Pkup Min Used	Pickup setting for multi source ground fault for summation zone 1…2 has been set to the minimum allowable (current setting is too low)	Check pickup setting for MSGF Summation zone. Value can be set higher if desired.

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Invalid MSGF Sum Zone1…2 Alrm Pkup Min Used	Pickup setting 1 for alarm only multi source ground fault for summation zone 1…2 has been set to the minimum allowable (current setting is too low)	Check pickup setting for MSGF Summation zone. Value can be set higher if desired.
Relays – High Resistance GF		
Pickup High Resistance GF	High resistance ground fault has entered pickup	
Dropout High Resistance GF	High resistance ground fault has dropped out of pickup	
Alarm High Resistance GF	High resistance ground fault alarm has operated	
Invalid Settings HRGF Unable To Detect Phase	The product of the pickup current setting and the ground resistance setting is greater than the nominal phase voltage	Check pickup current and ground resistance settings.
Relays – High Resistance GF Location		
HRGF Location - Fault Located Function 1-4	Logged when location function 1 located fault at a breaker. Each breaker that location function locates fault at will have a separate event logged.	
HRGF Location - Automatic Mode Started Function 1-4	Logged when location function 1 is started locating the fault in automatic mode.	
HRGF Location - Automatic Mode Ended Function 1-4	Logged when automatic mode finishes regardless of the location results for location function 1	
HRGF Location - Manual Mode Started Function 1-4	Logged when location function 1 is started locating the fault in manual mode.	
HRGF Location - Manual Mode Stopped Function 1-4	Logged when manual mode location is interrupted by user regardless of the location results for location function 1	
Alarm HRGF Location Function	Logged when location function 1 activates alarm.	
HRGF Location Trip Function 1-4 Could Not Issue Trip	Logged when HRGF Location could not issue a trip command.	
HRGF Location Trip Function 1-4 In Pick Up	Logged when HRGF Location is in pick up	
HRGF Location Trip Function 1-4 Drop Out	Logged when HRGF Location is in drop out	
HRGF Location - Breaker Trip	Logged when location function 1 trips located	
HRGF Location - Discrete Output Unavail Function 1-4	Logged when one of the following conditions takes place - no discrete I/O card in the system, wrongly configured or hardware failure - no discrete outputs are configured - none of the configured outputs is set to be operated by HRGF Location function 1	

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
HRGF Location - Detection Not Optioned Function 1-4	Logged when breaker that location function 1 is associated with does not have HRGF optioned.	
HRGF Location Incomplete Missing Data Function 1-4	This event is logged when some messengers are either decommissioned or non-communicating or not-synched.	
Relays – Synch Check		
Synch Check Control Enabled 1…12	Synch check relay 1…12 has been enabled	
Synch Check Control Disabled 1…12	Synch check relay 1…12 has been disabled	
Synch Check 1…12 Sources Not Synchronized	Messengers that are providing voltage information for synch check relay are not synchronized, so the CPU is unable to check for synchronization between voltage sources.	This should only happen on start-up, or when a Messenger is connected to the system (or rebooted). If it happens repeatedly during normal operation, contact GE Post Sales Service (see How to contact us on page 2).
Synch Check 1…12 Sources Not Compatible	Voltage sources for synch check relay 1…12 are not compatible; i.e., they have different PT configurations or ratings	• Verify that the Source Voltages for the synch check relay are correct. • Verify that the source voltages have the correct PT configurations.
Synch Check 1…12 Dead Source Operate	Dead source criteria for synch check relay 1…12 have been met	
Synch Check 1…12 Dead Source Drop Out	Dead source criteria for synch check relay 1…12 have been met	
Synch Check 1…12 V1 Above Minimum	Voltage source 1 for synch check relay 1…12 is above the live source threshold	
Synch Check 1…12 V1 Below Maximum	Voltage source 1 for synch check relay 1…12 is below the dead source threshold	
Synch Check 1…12 V2 Above Minimum	Voltage source 2 for synch check relay 1…12 is above the live source threshold	
Synch Check 1…12 V2 Below Maximum	Voltage source 2 for synch check relay 1…12 is below the dead source threshold	
Overcurrent (including GF)		
Pickup ST Overcurrent	Short time overcurrent function has entered pickup	
Dropout ST Overcurrent	Short time overcurrent function has dropped out of pickup	
Breaker Trip ST Overcurrent	Breaker tripped due to short time overcurrent condition	
Pickup LT Overcurrent	Long time overcurrent function has entered pickup	

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Dropout LT Overcurrent	Long time overcurrent function has dropped out of pickup	
Breaker Trip LT Overcurrent	Breaker tripped due to long time overcurrent condition	
Pickup Ground Fault	Ground fault function has entered pickup	
Dropout Ground Fault	Ground fault function has dropped out of pickup	
Breaker Trip Ground Fault	Breaker tripped due to ground fault condition	
Alarm Ground Fault	Ground fault alarm has operated	
Invalid Setting IOC Change Rejected	Attempt to enable or disable IOC has been rejected	The setting entered for IOC enable was inconsistent with the protection options configured at the Compartment ID. Verify that the protection options are correct.
Invalid Setting IOC Pickup Change Rejected	Attempt to change IOC pickup setting has been rejected	The value entered for the IOC pickup setting was inconsistent with the protection options and frame size configured at the Compartment ID. Select a value that is consistent with these parameters.
Invalid Setting GF Change Rejected	Attempt to enable or disable ground fault has been rejected	The setting entered for GF enable was inconsistent with the protection options configured at the Compartment ID. Verify that the protection options are correct.
Invalid Setting GF Pickup Change Rejected	Attempt to change the ground fault pickup setting has been rejected	The value entered for the GF pickup setting was inconsistent with the protection options and frame size configured at the Compartment ID. Select a value that is consistent with these parameters.
Invalid Setting ST Change Rejected	Attempt to enable or disable short time has been rejected	The setting entered for ST enable was inconsistent with the protection options configured at the Compartment ID. Verify that the protection options are correct.
Invalid Setting ST Pickup Change Rejected	Attempt to change the short time pickup setting has been rejected	The value entered for the ST pickup setting was inconsistent with the protection options and frame size configured at the Compartment ID. Select a value that is consistent with these parameters.
GF Trip Priority Disabled ZSI Not Optioned	During initialization, GF Tripping Priority function checks out whether ZSI is optioned in the system. If it finds out that ZSI is not optioned, this event is logged	
Alarm Pickup Ground Fault	Logged when current is above pickup level of ground fault alarm functionality.	

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Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Alarm Dropout Ground Fault	Logged when current goes below dropout level of ground fault alarm functionality.	
GF Trip Priority Suspended	This event is no longer needed. We are simplifying the implementation and removing dependencies on ZSI type as well as ZSI enabled/disabled state. As a result this event will be removed.	
GF Trip Priority Resumed	This event is no longer needed. We are simplifying the implementation and removing dependencies on ZSI type as well as ZSI enabled/disabled state. As a result this event will be removed.	
GF Trip Priority Disabled MSGF Optioned	Logged during initialization when GF Tripping Priority function detects MSGF option in the system. Function disables itself at this point	
GF Trip Priority Operated	Logged when function modifies time delay of GF protection element of any breaker that takes part in GF tripping priority scheme.	
High Current Transient Relay		
HCTR Waveforms Max Count Reached	Logged when maximum number of waveforms have been triggered by the function	
HCTR Waveforms Counter Reset	Logged when user reset triggered waveform counter	
Alarm Pickup High Current Trigger	Logged when current goes above pickup level.	
Alarm Dropout High Current Trigger	Logged when current goes below dropout level	
Alarm High Current Trigger	Logged when function operated	
Reduced Energy Let - Thru (RELT)		
RELT Mode ON / OFF	Logged when a breaker goes into or out of RELT mode	
RELT Mode Multipoint ON / OFF	Logged when Multi-point goes into or out of RELT mode	
RELT Mode System Wide ON / OFF	Logged when System Wide goes into or out of RELT mode	
RELT Mode - ON / OFF request from Initiating Breaker	Logged when an associated breaker initiates RELT mode on a breaker	See section 8.1.4 RELT Groups on page 230
RELT Mode - ON / OFF request from Modbus Device	Logged when a Modbus device initiates RELT mode on a breaker	See section 8 Reduced Energy Let-Thru Mode on page 225

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
RELT Mode Multipoint - ON / OFF request from User	Logged when a user enables or disables Multi-point RELT from the HMI	See section 8 Reduced Energy Let-Thru Mode on page 225
RELT Mode - ON / OFF request from User	Logged when a user enables or disables Single-point RELT from the HMI	See section 8 Reduced Energy Let-Thru Mode on page 225
RELT Mode System Wide - ON / OFF request from User	Logged when a user enables or disables System Wide RELT from the HMI	
RELT Mode System Wide - ON / OFF request from FlexLogic	Logged when FlexLogic enables or disables System Wide RELT	
RELT Mode Multipoint - OFF request from Modbus Dvc	Logged when a Modbus device initiates Multi-point RELT mode	
RELT Mode System Wide - ON request from Modbus Dvc	Logged when a Modbus device initiates System Wide RELT mode	
Attention: RELT lock limit reached - Modbus Device	Logged if more than 8 Modbus devices attempt to enable RELT for an individual breaker	
Attention: RELT Multipt lock limit reached-Modbus	Logged if more than 8 Modbus devices attempt to enable Multi-point RELT	
Attention: RELT Sys Wide lock limit reached-Modbus	Logged if more than 8 Modbus devices attempt to enable System Wide RELT	
Attention: RELT failed to initiate - iButn cfg err	RELT failed due to an IButton error	
Attention: RELT failed to initiate - Comm Loss	RELT failed due to a comm loss	
Attention: RELT failed to initiate - LT Pickup	RELT failed because one of the breakers was in Long Time Pickup	
Attn: RELT MPt failed to initiate-missing options	Multi-point RELT failed because none of the Multi-point relays are optioned	
RELT Mode Multipoint - ON / OFF Request From FlexLogic	Logged when FlexLogic enables / disables multipoint RELT	
RELT Mode - ON / OFF Request From FlexLogic	Logged when FlexLogic enables / disables RELT on an individual breaker	
Over and Under Demand Alarm		
Alarm Pickup Over-Demand Flex XX	Over-Demand Flex Relay has entered pickup	
Alarm Dropout Over-Demand Flex XX	Over-Demand Flex Relay has dropped out of pickup	
Alarm Over-Demand Flex XX	Over-Demand Alarm Relay has operated	

Table A-9 Protection Relay Events

Event	Description	Notes and Troubleshooting tips
Alarm Pickup Under-Demand Flex XX	Under-Demand Flex Relay has entered pickup	
Alarm Dropout Under-Demand Flex XX	Under-Demand Flex Relay has dropped out of pickup	
Alarm Under-Demand Flex XX	Under Demand Alarm Relay has operated	

A.2.9 Messenger/Breaker Config Status Events

Table A-10 Messenger/Breaker Config Status Events

Event	Description	Notes and Troubleshooting tips
Caution Flux Shifter Failure Reported	Messenger's Flux Shifter Circuit monitor has malfunctioned.	• Messenger should be replaced immediately.
Caution Messngr Control Power 1 Lost	Messenger reports that it has lost control power source 1	• Check LINE LED on UPS. If it is off, check the main power switch on the UPS. If it is off, turn it on. Otherwise, check the control power fuse between the transformer and the UPS. • If the LINE LED is on, check the ON LINE LED. If it is off, see the UPS manual. • Check UPS fuse. • Contact GE Post Sales Service (see How to contact us on page 2).
Caution Messngr Control Power 2 Lost	Messenger reports that it has lost control power source 2	Same as control power 1 lost
Messngr Control Power 1 OK	Messenger reports that control power source 1 is present	
Messngr Control Power 2 OK	Messenger reports that control power source 2 is present	
Note Invalid Breaker Type	Messenger reports a breaker type other than ANSI	Compartment ID button has been misconfigured, contact GE Post Sales Service (see How to contact us on page 2).
Protection Defaulted Invalid Frame Rating	Messenger reports a frame rating value that is not valid, protection settings set to values that are safe for all frame sizes	Compartment ID button has been misconfigured, contact GE Post Sales Service (see How to contact us on page 2).
Protection Defaulted Invalid CT Rating	Messenger reports a CT rating value that is not valid, protection settings set to values that are safe for all frame sizes	Compartment ID button has been misconfigured, contact GE Post Sales Service (see How to contact us on page 2).
Protection Defaulted Frame And CT Mismatch	Messenger reports frame and CT ratings that are inconsistent, protection settings set to values that are safe for all frame sizes	Compartment ID button has been misconfigured, contact GE Post Sales Service (see How to contact us on page 2).

Table A-10 Messenger/Breaker Config Status Events

Event	Description	Notes and Troubleshooting tips
Protection Defaulted Invalid Rating Switch	Messenger reports a rating switch value that is not valid, protection settings set to values that are safe for all frame sizes	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Check Switch Invald LT Overcurrent Set	Messenger reports a long time overcurrent protection pickup setting that is not valid	Contact GE Post Sales Service (see How to contact us on page 2).
Caution Enet Cable Disconnected Messngr CPUA	Messenger reports that it has no ethernet connection to CPU A	Check connection between CPU A and switch, and the switch and the Messenger.
Caution Enet Cable Disconnected Messngr CPUB	Messenger reports that it has no ethernet connection to CPU B	Check connection between CPU B and switch, and the switch and the Messenger.
Attention Messngr Synch Disabld Bad Freq CPUA	Messenger has received an invalid system frequency from CPU A and will not be able to synchronize from it	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Messngr Synch Disabld Bad Freq CPUB	Messenger has received an invalid system frequency from CPU B and will not be able to synchronize from it	Contact GE Post Sales Service (see How to contact us on page 2).
Invalid Setting IOC Mult CPUA Chng Rejected	Messenger has received an invalid IOC pickup setting from CPU A and has rejected the value	This event is recorded by CPU B based on status information sent to the Messenger by CPU A. The Sequence of Events for CPU A should have an “Invalid Setting IOC Change Rejected” or “Invalid Setting IOC Pickup Change Rejected” event. See the description of those events for details.
Invalid Setting IOC Mult CPUB Chng Rejected	Messenger has received an invalid IOC pickup setting from CPU B and has rejected the value	This event is recorded by CPU A based on status information sent to the Messenger by CPU B. The Sequence of Events for CPU B should have an “Invalid Setting IOC Change Rejected” or “Invalid Setting IOC Pickup Change Rejected” event. See the description of those events for details.
Invalid Setting ST From CPUA Change Rejected	Messenger has received an invalid short time enable or disable setting from CPU A and has rejected the value	This event is recorded by CPU B based on status information sent to the Messenger by CPU A. The Sequence of Events for CPU A should have an “Invalid Setting ST Change Rejected” or “Invalid Setting ST Pickup Change Rejected” event. See the description of those events for details.
Invalid Setting ST From CPUB Change Rejected	Messenger has received an invalid short time enable or disable setting from CPU B and has rejected the value	This event is recorded by CPU A based on status information sent to the Messenger by CPU B. The Sequence of Events for CPU B should have an “Invalid Setting ST Change Rejected” or “Invalid Setting ST Pickup Change Rejected” event. See the description of those events for details.

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Table A-10 Messenger/Breaker Config Status Events

Event	Description	Notes and Troubleshooting tips
Invalid Setting GF From CPUA Change Rejected	Messenger has received an invalid ground fault enable or disable setting from CPU A and has rejected the value	This event is recorded by CPU B based on status information sent to the Messenger by CPU A. The Sequence of Events for CPU A should have an "Invalid Setting GF Change Rejected" or "Invalid Setting GF Pickup Change Rejected" event. See the description of those events for details.
Invalid Setting GF From CPUB Change Rejected	Messenger has received an invalid ground fault enable or disable setting from CPU B and has rejected the value	This event is recorded by CPU A based on status information sent to the Messenger by CPU B. The Sequence of Events for CPU B should have an "Invalid Setting GF Change Rejected" or "Invalid Setting GF Pickup Change Rejected" event. See the description of those events for details.
Note Messngr Ignored Invalid Command CPUA	Messenger has received an invalid command from CPU A and will ignore it	Contact GE Post Sales Service (see How to contact us on page 2).
Note Messngr Ignored Invalid Command CPUB	Messenger has received an invalid command from CPU B and will ignore it	Contact GE Post Sales Service (see How to contact us on page 2).
Note Messngr Arbitrated Command From CPUA	Messenger has received conflicting commands from CPU A	Examine event logs from both CPUs to determine if CPUs sent conflicting commands at approximately the same time.
Note Messngr Arbitrated Command From CPUB	Messenger has received conflicting commands from CPU B	Examine event logs from both CPUs to determine if CPUs sent conflicting commands at approximately the same time.
Note Messngr Reports CPUA Command Timed Out	Command sent to Messenger from CPU A has timed out	• Verify that breaker is in the Test or Connect position. • If Open command timed out, check shunt trip fuse. • If Close command timed out, verify that breaker is an electric breaker. If it is, verify that closing spring is charged, also check the fuse for the charging motor. • Contact GE Post Sales Service (see How to contact us on page 2).
Note Messngr Reports CPUB Command Timed Out	Command sent to Messenger from CPU B has timed out	Same as CPU A above.
CPUA Synch Clock OK	Messenger reports that CPU A is using the CPU Synch Clock (event recorded by CPU B)	
CPUB Synch Clock OK	Messenger reports that CPU B is using the CPU Synch Clock (event recorded by CPU A)	
Caution CPUA Synch Clock Err Backup Clock On	Messenger reports that CPU A is not using the CPU Synch Clock (event recorded by CPU B)	Verify that CPU A is connected to the CPU Synch Clock, verify that the CPU Synch Clock is operating correctly.

Table A-10 Messenger/Breaker Config Status Events

Event	Description	Notes and Troubleshooting tips
Caution CPUB Synch Clock Err Backup Clock On	Messenger reports that CPU B is not using the CPU Synch Clock (event recorded by CPU A)	Verify that CPU B is connected to the CPU Synch Clock, verify that the CPU Synch Clock is operating correctly.
Messngr Synchronization OK	Messenger reports that it has successfully synchronized to one of the CPUs	
Messngr Synch Not Locked	Messenger reports that it is not synchronized to either CPUs	It is normal for this to occur during start-up, or when an Entellisys Messenger is first plugged in to the system or rebooted. If it occurs repeatedly during normal operation, contact GE Post Sales Service (see How to contact us on page 2).
Time Server Started	Logged when CPU switches to server mode and starts servicing time synchronization requests	
Time Server Stopped	Logged when CPU switches to client mode and starts polling server for current time	
Time Synchronization Successful	When in client mode CPU logs this event when it received the time packet from time server for the first time.	
Time Server Not Responding Or Not Reachable	When in client mode CPU logs this event when there was no response from time server for time packet request.	
Time Server Not Configured	Logged when server IP address has default value of 0.0.0.0	
Breaker Tripped Analog IOC	Messenger reports that it has tripped the breaker due to an IOC condition (analog circuit)	
Breaker Trip Instantaneous Overcurrent	Messenger reports that it has tripped the breaker due to an IOC condition	
Breaker Trip Backup ST Overcurrent	Messenger reports that it has tripped the breaker due to a short time overcurrent condition	
Breaker Trip Backup LT Overcurrent	Messenger reports that it has tripped the breaker due to a long time overcurrent condition	
Breaker Trip Backup Ground Fault	Messenger reports that it has tripped the breaker due to a ground fault condition	
Caution CPUA Not Rcv From 1 Or More Messngrs	Messenger reports that CPU A is not receiving data from at least one Messenger (event recorded by CPU B)	Check Ethernet connection between Entellisys Messenger and switch, and the connection between the switch and CPU A. Verify that Messenger is powered on and operating.

Table A-10 Messenger/Breaker Config Status Events

Event	Description	Notes and Troubleshooting tips
Caution CPUB Not Rcv From 1 Or More Messngrs	Messenger reports that CPU B is not receiving data from at least one Messenger (event recorded by CPU A)	Check Ethernet connection between Entellisys Messenger and switch, and the connection between the switch and CPU B. Verify that Messenger is powered on and operating.
Caution Messngr Not Receiving From CPUA	Messenger reports that it is not receiving data from CPU A	Check Ethernet connection between Entellisys Messenger and switch, and the connection between the switch and CPU A. Verify that CPU A is powered on and operating.
Caution Messngr Not Receiving From CPUB	Messenger reports that it is not receiving data from CPU B	Check Ethernet connection between Entellisys Messenger and switch, and the connection between the switch and CPU B. Verify that CPU B is powered on and operating.
System OK Receiving Broadcast From CPUA	Messenger reports that it is receiving data from CPU A	
System OK Receiving Broadcast From CPUB	Messenger reports that it is receiving data from CPU B	
Test Mode Initiated From Test Kit	Messenger reports that test mode has been initiated with the test kit	
Test Mode Ended From Test Kit	Messenger reports that test mode has ended	
Protection Suspended GF From Test Kit	Messenger reports that ground fault functionality is to be suspended	
Protection Resumed GF From Test Kit	Messenger reports that ground fault functionality can resume	
Attention Compartment ID Button Missing	Messenger reports that it has detected that the compartment ID button is missing	See DEH-235 Entellisys Low Voltage Switchgear EntelliGuard Messenger iButton Replacement Guide.
Note Messngr Error 5	Compartment ID Button contains valid configuration data, but EEPROM copy is bad	See DEH-235 Entellisys Low Voltage Switchgear EntelliGuard Messenger iButton Replacement Guide.
Caution Check Compartment ID Button Connection	Messenger reports that the compartment ID button connection needs to be checked	See DEH-235 Entellisys Low Voltage Switchgear EntelliGuard Messenger iButton Replacement Guide.
Attention Messngr Error 1 Replace ASAP	Messengr reports that its application flash memory has a CRC error and should be replaced	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Messngr Error 2 Replace ASAP	Messengr reports that its boot flash memory has a CRC error and should be replaced	Contact GE Post Sales Service (see How to contact us on page 2).
Attention Messngr Error 3 Replace ASAP	Messenger reports that it has an analog IOC error and should be replaced	Contact GE Post Sales Service (see How to contact us on page 2).

Table A-10 Messenger/Breaker Config Status Events

Event	Description	Notes and Troubleshooting tips
Attention Messngr Error 4 Replace ASAP	Messenger reports that it is not calibrated and should be replaced	Contact GE Post Sales Service (see How to contact us on page 2).

A.2.10 Preventative Maintenance Events

Table A-11 Preventative Maintenance Events

Event	Description	Notes and Troubleshooting tips
Breaker In Service Anniversary	Breaker anniversary date has been reached	
Breaker Mechanical Life At XX Percent	See section on Preventative Maintenance	
Breaker Load Life At XX Percent	See section on Preventative Maintenance	
Demand Reset All By Command	CPU received (via Modbus) and executed a command to reset the demand values for all breakers	