GE
Industrial Solutions

EntelliGuard* TU Trip Units

Installation, Operation, and Maintenance Manual

For UL/ANSI trip units used in the following circuit breakers and switches:

- EntelliGuard G
- WavePro
- AK, AKR
- Conversion Kits
- Power Break*
- Power Break* II
- HPC* Switch, New Generation

HAZARD CLASSIFICATIONS

The following important highlighted information appears throughout this document to warn of potential hazards or to call attention to information that clarifies a procedure.

Carefully read all instructions and become familiar with the devices before trying to install, operate, service or maintain this equipment.

⚠ DANGER

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

⚠ WARNING

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

CAUTION

Failure to comply with these instructions may result in product damage.

NOTICE

Indicates important information that must be remembered and aids in job performance.

TRADEMARKS

EntelliGuard®	WavePro®
Power Break®	Power +®
MicroVersaTrip®	EPIC®
ProTrip®	HPC™ Switch, New Generation

WARRANTY

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 herein 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. GE Industrial Solutions makes no representation or warranty, expressed, implied, or statutory, with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein. No warrantees of merchantability or fitness for purpose shall apply.

Contact your local sales office if further information is required concerning any aspect of EntelliGuard G, AKR, Power Break, Power Break II, New HPC, and WavePro circuit breaker operation or maintenance.

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SECTION 1. HOW TO USE THIS MANUAL

The information provided here is specific to the EntelliGuard electronic trip unit, which is offered in a wide variety of configurations to suit Air Circuit Breakers (EntelliGuard G, AKR, WavePro), Insulated Case Circuit Breakers (PowerBreak, PowerBreak II), and Fused Switches (New HPC). Before reading this manual it is best to acquaint yourself with the specific features of your circuit breaker or switch in order to understand which trip unit features apply to your product.

BREAKER AND SWITCH PRODUCT MANUAL PUBLICATION LIST

The full GE Electrical Distribution offering can be browsed via the online Buylog at gecatalogs.com. GE Installation and Application Guide Publications are available online at geindustrial.com.

- **WavePro:** DEH–134 (800 – 2000A Frame), DEH–135 (3200 – 5000A Frame)
- **EntelliGuard G Installation & Maintenance Manual:** DEH-41304
- **EntelliGuard G Application Guide:** DET-653
- **PowerBreak:** GEH-4693
- **PowerBreak II:** GEH-6270
- **New HPC:** DEH–41689
- **AKR:** GEI-86134, GEI-86151, others

TRIP TIME CURVE PUBLICATION LIST

GE Trip Time Curve Publications are available online at geindustrial.com.

Publications are available for Trip Time Curve data associated with the various EntelliGuard Trip Unit forms:

Table 1-1: Trip Time Curve Publications

Breaker or Switch	Long Time (I^2t)	Long Time (I^4t)	Short Time	Ground Fault	Instantaneous & RELT
EntelliGuard G	DES-090	DES-091	DES-092	DES-093	DES-094
AKR	DES-095	DES-096	DES-097	DES-098	DES-101
PowerBreak	DES-095	DES-096	DES-097	DES-098	DES-099
PowerBreak II	DES-095	DES-096	DES-097	DES-098	DES-100
WavePro	DES-095	DES-096	DES-097	DES-098	DES-101
New HPC	Refer to appropriate Fuse Protection Curve			DES-121	DES-122

Refer to these documents to determine overcurrent settings limits, available delay bands, and available delay band slope configurations for your breaker or switch application.

TERMINOLOGY CONVENTIONS USED IN THIS MANUAL:

For the sake of clarity we will refer to “trip units” and “relays” interchangeably when identifying the electronic controller in a circuit breaker or switch. In general a “relay” provides a subset of the features of a full trip unit, but the provided functions operate much the same way as they do on a breaker.

SECTION 2. TRIP UNIT FEATURES BY BREAKER/SWITCH TYPE

The EntelliGuard Trip Unit's feature set varies depending on the circuit breaker or switch in use. The table below lists all of the trip unit features and which circuit breakers/switches support those features. Consult "GTU Order Code" and Appendix A: GTU Nomenclature to determine which features are installed in your trip unit.

Table 2-1: Trip Unit Features

FEATURES	AKR	WAVEPRO	POWERBREAK	POWERBREAK II	ENTELLIGUARD G	New HPC
OVERCURRENT PROTECTION						
LONG TIME WITH I2T & I4T DELAY BANDS	X	X	X	X	X	-
SHORT TIME WITH SELECTABLE SLOPE BANDS	X	X	X	X	X	-
SWITCHABLE/DEFEATABLE SHORT TIME	X	X	X	X	X	-
NON SWITCHABLE INSTANTANEOUS	-	-	X	X	O	-
SWITCHABLE/DEFEATABLE INSTANTANEOUS	X	X	-	-	O	O
EXTENDED RANGE INSTANTANEOUS	-	-	-	-	O	-
FIXED HIGH RANGE INSTANTANEOUS	O	O	O	O	-	-
GROUND FAULT SUMMATION TRIP	O	O	O	O	O	O
GROUND FAULT CT TRIP	-	-	-	-	O	-
GROUND FAULT SUM ALARM	O	O	O	O	O	O
GROUND FAULT CT ALARM	-	-	-	-	O	-
SWITCHABLE GF FUNCTIONS	O	O	O	O	O	O
REDUCED ENERGY LET THROUGH	O	O	O	O	O	O
SELECTIVITY FEATURES						
ZONE SELECTIVE INTERLOCK - ST & GF	O	O	O	O	O	O
ZONE SELECTIVE INTERLOCK - ST , GF, INST	O	O	O	O	O	O
THRESHOLD ZSI [1] (T-ZSI)	O	O	O	O	O	O
METERING FEATURES						
CURRENT	X	X	X	X	X	X
VOLTAGE	O	O	O	O	O	O
FREQUENCY	O	O	O	O	O	O
ENERGY (kWH)	O	O	O	O	O	O
REAL POWER	O	O	O	O	O	O
APPARENT POWER	O	O	O	O	O	O
REACTIVE POWER	O	O	O	O	O	O
TOTAL POWER	O	O	O	O	O	O
PEAK POWER	O	O	O	O	O	O
POWER DEMAND	O	O	O	O	O	O

FEATURES	AKR	WAVEPRO	POWERBREAK	POWERBREAK II	ENTELLIGUARD G	New HPC
PROTECTIVE RELAYING FEATURES						
CURRENT ALARM	X	X	X	X	X	-
OVERVOLTAGE, UNDERVOLTAGE, POWER REVERSAL, CURRENT UNBALANCE, VOLTAGE UNBALANCE RELAYS	O	O	O	O	O	O
DIAGNOSTIC FEATURES						
TRIP TARGET	X	X	X	X	X	X
TRIP EVENT	X	X	X	X	X	X
WAVEFORM CAPTURE	O	O	O	O	O	O
TRIP COUNTER	X	X	X	X	X	X
HEALTH	X	X	X	X	X	X
DIGITAL TEST KIT SUPPORT [1]	X	X	X	X	X	X
ZSI TEST FUNCTION [1]	O	O	O	O	O	O
ZSI INPUT & OUTPUT STATUS [1]	O	O	O	O	O	O
COMMUNICATION FEATURES						
RS-232 MODBUS INTERFACE (TEST KIT)	X	X	X	X	X	X
RS-485 MODBUS INTERFACE	O	O	O	O	O	O
RS-485 PROFIBUS INTERFACE	-	-	-	-	O	-
CONTROL FEATURES						
DIGITAL INPUT(S) [2]	O	O	O	O	O	O
RELAY OUTPUT(S) [2]	X	X	X	X	X	X
BELL ALARM CONTROL [3]	-	-	-	X	-	X
LOCKOUT CONTROL [3]	-	X	X	X	-	X
FAN CONTROL	X	X	-	-	-	-
REMOTE CLOSE FROM TRIP UNIT [3]	-	-	-	-	X	-

[1] Requires trip unit firmware 08.00.26 or higher

[2] EntelliGuard G has two I/O, all others have one

[3] Requires optional breaker accessory installation

O = Optional, X = Standard, - = Unavailable

SECTION 3. TRIP UNIT FEATURES BY FIRMWARE VERSION

GE periodically releases updated firmware for the EntelliGuard Trip Unit. Certain features may change or be added. This list highlights significant changes to trip unit features by version

Version 08.00.26 Released 2013

- Adds ZSI Output Test Function
- Adds Threshold ZSI
- Adds ZSI Input/Output Status Indication
- Adds Enhanced Digital Test Kit support for use with EntelliGuard Manager Toolkit Software
- Adds separate Energy accumulation for incoming and outgoing power
- Adds the ability to reset accumulated energy values from the keypad
- Frequency measurement will be derived from voltage if it is available, current if no voltage signal is available
- Adds Password Protection of Ground Fault Defeat switching feature
- Breaker Opening Time Measurement Capability
- User Mapped Modbus Registers
- Ground Fault Summation Alarm and Ground Fault CT Alarm Event reporting

SECTION 4. GENERAL INFORMATION

The EntelliGuard TU Trip Unit is an electronic device that interfaces with a circuit breaker. It monitors current and/or voltage and trips the breaker in the event of an over-current or voltage related condition. It also provides protective relay functions, advanced metering, diagnostic features, and communications. The Trip Unit can be removed or replaced in the field by de-energizing and removing the cover of the circuit breaker.

The Trip Unit drives the circuit breaker flux shifter to provide the electromechanical tripping function. A user interface is provided on the front panel to allow adjustment of the Trip Unit's parameters.

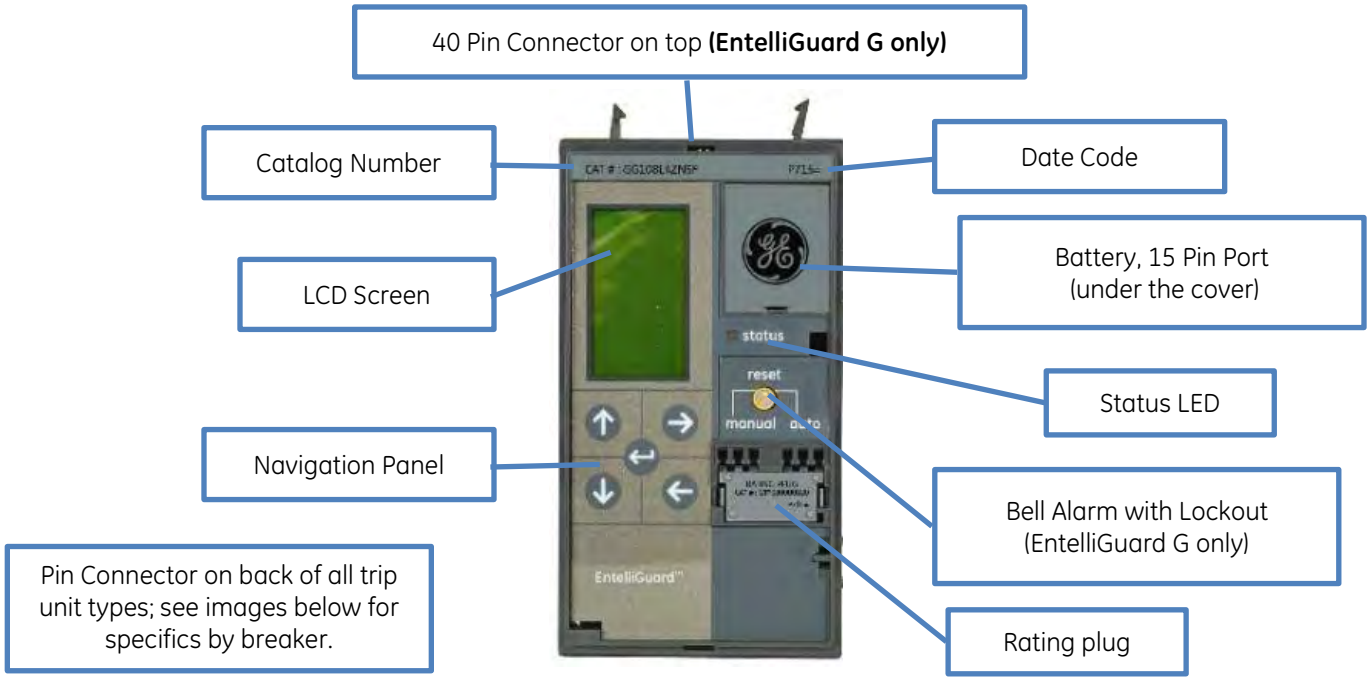
EntelliGuard TU Trip Unit has been designed to be plug and play compatible with previous generation trip units, MicroVersaTrip, MicroVersaTrip RMS-9, EPIC, MicroVersaTrip Plus, MicroVersaTrip PM, Power+ and ProTrip. In addition to trip unit upgrades, conversion kits are offered to upgrade ANSI type legacy breakers.

FRONT PANEL DISPLAY

The Trip Unit includes a graphical Liquid Crystal Display (LCD). The front panel is similar to those shown in Figure 4-1 through Figure 4-5.

When the trip unit is energized the LCD normally displays a menu of navigation options. If the trip unit is powered from an external DC supply, a backlight is provided and remains on. If the trip unit is powered from the circuit breaker's Current Sensors alone there is no backlight, but the navigation menu is available as long as current flow is at least 20% of the breaker's sensor rating. If the display is blank, pressing any key will turn on the menu using battery power.

Figure 4-1: EntelliGuard G Trip Units



⚠ WARNING

BOX SIZE AND CONNECTOR CONFIGURATION COMMONALITY DOES NOT SUGGEST INTERCHANGEABILITY BETWEEN POWERBREAK II AND WAVEPRO OR POWERBREAK AND AKR. THE OPTIONS ON THESE TRIP UNITS ARE DIFFERENT AND WILL CAUSE THEM TO BEHAVE AND OPERATE DIFFERENTLY.

Figure 4-2: Power Break II and WavePro Trip Units

Single 50 pin connector on the back.

Figure 4-3: Power Break I, AK, AKR, Conversion Kit Trip Units

Single 36 pin connector on the back.

Figure 4-4: EntelliGuard G Trip Units

Single 50 pin connector on the back, 40 pin connector on the top.

See Appendix E: GTU Pin Out Diagrams for the pin out diagrams for each trip unit type.

MENU ACCESS

The trip unit has five function keys as shown in Figure 4-5. All SETUP, STATUS, METER and EVENTS information is accessed through these five keys:

- **UP**: Scroll up or increment value
- **DOWN**: Scroll down or decrement value
- **RIGHT**: Next function or next page
- **LEFT**: Previous function or previous page
- **ENTER**: Save or set into memory

Figure 4-5: Trip Unit Keypad and Functions

ELECTRICAL REQUIREMENTS

⚠ WARNING

IMPROPER INSTALLATION, OPERATION AND MAINTENANCE

Ensure only qualified personnel install, operate, service and maintain all electrical equipment.

Failure to comply with these instructions could result in death or serious injury.

PowerBreak , PowerBreak II, New HPC, WavePro, AKR and EntelliGuard G Trip Units are powered from three different sources:

- **Primary Current flow:** Breaker current sensors provide sufficient power to energize the LCD when at least 20% of the sensor's ampere rating is flowing.
- **+24 VDC control power**. This is supplied externally, via the circuit breaker's secondary disconnect, or from the GTUTK20 test kit, or from the portable battery pack, (TVPBP and TVPBPACC). See Battery and Power Information for power consumption for each type.
- **Internal battery power**: Powers the unit temporarily when any keypad key is pressed. Battery power automatically turns off 40 sec after the last keypad press. The battery power supply is disabled when any current over 5% of the sensor rating is sensed through the current sensors. Breaker status (open/closed) is not reported under battery power.

Functions that require external 24 VDC:

- Communication (Modbus and Profibus)
- Zone Selective Interlocking—(Instantaneous only)
- WaveForm Capture
- Event log with time stamp
- Backlight
- Advanced Metering
- Relaying
- Input/output Contacts

NOTICE

If 24 VDC supply drops below 22V, expect the backlight of the trip unit to dim or shut off. In order to ensure this does not happen, have a reliable, consistent source of 24VDC.

EQUIPMENT INTERFACES

PowerBreak I, PowerBreak II, New HPC, WavePro, AK, AKR, Conversion Kits (for GE and other manufacturer breakers) and EntelliGuard G Circuit Breakers are supported by the GTU family of trip units.

Trip units do not require direct connection to the switchgear for basic protective operation. All trip unit connections external to the breaker are made through the circuit breaker secondary disconnect.

The following trip unit interfaces are available at the secondary disconnect:

- Serial Communications (RS-485) supporting Modbus or Profibus protocols.
- Zone Selective Interlocking digital input and output
- Digital Inputs (2 – EntelliGuard & 1 for PowerBreak I, PowerBreak II, WavePro, AK, AKR, Conversion Kits, and New HPC)
- Relay Outputs (2 – EntelliGuard & 1 for PowerBreak I, PowerBreak II, WavePro, AK, AKR, Conversion Kits, New HPC)
- Fan control digital output (5000A WavePro and AKR)
- Remote Close digital output (EntelliGuard G equipped with Command Close Coil accessory)
- Potential Transformer analog voltage Inputs
- Zero Sequence Current Transformer analog input (EntelliGuard G).
- Rogowski neutral sensor analog input (EntelliGuard G), Iron Core neutral sensor analog input (all others)

The front panel test kit port provides an interface to the GTUTK20 digital test kit. See DEH-4568A for additional detail.

In addition, the MicroVersaTrip portable battery pack (TVPBP) can also be used on the EntelliGuard Trip Unit using the TVPBPACC adaptor cable.

DEFINITIONS

BIM: Breaker Interface Module (only on EntelliGuard G). This is a non-volatile memory device on the circuit breaker that defines the breaker's configuration to the trip unit. The BIM stores configuration information on the breaker sensor rating, it's interrupting capacity, and the agency requirements (UL, IEC, ANSI) the breaker meets.

RELT: Reduced Energy Let Through. A second fully independent instantaneous trip function that can be temporarily engaged during maintenance procedures to ensure the breaker trips as quickly as possible to limit arc flash damage.

ZSI: Zone Selective Interlocking: A wired signaling scheme between cascaded breakers that enhances coordination and can improve protection without impacting selectivity. Available for Short Time, Ground Fault and Instantaneous/ Threshold.

WFR: Wave Form Recognition is the algorithm used in the EntelliGuard G adjustable selective instantaneous trip element to discern between unfettered fault current and the high peak/short duration, low energy let-through current allowed by a current limiting fuse or circuit breaker while in the process of melting or tripping. This algorithm allows the adjustable selective instantaneous to be set low and yet be selective in high prospective fault current systems. WFR allows circuit breakers to trip instantaneously for faults within their zone of protection while maintaining instantaneous clearing times in the 3-3.5 cycle range, depending on circuit breaker type, facilitating maximum arc flash mitigation possible with no sacrifice in selectivity.

WFC: Waveform Capture – an optional feature that captures an oscillographic record of system current and voltage at the moment the breaker trip unit is triggered.

Close and Latch Rating: the maximum fault current a circuit breaker or switch can close into and successfully latch.

HSIOC: High Set Instantaneous Overcurrent, also known as an instantaneous override. A fixed instantaneous trip function that operates if the breaker experiences a fault exceeding its Short Time Rating (Icw).

$\mathbf{I_n}$: Trip Plug Rating in amperes. This is the current rating of the rating plug installed in the trip unit. This is the maximum Long Time pick up a trip unit can have with a specific plug installed. A sensor can be applied with plugs between 37.5% or 40% to 100% of the sensor rating. Plugs are labeled in amperes.

$\mathbf{I_{cw}}$: Short Time Withstand Rating of a particular circuit breaker in amperes. The withstand rating is defined differently within different standards, but it is always the value of current that a circuit breaker can withstand for the maximum Short Time Delay before interrupting.

$\mathbf{I_{RMS}}$: True RMS current measurement through a phase

UEF, REF, SEF: specialized Earth Fault functions not commonly deployed in North America.

Making Current Release (MCR): This is an instantaneous override that will trip the circuit breaker if it is closed into a fault exceeding the breaker's close and latch rating.

X: X is a multiplier that may be applied in front of any rating value to denote a fraction of that rating. Ex: The Long Time Pickup is may be set at 0.5 xIn.

$\mathbf{xI_{CT}}$: Multiples of current sensor rating (non-dimensional)

GTU: Shorthand/abbreviation for EntelliGuard TU Trip Unit

GTU ORDER CODE

Below is the breakdown of what each column of the GTU order code represents. For specific possibilities see Appendix A: GTU Nomenclature. Also, find the Rating Plug order code in Appendix B: Rating Plug Nomenclature.

Table 4-1: GTU Nomenclature

Order Code	Representation
Digit 1 and 2	EntelliGuard Trip Unit Form
Digit 3	Frame Rating (Amperes) Short Circuit/Withstand
Digit 4 and 5	Sensor Rating (Amperes)
Digit 6 and 7	Overcurrent and Ground Fault Protection Packages
Digit 8	Zone Selective Interlocking
Digit 9	Advanced Features & Communications
Digit 10	Manual/Auto Trip Reset
Digit 11	Original or Replacement Trip Unit
Digits 12, 13, 14, and 15	RESERVED (Future)

Trip Unit: This term is used interchangeably between circuit breakers and switches to describe the electronic controller that provides protective functions.

ENTELLIGUARD SOFTWARE OPTIONS

There are two applications available to assist in configuring your EntelliGuard trip units. EntelliGuard Setup Software works with all versions of the trip unit. The EntelliGuard Manager Toolkit offers enhanced digital test kit functions for certain EntelliGuard trip units.

ENTELLIGUARD SETUP SOFTWARE

The EntelliGuard Setup Software provides a graphical user interface (GUI) to configure and monitor the operation of EntelliGuard Trip Unit functions. The software allows you to save setting files offline to be loaded or compared with current settings. It provides a means of creating documentation regarding all the trip unit settings.

The software also provides a tool to extract and view captured waveforms from EntelliGuard trip units equipped with the optional Waveform Capture feature. This feature also provides a means of determining harmonic content of the power system.

The EntelliGuard Setup software is available at no charge from either the GE EntelliGuard CD or the GE Industrial Solutions web-site.

In on-line mode the tool is connected over communication networks - Serial or Ethernet, you can communicate with an EntelliGuard device in real-time.

In off-line (Disconnected) mode, a settings file can be created for eventual downloading to the device.

Installing the Setup Software

The following minimum requirements must be met for the EntelliGuard Setup software to operate on your computer.

System Requirements

- Microsoft Windows™ 2000/XP/Vista/7 is installed and running properly.
- Minimum of 20 mb of hard disk space.
- Minimum 256 mb of RAM (512 mb recommended)
- RS-232 and/or Ethernet communication port.

Detailed instructions on the software's functions is provided by the software itself.

ENTELLIGUARD MANAGER TOOLKIT SOFTWARE

The EntelliGuard Manager Toolkit software is available from the GE Industrial Solutions website in two versions.

The Basic TKB version allows you to monitor trip unit values and customize trip unit settings remotely. This version is available at no charge.

The Standard TKS version adds enhanced digital test kit features and the ability to update trip unit firmware and add optional language packs. See the GE website for ordering information.

Some software functions are only compatible with certain trip unit firmware revisions. You can check the installed firmware revision of your trip unit under the Software Revision STATUS menu item.

Monitor, Waveform Capture, Settings – all firmware versions

Digital Test and Language updates – firmware revision 08.00.26 and later.

Use GE Instruction DEE-688 to learn how to install the EntelliGuard Manager Toolkit Software.

Use GE Instruction DEE-689 to learn how to use the many features of the Toolkit software.

System Requirements

- Microsoft Windows™ 2000/XP/Vista/7/8 is installed and running properly. Windows 8 requires a loop-back adapter – see DEE-688 for details.
- Minimum of 20 mb of hard disk space.
- Minimum 256 mb of RAM (512 mb recommended)
- RS-232 and/or Ethernet communication port.

RATING PLUGS

The EntelliGuard TU trip system is defined by the breaker's sensor rating and the installed Rating Plug. In ANSI/UL breakers the rating plug fixes the Rating Plug current at some fraction of the sensor value. In IEC applications the UNIVERSAL Rating Plug allows selection of rating plug current using the LCD and keypad.

The EntelliGuard TU trip rating plugs are unique in that they can be used with multiple trip units and circuit breakers within a specific sensor range, rather than only with a single specific sensor. The trip rating plug catalog number identifies the rating as well as the minimum and maximum sensor rating the plug may be used with. Appendix B lists trip-rating plugs available for each sensor and their part numbers and the two-digit codes used within the trip rating plug catalog numbers to identify sensor current ratings.

WAVEFORM CAPTURE

A total of eight cycles are captured when triggered:

- Four cycles pre-trigger.
- Four cycles post-trigger.

24 VDC external power is required for waveform capture.

When a waveform capture is triggered, the following channels will be captured simultaneously: Phase A current, Phase B Current, Phase C Current, Phase N Current, Phase L1 voltage, Phase L2 voltage, Phase L3 voltage.

The GE Setup Software contains waveform retrieval and graphical viewer capability. GE offers the software free via web download.

Once a capture occurs the trip unit makes a file available for download over the serial connection. If a captured waveform is not retrieved before the next trigger event the data will be overwritten. The exception to this is if the file is being downloaded the data will not be overwritten by a new event.

Captured waveforms can be cleared from within the software.

The EntelliGuard trip unit does not provide harmonic calculations but the GE Setup Software can extract and display detailed harmonic content from a captured waveform.

Table 4-2: Trigger WaveForm Capture Events

Event	Waveform Capture Setpoint
Manual trigger over communications	ON, OFF
Over current (GF, ST, LT, Inst)	ON, OFF
Protective relays	ON, OFF
Current alarm 1	ON, OFF
Current alarm 2	ON, OFF

EVENT LOGGING

The trip unit keeps a log of the last 10 events:

- Over current trips
- Protective relay trips
- Shunt trip (PBII and Global EntelliGuard G Trip Units Only)
- Under voltage Release trip (PBII and Global EntelliGuard G Trip Units Only)
- BIM Trip Unit Mismatch - Breaker Interface Module (EntelliGuard G, firmware versions 08.00.22 and earlier)
- Current Alarms

The following information is stored with each event:

- RMS currents
- Phase
- Type of trip
- Trip counter
- Time and date information is provided if external DC power is available. If no external DC power is supplied, time and date information will be zero.

LED STATUS INDICATOR

Table 4-3 shows the operation of the green LED located on the front of the trip unit.

Table 4-3: LED Operation

GTU Trip Units Status	LED Status
Normal	ON-OFF-ON-OFF (OFF for 2 sec)
Error	ON-OFF-ON-OFF-ON-OFF (OFF for 2 sec)
Trip	ON-OFF (OFF for 2 sec)
Pickup	ON-OFF-ON-OFF-ON-OFF-ON-OFF (continuous)

SECTION 5. PROTECTION

OVERCURRENT PROTECTION FUNCTIONS

The Trip Unit provides the following over current protections:

- Long Time (L)
- Short Time (S)
- Instantaneous (I, H=high range)
- Reduced Energy Let Through Instantaneous (RELT)
- Ground Fault Internal Summation (G)
- Ground Fault CT External Summation (C, EntelliGuard G only)
- Instantaneous Override (HSIOC)
- Making Current Release (MCR)

LONG TIME PROTECTION

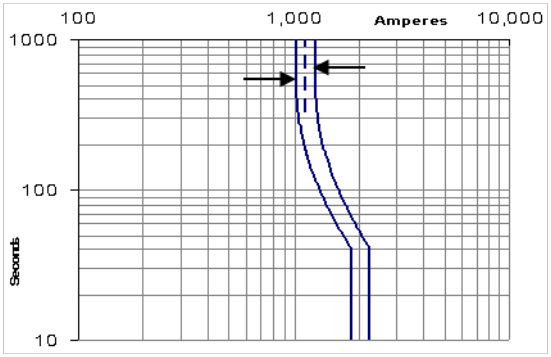
Long Time Pickup

This setpoint establishes the breaker's nominal ampere rating, xLT, as a fraction of the rating plug value, In:

xLT = LT multiplier x In

The adjustment range for long time pickup settings is 0.50 to 1.00 times xIn in steps of 0.05. The pickup value has a 10% tolerance. The band is drawn at 1/(1+10%) and 1/1-10%). The actual long time pickup is increased by 12% over the nominal so that 100% nominal current may be carried indefinitely. So a 1000 A setting is placed at 1120 A with the minimum pickup drawn (left side of band) is 1018A, and the maximum pickup (right side of band) is drawn at 1244A. Figure 5-1 shows the Long Time pickup setting.

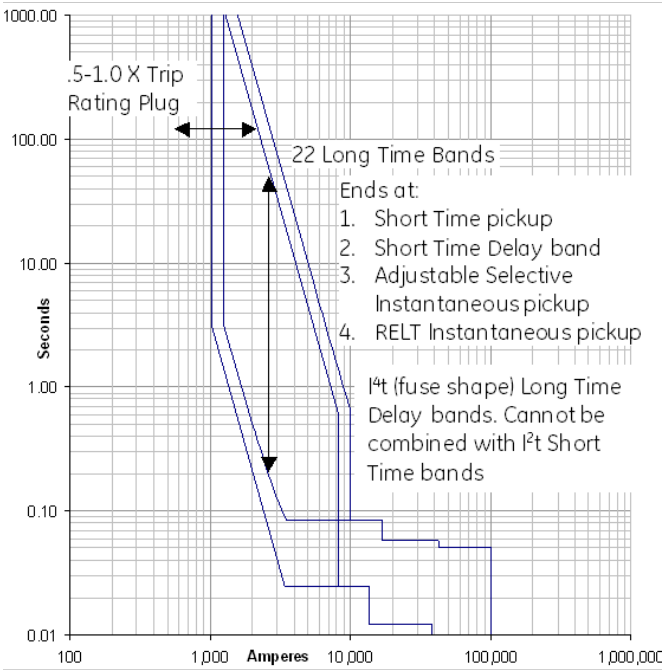
Figure 5-1: Long Time Pickup Settings



Long Time Delay

The trip unit provides up to 44 long time delay bands. There are 22 bands using a logarithmic (I^2t) type curve resembling the overcurrent response of a thermal magnetic circuit breaker, and 22 bands that simulate the overcurrent response of fuses (I^4t). The EntelliGuard circuit breaker is able to use all 44 bands. Power Break I, Power Break II, WavePro and AKR circuit breakers use the 19 lower thermal CB-type bands and the 22 fuse-type bands.

Figure 5-2: Long Time Delay Settings



Thermal Long Time Overcurrent

The thermal I^2t shape is similar to the typical curve of a thermal magnetic circuit breaker and matches the shape of many overcurrent devices used in industry today. The typical shape and range of settings may be seen in Figure 5-2. The range of time delays is shown in Table 5-1 at various multiples of nominal (100%) current setting. Drawn bands also include a mechanical constant time to account for circuit breaker operating and clearing time, which causes the slight widening of the band evident at the lower (right) end of the faster (lower) bands.

Thermal Memory

The Long Time and Short time algorithms digitally accumulate "heat" when they are in pickup, similar to the behavior of an analog thermal circuit breaker. The Thermal Memory feature controls what the trip unit does when the protection element drops out of pickup. With Thermal memory disabled all of the accumulated heat is cleared when the element drops out of pickup. With Thermal memory enabled the accumulated heat is digitally "cooled" over 12 minutes time. This can be useful under conditions where the protection is crossing in and out of pickup due to load variations, or where a breaker is reclosed into a fault repeatedly. Since the accumulated heat is not cleared when the breaker is opened subsequent trips will occur sooner, better protecting the equipment and cable.

Thermal memory is disabled by default, but can be enabled via communications either through the test kit port or the RS-485 connection if your trip unit has a serial communications feature installed. See Register 217 in Appendix C: Modbus Register Map.

Thermal memory timing is maintained by the battery when no external power is available. When thermal memory is in use battery life may be reduced.

Table 5-1 shows the nominal clearing and commit times for X multipliers of nominal pickup.

Table 5-1: Nominal Time Delays for Thermal Shaped Long Time Bands

X =	1.5	1.5	6	6	7.2	7.2	10	10
	Commit	**Clear**	**Commit**	**Clear**	**Commit**	**Clear**	**Commit**	**Clear**
Min CB	4.25	8.04	0.20	0.33	0.14	0.24	0.072	0.137
C-2	12.7	24.1	0.60	0.94	0.42	0.66	0.21	0.35
C-3	25.5	48.1	1.21	1.84	0.83	1.28	0.43	0.67
C-4	34.0	64.1	1.61	2.45	1.11	1.70	0.57	0.89
C-5	51.0	96.2	2.41	3.66	1.67	2.53	0.86	1.32
C-6	67.9	128	3.21	4.87	2.22	3.37	1.15	1.75
C-7	84.9	160	4.02	6.08	2.78	4.20	1.43	2.18
C-8	102	192	4.82	7.29	3.33	5.03	1.72	2.61
C-9	119	224	5.62	8.49	3.89	5.87	2.01	3.03
C-10	136	256	6.43	9.70	4.44	6.70	2.29	3.46
C-11	153	289	7.23	10.9	5.00	7.54	2.58	3.89
C-12	170	321	8.04	12.1	5.56	8.37	2.87	4.32
C-13	204	385	9.64	14.5	6.67	10.0	3.44	5.18
C-14	238	449	11.2	17.0	7.78	11.7	4.01	6.04
C-15	272	513	12.9	19.4	8.89	13.4	4.59	6.90
C-16	306	577	14.5	21.8	10.0	15.0	5.16	7.76
C-17	340	641	16.1	24.2	11.1	16.7	5.73	8.61
C-18	374	705	17.7	26.6	12.2	18.4	6.30	9.47
Max CB	408	769	19.3	29.1	13.3	20.0	6.88	10.3

- Algorithm will not commit below 1.5 cycles, clearing time will not be less than 0.088 seconds.
- Actual Long Time pickup is 112% of nominal pickup.

Fuse Shaped Steep Long Time Overcurrent

The steeper fuse characteristic is a straight line $K=I^4t$ shape for application in systems where fuses and circuit breakers are used together. Twenty-two different time bands are available in each trip unit. Figure displays minimum and maximum bands. Table 5-2 displays the nominal time delays for each of the 22 bands at various multiples of nominal current pickup.

Drawn bands also include a constant time component, which accounts for the slight widening evident in the time current curve at the lower (right) end of the faster (lower) time bands.

Table 5-2: Nominal Clearing Times for Fuse Shaped Long Time Bands

X =	1.5	1.5	6	6	7.2	7.2	10	10
	Commit	Clear	Commit	Clear	Commit	Clear	Commit	Clear
Min F	0.67	1.54	0.025	0.085	0.025	0.085	0.025	0.085
F-2	2.0	4.40	0.025	0.085	0.025	0.085	0.025	0.085
F-3	3.6	7.98	0.025	0.085	0.025	0.085	0.025	0.085
F-4	5.6	12.5	0.025	0.085	0.025	0.085	0.025	0.085
F-5	8.1	18.0	0.032	0.100	0.025	0.085	0.025	0.085
F-6	11.2	25.0	0.044	0.13	0.025	0.085	0.025	0.085
F-7	15.1	33.8	0.059	0.16	0.028	0.094	0.025	0.085
F-8	20.0	44.7	0.078	0.20	0.038	0.114	0.025	0.085
F-9	26.1	58.4	0.102	0.26	0.049	0.14	0.025	0.085
F-10	33.8	75.4	0.13	0.32	0.064	0.17	0.025	0.085
F-11	43.3	96.8	0.17	0.41	0.082	0.21	0.025	0.085
F-12	55.3	123	0.22	0.51	0.104	0.26	0.028	0.092
F-13	70.2	157	0.27	0.64	0.13	0.33	0.036	0.109
F-14	88.9	198	0.35	0.81	0.17	0.40	0.045	0.13
F-15	112	251	0.44	1.01	0.21	0.50	0.057	0.16
F-16	141	316	0.55	1.26	0.27	0.62	0.072	0.19
F-17	178	397	0.69	1.58	0.34	0.78	0.090	0.23
F-18	224	499	0.87	1.98	0.42	0.97	0.113	0.28
Max-F	280	626	1.10	2.48	0.53	1.21	0.142	0.35

- Algorithm will not commit below 1.5 cycles, clearing time will not be less than 0.088 seconds.
- Actual Long Time pickup is 112% of nominal pickup.

SHORT TIME PROTECTION

Short Time Pickup

The Short Time Pickup function establishes the current at which short time trip is activated. Short Time Pickup is set as a multiple of the Long Time Pickup setting. The pickup settings range from 1.5 to 12.0 times the Long Time setting, xLT, in steps of 0.5 xLT.

The maximum pickup depends on breaker type and frame as shown in Table 5-3, below:

The Short Time Pickup value tolerance band is approximately -9% to +11% of the set point based on a 10% current sensing accuracy with the pickup calculated with 1/ (1+Tolerance). The time current curve of short time pickup is shown in Figure 5-3.

Some breaker types will further limit the maximum Short Time Pickup depending on frame rating per Table 5-4: Short Time Settings by Breaker Type and Frame .

Figure 5-3: Short Time Pickup Time Current Curve

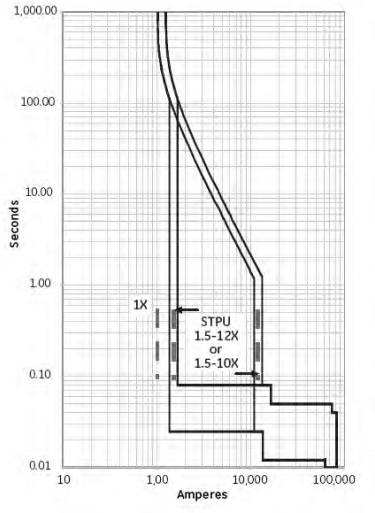


Table 5-3: Short Time Commit Times

Time Band	60 Hz ANSI, UL489	50 Hz ANSI, UL489
1	0.025 sec	0.030 sec
2	0.033 sec	0.040 sec
3	0.042 sec	0.050 sec
4	0.058 sec	0.060 sec
5	0.092 sec	0.090 sec
6	0.117 sec	0.120 sec
7	0.158 sec	0.160 sec
8	0.183 sec	0.180 sec
9	0.217 sec	0.220 sec
10	0.350 sec	0.350 sec
11	0.417 sec	0.420 sec
12	0.517 sec	0.520 sec
13	0.617 sec	0.620 sec
14	0.717 sec	0.720 sec
15	0.817 sec	0.820 sec
16	0.917 sec	0.920 sec
17	0.933 sec	0.940 sec

Table 5-4: Short Time Settings by Breaker Type and Frame

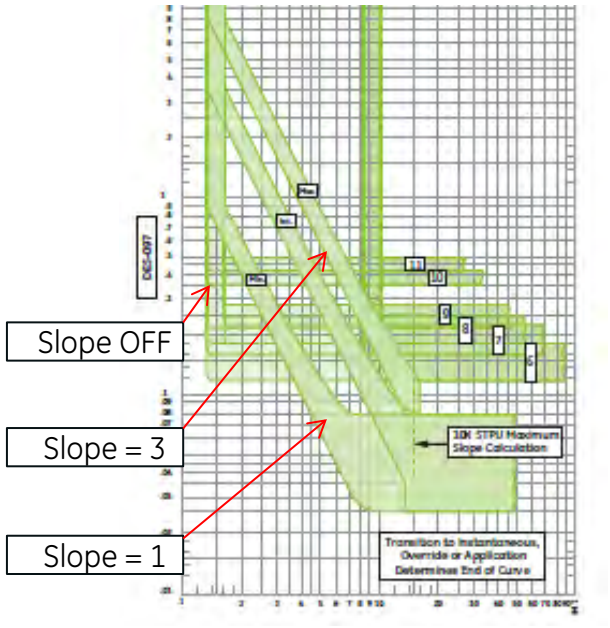
Breaker	Available Settings
Power Break I, Power Break II, WavePro, AKR conversion kits	OFF, 1.5 to 9, steps of 0.5
AKR and WavePro 5000A frame	OFF, 1.5 to 7, steps of 0.5
EntelliGuard G Frame 1 and 2	OFF, 1.5 to 12, steps of 0.5
EntelliGuard G Frame 3	OFF, 1.5 to 10, steps of 0.5

Short Time Delay

The Short Time Delay setting consists of both a slope setting and a fixed delay band setting. The slope and delay are independently selectable. The slope setting consists of three I^2t slopes (minimum (1), intermediate (2) and maximum (3)) and fixed delay (Off). The fixed delay bands consist of 11 constant time bands. The width of the bands varies by circuit breaker and with frequency. See Trip Time Curve Publication List for details your circuit breaker.

On all ANSI and IEC breakers, the Short Time can be disabled by setting the Short Time Delay to "OFF". Note that if Instantaneous is set to "OFF" Short Time cannot be turned off.

Figure 5-4: Short Time Delay



Short Time Slope

The slope setting modifies the initial portion of the ST delay band in the familiar "hockey stick" configuration. A setting of OFF puts the constant time band in effect, with no slope. Slope settings of 1, 2, or 3 put progressively higher slope values in effect. If the fault exceeds the sloped section of the curve, the constant time band setting takes effect.

Table 5-5: Short Time Delay Settings

Band	Time Delay Band Setting	Commit Time		EntelliGuard G	
		50 Hz	60 Hz	Clear Time 60 Hz	Clear Time 50 Hz
1	Min.	0.030	0.025	0.080	0.085
2	2nd	0.040	0.033	0.088	0.093
3	3rd	0.050	0.042	0.097	0.102
4	4th	0.060	0.058	0.113	0.118
5	5th	0.110	0.092	0.147	0.152
6	6th	0.130	0.117	0.172	0.177
7	7th	0.180	0.158	0.213	0.218
8	8th	0.210	0.183	0.238	0.243
9	9th	0.240	0.217	0.272	0.277
10	10th	0.280	0.350	0.405	0.410
11	Max.	0.340	0.417	0.472	0.477

- Short Time slope is forced to OFF when optional LT Fuse (I^4t) curves are in use.

INSTANTANEOUS PROTECTION

Adjustable Selective Instantaneous over current protection causes an undelayed breaker trip when the chosen current level and proper waveform is reached.

The pickup value may be set in steps of 0.5 xIn from 2.0 xIn to 15 xIn and steps of 1 xIn from 15 xIn to a maximum of 30 xIn. Greater than 15xIn is available only in trips provided with the "Extended Range Instantaneous" option on ANSI EntelliGuard G circuit breakers.

The maximum possible setting depends on the trip unit instantaneous option provided, the circuit breaker's withstand capability, and whether or not ST has been enabled.

EntelliGuard G breakers with the H High Range Instantaneous option will automatically engage Short Time protection when Instantaneous is set above 15xIn. If the trip unit does not have a Short Time Option the Short Time element is enabled at maximum pickup and delay in the background.

Table 5-6: Maximum Instantaneous for Power Break I, Power Break II, WavePro and AKR Trip Units

Frame (A)	ANSI (X In)		UL (X In)	
	With ST	W/O ST	With ST	W/O ST
800	15	10	15	10
1,600	15	10	15	10
2,000	15	10	15	10
2,500			13	10
3,000			13	10
3,200	13	10		
4000	9	9	9	9
5000	7	7		

- Instantaneous minimum setting is 2.0.
- RELT Instantaneous minimum setting is 1.5.
- Instantaneous may be turned OFF on certain models.

The Instantaneous pickup accuracy is +10%. On certain ANSI trip units with the user-selectable switchable instantaneous over current an additional value of OFF appears at the end of the listing of numerical values. Note that if Short Time Delay is set to off, you will not be able to also turn off Instantaneous. Refer to NEC 240.87 for guidance on disabling Instantaneous protection.

WaveForm Recognition vs. Peak Sensing

WFR is the standard algorithm used in the normal instantaneous trip function for all CB versions except Power Break I. The WFR algorithm is specially designed to optimize selectivity while achieving fast instantaneous tripping of the circuit breaker. The algorithm's measurements act as a proxy for measuring energy and hence are able to discern a fault current from a peak-let-through current allowed to flow by a current limiting fuse or current limiting circuit breaker while interrupting in a current limiting manner. This allows the trip setting to be set much lower than peak sensing trips and hence is sensitive to lower arcing fault currents that could be causing an arc flash event.

Reduced Energy Let Through (RELT)

The EntelliGuard TU trip unit's RELT capability provides the ultimate in user flexibility to reduce personnel hazard.

All versions of the EntelliGuard TU are available with optional Reduced Energy Let-Through (RELT) Instantaneous protection. RELT is an independent Instantaneous Protection element that can be temporarily engaged to reduce the Instantaneous Pickup threshold when personnel are in close proximity to the circuit breaker or electrical equipment to which the breaker supplies power. In the event of a fault, the trip unit will respond based on the RELT setting, minimizing damaging arc flash energy. Once personnel are safely clear of the area, RELT can be disengaged, returning the system to its normal selective Instantaneous settings. The RELT setting is fully independent of the normal adjustable selective Instantaneous. Even if instantaneous is set to OFF RELT instantaneous can be enabled on demand.

The pickup value may be set in steps of 0.5 xIn from 1.5 xIn to 15 xIn or the maximum allowed instantaneous pickup for the particular circuit breaker type, rating and size. The RELT Instantaneous pick up clears fault current in 50 milliseconds or less. The maximum setting depends on the trip unit catalog number, breaker type and frame, and whether or not ST is enabled. See Table 5-6: Maximum Instantaneous for Power Break I, Power Break II, WavePro and AKR Trip Units Table 5-6. For EntelliGuard G refer to DES-094 for full detail.

Clearing times for the various instantaneous functions vary by circuit breaker. The RELT function clearing time is 0.042 seconds for EntelliGuard G at 60Hz and 0.05 seconds at 50Hz. The adjustable selective instantaneous is 0.05 and 0.06 seconds at 60 and 50 Hertz respectively. For Power Break II, AKR, and WavePro circuit breakers the clearing times are 0.05 and 0.058 seconds for RELT and selective instantaneous respectively at 60 Hz. Power Break versions of the EntelliGuard TU trip unit clear in 0.05 seconds.

When the RELT option is configured in an EntelliGuard TU Trip Unit Digital Input 1 and Digital Output 1 are automatically and permanently assigned to function with RELT. RELT is a factory installed option—it cannot be "turned on" if it is not purchased as an option. The Digital Output will be energized whenever RELT protection is engaged. The Digital Input can be wired to one or more external contacts, such as a light curtain, to engage RELT when someone is within range of the equipment.

RELT can also be controlled remotely over Modbus Communications. RELT Status is also provided via Modbus register. Separate Modbus commands are required to engage and disengage RELT.

Whenever RELT is engaged the trip unit's LCD display will flash an obvious "RELT ON" warning.

Once engaged, all trigger sources (remote via Modbus and externally wired digital input) must be cleared before RELT will disengage. RELT will stay engaged for 15 seconds after the last trigger is cleared to give personnel time to clear the area.

To satisfy Lock-Out-Tag-Out (LOTO) safety requirements RELT cannot be turned on or off from the trip unit LCD.

NOTICE

RELT capability may be utilized with or without 24VDC control power. The RELT output relay may not activate when the trip unit is operated without control power, and the LCD backlight will not flash, but the RELT protection element is engaged if indicated by the trip unit display.

A RELT Switch Kit (catalog #GTURSK) can also be purchased to add a RELT switch to existing breakers. The kit includes the selector switch, LED bulb, NO/NC contacts, 8 feet of wire with spade connectors. The LED Bulb burden is 0.84 watts and the color of the switch is blue.

GROUND FAULT PROTECTION

The Trip Unit provides two types of ground fault protection: Ground Fault Summation and Ground Fault CT. These protections are independent, and both may be active at the same time on the trip unit. A related GF alarm function is available for both types of GF protection, and shares the same pickup level, band choices and tolerances as the GF trip functions. If both Ground Fault Summation and Ground Fault CT are desired, order both from the factory because after delivery these options cannot be changed.

Ground Fault Summation

This protection element operates continuously on the four current sensor inputs to the trip unit. On four pole breakers, the fourth (neutral) pole is built into the circuit breaker. On 3 pole breakers the 4th pole is connected to an external neutral sensor typically mounted on the neutral conductor and wired to the trip unit via the breaker's secondary disconnect.

NOTICE – ENTELLIGUARD G NEUTRAL

On 3 pole breakers where no neutral sensor is deployed, such as on 3-wire systems, the external neutral termination on the breaker's secondary disconnect MUST be jumpered (shorted) to avoid nuisance GF trip operation caused by stray noise pickup.

NOTICE

POWERBREAK, AK, AKR, WAVEPRO AND CONVERSION KITS:

Ground Fault Sum is used for single source and multiple source Ground Fault schemes.

ENTELLIGUARD G

GF Sum is used for single source ground fault only. For multiple source ground fault configurations see "Ground Fault CT" later in this manual.

Ground Fault CT

This protection element is available only on the EntelliGuard G. It is typically utilized for multi-source Ground Fault (MSGF) applications in ANSI/UL applications where neutral sensor data must be shared among multiple trip units on systems with multiple sources connected in parallel. A white paper on MSGF design is available at geindustrial.com, or you can contact your local sales office or the Burlington factory for details on GE's recommended MSGF implementation. When GF CT is specified in a breaker, a special "interposing CT" is installed in the breaker that is wired between the breaker's secondary disconnect and the trip unit's CT input. The full scale output of this interposing CT is 1.54mA at 100% of external sensor.

Ground Fault Pickup

The GF pickup value tolerance band is 15% of the set point. The ground fault pickup settings are listed in Table 5-7: as multiples of the current sensor rating (xCT), in steps of 0.01 xCT.

The maximum GF pickup value is limited to 1200 A per UL standard.

Multiple ground fault curves are also available: Definite time, I^2t slope, I^4t and a double break special selective ground fault with dual I^2t slopes. The pickup in all is drawn with a 10% tolerance and the bands are drawn with a 15% current tolerance. In the case of the double break selective ground fault the first slope is 10% tolerance, the second is 15%. See DES-093A for ground fault curve shapes.

Table 5-7: Ground Fault Pickup Setting Ranges by Sensor

Sensor, I_{CT}	Ground Fault Pickup Threshold ($\times I_{CT}$)
150–1200	0.20–1.0 in increments of 0.01.
1600	0.20 – 0.75
2000	0.20 – 0.6
2500	0.20 -0.48
3000	0.20 – 0.4
3200	0.20–0.37
4000	0.20–0.30
5000	0.20–0.24
6000	0.20

Ground-Fault Delay

This function sets the delay before the breaker trips when the ground-fault pickup current has been detected.

The Ground Fault Delay setting consists of a selection between two I^2t slopes: an optional steeper fuse slope, and fixed delay only. One of fourteen fixed time bands is also selected. The fixed delay bands are listed in Table 5-8.

The Ground Fault Delay settings consist of two user settings. The Time Delay band and the Ground Fault protective function curve shape. The time delay bands consist of up to 14 definite time response bands. Table 5-7: lists the available time delay bands for the various circuit breakers. There are four ground fault protective functions shapes that may be selected. Definite time (OFF), I^2t slope, I^4t slope and a double break special selective ground fault with dual I^2t slopes.

Refer to Figure 6-3 and Figure 6-4 for illustrations.

Table 5-8: Ground Fault Time Delay Bands, 50 Hz & 60 Hz

Time Band	EntelliGuard G UL Commit Time (S)		PB I, PB II, WavePro, AKR Commit Time (S)	
	60 Hz	50Hz	60 Hz	50Hz
1	0.042	0.050		
2	0.058	0.060	0.058	0.060
3	0.092	0.110	0.092	0.110
4	0.117	0.130	0.117	0.130
5	0.158	0.180	0.158	0.180
6	0.183	0.210	0.183	0.210
7	0.217	0.240	0.217	0.240
8	0.350	0.280	0.350	0.280
9	0.417	0.340	0.417	0.340
10	0.517	0.390	0.517	0.390
11	0.617	0.540	0.617	0.540
12	0.717	0.640	0.717	0.640
13	0.817	0.740	0.817	0.740
14	0.917	0.840	0.917	0.840

- Power Break I, Power Break II, WavePro and AKR time band width is 60 msec.
- EntelliGuard G 60 Hz time band width is 0.055 sec.
- EntelliGuard G 50 Hz time band width is 0.060 sec.

Ground-Fault Defeat

EntelliGuard trip units may be ordered with a defeatable or switchable Ground Fault feature. It is a separate option – if it is not included as part of the original order it cannot be added later.

The Defeat function is enabled by default in trip units with firmware versions 08.00.25 and earlier.

The GF defeat feature is disabled by default on trip units with firmware version 08.00.26 and later, but it can be enabled by entering a specific password value of 15.

Once the GF Defeat feature is enabled a GF Delay Band setting selection of OFF will become available. To disable Ground Fault simply select a Delay Band setting of OFF. The "OFF" value is found between Minimum and Maximum delay band setpoints.

GF Defeat functions on both Trip and Alarm GF Sum and GF CT options.

NOTICE

Ground Fault Defeat is only allowed under very limited exceptions to the NEC code. Do not defeat Ground Fault without consulting the NEC standard for your application.

ALARMS

Ground Fault Alarms

The Ground Fault alarm DOES NOT issue a trip event. If tripping on ground fault is required order LSI**G** not LSI**GA**. GF Alarm will turn on a digital output if an output is configured for it. It will always turn on an indication in the Modbus register map. The output can be used to turn on a light or other signal but it will not generate a trip.

All GTUs with a Ground Fault trip option can also send a digital I/O signal to indicate that a GF trip event occurred.

Current Alarm

The trip unit provides two current alarms. These alarms will trigger an alert when current consumption exceeds their setpoints. This is useful for implementing load shedding processes, and serves as an alert to impending Long Time pickup. The alert can be signaled either via communications or via digital output. The Current Alarms' ON/OFF pickup settings are 0.5 to 1.0 xIn in steps of 0.05.

The trip unit does not allow the current alarm OFF setpoint to be set above the ON setpoint.

If the highest measured phase current goes above the Current Alarm ON setpoint and remains above the setpoint for more than 60 seconds the alarm will be triggered. If the current falls below the Current Alarm OFF setpoint for more than 60 seconds while the Current Alarm is active, the alarm condition will be cleared.

The serial register indicating the state of the Current Alarm will assume a value 1 when the alarm is triggered and a value of zero if the alarm is cleared. If a digital output is mapped to the Current Alarm, it will be open if the alarm is clear, and closed if the Current Alarm is active. The alarm indications do not latch; they follow the state of the Current alarm.

The Current Alarms are not able to trip the breaker.

ZONE SELECTIVE INTERLOCKING

Zone-selective interlocking coordinates breakers so that the downstream breaker is allowed the first opportunity to clear a fault or overload event and upstream breakers are able to clear faults in their primary zone faster than would be possible using conventional nested time delay methods.

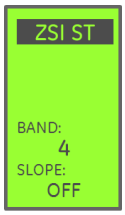
The optional Zone Selective Interlocking (.....) function operates with a group of series-connected breakers. ZSI is achieved with the use of the TIM1 module or an equivalent GE qualified and recommended device. Refer to publication GFK-64467A for TIM1 installation and configuration instructions.

There are two sets of settings in a breaker used in a Zone Selective Interlocking system. The normal or "unrestrained" setpoints are the main over current protection setpoints. A second set of ZSI or "restrained" setpoints are included for an interlocked GF or ST protection element. Instantaneous does not have any adjustable settings – I-ZSI delay is fixed.

If a ZSI-enabled protection element goes into pickup and the Zone Selective Interlock input is active, the "restrained" or ZSI settings will be in effect. If the Zone Selective Interlock input is not active when the overcurrent element enters pickup, the normal or unrestrained pickup setpoints will be effect.

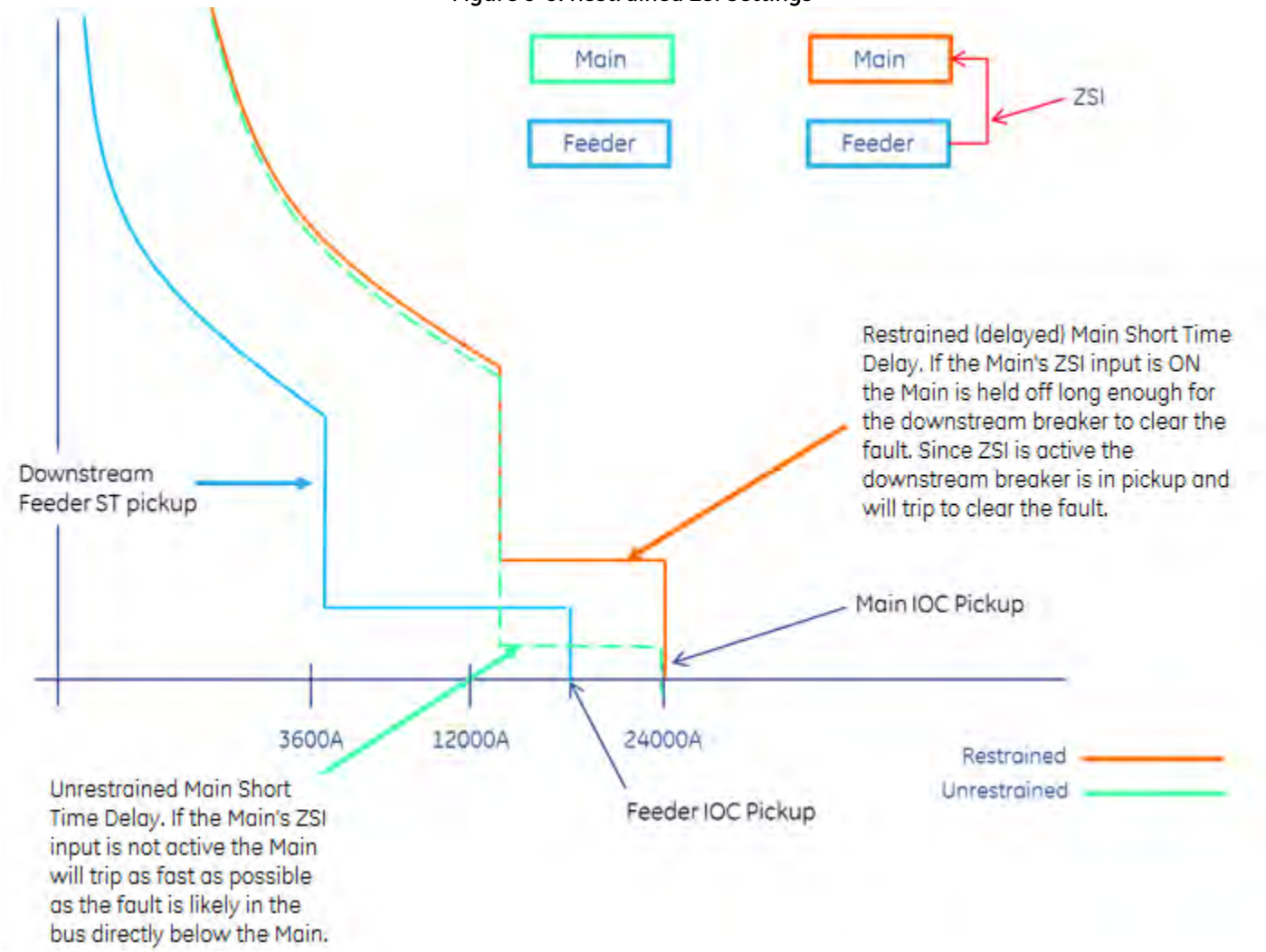
If the Zone Selective Input goes off while the restrained settings are in effect, they will remain in effect for 50 milliseconds. After that, the unrestrained settings will go into effect.

Unrestrained, normal mode ST setpoints: If the trip unit enters Short Time pickup and the ZSI input is OFF, these settings are in effect. In a ZSI configuration these settings applied on upper tiers (breakers that can receive a ZSI input from a downstream breaker) are optimized for protection of the cable/bus directly below the breaker, and not for selectivity with downstream breakers. Breakers at the load end of a ZSI scheme that have no ZSI signal coming in from downstream must have their unrestrained settings adjusted to coordinate with the downstream breaker if selective operation with these breakers is required.



Restrained settings: If the trip unit enters Short Time Pickup and the ZSI input is ON, these settings are in effect. This setting is intended to provide selectivity with the downstream breaker, so it will typically be set with a longer delay to give the downstream breaker a chance to clear the fault. Note that the Short Time ZSI Pickup value is not adjustable.

Figure 5-5: Restrained ZSI Settings



ZSI Options

There are two Zone Selective Interlocking options available in the EntelliGuard trip unit. Option "T" provides GF and ST interlocking. Option "Z" adds I-ZSI for Instantaneous ZSI protection.

Any combination of the available protection elements may be selected. See Zone Selective Interlocking Setup for a list of the available combinations. To enable ZSI for GF, ST, or I you must select which of those elements will participate in the ZSI scheme. When a breaker receives a ZSI input from a downstream breaker only those elements enabled for participation will be restrained.

In Power Break II and Spectra MicroEntelliGuard Circuit Breakers the "T" option only enables instantaneous ZSI as an output to interlock with upstream circuit breakers such as a GE WavePro, AK, AKR, Conversion Kits or new EntelliGuard G (ANSI or UL489). The T option requires 24 VDC external power. The T option does not modify Instantaneous timing on PowerBreak I, PowerBreak II and Spectra MicroEntelliGuard circuit breakers.

When the upstream breaker receives a ZSI signal from a downstream breaker it will adopt the settings that have been programmed in the "ZSI ST" and "ZSI GF" screens of the trips Setting menu. If the upstream breaker instantaneous trip has been selected for ZSI operation, the signal from the downstream breaker will cause the upstream breaker to adopt a fixed, non-adjustable delay in the instantaneous trip element which will allow the downstream breaker to trip instantaneously first.

Note that an upstream breaker is not informed of the cause of the incoming ZSI signal. It only knows that the downstream breaker is in pickup. Thus a downstream breaker in GF pickup can put the GF, ST, and I restrained settings into effect.

The restrained ST ZSI Delay Bands are independent and have the same bands available as the unrestrained setpoint. Slope settings may also be interlocked. Pickup is not adjustable.

The restrained GF ZSI Delay Bands are independent and have the same bands available as the unrestrained settings. Slope settings may also be interlocked. Pickup is not adjustable.

Instantaneous ZSI is either enabled or disabled. There are no settings to modify the action of I-ZSI.

INST ZSI timing is as follows:

- **EntelliGuard G (ANSI and UL489):** An additional 2.5 cycles (ignore inst for 3 cycles after seeing input and trip on the 7th half cycle)
- **AKR, WavePro and Conversion Kits:** An additional 4 cycles (ignore inst for 4.5 cycles after seeing input and trip on the 9th half cycle.)

Threshold ZSI

Starting with firmware release 08.00.26 the EntelliGuard Trip Unit provides a Threshold ZSI (T-ZSI) function that adds greater flexibility when designing for selectivity.

Threshold ZSI is available only when the I-ZSI factory option is installed. Threshold ZSI functions on Short Time and Instantaneous protection. Ground Fault does not participate.

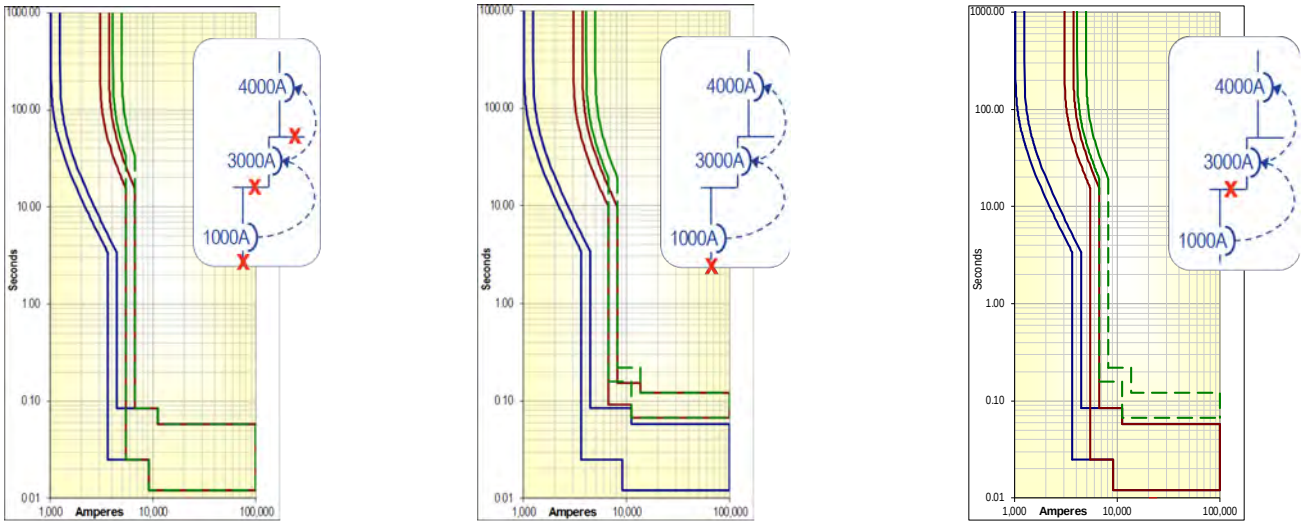
With Threshold ZSI enabled it is possible to set the Short Time and Instantaneous protection of multiple breaker tiers at the same pickup thresholds, maximizing in-zone sensitivity for unrestrained operation. Without this feature in-zone pickup thresholds must be nested from feeder to main to maintain selectivity.

With Threshold ZSI engaged the lowest tier breaker to enter pickup will issue a ZSI Output signal when the fault current exceeds 81% of the user-set threshold.

On receipt of a downstream ZSI signal an upstream breaker with T-ZSI enabled will do two things – it will engage the restrained (slower, selective) delay settings as set by the user, and it will increase its pickup threshold to 123% of the nominal user setting.

This feature eliminates concerns about trip system current measurement tolerance interfering with selectivity while providing maximum sensitivity.

Figure 5-6: T-ZSI Example



All breakers set for maximum protection. 3000A and 4000A breakers overlap.	Feeder fault – ZSI shifts 3000A and 4000A delay bands up to allow the feeder time to clear the fault.	Bus fault – T-ZSI shifts 3000A Pickup to 81%, 4000A Pickup to 123%, and 4000A Delay band per ZSI settings.

INTERRUPTION PROTECTION

Making Current Release (MCR)

Every EntelliGuard G circuit breaker uses a making current release. The making current release threshold varies per circuit breaker Envelope and is related to the circuit breaker's close and latch rating.

The MCR override is activated at the time the circuit breaker closes and for six cycles thereafter. When the six cycles are over, the override pickup threshold changes to the HSIOC pickup setting.

WavePro, AKR, PowerBreak, PowerBreak II, and New HPC do not have a making current release trip.

High Set Instantaneous Protection (HSIOC)

HSIOC is an Instantaneous Override protection element. Some EntelliGuard G circuit breakers may be provided with an override instantaneous trip based on their ratings.

If the circuit breaker's withstand rating (Icw) is equal to the short circuit rating (Icu) then the trip unit will not have an override pickup. If the withstand rating is lower than the short circuit rating then the trip will have override protection set at the short time withstand rating level.

In UL 489 circuit breakers the HSIOC setting is nominally at 107% of the Icw for the circuit breaker. Taking tolerance into account, the override's minimum trip is at 100% of the circuit breaker's Icw.

In UL 1066 (ANSI) circuit breakers the HSIOC setting is also at 107% Icw if the adjustable selective instantaneous is ON. If the adjustable selective instantaneous is OFF then the HSIOC nominal pick up is at 98% of the circuit breaker's Icw and, considering tolerance, the minimum pickup is at 91% of the circuit breaker's Icw.

Power Break I, WavePro and AKR circuit breakers do not employ an override function. Power Break II circuit breakers use a mechanical override function.

Breaker Interface Module (BIM)

The EntelliGuard G Breaker uses a Breaker Interface Module which is internally connected to the EntelliGuard G Trip Unit. This allows the breaker to electronically reject an incorrect trip unit being inserted into a breaker, instead of the traditional mechanical rejection methodology used on other GE circuit breakers.

The BIM contains information that describes the breaker configuration to the trip unit. The trip unit extracts information on Sensor Rating, Interruption Rating, and pole configuration from the BIM. This is a one-time event that occurs when a new trip unit is first powered either from the breaker CTs or from an external DC supply when it is installed in a breaker. On every subsequent power up the trip unit compares information read from the BIM to the information it previously stored in its memory. If the information does not match the trip unit will set a BIM Error Flag. The BIM is not active when the trip unit is powered by its internal battery.

NOTICE

ENTELLIGUARD G BIM ERROR BEHAVIOR

If a trip unit is unable to retrieve information from the breaker's BIM one of two actions will occur :

1. If the trip unit firmware is earlier than 08.00.23 the breaker will be tripped and an event logged.
2. Newer firmware will display an error condition and adjust internal breaker frame settings for the minimum breaker rating for safety. Restoring normal BIM operation will also restore the original settings.

Under certain circumstances, it is possible to reconfigure a trip unit so that it can be installed in a different circuit breaker, or to clear a BIM Error condition. This involves "divorcing" the BIM and trip unit so that the trip unit can be "remarried" to a circuit breaker.

BIM Remarry Sequence

1. Install the trip unit on the target breaker.
2. Apply external DC power. A test kit can be used for this.
3. BIM mismatch will be indicated.
4. Press Right + Left + Up keypad buttons simultaneously and hold.
5. "BIM OK" will flash in the upper left corner of the LCD display if marry succeeded
6. "BIM ERROR" will show if the marry failed.

Upon execution of the procedure, GTU will upload the data if the breaker is open and the following data in the BIM matches the GTU data programmed in the factory:

- Sensor
- Standard (UL/ANSI/IEC)
- MCR
- HSIOC
- Breaker interruption rating (Frame)

Universal Trip Unit

The "Universal Trip Unit" can be used as a replacement across a wide range of EntelliGuard G circuit breakers. The Protection and Advanced Features of the Universal trip unit must match the configuration of the trip unit being replaced to maintain the same functionality. The Universal

trip unit is programmed with default minimum values for all protection, and it will automatically read the BIM values from the first breaker it is installed in. This will force the Universal Trip Unit to assume the identical breaker configuration of the trip unit it is replacing. Once this process is complete, the Universal Trip Unit cannot be moved to another breaker – it "marries" the breaker.

This concept of a Universal Trip unit is unique to the EntelliGuard G. Other breakers such as the WavePro require that a replacement trip unit have mechanical rejection features that match those of the host breaker. This ensures that the replacement trip unit is configured to match the breaker. Each breaker frame and sensor combination requires a unique spare trip unit. EntelliGuard G Universal Trip Units can be installed in any frame/sensor combination, greatly reducing the number of spares required to maintain a system.

PROTECTIVE RELAYS

The protective relay functions can be set either to trip or generate an alarm. If the Protective Relay Enable setting is enabled a trip and alarm will be generated, if set to OFF only an alarm will be generated. The alarms can provide external indication by using the digital output contacts. See "Output Relays," elsewhere in this manual for information about output contact configuration and behavior.

Note that all Protective Relay functions other than Current Unbalance require that voltage data be available in the trip unit. This requires a Potential Transformer connection through GE Voltage Conditioners to provide the necessary data. See Potential Transformer Voltage

Voltage Unbalance

This function compares the highest or lowest phase voltage with the average of all three phases and initiates a trip if the difference exceeds the setpoint.

Table 5-9: Voltage Unbalance Settings

Item	Option
Voltage unbalance pickup	Adjustable from 10% to 50% in increments of 1%.
Voltage unbalance delay setting	Adjustable from 1 sec to 15 sec in increments of 1 sec. Setting this value to OFF disables this function.

Current Unbalance

This function compares the current in the highest or lowest phase with the average of all three phases and initiates a trip if the difference exceeds the setpoint.

Table 5-10: Current Unbalance Settings

Item	Option
Current unbalance pickup	Adjustable from 10% to 50% in increments of 1%.
Current unbalance delay setting	Adjustable from 1 sec to 15 sec in increments of 1 sec. Setting this value to OFF disables this function.

Undervoltage Relay

This function measures the voltage in all phases and initiates a trip if any phase voltage drops below the set point. This internal trip unit relay feature operates independently of any separately installed undervoltage Relay Accessory on the circuit breaker.

Table 5-11: Under Voltage Settings

Item	Option
Under voltage pickup	Adjustable from 50% to 90% in increments of 1%.
Under voltage delay setting:	Adjustable from 1 sec to 15 sec in increments of 1 sec. Setting this value to OFF disables this function.

Zero Voltage Trip

"Trip on Zero Volts" is a setpoint that defines the operation of the UVR relay on a "dead bus". It determines whether the protective relay UVR trip unit function trips or not when all three phase voltages drop to zero.

Overvoltage Relay

This function measures the voltage in all phases and initiates a trip if any phase voltage exceeds the setpoint. See Table 5-12.

Table 5-12: Over Voltage Settings

Item	Option
Over voltage pickup	Adjustable from 110% to 150% in increments of 1%.
Over voltage delay	Adjustable from 1 sec to 15 sec in increments of 1 sec. Setting this value to OFF disables this function.

Power Reversal Relay

This function measures the direction of power flow through the breaker and initiates a trip if a sufficient magnitude of reverse power is detected.

Table 5-13: Power Reversal Settings

Item	Option
Power reversal pickup	Adjustable from 10 kW to 990 kW in increments of 10 kW.
Power reversal delay	Adjustable from 1 sec to 15 sec in increments of 1 sec. Setting this value to zero (0) will disable this function.

VOLTAGE MEASUREMENT

NOTICE
An incorrect PT voltage set point will result in incorrect voltage and power metering values.

The EntelliGuard trip unit has three settings to configure voltage measurement to match the system voltage and wiring configuration. Please read "Voltage Input Wiring" for more information on voltage input wiring and configuration.

Power Direction Setup

This function selects the normal power flow direction for the breaker. Set this parameter to match the direction of current flow through the breaker during normal operating conditions. This direction setup also affects the sign of the normal power metering displays starting with firmware revision 08.00.26.

Potential Transformer Voltage

Enter the primary voltage rating of the potential transformer. The range of values is 120 V to 600 V, with an increment of 1V. The voltage input coming into the trip unit must be wired into using voltage conditioners which steps the voltage down to an acceptable voltage level. See below for voltage conditioner plate wiring diagrams.

POTENTIAL TRANSFORMER CONNECTION

Select the appropriate potential transformer connection, either line-to-line (Ph-Ph) or line-to-neutral (Ph-N). See "PT Connection" for more details.

OUTPUT RELAYS

The number of outputs available varies by breaker. These are relay contact outputs to the secondary disconnect. Each output can be configured per Table 5-14.

The contacts are rated for **30 VDC/25 VAC max, 1 A**.

Power Break I, Power Break II, WavePro, AK, AKR and Conversion Kit Trip Units have one output relay. EntelliGuard G Trip Units have two output relays. The relay output can be assigned to the following functions:

- Group 1 – GF Sum and GF CT alarm only. Does not latch.
- Group 2 – Overcurrent (LT, ST, Instantaneous, GF, CT GF). Latches
- Group 3 – Protective Relay. Latches if trip.
- Group 4 – Current alarm 1
- Group 5 – Current Alarm 2
- Group 6 – Health Status
- Group 7 – RELT (Dedicated to Output 1 when optioned)
- Group 8 – GF sum and GF CT Alarm and TRIP functions.
- Group 9 – REF (restricted earth fault) trip (IEC applications only)
- Group 10 – SEF (standby earth fault) trip (IEC applications only)
- Group 11 – UEF (unrestricted earth fault) trip (IEC applications only)

The trip units must have the specific option (as an example protective relay must be enabled in order for protective function to actuate the relay) enabled in order to actuate the relay.

Fan/Command Close Control

EntelliGuard trip units include an output dedicated to controlling either an external breaker cooling fan (5000A WavePro and AKR breakers only) or a remote close accessory (EntelliGuard G breakers only). Breaker documentation provides wiring information.

For WavePro and AKR breakers, the trip unit automatically calculates cooling requirements and activates the fan control output to maintain the breaker's operating temperature. The fan may also be commanded using Modbus command 111.

For EntelliGuard G breakers, the remote close command is available via Modbus command. Issuing command 111 will operate the command close coil accessory on the circuit breaker (remotely closes the breaker).

Table 5-14: Output Configuration

Group #	Function	Summary Description
1	GF alarm	Turns on when GF alarm is activated. Does not latch.
2	Overcurrent trip (GF, INST, LT, ST)	Over-current trip turns ON the relay. Relay latches.
3	Protective relays	When protective relay trips the relay contact closes and latches.
4	Current alarm 1	Exceeding current alarm 1 pick-up turns closes the relay contact. Does not latch.
5	Current alarm 2	Exceeding current alarm 2 pick-up turns closes the relay contact. Does not latch.
6	*Health status	Relay contact will be closed or opened depending on the Health contact setting. (Either normally open (NO) or normally closed (NC) set via communication).
7	Reduced Energy Let-Through (RELT)	Output relay contact closes when the RELT pickup is enabled. Remains latched until RELT function is disengaged.
8	GF Sum or GF CT Alarm	Activated when GF Sum or GF CT alarm function picks up. Relay latches.
9	REF	Activated when Restricted Earth Fault element operates (IEC only). Relay latches.
10	SEF	Activated when the Standby Earth Fault element operates (IEC only). Relay latches.
11	UEF	Activated when the Unrestricted Earth Fault element operates (IEC only). Relay latches.

BELL ALARM & LOCKOUT ACCESSORY

Accessory Configuration

A Bell Alarm accessory is available for all breaker types.

In the Power Break II the Bell Alarm and Lockout is triggered by the trip unit and the accessory can be configured through trip unit settings to respond to a variety of breaker protective functions. See Bell Alarm & Lockout Accessory for more details.

The WavePro circuit breaker Bell Alarm accessory is triggered by the trip unit, but its Lockout function is determined by how the accessory is installed. Consult DEH-163 for details. See Bell Alarm & Lockout Accessory later in this manual for trip unit configuration settings.

Bell Alarm Operation – EntelliGuard G breakers

The EntelliGuard G breaker has a mechanical lockout built into the breaker's trip mechanism. The lockout actuator is always triggered when the flux shifter actuator "trips" the circuit breaker. The breaker's mechanical lockout is not actuated if the breaker is "opened" using the front panel pushbuttons, or an optional shunt trip or UVR accessory.

There are two modes of operation for the Lockout button in UL & ANSI applications – MANUAL and AUTOMATIC. The trip unit's Lockout button configuration is fixed based on the catalog number of the trip unit. MANUAL or AUTO operation is fixed at the factory. Do not attempt to rotate the knob as it will damage the locking mechanism.

If you wish to change a trip unit with MANUAL lockout to AUTOMATIC lockout operation order retrofit kit **GLKAR**. To convert from AUTOMATIC to MANUAL lockout configuration order kit **GLKMR**.

In MANUAL mode the trip unit's lockout button will "pop out" when the breaker is tripped. When the button is extended the breaker mechanism is "locked out" and cannot be closed until the button on the trip unit is pushed back in.

In AUTOMATIC mode the trip unit's lockout button is fixed in the Reset position. This prevents the mechanism from "locking out" so the breaker can be immediately reclosed without any manual intervention.

The optional breaker bell alarm contact accessory provides a signal whenever the breaker's mechanical lockout operates. In MANUAL mode this contact will remain closed as long as the trip unit lockout reset button remains extended. In AUTO mode this contact will close briefly when a trip occurs, but does not latch. The dwell time of the contact in AUTO mode is on the order of a few milliseconds – typically not enough to be useful for control purposes.

DIGITAL INPUT RELAYS

Inputs can be assigned to three main functionalities:

- Reduced Energy Let-Through (RELT)
- Trip the breaker
- Remotely reset latched relays

Table 5-15 shows the possible assignments for the inputs.

Input 1:

- If the trip unit is equipped with the Reduced Energy Let Through (RELT) option this input is automatically and permanently assigned to engage RELT settings when the input is activated.
- If RELT is not available on the trip unit, Input 1 can be set to OFF (no action), Trip the Breaker, or Reset latched output relays.

Table 5-15: Digital Input Assignments

Input	Input 1 Assignment	Summary Description
1	OFF	No action taken.
	RESET	Resets Latched Output Relays
	RELT	Causes unit to use the RELT protection setpoints as long as input 1 is active.
	TRIP	Causes the breaker to trip.
2	OFF	No action taken.
	RESET	Resets Latched Output Relays
	RELT	Causes unit to use the RELT protection setpoints as long as input 2 is active.
	TRIP	Causes a breaker to trip.

NOTICE

High fidelity external contacts are recommended for use with inputs to reduce the likelihood of contact bounce being interpreted as multiple input commands.

In addition to the Digital Inputs indicated above, Power Break I, Power Break II, WavePro, AKR, New HPC, and EntelliGuard G Trip Units also receive inputs from external voltage conditioners, a +24 VDC control power supply, and communication connections. (External +24 VDC control power is required for communication.)

All EntelliGuard trip unit types have a connection to an auxiliary switch within the breaker that senses the breaker's contact position (OPEN or CLOSED). This status indication requires +24 VDC or current > 20% sensor. Breaker position status is not available under battery power.

SECTION 6. SETTING UP THE TRIP UNIT

SETUP NAVIGATION

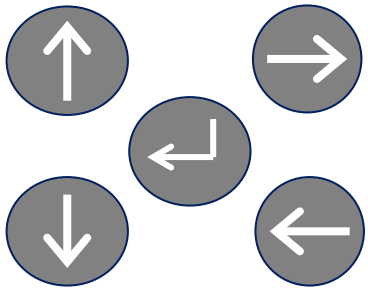
The trip unit will always start up on its "Home Screen" or Main Menu window.

You can quickly return to this menu from any other screen by pressing and holding the LEFT arrow button.

Use the UP and DOWN arrow buttons to select from the Main Menu choices.

To access the trip unit setpoints from the Main Menu, first move the highlight to the SETUP item as shown here using the UP and DOWN arrow buttons, then press the RIGHT or LEFT arrow buttons to proceed through the settings screens.

Figure 6-1: Navigation Keypad Buttons

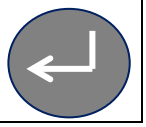


Use the LEFT and RIGHT arrows to navigate from screen to screen and to move between multiple items on a screen — Pickup, Band, etc.

Use the UP and DOWN arrows to adjust setpoint item values. For example, pickup ranges from 0.50 to 1.00.

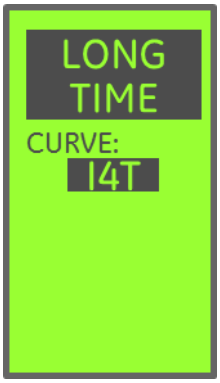
NOTICE

Until you hit the middle ENTER key the setting will not be saved. The setting will revert to its previous value on exit.



If you try to SAVE and you see the message "LOCKED" on the LCD, you must enter the access password. See "Password Setup" in SECTION 1 for more information.

LONG TIME CURVE SELECTION



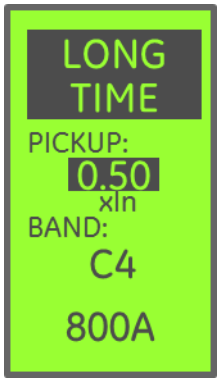
Long Time Curve selects the type of LT protection curves available for configuration.

The I^2t selection provides the "C" range of protection that mimics the logarithmic response of a thermal breaker (delay band settings of C1 – CMAX)

The I^4T selection adds the "F" range of protection that mimics the response of a fuse (delay band settings of F1 – FMAX).

Long Time is optional on some breaker configurations. If your trip unit does not have the Long Time Protection feature enabled these screens will not be available.

LONG TIME PICKUP



Long Time Pickup defines the fault current threshold where the Long Time protection element begins to "timeout" toward tripping as a percentage of the Rating Plug current (In). The actual pickup threshold, in amperes, is indicated at the bottom of the screen

The LT pickup adjustment range is between 50% (0.50) and 100% (1.0) of the rating plug current.

What this shows:
The Pickup setpoint is highlighted and set to 50%. This breaker has a 1600A Rating Plug, since the indicated pickup threshold is 800A (50% of 1600A = 800A)

LONG TIME DELAY

Long Time Band selects the "delay band" for the LT element, or how long the trip unit will allow an overload to persist before the breaker is commanded to open.

Refer to Table 5-1 for typical thermal (I^2t) delay band timing values.

Refer to Table 5-2 for typical fuse (I^4t) delay band timing values.

See GE publications DES-90 and DES-095 for thermal curves. See DES-91 and DES-096 for fuse curve information.

The thermal (I^2t) band is adjustable from C MIN to a maximum that varies by circuit breaker application.

The fuse (I^4t) band is adjustable from F MIN to F MAX.

The Fuse and Thermal band selections are both included in the Band setpoint list – continue scrolling past the min or max thermal (I^2t) setting values to reach the fuse (I^4t) band setpoints.

What this shows:
The C4 I^2t delay band is currently selected.

Tip: You can navigate completely through the entire range of settings using just the UP or DOWN arrow.

SHORT TIME PICKUP

Short Time Pickup defines the threshold where the ST element begins to "timeout" toward tripping, as a multiple of the Long Time Pickup threshold.

If Long Time Pickup is set to 800A, and Short Time Pickup is set to 2.5, ST will go into pickup when the current exceeds 2000A.

Short Time is an optional element. If ST is not installed in your trip unit, this screen will not appear.

The ST pickup adjustment range is between 1.5 and a breaker dependent maximum. Check DES-092 and DES-097 for pickup threshold limits.

What this shows:
The Pickup setpoint is highlighted and set to 2.5 x the LT pickup value.

SHORT TIME DELAY

Short Time Band selects the "delay band" for the ST element, or how long the trip unit will allow an overload to persist before the breaker is commanded to open.

See DES-092 and DES-097 for delay band information.

The band is adjustable from 1.5 to a maximum that varies by circuit breaker application.

ST can be disabled by selecting OFF as the ST Band setting. OFF is found between the minimum and maximum delay band setting positions.

If ST is turned off (Disabled) you cannot also disable Instantaneous protection. Likewise, if Instantaneous is disabled, you cannot turn off ST.

NOTICE – ZSI OPERATION

The Short Time settings described here are the "unrestrained" settings when using Zone Selective Interlocking. When there is no ZSI input from a downstream breaker these settings are in force.
On receipt of a valid ZSI input the breaker will put the Restrained or Selective (ZSI) settings in force.

What this shows:
The ST delay is set to Band 4.

SHORT TIME SLOPE

The **Short Time** element protects the electrical system from higher level overloads and moderate short circuit currents.

Short Time Slope modifies the shape of the "delay band" for the ST element.

See DES-092 and DES-097 for trip time curve information.

Figure 6-2 illustrates the various ST Slope settings.

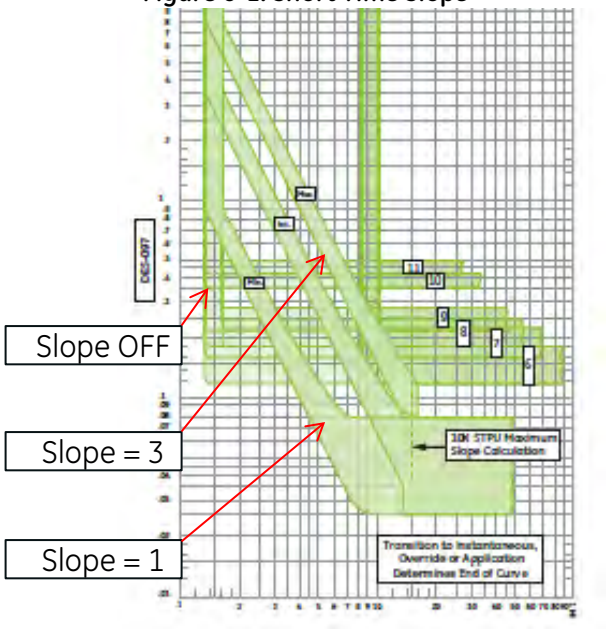
The Slope setpoint has four available values:

- **OFF** – constant-time delay band
- **1** – Minimum slope (shown as MIN)
- **2** – Intermediate slope (shown as INT)
- **3** – Maximum slope (shown as MAX)

What this shows:
The ST Slope is set to OFF (Constant Time).

Note: When using the I^4t Fuse delay band settings for Long Time the Short Time Slope setting is automatically set to OFF and cannot be changed.

Figure 6-2: Short Time Slope



INSTANTANEOUS PICKUP

Instantaneous Pickup defines the threshold where the INST element begins to "timeout" toward tripping, as a multiple of the Rating Plug current (In).

If a 1600A Rating plug is installed, and INST Pickup is set to 10.0, INST will go into pickup when the current exceeds 16000A.

Instantaneous is an optional element. If INST protection is not installed in your trip unit, this screen will not appear.

INST pickup range is from 2.0 to a maximum value that is breaker dependent. See DES-094 for EntelliGuard G, DES-099 for Power Break, DES-100 for Power Break II, and DES-122 for New HPC.

EntelliGuard G circuit breakers offer an optional "High Range Instantaneous" that extends the Instantaneous pickup as high as 30 x the Rating Plug current (frame limited).

Certain breaker types allow INST to be turned off. This is accomplished by selecting OFF as the Pickup threshold. OFF is found between the minimum and maximum pickup location if it the option is available.

What this shows:
The INST Pickup setpoint is highlighted and set to 10.0 x the Rating Plug current.

RELT INSTANTANEOUS PICKUP

Reduced Energy Let-Thru (RELT) is a second Instantaneous protection element that is fully independent of all other protection elements. RELT can be engaged or disengaged by dedicated remote contact or via communications. It cannot be controlled from the local keypad on the trip unit.

RELT Pickup defines the threshold where the RELT INST element begins to "timeout" toward tripping, as a multiple of the Rating Plug current.

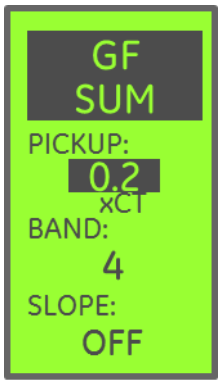
RELT is an optional element. If it is not installed on your trip unit, this screen will not appear.

RELT is adjustable between 1.5 and a breaker frame-dependent maximum, similar to the INST element.

When RELT is provided in the trip unit, Digital Output 1 and Digital Input 1 are automatically and permanently assigned to the RELT function. The output will close when RELT is engaged, and the input can be used with a light curtain or toggle switch to engage RELT. Please refer to later sections on Digital I/O and Serial Communications for further details on RELT operation.

What this shows:
The Pickup setpoint is highlighted and set to 1.5 x the Rating Plug current.

GROUND FAULT SUM PICKUP



The **Ground Fault Sum** element protects the electrical system against unintentional connections to earth ground.

Ground Fault Sum Pickup defines the threshold where the GF Sum element begins to "timeout" toward tripping, as fraction of the breaker sensor value.

GF Summation always uses four current sensor inputs (Phase A, B, C, and N) to calculate a phasor sum when determining pickup.

Ground Fault Summation is an optional element. If GF Sum is not installed in your trip unit, this screen will not appear.

For ANSI and UL breakers the GF Sum pickup adjustment range is between 0.2 and a breaker-dependent maximum (See Table 5-7).

Use DES-093 for EntelliGuard G GF curve characteristics and DES-098 for Power Break, AKR, and WavePro, and DES-121 for New HPC GF curve characteristics.

What this shows:
The Pickup setpoint is highlighted and set to 0.2x the breaker's installed sensor rating.

GROUND FAULT SUM DELAY

Ground Fault Sum Band selects the "delay band" for the GF element, or how long the trip unit will allow an overload to persist before the breaker is commanded to open.

See DES-093 for trip time curve information on EntelliGuard G.

See DES-098A for trip time curve information on Power Break, AKR, and WavePro.

See DES-121 for New HPC TOC.

Ground Fault Trip protection delay band can be set between 1 and 14.

Optional configurations will allow for GF to be turned off by setting the delay band to OFF. This value is found between the minimum and maximum band selections for the trip unit. See "Ground-Fault Defeat" elsewhere in this manual.

NOTICE
These settings are in force when GF ZSI is not active, defined as the protective unrestrained setpoint. When ZSI is engaged the GF ZSI settings are put into force. Those are the selective or restrained settings.

GROUND FAULT SUM SLOPE

Ground Fault Slope modifies the shape of the "delay band" for the GF element.

See DES-093 for trip time curve information on EntelliGuard G (shown below).

See DES-098 for trip time curve information on Power Break, AKR, and WavePro.

See DES-121 for New HPC.

The Slope setpoint has these possible values:

- **OFF** – definite-time delay
- **1** – I^2t slope
- **2** – SGF slope
- **3** – I^4t slope

What this shows:
The GF Slope is set to OFF (Constant Time).

Figure 6-3: Ground Fault Sum Slope, Options 1 & 3

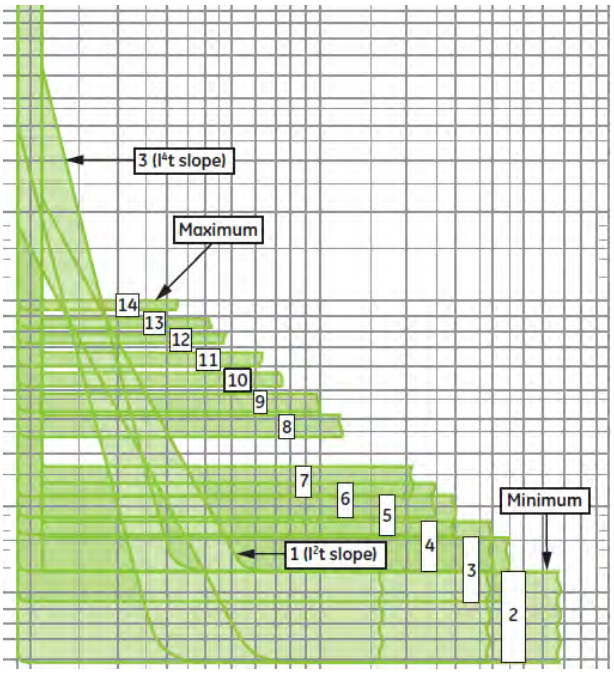
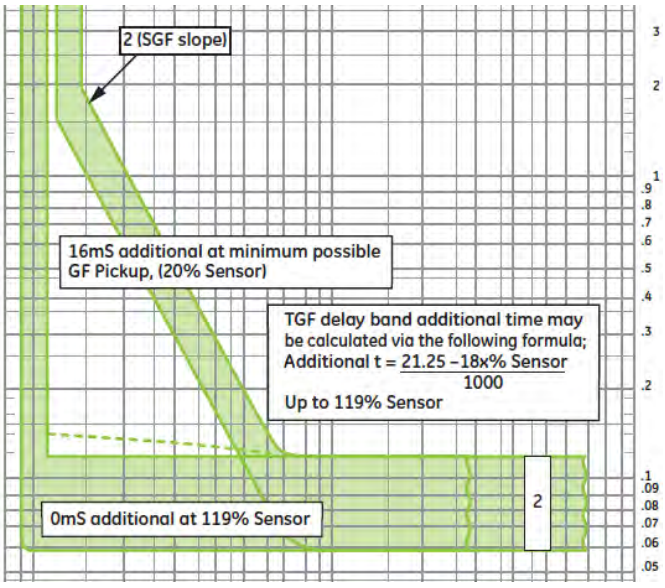
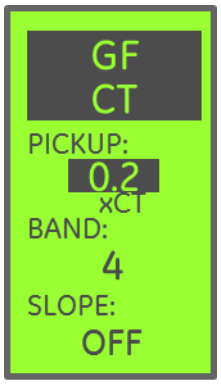


Figure 6-4: Ground Fault Sum Slope, Option 2



GROUND FAULT CT PICKUP (ENTELLIGUARD G ONLY)



The **Ground Fault CT** element protects the electrical system against unintentional connections to earth ground.

Ground Fault CT Pickup defines the threshold where the GF CT element begins to "timeout" toward tripping, as fraction of the breaker sensor value.

GF CT is used with Multi-Source Ground Fault installations.

Ground Fault CT is an optional element. If GF CT is not installed in your trip unit, this screen will not appear.

GF CT is available only on EntelliGuard G circuit breakers.

The GF Sum pickup adjustment range is between 0.1 and 1.0. Both the minimum and maximum are breaker and application dependent.

Settings below 0.2 require an external 24VDC power supply for proper operation.

What this shows:
The Pickup setpoint is highlighted and set to 0.2 x the breaker's installed sensor rating.

GROUND FAULT CT DELAY

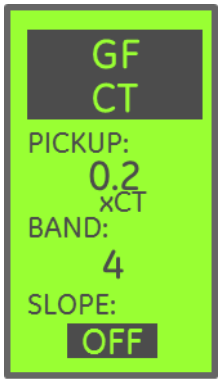
Ground Fault CT Band selects the "delay band" for the GF element, or how long the trip unit will allow an overload to persist before the breaker is commanded to open.

See DES-093 for trip time curve information on EntelliGuard G.

Ground Fault Trip protection delay band can be set between 1 and 14.

Optional configurations will allow for GF to be turned off by setting the delay band to OFF. This value is found between the minimum and maximum band selections for the trip unit.

GROUND FAULT CT SLOPE



Ground Fault CT Slope modifies the shape of the "delay band" for the GF element.

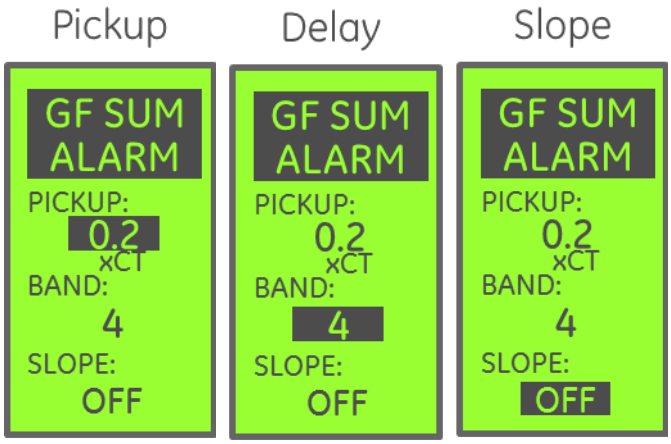
See DES-093 for trip time curve information on EntelliGuard G.

The Slope setpoint has three available values:

- **OFF** – definite-time delay
- **1** – I^2t slope
- **2** – SGF slope
- **3** – I^4t slope

What this shows:
The GF Slope is set to OFF (Constant Time).

GROUND FAULT SUM ALARM



This is the **Ground Fault Sum Alarm Setup Screen**.

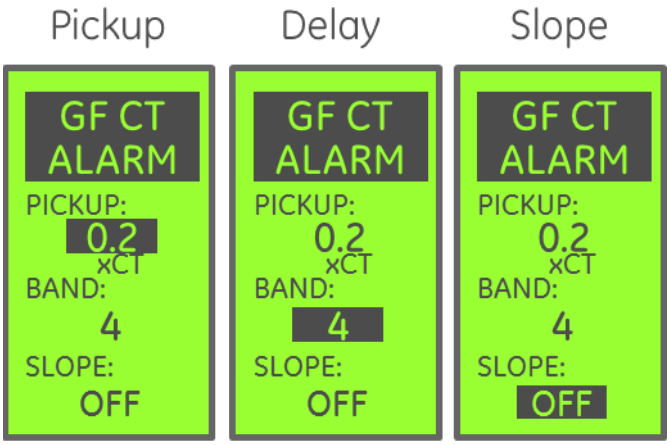
GF Sum Alarm operates identically to GF Sum Protection, but instead of tripping the circuit breaker, Alarm will raise a flag available over Modbus, or it can be configured to energize a digital output for external signaling.

See the section on Digital Output configuration for information on how to set up an external contact closure on GF Sum Alarm activation.

See the latest DES-093 for trip time curve information on EntelliGuard G.

See DES-098 for trip time curve information on Power Break, Power Break II, Wavepro, AKR. Refer to DES-121 for New HPC control units.

GROUND FAULT CT ALARM



This is the **Ground Fault CT Alarm Setup Screen**.

GF CT Alarm operates identically to GF CT Protection, but instead of tripping the circuit breaker, Alarm will raise a flag available over Modbus, or it can be configured to energize a digital output for external signaling.

See the section on Digital Output configuration for information on how to set up an external contact closure on GF CT Alarm activation.

GF CT is available only with EntelliGuard G circuit breakers.

See DES-093 for trip time curve information on EntelliGuard G.

ZONE SELECTIVE INTERLOCKING SETUP

The optional **Zone Selective Interlocking (ZSI)** feature allows enhanced coordination of tiered breaker installations.

The **Zone Selective Interlocking** settings let you select which protection elements will participate in the ZSI scheme, enable or disable Threshold ZSI, and provide a test function that is useful when commissioning switchgear installations.

Enabling ZSI – you can select a combination of GF, ST and/or Instantaneous, or none. The options available for selection are dependent on which factory options were ordered on the trip unit. If no ZSI option is installed on the trip unit, this screen will not appear.

The list below shows all possible combinations available in the EntelliGuard Trip Unit. The configurations available on your trip unit will vary with the ordered options.

- OFF
- GF ONLY
- GF & ST
- ST ONLY
- INST ONLY
- GF-INST
- ST-INST
- GF-INST-ST

What this shows:
This screen shows you that no protection elements have been configured with ZSI.

THRESHOLD ZSI SETUP

Threshold ZSI is a specialized function. It is only available when the I-ZSI option is installed in the trip unit. When active, a downstream breaker will command its ZSI Output signal ON when the affected element reaches 80% of pickup. When an upstream breaker has Threshold ZSI enabled and it receives a ZSI input from a downstream breaker it will increase its ZSI pickup setpoint to 123% of the user setpoint.

The only available settings are YES and NO. If the GF-ST-I configuration is not set then the YES setting will be unavailable.

This feature is only available on trip units with Firmware Revision 08.00.26 or higher.

ZSI TEST SETUP

The **ZSI Test Setup** screen provides a useful diagnostic tool for setting up or periodically evaluating your ZSI network. If ZSI Test is set to ON the trip unit will command its ZSI Output signal to be ON for 30 seconds. After 30 seconds has elapsed the ZSI output will be automatically turned off.

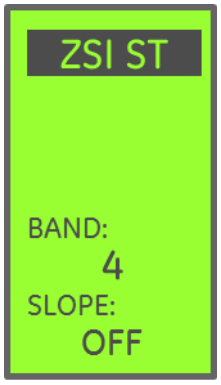
While the ZSI output is active you can monitor the upstream devices' ZSI input status to confirm that the

upstream breaker is properly receiving the downstream breaker's ZSI output signal.

This feature is only available on trip units with Firmware Revision 08.00.26 or higher.

NOTICE
Upstream breakers will put their restrained settings into force on receipt of a downstream ZSI Test signal. The test signal is treated as a valid ZSI input by upstream devices.

ZONE SELECTIVE INTERLOCK SHORT TIME (ST) SETUP



The **Zone Selective Interlock (ZSI) ST** setting is an alternative ST delay band and slope combination that will override the GTU ST setpoints whenever the trip unit receives a valid ZSI input signal. This equates to the RESTRAINED, selective setting.

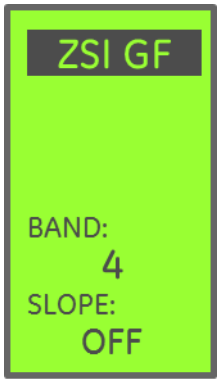
The normal short time setting is the unrestrained, protective setting.

If the ZSI option is not installed or if ZSI is not configured to operate with the ST element, this screen will not appear.

If the ST element is switched OFF (disabled) the ZSI ST element is also disabled, regardless of the setting on this screen.

What this shows:
The ST Delay band configuration that will be put in force when the ZSI input signal is active

ZONE SELECTIVE INTERLOCK GROUND FAULT SETUP



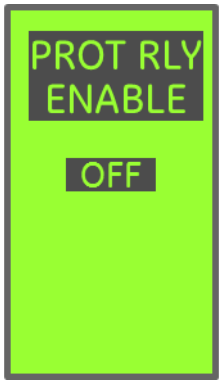
The **Zone Selective Interlock (ZSI) GF** setting sets an alternative GF delay band and slope setpoint combination that will override the GTU GF setpoints whenever the trip unit receives a valid ZSI input signal.

If the ZSI option is not installed or if ZSI is not configured to operate with the GF element, this screen will not appear.

If the GF element is disabled, the ZSI GF element is also disabled, regardless of the value displayed here.

What this shows:
The GF Delay band configuration that will be put in force when the ZSI input signal is active.

PROTECTIVE RELAY ENABLED



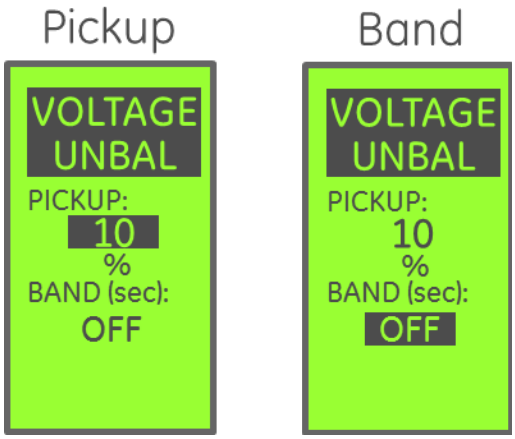
The **Protective Relay** setting screen enables or disables tripping for protective relays:

- **OFF** – protective relays will not trip the breaker
- **ON** – protective relays will trip the breaker if the relay is configured to trip.

Protective Relaying is an optional feature. If it is not installed on the trip unit, this screen will not appear.

Each relay can be disabled singly – so you can turn all of them off with this screen, and allow any that are configured to trip to do so.

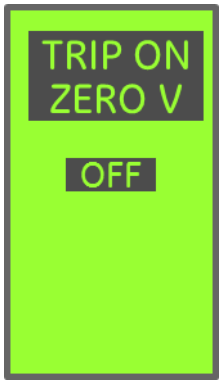
VOLTAGE UNBALANCE RELAY



Voltage Unbalance is part of the optional protective relay feature. If protective relaying is not installed on the trip unit, this screen will not appear.

- **Pickup** – settable between 10% and 50% of system voltage setpoint.
- **Band** – delay, from 1 to 15 seconds, between pickup and trip. Setting the Band to OFF disables the relay.

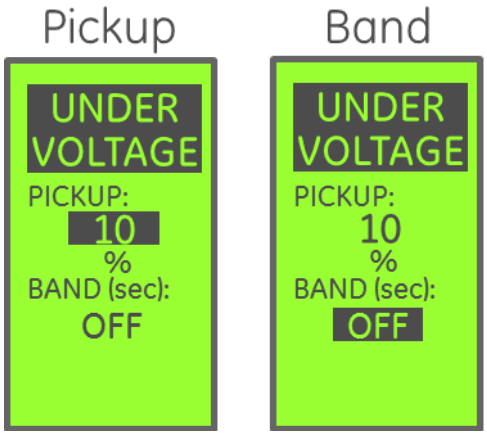
ZERO VOLTAGE TRIPPING



The only **Trip on Zero Volts** settings available are

- **OFF** – do not trip
- **ON** – trip when all three phases are zero

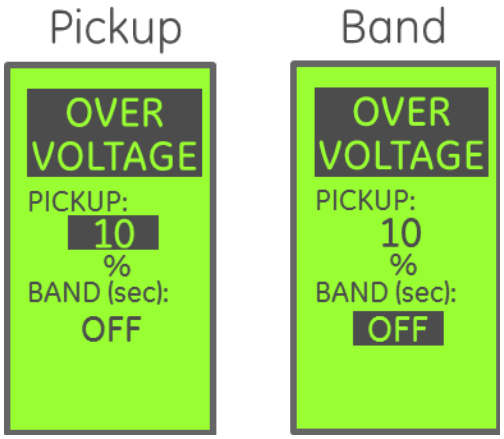
UNDERVOLTAGE RELAY



Undervoltage is part of the optional protective relay feature. If protective relaying is not installed on the trip unit, this screen will not appear.

- **Pickup** – settable between 50% and 90% of system voltage setpoint
- **Band** – delay, from 1 to 15 seconds, between pickup and trip. Setting the Band to OFF disables the relay

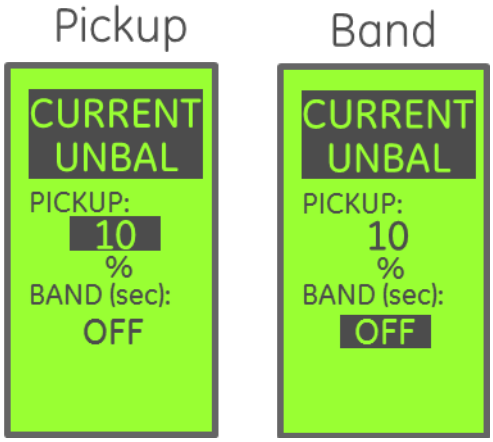
OVERVOLTAGE RELAY



Overvoltage is part of the optional protective relay feature. If protective relaying is not installed on the trip unit, this screen will not appear.

- **Pickup** – settable between 110% and 150% of system voltage setpoint
- **Band** – delay, from 1 to 15 seconds, between pickup and alarm/trip. Setting the Band to OFF disables the relay

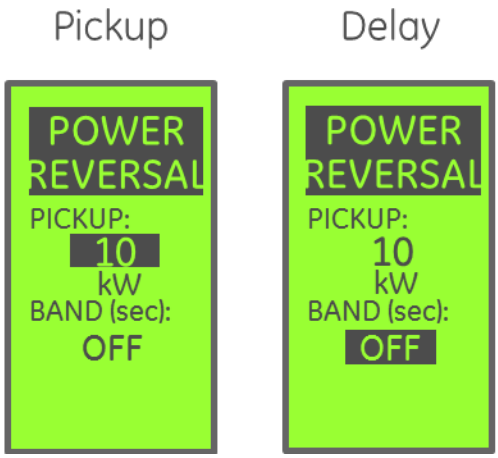
CURRENT UNBALANCE RELAY



Current Unbalance is part of the optional protective relay feature. If protective relaying is not installed on the trip unit, this screen will not appear.

- **Pickup** – settable between 10% and 50% of the average 3 phase current
- **Band** – delay, from 1 to 15 seconds, between pickup and trip. Setting the Band to OFF disables the relay

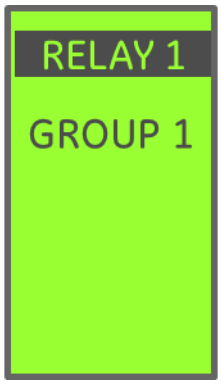
POWER REVERSAL



Power Reversal is part of the optional protective relay feature. If protective relaying is not installed on the trip unit, this screen will not appear.

- **Pickup** – settable between 10kW and 990kW, in 10kW steps
- **Band** – delay, from 1 to 15 seconds, between pickup and trip. Setting the Band to OFF disables the relay

OUTPUT RELAY – GROUP 1



Output Relay configuration **Group 1** links the Output Relay to the GF Sum Alarm and GF CT Alarm protection functions.

If the GF Sum or GF CT Alarm elements pick up, the Output Relay turns on, but does not latch. When the GF alarm element drops out of pickup, the Output Relay also drops out.

You can assign only one function per output relay.

If a relay assigned to GROUP 1 is ON, it cannot be reset by command.

OUTPUT RELAY – GROUP 2

Output Relay configuration **Group 2** links the relay to the overcurrent trip functions (LT, ST, INST, GF, CT GF)

1. If an Overcurrent Tripping element operates, the Output Relay is latched on.
2. The Output Relay will remain latched after the tripping element drops out until one of the following occurs:
   - DC power is removed from the trip unit.
   - The RESET RELAYS command is issued from the STATUS menu on the trip unit LCD. Reset is accomplished by pressing the ENTER button from that screen.
   - Modbus command 112 OFF is sent to the trip unit.
   - An Input has been mapped to the "Reset Relays" function, and is activated.

NOTICE

Although it is not explicitly mentioned here, RELT will also latch an output relay mapped to Group 2. The RELT trip will generate an Instantaneous trip event that will trigger and latch this relay.

OUTPUT RELAY – GROUP 3

Output Relay configuration **Group 3** links the relay to the Protective Relay trip functions (Voltage Unbalance, Under Voltage, Over Voltage, Current Unbalance, Power Reversal).

1. If a Protective Relay Tripping element operates, the Output Relay is latched on.
2. If the Protective Relay drops out of pickup, the Output Relay will remain latched.
3. The Output Relay will remain latched after the Protective Relay drops out until one of the following occurs:
   - DC power is removed from the trip unit.
   - The RESET RELAYS command is issued from the STATUS menu on the trip unit LCD. Reset by pressing the ENTER button from that screen.
   - Modbus command 112 OFF is sent to the trip unit.
   - An Input has been mapped to the "Reset Relays" function, and is activated.

OUTPUT RELAY – GROUP 4 AND 5

Output Relay configurations **Group 4** and **Group 5** link the relay to the Current Alarm 1 and Current Alarm 2 element, respectively.

1. If the associated Current Alarm goes into pickup, the Output Relay is turned on.
2. The Output Relay drops out when the associated Current Alarm drops out of pickup, or if DC power is removed.
3. The Output Relay cannot be reset by LCD command as long as the Current Alarm is in pickup.
4. The Output Relay cannot be reset over Modbus as long as the Current Alarm is in pickup.

OUTPUT RELAY – GROUP 6

Output Relay Configuration **Group 6** links the output relay to the Error status of the trip unit. Any internal error condition that results in a display on the Error Status screen will set this output. The output does not latch – it remains energized as long as the error condition persists.

OUTPUT RELAY – GROUP 7

Output Relay configuration **Group 7** links the relay to the Reduced Energy Let Through (RELT) function. Whenever RELT is engaged the output relay will be closed.

The RELAY cannot be reset from the LCD or via communications while RELT is active.

When the RELT command is removed, RELT remains in force for 10-15 seconds. The Output Relay remains closed during this time as well.

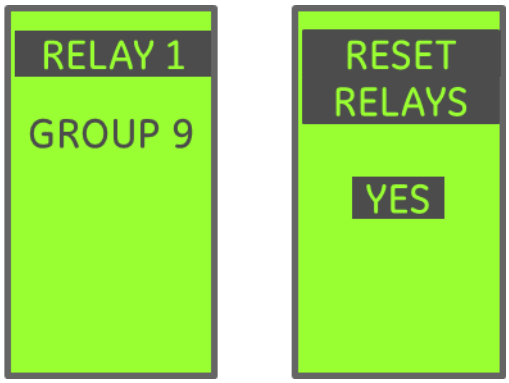
Relay 1 is automatically and permanently assigned Group 7 on any trip unit with the RELT option installed.

OUTPUT RELAY –GROUP 8

Output Relay configuration **Group 8** (ALARM and TRIP) links the relay to the GF Sum Alarm, GF Sum Trip, GF CT Alarm, and GF CT Trip protection functions.

1. If the GF Sum or GF CT Tripping elements operate, the Output Relay is latched on.
2. The Output Relay will not drop out if the tripping element falls out of pickup.
3. The Output Relay will remain latched after the tripping element drops out of pickup until one of the following occurs:
   - DC power is removed from the trip unit.
   - The RESET RELAYS command is issued from the STATUS menu on the trip unit LCD. Reset is accomplished by pressing the ENTER button from that screen.
   - Modbus command 112 OFF is sent to the trip unit.
   - An Input has been mapped to the “Reset Relays” function, and is activated.
4. If the GF Sum or GF CT Alarm elements pick up, the Output Relay turns on, but does not latch. When the GF alarm element drops out of pickup, the relay also drops out.
5. If both GF Trip and Alarm elements trigger the relay, it will latch, requiring reset.

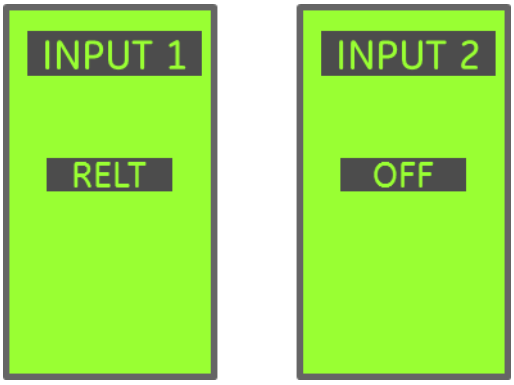
OUTPUT RELAY – GROUPS 9, 10 AND 11



Output Relay configuration **Groups 9, 10, and 11** (IEC devices only) link the relay to the REF Trip, SEF Trip, and UEF Earth Fault Trip protection functions, respectively.

1. If the associated Earth Fault Tripping element operates, the Output Relay is latched on.
2. The Output Relay will not drop out if the tripping element falls out of pickup.
3. The Output Relay will remain latched after the element drops out until one of the following occurs:
   - DC power is removed from the trip unit.
   - The RESET RELAYS command is issued from the STATUS menu on the trip unit LCD. Reset is accomplished by pressing the ENTER button from that screen.
   - Modbus command 112 OFF is sent to the trip unit.
   - An Input has been mapped to the "Reset Relays" function, and is activated.

DIGITAL INPUT CONFIGURATION



Digital Inputs are available as options on many different breakers.

The number of available inputs varies by circuit breaker.

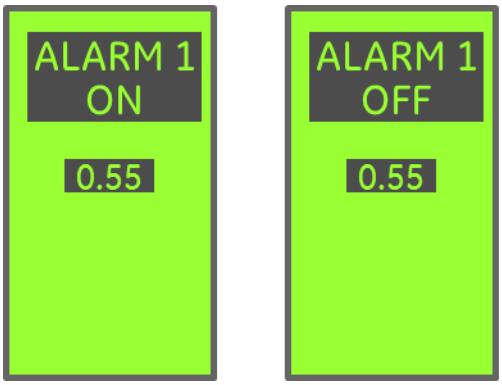
Power Break, Power Break II, AKR, New HPC and WavePro breakers (switches) provide one digital input.

EntelliGuard G provides two digital inputs. The number of inputs available matches the number of screens visible on the trip unit

Inputs can be assigned functions as follows:

- **RELT** – if the RELT option is installed, INPUT 1 is automatically and permanently assigned to RELT activation.
- **OFF** – activating the input does not produce any response.
- **TRIP** – the breaker will be commanded to trip on receipt of a valid input signal.
- **RESET** – any latched relay outputs are unlatched on receipt of a valid input signal.

CURRENT ALARMS



Current Alarms are standard on every UL and ANSI GTU trip unit. Current Alarms are not available on New HPC controllers.

Current alarms can be configured to actuate relay outputs when they go into pickup. They also have status flags that can be monitored over Modbus.

The ON setting determines the level, as a percent of rating plug current, where the current alarm will pick up.

If the highest measured phase current exceeds the pickup threshold for more than 60 seconds, the alarm will activate. Setting range is 50% to 100%.

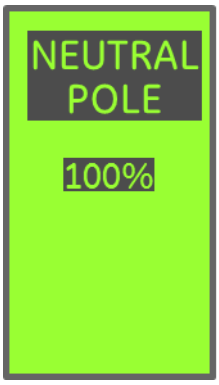
Once in pickup, if the highest measured phase falls below the OFF threshold for more than 60 seconds, the alarm will drop out.

The Output Relay assigned to the Current Alarm does not latch. It tracks the state of the current alarm.

The OFF Setting cannot be set higher than the ON setting.

ALARM 1 and ALARM 2 operate identically, and independently.

NEUTRAL POLE (ENTELLIGUARD G ONLY)



Neutral Pole setting determines the overcurrent protection setting for the neutral pole of a 4 pole breaker.

This screen may be displayed on a 3 pole breaker, in which case it is recommended that it be set to off. There is no way for a 3 pole breaker to open the neutral pole, so there is no added protection provided by enabling this feature.

The available settings are OFF, 50%, 63%, and 100%. This determines the percentage of the Long Time pickup setting that will apply to the neutral pole.

For example, if the Long Time Pickup is set to 1.0 and the Neutral Pole is set to 50%, the Long Time Pickup setpoint for the Neutral is 50%.

The neutral pole screen is not available on PB1, PBII, WavePro, AK, AKR or Conversion Kit trip units.

BELL ALARM LOCKOUT

PBII and WavePro breakers can be equipped with an optional Bell Alarm Lockout accessory.

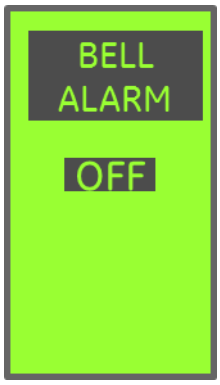
This screen will appear on trip units configured for these breaker types only.

The WavePro Lockout is triggered whenever the Bell Alarm is triggered. The WavePro Lockout function is configured during mechanical installation of the accessory. Consult DEH-163 for details. There is no trip unit setting that affects WavePro Lockout operation.

Lockout Settings (Applicable to PBII Only)

- **OFF** – Disabled/OFF
- **1** - Shunt Trip
- **2** - UVR Trip
- **3** - Over Current Trip
- **4** - Protective Relay Trip **5** - Shunt, UVR
- **6** - Shunt, Over Current
- **7** - Shunt, Protective Relay
- **8** - UVR, Over Current
- **9** - UVR, Protective Relay
- **10** - Over Current, Protective Relay
- **11** - Shunt Trip, UVR, Over Current
- **12** - Shunt, UVR, Protective Relay
- **13** - Shunt, Over Current, Protective Relay
- **14** - UVR, Over Current, Protective Relay
- **15** - Shunt, UVR, Over Current, Protective Relay

BELL ALARM



PBII and WavePro breakers can be equipped with an optional Bell Alarm accessory that is triggered by the trip unit.

This setting defines which trip unit functions will trigger the **Bell Alarm**.

The WavePro Bell Alarm accessory only supports selections with Overcurrent and Protective Relay options. WavePro will not respond to Shunt or UVR activity.

Settings Selections

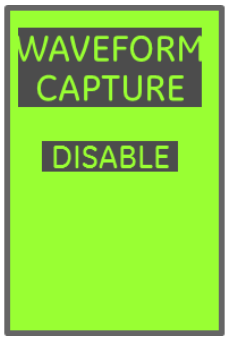
- **OFF** – Disabled/OFF
- **1** - Shunt Trip
- **2** - UVR Trip
- **3** - Over Current Trip
- **4** - Protective Relay Trip
- **5** - Shunt Trip, UVR
- **6** - Shunt Trip, Over Current
- **7** - Shunt Trip, Protective Relay
- **8** - UVR, Over Current
- **9** - UVR, Protective Relay
- **10** - Over Current, Protective Relay
- **11** - Shunt Trip, UVR, Over Current
- **12** - Shunt Trip, UVR, Protective Relay
- **13** - Shunt Trip, Over Current, Protective Relay
- **14** - UVR, Over Current, Protective Relay
- **15** - Shunt Trip, UVR, Over Current, Protective Relay

POWER DEMAND INTERVAL

This setting determines the time interval for power demand averaging.

Setting range is 5 to 60 minutes.

WAVEFORM CAPTURE



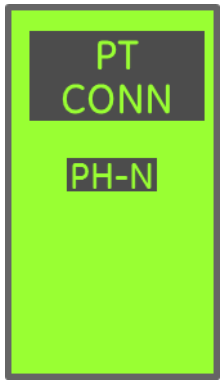
Waveform Capture is an optional feature. If the feature is not installed, this screen will not be available.

This screen determines the trigger source for the trip unit's waveform capture utility.

Available Settings

- **DISABLE** – waveform capture will not be triggered
- **MANUAL** – the waveform is commanded over Modbus
- **OVERCURRENT** – GF, LT, ST, INST overcurrent trips will trigger a capture
- **PROT REL** – Any protective relay trip will trigger a capture
- **CUR AL 1, CUR AL 2** – Current Alarm 1 or 2 can trigger a capture
- **ALL** – any of the above sources will generate a waveform capture. See "WaveForm Capture" elsewhere in this manual on how to view a captured waveform and clear the waveform

PT CONNECTION



PT connection allows the trip unit voltage input configuration to be set to match the wiring of incoming Potential Transformer (PT).

On a 4 wire wye system, phase to neutral voltage (PH-N) would be selected.

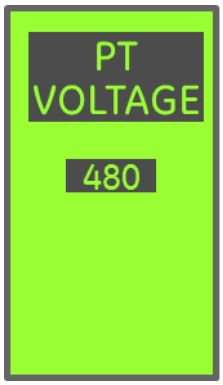
On a 3 wire delta system, phase to phase voltage (PH-PH) would be selected.

With PH-N selected, power metering values are shown per-phase only.

With PH-PH selected, power metering values are shown as 3 phase totals only.

This setpoint must match the wiring of the potential transformer serving the trip unit.

PT VOLTAGE

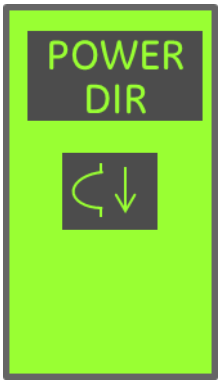


PT Voltage configures the trip unit so that a full scale reading at the potential transformer input is correctly scaled.

The transformer ratios and voltage conditioning circuits used with the GTU will deliver 1.767VAC at rated system voltage. This setpoint determines what voltage is displayed at full scale, and is normally set to match the system voltage.

The range of setpoints is 120V to 600V. It can be set in increments of 1V or 10V by scrolling.

POWER DIRECTION



Power Direction describes to the trip unit how power is flowing through the breaker, and thus determines the polarity.

This setting is used to determine the correct sign for power factor and other power readings. It is also critical for the proper operation of the power reversal protective relay.

This setting should reflect the direction of current flow during normal breaker operating conditions to ensure proper polarity.

FREQUENCY

Frequency sets the trip unit's internal frequency to match the system frequency.

Available settings are 50 and 60 Hz.

MODBUS

Sets the Modbus communication parameters for the trip unit.

See SECTION 11: "Serial Communication" for details on how to set up the Modbus communication.

PROFIBUS

Sets the Profibus communication parameters for the trip unit.

See SECTION 12: "Profibus Communication" for details on how to set up the Modbus communication.

Profibus is an optional feature. If your trip unit does not have this option installed this screen will not appear.

DATE AND TIME

Sets the **DATE** and **TIME** parameters.

The EntelliGuard Trip Unit has a Date and Time setting used for Event Logs. The Date and Time can be set via the front keypad, set-up software, or via Modbus communications. The Modbus communication enables the Date and Time to be set via a Clock Synchronization computer/server (requires computer/server to communicate the Date and Time in Modbus format).

Date and time values are pre-loaded for some point in the future in registers 287 – 293. At the date and time entered in those registers, command 103 is sent to the device, which updates the device's current date/time settings with the new settings in the master clock.

The Date and Time need to be updated for Daylight savings time, as it doesn't have location based circuitry in the trip unit. For the Event Log to record the Date and Time Stamp, 24VDC is required on the trip unit.

Date

Y: Year, 3 Digits (2XXX), where XXX is the current year. Example: 2010 would be Y: 010

M: Month, 2 Digit Field, 1 = January, 2 = February, etc..

D: Day, 2 Digit Field, 1 – 31

Time

H: Hours, 2 Digit Field, 0-24 Hours where ZERO (0) is Midnight

M: Minutes, 2 Digit Field, 0-60 Minutes

S: Seconds, 2 Digit Field, 0-60 Seconds

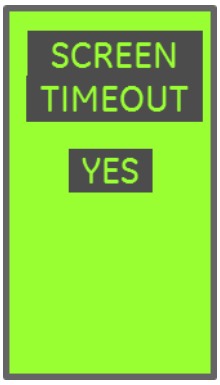
LANGUAGE

Sets the display **language**.

Available Languages

- English
- Spanish
- French
- German
- Chinese

SCREEN TIMEOUT

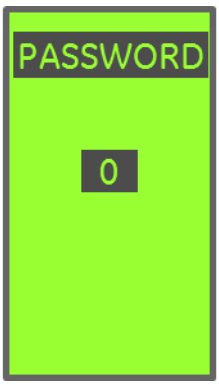


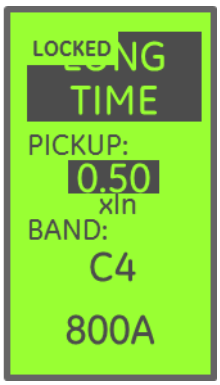
Enables and disables the "return to home screen" feature.

Two selections are available, Yes and No. When Yes is selected any time a Metering screen is left visible for more than 10 minutes the trip unit will automatically return to the home screen. Non-Metering screens will NOT return home with this feature.

When using Modbus communications it is recommended that this feature be set to Yes.

PASSWORD SETUP





Allows entry of various passwords:

Lock Settings: enter a password of 16 to lock the trip unit settings and prevent changes from the keypad.

Attempts to modify settings from the keypad will display the LOCKED message shown to the right.

Unlock Settings: enter a password of 19 to unlock the settings and allow keypad changes.

Ground Fault Defeat: if the trip unit is provided with a switchable Ground Fault option then the GF Defeat capability can be enabled by entering a password of 15. This must be done with the keypad unlocked.

Certain combinations of password changes and settings changes can result in the Ground Fault Defeat feature being turned off. Simply re-enter the password value of 15 to restore.

> **NOTICE**
> Ground Fault Defeat is only allowed under very limited exceptions to the NEC code. Do not defeat Ground Fault without consulting the NEC standard for your application.

All other available password values do not result in any action.

What this shows:
Lock Example on the Long Time configuration screen

LCD BRIGHTNESS CONTROL

This feature provides a way to adjust the contrast of the LCD display.

The default value is 30 but it can be adjusted between 20 and 40 as desired.

SECTION 7. METERING SCREENS

All Entelliguard Trip Units provide Current Metering as a standard feature.

Available optional metering features add Voltage, Frequency, and Power values.

METERING ACCURACY

Current metering values are dependent on the accuracy of the current sensors in the breaker. Current sensors are optimized for protection accuracy. The table below shows the typical EntelliGuard Trip Unit metering accuracy based on the percentage of sensor utilized.

Table 7-1: GTU Nomenclature

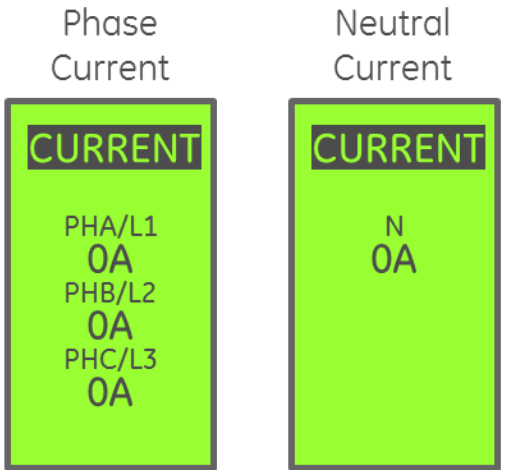
% of Sensor (A)	Accuracy - % of Reading
20% - 50%	± 10.0%
50% – 85%	± 5.0%
85% - 100%	± 2.0%

If you see negative or non-directionally correct power values check your power direction setting and/or your voltage configuration and wiring.

Starting with firmware release 08.00.26 frequency is derived from voltage inputs if they are available. Older firmware and all installations without voltage input derive their frequency data from the current input. Highly distorted current waveforms may yield erratic frequency display.

Frequency measurement derived from the current input requires primary current flow of at least 15% of the circuit breaker sensor rating before it will be displayed.

CURRENT METERING DISPLAY



What this shows:
The level of current flowing in each breaker phase.

Phase current metering is a standard feature of every GTU.

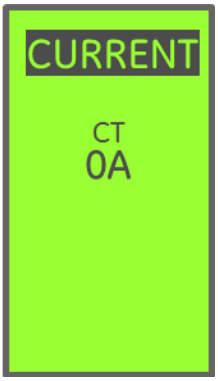
Neutral current display is optional and depends on the configuration of the circuit breaker.

With 24V external power, metering data will be displayed down to 8% of the installed sensor rating. Below 8% zero will be displayed.

Without 24V external Power, the primary current flow needs to cross the self-power operating threshold which occurs between 10% and 15% of sensor before any metering activity occurs, but is guaranteed to occur before you reach 20% of sensor. If metering is required below this level, an external means of powering the trip unit will need to be provided, because the breaker CTs are not capable of generating enough energy to operate the trip unit below this threshold.

Tip: When using Modbus serial communications, do not leave a metering window displayed. Modbus response time will increase due to the higher computing overhead to continually update metering values.

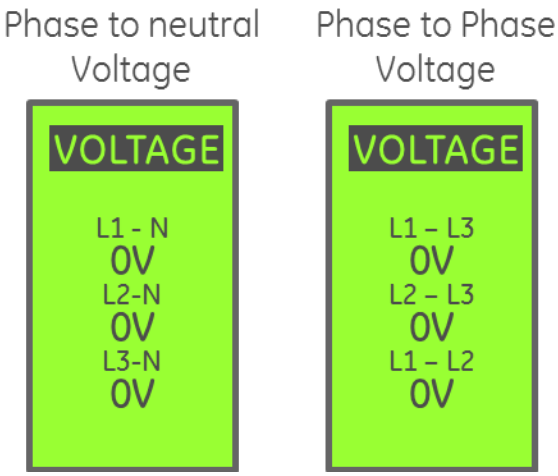
EXTERNAL CT CURRENT METERING DISPLAY (ENTELLIGUARD G ONLY)



What this shows:
The level of current flowing in the external CT channel.

This display is only enabled when the trip unit has Earth Fault or CT Ground Fault protection options installed, and the Monitoring advanced feature enabled.

VOLTAGE METERING DISPLAY



What this shows:
The system voltage.

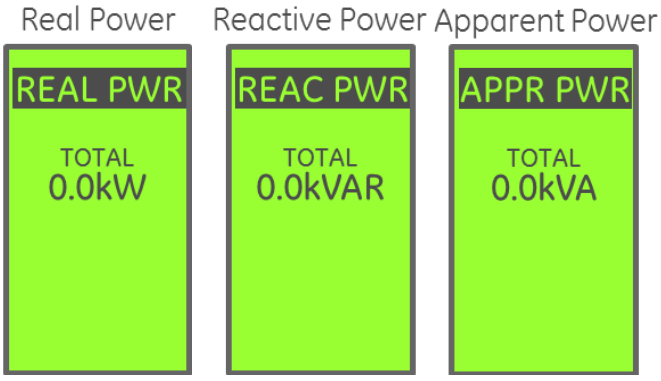
This display is accessible only if the optional Monitoring Function is installed.

When the PT Connection setpoint is PH-N the trip unit will display only Phase – to – Neutral voltage values.

When the PT connection setpoint is PH-PH the trip unit will display only Phase – to- Phase voltage values.

Please see Voltage Input Wiring for further explanation on voltage sensing.

POWER METERING DISPLAY: PH –PH

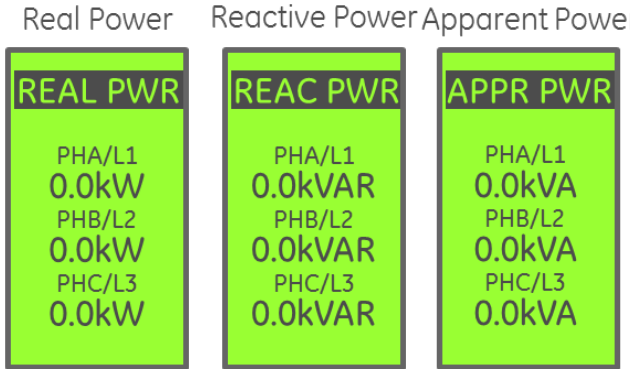


What this shows:
Apparent, Reactive, and Real Power as a 3 phase total.

This display is accessible only if the optional Monitoring Function is installed.

Total Power is only available when the trip unit voltage input is wired and configured for Phase-to-Phase measurement. In this configuration no Phase-to-Neutral data are available.

POWER METERING DISPLAY: PH—N

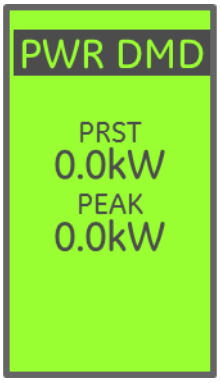


What this shows:
Apparent, Reactive, and Real Power per phase.

This display is accessible only if the optional Monitoring Function is installed.

Per-phase Power display is only available when the trip unit voltage input is wired and configured for Phase-to-Neutral measurement. In this configuration no Total Power data is available.

DEMAND METERING DISPLAY



What this shows:
Present and Peak Demand.

This display is accessible only if the optional Monitoring Function is installed.

Demand interval is configured in Setup.

ENERGY METERING DISPLAY

What this shows:
Energy as a 3-phase total.

This display is accessible only if the optional Monitoring Function is installed.

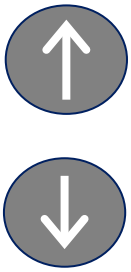
The window shown at left applies to EntelliGuard trip units with firmware revisions of 08.00.25 or earlier.

Energy reset is supported from setup software and over communications for all firmware versions.

For all firmware versions the total value displayed will auto-range to a maximum of 999MWh.

Starting with firmware release 08.00.26 a separate display is provided for incoming and outgoing energy and power flow direction .

With firmware revision 08.00.26 and higher energy values can be zeroed from the keypad :



With the Energy Screen displayed, press the UP and DOWN keypad buttons simultaneously and hold until the accumulated energy display goes to zero.

FREQUENCY METERING DISPLAY

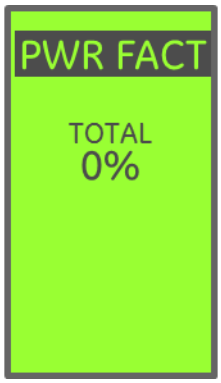
What this shows:
System frequency in hertz.

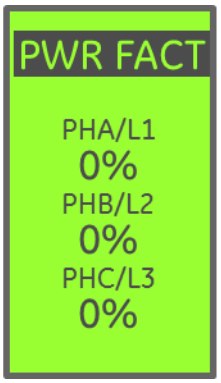
This display is accessible only if the optional Monitoring Function is installed.

Starting with firmware revision 08.00.26 frequency data is derived from the voltage signal input if it is available.

For installations with earlier firmware and all installations where voltage data is unavailable the frequency measurement is derived from the primary current signal. The frequency display will go to zero if <15% of sensor current is flowing in the bus when frequency is derived from current.

POWER FACTOR METERING DISPLAY





What this shows:
Power Factor as a percentage.

This display is accessible only if the optional Monitoring Function is installed.

The display will go to zero if <5% of sensor current is flowing in the bus.

3 phase total is shown when PT Connection is set to PH-PH. Per Phase values are not available when the PT connection is configured for PH-PH.

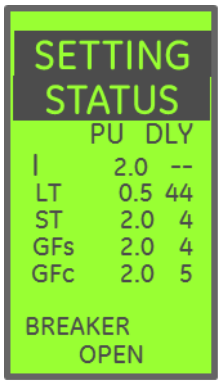
Per-phase shown when PT Connection is set to PH-N. PF totals are not available when the PT connection is set to PH-N.

Please see Voltage Input Wiring for further explanation on how voltage sensing wiring affects Power and Power Factor Displays.

SECTION 8. STATUS SCREENS

The STATUS menu provides information on settings and various breaker inputs and outputs.

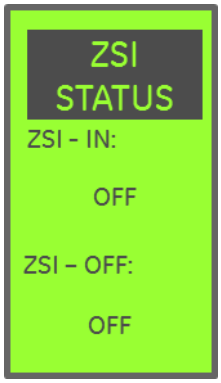
SETTINGS STATUS SCREEN



What this shows:
A summary of all active overcurrent protection elements. If an element is available in the trip unit, but disabled by setting it to OFF, it will not appear on this list.

The current breaker contact status (OPEN/CLOSED) is shown at the bottom of the screen.

ZSI STATUS



What this shows:
This shows the current state of the ZSI input and ZSI output signals on the trip unit.

This screen is only available when the ZSI option is enabled.

This feature is only available on Firmware Revisions 08.00.26 and later.

OUTPUT RELAY RESET

What this shows:
Pressing ENTER will unlatch any latched output relays unless their fault condition is still present.

PICKUP STATUS MESSAGES

Main Menu Pickup Message

Status Menu Pickup Message

Whenever one or more protection elements are “picked up” and timing out toward tripping, a PICKUP indication will be visible on the Home screen, and on the Pickup Status screen.

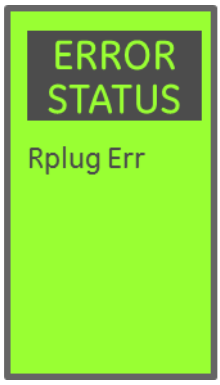
When the trip unit is not in pickup, the word “Pickup” is not displayed.

- When the trip unit is approaching LT pickup (above 95% of setpoint) the word “Pickup” will be flashing.
- When the trip unit is solidly in pickup, the word “Pickup” is constantly displayed.

- The green STATUS indicator on the trip unit also indicates pickup status.
- When not picked up, the LED blinks twice, turns off for a brief period, repeating.
- When in pickup, the LED blinks continuously.
- Protective Relays will cause a PICKUP display.

RATING PLUG ERROR MESSAGES

Main Menu
Rating Plug
Error



Status
Menu Error
Message

When this error is displayed the trip unit uses its lowest protection settings.

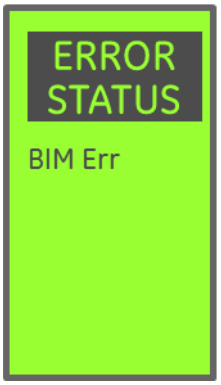
The rating plug error is generated under the following conditions:

1. The rating plug is not installed.
2. The rating plug is not fully inserted into the trip unit.
3. The rating plug value is outside the range allowed for the breaker's sensor. For example, plugging a 4000A rating plug in a 400A sensor circuit breaker will generate this error as will a 400A plug installed in a 4000A Sensor Circuit Breaker
4. For IEC or Euro configurations, where the trip unit rating is set programmatically, use of a rating plug other than the UNIVERSAL type (The catalog number for a universal rating plug is GTPUNIVU0000) will generate this error.

What this shows:
A Rating Plug error of some sort exists. The error can be cleared by installing the correct rating plug.

BIM ERROR MESSAGES

Main Menu
BIM Error



Status Menu
Error Message

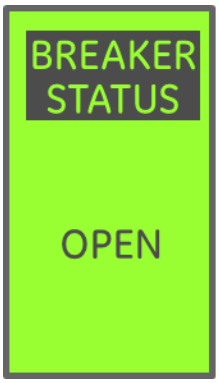
The Breaker Information Module (BIM) is an electronic rejection feature on EntelliGuard G Breakers only. Each time the trip unit powers up it compares its stored information to that in the breaker's BIM. If the data do not match a BIM error condition exists.

NOTICE

BREAKER TRIP SOFTWARE REVISION 08.00.23 AND GREATER.
If a BIM read operation fails the trip unit will not open the breaker. Instead, it will modify its internal configuration to match the AIC rating of the least capable breaker in the family. The trip unit will periodically read the BIM after that, and on a successful match the original settings will be restored. While the error persists, the LCD displays a BIM Err message.

What this shows:
There is a mismatch between the Trip Unit's stored breaker configuration and the breaker configuration read back from the breaker's information module (BIM). This can be caused by swapping trip units between breakers, or by a bad connection between the BIM and the trip unit. Refer to the section BIM Remarry Sequence for instructions on correcting a BIM error.

BREAKER STATUS INDICATIONS



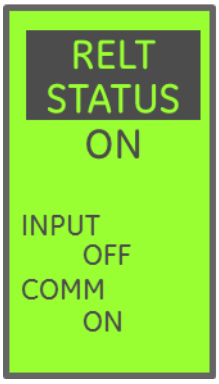
This is the **Breaker Status** display.

What this shows:
State of the circuit breaker contacts – OPEN or CLOSED.

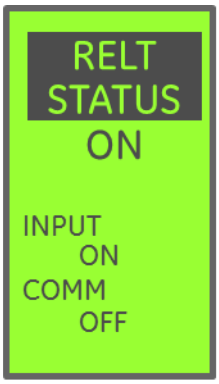
With 24VDC or primary current >20% of sensor flowing the status is correctly displayed.

Under battery power this value will not be displayed.

RELT STATUS INDICATIONS



RELT Status Display – activated via serial link



RELT Status Display – activated via Input 1

What this shows:
The source of the RELT command is shown, either via Modbus command, or external contact closure.

This screen only appears if the RELT option was provided on the trip unit.

RELT ACTIVATED INDICATIONS

Main Menu Normal Display

Main Menu RELT Display – backlight on

Main Menu RELT Display – backlight off

Main Menu Normal Display – backlight off

This is the display when **RELT** is engaged.

What this shows:
The currently displayed window will flash through the four screen sequence shown above every 2-3 seconds as soon as RELT is engaged.

After RELT is disengaged, the trip unit will remain in this mode for approximately 15 seconds.

This sequence will be visible on any window that is displayed while RELT is engaged.

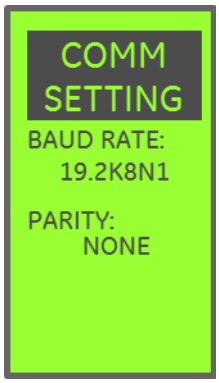
Any digital output assigned to RELT will remain energized for the same duration as the status display.

SOFTWARE REVISION

This is the **GTU Firmware Revision** display.

What this shows:
This shows the current installed version of GTU software on the trip unit.

COMMUNICATION SETTINGS



This is the GTU **Serial Port** configuration.

What this shows:
This shows the settings for the RS232 and RS485 serial ports.

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SECTION 9. EVENT MESSAGES

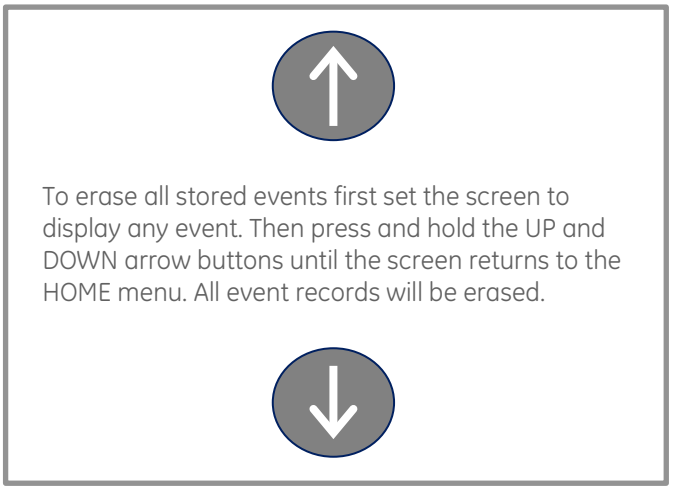
The EntelliGuard Trip Unit maintains up to 10 event records. These records can be accessed from the front panel by selecting the EVENT menu item and scrolling through the available event records. The EntelliGuard Setup Software will also allow event retrieval and viewing via serial communications.

Once the event log contains 10 events, new events will overwrite the oldest stored event.

The trip unit will record event information for any of the following:

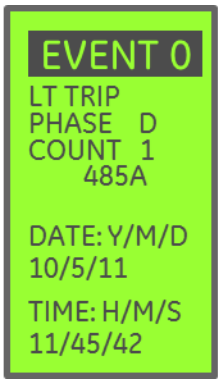
- Long Time Trip
- Short Time Trip
- Instantaneous Trip
- Ground Fault Summation Trip
- Ground Fault CT Trip
- Unrestricted Earth Fault Trip
- Restricted Earth Fault Trip
- Standby Earth Fault Trip
- Power Reversal Trip
- Voltage Unbalance Trip
- Undervoltage Trip
- Current Unbalance Trip
- UVR Accessory Trip[1]
- Shunt Accessory Trip[1]
- RELT Trip
- Current Alarm[2]
- GF Sum Alarm[2]
- GF CT Alarm[2]

[1] EntelliGuard G only: Accessory Trip Events require optional Accessory signaling contacts.
[2] These functions will not trip the breaker.



LONG TIME TRIP EVENT MESSAGES

Main Menu
Long Time
Trip Event



Event Menu
Event
Message

What this shows:
The main window shows that the cause of the latest trip was due to LT and the fault current level was at least 485A.

The Event window provides additional detail:
In addition to the tripping element the faulted conductor (neutral bus in this example), the total number of LT trips recorded by the trip unit, the fault current, and the date & time of the fault.

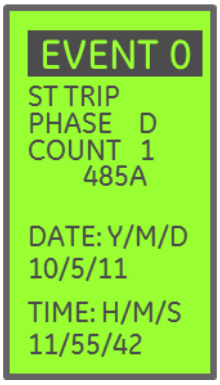
The count is incremented each time a Long Time trip occurs, regardless of the location. Accumulated count values can be reset to zero via serial communications. The EntelliGuard Setup Software provides this capability.

The date code information is only populated if the trip unit was supplied with external DC power. When the trip unit is powered from the current sensors the time and date values will be zero.

Viewing the event log clears the event display on the main window.

SHORT TIME TRIP EVENT MESSAGES

Main Menu
Short Time
Trip Event



Event Menu
Event Message

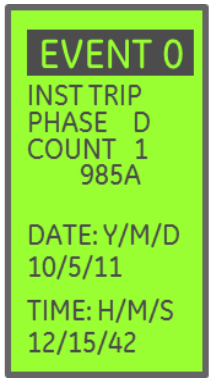
What this shows:
The main window shows that the cause of the latest trip was due to ST, and the fault current level was 485A.

The Event window provides additional detail:
Tripping phase, the total number of ST trips recorded by the trip unit, the fault current, and the date & time of the fault.

Viewing the event log clears the event display on the main window.

INSTANTANEOUS TRIP EVENT MESSAGES

Main Menu
Instantaneous
Trip Event



Event Menu
Event Message

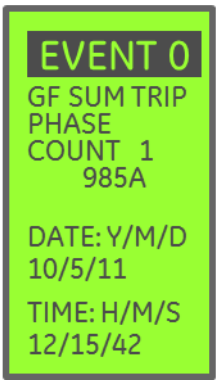
What this shows:
The main window shows that the cause of the latest trip was due to Instantaneous, and the fault current level was 985A.

The Event window provides additional detail:
Tripping phase, the total number of INST trips recorded by the trip unit, the fault current, and the date & time of the faults

Viewing the event log clears the event display on the main window.

GROUND FAULT SUM TRIP EVENT MESSAGES

Main Menu
Ground Fault
Trip Event



Event Menu
Event Message

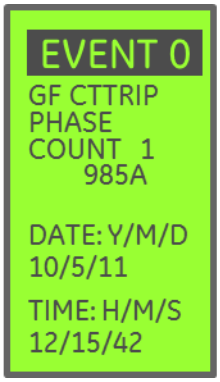
What this shows:
The main window shows that the cause of the latest trip was due to GF Sum, and the fault current level was 985A.

The Event window provides additional detail:
The total number of GF Sum trips recorded by the trip unit, the fault current, and the date & time of the faults

Viewing the event log clears the event display on the main window.

GROUND FAULT CT TRIP EVENT MESSAGES

Main Menu
Ground Fault
Trip Event



Event Menu
Event Message

What this shows:
The main window shows that the cause of the latest trip was due to GF CT, and the fault current level was 985A.

The Event window provides additional detail:
The total number of GF CT trips recorded by the trip unit, the fault current, and the date & time of the faults

Viewing the event log clears the event display on the main window.

SECTION 10. TRIP UNIT INTEGRATION

REDUCED ENERGY LET-THROUGH (RELT) FUNCTION WIRING

The RELT enabling function may be connected to an external manually operated two-position switch, a remote sensor, or both simultaneously.

Any external switch circuit must provide a 24VDC signal to the trip unit's Digital Input terminals to engage RELT.

The EntelliGuard TU trip unit provides both visual and electrical feedback directly from the trip unit so you know the enabling signal got to the trip unit and the settings have changed. The feedback features are as follows:

- The top line of the LCD display will flash the highlighted words "RELT ON" once per second.
- The LCD backlight will flash on and off.
- Digital Output #1 will toggle to the ON state as long as RELT is active.

While not required, an external 24VDC supply to the trip unit is recommended for the most effective RELT indication. Without external DC the trip unit LCD backlight will not flash and the relay output may not engage to energize external indicators. The RELT protection will be in force.

The wiring diagrams to the right illustrate typical configurations for RELT signaling. One indicating light is provided to show that DC power is available to engage RELT function and another indicating light is provided to show that RELT is engaged.

The positive feedback wiring method will provide the best indication since the RELT ON light will remain on as long as the trip unit has RELT engaged. The other method will only display the RELT ON light when the manual input switch is in the ON position.

Figure 10-1: RELT Connection when Using Positive Feedback from EntelliGuard TU Trip Unit

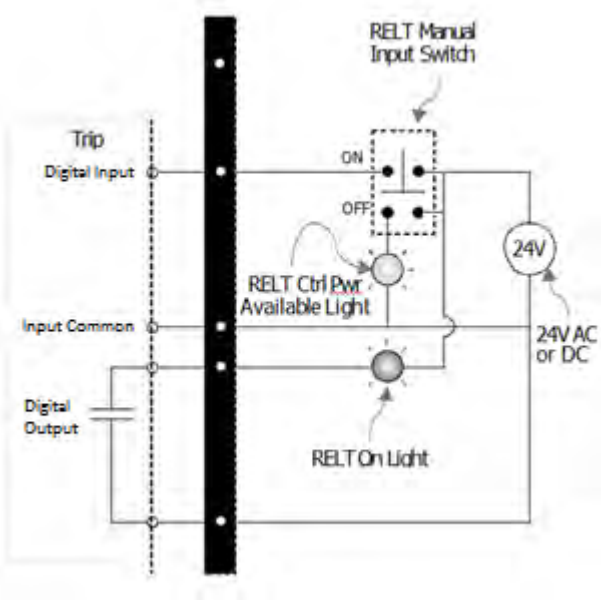
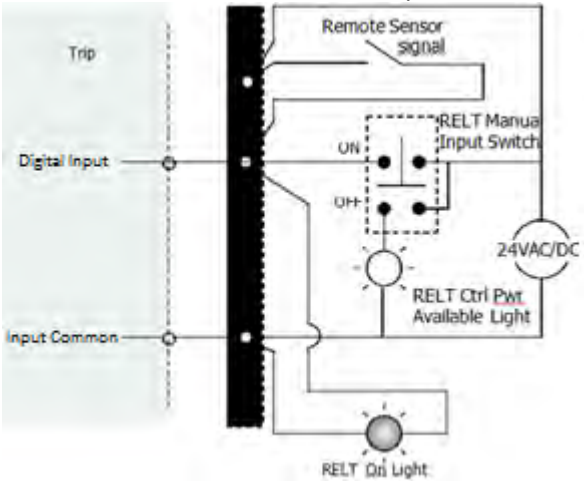
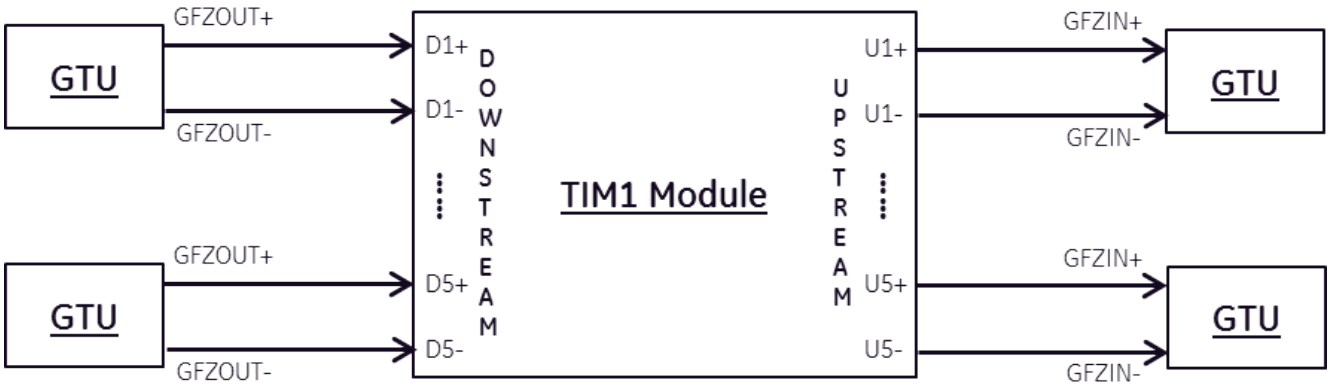


Figure 10-2: RELT Connection without Positive Feedback from EntelliGuard TU Trip Unit



TIM1 WIRING

Figure 10-3: TIM1 Wiring



TIM1 Wiring Basics:

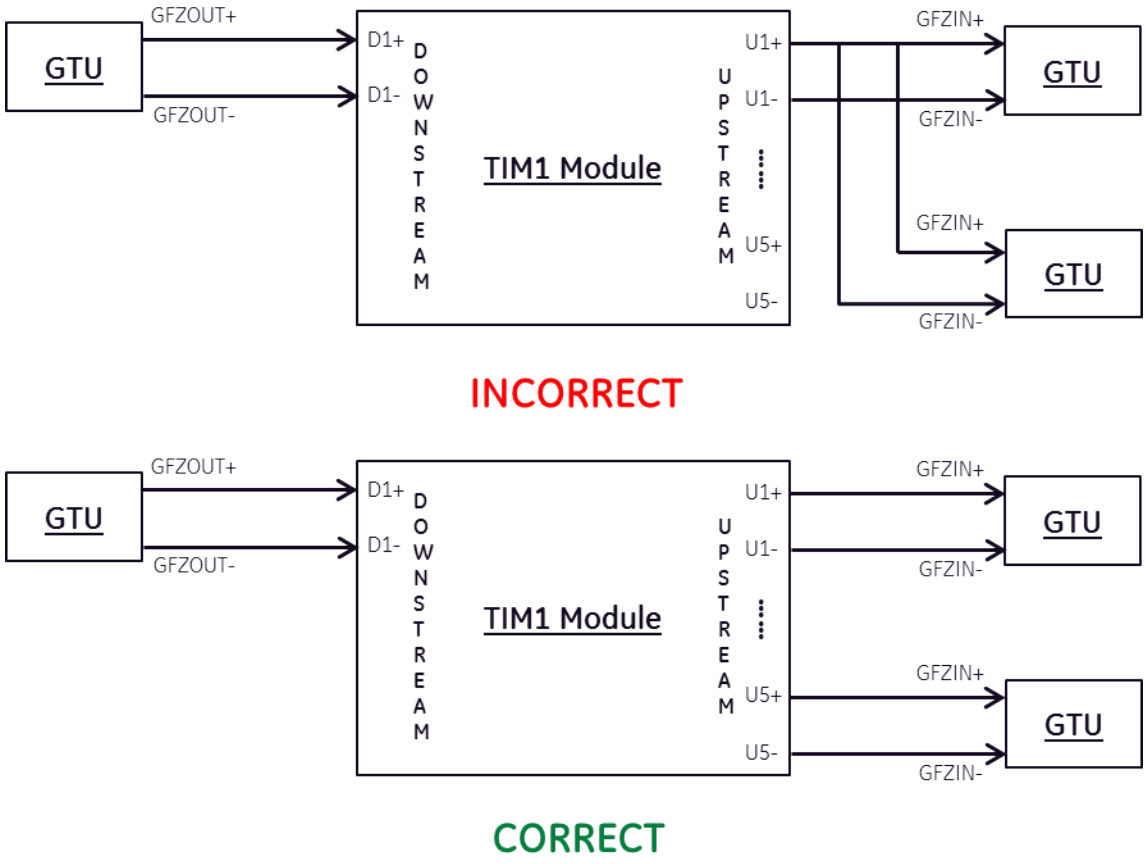
1. The *GFZOUT* terminals on the EntelliGuard G (GTU) are wired from the downstream breaker secondary disconnect to the *DOWNSTREAM* input on the TIM1 module.
2. The *GFZIN* terminals on the EntelliGuard G are wired from the upstream breaker secondary disconnect to the *UPSTREAM* input on the TIM1 module.
3. Polarity must be observed at all times for proper operation.
4. Up to 6 (six) trip unit GFZOUT terminals can be connected in parallel to a single DOWNSTREAM TIM1 connection terminal pair.
5. Each UPSTREAM TIM1 connection can have a maximum of 1 (one) trip unit.

ZSI TEST AND ZSI I/O STATUS INDICATIONS

With the release of EntelliGuard Trip Unit Firmware version 08.00.26 the device offers a ZSI test Setup and a ZSI Status display feature that can be helpful during ZSI setup, commissioning, and periodic maintenance checks. From the downstream breaker you can use the ZSI test function to engage the ZSI Output, triggering the upstream TIM1 Module. This in turn will signal the upstream breaker. The upstream breaker's ZSI Input Status can be observed on its ZSI status screen. With this method the ZSI signaling circuits can be completely validated and confirmed before energizing the system without any additional tools.

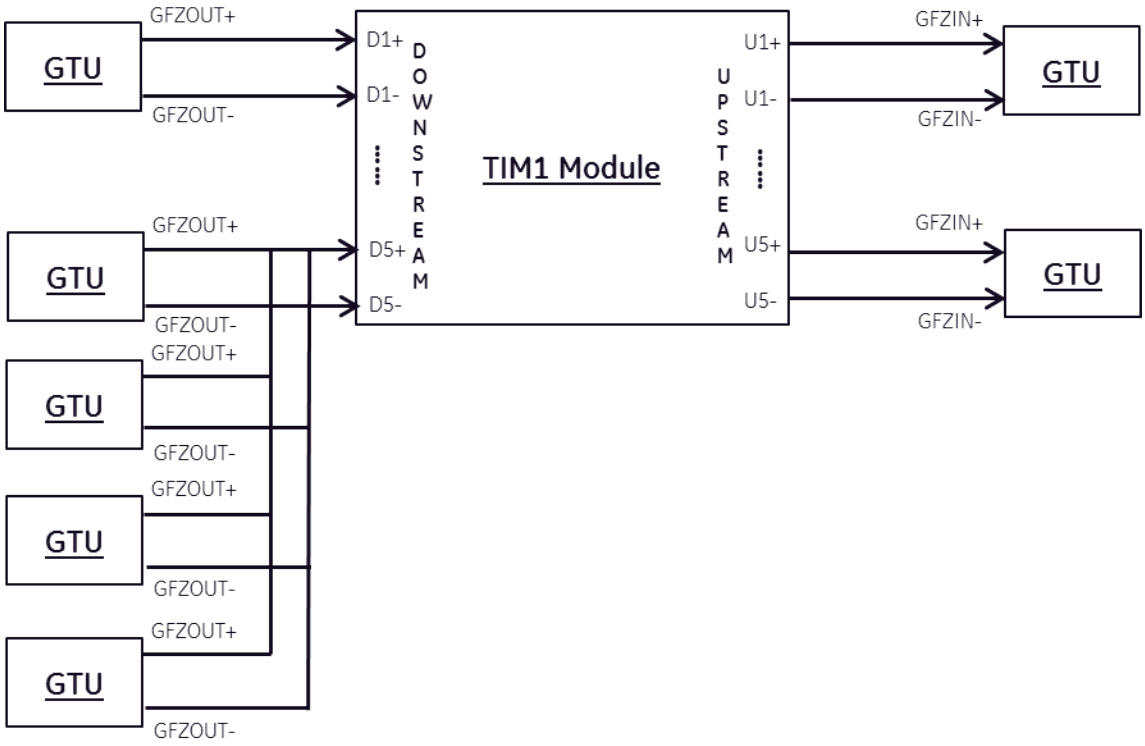
Additional information on the TIM1 module's wiring and operation can be found in GE Publication GEK 64467.

Figure 10-4: Incorrect and Correct TIM1 Wiring



UPSTREAM TIM1 connections **can be connected to only one trip unit.**

Figure 10-5: Six Trip Units Connected in Parallel to a Single Downstream TIM1 Input Pair

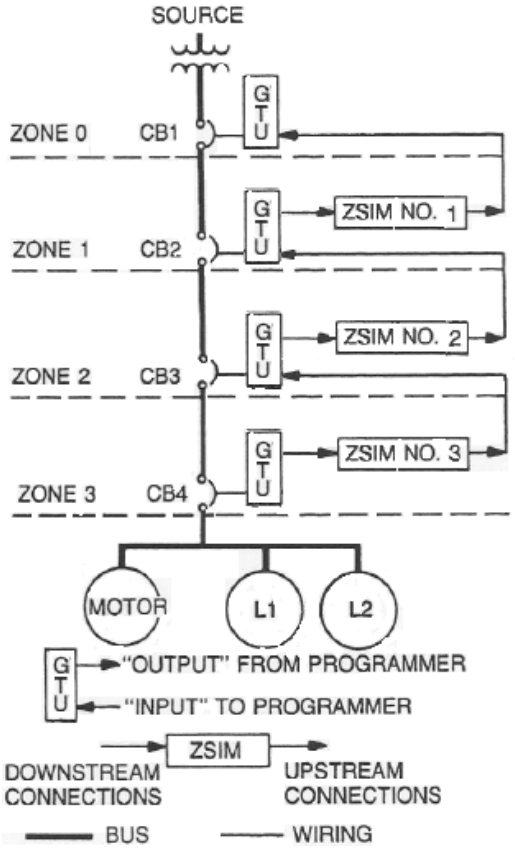


A **maximum of six** trip units can be connected in parallel to **a single DOWNSTREAM TIM1 input pair.**

TIM1 Zone Wiring basics:

1. The lowest breaker in the chain (typically the feeder breaker) does not have its GFZIN input wired, since there is no downstream breaker.
2. The topmost breaker in the chain (typically the Main) does not have its GFZOUT output wired, since there is no upstream breaker.
3. Breakers situated between an upstream and a downstream breaker will have both their GFZIN and GFZOUT terminals wired as shown in the diagram.

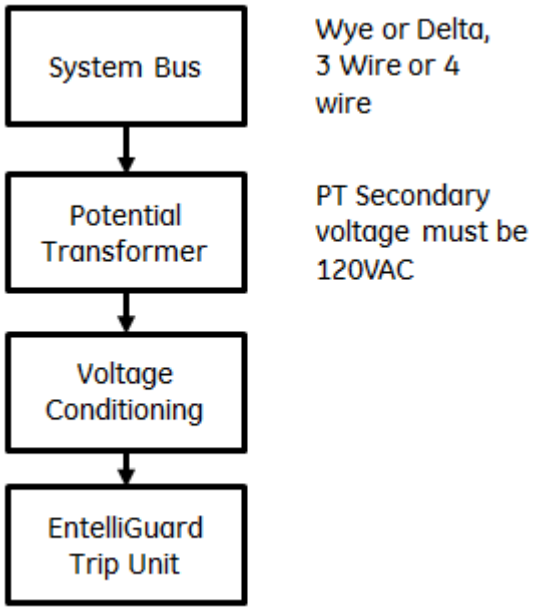
Figure 10-6: TIM1 Zone Wiring Diagram



VOLTAGE INPUT WIRING

To make full use of Advanced Metering, Waveform Capture, and Protective Relay functions the trip unit must be provided with properly conditioned voltage signals from the system bus.

Figure 10-7: Components of an EntelliGuard Voltage Measurement Installation



GE provides several voltage sensing solutions for a variety of installations.

GE Voltage Conditioner Plates

These assemblies contain everything needed to complete the connection between the system bus and the trip unit voltage inputs. Potential Transformers, voltage conditioning, and inline fuse protection is integral to the assembly. The plate catalog number is selected based on the nominal system voltage and wiring type.

Table 10-1: Conditioner Plate Ordering Information

GE Catalog Number	Source Voltage Rating	System Wiring
SVCA120Y	120VAC WYE	PH-N
SVCA208Y	208VAC WYE	PH-N
SVCA240D	240V DELTA	PH-PH
SVCA277Y	277VAC WYE	PH-N
SVCA480Y	480VAC WYE	PH-N
SVCA480D	480VAC DELTA	PH-PH
SVCA600D	600VAC DELTA	PH-PH

GE Publications GEH-6252 and GEH-5264 provide complete installation details for these products.

GE Voltage Conditioner Blocks

If your system already has Potential Transformers (PTs) installed you can add discrete voltage conditioner blocks to your system to provide the signal levels required by the EntelliGuard trip units. GE PLVC1G01 Voltage Conditioners can be installed between your PT secondary and the

EntelliGuard Breaker secondary disconnect to provide conditioned voltage signals. One PLVC1G01 is installed per phase.

See GE Publication GEH-5946 for wiring and application information.

GE Voltage Conditioner - GMPU

In late 2014 GE will offer a new 3-phase voltage conditioning product that will provide a complete voltage sensing solution in a compact DIN rail mounted format that is substantially smaller than the SVCA-style voltage conditioner plates.

GE Publication DEH-6259 provides information on available configurations and installation instructions. Check with your local distributor or geindustrial.com for availability.

VOLTAGE WIRING CONSIDERATIONS

The EntelliGuard Trip Unit voltage data is formatted to match the wiring of the power system that is monitored.

When the system is wired in Wye with a neutral bus connection the voltage conditioner wiring and the trip unit configuration are set for phase-to-neutral voltage measurement. All voltage data in the trip unit, either displayed on the trip unit or available over serial communications is displayed as a phase-to-neutral measurement. No phase to phase measurements are available. All power measurements are provided on a per-phase basis, no totals.

On a Delta system where no neutral connection is possible the voltage conditioner wiring and the trip unit configuration are set for phase-to-phase voltage measurement. All voltage data in the trip unit is formatted as phase-to-phase. No phase-to-neutral data is available since there is no neutral reference. All power measurements are presented as totals, with no per-phase values available.

Please note that although both Phase-to-Neutral and Phase-to-Phase values may be accessed at any time over the serial link, only the data associated with your selected wiring method is valid.

SERIAL NETWORK PHYSICAL INSTALLATION

RS-232 and RS-485 Connections

On the front panel of the EntelliGuard Trip Unit is a 15-pin connector for the RS-232 Modbus connection. This connector mates with a cable supplied with the GTUTK20 Digital Test Kit.

If the trip unit and circuit breaker are equipped with optional RS-485 serial communications support the secondary disconnect of the circuit breaker will have connections designated for Communications.

RS-485 Network Configuration

Figure 10-8 illustrates a standard two-wire RS485 wiring topology. This is an example of proper “daisy chaining” of network devices, where there is a unique “head” and “tail” to the network. A “Star” configuration with multiple branches is not allowed, because they introduce unwanted reflections and can result in network instability.

RS-485 Termination Considerations

To minimize the effects of reflections from the ends of the RS-485 cable caused by impedance discontinuities in the system, a line-terminating RC network must be placed at each end of the bus as recommended by the EIA485 standard.

For networks with baud rates below 38,400 GE recommends their SCI Terminator Assembly, part number 1810-0106. The terminator is wired across the RX/TX connections at the head end and the tail end of each daisy chain. For trip units the terminator can be located at the secondary disconnect of the circuit breaker. You can fabricate terminators using 120 Ω 5% ¼ watt resistors in series with 50V 120pf capacitors.

For high speed networks such as Profibus proprietary Profibus terminators must be used to maintain network integrity. An example Siemens Profibus terminator assembly part number is 6AG1972-ODa00-2AA0.

In the case of repeaters a terminator is required on the output side of the repeater and the last device on the chain or the next repeater. Some Profibus repeaters such as the Siemens 6ES7972-0AA02-0XA0 provide a terminator as part of the repeater itself.

RS-485 Biasing Considerations

In most cases, pull up and pull down resistors are not required. If one or more connected devices require polarization, or if the master device does not provide proper polarization, then a pair of resistors must be attached to the RS-485 balanced wire pair, as follows:

- Pull-up resistor to 5 V on the positive line
- Pull-down resistor to common on the negative line

These resistors must be between 450 Ω and 650 Ω, and are selected based on the maximum current flow permitted by the connected devices. The latter may allow a higher number of devices to be connected to the serial bus.

Cable Recommendations

For lower-speed networks typical of Modbus installations GE recommends Belden V 9841 CM cable.

High speed Profibus networks typically utilize proprietary cable assemblies from Siemens. An example part number for a 300m cable is 6XV1830-0AT30.

Cable Segment Lengths

For Modbus networks the maximum distance of a segment is 4000 feet. This can be extended by adding repeaters.

For Profibus the maximum segment length is 100m for baud rates of 3Mbps and higher. This can also be extended through the use of repeaters.

Cable Routing Recommendations

The NEC code (NFPA 70) Article 800.133 defines rules governing communication cable placement within electrical systems. Communication cables must be separated by at least 2 inches (50mm) from conductors of any electric, power, Class 1, non-power-limited fire alarm or medium power network-powered broadband communication circuits.

Grounding & Shielding Considerations

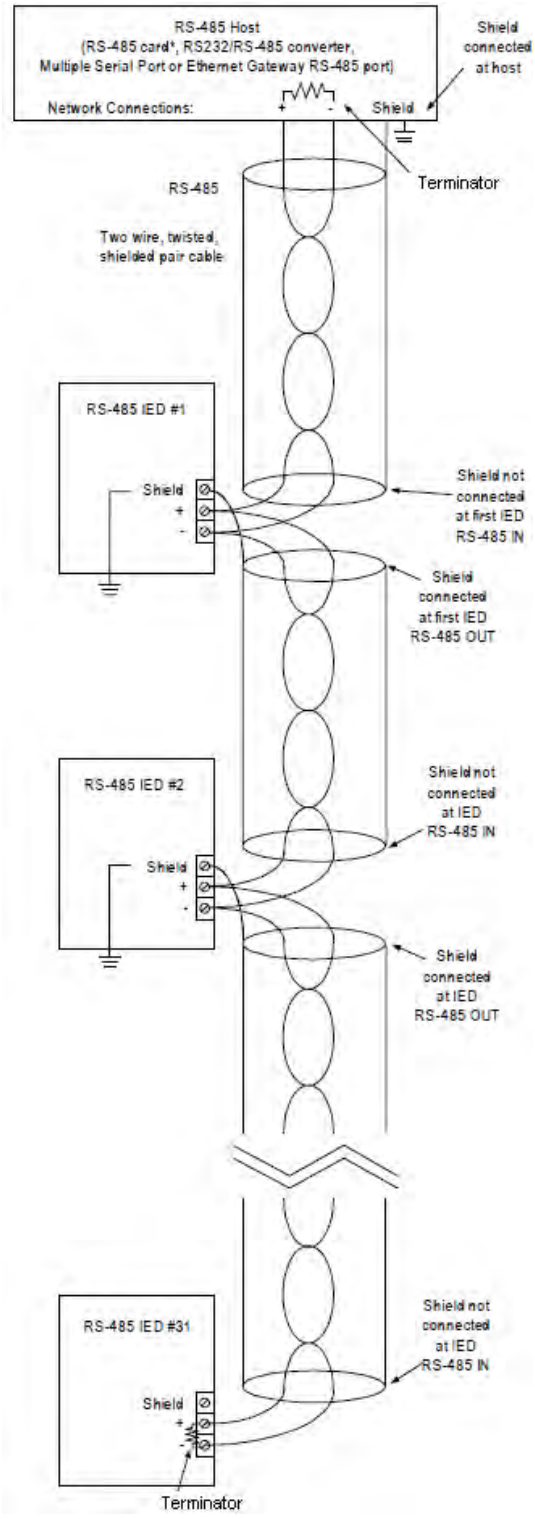
Figure 10-8 illustrates correct wiring for device and communication cable shield grounding. Follow this example to create a secure grounding point for each device on the network. By grounding the communications cable shield only at the output terminal of each network device any surge will dissipate locally without being carried up or down the network to other devices. This minimizes the chance for damage to devices due to surge or EMI.

Table 10-2: EntelliGuard Serial Communication Connections

Secondary Disconnect Terminal	Pin Name	Purpose	Connect for Modbus	Connect for Profibus
B31	ISO GND	Isolated ground	Yes	Yes
B32	5V_ISO	Isolated 5Vdc supply from trip unit	No	Optional
B33	TX_EN_1	Allows control of Profibus interface	No	Optional
B34	RX	(-) Receive Channel	Yes	Yes
B35	TX	(+) Transmit Channel	Yes	Yes

For other trip units refer to the breaker installation guide.

Figure 10-8: Device and Communication Cable Shield Grounding



SECTION 11. SERIAL COMMUNICATION

The EntelliGuard Trip Unit offers Modbus RTU or Profibus DP over RS-485 optionally, via terminals on the circuit breaker's secondary disconnect. Modbus RTU over RS-232 is always available via the front panel 15 pin Test Kit D-connector. To use the RS232 Port in the front, the GTUTK20 Trip Unit Test Kit is recommended. The Test Kit supplies convenient connections to computer serial ports and the 24VDC required for communication.

If a GTUTK20 test kit is not available you can create your own test kit communications cable, using the following pin assignments:

- **Pin 2:** Modbus RX
- **Pin 3:** Modbus TX
- **Pin 6:** +24VDC
- **Pin 8:** 24V Return

It is also possible to provide power to the trip unit through the secondary disconnect on breakers so equipped, eliminating the need to supply 24V through the test kit port.

Connection to computers lacking a 9 pin serial port may be done reliably through a USB-to-serial converter readily available at most office supply stores.

NETWORK WIRING

Refer to Section 10 for recommendations on serial network wiring.

MODBUS RTU

Modbus is a master-slave protocol where a single host or master device initiates and controls all communication with the other devices (or slaves) on the network. The hardware interface is implemented as duplex two-wire RS-485, where data are transmitted and received in separate time slices. Per the EIA-485 standard the number of devices that can be connected on a single communication port is limited to 32 (including the master).

MODBUS ADDRESS SETTING

In a Modbus RTU Network, each EntelliGuard Trip Unit module must have a unique address that can be set from 1 to 247. Addresses do not have to be sequential, but no two units can have the same address.

Generally, each unit added to the link uses the next higher address, starting at 1. The Modbus slave address can be set using the keypad.

The Modbus slave address configuration can be set using the LCD keypad, or over Modbus communications.

For LCD configuration, navigate to the Modbus Settings window under the SETUP main menu item. Use the up and down arrows to set the address to the desired value.

Modbus Baud Rate and Port Configuration

The EntelliGuard G Trip Unit supports the configured baud rate settings listed below, which can be set using the keypad. The Modbus Communications parameter setting screen is shown In Illustration to the left. The EntelliGuard Trip Unit supports the configured baud rate settings listed below, which can be set via keypad. The first number is the baud rate (300–19,200), the first digit after the dash is the number of data bits (fixed at 8), the letter represents the parity setting (N = none, E = even, O = odd), and the last digit is the stop bit.

- 300-8N2
- 300-8O1
- 300-8E1
- 300-8N1
- 600-8N2
- 600-8O1
- 600-8E1
- 600-8N1
- 1200-8N2
- 1200-8O1
- 1200-8E1
- 1200-8N1
- 2400-8N2
- 2400-8O1
- 2400-8E1
- 2400-8N1
- 4800-8N2
- 4800-801
- 4800-8E1
- 4800-8N1
- 9600-8N2
- 9600-801
- 9600-8E1
- 9600-8N1
- 19200-8N2
- 19200-8O1
- 19200-8E1
- 19200-8N1

Modbus Function Codes

The EntelliGuard Trip Unit supports the following function codes:

- **03:** Read Holding Registers
- **04:** Read Input Registers
- **05:** Force Single Coil
- **06:** Preset Single Register
- **16:** Preset Multiple Registers
- **20:** Read General Reference

Modbus RTU Message Format

The Modbus RTU protocol is strictly based upon a transaction scheme in which a master device generates a query and a slave device replies with a response. Each query and response message transaction consists of the following parts:

- **Device address**: 1 byte
- **Function code**: 1 byte
- **Data**: N bytes
- **CRC**: 2 bytes
- **Dead time**: 3.5 bytes transmission time

These parts are as follows:

- **Device address** – This is the first byte of each Modbus RTU transmission. The device address is a number limited to the range of 1–247 and is associated with a single device configured with a matching address. This device receives and processes the transmission from the master. Only the addressed slave device responds to a transmission beginning with this address. A device address of 0 indicates a broadcast command.
- **Function code** – This is the second byte of each transmission and represents the commanded action to the slave device (for queries from the master) or the action that was taken by the slave device (for responses from the slave). Codes between 1 and 127 are defined as Modbus RTU functions. If a slave device responds with a function code with the most significant bit (MSB) equal to 1 (or equivalently a function code greater than 127), then the slave device did not perform the commanded action and is signaling an error response.
- **Data** – This field contains a variable number of bytes, depending on the function performed. Data may contain addresses, actual values, or setpoints.
- **CRC** – This is a two-byte error-checking code, known as a Cyclic Redundancy Check. The Modbus RTU standard requires each message to have a two-byte CRC (commonly known as CRC-16 for 16 bits of error checking) to be appended to every transmission.

If the EntelliGuard Trip Unit detects a CRC error in a received Modbus message, the EntelliGuard Trip Unit does not respond to the message. An error in the CRC calculation indicates that one or more bytes of the transmission were received incorrectly, so the entire transmission is ignored, preventing an unintended operation.

The CRC-16 calculation is an industry-standard method used for error detection.

ENTELLIGUARD TRIP UNIT FUNCTION CODES

The following sections describe the Modbus function code supported by the EntelliGuard G Trip Unit.

Function Code 03H

For the EntelliGuard Trip Unit implementation of Modbus, this function code can be used to read any setpoints ("holding registers"). Holding registers are 16 bit (two byte) values transmitted high order byte first. Thus all EntelliGuard Trip Unit setpoints are sent as two bytes. The maximum number of registers that can be read in one transmission is 125.

The slave response to this function code is the slave address, function code, a count of the number of data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte first.

For example, consider a request for slave II to respond with 3 registers starting at address 006B. For this example the register data in these addresses is listed below:

Table 11-1: Function Code 03H Example

Address	Data
0002	0001
0003	0000
0004	0012

The master/slave packets have the following format:

Table 11-2: Modbus Packet Format for Function Code 03H

Master Transmission	Bytes	Example	Description
Slave Address	1	11	message for slave 2
Function Code	1	03	read registers
Data Starting Address	2	00 6B	data starting at 006B
Number of Setpoints	2	00 03	3 registers = 6 bytes total
CRC	2	78 87	CRC error code
Slave Response	**Bytes**	**Example**	**Description**
Slave Address	1	11	message from slave 17
Function Code	1	03	read registers
Byte Count	1	06	3 registers = 6 bytes
Data 1 (see definition above)	2	02 2B	value in address 006B
Data 2 (see definition above)	2	00 00	value in address 006C
Data 3 (see definition above)	2	00 64	value in address 006D
CRC	2	54 83	CRC error code

Function Code 04H

Modbus Implementation:
Read Input Registers.

EntelliGuard Trip Unit implementation:
Read Actual Values

For the EntelliGuard Trip Unit implementation of Modbus, this function code can be used to read any actual values ("input registers"). Input registers are 16 bit (two byte) values transmitted high order byte first. Thus all EntelliGuard Trip Unit Actual Values are sent as two bytes. The maximum number of registers that can be read in one transmission is 125.

The slave response to this function code is the slave address, function code, a count of the data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first.

For example, request slave 17 to respond with 1 register starting at address 0008. For this example the value in this register (0008) is 0000.

Table 11-3: Modbus Packet Format for Function Code 04H

Master Transmission	Bytes	Example	Description
Slave Address	1	11	message for slave 17
Function Code	1	04	read registers
Data Starting Address	2	00 08	data starting at 0008
Number of Actual Values	2	00 01	1 register = 2 bytes
CRC	2	B2 98	CRC error code
Slave Response	**Bytes**	**Example**	**Description**
Slave Address	1	11	message from slave 17
Function Code	1	04	read registers
Byte Count	1	02	1 register = 2 bytes
Data (see definition above)	2	00 00	value in address 0008
CRC	2	78 F3	CRC error code

Function Code 05H

Modbus Implementation:
Force Single Coil

EntelliGuard Trip Unit implementation:
Execute Operation

This function code allows the master to request an EntelliGuard Trip Unit to perform specific command operations.

For example, to request slave 17 to execute operation code 108 (Trip Breaker), we have the following master/slave packet format:

Table 11-4: Modbus Packet Format for Function Code 05H

Master Transmission	Bytes	Example	Description
Slave Address	1	11	message for slave 17
Function Code	1	05	execute operation
Operation Code	2	00 6C	operation code 108
Code Value	2	FF 00	perform function
CRC	2	4E B7	CRC error code
Slave Response	**Bytes**	**Example**	**Description**
Slave Address	1	11	message from slave 17
Function Code	1	05	execute operation
Operation Code	2	00 6C	operation code 108
Code Value	2	FF 00	perform function
CRC	2	4E B7	CRC error code

Function Code 06H

Modbus Implementation:
Preset Single Register

EntelliGuard Trip Unit implementation:
Store Single Setpoint

This command allows the master to store a single setpoint into the memory of an EntelliGuard Trip Unit. The slave response to this function code is to echo the entire master transmission.

For example, request slave 17 to store the value 2 in setpoint address 215 (00 D7). After the transmission in this example is complete, setpoints address 215 will contain the value 2. The master/slave packet format is shown below:

Table 11-5: Modbus Packet Format for Function Code 06H

Master Transmission	Bytes	Example	Description
Slave Address	1	11	message for slave 17
Function Code	1	06	store single setpoint
Data Starting Address	2	00 D7	setpoint address 00 D7
Data	2	00 02	data for setpoint address00 D7
CRC	2	BA A3	CRC error code

Function Code 10H

Modbus Implementation:
Preset Multiple Registers

EntelliGuard Trip Unit implementation:
Store Multiple Setpoints

This function code allows multiple Setpoints to be stored into the EntelliGuard Trip Unit memory. Modbus "registers" are 16-bit (two byte) values transmitted high order byte first. Thus all EntelliGuard Trip Unit setpoints are sent as two bytes. The maximum number of Setpoints that can be stored in one transmission is dependent on the slave device. Modbus allows up to a maximum of 60 holding registers to be stored. The EntelliGuard Trip Unit response to this function code is to echo the slave address, function code, starting address, the number of Setpoints stored, and the CRC.

For example, consider a request for slave 17 to store the value 00 02 to setpoint address 00 D7 and the value 01 F4 to setpoint address 04 5D. After the transmission in this example is complete, EntelliGuard Trip Unit slave 17 will have the following setpoints information stored: The master/slave packets have the following format:

Table 11-6: Modbus Packet Format for Function Code 10H

Master Transmission	Bytes	Example	Description
Slave Address	1	11	message for slave 17
Function Code	1	10	store setpoints
Data Starting Address	2	04	5C setpoint address 04 5C
Number of Setpoints	2	00 02	2 setpoints = 4 bytes total
Byte Count	1	04 4	bytes of data
DATA	1	2 00 02	data for setpoint address 04 5C
DATA	2	2 01 F4	data for setpoint address 04 5D
CRC	2	31 11	CRC error code
Slave Response	**Bytes**	**Example**	**Description**
Slave Address	1	11	message from slave 17
Function Code	1	10	store setpoints
Data Starting Address	2	04 5C	setpoint address 04 5C
Number of Setpoints	2	00 02	2 setpoints
CRC	2	82 7A	CRC error code

Function Code 14H

Modbus Implementation:
Read File Record

This command allows the master to read stored waveform data. All Request Data Lengths are provided in terms of number of bytes and all Record Lengths are provided in terms of registers.

Table 11-7: Modbus Packet Format for Function Code 14H

Master Transmission	Bytes	Value
Slave Address	1	1 - 245
Function Code	1	0x14
Byte Count	1	0x07 to 0xF5
Reference Type	2	06
File Number	2	0x0001 (Read all 255 Events) 0x0002 (Read Current RMS)
Record Number	2	0x 0000 to 0x03E8
Register Length	2	0x0000 to 0 x 007B

Waveforms are retrieved using a 3 step process.

Step #1 – Check to see if a waveform record is available for download. If Discrete Input Register 54 returns a value of 1 then a record is available.

Further control of the waveform record is available with Command Register 143 (Trigger Waveform) and 144 (clear stored waveform data).

Note that the trigger waveform command will only work if Manual trigger mode is enabled by setting Holding Register 285 to a value of 1 or 6.

Step #2 – Read the Configuration File

Send the query defined below three times, with a 1 second wait period between queries, to download the .cfg file.

Master Transmission	Bytes
Slave Address	(ADDRESS OF THE UNIT)
Function Code	20 (14H)
Byte Count	0x07
Reference Type	06
File Number	1
Record Number	3
Register Length	83 (53H)

Step #3 – Read the Data File

Send the query defined below 48 times for a 50 hz waveform record, or 40 times for a 60 hz record to retrieve the entire .dat file. Maintain a 1 second wait period between queries.

Master Transmission	Bytes
Slave Address	(ADDRESS OF THE UNIT)
Function Code	20 (14H)
Byte Count	0x07
Reference Type	06
File Number	2
Record Number	40 (28H) for 60 Hz 48 (30H) for 50Hz
Register Length	88 (58H)

ERROR RESPONSES

When an EntelliGuard Trip Unit detects an error other than a CRC error, a response will be sent to the master. The MSBit of the FUNCTION CODE byte will be set to 1 (i.e. the function code sent from the slave will be equal to the function code sent from the master plus 128). The following byte will be an exception code indicating the type of error that occurred. Transmissions received from the master with CRC errors will be ignored by the EntelliGuard Trip Unit.

The slave response to an error (other than CRC error) will be:

Table 11-8: Slave Responses to Errors

Slave Address:	1 byte
Function Code	1 byte (with MSbit set to 1) Exception
Code	1 byte
Crc:	2 bytes

The EntelliGuard Trip Unit implements the following exception response codes:

- **01** - Illegal Function:
  The function code transmitted is not one of the functions supported by the EntelliGuard Trip Unit..
- **02** - Illegal Data Address:
  The address referenced in the data field transmitted by the master is not an allowable address for the EntelliGuard Trip Unit.
- **03** - Illegal Data Value:
  The value referenced in the data field transmitted by the master is not within range for the selected data address.

MODBUS REGISTER MAP

- **Function Code 02** – Read Input Status
- **Function Code 03** - Read Holding Registers
- **Function Code 04** – Read Input Registers
- **Function Code 05** – Force Single Coil
- **Function Code 06** - Preset Single Holding Register
- **Function Code 16** Write Multiple Holding Registers

See Appendix C: Modbus Register Map.

PRACTICAL MODBUS SETUP

This section is intended to give you a quick and simple checklist to run through when commissioning an EntelliGuard Trip Unit on a Modbus Network. The goal is to give you some concrete steps to get your device up and running quickly by eliminating some of the guesswork.

Step 1: Set up the Serial Port on the Master Device

If your computer does not have a built-in 9 pin serial port, you will have to attach a USB-to-serial adapter. These devices are readily available at most office supply stores or online. For best results, buy a name brand. Be sure to install the driver software that comes with the device.

Once the serial port hardware is enabled on the computer, determine which "logical port" (COM1, COM2, etc.) the computer has assigned to the port you plan to use. This information is available in the "Device Manager" function of Windows. Consult the web or your computer's help facility for information on how to access the Device Manager.

The Device Manager will display information similar to what you see below. The serial ports are listed under the heading "Ports (COM & LPT)."

In this example, a USB-to-serial port has been configured as COM1, and would be the port you would use to communicate with the trip unit.

Step 2: Configure the Communication Settings on the Trip Unit: Baud Rate, Parity, Stop Bits, Modbus Slave Address/ID

Step 3: Supply 24VDC to the Trip Unit, and Connect the Trip Unit to the Computer

You can connect a test kit between the computer and the 15 pin front panel port, or you can wire to the RS-485 terminals on the circuit breaker secondary disconnect.

Step 4: Configure the Master's Communication Parameters

- Modbus Address matches the trip unit
- Baud Rate matches trip unit
- Parity matches trip unit
- Stop bits equals trip unit
- Modbus requests are made using "Modbus RTU Serial"

Step 5: Attempt to Communicate with the Device

The registers listed below will return easily identified values that can be confirmed by reading the same setting from the device via LCD. This gives you instant feedback on whether the system is properly configured or not.

Read Modbus address.

Register Address: 211. If using Modicon addressing, add 40001 for an address of 40212.

Function Code: 03

Expected Value: matches the Modbus address of the trip unit

Trip the breaker.

Register Address: 108. If using Modicon addressing, add 1 for an address of 109.

Function Code: 05 ON (send 0x00FF)

Expected Value: a closed breaker will trip.

Read voltage on Phase A. To generate voltage data, engage the "Phase Current" feature on the GTUTK20 digital test kit.

Register Address: 18. If using Modicon addressing, add 30001 for an address of 30019.

Function Code: 04

Expected Value: matches the voltage metering value displayed for phase A.

MODBUS ONLY TRIP UNIT FEATURES

This section describes how to use two trip unit features that are only available via Modbus communications.

User-assignable Registers

Starting with firmware revision 08.00.26 the trip unit offers 40 user-mapped holding registers. 20 registers can be mapped to Input Register values, and the other 20 can be mapped to Input Status values. By mapping commonly polled data into this user-defined area you can reduce the number of Modbus queries required to retrieve data and improve network throughput.

Holding Registers 600 – 619 can be mapped to input registers such as Volts and Amps. For example, to map Phase A Volts to Register 600 you would program a value of 18 in Register 600. From that point on any query of register 600 would return the value of Volts A.

Holding Registers 620 – 639 can be mapped to Input Status bits, such as Breaker Position. If you wanted to map Breaker Position to register 620 simply program the value 27 into register 20. Whenever you poll register 620 you will get the current status of the breaker position input.

Mechanism Self Timing

Starting with firmware revision 08.00.26 the trip unit will record the time from the firing of the actuator to the opening of the breaker's aux contacts. This information can be tracked over time to provide an indication of breaker performance and alert you to the need to service the equipment. Note that breaker operations initiated manually or by Shunt Trip or other means are not recorded. Only those trip events initiated by the trip unit's protection will generate timing data.

Input Registers 392 – 415 are split up into 8 blocks of 3 registers each. Each block contains the opening time in milliseconds, the fault level, and a breaker pole identifier.

The first three blocks are fixed in memory once they have been populated. This forms the "baseline data" for the performance of the breaker. The remaining five blocks contain the five most recent trip events. As additional events occur the oldest of the five is deleted and replaced with the new information. These five registers can be compared to the original three registers to determine if there is a need to service the breaker.

To use the feature you only need to extract the data via Modbus. Data collection is automatic and initiated at the factory when the breaker is constructed.

SECTION 12. PROFIBUS COMMUNICATION

DEFINITIONS

Profibus DP (Process Field Bus): An open standard based on EN 50170 for field bus communication with DP communication protocol. DP variant (decentralized periphery) is the high-speed communication. Profibus DP allows cyclic data transfer only between the automation device (master) and the peripheral devices in a network. The cyclic data transfer involves parameters, metering, and diagnostic, analog, and alarm data. See Table 4-12 for a complete list of cyclic telegrams.

Profibus DPV1: An extension of the DP protocol, which in addition to the cyclic communication, provides acyclic communication for parameterization, alarm, diagnostic, analog, RTC control, and control of the slaves.

A Profibus DP slave: Any peripheral device, such as GTU DP, which processes information and sends its output to the Profibus class 1 and/or class 2 master. It must comply with EN 50 170 standard, Volume 2, Profibus.

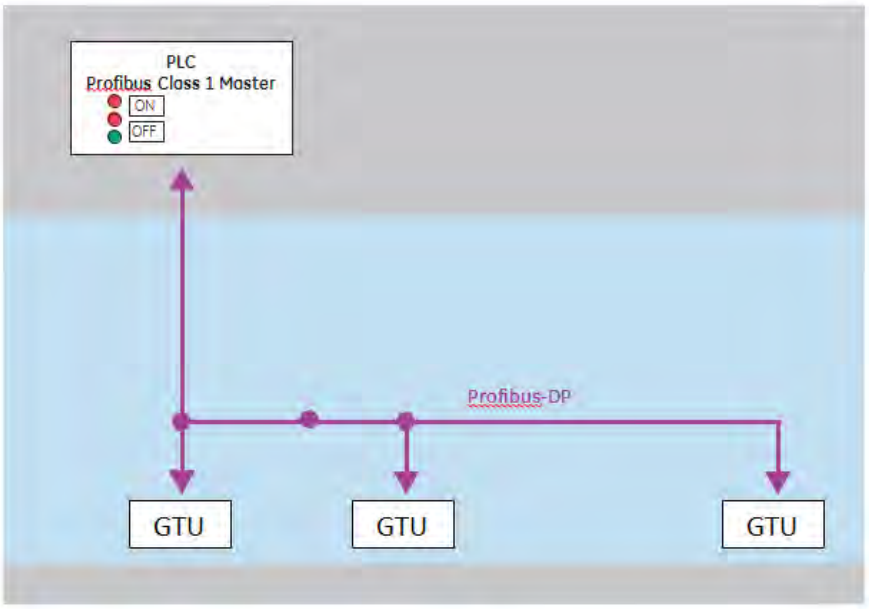
Class 1 master: The main controller for the high-speed data exchange with its Profibus slave devices that is usually a programmable logic controller (PLC) or a PC running Profibus base logic.

GSD: A device data (GSD), which is provided by GE on its website, that has the operational characteristic of the GTU DP. It provides the system with an easier means to change communication options, diagnostic, metering among other parameters.

PROFIBUS SYSTEM CONCEPT

The figure on the right shows the communication network system overview consisting of: Profibus class 1 master (PLC or PC), with cyclic data exchange GTU which are Profibus DP slaves.

Figure 12-1: Profibus Communication Network



PROFIBUS DP-PARAMETERIZATION

The GTU supports parameterization. The relay keeps its user parameter data / setpoints in a non-volatile memory and does not need device related parameterization during startup of the DP master.

GTU can be parameterized via Profibus Class 1 using Profibus parameterized service. In this case only default configurations are allowed.

COMMUNICATION SETUP AND STATION ADDRESSES

The Profibus-DPV1 basic configuration has one DP master and one DP slave. In a typical bus segment up to 32 stations can be connected (a repeater has to be used if more than 32 stations operate on a bus). The end nodes on a Profibus- DP network must be terminated to avoid reflections on the bus line.

During projecting of the bus structure ensure that the bus line is segmented dependent upon the length of the branch lines, the maximum cable length, and the number of bus stations. The allowable lengths are dependent upon transmission speeds and are specified in the Profibus standard DIN 19245-3 and in other publications dealing with this topic.

The Profibus bus address (MAC ID) of the GTU slave, which has a range from 1 to 125, can be set via the front cover switches. At power up, the GTU reads its address from the two rotary switches on its front and initializes the bus communication. Changes of the station address take effect with the next reset or power up.

The GTU supports auto-baud rate detection. The available baud rates and other slave specific information needed for configuration are in the GTU GSD file, which is used by a network configuration program.

To communicate with a Class 1 master (PLC) in a system, the GTU GSD file is required.

PROFIBUS GTU DP CYCLIC DATA

The cyclic data is a fast process data transfer between the Profibus DP master and the slave, which occurs once in every DP cycle. GTU is a modular device supporting up to 144 bytes of input data.

Modules define a block size of input and output data to be read by the master, starting from offset zero. During the network configuration session, modules with varying sizes of input data are provided in the GSD file.

GTU CYCLIC READ TELEGRAM DEFINITIONS

Table 12-1: GTU Cyclic Read Telegram Definitions

Cyclic Read Telegram ID	Parameter	No. of Bytes	Units
B5020	Temperature Input 1	2	
B5021	Temperature Input 2	2	
B5022	Temperature Input 3	2	
B5023	Temperature Input 4	2	
B5024	Voltage Phase A	2	
B5025	Voltage Phase B	2	
B5026	Voltage Phase C	2	
B5027	Current Phase A	4	
B5028	Current Phase B	4	
B5029	Current Phase C	4	
B5030	Current Phase N	4	
B5031	Energy Total	8	
B5032	Energy Rollover Count	2	
B5033	Power Factor Phase A	2	
B5034	Power Factor Phase B	2	
B5035	Power Factor Phase C	2	
B5036	Power Factor Total	2	
B5037	Power Real Phase A	2	
B5038	Power Real Phase B	2	
B5039	Power Real Phase C	2	
B5040	Power Real Total	2	
B5041	Power Reactive Phase A	2	
B5042	Power Reactive Phase B	2	
B5043	Power Reactive Phase C	2	
B5044	Power Reactive Total	2	
B5045	Power Apparent Phase A	2	
B5046	Power Apparent Phase B	2	
B5047	Power Apparent Phase C	2	
B5048	Power Apparent Total	2	
B5049	Power Demand Total	2	
B5050	Frequency Measured	2	
B5051	Longtime Pickup Status	2	
B5052	Discrete Flags	6	

The following tables describe the 6 bytes of GTU discrete flags cyclic input data provided in the GSD file:

Table 12-2: Byte 1

Shunt 1 Trip Status	Bell Alarm/ Lockout Actuation	Bell Alarm Actuation	Input 4 Status	Input 3 Status	Input 2 Status	Input 1 Status	Relay 4 Status
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
B1_7	B1_6	B1_5	B1_4	B1_3	B1_2	B1_1	B1_0
1	1	1	1	1	1	1	1
255							

Table 12-3: Byte 2

Relay 3 Status	Relay 2 Status	Relay 1 Status	ZSI OUT Active	ZSI IN active	GF Sum Pickup State	Short Time Pickup State	Long Time Pickup State
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
B0_7	B0_6	B0_5	B0_4	B0_3	B0_2	B0_1	B0_0
1	1	1	1	1	1	1	1
255							

Table 12-4: Byte 3

Disconnect Indication	Test Position	Breaker Connected	Breaker Closed and Connected	Spring Charge	Breaker Ready to Close	Breaker Position	V Detect
33	**32**	**31**	**30**	**29**	**28**	**27**	**26**
B3_7	B3_6	B3_5	B3_4	B3_3	B3_2	B3_1	B3_0
1	1	1	1	1	1	1	1
255							

Table 12-5: Byte 4

Power Reversal Status	Current Unbalance Status	Overvoltage Status	Undervoltage Status	Voltage Unbalance Status	UVR 2 Trip Status	UVR 1 Trip Status	Shunt 2 Trip Status
25	**24**	**23**	**22**	**21**	**18**	**17**	**16**
B2_7	B2_6	B2_5	B2_4	B2_3	B2_2	B2_1	B2_0
1	1	1	1	1	1	1	1
255							

Table 12-6: Byte 5

RELT Status	Current Alarm 2 Status	Current Alarm 1 Status	GF CT Alarm Status	GF Sum Alarm Status	Power Reversal Alarm Status	Current Unbalance Alarm Status	Overvoltage Alarm Status
65	**64**	**63**	**62**	**61**	**60**	**59**	**58**
B5_7	B5_6	B5_5	B5_4	B5_3	B5_2	B5_1	B5_0
1	1	1	1	1	1	1	1
255							

Table 12-7: Byte 6

Undervoltage Alarm Status	Voltage Unbalance Alarm Status	GF CT Status	WFC Data Available	GTU Tripped	Remote Close	Draw Out	Cassette Indication
57	**56**	**55**	**54**	**51**	**44**	**35**	**34**
B4_7	B4_6	B4_5	B4_4	B4_3	B4_2	B4_1	B4_0
1	1	1	1	1	1	1	1
255							

SECTION 13. BATTERY AND POWER INFORMATION

The trip unit has a front panel-mounted battery. When the battery is present, the user can view data on the LCD and read or program the trip unit via the keypads. The battery allows the user to display data, change set points and provide thermal memory.

During normal operation the trip unit is powered either from current flow in the circuit breaker's internal current sensors or from an external DC supply. When neither source is available the trip unit will power up when a key is pressed using battery power.

The trip unit will automatically shut off after 20 - 40 seconds when battery powered to maximize battery life.

Duracell CR2 is the replacement battery for all GTU Trip units of any production year.

Battery Function

Pressing any key on the face of the trip unit powers the unit from its internal battery. Battery power is maintained for 20 – 40 seconds after the last key is pressed.

This self-powered mode allows setting up the trip unit or viewing trip targets when the breaker is de-energized and external control power is unavailable.

All normal setup, meter, and status functions can be performed with battery power.

Battery Operation Under Light Load Conditions

The battery supply is shut off whenever the current sensor or external DC supply is available. Under certain specific light breaker loading conditions it is possible that the trip unit will disable the battery supply even if there is not sufficient CT power available to power the display. In this condition the display will not turn on under battery power when a keypad key is pressed, or the display will go off as soon as the button is released. Either increase breaker loading or provide power externally, such as from a test kit, to restore full LCD and keypad function under these conditions.

Battery Replacement

⚠ WARNING

IMPROPER REPLACEMENT

- Replace the battery with CR2 lithium battery only

Failure to comply with these instructions could result in serious injury.

⚠ WARNING

IMPROPER DISPOSAL

- Ensure battery is properly disposed of according to all applicable regulations.

Replace the battery if it does not power up the trip unit display when any key is pressed.

Lift the battery cover on the front of the trip unit to expose the 3V or 3.6 V ½ AA lithium cell. A suitable replacement is a Duracell CR2.

Trip Unit Power Consumption by Type

When providing DC power to the trip unit use the following maximum values when sizing a supply:

GTU for AKR & PowerBreak:
90mA
GTU for PowerBreak II, WavePro, New HPC:
90mA
For EntelliGuard G with Modbus:
120mA with Modbus active
50mA with no Modbus option
For EntelliGuard G with Profibus:
300mA with Profibus active

For purposes of sizing system power supplies when mixing EntelliGuard and MicroEntelliGuard units, use a value of 50mA for the MicroEntelliGuard.

When selecting a power supply be certain that any supply overcurrent protection features are compatible with the breaker actuator loads. Some supplies will shut off when the brief actuator overcurrent is applied. Actuator draw varies by breaker, but in general they will require several amperes for 4-8 milliseconds.

GE recommends the PLPS4G01 power supply for use with EntelliGuard trip units. GE Publication GEH-6492 provides full information on this supply. The maximum recommended breakers per power supply is as follows:

- PowerBreak/PowerBreak II/New HPC – 15
- EntelliGuard w/Modbus – 11
- EntelliGuard w/Profibus – 5
- WavePro - 14

SECTION 14. MAINTENANCE AND TROUBLESHOOTING

⚠ DANGER

ELECTROCUTION

Ensure the circuit breaker has been tripped, indicating OFF, and the main springs are fully discharged when performing circuit breaker maintenance.

Failure to comply with these instructions could result in death or serious injury.

⚠ WARNING

IMPROPER INSTALLATION, OPERATION AND MAINTENANCE

Ensure only qualified personnel install, operate, service and maintain all electrical equipment.

Failure to comply with these instructions could result in death or serious injury.

⚠ WARNING

PERSONAL INJURY

- Avoid risk of injury from moving parts while handling the circuit breaker
- If advisable, use a cable/busbar lockable grounding device (optional accessory) to provide additional safety during system maintenance

Failure to comply with these instructions could result in death or serious injury.

RATING PLUG REMOVAL AND REPLACEMENT

NOTICE

Removal of the rating plug while the breaker is carrying current reduces the breaker's current-carrying capacity to approximately 40% of the current sensor rating.

Interchangeable rating plugs are removed with a Rating Plug Extractor, Catalog No. TRTOOL. (Suitable equivalents are commercially available as "integrated circuit [DIP] extractors.") Grasp the rating plug tabs with the extractor and pull the plug out as shown in the figure below.

Be sure to grab the tabs and not the front cover of the rating plug, or the plug may be damaged.

Figure 14-1: Trip Unit with Rating Plug Removed

TROUBLESHOOTING GUIDE

Table 14-1: Troubleshooting Guide

Error	Potential Cause of Error	Possible Solution
The trip unit display is blank or backlight is intermittent.	External +24 VDC is absent or dipping below 22 VDC. The load current fluctuates near 20% of the breaker se nsor rating.	At least 20% of the current sensor rating, (xCT) must be flowing through the breaker to activate the display. If not, power the trip unit with the internal battery. The battery power supply is disabled when any current is sensed through the current sensors. Check that the control power supply is present and operational.
The trip unit displays E02 or Bim Error.	BIM error.	No communication with the BIM Check the BIM harness. Mismatch trip unit / BIM option. Attempt BIM Remarry procedure to restore normal operation.
The trip unit displays E03.	Memory failure.	Return the unit to GE.
The trip unit displays E06.	Internal failure.	Return the unit to GE.
The trip unit displays E08 or Rplug Error.	Invalid rating plug.	Check the rating plug. The rating plug value shall not exceed and be below 40% of the breaker sensor. Ensure the rating plug is properly inserted.
Unit does not communicate with the Master.	The communication wires are shorted or improperly connected. Incorrect baud rate. Incorrect address.	Locate and repair the short or the incorrect connection. Check that the baud rate assigned to the trip unit, agrees with the baud rate at the host. Check that the address assigned to the trip unit, agrees with the address at the host.
Current readings are incorrect.	Incorrect rating plug value.	Check the rating plug label.
Voltage readings are incorrect.	The potential transformer (PT) primary voltage was defined incorrectly. The PT connection was defined incorrectly. Voltage conditioner or PT wiring is incorrect.	Read the PT primary rating from the PT name plate and set trip unit PT to this value. Set the trip unit phase to phase PH-PH or phase to neutral PH-N according to the system.
The display is blank or the Low Battery symbol appears when the BATTERY key is pressed. Line current is below 20% of the breaker sensor rating.	The battery is discharged. The battery was stored too long with no power applied to the trip unit.	Replace the battery. Power the trip unit with external power or by energizing the breaker for several days to freshen the battery.
Modbus communication is intermittent or frequent timeouts	Metering calculations are exhausting CPU capacity.	Ensure trip unit is not displaying a metering screen. Use the Screen Timeout setting to automatically return to the main menu.
Modbus communication is intermittent or frequent timeouts	Power Supply capacity insufficient	Ensure the external DC power supply is not momentarily falling below 22V during maximum loading.

Error	Potential Cause of Error	Possible Solution
Tripping with no event record with external DC power applied	External Power Supply capacity insufficient.	During tripping the breaker actuator will draw as much as 5A from the power supply for a few milliseconds. Certain power supply designs with aggressive overcurrent protection may shut off their outputs under these conditions, causing the trip unit to lose power while saving event data into memory which will cause a loss of that data.
Trip unit with Defeatable GF option does not have an "OFF" selection in the GF Delay Band setting	The Ground Fault Defeat feature has not been enabled. (This applies only to firmware versions 08.00.26 and higher)	The GF Defeat feature is disabled by default when the trip unit ships. To permit GF Defeat you must enter the correct password. See "Passwords" elsewhere in this manual. Under some circumstances the password may need to be re-entered if a different password was entered for another purpose.

Other General Troubleshooting Issues

- **Nuisance tripping**
  Review Pickup, Band and Slope settings. Coordination Study is optimal, but remember that EntelliGuard has Delay bands and slopes that can be much faster than MicroVersaTrip. Settings that are lower than application can support can create nuisance tripping. E.g. Transformer or Motor Magnetizing inrush can be up to 10 to 15X nominal and setpoints set to low enough pickup and delay may nuisance trip on this if not set appropriately.
- **Nuisance firing of Bell Alarm on PB2**
  Review settings of Bell Alarm LO (lockout) and Bell Alarm (alarm only). Consult settings instruction. Group 3 is for Overcurrent trip only (most used setting). Many units have had default setting of Group 15 where any trip condition such as shunt, UVR or Prot. Relay will fire the bell alarm. If Bell Alarm still nuisance fire with the correct setting, contact Post Sales Service (PSS).
- **Display will not come up with battery power and or line current**
  The internal battery power supply can be used at 10% or lower current and CT's will power up the trip unit at 15% or greater. Between 10 and 15% the CT's or the internal battery power supply may not power the display. A test kit or external battery pack tvpbp and tvpbpacc can be used as well as external 24VDC power. The backlight requires external DC power either from a test kit or a separate source.
- **Nuisance trip when pressing keypad and under communication**
  Contact Post Sales Service: 1-888-GE-RESOLVE.
- **RELT Instantaneous cannot be set**
  For firmware versions prior to v08.00.26: If the trip unit does not have the required 24VDC control power, it cannot read RELT inputs and will not allow setting to be changed. You can change settings when powered with 24VDC, test kit or battery pack.

  Starting with v08.00.26 RELT can be adjusted and will operate under self power. See Reduced Energy Let Through (RELT) for details.
- **Confusion about GF CT vs. GF Sum**

  The EntelliGuard G circuit breaker offers both GF Sum and GF CT ground fault protection, but the elements are not interchangeable.

  GF Sum works by continuously calculating a phasor sum of the breaker's phase and neutral current sensors. On a 3 wire system the neutral sensor can be omitted, but the sensor input must be shorted to prevent nuisance operation. On a 4 wire breaker the neutral sensor is integral to the breaker.

  GF CT is most often utilized in Multi-Source Ground Fault schemes where there are multiple neutral return paths. In this case the return current sensor data is shared by all trip units involved in the scheme.
- **Settings cannot be changed to desired level**
  Check in the SETUP Long time pickup screen that the LT pickup multiplied by the Rating plug equals the Pickup Amps displayed (e.g. 0.5 LTPU times a 2000A plug equals 1000A displayed on the bottom of LTPU screen.
- **GF Alarm relay is not staying on**
  If the output Relay is used for GF Alarm, it is momentary duty and the contacts are closed only during the GF Fault condition.
- **Breaker contact status reads incorrectly (e.g., on a PB2 display reads Closed when breaker is Open)**
  Trip unit can only read correct status when trip unit if fully powered by either CT current of approximately. 80%, 24VDC, test kit or battery pack.

- **Batteries go dead prematurely (e.g., within few months)**
  Excessive use of keypad (hours) can cause this. Otherwise if load current is constantly at 10 to 20% of CT rating, contact PSS.
- **GF nuisance tripping on EntelliGuard G breakers**
  The most common cause is an open neutral sensor connection on a 3 pole/3 Wire system. The neutral sensor MUST be shorted at the secondary disconnect if not in use. Verify there is not a GF sensing application issue such as incorrect neutral sensor polarity, incorrect bonding at neutral CT or downstream or related issues. Check current metering when breaker is OPEN, if currents do not read zero trip unit will need to be replaced-contact PSS to determine if warranty.
- **BIM trip**
  If trip unit is installed into a breaker other than the one this was first installed in, this will occur. New trip units should not cause this when first installed into a breaker. If this occurs with a new trip unit that was not installed in a breaker, contact PSS as the breaker BIM module might be corrupt.

  Software Revision 8.00.23 and greater: a BIM error will generate an error message but will not trip the breaker. Please see Breaker Interface Module (BIM) section for more information.
- **Nuisance trip with NO EVENT information**
  Verify there are no accessories and that settings are not too low in the presence of high inrush conditions at low CT current causing the trip and then contact PSS.

SECTION 15. TESTING AND QUALITY

CONFORMAL COATING

All EntelliGuard Trip Unit circuit boards have a solder mask and are conformally coated using an acrylic coating per IPC-CC-830. The coating is compliant with RoHS directive 2002/95/EC, recognized under UL File E105698, and is MIL-I-46058C qualified.

GLOBAL STANDARDS

The EntelliGuard Trip unit conforms to the following standards:

- ANSI/IEEE C37.9.1 Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
- IEC 60947-2, Edition 4
- IEC 60947-2, Edition 4 Annex F
- IEC 60947-2, Edition 4 Annex J
- UL489
- UL489 Supplement SE
- UL1053
- UL1066
- NEMA SG3 / SG5 - Low Voltage Power Circuit Breakers
- ANSI C37.13, 16, 17, 20, 50

SECTION 16. INSTALLATION

⚠ DANGER

ELECTROCUTION

- Ensure the circuit breaker has been tripped, indicating OFF and that applicable lock-out/tag-out requirements are met and followed
- Ensure the main springs are fully discharged
- Do not touch the circuit breaker's isolating contacts during lifting

Failure to comply with these instructions could result in death or serious injury.

⚠ WARNING

IMPROPER INSTALLATION, OPERATION, SERVICE, AND MAINTENANCE

- Ensure only qualified personnel install, operate, service and maintain all electrical equipment
- Do not perform any maintenance, including breaker charging, closing, tripping, or any other function that could cause significant movement of circuit breaker while it is on the draw-out extension rails
- Ensure circuit breaker is always left in the CONNECTED, TEST or DISCONNECTED position to avoid mispositioning of the breaker and flashback

Failure to comply with these instructions could result in death or serious injury.

⚠ WARNING

FALLING OBJECT

- Ensure lifting equipment has capability for device being lifted
- Wear hard hat, gloves and safety shoes

Failure to comply with these instructions could result in death or serious injury.

CAUTION

Product Damage

- Contact GE for rewiring information before using the EntelliGuard TU trip unit to replace the Micro-Versa PM trip unit. This is because connecting the MicroVersa's 24 V (commnet system) directly to the EntelliGuard (Modbus system) will damage the EntelliGuard's RS485 chip
- Ensure circuit breaker and its accessories are always used within their designated ratings
- Ensure the correct trip unit is paired with the correct circuit breaker
- Do not use excessive force when installing a trip unit.
- Do not allow circuit breaker to hit a hard surface while handling.
- Do not drag or slide circuit breaker across a hard or rough surface.

Failure to comply with these instructions could result in death or serious injury.

TRIP UNIT REMOVAL AND REPLACEMENT

Power Break I, Power Break II, WavePro and AKR Trip Units have rejection pins, installed on the rear of these trip units, to prevent installation of an incorrect trip unit into a breaker.

Replacement of a trip unit always requires repeating the setup procedures

Power Break I and Power Break II Insulated Case Circuit Breakers and New HPC Switch

The trip unit procedures for Power Break I and Power Break II circuit breakers are very similar and are outlined below. The EntelliGuard TU trip unit for a Power Break II is different than that for a Power Break"). Ensure the correct trip unit is used.

Trip Unit Removal

Loosen the four #8-32 screws on the circuit breaker trim-plate assembly and remove the trim plate.

Loosen the four #10-32 screws at the corner of the breaker cover. Remove the cover from the breaker face.

Pull the trip unit locking lever to the right, then hold the trip unit near the battery cover and lift it straight out of the circuit breaker.

Trip Unit Reinstallation

Pull the trip unit locking lever to the right. While holding the lever, carefully align the connector on the rear of the trip unit with the connector in the breaker. Press down on the trip unit while holding it near the battery cover. When the trip unit is fully seated, slide the locking lever back to the left.

Reinstall the breaker top cover and tighten the four #10-32 screws to 32 in-lb.

Replace the trim plate and tighten the four #8-32 screws to 20 in-lb.

WAVEPRO CIRCUIT BREAKERS

Removal

Open the circuit breaker and remove it from the cubicle or substructure. Place it on a suitable work surface.

For 800 A, 1600 A and 2000 A frame circuit breakers, insert the racking handle (catalog number 568B731G1) and move the racking mechanism to the TEST position, as shown on the draw-out position indicator.

Depress the OPEN button to close the racking door.

Remove the wire forms and remove the trim plate from the breaker.

Remove the six ¼ hex head screws, securing the escutcheon to the breaker (three at top and three at bottom). Pull the manual-charging handle out part way, and then slide off the escutcheon.

Pull out the locking side on the right of the trip unit mounting plate, and then pull the trip unit out carefully disengaging the pins on the rear connector.

Pull out the locking side on the right of the trip unit mounting plate, and then pull the trip unit out carefully disengaging the pins on the rear connector.

Reinstallation

Pull out the locking side on the right of the trip unit mounting plate. Push the trip unit into place, carefully, engaging the 50 pin connector and lining up the rejection posts on the rear of the trip unit with the holes in the mounting plate. Push the locking slide to the left.

Ensure the breaker racking mechanism is still in the TEST position. Pull the manual charging handle out partway, and then slide the handle through the slot in the escutcheon and move escutcheon into place. Insert the six mounting screws and tighten to 14-20 in-lb.

Replace the trim plate around the escutcheon by re-hooking the wire forms into the sides.

Insert the racking handle and return the racking mechanism to the DISC position, as shown by the draw-out position indicator.

Reinstall the circuit breaker into its cubical or substructure.

AK/AKR (225 A TO 5000 A FRAMES) CIRCUIT BREAKERS

Open the circuit breaker by pressing the red TRIP button on the front of the breaker escutcheon.

Disconnect any secondary wire harnesses between the breaker and the switchgear.

On draw-out breakers, rack the breaker all the way out to the DISCONNECT position.

Follow the instructions on the label attached to the PROGRAMMER RELEASE LEVER to remove the trip unit. There are three types of mounting plates:

Type 1: Push in the lever to release the trip unit

Type 2: Pull out the lever to release the trip unit as shown in Figure 16-1

Type 3: Push down on the lever

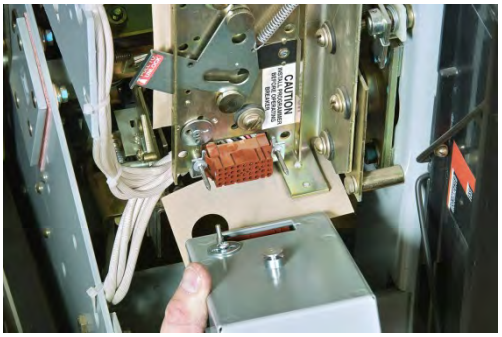
Figure 16-1: Removing the Old Trip Unit

If the breaker is equipped with a MicroVersaTrip RMS 9 trip unit, the 36-pin trip unit connector must be removed and remounted on the adapter bracket provided. Slide the connector out of the mounting plate and install it on the adapter bracket, as shown in Figure 16-2.

Figure 16-2: Circuit Breaker without Trip Unit

Align the connectors and rejection pin and connect the EntelliGuard TU to the circuit breaker, as shown in Figure 16-3.

Figure 16-3: Installing the New Trip Unit



ENTELLIGUARD G CIRCUIT BREAKER INSTALLATION

Trip Unit Removal (Figure 16-4 through Figure 16-7)

Loosen the six screws on the breaker fascia assembly and remove the fascia.

Depress the trip unit locking lever on the left side of the trip unit, then hold the trip unit near the bottom and lift it straight out of the mounting base.

Figure 16-4: Trip Unit Removal Sequence, Step A

Figure 16-5: Trip Unit Removal Sequence, Step B

Figure 16-6: Trip Unit Removal Sequence, Step C

Figure 16-7: Trip Unit Removal Sequence, Step D

Trip Unit Reinstallation

Depress the trip unit locking lever on the left side of the trip unit. While depressing the lever, carefully align the connector on the rear of the trip unit with the connector in the mounting base on the breaker. Press down on the trip unit while holding it near the bottom.

When the trip unit is fully seated, stop depressing the trip-unit-locking lever and allow the lever to come up and lock the trip unit to the mounting base.

Reinstall the breaker fascia and ensure that the Trip unit is centered in the fascia window before tightening the fascia fixing screws.

APPENDIX A: GTU NOMENCLATURE

Table A-1: EntelliGuard Trip Unit Form, Characters 1 & 2

Code	Explanation
GA	PB1 (UL)
GB	PB2 (UL)
GC	AKR (ANSI)
GW	WP (ANSI)
GL	Mpact Low (IEC)
GH	Mpact 24-48V (IEC)
GQ	Mpact 120-240V (IEC)
GG	EntelliGuard G ACB (ANSI)
GU	EntelliGuard G ACB (UL)
GS[1]	EntelliGuard G Switch (UL/ANSI)
GT	EntelliGuard G ACB (IEC)
GE	Entellisys Breakers (ANSI)
GF	New HPC Switch Control Unit (UL)
G1	EntelliGuard Trip Universal Spare
G2	Type A Conversion Kits (ANSI)
G3	EntelliGuard G Switch (IEC)
G4	RESERVED (Future)
G5	RESERVED (Future)
G6	RESERVED (Future)
G7	RESERVED (Future)
VB	EntelliGuard MTU (IEC)
GM	AEG Frame 3 ACB (IEC)

1. Ground Fault Relay version for EntelliGuard G switches (future).

Table A-2: Frame Rating (amperes) Character 3 for AKR

Code	Explanation
1	800A
2	1600A
3	2000A
4	2500A (Not Applicable)
5	3000A (Not Applicable)
6	3200A
7	4000A
8	5000A
9	6000A (Not Applicable)
W	800A AKR30S

Table A-3: Frame Rating (amperes) Character 3 for PowerBreak (PB1)

Code	Explanation
1	800A
2	1600A
3	2000A
4	2500A
5	3000A
6	3200A (Not Applicable)
7	4000A
8	5000A (Not Applicable)
9	6000A (Not Applicable)

Table A-4: Frame Rating (amperes) Character 3 for PowerBreak II (PB2) and New HPC Switch

Code	Explanation
1	800A
2	1600A
3	2000A
4	2500A
5	3000A
6	3200A (Not Applicable)
7	4000A
8	5000A (Not Applicable)
9	6000A (Not Applicable)
A	1200A (Reserved for New HPC Switch future)

Table A-5: Frame Rating (amperes) Character 3 for WavePro

Code	Explanation
1	800A
2	1600A
3	2000A
4	2500A (Not Applicable)
5	3000A (Not Applicable)
6	3200A
7	4000A
8	5000A
9	6000A (Not Applicable)

Table A-6: Frame Rating (amperes) Character 3 for EntelliGuard G Series – Factory Installed Trip Units (ALL) – ANSI/UL, Entellisys (ANSI/UL), IEC

Code	Explanation
S	50kAIC @ 440/500V IEC, 40kAIC @ 690V IEC
E	Sq. Rated (ICW = ICU) 400-2000A, 85kAIC @ 480/508V
B	Sq. Rated (ICW = ICU) 3200-6000A, 100kAIC @ 480/508V
N	65kAIC @ 440/480/508/600/635V, 40kAIC @ 690V
H	85kAIC @ 440/480/508V, 65kAIC @ 600/635V, 65kAIC @ 690V
M	100kAIC @ 440480/508V, 85kAIC @ 600/635V, 85kAIC @ 690V
L	150kAIC @ 440/480/508V, 100kAIC @ 600/635V, 100kAIC @ 690V
P	100kAIC @ 440/480/508V, 65kAIC @ 600/635V
R[1]	260kAIC (future)
T[1]	PCTO/F5 (future)
U	Miniguard 85kA
V[1]	AKR Retrofit Breakers (future)
Y	Miniguard 100kA
X	EntelliGuard Universal Spare
G	IEC Universal Unit

[1] DC trip unit is not included. DC Rated Circuit Breakers require external control devices.

Table A-7: Frame Rating (amperes) Character 3 for *Mpact

Code	Explanation
1	Frame 1 (400A, 630A, 800A, 1000A, 1250A, 1600A, 2000A, 2500A)
2	Frame 2 (800A, 1000A, 1250A, 1600A, 2000A, 2500A, 3200A, 4000A)

Table A-8: Frame Rating (amperes) Character 3 for TYPE A Conversion Kits

Code	Explanation
A	225A
C	600A
W	800A (For AKR30S Only)
1	800A
2	1600A
3	2000A
4	2500A (Not Applicable)
5	3000A
6	3200A
7	4000A
8	5000A (Not Applicable)
9	6000A (Not Applicable)

Table A-9: Frame Rating (amperes) Character 3 for Compact VCB (Medium Voltage)

Code	Explanation
P	25kAIC @12kV
Q	31.5kAIC @12kV

Table A-10: Sensor Rating (amperes): Characters 4 & 5
Refer to breaker or switch documentation for specific sensor availability for your device.

Code	Explanation
00	UNIV[1]
01	150
02	200
03	225
04	400
06	600
07	630[1]
08	800
10	1000
12	1200
13	1250[1]
14	Reserved
15	Reserved
16	1600
20	2000
25	2500
30	3000
32	3200
40	4000
50	5000
60	6000
64	6400[1]

[1] EntelliGuard G IEC designs only

Table A-11: OC and GF Protection Packages Characters 6 & 7 EntelliGuard G ANSI/UL OC Protection

Code	Explanation
L1	RESERVED
L2	RESERVED
L3	LSI (S, switchable) (I, switchable ANSI only) (I is non-switchable for AKR30S conversion kits)
L4	LSIG (S, switchable) (I, switchable ANSI only) (I is non-switchable for AKR30S conversion kits)
L5	LSIGA (S, switchable) (I, switchable ANSI only)
L6	LSIC (S, switchable) (I, switchable ANSI only)
L7	LSICA (S, switchable) (I, switchable ANSI only)
L8	LSIGDA (S, G, A all switchable) (I, switchable ANSI only)
L9	LSIGCDA (S, G, C, A all switchable) (I, switchable ANSI only)
LA	RESERVED
LB	RESERVED
LC	LSH (S, switchable) (H, switchable ANSI only) (H fixed in AKR30S conversion kits)
LD	LSHG (S, switchable) (H, switchable ANSI only) (H fixed in AKR30S Conversion Kits)
LE	LSHGA (S, switchable) (H, switchable ANSI only)
LF	LSHC (S, switchable) (H, switchable ANSI only)
LG	LSHCA (S, switchable) (H, switchable ANSI only)
LH	LSHGDA (S, G, A all switchable) (H, switchable ANSI only)
LK	LSHGCDA (S, G, C, A all switchable) (H, switchable ANSI only)
LM	RESERVED
LN	RESERVED
LP	LSI (S, switchable) (I, Non-switchable, used for WavePro in Switchboards)
LQ	LSIG (S, switchable) (I, Non-switchable, used for WavePro in Switchboards)
LR	LSIGA (S, switchable) (I, Non-switchable, used for WavePro in Switchboards)
LS	LSIGDA (S, G, A all switchable) (I, Non-switchable, used for WavePro in Switchboards)
LT	RESERVED
LU	RESERVED
LV	RESERVED
LW	G (PB II Switch and EntelliGuard Switch GF Relay only)
LY	GA (PB II Switch and EntelliGuard Switch GF Relay only)
LZ	All Protection Disabled (Entellisys)

Note: All "L" protection combinations include Long Time Fuse (I^4t) Curve Delay Bands.

Table A-12: OC and GF Protection Packages Characters 6 & 7 EntelliGuard G ANSI/UL OC Protection with Fuse Settings

Code	Explanation
J1	RESERVED
J2	RESERVED
J3	Replaced by L3
J4	Replaced by L4
J5	Replaced by L5
J6	Replaced by L6
J7	Replaced by L7
J8	Replaced by L8
J9	Replaced by L9
JA	RESERVED
JB	RESERVED
JC	Replaced by LC
JD	Replaced by LD
JE	Replaced by LE
JF	Replaced by LF
JG	Replaced by LG
JH	Replaced by LH
JK	Replaced by LK
JM	RESERVED
JN	RESERVED
JP	Replaced by LP
JQ	Replaced by LQ
JR	Replaced by LR
JS	Replaced by LS
JT	RESERVED
JU	RESERVED
JV	RESERVED
JW	RESERVED
JY	RESERVED

Table A-13: OC and GF Protection Packages Characters 6 & 7, EntelliGuard G IEC Series OC Protection

Code	Explanation
K1	LS (both non-switchable)
K2	LSG (all non-switchable)
K3	LSIG (L, S, G, (all not switchable), I (switchable)
K4	LSHG (L, S, G (all not switchable), H (switchable)
K5	LSIGCD (L , S, I, G and C (all switchable)
K6	LSIGCDA (L, S, I, G, C and A (all switchable)
K7	LSHGCD (L, S, H, G and C (all switchable)
K8	LSHGCDA (L, S, H, G, C and A (all switchable)
K9	LSI (L, S (not switchable, I (switchable)
KA	NONE - All protections disabled
KE	LSIED (L , S, I, E - only L, S, & I are switchable)
KG	LSHED (L, S, H, E - only L, S, and H are switchable)
KS	S (non-switchable)

Table A-14: OC and GF Protection Packages Chars. 6 & 7, EntelliGuard G IEC Series OC Protection with Fuse Settings

Code	Explanation
N1	JS (both non-switchable)
N2	JSG (all non-switchable)
N3	JSIG (J, S, G, (all non-switchable), I (switchable))
N4	JSHG (J, S, G (all non-switchable), H (switchable)
N5	JSIGCD (J , S, I, G and C (all switchable)
N6	JSIGCDA (J, S, I, G, C and A (all switchable)
N7	JSHGCD (J, S, H, G and C (all switchable)
N8	JSHGCDA (J, S, H, G, C and A (all switchable)
N9	JSI (J, S (non-switchable), I (switchable)
ND	JSIED (J , S, I, E - only L, S, & I are switchable)
NF	JSHED (J, S, H, E - only L, S, and H are switchable)

Table A-15: OC and GF Protection Packages Chars. 6 & 7, Mpact Series OC Protection (IEC)

Code	Explanation
M1	LS (all non-switchable)
M2	LSG (all non-switchable)
M3	LSI (L ,S (non-switchable), I (switchable)
M4	LSIGCD (L, S, I, G and C (all switchable)
M5	RESERVED
M6	RESERVED
M7	RESERVED
M8	RESERVED
M9	RESERVED
MA	NONE - All protections disabled
MC	LSIED (L, S, I, E - only L, S, & I are switchable)

Table A-16: OC and PROTECTION Definitions: Chars. 6 & 7

Code	Explanation
L	Long Time Protection (L) + Fuse Settings (Selectable I^2t or Fuse Setting)
J	Replaced by L
S	Short Time (switchable if Instantaneous (I) protection is enabled)
I	Standard Range Adjustable Instantaneous, (IOC, 2x-15x)
H	High Range Adjustable Instantaneous (IOC, 2x-30x) (Fixed 22kA for AKR30S Conversion Kits)
G	Ground Fault Protection (GFP, 3-wire or 4-wire, internal summing)
C	External CT for ground fault detection (input from external summing CTs, used for multiple source ground fault detection)
D	Makes G & C options switchable
A	Enable Alarm Function for Ground Fault and/or External CT GF. Not available with E option
K	Long Time Inverse IEC protection curves
E	UEF, REF, SEF; non switchable, no alarm function

Table A-17: OC and GF Protection Packages Chars. 6 & 7, WavePro

Code	Explanation
L3	LSI (S, switchable) (I, switchable ANSI only (Code 1&2, WP)
L4	LSIG (S, switchable) (I, switchable ANSI only (Code 1&2, WP)
L5	LSIGA (S, switchable) (I, switchable ANSI only (Code 1&2, WP)
L8	LSIGDA (S, G, A all switchable) (I, switchable ANSI only (Code 1&2, WP)
J3	Replaced by L3
J4	Replaced by L4
J5	Replaced by L5
J8	Replaced by L8

Table A-18: OC and GF Protection Packages Chars. 6 & 7, WavePro when Used in UL891 Switchboards with 5-Cycle Withstand Busing

Code	Explanation
LP	LSI (S, switchable) (I, Non-switchable, used for WavePro in Switchboards)
LQ	LSIG (S, switchable) (I, Non-switchable, used for WavePro in Switchboards)
LR	LSIGA (S, switchable) (I, Non-switchable, used for WavePro in Switchboards)
LS	LSIGDA (S, G, A all switchable) (I, Non-switchable, used for WavePro in Switchboards)
JP	Replaced by LP
JQ	Replaced by LQ
JR	Replaced by LR
JS	Replaced by LS

Table A-19: AKR, Conv. Kits with OC Protection Characters 6 & 7

Code	Explanation
L3	LSI (S, switchable) (I, switchable)
L4	LSIG (S, switchable) (I, switchable)
L5	LSIGA (S, switchable) (I, switchable)
L8	LSIGDA (S, G, A all switchable) (I, switchable)
J3	Replaced by L3
J4	Replaced by L4
J5	Replaced by L5
J8	Replaced by L8

Table A-20: PowerBreak I & II Chars. 6 & 7

Code	Explanation
L3	LSI (S, switchable) (I, Non-switchable)
L4	LSIG (S, switchable) (I, Non-switchable)
L5	LSIGA (S, switchable) (I, Non-switchable)
L8	LSIGDA (S, G, A all switchable) (I, Non-switchable)
J3	Replaced by L3
J4	Replaced by L4
J5	Replaced by L5
J8	Replaced by L8

Table A-21: EntelliGuard G ANSI & UL Type S Chars. 6 & 7

Code	Explanation
L3	LSI (S, switchable) (I, switchable ANSI only) (I is non-switchable for AKR30S conversion kits)
L4	LSIG (S, switchable) (I, switchable ANSI only) (I is non-switchable for AKR30S conversion kits)
L5	LSIGA (S, switchable) (I, switchable ANSI only)
L6	LSIC (S, switchable) (I, switchable ANSI only)
L7	LSICA (S, switchable) (I, switchable ANSI only)
J3	Replaced by L3
J4	Replaced by L4
J5	Replaced by L5
J6	Replaced by L6
J7	Replaced by L7

Table A-22: CVCB MTU IEC Medium Voltage OC Protection Chars. 6 & 7

Code	Explanation
C1	KS (both non-switchable)
C2	KSG (all non-switchable)
C3	KSHG (K, S, G (all not switchable), H (switchable)
C4	KSHGCD (K, S, H, G and C (all switchable)
C5	KSHGCDA (K, S, H, G, C and A (all switchable)

Table A-23: New HPC Switch Control Unit OC Protection Chars. 6 & 7

Code	Explanation
S1	I (Switchable)
S2	IG (I switchable)
S3	IGA (I switchable)
S4	IGDA (all switchable)
S5	GDA (All switchable)
LW	G
LY	GA
LZ	All Protection Disabled (New HPC)

Table A-23: Zone Selective Interlocking Character 8

	EntelliGuard G ANSI/UL	EntelliGuard G IEC	Power Break I & II, New HPC	WavePro, AKR, Conv Kits	EntelliGuard MTU
Z = ZSI, Short time and GF; user selectable	Z	Z	Z[1]	Z	
T = Z + I-ZSI + T-ZSI[2]; user selectable	T	T	T[3]	T	
X = None Selected	X	X	X	X	X
V = Reserved					
W =Reserved					

[1] ST ZSI is not applicable to New HPC Control Unit.
[2] Available on trip units with firmware version 08.00.26 or higher.
[3] PowerBreak. PowerBreak II and New HPC will "pass through" an Instantaneous ZSI signal to an upstream breaker but will not delay their own Instantaneous protection element.

Table A-24: Advanced Features and Communications Character 9

	EntelliGuard G (ANSI/UL)	WavePro, AKR, Power Break I & II, Conv. Kits Circuit OR Fuse Setting	New HPC	EntelliGuard MTU Medium Voltage Feature Packages
1 = RELT	1	1	1	1
2 = Modbus Protocol + RELT	2	2	2	2
3 = Profibus Protocol + RELT	3			
4 = Monitoring + RELT	4	4		4
5 = Monitoring + Relay Package + RELT	5	5		5
6 = Monitoring + Data Acquisition, Modbus Protocol + RELT	6	6	6	6
7 = Monitoring, Profibus Protocol + RELT	7			
8 = Monitoring + Data Acquisition + Relay Package, Modbus + RELT	8	8	8	8
9 = Monitoring + Relay Package, Profibus + RELT	9			
X = NONE SELECTED	X	X	X	X
A = Modbus Protocol (W/O RELT)		A	A	
B = Monitoring (W/O RELT)		B		
C = Monitoring + Relay Package (W/O RELT)		C		
D = Monitoring + Data Acquisition, Modbus Protocol (W/O RELT)		D	D	
E = Monitoring + Data Acquisition + Relay Package, Modbus (W/O RELT)		E	E	

Table A-25: Manual/Auto Trip Reset Character 10

	EntelliGuard (ANSI/UL)	WavePro, AKR, PBI & II, New HPC, Conv. Kits	EntelliGuard (IEC)	EntelliGuard MTU
M = Manual Lockout[1]	M			
A = Auto Reset/Reclose[1]	A			A
S = Auto/Manual Lockout (Selectable)[2]			S	
X = NOT SELECTED[3]		X		

1. Feature not available for legacy breakers.
2. Feature not available for legacy and ANSI/UL EG, IEC only.
3. Not for GACB and Mpact breakers.

Table A-26: Original or Replacement Trip Unit Character 11

Code	Explanation
F	Factory installed trip unit (original)
R	Replacement trip unit (shipped loose)

Nomenclature Characters 12 through 15 are reserved for future use.

APPENDIX B: RATING PLUG NOMENCLATURE

Table B-1: EntelliGuard G ACB Rating Plug Nomenclature

	Type	Rating	CT	Min. Sensor	Max. Sensor
	GTP	100-6400		200-6400	800-6400
	1, 2, 3	4,5,6,7	8	9, 10	11, 12
Amperes	Prefix	SKU Code			
150	GTP	0150	U	01	04
200	GTP	0200	U	02	04
225	GTP	0225	U	03	06
250	GTP	0250	U	04	07
300	GTP	0300	U	04	08
350	GTP	0350	U	04	08
400	GTP	0400	U	04	10
450	GTP	0450	U	06	12
500	GTP	0500	U	06	13
600	GTP	0600	U	06	16
630[1]	GTP	0630	U	07	17
700	GTP	0700	U	08	16
750	GTP	0750	U	08	20
800	GTP	0800	U	08	20
900	GTP	0900	U	10	20
1000	GTP	1000	U	10	25
1100	GTP	1100	U	12	25
1200	GTP	1200	U	12	32
1250[1]	GTP	1250	U	13	32
1500	GTP	1500	U	16	40
1600	GTP	1600	U	16	40
1900	GTP	1900	U	20	50
2000	GTP	2000	U	20	50
2200	GTP	2200	U	25	50
2400	GTP	2400	U	25	64
2500	GTP	2500	U	25	64
3000	GTP	3000	U	30	64
3200	GTP	3200	U	32	64
3600	GTP	3600	U	40	64
4000	GTP	4000	U	40	64
5000	GTP	5000	U	50	64
6000[2]	GTP	6000	U	60	64
6400[1]	GTP	6400	U	64	64
Universal	GTP	UNIV	U	00	00

1. IEC only.
2. UL only.

Table B-2: Legacy Rating Plug Nomenclature

	Type	Rating	CT	Min. Sensor	Max. Sensor
	GTP	100-6400		200-6400	800-6400
	1, 2, 3	4,5,6,7	8	9, 10	11, 12
Amperes	Prefix	SKU Code			
60	GTP	0060	U	01	01
80	GTP	0080	U	01	01
100	GTP	0100	U	01	03

Table B-3: ITE 4000A Sensor Akits Rating Plug Nomenclature

	Type	Rating	CT	Min. Sensor	Max. Sensor
	GTP	100-6400		200-6400	800-6400
	1, 2, 3	4,5,6,7	8	9, 10	11, 12
Amperes	Prefix	SKU Code			
1600	GTP	1600	K	40	40
2000	GTP	2000	K	40	40
3000	GTP	3000	K	40	40
4000	GTP	4000	K	40	40

APPENDIX C: MODBUS REGISTER MAP

Table C-1: Public Parameters

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
202	40203	GACB Euro Breaker rating	0 - Undefined 1 - 250, 2 - 280, 3 - 315, 4 - 350, 5 - 400, 6 - 450, 7 - 500, 8 - 560, 9 - 605, 10 - 610, 11 - 615, 12 - 630, 13 - 720, 14 - 768, 15 - 776, 16 - 784, 17 - 800, 18 - 900, 19 - 960, 20 - 970, 21 - 980, 22 - 1000,	23 - 1125, 24 - 1196, 25 - 1210, 26 - 1225, 27 - 1250, 28 - 1280, 29 - 1440, 30 - 1536, 31 - 1552, 32 - 1568, 33 - 1600, 34 - 1800, 35 - 1920, 36 - 1940, 37 - 1960, 38 - 2000, 39 - 2250, 40 - 2400, 41 - 2425, 42 - 2450, 43 - 2500, 44 - 2560,	45 - 2880, 46 - 3072, 47 - 3104, 48 - 3136, 49 - 3200, 50 - 3840, 51 - 3880, 52 - 3920, 53 - 4000, 54 - 4800, 55 - 4850, 56 - 4900, 57 - 5000, 58 - 6144, 59 - 6208, 60 - 6272, 61 - 6400, 62 - 160, 63 - 180, 64 - 380, 65 - 385, 66 - 390	Applicable only for GTU ACB IEC trip unit. Sets the breaker rating. Refer to Appendix A: GTU Nomenclaturefor valid combinations
206	40207	Neutral Pole Construction	0 - OFF 1 - 50%	2 - 63% 3 - 100%		Sets Neutral Pole protection as a fraction of the Long Time Pickup
207	40208	ZSI Combination	0 1 - GF 2 - GF&ST	3- ST 4- Instantaneous 5 - GF & Inst	6 - ST & Inst 7 - GF & ST & Inst	
208	40209	PT Primary Voltage	120 - 700			
209	40210	PT Connection	0 - Ph-N 1 - Ph-Ph			
210	40211	Password Protection	0 to 20 15 – Enable Switchable GF	16 - Lock 19 – Unlock/ Disable SW GF		
211	40212	Modbus Slave Address	8 bit value 1 to 247			
212	40213	Profibus Slave Address	8 bit value 1 to 126			
213	40214	Communication Setting	0 - 300-8N2 1 - 600-8N2 2 - 1200-8N2 3 - 2400-8N2 4 - 4800-8N2 5 - 9600-8N2 6 - 19200-8N2 7 - 300-8O1 8 - 600-8O1 9 - 1200-8O1	10 - 2400-8O1 11 - 4800-8O1 12 - 9600-8O1 13 - 19200-8O1 14 - 300-8E1 15 - 600-8E1 16 - 1200-8E1 17 - 2400-8E1 18 - 4800-8E1	19 - 9600-8E1 20 - 19200-8E1 21 - // 300-8N1 22 - // 600-8N1 23 - // 1200-8N1 24 - // 2400-8N1 25 - // 4800-8N1 26 - // 9600-8N1 27 - // 19200-8N1	
215	40216	Long Time Trip Pickup	1 - 0.5 2- 0.55 3- 0.6 4- 0.65 5- 0.7	6-0.75 7-0.8 8-0.85 9 - 9 10 -9.5	11 - 1.0 12 - 0.4 (Model 17 and 40 only) 13 - 0.45 (Model 17 and 40 only)	

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
216	40217	Long Time Trip Delay	I^2t – 22 bands I^4t – 44 bands IEC curves – 13 bands	Cmin – Cmax Cmin – Fmax Cmin - Cmax		For GTU ACB I and Euro refer to Appendix for valid combinations. For GTU C and D if LT Curve Selection is I^2t Bands 1-19 are selectable. If LT Curve Selection is I^4t 1-19 & 23-44 are selectable, Setting 0(Off) only available if LT is switchable.
217	40218	Long Time Cooling Constant	0 - goes to 0 1 - 12 min. cooling			
218	40219	LT Curve Selection	0- I^2t 1-I^4t 2-SI (IEC) 3-VI (IEC) 4-EI (IEC) 5-CDLY (IEC)			
219	40220	Protective Relay Trip Enable	0 – OFF 1 – ON	Alarm Only Trip		ON – Trip, alarm, digital I/O trigger OFF – Alarm and Digital I/O only.
220	40221	Frequency	0 - 50Hz	1 - 60Hz		
221	40222	Earth Fault Type	0 - Off 1 - UEF 2 - UEF + REF	3 - UEF + SEF 4 - REF + SEF	5 - UEF + REF + SEF	
222	40223	Short Time Trip Pickup	1 - 1.5 2- 2.0 3- 2.5 4- 3.0 5- 3.5 6- 4.0 7- 4.5 8- 5.0	9- 5.5 10- 6.0 11- 6.5 12 - 7.0 13- 7.5 14- 8.0 15- 8.5	16- 9.0 17- 9.5 18- 10 19 - 10.5 20 - 11 21 - 11.5 22 - 12	
223	40224	Short Time Trip Delay	0 - Off 1- Band1 2- Band2 3- Band3 4- Band4 5- Band5	6- Band6 7- Band7 8- Band8 9- Band9 10- Band10 11- Band11	12- Band12 13- Band13 14- Band14 15 - Band 15 16 - Band 16 17 - Band 17	
224	40225	Short Time Kst	0 - 0 1 - 2	2 - 8 3 - 18		Sets Slope value for short time protection; Setting 0(OFF) Sets I^2t OUT;If LT delay is Fuse type(Delay band >22) then Kst is always OFF
225	40226	Instantaneous Trip Pickup	0- Off (For switchable Inst only) 1- Invalid 2- 2 3- 2.5 4- 3 5- 3.5 6- 4 7- 4.5 8- 5 9- 5.5 10- 6 11- 6.5 12- 7 13- 7.5	14- 8 15- 8.5 16- 9 17- 9.5 18- 10 19- 10.5 20- 11 21- 11.5 22- 12 23- 12.5 24- 13 25- 13.5 26- 14 27- 14.5 28- 15 29- 16	30- 17 31- 18 32- 19 33- 20 34- 21 35- 22 36- 23 37- 24 38- 25 39- 26 40- 27 41- 28 42- 29 43- 30	

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
226	40227	Reduced Instantane-ous Trip Pickup	1- 1.5 2- 2 3- 2.5 4- 3 5- 3.5 6- 4 7- 4.5 8- 5 9- 5.5 10- 6	11- 6.5 12- 7 13- 7.5 14- 8 15- 8.5 16- 9 17- 9.5 18- 10 19- 10.5 20- 11	21- 11.5 22- 12 23- 12.5 24- 13 25- 13.5 26- 14 27- 14.5 28- 15	
227	40228	GF CT Trip Pickup	1- 0.10 2- 0.11 3- 0.12 4- 0.13 5- 0.14 6- 0.15 7- 0.16 8- 0.17 9- 0.18 10- 0.19 11 - 0.20	12- 0.21 13- 0.22 14- 0.23 15- 0.24 16- 0.25 17 - 026 .... 78- 0.87 79- 0.88 80- 0.89 81- 0.90	82- 0.91 83- 0.92 84- 0.93 85- 0.94 86- 0.95 87- 0.96 88- 0.97 89- 0.98 90- 0.99 91- 1.00	LCD / MODBUS ANY IEC GTU 17 / 40 - 0.1 - 1.0 (IEC) NON IEC GTU D/C - 0.2 to 0.6 (sensor <=2000A) GTU D/C - 0.2 – 0.37 (sensor 2500 & 3200A) GTU D/C - 0.2 – 0.3 (sensor 4000A) GTU D/C - 0.2 – 0.24 (sensor 5000A) GTU D/C - 0.2 (6000 – 6400)
228	40229	GF CT Trip Delay	0 - Off 1 - Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11- Band11 12- Band12 13- Band13 14- Band14	
229	40230	GF CT Trip K Value	IEC/ANSI: 0 - OFF 1 - I^2t 2 2 - I^2t 4.4 3 - I^4t 19.8 UL: 0 - OFF 1 - I^2t 2 2 - I^2t 150, I^2t 3.2 3 - I^4t 4.9			
230	40231	GF CT Alarm Pickup	1- 0.10 2- 0.11 3- 0.12 4- 0.13 5- 0.14 6- 0.15 7- 0.16 8- 0.17 9- 0.18 10- 0.19 11 - 0.20	12- 0.21 13- 0.22 14- 0.23 15- 0.24 16- 0.25 17- 0.26 ... 78- 0.87 79- 0.88 80- 0.89 81 - 0.90	82- 0.91 83- 0.92 84- 0.93 85- 0.94 86- 0.95 87- 0.96 88- 0.97 89- 0.98 90- 0.99 91- 1.00	
231	40232	GF CT Alarm Delay	0 - Off 1 - Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11- Band11 12- Band12 13- Band13 14- Band14	Band 1 for GACB only

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
232	40233	GF CT Alarm K Value	IEC/ANSI: 0 - OFF 1 - I^2t 2 2 - I^2t 4.4 3 - I^4t 19.8 UL: 0 - OFF 1 - I^2t 2 2 - I^2t 150, I^2t 3.2 3 - I^4t 4.9			
233	40234	GF Sum Trip Pickup	1- 0.10 2- 0.11 3- 0.12 4- 0.13 5- 0.14 6- 0.15 7- 0.16 8- 0.17 9- 0.18 10- 0.19 11 - 0.20	12- 0.21 13- 0.22 14- 0.23 15- 0.24 16- 0.25 17 - 0.26 .... 78- 0.87 79- 0.88 80- 0.89 81 - 0.90	82- 0.91 83- 0.92 84- 0.93 85- 0.94 86- 0.95 87- 0.96 88- 0.97 89- 0.98 90- 0.99 91- 1.00	See Appendix for Settings Limits
234	40235	GF SumTrip Delay	0 - Off 1- Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11- Band11 12- Band12 13- Band13 14- Band14	Band 1 for GACB only
235	40236	GF Sum K Value	IEC/ANSI: 0 - OFF 1 - I^2t 2 2 - I^2t 4.4 3 - I^4t 19.8 UL: 0 - OFF 1 - I^2t 2 2 - I^2t 150, I^2t 3.2 3 - I^4t 4.9			
236	40237	GF Sum Alarm Pickup	1- 0.10 2- 0.11 3- 0.12 4- 0.13 5- 0.14 6- 0.15 7- 0.16 8- 0.17 9- 0.18 10- 0.19 11 - 0.20	12- 0.21 13- 0.22 14- 0.23 15- 0.24 16- 0.25 17- 0.26 ... 78- 0.87 79- 0.88 80- 0.89 81 - 0.90	82- 0.91 83- 0.92 84- 0.93 85- 0.94 86- 0.95 87- 0.96 88- 0.97 89- 0.98 90- 0.99 91- 1.00	See Appendix for Settings Limits
237	40238	GF Sum Alarm Delay	0 - Off 1 - Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11- Band11 12- Band12 13- Band13 14- Band14	Band 1 for GACB only

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
238	40239	GF Sum Alarm K Value	IEC/ANSI: 0 - OFF 1 - I^2t 2 2 - I^2t 4.4 3 - I^4t 19.8 UL: 0 - OFF 1 - I^2t 2 2 - I^2t 150, I^2t 3.2 3 - I^4t 4.9			
239	40240	UEF Pickup	1- 0.10 2- 0.11 3- 0.12	.... 89- 0.98	90- 0.99 91- 1.00	1 (0.1) only available with Aux Power UEF is an IEC-only function
240	40241	UEF Delay	0 - Off 1- Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11- Band11 12- Band12 13- Band13 14- Band14	When UEF is used in combination with REF, SEF, or SEF and REF, it cannot be switched OFF
241	40242	UEF K	0 - 0 1 - I^2t 2	2 - I^2t 4.4 3 - I^4t 19.8		
242	40243	SEF Pickup	1- 0.10 2- 0.11 3- 0.12	.... 89- 0.98	90- 0.99 91- 1.00	1 (0.1) only available with Aux Power. The SEF Pickup must be greater than UEF Pickup Setting. IEC Only
243	40244	SEF Delay	0 - Off 1- Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11- Band11 12- Band12 13- Band13 14- Band14	The SEF Delay must be at least 0.1 second greater than UEF delay setting
244	40245	SEF K	0 - 0 1 - I^2t 2	2 - I^2t 4.4 3 - I^4t 19.8		
245	40246	REF Pickup	1- 0.10 2- 0.11 3- 0.12	.... 89- 0.98	90- 0.99 91- 1.00	1 (0.1) only available with Aux Power REF is an IEC-only function.
246	40247	REF Delay	0 - OFF	1 - Fixed 130ms delay		
247	40248	Timeout Metering	0 - No 1 – Yes			If lcd screen is left at Metering, will go to Home Menu after 5 minutes
258	40259	Over Voltage Pickup	1- 110 2- 111 3-112 4- 113 5-114 6- 115 7-116 8- 117 9- 118 10- 119 11 - 120 12- 121 13- 122 14- 123	15- 124 16- 125 17- 126 18- 127 19- 128 20-129 21- 130 22- 131 23-132 24- 133 25-134 26- 135 27-136 28- 137	29- 138 30- 139 31 - 140 32- 141 33- 142 34- 143 35- 144 36- 145 37- 146 38- 147 39- 148 40-149 41- 150	
259	40260	Over Voltage Delay	0 - Off 1- 1 2- 2 3- 3 4- 4 5- 5	6- 6 7- 7 8- 8 9- 9 10- 10	11- 11 12- 12 13- 13 14 - 14 15 - 15	

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
260	40261	Under Voltage Pickup	1- 50 2- 51 3-52 4- 53 5-54 6- 55 7-56 8- 57 9- 58 10- 59 11 - 60 12- 61 13- 62 14- 63	15- 64 16- 65 17- 66 18- 67 19- 68 20-69 21- 70 22- 71 23-72 24- 73 25-74 26- 75 27-76 28- 77	29- 78 30- 79 31 – 80 32- 81 33- 82 34- 83 35- 84 36- 85 37- 86 38- 87 39- 88 40-89 41- 90	
261	40262	Under Voltage Delay	0 – Off 1- 1 2- 2 3- 3 4- 4 5- 5	6- 6 7- 7 8- 8 9- 9 10- 10	11- 11 12- 12 13- 13 14 - 14 15 - 15 C22	
262	40263	Under Voltage Zero-Volt Trip Enable	0 - Disable 1 – Enable			
263	40264	Voltage Unbalance Pickup	1- 10 2- 11 3-12 4- 13 5-14 6- 15 7-16 8- 17 9- 18 10- 19 11 - 20 12- 21 13- 22 14- 23	15- 24 16- 25 17- 26 18- 27 19- 28 20-29 21- 30 22- 31 23-32 24- 33 25-34 26- 35 27-36 28- 37	29- 38 30- 39 31 - 40 32- 41 33- 42 34- 43 35- 44 36- 45 37- 46 38- 47 39- 48 40-49 41- 50	
264	40265	Voltage Unbalance Delay	0 - Off 1- 1 2- 2 3- 3 4- 4 5- 5	6- 6 7- 7 8- 8 9- 9 10- 10	11- 11 12- 12 13- 13 14-14 15-15	
265	40266	Current Unbalance Pickup	1- 10 2- 11 3-12 4- 13 5-14 6- 15 7-16 8- 17 9- 18 10- 19 11 - 20 12- 21 13- 22 14- 23	15- 24 16- 25 17- 26 18- 27 19- 28 20-29 21- 30 22- 31 23-32 24- 33 25-34 26- 35 27-36 28- 37	29- 38 30- 39 31 - 40 32- 41 33- 42 34- 43 35- 44 36- 45 37- 46 38- 47 39- 48 40-49 41- 50	

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
266	40267	Current Unbalance Delay	0 - Off 1- 1 2- 2 3- 3 4- 4 5- 5	6- 6 7- 7 8- 8 9- 9 10- 10 11- 11	12- 12 13- 13 14-14 15-15	
267	40268	Power Reversal Pickup	1- 10 2- 20 3-30 4- 40 5-50 6- 60 7- 70 8- 80 9- 90 10- 100 11 - 110 12-120 13- 130 14-140 15- 150 16- 160 17- 170 18- 180 19- 190 20-200 21- 210 22- 220 23- 230 24-240 25- 250 26- 260 27- 270 28- 280 29- 290 30-300 31- 310 32- 320 33-330	34- 340 35- 350 36- 360 37- 370 38- 380 39- 390 40- 400 41- 410 42- 420 43- 430 44- 440 45- 450 46- 460 47- 470 48- 480 49- 490 50-500 51- 510 52- 520 53- 530 54-540 55- 550 56- 560 57- 570 58- 580 59- 590 60-600 61- 610 62- 620 63-630 64- 640 65-650 66- 660	67- 670 68- 680 69- 690 70- 700 71 - 710 72-720 73- 730 74-740 75- 750 76- 760 77- 770 78- 780 79- 790 80-800 81- 810 82- 820 83- 830 84-840 85- 850 86- 860 87- 870 88- 880 89- 890 90-900 91- 910 92- 920 93-930 94- 940 95-950 96- 960 97- 970 98- 980 99- 990	
268	40269	Power Reversal Delay	0 - Off 1- 1 2- 2 3- 3 4- 4 5- 5	6- 6 7- 7 8- 8 9- 9 10- 10	11- 11 12- 12 13- 13 14-14 15-15	
269	40270	Power Direction Setting	0 - Line to Load 1 - Load to Line			
270	40271	Power Demand Interval	1 - 5 2 - 10 3 - 15	4 - 20 5 - 15	.. 12 – 60	
271	40272	Relay1 (Output1) Function	1 - Group 1 2 - Group 2 3 - Group 3 4 - Group 4	5 - Group 5 6 - Group 6 7 - Group 7 8 - Group 8	9 - Group 9 10 - Group 10 11 - Group 11	If RELT is optioned, Output 1 will assigned to Group 7 permanently.
272	40273	Relay2 (Output2) Function	1 - Group 1 2 - Group 2 3 - Group 3 4 - Group 4	5 - Group 5 6 - Group 6 7 - Group 7 8 - Group 8	9 - Group 9 10 - Group 10 11 - Group 11	

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
273	40274	Relay3 (Output3) Function	1 - Group 1 2 - Group 2 3 - Group 3 4 - Group 4	5 - Group 5 6 - Group 6 7 - Group 7 8 - Group 8	9 - Group 9 10 - Group 10 11 - Group 11	GTU 40 Only (IEC Version)
274	40275	Relay4 (Output4) Function	1 - Group 1 2 - Group 2 3 - Group 3 4 - Group 4	5 - Group 5 6 - Group 6 7 - Group 7 8 - Group 8	9 - Group 9 10 - Group 10 11 - Group 11	GTU 40 Only (IEC Version)
275	40276	Input 1 Function	0 - None 2 - Reduce Instantaneous		3 - Reset Relays	If RELT is optioned, Input 1 will be assigned to RELT permanently.
276	40277	Input 2 Function	0 - None 1 - Trip Breaker	2 - NA 3 - Reset Relays		
277	40278	Input 3 Function	0 - None 1 - Trip Breaker	2 - NA 3 - Reset Relays		GTU 40 Only (IEC Version)
278	40279	Input 4 Function	0 - None 1 - Trip Breaker	2 - NA 3 - Reset Relays		GTU 40 Only (IEC Version)
285	40286	Waveform Capture	0 - Disable 1 - Manual 2 - Over Current	3 - Protection Relays 4 - Current Alarm 1	5 - Current Alarm 2 6 - All	
286	40287	Language	0 - English 1 - French	2 - Spanish 3 - German	4 - Chinese	
287	40288	Time Sync Year	8 bit			Date and time values are pre-loaded for some point in the future in registers 287 – 293. At the date and time entered in those registers, command 103 is sent to the device, which updates the device's current date/time settings with the new settings.
288	40289	Time Sync Month	8 bit			
289	40290	Time Sync Date	8 bit			
291	40292	Time Sync Hour	8 bit			
292	40293	Time Sync Minute	8 bit			
293	40294	Time Sync Second	8 bit			
294	40295	Health status output type	0 - NC 1 - NO			
295	40296	HSI Output Polarity				
296	40297	Current Alarm 1 Pickup On	1 - 0.5 2 - 0.55 3 - 0.60 4 - 0.65	5 - 0.70 6 - 0.75 7 - 0.80 8 - 0.85	9 - 0.90 10 - 0.95 11 - 1.00	
297	40298	Current Alarm 1 Pickup Off	1 - 0.5 2 - 0.55 3 - 0.60 4 - 0.65	5 - 0.70 6 - 0.75 7 - 0.80 8 - 0.85	9 - 0.90 10 - 0.95 11 - 1.00	
298	40299	Current Alarm 2 Pickup On	1 - 0.5 2 - 0.55 3 - 0.60 4 - 0.65	5 - 0.70 6 - 0.75 7 - 0.80 8 - 0.85	9 - 0.90 10 - 0.95 11 - 1.00	
299	40300	Current Alarm 2 Pickup Off	1 - 0.5 2 - 0.55 3 - 0.60 4 - 0.65	5 - 0.70 6 - 0.75 7 - 0.80 8 - 0.85	9 - 0.90 10 - 0.95 11 - 1.00	

Register Address	Modicon Address	Variable Name	Allowable Values			Notes
300	40301	Bell Alarm (Bell Alarm 1)	0 - Disabled 1 - Shunt Trip 2 - UVR Trip 3 - Over Current Trip 4 - Protective Relay Trip 5 - Shunt, UVR 6 - Shunt, Over Current	7 - Shunt, Protective Relay 8 - UVR, Over Current 9 - UVR, Protective Relay 10 - Over Current, Protective Relay 11 - Shunt Trip, UVR, Over Current	12 - Shunt, UVR, Protective Relay 13 - Shunt, Over Current, Protective Relay 14 - UVR, Over Current, Protective Relay 15 - Shunt, UVR, Over Current, Protective Relay	
301	40302	Bell Alarm with lockout (Bell Alarm 2)	0 - Disabled 1 - Shunt Trip 2 - UVR Trip 3 - Over Current Trip 4 - Protective Relay Trip 5 - Shunt, UVR 6 - Shunt, Over Current	7 - Shunt, Protective Relay 8 - UVR, Over Current 9 - UVR, Protective Relay 10 - Over Current, Protective Relay 11 - Shunt Trip, UVR, Over Current	12 - Shunt, UVR, Protective Relay 13 - Shunt, Over Current, Protective Relay 14 - UVR, Over Current, Protective Relay 15 - Shunt, UVR, Over Current, Protective Relay	
302	40303	ZSI Short Time Delay Band	0 - OFF 1- Band1 2- Band2 3- Band3 4- Band4 5- Band5	6- Band6 7- Band7 8- Band8 9- Band9 10- Band10 11- Band11	12- Band12 13- Band13 14- Band14 15 - Band 15 16 - Band 16 17 - Band 17	Bands 12-17 are available for IEC only.
303	40304	ZSI Short Time Kst	0 - 0 1 - 2	2 - 8 3 - 18		
304	40305	ZSI GF Trip Delay	0 - OFF 1 - Band1 2- Band2 3- Band3 4- Band4	5- Band5 6- Band6 7- Band7 8- Band8 9- Band9	10- Band10 11 - Band 11 12-Band 12 13-Band13 14-Band14	
305	40306	ZSI GF Trip K Value	0 - 0 1 - I^2t 2	2 - I^2t 3 3 - I^4t 18		Can set a value of 3 only if I^4t is enabled
312	40313	Reduced Instantaneous Let Through (RELT)	0 – OFF 1 – ON	Disengage Engage		
313	40314	LCDBrigthness	20 -40			Adjust LCD brightness.
350	40351	Trip Unit Name				User Assignable trip unit name stored as packed 8 bit ASCII text (2 characters per register)
351	40352	Trip Unit Name				
352	40353	Trip Unit Name				
353	40354	Trip Unit Name				
354	40355	Trip Unit Name				
600	40601	User Programmable 600 - 619	0 - 1023			These registers are useful for grouping Input register data into a contiguous data block. This reduces the number of Modbus queries necessary to retrieve data that is spread across multiple registers. To use the feature write the address of the Input Register addresses you want to group into these registers.
601	40602					
602	40603					
603	40604					
604	40605					
605	40606					
606	40607					

Register Address	Modicon Address	Variable Name	Allowable Values	Notes
607	40608			Once written, use Function Code 04 to retrieve the values. Example: Program the values 18 into register 600. Program the values 21 and 22 into 601 and 602. Program 36 into register 603. Using Function code 04, retrieve Volts, Amps, and Power Factor for phase A by requesting four registers starting with 600.
608	40609			
609	40610			
610	40611			
611	40612			
612	40613			
613	40614			
614	40615			
615	40616			
616	40617			
617	40618			
618	40619			
619	40620			
620	40621	User Programm-able 620 - 639	0 - 1023	These registers are useful for grouping Discrete I/O data into a contiguous data block. This reduces the number of Modbus queries necessary to retrieve data that is spread across multiple registers. To use the feature write the address of the Discrete I/O registers you want to group into these registers. Once written, use Function Code 04 to retrieve the Discrete I/O values.
621	40622			
622	40623			
623	40624			
624	40625			
625	40626			
626	40627			
627	40628			
628	40629			
629	40630			
630	40631			
631	40632			
632	40633			
633	40634			
634	40635			
635	40636			
636	40637			
637	40638			
638	40639			
639	40640			

Table C-2: Inputs from GTU

Register Address	Modicon Address	Description	Range
14	30015	Power Peak Demand Total - Lo 32 bits	Combine registers to create a single 32 bit raw value. Divide the Raw 32 bit value by 10 for the scaled value.
15	30016	Power Peak Demand Total - Hi 32 bits	
16	30017	Power Flow Direction (Actual)	0 = Line to Load, 1 = Load to Line
18	30019	Voltage Phase A	16 bit, Scaling 1:1
19	30020	Voltage Phase B	16 bit, Scaling 1:1
20	30021	Voltage Phase C	16 bit, Scaling 1:1
21	30022	Current Phase A (LO 16 bits)	32 bit, Scaling 1:1
22	30023	Current Phase A (HI 16 bits)	32 bit, Scaling 1:1
23	30024	Current Phase B (LO 16 bits)	32 bit, Scaling 1:1
24	30025	Current Phase B (HI 16 bits)	32 bit, Scaling 1:1
25	30026	Current Phase C (LO 16 bits)	32 bit, Scaling 1:1
26	30027	Current Phase C (HI 16 bits)	32 bit, Scaling 1:1
27	30028	Current Phase N (LO 16 bits)	32 bit, Scaling 1:1
28	30029	Current Phase N (HI 16 bits)	32 bit, Scaling 1:1

Register Address	Modicon Address	Description	Range
29	30030	Rating Plug Value	0 - 0, 1 - 150, 2 - 200, 3 - 225, 4 - 250, 300, 350, 400, 450, 500, 600, 630, 700, 800, 900, 1000, 1100, 1200, 1250, 1500, 1600, 1900, 2000, 2200, 2400, 2500, 3000, 3200, 3600, 4000, 5000, 6000, 100, 750, 3500, 4500, 6400, 60, 80
30	30031	Energy Rollover Count load to Line	Multiply value by 1000MWH and add to Energy Load to Line for a total.
31	30032	Energy Line to Load (0-15 bits)	32 bit value of Energy Line to Load. Divide Raw value by 10 to yield energy in kWH. Rolls over above 990MWH.
32	30033	Energy Line to Load (16-31 bits)	
33	30034	Energy Load to Line (0-15 bits)	32 bit value of Energy Load to Line. Divide Raw value by 10 to yield energy in kWH. Rolls over above 990MWH.
34	30035	Energy Load to Line (16-31 bits)	
35	30036	Energy Rollover Count Line to Load	Multiply value by 1000MWH and add to Energy Line to Load for a total.
36	30037	Power Factor Phase A	16 bit
37	30038	Power Factor Phase B	16 bit
38	30039	Power Factor Phase C	16 bit
39	30040	Power Factor Total	16 bit
40	30041	Power Real Phase A - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
41	30042	Power Real Phase A - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
42	30043	Power Real Phase B - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
43	30044	Power Real Phase B - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
44	30045	Power Real Phase C - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
45	30046	Power Real Phase C - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
46	30047	Power Real Phase Total - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
47	30048	Power Real Phase Total - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
48	30049	Power Reactive Phase A - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
49	30050	Power Reactive Phase A - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
50	30051	Power Reactive Phase B - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
51	30052	Power Reactive Phase B - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
52	30053	Power Reactive Phase C - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
53	30054	Power Reactive Phase C - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
54	30055	Power Reactive Phase Total - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
55	30056	Power Reactive Phase Total - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
56	30057	Power Apparent Phase A - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
57	30058	Power Apparent Phase A - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
58	30059	Power Apparent Phase B - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
59	30060	Power Apparent Phase B - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
60	30061	Power Apparent Phase C - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
61	30062	Power Apparent Phase C - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
62	30063	Power Apparent Phase Total - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
63	30064	Power Apparent Phase Total - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
64	30065	Power Demand Total - Lo 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
65	30066	Power Demand Total - Hi 16 bits	32 bit (Divide value by 10 to get KW) Scaled value: 32 bit value/10
66	30067	Frequency Measured	16 bit

Register Address	Modicon Address	Description	Range
67	30068	Event 1	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
68	30069	Year	8 bit
69	30070	Month	8 bit
70	30071	Date	8 bit
71	30072	Hour	8 bit
72	30073	Minute	8 bit
73	30074	Second	8 bit
74	30075	Phase	8 bit
75	30076	Event Specific - Low 16 bits	16 bit
76	30077	Event Specific - Hi 16 bits	16 bit
77	30078	Event 2	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
78	30079	Year	8 bit
79	30080	Month	8 bit
80	30081	Date	8 bit
81	30082	Hour	8 bit
82	30083	Minute	8 bit
83	30084	Second	8 bit
84	30085	Phase	8 bit
85	30086	Event Specific - Low 16 bits	16 bit
86	30087	Event Specific - Hi 16 bits	16 bit
87	30088	Event 3	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
88	30089	Year	8 bit
89	30090	Month	8 bit
90	30091	Date	8 bit

Register Address	Modicon Address	Description	Range
91	30092	Hour	8 bit
92	30093	Minute	8 bit
93	30094	Second	8 bit
94	30095	Phase	8 bit
95	30096	Event Specific - Low 16 bits	16 bit
96	30097	Event Specific - Hi 16 bits	16 bit
97	30098	Event 4	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
98	30099	Year	8 bit
99	30100	Month	8 bit
100	30101	Date	8 bit
101	30102	Hour	8 bit
102	30103	Minute	8 bit
103	30104	Second	8 bit
104	30105	Phase	8 bit
105	30106	Event Specific - Low 16 bits	16 bit
106	30107	Event Specific - Hi 16 bits	16 bit
107	30108	Event 5	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
108	30109	Year	8 bit
109	30110	Month	8 bit
110	30111	Date	8 bit
111	30112	Hour	8 bit
112	30113	Minute	8 bit
113	30114	Second	8 bit
114	30115	Phase	8 bit
115	30116	Event Specific - Low 16 bits	16 bit
116	30117	Event Specific - Hi 16 bits	16 bit

Register Address	Modicon Address	Description	Range
117	30118	Event 6	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
118	30119	Year	8 bit
119	30120	Month	8 bit
120	30121	Date	8 bit
121	30122	Hour	8 bit
122	30123	Minute	8 bit
123	30124	Second	8 bit
124	30125	Phase	8 bit
125	30126	Event Specific - Low 16 bits	16 bit
126	30127	Event Specific - Hi 16 bits	16 bit
127	30128	Event 7	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 - Overvoltage trip 11 - Undervoltage Release 1 Trip 12 - Undervoltage Release 2 Trip 13 - Shunt 1 Trip 14 - Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
128	30129	Year	8 bit
129	30130	Month	8 bit
130	30131	Date	8 bit
131	30132	Hour	8 bit
132	30133	Minute	8 bit
133	30134	Second	8 bit
134	30135	Phase	8 bit
135	30136	Event Specific - Low 16 bits	16 bit
136	30137	Event Specific - Hi 16 bits	16 bit
137	30138	Event 8	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
138	30139	Year	8 bit
139	30140	Month	8 bit
140	30141	Date	8 bit

Register Address	Modicon Address	Description	Range
141	30142	Hour	8 bit
142	30143	Minute	8 bit
143	30144	Second	8 bit
144	30145	Phase	8 bit
145	30146	Event Specific - Low 16 bits	16 bit
146	30147	Event Specific - Hi 16 bits	16 bit
147	30148	Event 9	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
148	30149	Year	8 bit
149	30150	Month	8 bit
150	30151	Date	8 bit
151	30152	Hour	8 bit
152	30153	Minute	8 bit
153	30154	Second	8 bit
154	30155	Phase	8 bit
155	30156	Event Specific - Low 16 bits	16 bit
156	30157	Event Specific - Hi 16 bits	16 bit
157	30158	Event 10	0 - No Event 1 - Long Time Trip 2 - Short Time Trip 3 - Instantaneous Trip 4 - Ground Fault Sum Trip 5 - Ground Fault CT Trip 6 - Power Reversal Trip 7 - Voltage Unbalance Trip 8 - Under Voltage Trip 9 - Current unbalance trip 10 -Overvoltage trip 11 -Undervoltage Release 1 Trip 12 -Undervoltage Release 2 Trip 13 -Shunt 1 Trip 14 -Shunt 2 Trip 15 - Comms Fail 17 – BIM Serial Mismatch 18 – UEF Trip 19 – REF Trip 20 – SEF Trip 21 - CURRENT ALM 1 22 – CURRENT ALM 2 23 – GF SUM ALARM 24 – GF CT ALARM
158	30159	Year	8 bit
159	30160	Month	8 bit
160	30161	Date	8 bit
161	30162	Hour	8 bit
162	30163	Minute	8 bit
163	30164	Second	8 bit
164	30165	Phase	8 bit
165	30166	Event Specific - Low 16 bits	16 bit
166	30167	Event Specific - Hi 16 bits	16 bit
167	30168	Long Time Trip Count	16 bit
168	30169	Short Time Trip Count	16 bit
169	30170	Instantaneous Trip Count	16 bit
170	30171	Ground Fault Sum Trip Count	16 bit
172	30173	Power Reversal Trip Count	16 bit
173	30174	Voltage Unbalance Trip Count	16 bit
174	30175	Under Voltage Trip Count	16 bit
175	30176	Current unbalance Trip Count	16 bit
176	30177	Overvoltage trip Count	16 bit

Register Address	Modicon Address	Description	Range
177	30178	Undervoltage Release 1 Trip Count	16 bit
178	30179	Undervoltage Release 2 Trip Count	16 bit
179	30180	Shunt 1 Trip Count	16 bit
180	30181	Shunt 2 Trip Count	16 bit
181	30182	Total Trip Count	16 bit
195	30196	GF CT Trip Count	8 bit
198	30199	GTU in Diagnostic Mode	0 - No 1 - Yes
227	30228	Breaker Position	1 - CLOSE 0 - OPEN
228	30229	Error Code log – Note that all Error Code registers should be read with a single query.	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
229	30230	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
230	30231	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
231	30232	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
232	30233	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
233	30234	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
234	30235	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
235	30236	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
236	30237	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
237	30238	Error Code log	00 - No Error 02 - BIM Error 03 - Data Flash R/W 05 - EEPROM Malfunction 08 - Incorrect Rating Plug
238	30239	Error Counter	1 to 10
239	30240	Long Time pickup state	0 - Not in Pickup 1 - Near Pickup 2 - In Pickup
240	30241	Event Counter Index	
241	30242	Software Rev byte 1	16 bytes packed ASCII text (2 ASCII characters per register)
242	30243	Software Rev byte 2	Software revision format: MM.00.mm
243	30244	Software Rev byte 3	MM = Major Revision
244	30245	Software Rev byte 4	mm = minor revision
245	30246	Software Rev byte 5	Example: 08.00.27
246	30247	Software Rev byte 6	Undefined bytes are loaded by option dispenser with pad values.
247	30248	Software Rev byte 7	
248	30249	Software Rev byte 8	
249	30250	UEF Time Trip Count	16 bit
250	30251	REF Time Trip Count	16 bit
251	30252	SEF Time Trip Count	16 bit
252	30253	Current Alarm1 Count	16 bit
253	30254	Current Alarm2 Count	16 bit
254	30255	GF SUM Alarm Count	16 bit
255	30256	GF CT Alarm Count	16 bit

Register Address	Modicon Address	Description	Range
392	30393	Breaker Opening Time Location 1	16 bit value. Divide by 10 to determine opening time in milliseconds.
393	30394	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
394	30395	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
395	30396	Breaker Opening Time Location 2	16 bit value. Divide by 10 to determine opening time in milliseconds.
396	30397	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
397	30398	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
398	30399	Breaker Opening Time Location 3	16 bit value. Divide by 10 to determine opening time in milliseconds.
399	30400	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
400	30401	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
401	30402	Breaker Opening Time Location 4	16 bit value. Divide by 10 to determine opening time in milliseconds.
402	30403	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
403	30404	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
404	30405	Breaker Opening Time Location 5	16 bit value. Divide by 10 to determine opening time in milliseconds.
405	30406	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
406	30407	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
407	30408	Breaker Opening Time Location 6	16 bit value. Divide by 10 to determine opening time in milliseconds.
408	30409	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
409	30410	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
410	30411	Breaker Opening Time Location 7	16 bit value. Divide by 10 to determine opening time in milliseconds.
411	30412	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
412	30413	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
413	30414	Breaker Opening Time Location 8	16 bit value. Divide by 10 to determine opening time in milliseconds.
414	30415	Event Specific Information	Fault measurement (Amps, Watts, Volts) limited to 65,000 max.
415	30416	Participating Phase	0 = NA, 1 = Phase A, 2 = Phase B, 3 = Phase C, 4 = Phase D (Neutral)
416	30417	Breaker opening time location index	Index of last opening time record. Value is zero if no timing measurements are available. NOTE: first three Time Locations stored are factory only. Remaining five Time Locations retain the last five operations of the breaker. The earliest record is the first to be overwritten with a new operation. The first three create the baseline timing of the breaker as new.
418	30419	General language code	0 - English 1 - French 2 - Spanish 3 - German 4 - Chinese 5- 6- Portuguese 7- Russian * some languages are optional

Table C-3: Commands

Register Address	Modicon Address	Parameter	Values
101	102	Save Settings	
103	104	Save Real Time Clock Registers to trip unit clock	
104	105	Read Real Time Clock Registers from trip unit	
105	106	Save EEPROM Data	
106	107	Clear Power Demand	1 - clear
108	109	Trip Breaker	0 - Reset 1 - Trip
110	111	Profibus Status	0 - Disable 1 - Enable
111	112	Fan State / Command Close Coil GTU C/D: Fan state EntelliGuard G: activate Command Close Accessory	0 - Off 1 - On
112	113	Relay 1 state (GTU C/D, EntelliGuard G, MPRO 50)	0 - Off 1 - On
113	114	Relay 2 state (EntelliGuard G, MPRO 50)	0 - Off 1 - On
114	115	Relay 3 state (MPRO 50)	0 - Off 1 - On
115	116	Relay 4 state (MPRO 50)	0 - Off 1 - On
116	117	Clear All Events	1 - Clear
117	118	Clear EEPROM	1 - Clear
118	119	Clear Energy Total	1 - Clear
119	120	Clear All Trip Counters	1 - Clear
120	121	Clear LT Trip Counter	1 - Clear
122	123	Clear Short Time Trip Count	1 - Clear
123	124	Clear Instantaneous Trip Count	1 - Clear
124	125	Clear Ground Sum and Ground Fault CT Trip Counts	1 - Clear
126	127	Clear Power Reversal Trip Count	1 - Clear
127	128	Clear Voltage Unbalance Trip Count	1 - Clear
128	129	Clear Under Voltage Trip Count	1 - Clear
129	130	Clear Current unbalance Trip Count	1 - Clear
130	131	Clear Overvoltage trip Count	1 - Clear
131	132	Clear Undervoltage Release 1 Trip Count	1 - Clear
132	133	Clear Undervoltage Release 2 Trip Count	1 - Clear
133	134	Clear Shunt 1 Trip Count	1 - Clear
134	135	Clear Shunt 2 Trip Count	1 - Clear
143	144	Trigger Waveform Capture	1 - Trigger
144	145	Clear Waveform Capture Data Buffer	1 - Clear
158	159	Save Trip Unit Custom Name Details	1 - Save
159	160	Clear Trip Unit Custom Name Details	1 - Clear
160	161	Control ZSI Output	1 – ZSI Output ON 0 - ZSI Output OFF
161	162	Clear UEF Trip Counter	1 - Clear
162	163	Clear REF Trip Counter	1 - Clear
163	164	Clear SEF Trip Counter	1 - Clear
164	165	Clear Current Alarm 1 Counter	1 - Clear
165	166	Clear Current Alarm 2 Counter	1 - Clear
166	167	Clear GF Sum Alarm Counter	1 - Clear
167	168	Clear GF CT Alarm Counter	1 - Clear

Table C-4: Discrete Inputs from GTU

Register Address	Modicon Address	Parameter	Value
0	10001	Long time pickup state	0 – OUT 1 - in
1	10002	Short time pickup state	0 – OUT 1 - in
2	10003	GF Sum Pickup state	0 – OUT 1 - in
3	10004	ZSI Input Active	0 – OFF 1 - ON
4	10005	ZSI Output Active	0 – OFF 1 - ON
5	10006	Relay 1 Status	0 – OFF 1 - ON
6	10007	Relay 2 Status	0 – OFF 1 - ON
7	10008	Relay 3 Status (MPRO only)	0 – OFF 1 - ON
8	10009	Relay 4 Status (MPRO only)	0 – OFF 1 - ON
9	10010	Input 1 Status	0 – OFF 1 - ON
10	10011	Input 2 Status	0 – OFF 1 - ON
11	10012	Input 3 Status (MPRO only)	0 – OFF 1 - ON
12	10013	Input 4 Status (MPRO only)	0 – OFF 1 - ON
15	10016	Shunt 1 Trip status	0 – OFF 1 - ON
16	10017	Shunt 2 Trip Status	0 – OFF 1 - ON
17	10018	UVR 1 Trip Status	0 – OFF 1 - ON
18	10019	UVR 2 Trip Status	0 – OFF 1 - ON
21	10022	Voltage Unbalance Status	0 - Normal 1 - Pickup
22	10023	Under Voltage Status	0 - Normal 1 - Pickup
23	10024	Over Voltage Status	0 - Normal 1 - Pickup
24	10025	Current Unbalance Status	0 - Normal 1 - Pickup
25	10026	Power Reversal Status	0 - Normal 1 - Pickup
27	10028	Breaker position	0 – Open 1 - Closed
28	10029	Breaker Ready to close	0 – OFF 1 - ON
29	10030	Spring Charge	0 – OFF 1 - ON
37	10038	SEF Pickup	0 – OUT 1 - in
38	10039	UEF Pickup	0 – OUT 1 - in
39	10040	REF Pickup	0 – OUT 1 - in
51	10052	GTU Tripped	0 – No 1 - Yes
54	10055	WFC Data Available	0 – No 1 - Yes
55	10056	GF CT Status	0 - Normal 1 - Pickup
56	10057	Voltage Unbalance Alarm Status	0 - Normal 1 - Alarm
57	10058	Under Voltage Alarm Status	0 - Normal 1 - Alarm
58	10059	Over Voltage Alarm Status	0 - Normal 1 - Alarm
59	10060	Current Unbalance Alarm Status	0 - Normal 1 - Alarm
60	10061	Power Reversal Alarm Status	0 - Normal 1 - Alarm
61	10062	GF Sum Alarm Status	0 - Normal 1 - Alarm
62	10063	GF CT Alarm Status	0 - Normal 1 - Alarm
63	10064	Current Alarm 1 Status	0 - Normal 1 - Alarm
64	10065	Current Alarm 2 Status	0 - Normal 1 - Alarm
65	10066	RELT Status	0 – OFF 1 - ON

APPENDIX D: GTU COORDINATION CURVE SETTINGS COMPARISON

NOTICE

These settings approximate settings on previous generation trip units. It is recommended to evaluate each breaker on a case by case basis to determine if alternate settings provide improved coordination and protection versus the approximate settings listed below.

ST Band Comparisons have been developed not to exceed max clearing time of other trip units to maintain or lower arc flash hazard values.

Table D-1: ST Band Comparisons

Trip Unit	Function	Setting	GTU Curves within Band	GTU Curve Best Approximating Max Clearing Time	Supporting TCC
MVT / MVT PM / MVT+	LT Pickup - MVT	0.5-1.1 in 0.05 increments	LT Pickup Values may be set according to old setting		
& Power+	LT Pickup - Power+	0.5, .6, .7, .8, .9, .95, 1, 1.1	LT Pickup Values may be set according to old setting		
(LSIG)	LT Delay	1	C4, C5	C5	MVT LT 1.pdf
	LT Delay	2	C6, C7, C8	C7	MVT LT 2.pdf
See Publications	LT Delay	3	C10, C11, C12, C13	C12	MVT LT 3.pdf
GES-9865	LT Delay	4	C15, C16, C17, C18	C18	MVT LT 4.pdf
GES-9863	ST Pickup - MVT	1.5 - 9.0 in 0.5 increments	ST Pickup Values may be set according to old setting		
DES-001B	ST Pickup - Power+	1.5, 2, 2.5, 3, 4, 5, 7, 9	ST Pickup Values may be set according to old setting		
DES-002B	ST Delay	1 (Min)	Bands 5, 6, 7	Band 6	MVT ST 1(Min).pdf
	ST Delay	2 (Int)	Bands 8, 9	Band 9	MVT ST 2(Int).pdf
	ST Delay	3 (Max)	Bands 10, 11	Band 11	MVT ST 3(Max).pdf
	ST I^2t	Out / Off	ST Slope = 0 (OFF)	ST Slope = 0 (OFF)	see above curves
	ST I^2t	In / On	ST Slope = 3 (Max)	ST Slope = 3 (Max)	MVT ST I2T.pdf
	Inst	Dependent on trip unit rating	Instantaneous Pickup Values may be set according to old setting		
	GF Pickup	Dependent on trip unit rating	GF Pickup Values may be set according to old setting		
	GF Delay	1 (Min)	Bands 3, 4	Band 4	MVT GF 1(Min).pdf
	GF Delay	2 (Int)	Band 7	Band 7	MVT GF 2(Int).pdf
	GF Delay	3 (Max)	Bands 8, 9	Band 9	MVT GF 3(Max).pdf
	GF I^2t	Out / Off	GF Slope = 0 (OFF)	ST Slope = 0 (OFF)	see above curves
	GF I^2t	In / On	GF Slope = I^2t	GF Slope = I^2t	MVT GF I2T.pdf

APPENDIX E: GTU PIN OUT DIAGRAMS

Table E-1: GTU-C Power Break I and AKR Trip Units

Pin #	GTU-C	Signal Description GTU-C
1	Breaker Position Switch	Breaker Position switch +
2	Input Common	Digital Input Return
3	FANOUT	Fan output (AKR 5000A only)
4	Input +	Digital Input +
5	GFZIN+	Zone Select In+
6	GFZIN-	Zone Select In-
7	GFZOUT+	Zone Select Out+
8	GFZOUT-	Zone Select Out-
9	RX-neg	Modbus RX
10	Phase A High Inst. CT	HiBreak Air Core Input A +
11	Phase B High Inst. CT	HiBreak Air Core Input B +
12	Phase C High Inst. CT	HiBreak Air Core input C +
13	TX-pos	Modbus TX
14	Phase A High Inst. CT Ret	HiBreak Air Core input A -
15	Phase B High Inst. CT Ret	HiBreak Air Core input B -
16	Phase C High Inst. CT Ret	HiBreak Air Core input C -
17	NRTN	Neutral CT Return
18	ARTN	Phase A CT Return
19	BRTN	Phase B CT Return
20	CRTN	Phase C CT Return
21	CTN	Neutral CT input
22	PHA	Phase A CT Input
23	PHB	Phase B CT Input
24	PHC	Phase C CT Input
25	VC	Phase C Voltage Input
26	NC	Not Connected
27	Relay 1	Output 1 Relay NO terminal
28	FLUXSHFT -	Flux Shifter -
29	VB	Phase B Voltage Input
30	RELAY_2	Output 1 Relay common terminal
31	Breaker Position Switch	Breaker Position switch +
32	24VDC	Flux Shifter +
33	VA	Phase A Voltage Input
34	DGND	Breaker Position Return
35	DGND	24V Control Power -
36	24V EXTRN +	24V Control Power +

Table E-2: GTU-D PowerBreak II and WavePro

Pin #	GTU-D	Signal Description GTU-D
1	TRIPPWR + (24VDC)	Main Flux Shifter +
2	RELAY_1	Output 1 Relay NO terminal
3	PHAHII	PBII HiBreak Air Core
4	PHBHII	PBII HiBreak Air Core
5	PHCHII	PBII HiBreak Air Core
6	Keying Pin	Placement Aid for Connector
7	DGND	Digital Ground
8	DGND	Digital Ground
9	ST_CONN	Trip Signal from PBII Shunt Trip
10	DGND	Shunt Trip Reference
11	UVR_24 V	24 Volt Signal From PBII UVR
12	RELAY_2	Output 1 Relay common terminal
13	FANON	Fan Signal for 5000A AKR
14	24V_AUX	24V Control Power +
15	DGND	24V Control Power -
16	VIN C	Phase C Voltage Input
17	VIN A	Phase A Voltage Input
18	FLUX_SHIFTE	Main Flux Shifter
19	N/C	N/C
20	PHAHIR	PBII HiBreak Air Core
21	PHBHIR	PBII HiBreak Air Core
22	PHCHIR	PBII HiBreak Air Core
23	INPUT	Input +
24	BREAKER_POSITION_CONN	Contact position Switch
25	BA_MRL_P	Bell Alarm Fire +
26	BA_MRL_P	Lock Out Fire +
27	DGND	UVR 24V Ground
28	AGND	Analog Ground
29	TX_POS	Modbus TX
30	GFZOUT+	Zone Select Out +
31	GFZIN+	Zone Select In +
32	DGND	Draw Out Switch Return
33	VINB	Phase B Voltage Input
34	PHA	Phase A CT
35	CTCOM	Phase A CT Return
36	PHB	Phase B CT
37	CTCOM	Phase B CT Return
38	PHC	Phase C CT
39	CTCOM	Phase C CT Return
40	INPUT_COMMON	Input Common
41	MRL_RTN	Lock Out Fire -

Pin #	GTU-D	Signal Description GTU-D
42	BA_RTN	Bell Alarm Fire -
43	ST_24 V	24V from Shunt Trip
44	UVR_CONN	UVR_CONN
45	RX_NEG	Modbus RX
46	GFZOUT -	Zone Select Out -
47	GFZIN -	Zone Select In -
48	D_OUT_CONN	Draw Out Switch Input
49	CTN	Neutral CT
50	CTCOM	Neutral CT Return

Table E-3: GTU-ACB

Pin #	EntelliGuard G (50-Pin Rear connector)	EntelliGuard G (40-Pin Top connector)
1	Flux Shifter -	Not Used
2	PHASE D ROGOWSKI +	Not Used
3	PHASE C ROGOWSKI +	Spring Charge Indication
4	PHASE B ROGOWSKI +	ST 2 Status
5	PHASE A ROGOWSKI -	Breaker Ready to Close
6	PHASE C ROGOWSKI -	Not Used
7	PHASE B ROGOWSKI -	Not Used
8	PHASE A ROGOWSKI +	Not Used
9	PHASE D ROGOWSKI -	UVR 2 Status
10	OUTPUT 1a	Not Used
11	OUTPUT 1b	UVR 1 Status
12	OUTPUT 2a	Not Used
13	OUTPUT 2b	N/C
14	AUXILIARY POWER + (24V)	ST 1 Status
15	PHASE C CT+	Not Used
16	PHASE B CT+	Not Used
17	PHASE A CT+	Not Used
18	ENTELLYSIS FORCE TRIP	Remote Close Signal to Command Close Coil
19	GND	GFZIN+
20	GND	GFZIN-
21	GND	TX_EN_1 (Profibus Network Device Enable)

Pin #	EntelliGuard G (50-Pin Rear connector)	EntelliGuard G (40-Pin Top connector)
22	GND	Modbus/Profibus RXD
23	GND	Modbus/Profibus TXD
24	GND	5VDC Isolated for communication
25	GND	Isolated Ground for Communication
26	GND	Ground – Status Return
27	GND	Ground – Status return
28	Fluxshifter + (24VDC)	Not Used
29	+ 24 V DC	GFZOUT-
30	N/C	GFZOUT+
31	PHASE C CT+	PHASE B VOLTAGE
32	PHASE B CT+	PHASE C VOLTAGE
33	PHASE A CT+	Ground – Status Return Common
34	Breaker Position Switch +	PHASE A VOLTAGE
35	Breaker Position Switch -	N/C
36	Earth Leg CT +	Ground – Status Return Common
37	Earth Leg CT -	N/C
38	N/C	INPUT 1
39	Keying Pin	INPUT 2
40	N/C	INPUT COMMON
41	N/C	
42	BIM - SDA_ISO (BIM Connector Pin 1)	
43	BIM - SCL_ISO (BIM Connector Pin 2)	
44	BIM 5V Isolate (BIM Connector Pin 3)	
45	BIM ISOLATED Ground (BIM Connector Pin 4)	
46	N/C	
47	CT_COMMON	
48	CT_COMMON	
49	CT_COMMON	
50	CT_COMMON	

Table E-4: Pin Out for Legacy Breakers

Pin #	RMS7	RMS9C	RMS9D	Signal Description
1	TRIPPWR +	N/C	TRIPPWR +	Main Flux Shifter +
2		N/C	PL_PWR	Remote Close
3		FANOUT	PHAHII	PBII HiBreak Air Core
4		N/C	PHBHII	PBII HiBreak Air Core
5		GFZIN+	PHCHII	PBII HiBreak Air Core
6	Keying Pin	GFZIN-	Keying Pin	Placement Aid for Connector
7	DGND	GFZOUT+	DGND	
8	DGND	GFZOUT-	DGND	Contact Position Switch
9	/ST	Commnet -	/ST	Trip Signal from PBII Shunt Trip
10	DGND	Phase A High Inst. CT	DGND	Shunt Trip Reference
11	UVR_24 V	Phase B High Inst. CT	UVR_24 V	24 Volt Signal From PBII UVR
12	IPC +	Phase C High Inst. CT	IPC	Factory Test Communications
13		Commnet +	FANON	Fan Signal for 5000A AKR
14	24V EXTRN	Phase A High Inst. CT Rtn	24V EXTRN	24V Control Power +
15	DGND	Phase B High Inst. CT Rtn	DGND	24V Control Power -
16		Phase C High Inst. CT Rtn	VC	Phase C Voltage Input
17		Phase N CT White	VA	Phase A Voltage Input
18	FLUXSHT -	Phase A CT Return	FLUXSHT -	Main Flux Shifter -
19		Phase B CT Return	PL_RTN	Remote Close
20		Phase C CT Return	PHAHIR	PBII HiBreak Air Core
21		Phase N CT Return	PHBHIR	PBII HiBreak Air Core
22		Phase A CT Black	PHCHIR	PBII HiBreak Air Core
23		Phase B CT Black		
24	BKRPOS	Phase C CT Black	BKRPOS	Contact position Switch
25	BA_MLR_P	Phase C Voltage Conditioner	BA_MRL_P	Bell Alarm Fire +
26	BA_MLR_P	IPC	BA_MRL_P	Lock Out Fire +
27	DGND		DGND	UVR 24V Ground
28	AGND	Flux Shifter -	AGND	Analog Ground
29		Phase B Voltage Conditioner	HMNET-C	Commnet +
30			GFZOUT+	Zone Select Out +
31		Aux Microswitch	GFZIN+	Zone Select In +
32	DGND	Flux Shifter +	DGND	Draw Out Switch Return
33		Phase A Voltage Conditioner	VB	Phase B Voltage Input
34	PHA+	Aux Microswitch	PHA	Phase A CT
35	PHA-	-24v Control	CTCOM	Phase A CT Return
36	PHB+	+24v Control	PHB	Phase B CT
37	PHB-	NA	CTCOM	Phase B CT Return
38	PHC+	NA	PHC	Phase C CT
39	PHC-	NA	CTCOM	Phase C CT Return
40		NA		N/C
41	FS2_RTN	NA	MRL_RTN	Lock Out Fire -
42	FS2_RTN	NA	BA_RTN	Bell Alarm Fire -
43	ST_24 V	NA	ST_24 V	24V from Shunt Trip
44	/UVR	NA	/UVR	Trip Signal from UVR
45	DGND	NA	DGND	Commnet -
46		NA	GFZOUT -	Zone Select Out -
47		NA	GFZIN -	Zone Select In -
48		NA	D_OUT	Draw Out Switch Input
49	PHN+	NA	CTN	Neutral CT
50	PHN-	NA	CTCOM	Neutral CT Return

Table E-5: Pin Out for GTUTK20 Test Kit port
Applies to GTU C, GTU D, EntelliGuard G, L, SL, MPRO variants.

Pin #	(15 pin Test Kit - front)
1	Force Trip – 11 to 24VDC – 100ms pulse max
2	RX – RS232
3	TX - RS232
4	N/C
5	N/C
6	24VDC external power
7	Diagnostic Mode Connection - +24VDC to simulate current and voltage metering
8	Circuit common (not earth ground)
9	Circuit common (not earth ground)
10	Test Kit Burden – apply +24VDC to simulate fault current
11	Ground Fault Defeat - apply +5V to disable GF functions
12	N/C
13	N/C
14	N/C
15	N/C

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GE
41 Woodford Avenue
Plainville, CT 06062
www.geindustrial.com

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