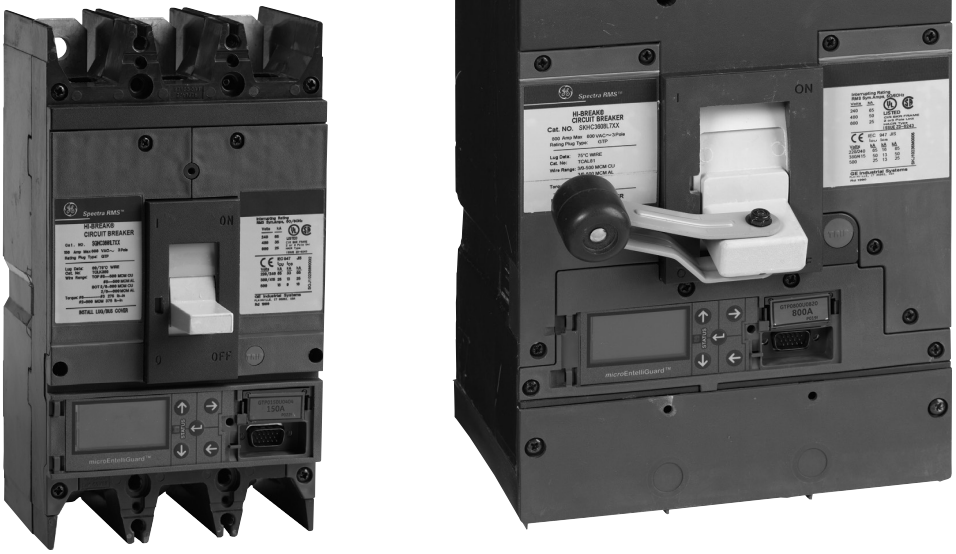
GE Energy
Industrial Solutions

GEH-702 Users Manual

Spectra® RMS Molded Case Circuit Breakers

with *micro*EntelliGuard™ Trip Units



Spectra® RMS Circuit Breakers with microEntelliGuard™ Trip Unit

The *micro*EntelliGuard™ Trip Unit is the latest and most advanced trip unit available in the Spectra line of molded case circuit breakers. The trip unit design is based on the EntelliGuard trip unit platform. The *micro*EntelliGuard™ Trip Unit incorporates many of the advanced features and protective functions available on the EntelliGuard Trip Unit and is available in the 600-amp Spectra G and 1200-amp Spectra K frames. Spectra breakers with *micro*EntelliGuard™ Trip Units allow you to select the enhanced system protection, coordination, and communication options required for the application.

Standard Protection
Long Time
Short Time
Instantaneous
Ground Fault (trip or alarm)

Advanced Protection
Neutral Protection
Zone Selective Interlock (ST/GF/INST)
Reduced Energy Let-through

Advanced Features
Metering (Basic/Advanced)
Communications (Modbus)
Waveform Capture

Table 1. Catalog Number Nomenclature

SK PC 36 12 L4 R 6

Code	Description	Function
SK	SK1200	Frame Designation
HC LC/TC[1] PC/SC[1]	35kA at 480Vac 65kA at 480Vac 100kA at 480 Vac — Standard UL Rating	Interruption Rating
HH LL/TT[1] PP/SS[1]	35kA at 480Vac 65kA at 480Vac 100kA at 480 Vac — 100% Continuous UL Rating	
3, 4 or 6	3 Poles, 480Vac or 600Vac	Poles, Max UL Voltage
08 10 12	800 Amps 1000 Amps 1200 Amps — SK Frame	Max Amps
L3 L4 L5 L7	LSI LSIG LSIA LSI-CP	L = Long Time S = Short Time I = Instantaneous G = Ground Fault A = Ground Fault Alarm CP = Control Power Standard Protection Functions
X	None	Advanced Protection Functions
K	Neutral Protection	
Z	ZSI (ST/GF)	
T	ZSI (ST/GF/INST)	
R	RELT	
L	ZSI (ST/GF) + RELT	
M	ZSI (ST/GF) + Neutral Protection	
N	ZSI (ST/GF) + RELT + Neutral Protection	
V	RELT + Neutral Protection	
P	ZSI (ST/GF/INST) + RELT	
S	ZSI (ST/GF/INST) + Neutral Protection	
W	ZSI (ST/GF/INST) + RELT + Neutral Protection	
X	Metering (Basic)	Advanced Features & Communication
2	Metering (Basic) + Modbus	
6	Metering (Adv) + Modbus + Waveform Capture	
8	Metering (Adv) + Modbus + Waveform Capture + Protective Relays	

1. SKT and SKS catalog codes are optimized for selectivity and will carry a 480Vac maximum voltage rating.

Warnings, Cautions, and Notes as Used in this Publication

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

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

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

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

This document is based on information available at the time of its publication. While efforts have been made to ensure accuracy, the information contained herein does not cover all details or variations in hardware and software, nor does it provide for every possible contingency in connection with installation, operation, and maintenance. Features may be described 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.

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Section 1

Read This First

Proper circuit protection depends on setting up and installing the circuit breaker correctly. Do not attempt to energize the circuit breaker before thoroughly understanding all of the trip unit setup parameters and ensuring that they are set correctly and that associated equipment and interfaces are also installed and connected correctly.

Spectra breakers with *micro*EntelliGuard™ Trip Units use rating plugs to set the breaker current rating. Ensure that an appropriately sized rating plug is installed into the trip unit prior to programming the trip unit. Failure to install a rating plug can result in unwanted trips. Installing a rating plug that is not intended for the frame rating can result in unwanted trips, and could result in improper protection.

When setting up the trip unit for the first time, use external 24Vdc control power (via external control power, test kit, or portable batter pack) to ensure that all protection parameters are programmed correctly.

CAUTION - Removal of the rating plug while the breaker is carrying current reduces the breaker's current-carrying capacity to the minimum rating plug value of the current sensor. This may result in unwanted tripping.

NOTE - Trip Units as received may have settings that are undesirable for the specific application. Ensure that settings are appropriately adjusted before energizing the breaker.

Trip Unit Functions

This section describes the standard and advanced protective functions and the advanced features and communication capabilities offered on the *micro*EntelliGuard™ Trip Unit.

Standard Protection Functions

Adjustable Long Time (pickup and time delay) is standard. Three different sets of curve shapes are available with slopes that mimic traditional MicroVersaTrip® long time curves (I^2t), recursive thermal curves (thermal-mag circuit breaker) and fuse emulation (I^4t).

Adjustable Short Time (pickup and time delay) is standard. An option to turn the short time function off is also included. Multiple slope functions are available with I^2t IN or OUT.

Adjustable Instantaneous (pickup) is standard.
Adjustable Ground Fault (pickup and time delay) is optional. This feature causes the breaker to TRIP when responding to a ground fault.

Adjustable Ground Fault Alarm (pickup and time delay) is optional. This feature causes the breaker to ALARM (programmable output contact closure) when responding to a ground fault (the breaker will NOT trip).

Advanced Protection Functions

Neutral Protection (pickup and time delay) is optional. This protection function is designed to protect the neutral from an overload condition (typical in applications where there are harmonics).

Zone Selective Interlock (ZSI) is optional. Restraint signals are available on Short Time, Ground Fault and Instantaneous.

Reduced Energy Let-Through (RELT) is optional. This feature allows a second instantaneous pickup setting at a reduced level and is enabled via an external signal (contact closure or communications).

Advanced Features and Communications

Basic Metering is standard. The metering option displays current for all three phases.

Advanced Metering is optional. This feature displays current, voltage, real power, reactive power, apparent power, peak power demand, energy, frequency, and power factor for all three phases. Proper operation of the advanced metering function requires multiple system accessories including power supplies, voltage conditioners, junction boxes, and interconnect cables.

Modbus Communications is optional. The communications option allows the breaker/trip unit to communicate all breaker data to an outside network.

Waveform Capture is optional. This option stores eight cycles worth of data into digital memory that can be output via the trip unit's DB-15 connector, or over the Modbus interface.

Two Programmable Output Contacts (two) are optional. This feature is included on breakers/trip units that are optioned with any of the following functions or features
- Ground Fault Alarm
- Zone Selective Interlock
- Reduced Energy Let-Through
- Protective Relays

Breakers/trip units optioned with any of the above features have a 20-pin harness/connector and require accessories that accommodate the 20-pin connector (see section on equipment interfaces).

Rating Plugs

The *micro*EntelliGuard™ Trip Unit uses a rating plug to establish or change the current rating of the breaker. Each breaker frame/sensor combination has multiple rating plugs available that are interchangeable within the trip unit. Rating plugs available for *micro*EntelliGuard™ Trip Units are shown in Table 2. These rating plugs are compatible with EntelliGuard trip units. Note that the same rating plug catalog number can be used across multiple breaker sensor ratings. For example, GTP0150U0104 is a 150 amp-rating plug that can be used in the Spectra *micro*EntelliGuard™ G frame with 150 amp or 400 amp sensors.

Table 2.Rating Plug Catalog Numbers

		SG (Max Amps)			SK (Max Amps)		
Rating Plug Product Numbers	**Trip Amps**	**150**	**400**	**600**	**800**	**1000**	**1200**
GTP0060U0101	60	x					
GTP0080U0101	80	x					
GTP0100U0103	100	x					
GTP0125U0103	125	x					
GTP0150U0104	150	x	x				
GTP0200U0204	200		x				
GTP0225U0306	225		x	x			
GTP0250U0407	250		x	x			
GTP0300U0408	300		x	x	x		
GTP0350U0408	350		x	x	x		
GTP0400U0410	400		x	x	x		
GTP0450U0612	450			x	x	x	x
GTP0500U0613	500			x	x	x	x
GTP0600U0616	600			x	x	x	x
GTP0700U0816	700				x	x	x
GTP0750U0820	750				x	x	x
GTP0800U0820	800				x	x	x
GTP0900U1020	900					x	x
GTP1000U1025	1000					x	x
GTP1100U1225	1100						x
GTP1200U1232	1200						x

Equipment Interfaces

Equipment interfaces for Spectra *micro*EntelliGuard™ breakers require special attention be paid to the wiring harness arrangement on the circuit breaker which depends on the features and functions that are selected for the *micro*EntelliGuard™ Trip Unit. The three wiring harness arrangements are NO harness, 12-Pin harness, and 20-Pin harness. Table 3 identifies the harness arrangement based on the last four digits of the circuit breaker catalog number.

Table 3. Harness Type Definition

	Std. Protect Function	Adv. Protect Function	Adv. Features & Modbus
Example: SGHC3601....	L3	X	X
No Harness	L3	X	X
20-Pin Harness	L5	Any	Any
20-Pin Harness	Any	Z,T,R, L,M,N, V,P,S,W	Any
20-Pin Harness	Any	Any	8
12-Pin Harness	All Other Cases		

Note: Find the last four digits of the breaker catalog number in the table to identify the harness type.

Neutral Current Transformers

Neutral CT's are required on breakers optioned for neutral protection. Neutral CT's are also required on breakers optioned for Ground Fault/Ground Fault Alarm where the system voltage is three-phase/four-wire or single phase/three-wire. The list of available neutral CT's is shown in Table 4.

Table 4. Neutral CT's

Breaker Type	Breaker Current Sensor Rating (S)	Catalog Number
SG	150	TSRG201
	400	TSRG204
	600	TSRG206
SK	800	TSKG408
	1200	TSKG412

Connection to the neutral CT is made via a distribution cable terminal block (three options) or a distribution cable junction box (two options). Note: Terminal block and junction box selection depends on the breaker wiring harness, either a 12-Pin harness or 20-Pin harness. Refer to Figure 1 for an example neutral CT wiring connection diagram using a terminal block.

CAUTION: Neutral-current sensors are required for three-phase/four-wire and single-phase/three-wire systems. When the trip unit is connected to a three phase/three-wire system, the neutral-current sensor terminals are left open. Do not short any neutral-current sensor terminals in a three-phase/three-wire system, as this could result in damage to or malfunction of the electrical system.

Terminal Blocks

Three different terminal block options are available for Spectra *micro*EntelliGuard™ breakers. Breakers with a 12-Pin harness have one option for a terminal block where breakers with a 20-Pin harness have two terminal block options. The table below shows the terminal descriptions for each terminal block catalog number.

Table 5. Terminal Block Descriptions

Terminal Description	SDCTBA11 12-Pin harness	SDCTBA11C 20-Pin harness	SDCTBA22C 20-Pin harness
POWER (+24Vdc)	X	X	X
POWER (common)	X	X	X
Communications +	X	X	X
Communications -	X	X	X
Aux Switch (red)	X		X
Aux Switch (white)	X		X
Voltage – Ph A	X		X
Voltage – Ph B	X		X
Voltage – Ph C	X		X
Neutral CT (black)	X	X	X
Neutral CT (white)	X	X	X
ZSI input +			X
ZSI input -			X
ZSI output +			X
ZSI output -			X
RELT input +		X	X
RELT input -		X	X
RELT output +		X	X
RELT/GFA output -		X	X
GFA output +		X	X

Terminal blocks are used for input and output connections for multiple trip unit functions, metering, and communications.

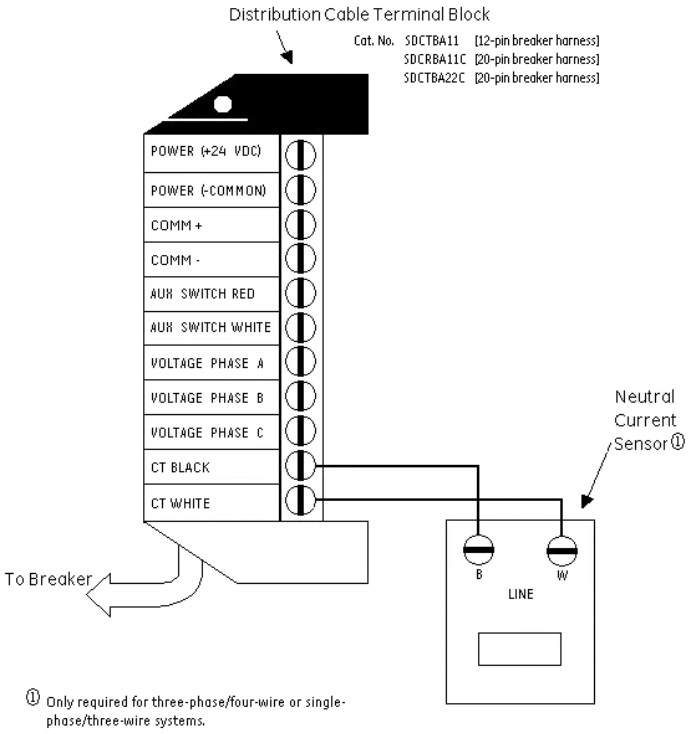


Figure 1. Typical Neutral CT Connection Using a Terminal Block

Distribution Cable Junction Boxes

Two different distribution cable junction boxes are available for Spectra *micro*EntelliGuard™ breakers. Breakers with a 12-Pin harness use catalog number SDCJBB. Breakers with a 20-Pin harness use catalog number SDCJBBC. The junction box serves as the interconnection point between various shared input and output signals, and also acts as the interface between multiple breakers within a system.

Table 6. Junction Box Descriptions

Description	SDCJBB	SDCJBBC
Breaker Harness (qty. 1)	12-Pin	20-Pin
Output Harness (qty. 2)	12-Pin	12-Pin
Aux Switch (red/white)	X	X
Neutral CT (black/white)	X	X
Communications	X	X
ZSI input +/-		X
ZSI output +/-		X
RELT input		X
Prog Contact output +/-		X
Prog Contact output +/-		X

The programmable contact output connections on the SDCJBBC are dedicated if ground fault alarm and/or reduced energy let-through features are optioned in the trip unit. Otherwise, the output contacts can be programmed to signal on various overcurrent trip conditions and protective relays.

Power Supplies

An outside source of 24Vdc control power is required for communications and waveform capture. Control power is also required for programming the trip unit under no-load or low-load conditions (less than 20% of sensor rating). Control power connections to the breaker can be made through the terminal block or the distribution cable junction box. Five different power supply plate assemblies are available. The power supplies are rated 24 watts (+24 Vdc at 1.0 amps) and have the capacity to power 20 Spectra breakers/trip units over a length of 40 feet (total distance from power supply to last breaker). The power supply plate assemblies include the power supply, fuse protection and a control power transformer for ac source voltages over 240 VAC. All of these components are mounted on a base plate. Table 7 lists the available power supply plate assemblies. Figure 2 shows a typical power supply connection using a terminal block.

Table 7. Power Supply Plate Catalog Numbers

Cat. No.	AC Source Rating
SPSAI20	120 Vac, one-phase input & one neutral input[1]
SPSA208	208 Vac, two-phase inputs
SPSA240	240 Vac, two-phase inputs
SPSA480	480 Vac, two-phase inputs[2]
SPSA600	600 Vac, two-phase inputs[2]

1. Fuse protection on one leg only.
2. Contain a control power transformer to step the voltage down.

The power supply used in the power supply plate assemblies is available as a stand-alone component (catalog number SPSAA) and requires an 85-240 Vac, 60 Hz input.

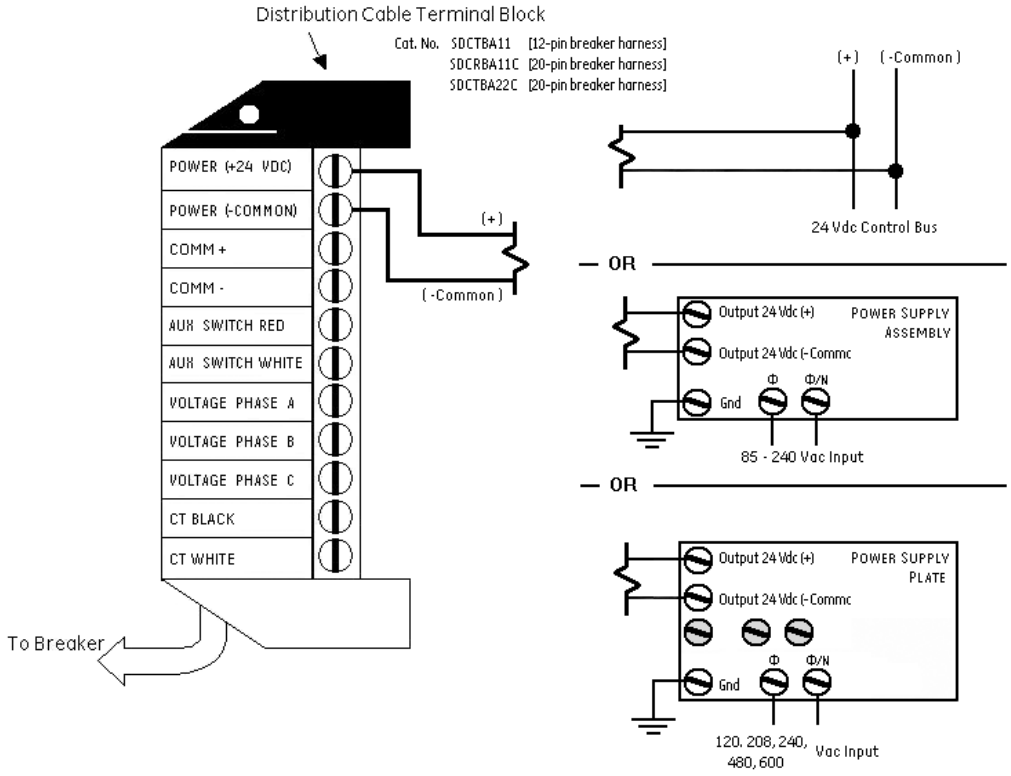


Figure 2. Typical Power Supply Connection Using a Terminal Block

Voltage Conditioners

System voltage inputs are required in order for some advanced metering and protective relay functions to operate correctly (any calculation involving voltage such as power or undervoltage). Seven different voltage conditioner plate assemblies are available. The voltage conditioner used in the assembly has the capacity to provide voltage-sensing signals to 20 Spectra breaker/trip units over a length of 40 feet (total distance from voltage conditioner to last breaker). The voltage conditioner requires +24 Vdc control power (see section on Power Supplies). The voltage conditioner plate assemblies include the voltage conditioner, fuse protection and three 1-VA high-accuracy potential transformers.

Table 8 lists the available voltage conditioner plate assemblies. The voltage conditioner used in the voltage conditioner plate assemblies is available as a stand-alone component (catalog number SPSAA).

Table 8. Voltage Conditioner Plate Assemblies

Catalog Number	Source Voltage Rating	Comments
SVCA120Y	120 Vac Wye conn.	(Φ to **N** potential)
SVCA208Y	208 Vac Wye conn.	(Φ to Φ potential)
SVCA240D	240 Vac Delta conn.	(Φ to Φ potential)
SVCA277Y	277 Vac Wye conn.	(Φ to **N** potential)
SVCA480Y	480 Vac Wye conn.	(Φ to Φ potential)
SVCA480D	480 Vac Delta conn.	(Φ to Φ potential)
SVCA600D	600 Vac Delta conn.	(Φ to Φ potential)

Voltage Modules

For Spectra Series™ Switchboard applications involving Spectra *micro*EntelliGuard™ breakers that require control power and voltage signals, modules are available that incorporate both the power supply and voltage conditioner (see Table 9). The modules are 5 "X" units high (6 7/8 inches) and mount in 45-inch wide distribution sections. The modules connect to the vertical bus bars in the switchboard and provide control power and voltage signals to the system.

Table 9. Voltage Module Catalog Numbers

Catalog Number	Source Voltage Rating	Comments
ADSVMA120Y	120 Vac Wye conn.	Φ to **N** potential
ADSVMA208Y	208 Vac Wye conn.	Φ to Φ potential
ADSVMA240D	240 Vac Delta conn.	Φ to Φ potential
ADSVMA277Y	277 Vac Wye conn.	Φ to **N** potential
ADSVMA480Y	480 Vac Wye conn.	Φ to Φ potential
ADSVMA480D	480 Vac Delta conn.	Φ to Φ potential
ADSVMA600D	600 Vac Delta conn.	Φ to Φ potential

Mounting a distribution cable junction box in the front vertical upright of the switchboard across from the Spectra *micro*EntelliGuard™ breaker/trip unit permits group mounting of the breaker. Group mounted Spectra breakers with an auxiliary switch that connects to a junction box require a 1 "X" filler plate adjacent to the breaker's right-hand side to accommodate the auxiliary switch wiring.

Distribution and Extension Cables Interconnection cables are required if equipment interfaces such as the distribution cable junction box, power supply plate assembly, voltage conditioner plate assembly are used. These cables transmit electronic signals and/or control power between the various interconnected components. There are two different types of interconnection cables available for Spectra *micro*EntelliGuard™ breakers – distribution cables and extension cables.

Distribution cables are used to interconnect the junction box, power supply plate assembly, and voltage conditioner plate assembly. These cables have 12-Pin connectors and are available in three different lengths. Table 10 shows the different lengths and their associated catalog numbers.

Table 10. Distribution Cable Harness Options

Catalog Number	Length (in)	Wire Connectors
SDCHA11	11	12-Pin
SDCHA30	30	12-Pin
SDCHA60	60	12-Pin

Extension cables are used to increase the length of an existing cable. Because the Spectra *micro*EntelliGuard™ breakers come with both 12-Pin and 20-Pin wiring harnesses, there are two different extension cables available.

Table 11. Extension Cable Harness Options

Catalog Number	Length (in)	Wire Connectors
SDCEA30	30	12-Pin
SDCEA30C	30	20-Pin

Voltage exchange cables are available and are necessary for breakers with advanced metering when installed in group-mounted equipment. These cables connect between the breaker and the distribution cable junction box and reverse the voltage signals being input to the breaker (from $V_A V_B V_C$ to $V_C V_B V_A$). Refer to the Phase Rotation description in the Setup Mode section of this manual.

Table 12. Voltage Exchange Harness Options

Catalog Number	Length (in)	Wire Connectors
SDCAA6	6	12-Pin
SDCAA6C	6	20-Pin

Auxiliary Switches

An auxiliary switch is used to monitor the state of the circuit breaker main contacts. Spectra *micro*EntelliGuard™ breakers with communications are capable of communicating the breaker position when an auxiliary switch is installed and connected via a terminal board or junction box. Note: auxiliary switches with gold plated contacts are required.

Table 13. Auxiliary Switch Options

Catalog Number	No. of Switch Elements	Switch Rating
SAUXGAB1 SAUXGAB2	1 form C 2 form C	Gold-Plated Contacts 0.5 A @ 30 V

All Spectra circuit breakers use the same auxiliary switches, which are installed in the breaker's right-hand accessory compartment. Group mounted Spectra breakers with an auxiliary switch that connects to a junction box require a 1 "X" filler plate adjacent to the breaker's right-hand side to accommodate the auxiliary switch wiring.

Communications

The Spectra *micro*EntelliGuard™ breaker is available with Modbus communications, which allows connection to an external Modbus network and monitoring platform. Connection to the network requires the appropriate terminal board or junction box. Proper operation of the circuit breaker's protective functions is not dependent on the communications network.

Spectra *micro*EntelliGuard™ breakers are compatible with EnerVista Viewpoint power system software allowing for remote monitoring and control of the breaker. Viewpoint Monitoring automatically detects Spectra *micro*EntelliGuard™ breakers, generates custom tailored monitoring screens, monitors power quantities in real time (current, voltage, VARs, etc.), and identifies the status of protected assets.

Reduced Energy Let-Through

Reduced energy let-through, or RELT, is an advanced protective function that allows the trip unit to have an alternate instantaneous pickup value. This feature is intended to allow the user to set a lower instantaneous pickup level and reduce the amount of breaker let-through energy in the event of a fault. Trip units optioned with the RELT function require either a terminal board or junction box in order to wire the RELT input and output signals. The RELT switch is enabled via a 24V (AC or DC) signal across the input contacts or via the Modbus communications network. This signal can be derived from the power supply plate assembly or it can be from a separate source. Trip units optioned with the RELT function have dedicated input and output contacts. The output contacts change state when the RELT function is enabled. The output contacts are rated 1 amp, 60 Vac/Vdc. A RELT kit (catalog number GTURSK) is available that provides an illuminated 3-position selector switch allowing the user to select between NORMAL, TEST, and ON positions. A typical wiring diagram for the RELT connections is shown in Figure 3.

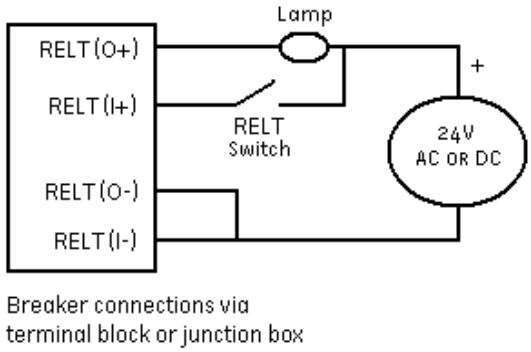


Figure 3. Typical RELT Wiring Diagram

Caution: Setting the RELT instantaneous pickup value greater than the standard instantaneous pickup value will result in higher breaker let-through energy in the event of a fault. The factory default setting for RELT instantaneous is 1.5 x sensor rating which is the minimum setting value.

Zone Selective Interlock

Zone Selective Interlocking, or ZSI, is an advanced protective function that allows one ZSI enabled trip unit to communicate with another ZSI enabled trip unit. The *micro*EntelliGuard™ trip unit is available with ZSI signaling on the short time, ground fault, and instantaneous functions. In the event of an overcurrent pickup condition, the downstream ZSI trip unit signals the upstream ZSI trip unit to temporarily change the affected pickup settings to values that allow the downstream trip unit/breaker to respond to the overcurrent condition (and the upstream breaker to remain closed and continue to service other loads).

Trip units optioned with the ZSI function require either a terminal board or junction box in order to wire the ZSI input and output signals and +24Vdc control power. A ZSI module (catalog number TIM1) is available that allows multiple ZSI enabled trip units to communicate with one another for optimal system selectivity.

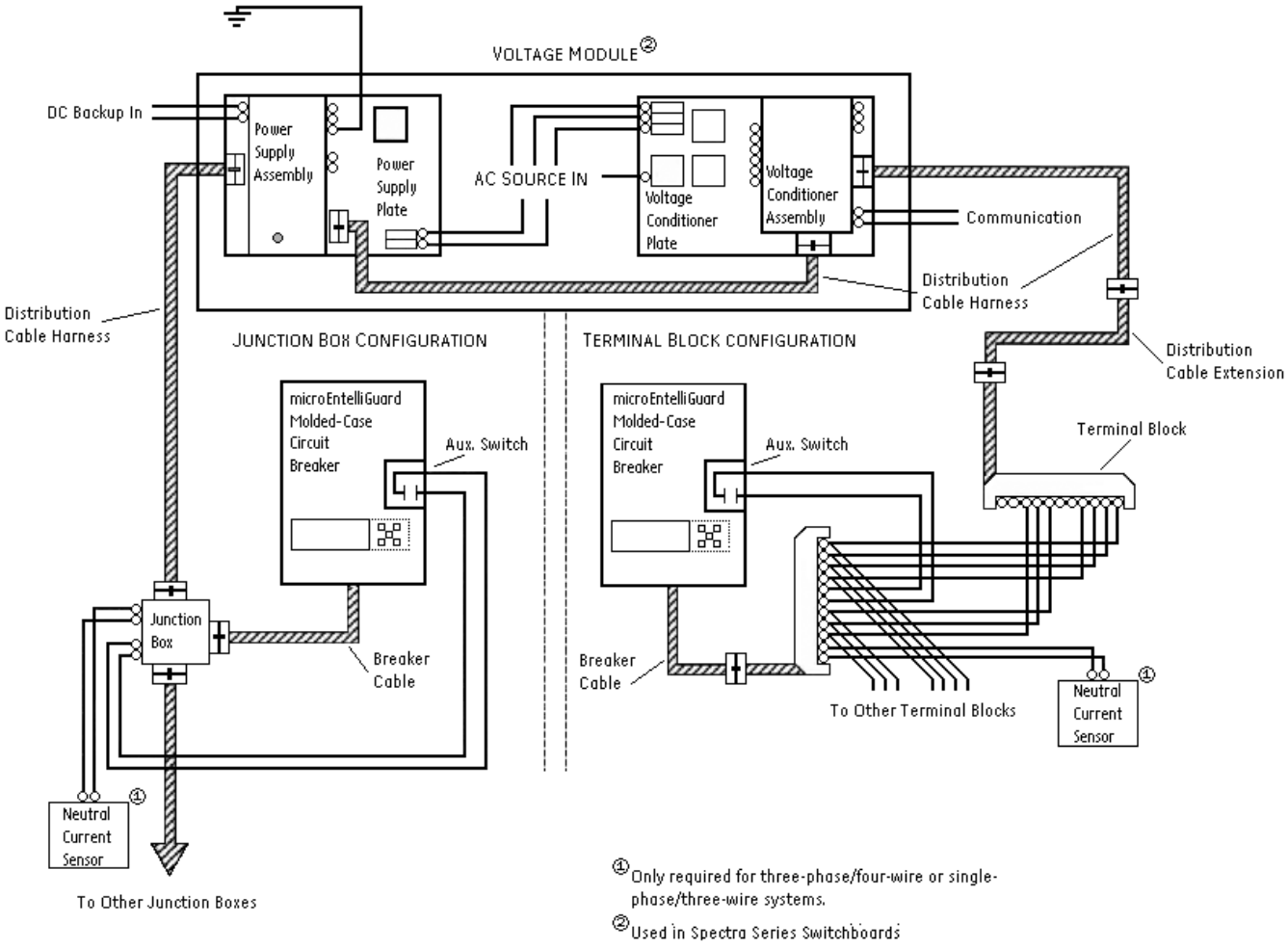


Figure 4. Typical *micro*EntelliGuard™ System

Section 2
*micro*EntelliGuard™ Trip Unit

Overview
The *micro*EntelliGuard™ Trip Unit is the latest and most advanced trip unit available in the Spectra line of molded case circuit breakers. The trip unit design is based on the EntelliGuard™ Trip Unit platform. Unlike the EntelliGuard™ Trip Unit (which is removable), the *micro*EntelliGuard™ Trip Unit is integral to the Spectra G & K frame circuit breakers. The next sections of this instruction review the trip unit's HMI (Human Machine Interface), power requirements, operating modes, and communications. If you are familiar with the EntelliGuard™ Trip Unit, then many of the following sections will be familiar to you.

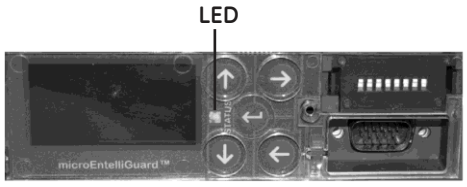


Figure 5. LED Location

HMI
The *micro*EntelliGuard™ HMI consists of a five-button membrane keypad, a liquid crystal display (LCD), and an LED indicator.

The membrane keypad has five pushbuttons that are used to navigate between the various operating modes and set up screens. The pushbuttons are raised, which helps with programming in low-light conditions. The effects of each pushbutton are shown in the following figure.

↑	**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 6. Keypad Definition

Pushing and holding the UP and DOWN buttons causes the displayed value to continuously increment or decrement. The RIGHT, LEFT, and ENTER buttons operate with individual keystrokes. Pressing and holding the LEFT button causes the trip unit to return to the "home" screen.

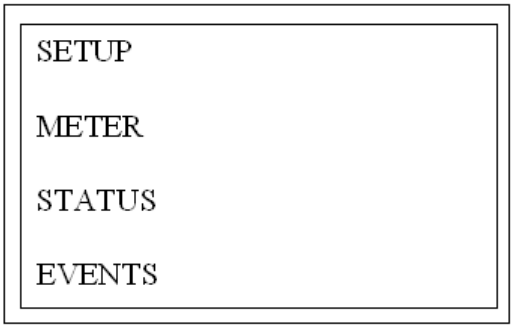


Figure 7. Typical LCD Screen

It is important to note that any programmable value that is changed is NOT saved until the ENTER key is pushed and that the ENTER key is pushed before proceeding to the next or previous programming screen. Advancing to the next screen or returning to a previous screen without hitting the ENTER key causes any changes to be lost.

Liquid Crystal Display and Power Requirements
The LCD is the visual interface that displays the operating modes and setup screens of the trip unit. Input power is required in order to illuminate the *micro*EntelliGuard™ Trip Unit's LCD for viewing the display screens or making changes to setup values. Any of the following power sources can be used.

Load Current – the trip unit will "self power" and illuminate the LCD when sufficient current passes through the circuit breaker. Sufficient current is defined as 20% of the breaker's sensor rating. A breaker with 150 amp sensors requires at least 30 amps to illuminate the LCD.

24 Vdc Control Power – *micro*EntelliGuard™ Trip Units with 12-Pin and 20-Pin wiring harnesses can be connected to 24 Vdc control power via a terminal board connection or a junction box to illuminate the LCD.

Digital Test Kit – the EntelliGuard test kit (catalog number GTUTK20) connects to the *micro*EntelliGuard™ DB-15 connector and provides 24 Vdc power to illuminate the LCD.

Portable Battery Pack – the Spectra portable battery pack (catalog number TVPBP) in conjunction with an adapter cable (TVPBPACC) connects to the *micro*EntelliGuard™ DB-15 connector and provides 24 Vdc power to illuminate the LCD.

LED Status Indicator

The *micro*EntelliGuard™ HMI includes a green LED status indicator, which signals the status of the trip unit/breaker. There are four different status conditions. NORMAL status means the breaker and trip unit are functioning properly and that the trip unit is NOT in a pickup condition. PICKUP status means that one of the over-current protective functions or protective relays has gone into pickup and that a trip is imminent. TRIP status means that the breaker/trip unit has tripped due to an over-current protective function, protective relay, or trip unit error. ERROR status can mean any number of conditions (for example, the rating plug is missing or an improper rating plug is installed). In the event that the LED sequence indicates an ERROR, check the error code in the trip unit's status menu. To reset the LED pattern, once the issue is corrected, hold down the right arrow key for two seconds.

Table 14. LED Status Flash Sequence

Breaker/Trip Unit Status	LED Sequence
NORMAL	ON-OFF-ON-OFF (wait for 2 sec)
PICKUP	ON-OFF-ON-OFF (continuous)
TRIP	ON-OFF (wait 2 sec)
ERROR	ON-OFF-ON-OFF-ON-OFF (wait 2 sec)

Trip Unit Operating Modes

The *micro*EntelliGuard™ trip unit has four different operating modes. They are SETUP, METERING, STATUS, and EVENTS. The SETUP mode is used to make changes to all of the adjustable parameters optioned in the trip unit. The METERING mode displays the current in each phase of the breaker. Trip units that are optioned with advanced metering can display voltage, power, and other pertinent parameters associated with the system voltage. The STATUS mode displays pertinent information on trip unit protection settings, if the trip unit is in pickup mode, the position of the breaker's main contacts (requires installation of auxiliary switch) and communications settings. The EVENTS mode displays information regarding over-current events.

Setup Mode

The following instructions describe setup procedures for all of the available trip unit functions. All *micro*EntelliGuard™ Trip Units have adjustable long time, short time and instantaneous over-current protection options as well as a selectable ammeter. All other functions are optional and depend on how the trip unit is optioned. If a specific trip unit function has not been optioned, that function will not appear in the display. Setting for the over current protective parameters (long time, short time, instantaneous, and ground fault) establish the shape of the trip unit/breaker's time current curve. All optioned trip unit parameters are factory preset values (reference appendix A for factory preset values).

Prior to setting up the trip unit, ensure that

- An appropriate rating plug is installed (the trip unit automatically checks and records the value of the installed rating plug and will issue an error if the rating plug is not appropriate or missing).
- A professional engineer has performed a system coordination study and provided the appropriate setup values to be programmed into the trip unit (inappropriate setup values can cause the breaker to trip unexpectedly or not provide the intended circuit protection).
- The LCD is illuminated via an appropriate power source.

When the LCD is first illuminated, the "home" page displays SETUP, METERING, STATUS, EVENTS. Use the buttons on the keypad to move up and down the menu. When STATUS is highlighted, push the right button to get into the SETUP screens. Use the RIGHT and LEFT buttons to move to the various setup options. Use the UP and DOWN buttons to change parameter values. Any value that is changed using the UP or DOWN buttons will flash to indicate that a change has been made. Note: values that are changed must be saved to memory on the screen in which they were changed. Press and hold the ENTER button to save changes. Failure to save setting changes before proceeding to the next screen causes the setting to return to its previous setting. Always confirm trip unit settings after making changes by exiting and re-entering the SETUP mode and rechecking each setting.

Language (Standard)
This setpoint is used to establish the language that is displayed in the LCD. The available language choices are English, French, Spanish, German, and Chinese. The default language is English.

Long Time Pickup (Standard)
This setpoint is used in establishing the breaker's nominal ampere rating and is a function of the rating plug installed in the trip unit. The breaker's nominal ampere rating "C", is calculated by multiplying the long time pickup value times the rating plug value "X". The available range of long time pick up values is 0.5 to 1.0 in increments of 0.05.

Example:
Rating Plug = 800 amps
LT Pickup Setting = 0.50
LT Pickup Value = Nominal Ampere Rating "C" =
800 amps x 0.50 = 400 amps

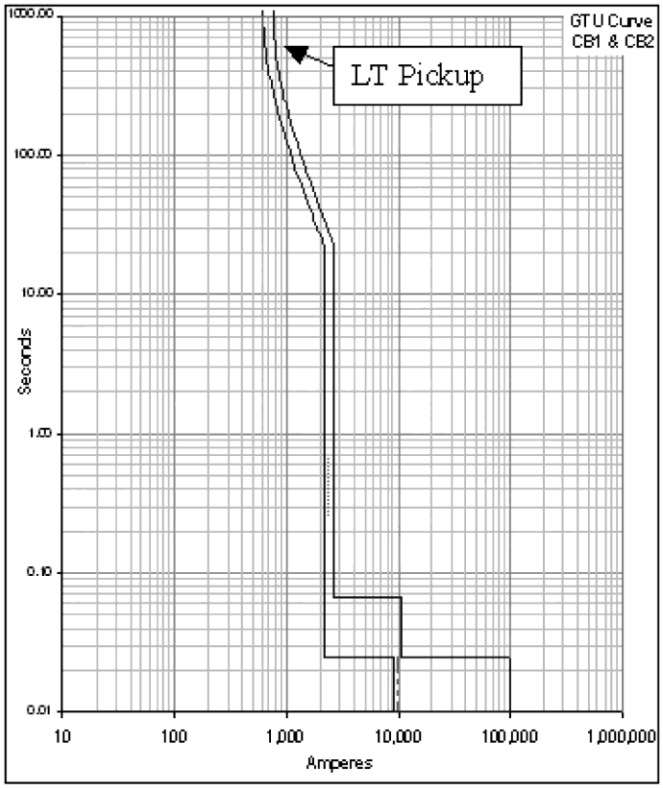


Figure 8. Long Time Pickup

Long Time Delay (Standard)
This set point is used to allow momentary overloads without nuisance tripping the breaker. It is also used to establish the shape of the thermal portion of the time current curve. Three different long time curve shapes are available:

MVT > proportional to current squared; same as Spectra MicroVersaTrip® TCC

C > similar to thermal magnetic circuit breaker TCC

F > proportional to current to the fourth power; similar to fuse TCC

The nominal time delays for each setting are listed below.

Table 15. Nominal Time Delays

Band	Delay (sec) @ 600%	Band	Delay (sec) @ 600%	Band	Delay (sec) @ 300%
MVT1	3	C1	0.3	F1	0.2
MVT2	6	C2	0.5	F2	0.4
MVT3	12	C3	0.8	F3	0.8
MVT4	25	C4	1.2	F4	2
		C5	2	F5	4
		C6	3	F6	10
		C7	5	F7	20
		C8	7		
		C9	12		
		C10	18		

Note: The MVT4, and C10 settings are not available on Spectra G Frame.

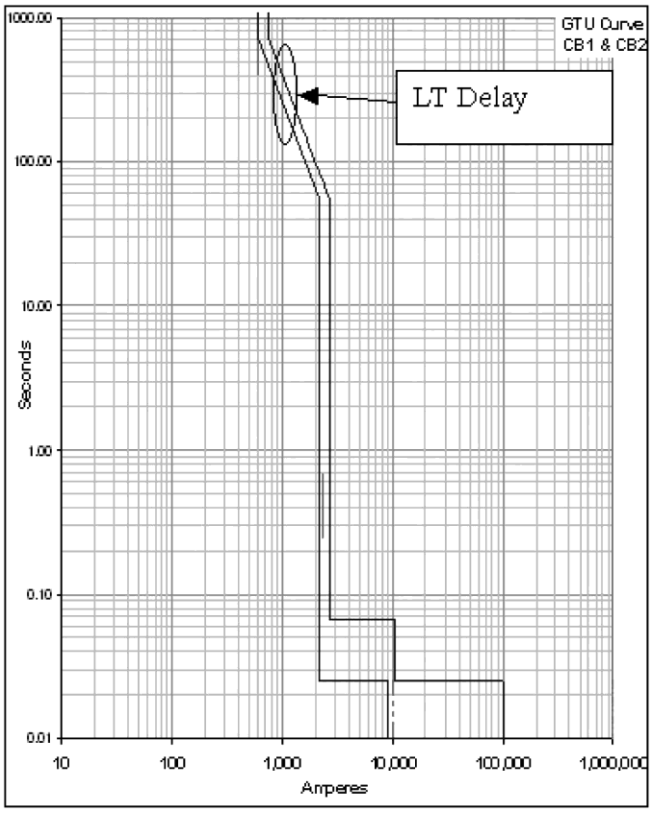


Figure 9. Long Time Delay

Short Time Pickup (Standard)

This set point is used to establish the short time pickup of the trip unit. The short time pickup of the trip unit is calculated by multiplying the short time pickup value times the breaker's nominal ampere rating "C". It is important to note that changes to the long time pickup value affect the short time pickup value. The available range of short time pickup values is 1.5 to 9.0 in increments of 0.5. The short time pickup parameter can also be turned OFF. This is accomplished in the short time delay menu.

Example:

Breaker Nominal Ampere Rating "C" = 400 amps
ST Pickup Setting = 9.0
ST Pickup Rating = 400 amps x 9.0 = 3,600 amps

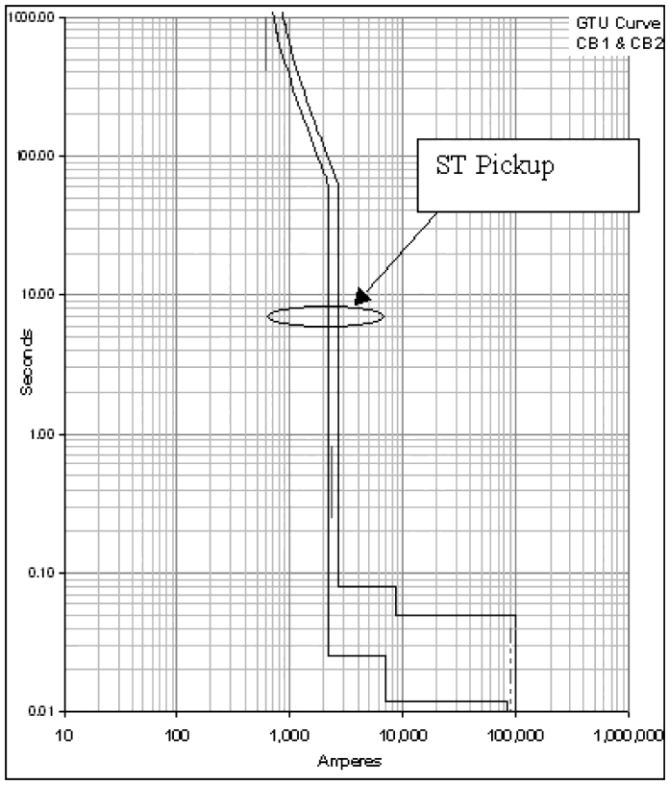


Figure 10. Short Time Pickup

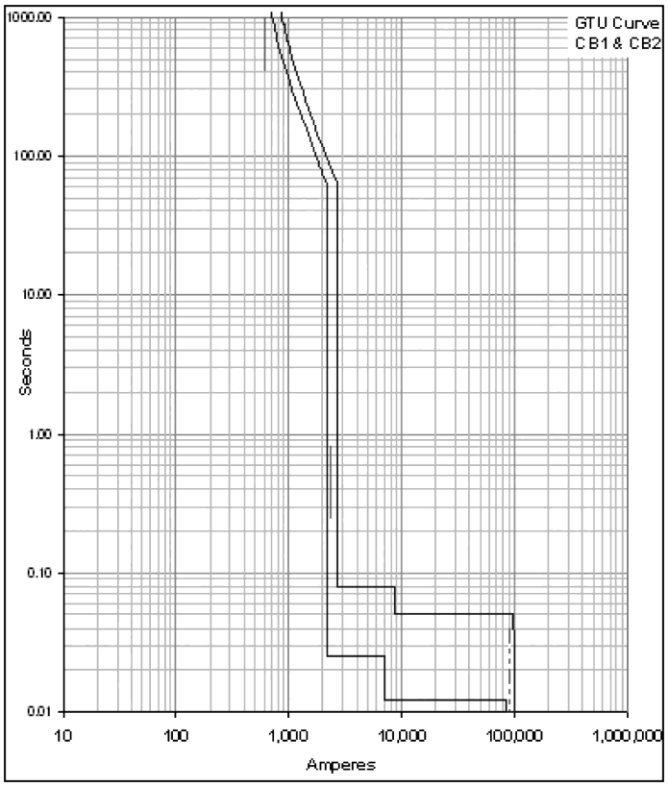


Figure 11. Short Time Delay with Slope Off

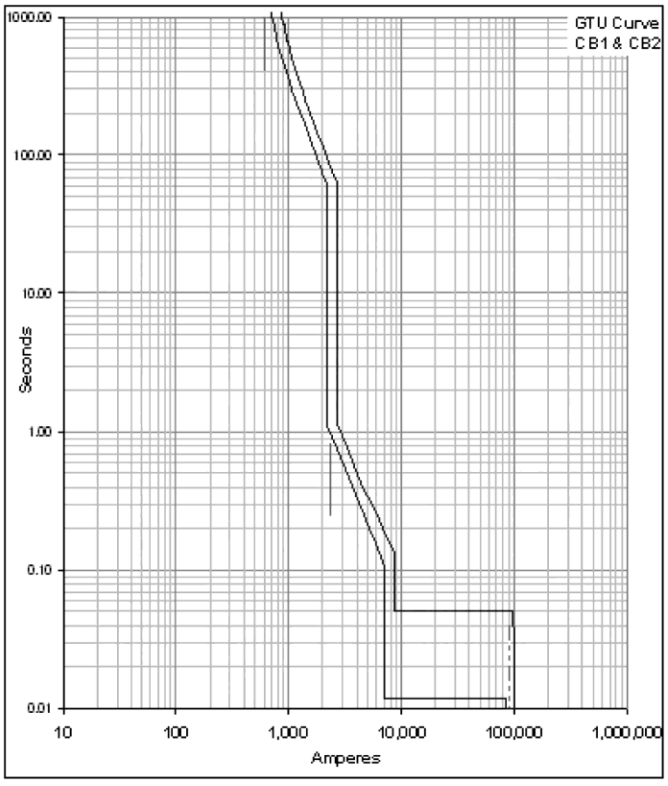


Figure 12. Short Time Delay Set to Maximum

Short Time Delay (Standard)

This set point is used to allow momentary inrush currents without nuisance tripping the breaker. It is also used to establish the shape of the short time portion of the time current curve. Twelve time delay bands and four curve slopes are available. The short time delay is a function of both the time delay band and the slope.

Instantaneous Pickup (Standard)
This set point is used to establish the ampere value that immediately causes the breaker to trip. The instantaneous trip value is calculated by multiplying the setting value times the breaker sensor value. The available range of instantaneous pickup values are shown below. Maximum settings are dependent on breaker frame and sensor rating:

Table 16. Available Instantaneous Pickup

Breaker	Interrupt Tier	Sensor / CT	MIN INSTPU	Max INSTPU
Spectra G	H, L, P	All	2.0	10.0
Spectra K	H, L, P	All	2.0	10.0
	T, S	800	2.0	25.5
		1000	2.0	20.5
		1200	2.0	17.0

Reference Appendix A: Table 27 for Instantaneous Pickup increments

Example:
Breaker Sensor "S" = 800 amps

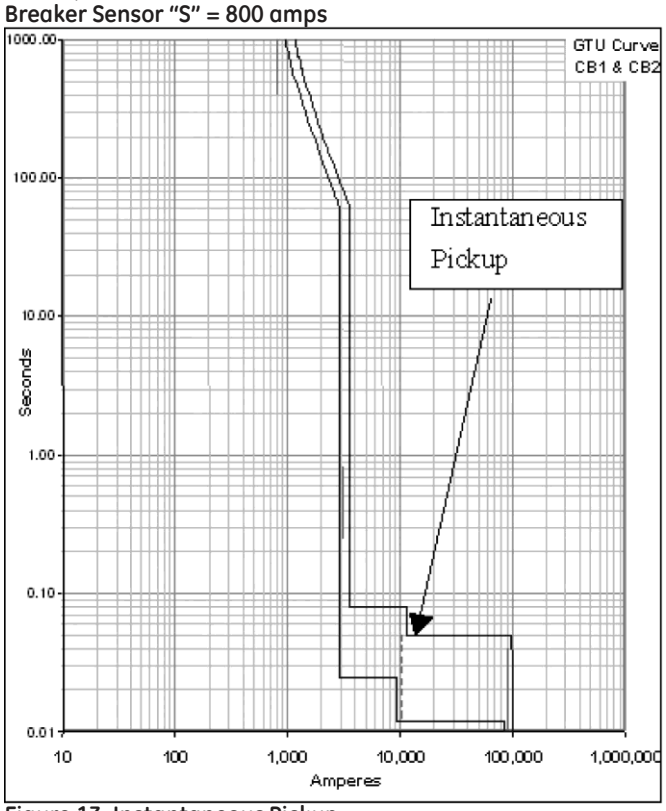


Figure 13. Instantaneous Pickup

Reduced Energy Let-Through (RELT) Instantaneous Pickup (Optional)
This set point is used to establish the ampere value that immediately causes the breaker to trip when the breaker/trip unit is set to the RELT mode via an input signal or communications. The RELT instantaneous trip value is calculated by multiplying the setting value times the breaker sensor value. The available range of RELT instantaneous pickup values is 1.5 to 10.0 in increments of 0.5.

Ground Fault Pickup (Trip or Alarm) (Optional) This set point is used to establish the ampere value that causes the breaker to trip/alarm under a ground fault condition. Trip units can be optioned to have either ground fault TRIP or ground fault ALARM. When optioned with ground fault TRIP, the breaker will trip when a ground fault is sensed and exceeds the setup parameters. When optioned with ground fault ALARM, the breaker will not trip when a ground fault is sensed and exceeds the setup parameters. Instead, a set of output contacts will change state allowing signaling to an external control device (output contacts require the proper terminal board or junction box accessory). The ground fault trip/alarm value is calculated by multiplying the setting value times the circuit breaker's sensor value "S". The available range of ground fault trip/alarm values is 0.40 to 1.0 in increments of 0.01.

Example:
Breaker Sensor "S" = 1200 amps
GF Pickup Setting = 8.0
GF Trip Value = 1200 amps x 8.0 = 9,600 amps

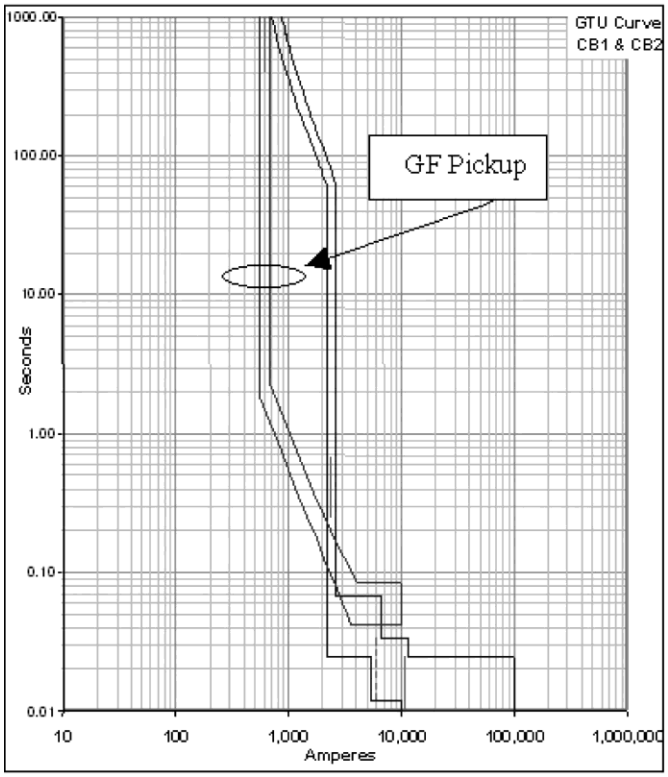


Figure 14. Ground Fault Pickup

Ground Fault Delay (Trip or Alarm) (Optional)
This set point is used to allow momentary ground fault currents without nuisance tripping the breaker. It is also used to establish the shape of the ground fault time current curve. Fifteen time delay bands and four curve slopes are available (slope equal to zero represents zero slope or I^2t OUT). The ground fault time delay is a function of both the time delay band and the slope.

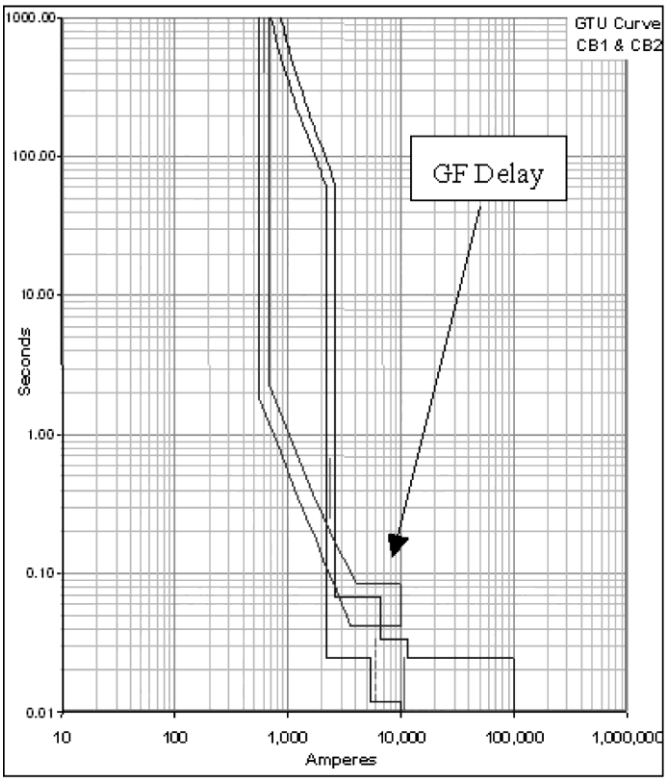


Figure 15. Ground Fault Delay

Zone Selective Interlock (ZSI) (Optional)
Zone Selective Interlock set points are available for Short Time (ST) and Ground Fault (GF). The set point includes the pickup, time delay, and slope parameters.

The ZSI Short Time pickup setting is used to establish the ST pickup of the trip unit when another ZSI trip unit signals it. The ZSI ST pickup is calculated by multiplying the ZSI ST pickup value times the breaker's nominal ampere rating "C". It is important to note that changes to the long time pickup value affect the ZSI ST pickup value. The available range of ZSI ST pickup values is 1.5 to 9.0 in increments of 0.5.

The ZSI ST delay setting is used to establish the ST delay of the trip unit when another ZSI trip unit signals it. This setting is used to allow momentary inrush currents without nuisance tripping the breaker. Twelve time delay bands and four curve slopes are available. The ZSI ST delay is a function of both the time delay band and the slope.

The ZSI Ground Fault pickup setting is used to establish the GF pickup of the trip unit when another ZSI trip unit signals it. The ZSI GF pickup is calculated by multiplying the ZSI GF pickup value times the breaker's sensor value "S". The available range of ZSI GF pickup values is 0.4 to 1.0 in increments of 0.05.

The ZSI GF delay setting is used to establish the GF delay of the trip unit when another ZSI trip unit signals it. This setting is used to allow momentary inrush currents without nuisance tripping the breaker. Fifteen time delay bands and four curve slopes are available. The ZSI GF delay is a function of both the time delay band and the slope.

NOTE - the trip unit's primary ST pickup value is interdependent with the ZSI ST pickup value. Changing the ZSI ST pickup value automatically changes the primary ST pickup value to the same value as the ZSI ST value. This interdependency also applies to the ZSI GF pickup and the trip unit's primary GF pickup setting.

Zone Selective Interlock is also available for the instantaneous (INST) trip function. This feature only functions as an output signal to an upstream trip unit optioned with ZSI INST (Spectra *micro*EntelliGuard™ breakers cannot accept a ZSI INST input signal). With this feature enabled, a ZSI signal is sent to the upstream trip unit when the trip unit responds to an instantaneous inrush current. No settings are available for the ZSI Instantaneous set point other than enabling the feature per the table below.

There are multiple combinations of ST/GF/INST that can be enabled. The available combinations of setting ZSI are as follows:

Table 17. ZSI Settings

ZSI (ST/GF) enabled	ZSI (ST/GF/INST) enabled
OFF	OFF
GF only	GF only
GF, ST	GF, ST
ST only	ST only
	ST, INST
	ST, GF, INST

Neutral Protection Pickup (Optional)
This set point is used to provide overcurrent protection on the system neutral. Overcurrent protection on the system neutral is directly proportional to the parameters previously established for both the Long Time and Short Time pickup settings. The available settings for this parameter are OFF, 50%, 100% and 150%.

This optional set point requires a neutral CT connection and the appropriate equipment interfaces.

Protective Relays (Optional)
Voltage Unbalance Relay Pickup – this relay compares the highest and lowest true RMS phase voltage with the average of all phase voltages and initiates a trip or alarm is the difference exceeds the set point pickup and delay values. The available range of voltage unbalance set point values is 10% to 50% in increments of 1%.

Voltage Unbalance Relay Delay – this setting enables a time delay from the point of pickup to the initiation of a trip signal. The available range of time delay settings is 1 to 15 seconds in increments of 1 second. Choosing OFF disables the relay.

Current Unbalance Relay Pickup – this relay compares the highest and lowest true RMS phase current with the average of all phase currents and initiates a trip or alarm is the difference exceeds the set point pickup and delay values. The available range of current unbalance set point values is 10% to 50% in increments of 1%.

Current Unbalance Relay Delay – this setting enables a time delay from the point of pickup to the initiation of a trip signal. The available range of time delay settings is 1 to 15 seconds in increments of 1 second. Choosing OFF disables the relay.

Under Voltage Relay Pickup – this relay measures the true RMS phase voltage in all phases and initiates a trip or alarm if any phase voltage drops below the set point and delay values. The available range of under voltage set point values is 50% to 90% of the nominal voltage in increments of 1%.

Under Voltage Relay Delay –this setting enables a time delay from the point of pickup to the initiation of a trip signal. The available range of time delay settings is 1 to 15 seconds in increments of 1 second. Choosing OFF disables the relay.

Over Voltage Relay Pickup – this relay measures the true RMS phase voltage in all phases and initiates a trip or alarm if any phase voltage exceeds the set point and delay values. The available range of over voltage set point values is 110% to 150% of the nominal voltage in increments of 1%.

Over Voltage Relay Delay – this setting enables a time delay from the point of pickup to the initiation of a trip signal. The available range of time delay settings is 1 to 15 seconds in increments of 1 second. Choosing OFF disables the relay.

Power Reversal Relay Pickup – this relay measures the direction of power flow through the breaker and initiates a trip or alarm if a sufficient magnitude of reverse power is detected. The available range of power reversal set point values is 10 to 990 kW in increments of 10 kW.

Power Reversal Relay Delay – this setting enables a time delay from the point of pickup to the initiation of a trip signal. The available range of time delay settings is 1 to 15 seconds in increments of 1 second. Choosing OFF disables the relay.

Load Alarm – this relay is also referred to as the load shedding relay. The purpose of this relay is to signal that the breaker is approaching a percentage of the trip unit's established ampere rating "C" (long time setting × rating plug value). There are two set points associated with this relay; Load Alarm ON and Load Alarm OFF. The Load Alarm OFF setting is interdependent on the Load Alarm ON setting.

The range of available settings for Load Alarm ON is 0.55 to 1.00 in increments of 0.05. This value multiplied by the ampere rating "C" establishes the current that the Load Alarm relay changes state.

The range of available settings for Load Alarm OFF is 0.50 to 0.95 in increments of 0.05. This value multiplied by the ampere rating "C" establishes the current that the Load Alarm relay returns to its original state. The Load Alarm OFF setting must always be less than the Load Alarm ON setting.

Input/Output Relays (Optional)
Breakers that are optioned with a 20-Pin harness are enabled with an Input Relay function. If the Reduced Energy Let-Through (RELT) function is also optioned, then the input relay is dedicated to a RELT input signal and there will be no setup screen. If the RELT function is not optioned, then the input relay can be used as a shunting device to trip the breaker. A 24Vac/Vdc signal is required. The available settings are TRIP or OFF.

Breakers that are optioned with a 20-Pin harness are enabled with two programmable output relays. These relays are used as a signaling means for functions such as ground fault alarm, reduced energy let-through, zone selective interlocking, protective relays, load alarm, health status, or an overcurrent trip condition. For trip units optioned with reduced energy let-through (RELT), RELAY 2 is dedicated to the RELT output function. In the setup mode, there are six groups assigned to RELAY 1 and RELAY 2. The table below describes the function associated with each group.

Table 18. Output Relay Group Assignments

Relay 1 & 2 Setup Options	Assignment
Group 1	Ground Fault Alarm
Group 2	Over Current Trip
Group 3	Protective Relay Trip
Group 4	Load Alarm (Load Shedding)
Group 5	Health Status
Group 6	RELT

Relays 1 and 2 will change state in the event that the function assigned to that relay experiences an event. The relays are rated 1 amp, 60Vac/Vdc. The Group 5 "Health Status" assignment will cause a contact closure in the event that the trip unit's self-diagnostic feature detects that the trip unit has malfunctioned.

Waveform Capture (Optional)
When a fault has taken place, it is important to visualize the event. The Waveform Capture option included in the advanced trip unit can track and visualize any fault event. The device tracks eight cycles, four before and four after the event, with resolution of 48 samples per cycle at 60Hz, and stores the results in memory. It registers events in all three phases and the neutral. After the event, the waveform is stored in COMTrade format and can be accessed by using the waveform client module of the EnerVista software.

The available setup options for this feature are as follows:

Table 19. Waveform Capture Setup

Setup Options	Disable	Manual	Over Current	Prot. Relay
Option 1	X			
Option 2		X		
Option 3			X	
Option 4				X
Option 5		X	X	
Option 6		X		X
Option 7			X	X
Option 8		X	X	X

Each recording event overwrites the previously stored data. A Modbus command is required to trigger Manual waveform capture. An outside source of 24Vdc control power is required for communications and waveform capture.

Frequency (Standard)
This set point establishes the system frequency. The available settings for frequency are 50 Hz and 60 Hz.

Potential Transformer Primary Voltage (Optional)
This set point establishes the primary voltage rating of the potential transformers. The PT Voltage value is used in calculations for the metering function. The available range of potential transformer primary voltage is 100 to 690 in steps of 1.

Potential Transformer Connection (Optional) This set point establishes how voltage and power options are displayed in the metering mode. The available choices for potential transformer connection are PH-PH (phase-to-phase) or PH-N (phase-to-neutral).

Power Direction (Optional)
This set point establishes the normal direction of current flow in the breaker. There are two available choices. A DOWN Arrow represents current flowing from Line to Load. An UP Arrow represents current flowing from Load to Line (reverse fed).

Phase Rotation (Standard)
The Phase Rotation setup feature is used for Spectra *micro*EntelliGuard™ breakers that are mounted back-to-back in group-mounted equipment applications. This feature identifies the orientation of the breaker pole connections to the equipment bus. There are two available setup choices; ABC represents the left pole of the breaker being connected to bus Phase A. CBA represents the right pole of the breaker being connected to bus Phase A.

Trip units with Phase Rotation set to CBA (right pole of breaker connected to bus Phase A) that are optioned with advanced metering and also utilize voltage input signals require a voltage exchange cable in order to transpose the voltage signal. Figure XX illustrates a typical group-mounted equipment installation with a voltage exchange cable.

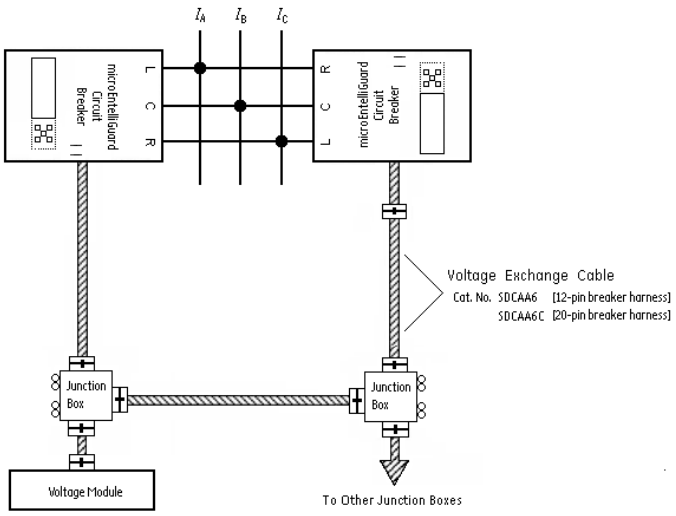


Figure 16. System With Voltage Exchange Cable

Thermal Memory (Standard)
The available Thermal Memory settings are YES and NO. Selecting YES enables the thermal memory software to digitally store the breaker's heating/ thermal characteristics as a function of current and time. With thermal memory enabled, in the event of a trip and a subsequent contact re-closure, the trip unit will recall the breaker's heating/thermal characteristics and use this information in future overcurrent calculations. This feature requires 24Vdc control power. Selecting NO disables this function.

Auxiliary Switch (Standard)
The available Auxiliary Switch Installed settings are YES and NO. Selecting YES enables the trip unit to monitor and display the state of the circuit breaker main contacts (in the STATUS mode). Spectra *micro*EntelliGuard™ breakers with communications are capable of communicating the breaker position when an auxiliary switch is installed and connected via a terminal board or junction box. Selecting NO disables this function.

Modbus (Optional)
The Modbus communications set points set the communication baud rate and the Modbus address for the breaker. The baud rate can be set to any standard baud rate from 300 to 19,200 with even, odd or no parity. The default value is 19,200 with eight-bit word length, no parity and one stop bit. The default Modbus address is one.

Date and Time (Standard)
This set point establishes a date and time in the breaker that can be used to time stamp events in the event log. The time and date field are also available over Modbus. It should be noted that removing all power from the unit (no external 24VDC source and less than 20% current flow through the breaker) will cause the time and date to be reset to the factory default. The date setting is year, month and day. The time setting is hour, minutes and seconds.

Metering Mode

Spectra *micro*EntelliGuard™ breakers are available with basic and advanced metering options. Basic metering includes an ammeter that displays phase currents only. Advanced metering includes an ammeter and voltmeter and can display energy, real power, apparent power, and frequency. Current and voltage are computed as true RMS values. All metering displays are computed and updated at a rate of one times per second. All values, except frequency, are displayed to three significant figures. For example, current might be displayed as 60.7 amps, 492 amps, or 1.20 kA. The trip unit must be energized to display metered values (refer to the power requirements section of this instruction).

Operating Mode
To enter the metering mode from the "home" page (SETUP, METERING, STATUS, EVENTS) press the UP or DOWN button until METERING is highlighted and then push the right button to get into the METERING screens. Use the RIGHT and LEFT buttons to move to the various metering options. Use the UP and DOWN buttons to cycle between phases A, B, and C. The following sections describe each of the different metering screens.

Current (all trip units)
This screen displays RMS current on phases A, B, and C. Any current value less than 5% of the breaker's current sensor rating is displayed as zero.

Voltage (advanced metering only)
This screen displays RMS current on phases A, B, and C. The value of voltage displayed depends on how the trip unit was configured in the SETUP mode (reference the Potential Transformer Connection section on page 21). If the breaker was configured with line-to-neutral connections, the display will show individual phase voltages. If the breaker was configured with line-to-line connections, the display will show voltages between phases.

Real Power (advanced metering only)
This screen displays real power on or between phases A, B, and C. The value of power displayed depends on how the trip unit was configured in the SETUP mode (reference the Potential Transformer Connection section on page 21). If the breaker was configured with line-to-neutral connections, the display will show the real power in each phase. If the breaker was configured with line-to-line connections, the display will show the aggregate power. Display values will range from 0 to 999 kW or from 1.00 to 999 MW.

Reactive Power (advanced metering only)
This screen displays reactive power on or between phases A, B, and C. The value of power displayed depends on how the trip unit was configured in the SETUP mode (reference the Potential Transformer Connection section on page 21). If the breaker was configured with line-to-neutral connections, the display will show the reactive power in each phase. If the breaker was configured with line-to-line connections, the display will show the aggregate power. Display values will range from 0 to 999 kVAR or from 1.00 to 999 MVAR.

Apparent Power (advanced metering only)
This screen displays apparent power on or between phases A, B, and C. The value of power displayed depends on how the trip unit was configured in the SETUP mode (reference the Potential Transformer Connection section on page 21). If the breaker was configured with line-to-neutral connections, the display will show the apparent power in each phase. If the breaker was configured with line-to-line connections, the display will show the aggregate power. Display values will range from 0 to 999 kVA or from 1.00 to 999 MVA.

Peak Power Demand (advanced metering only) This screen displays the peak power demand on or between phases A, B, and C. There are two values displayed on the peak power screen. The first value shows the power demand in the most recent interval. The second value displays the maximum power that has been measured. Display values will range from 0 to 999 kW or from 1.00 to 999 MW.

Energy (advanced metering only)
This screen displays the aggregate energy flow through the breaker. The value of energy displayed depends on how the trip unit was configured in the SETUP mode (reference the Power Direction section on page 22). A DOWN Arrow represents current flowing from Line to Load. An UP Arrow represents current flowing from Load to Line - reverse fed). Energy is continuously accumulated while the breaker is energized. The value displayed can be reset with a Modbus command. Display values range from 0 to 999 kWh or from 1.00 to 999 MWh. When 999MWh is exceeded, the display reverts back to 0 kWh. A counter is available via the Modbus communications port that will indicate if the display has exceeded the 999MWh value.

Frequency (advanced metering only)
The frequency screen displays the system frequency as measured by the trip unit. The frequency is displayed in Hertz.

Power Factor (advanced metering only)
The power factor screen displays the system power factor as measured by the trip unit. The power factor is displayed as a percentage.

Settings Mode

Spectra *micro*EntelliGuard™ breakers include a settings mode. This mode allows convenient review of the breaker settings without moving through all of the setup screens.

Setting Status
The setting status screen displays the pickup and delay settings for short time, long time, and instantaneous protections in a tabular format. It is normal to see dashes where a particular setting does not apply. An example of a non-applicable setting is instantaneous delay.

Pickup Status
Pickup status blinks the word pickup if the breaker has detected a fault but not yet tripped. If the system load decreases before the trip occurs this screen will return to only the top line of the screen and stop blinking.

Error Status
The error status screen will display any error that has been detected by the system. The errors are defined in appendix E of this document.

Version
The version screen displays the software version and build date. This information may be required if a problem is encountered in the system and phone support is necessary.

Comm Settings
The communication settings display the baud rate and parity setting that have been selected for communication. If either of these values do not match the communication host, communication with the unit will not be possible.

Events Mode

Spectra *micro*EntelliGuard™ breakers include an event queue. This queue allows review of the last 10 trips that have happened on the system. The first event, called Event 1, is the most recent event. The tenth event is the oldest event in the memory. Each event will display the trip type, phase, count, and level of fault that caused the trip. The event log can be cleared of all trip events by simultaneously pressing the up and down buttons.

Appendix A. Display Screen Flow

Table 20. Setup Mode Programming

Function	Title (as implemented)	Min. Value	Max. Value	Default Setting	Setting Choices
Language	LANGUAGE	ENGLISH	FRANÇAIS	ENGLISH	English, Français, Español,Deutsch, Chinese
Long Time	LONG TIME PICKUP	0.5	1.0	1.0	0.50X to 1.00X steps of 0.05X
	LONG TIME DELAY BAND	MVT1	F7	CB 6	MVT1-4, C1-C10, F1-F7 (Max. values vary by frame)
Short Time	SHORT TIME PICKUP	1.5	9.0	1.5	1.5C to 9.0C steps of 0.5C
	SHORT TIME DELAY BAND	1	12	5	1 to 12 time bands
	SHORT TIME SLOPE	0	3	0	0 to 3
Instantaneous	INSTANTANEOUS PICKUP	2.0	25.5	2.0	2.0X to 14.0X steps of 0.5X 15.0X to 19.0X steps of 1.0X 20.5X to 25.0 steps of 1.5X 25.5X (Max. values vary by frame)
Reduced Energy Let Through	RELT INST PICKUP	1.5	10	1.5	1.5X to 10.0X steps of 0.5X
Ground Fault	GF TRIP PICKUP	0.4	1.0	1.0	0.4S to 1.0S steps of 0.05S
	GF TRIP DELAY BAND	OFF	15	5	OFF or 2 to 15 time bands
	GF TRIP SLOPE	0	3	0	0 to 3
	GF ALARM PICKUP	0.4	1.0	1.0	0.4S to 1.0S steps of 0.05S
	GF ALARM DELAY BAND	OFF	15	5	OFF or 2 to 15 time bands
	GF ALARM SLOPE	0	3	0	0 to 3
Zone Selective Interlock	ZONE SEL INTLK	OFF	GF/ST/INST	OFF	GF, GF/ST, ST, ST/INST, GF/ST/INST
	ZSI ST PICKUP	1.5	9.0	1.0	1.5C to 9.0C steps of 0.5C
	ZSI ST DELAY BAND	1	12	6	1 to 12 time bands
	ZSI ST SLOPE	0	3	0	0 to 3
	ZSI GF PICKUP	0.4	1.0	1.0	0.4S to 1.0S steps of 0.05S
	ZSI GF DELAY BAND	OFF	15	5	OFF or 1 to 15 time bands
	ZSI GF SLOPE	0	3	O	0 to 3
Neutral Protection	NEUTRAL PROT	OFF	150%	OFF	OFF, 50%, 100%, 150%
Protective Relays	PROT RLY ENABLE	ON	OFF	OFF	ON, OFF
	VOLTAGE UNBAL PICKUP	10%	50%	10%	10% to 50% steps of 1%
	VOLTAGE UNBAL DELAY	OFF	15	1	OFF or 1 to 15 Seconds steps of 1 Second
	TRIP ON ZERO V	ON	OFF	OFF	ON, OFF
	CURRENT UNBAL PICKUP	10%	50%	10%	10% to 50% steps of 1%
	CURRENT UNBAL DELAY	OFF	15	1	OFF or 1 to 15 Seconds steps of 1 Second
	UNDER VOLTAGE PICKUP	50%	90%	50%	50% to 90% steps of 1%
	UNDER VOLTAGE DELAY	OFF	15	1	OFF or 1 to 15 Seconds steps of 1 Second
	OVER VOLTAGE PICKUP	110%	150%	110%	110% to 150% steps of 1%
	OVER VOLTAGE DELAY	OFF	15	1	OFF or 1 to 15 Seconds steps of 1 Second
	POWER REVERSAL PICKUP	10	990	10	10KW to 990KW steps of 10KW
	POWER REVERSAL DELAY	1	15	1	1 to 15 Seconds steps of 1 Second
	LOAD ALARM ON	0.55	1.0	.55	0.55 to 1.00 xLT steps of 0.05
	LOAD ALARM OFF	0.5	0.95	.5	0.50 to 0.95 xLT steps of 0.05 Note: OFF must be less than ON value

Function	Title (as implemented)	Min. Value	Max. Value	Default Setting	Setting Choices
Inputs and Outputs	INPUT 1 (if not RELT optioned)	TRIP	OFF	OFF	
	RELAY 1	OFF	GROUP 6	OFF [GROUP 6 if RELT Enabled]	Fixed to GROUP 6 if RELT is optioned, else available options are GROUP 1 to 5. GROUP 1: GF Alarm GROUP 2: Over Current Trip GROUP 3: Protective Relay Trip GROUP 4: Load Alarm GROUP 5: Health Status GROUP 6: RELT
	RELAY 2	OFF	GROUP 6	OFF [GROUP 6 if RELT Enabled]	Available options are GROUP 1 to 6 if RELT is optioned, else GROUP 1 to 5
Waveform Capture	WAVEFORM CAPTURE	DISABLE	ALL	ALL	Available options are: Disable, Manual, OverCurrent, Protective Relays, Manual/OverCurrent, Manual/ ProtectiveRelays, OverC urrent/ ProtectiveRelays, All
Frequency	FREQUENCY	50Hz	60Hz	60	50Hz, 60Hz
Operating Voltage	PT VOLTAGE	100	690	480	100 to 690 Volts steps of 1 Volt
	PT CONNECTION	PH-PH	PH-N	PH-PH	PH-PH, PH-N
Power Direction	POWER DIRECTION	UP	DOWN	DOWN	UP, DOWN
Phase Rotation Setup	PHASE ROTATION	ABC	CBA	ABC	Available Options: ABC, CBA
Thermal Memory	THERMAL MEMORY	YES	NO	NO	YES, NO
Auxiliary Switch	AUX SWITCH INST	YES	NO	NO	YES, NO
Communications	MODBUS BAUDRATE	4800	19200	19200	4800 to 19200 standard baud increments
	MODBUS ADDRESS	0	254	1	0 to 254 steps of 1
Date and Time	SET DATE	Y/M/D			
	SET TIME	H:M:S			

Table 21. Wye Configuration Metering

Function	Title (as implemented)	Data Presented	Notes
Current Metering	CURRENT	PHA - 0A PHB - 0A PHC - 0A	Each phase current
	CURRENT	N - 0A	Neutral current
Voltage Metering	VOLTAGE	L1-N - 0V L2-N - 0V L3-N - 0V	Phase to neutral voltages
Power Metering	REAL PWR	PHA - 0KW PHB - 0KW PHC - 0KW	Real power by phase
	REAC PWR	PHA - 0KW PHB - 0KW PHC - 0KW	Reactive power by phase
	APPR PWR	PHA - 0KVA PHB - 0KVA PHC - 0KVA	Apparent power by phase
	PWR DMD	PRST – 0KW PEAK – 0KW	PRST-Peak power during last demand interval PEAK-Peak power since first power
Energy Metering	ENERGY	TOTAL–0KWH	Total energy usage
Frequency	FREQUENCY	60HZ	Frequency measurement
Power Factor	PWR FACTOR	PHA - 0% PHB - 0% PHC - 0%	Power factor by phase

Table 22. Delta Configuration Metering

Function	Title (as implemented)	Data Presented	Notes
Current Metering	CURRENT	PHA - 0A PHB - 0A PHC - 0A	Each phase current
	CURRENT	N - 0A	Neutral current
Voltage Metering	VOLTAGE	L1-L2 - 0V L2-L3 - 0V L1-L3 - 0V	Line to line voltages
Power Metering	REAL PWR	TOTAL– 0KW	Total real power
	REAC PWR	TOTAL– 0KW	Total reactive power
	APPR PWR	TOTAL– 0KVA	Total apparent power
	PWR DMD	PRST – 0KW PEAK – 0KW	PRST-Peak power during last demand interval PEAK-Peak power since first power
Energy Metering	ENERGY	TOTAL– 0KWH	Total energy usage
Frequency	FREQUENCY	60HZ	Frequency measurement
Power Factor	PWR FACTOR	TOTAL–00%	Total power factor

Appendix B. Modbus Register Map.

Table 23. Status Screen Definitions

Function	Title (as implemented)	Data Presented	Notes
Setting status	SETTING STATUS	PU DLY LT 1.0 4 ST 1.5 2 I 2.0 -- GF 0.4 4	Shows pickup and delay settings for current protections
Pickup status	PICKUP STATUS	PICKUP	Blank if not in pickup
Error status	ERROR STATUS	E08	E08 – Rating plug error E03 – Internal Error E04 – Internal Error
Breaker status	BREAKER STATUS	CLOSED/OPEN	Only available if Aux switch is configured
Software version	VERSION	SOFTWARE VERSION BUILD DATE	
Communication settings	COMM SETTING	BAUD RATE PARITY	

Table 24. Event Mode Screen Definitions

Function	Title (as implemented)	Data Presented	Notes
Event Record Display	EVENT 0	ST Phase A 3 350 1/3/10 12:05	Event type Phase Number of occurrences Magnitude of event Date and time
	EVENT 1	Same as event 0	Same as event 0
	EVENT 2	Same as event 0	Same as event 0
	EVENT 3	Same as event 0	Same as event 0
	EVENT 4	Same as event 0	Same as event 0
	EVENT 5	Same as event 0	Same as event 0
	EVENT 6	Same as event 0	Same as event 0
	EVENT 7	Same as event 0	Same as event 0
	EVENT 8	Same as event 0	Same as event 0
	EVENT 9	Same as event 0	Same as event 0

Table 25. Discrete Input, Function Code 2

Register	Parameter	Value
0	Long time pickup state	0 - Out 1 - In
1	Short time pickup state	0 - Out 1 - In
2	GF Sum Pickup state	0 - Out 1 - In
3	ZSI IN active	0 - On 1 - Off
4	ZSI-Out active (Output 3)	0 - On 1 - Off
5	Relay 1 Status (Output 1)	0 - On 1 - Off
6	Relay 2 Status (Output 2)	0 - On 1 - Off
8	GF Defeat	0 - On 1 - Off
9	Input 1 Status	0 - On 1 - Off
11	Relt Status	0 - Off 1 - On
21	Voltage Unbalance Status	0 - Normal 1 - Pickup
22	Under Voltage Status	0 - Normal 1 - Pickup
23	Over Voltage Status	0 - Normal 1 - Pickup
24	Current Unbalance Status	0 - Normal 1 - Pickup
25	Power Reversal Status	0 - Normal 1 - Pickup
27	Breaker position	0 - Open 1 - Closed
51	MET Tripped	0 - No 1 - Yes
54	WFC Data Available	0 - No 1 - Yes
56	Voltage Unbalance Alarm Status	0 - Normal 1 - Alarm
57	Under Voltage Alarm Status	0 - Normal 1 - Alarm
58	Over Voltage Alarm Status	0 - Normal 1 - Alarm
59	Current Unbalance Alarm Status	0 - Normal 1 - Alarm
60	Power Reversal Alarm Status	0 - Normal 1 - Alarm
61	GF Sum Alarm Status	0 - Normal 1 - Alarm
63	Load Shedding Status	0 - Normal 1 - Alarm
65	Diagnostic Mode status	0 - Off 1 - On
66	Defeatable GF	0 - Off 1 - On

Table 26. Communication Parameters Modbus Function 3 (Read Only)

Register Address	Variable	Value	Read/Write
2	GF Protection Enable	0 - No 1 - Yes	Read
6	Protective Relay Protections	0 - No 1 - Yes	Read
7	Full Metering Enable	0 - No 1 - Yes	Read
10	Long Time Protection Enable	0 - No 1 - Yes	Read
11	Short Time protection Enable	0 - No 1 - Yes	Read
22	Current Sensor Rating	0 - Invalid 1 - 150A 4 - 400A 5 - 600A 6 - 800A 7 - 1000A 8 - 1200A	Read
23	Neutral Monitoring Enable (Neutral Pole Protection / 4th Wire)	0 - No 1 - Yes	Read
24	Ground Fault Alarm Enable	0 - No 1 - Yes	Read
35	ZSI	0 - Disable 1 - GF-ST 2- GF-ST-Inst	Read
81	Instantaneous	0 - Disable 1- Switchable 2 - Non-switchable	Read
83	Waveform Capture Enable	0 - No 1 - Yes	Read
107	Reduced Energy Let-Through (RELT)	0 - Disable 1 - Enable	Read

Table 27. Communication Parameters: Modbus Function 3 (Read/Write Parameters)

Register Address	Variable	Value	Factory Default	Read/Write
206	Neutral Pole Derating	0 - OFF 1 - 50% 2 - 100% 3 - 150%	0	Read/Write
207	ZSI Combination	0 1 - GF 2 - GF&ST 3 - ST 4 - ST & Inst 5 - GF & ST & Inst	0	Read/Write
208	PT Primary Voltage	100 - 690	120	Read/Write
209	PT Connection	0 - Ph-N 1 - Ph-Ph	1	Read/Write
211	Modbus Slave Address	1 - 247	1	Read/Write
213	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	27	Read/Write
215	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 - 0.9 10 - 0.95 11 - 1.0	11	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
216	Long Time Trip Delay	0 - Off 1 - MVT1 2 - MVT2 3 - MVT3 4 - MVT4 5 - C- Min 6~14 - C2..C10 15 - C-Max 16 - F-Min 17~22 - F2..F7 23 - F-Max	10	Read/Write
217	Thermal Memory Available	0 - OFF 1 - 12 min. cooling	0	Read/Write
219	Protective Relay Enable	0 - OFF 1 - ON	0	Read/Write
220	Frequency	0 - 50Hz 1 - 60Hz	1	Read/Write
222	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	1	Read/Write
223	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	5	Read/Write
224	Short Time Kst	0 - 0 1 - 2 2 - 8 3 - 18	0	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
225	Instantaneous Trip Pickup	0 - Off (For switchable Inst only) 1 - Invalid 19 - 10.5 2 - 2.0 20 - 11.0 3 - 2.5 21 - 11.5 4 - 3.0 22 - 12.0 5 - 3.5 23 - 12.5 6 - 4.0 24 - 13.0 7 - 4.5 25 - 13.5 8 - 5.0 26 - 14.0 9 - 5.5 27 - 15.0 10 - 6.0 28 - 16.0 11 - 6.5 29 - 17.0 12 - 7.0 30 - 18.0 13 - 7.5 31 - 19.0 14 - 8.0 32 - 20.5 15 - 8.5 33 - 22.0 16 - 9.0 34 - 23.5 17 - 9.5 35 - 25.0 18 - 10.0 36 - 25.5	2	Read/Write
226	Reduced Instantaneous 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	1	Read/Write
227	Aux Switch Installed	0 - No 1 - Yes	0	Read/Write
228	Phase Direction	0 - ABC 1 - CBA	0	Read/Write
233	GF Trip Pickup	1 - 0.40 2 - 0.41 3 - 0.42 ------ 59 - 0.98 60 - 0.99 61 - 1.00	61	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
234	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 - Band11 12 - Band12 13 - Band13 14 - Band14 15 - Band 15	5	Read/Write
235	GF K Value	0 - 1 - 2 - 3 -	0	Read/Write
236	GF Alarm Pickup	1 - 0.40 2 - 0.41 3 - 0.42 ------ 59 - 0.98 60 - 0.99 61 - 1.00	1	Read/Write
237	GF Alarm Delay	0 - Off 1 - Band1 2 - B and2 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	5	Read/Write
238	GF Alarm K Value	0 - 1 - 2 - 3 -	0	Read/Write
243	Current Unbalance Action	0 - Alarm 1 - Trip 2 - Both	0	Read/Write
244	Voltage Unbalance Action	0 - Alarm 1 - Trip 2 - Both	0	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
245	Under Voltage Action	0 - Alarm 1 - Trip 2 - Both	0	Read/Write
246	Over Voltage Action	0 - Alarm 1 - Trip 2 - Both	0	Read/Write
247	Power reversal Action	0 - Alarm 1 - Trip 2 - Both	0	Read/Write
258	Over Voltage Pickup	1 - 110 2 - 111 3 - 112 ---- [Increments by 1] 40 - 149 41 - 150	1	Read/Write
259	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	0	Read/Write
260	Under Voltage Pickup	1 - 50 2 - 51 ---- [Increments by 1] 40 - 89 41 - 90	1	Read/Write
261	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	0	Read/Write
262	Under Voltage Zero-Volt Trip Enable	0 - Disable 1 - Enable	0	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
263	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 ---- [Increments by 1] 40 - 49 41 - 50	1	Read/Write
264	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	1	Read/Write
265	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 ---- [Increments by 1] 40 - 49 41 - 50	1	Read/Write
266	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	0	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
267	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 ---- [10x read value] 67 - 670 68 - 680	1	Read/Write
268	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	0	Read/Write
269	Power Direction Setting	0 - Line to Load 1 - Load to Line	0	Read/Write
270	Power Demand Interval	1 - 5 minutes 2 - 10 3 - 15 4 - 20 5 - 25 ---- [5x read value] 12 - 60	5	Read/Write
271	Relay1 (Output1) Function	0 - None 1 - Group 1 2 - Group 2 3 - Group 3 4 - Group 4 5 - Group 5 6 - Group 6	0	Read/Write
272	Relay2 (Output2) Function	0 - None 1 - Group 1 2 - Group 2 3 - Group 3 4 - Group 4 5 - Group 5	0	Read/Write
275	Input 1	0 - None 1 - Trip 2 - RELT	0	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
285	Waveform Capture	0 - Disable 1 - Modbus 2 - OverCurrent 3 - Protective Relays 4 - Manual / OverCurrent 5 - Manual / Protective Relays 6 - OverCurrent / Protective Relays 7 - All	7	Read/Write
286	Language	0 - English 1 - French 2 - Spanish 3 - German 4 - Chinese	0	Read/Write
287	Time Sync Year	16 bit	2010	Read/Write
288	Time Sync Month	8 bit	1	Read/Write
289	Time Sync Date	8 bit	1	Read/Write
291	Time Sync Hour	8 bit	0	Read/Write
292	Time Sync Minute	8 bit	0	Read/Write
293	Time Sync Second	8 bit	0	Read/Write
296	Current Alarm 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	2	Read/Write
297	Current Alarm 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	1	Read/Write

Register Address	Variable	Value	Factory Default	Read/Write
302	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	4	Read/Write
303	ZSI Short Time Kst	0 - 0 1 - 2 2 - 8 3 - 18	0	Read/Write
304	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 - Band11 12 - Band12 13 - Band13 14 - Band14 15 - Band 15	0	Read/Write
305	ZSI GF Trip K Value	0 - 0 1 - I2T 2 2 - I2T 3 3 - I4T 18	0	Read/Write
312	Reduced Instantaneous Let Through (RELT)	0 - OFF 1 - ON	0	Read/Write

Table 28. Communication Parameters: Modbus Function 4

Register	Parameter Name	Allowable Values	Read/Write
14	Power Peak Demand Total - Lo 16 bits	32 bit	Read
15	Power Peak Demand Total - Hi 16 bits		Read
18	Voltage Phase A	16 bit	Read
19	Voltage Phase B	16 bit	Read
20	Voltage Phase C	16 bit	Read
21	Current Phase A	16 bit	Read
23	Current Phase B	16 bit	Read
25	Current Phase C	16 bit	Read
27	Current Phase N	16 bit	Read
29	Rating Plug Value	0 60 80 100 125 150 200 225 250 300 350 400 450 500 600 700 750 800 900 1000 1100 1200	Read
31	Energy Total (0-15 bits)	16 bit	Read
32	Energy Total (16-31 bits)	16 bit	Read
35	Energy Rollover Count	16 bit	Read
36	Power Factor Phase A	16 bit	Read
37	Power Factor Phase B	16 bit	Read
38	Power Factor Phase C	16 bit	Read
39	Power Factor Total	16 bit	Read
40	Power Real Phase A - Lo 16 bits	32 bit	Read
41	Power Real Phase A - Hi 16 bits		Read
42	Power Real Phase B - Lo 16 bits	32 bit	Read
43	Power Real Phase B - Hi 16 bits		Read
44	Power Real Phase C - Lo 16 bits	32 bit	Read
45	Power Real Phase C - Hi 16 bits		Read
46	Power Real Phase Total - Lo 16 bits	32 bit	Read
47	Power Real Phase Total - Hi 16 bits		Read
48	Power Reactive Phase A - Lo 16 bits	32 bit	Read
49	Power Reactive Phase A - Hi 16 bits		Read
50	Power Reactive Phase B - Lo 16 bits	32 bit	Read

Register	Parameter Name	Allowable Values	Read/Write
51	Power Reactive Phase B - Hi 16 bits		Read
52	Power Reactive Phase C - Lo 16 bits	32 bit	Read
53	Power Reactive Phase C - Hi 16 bits		Read
54	Power Reactive Phase Total - Lo 16 bits	32 bit	Read
55	Power Reactive Phase Total - Hi 16 bits		Read
56	Power Apparent Phase A - Lo 16 bits	32 bit	Read
57	Power Apparent Phase A - Hi 16 bits		Read
58	Power Apparent Phase B - Lo 16 bits	32 bit	Read
59	Power Apparent Phase B - Hi 16 bits		Read
60	Power Apparent Phase C - Lo 16 bits	32 bit	Read
61	Power Apparent Phase C - Hi 16 bits		Read
62	Power Apparent Phase Total - Lo 16 bits	32 bit	Read
63	Power Apparent Phase Total - Hi 16 bits		Read
64	Power Demand Total - Lo 16 bits	32 bit	Read
65	Power Demand Total - Hi 16 bits		Read
66	Frequency Measured	16 bit	Read
67	Event 1 (See Note 1)	8 bit	Read
68	Year	8 bit	Read
69	Month	8 bit	Read
70	Date	8 bit	Read
71	Hour	8 bit	Read
72	Minute	8 bit	Read
73	Second	8 bit	Read
74	Phase	8 bit	Read
75	Event Specific - Low 16 bits	16 bit	Read
76	Event Specific - Hi 16 bits	16 bit	Read
77	Event 2 (See Note 1)	8 bit	Read
78	Year	8 bit	Read
79	Month	8 bit	Read
80	Date	8 bit	Read
81	Hour	8 bit	Read
82	Minute	8 bit	Read
83	Second	8 bit	Read
84	Phase	8 bit	Read
85	Event Specific - Low 16 bits	16 bit	Read
86	Event Specific - Hi 16 bits	16 bit	Read
87	Event 3 (See Note 1)	8 bit	Read
88	Year	8 bit	Read
89	Month	8 bit	Read
90	Date	8 bit	Read
91	Hour	8 bit	Read
92	Minute	8 bit	Read
93	Second	8 bit	Read
94	Phase	8 bit	Read
95	Event Specific - Low 16 bits	16 bit	Read

Register	Parameter Name	Allowable Values	Read/Write
96	Event Specific - Hi 16 bits	16 bit	Read
97	Event 4 (See Note 1)	8 bit	Read
98	Year	8 bit	Read
99	Month	8 bit	Read
100	Date	8 bit	Read
101	Hour	8 bit	Read
102	Minute	8 bit	Read
103	Second	8 bit	Read
104	Phase	8 bit	Read
105	Event Specific - Low 16 bits	16 bit	Read
106	Event Specific - Hi 16 bits	16 bit	Read
107	Event 5 (See Note 1)	8 bit	Read
108	Year	8 bit	Read
109	Month	8 bit	Read
110	Date	8 bit	Read
111	Hour	8 bit	Read
112	Minute	8 bit	Read
113	Second	8 bit	Read
114	Phase	8 bit	Read
115	Event Specific - Low 16 bits	16 bit	Read
116	Event Specific - Hi 16 bits	16 bit	Read
117	Event 6 (See Note 1)	8 bit	Read
118	Year	8 bit	Read
119	Month	8 bit	Read
120	Date	8 bit	Read
121	Hour	8 bit	Read
122	Minute	8 bit	Read
123	Second	8 bit	Read
124	Phase	8 bit	Read
125	Event Specific - Low 16 bits	16 bit	Read
126	Event Specific - Hi 16 bits	16 bit	Read
127	Event 7 (See Note 1)	8 bit	Read
128	Year	8 bit	Read
129	Month	8 bit	Read
130	Date	8 bit	Read
131	Hour	8 bit	Read
132	Minute	8 bit	Read
133	Second	8 bit	Read
134	Phase	8 bit	Read
135	Event Specific - Low 16 bits	16 bit	Read
136	Event Specific - Hi 16 bits	16 bit	Read
137	Event 8 (See Note 1)	8 bit	Read
138	Year	8 bit	Read
139	Month	8 bit	Read
140	Date	8 bit	Read

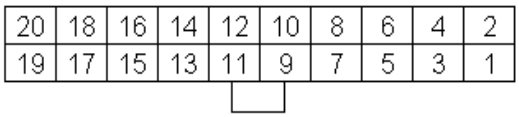
Register	Parameter Name	Allowable Values	Read/Write
141	Hour	8 bit	Read
142	Minute	8 bit	Read
143	Second	8 bit	Read
144	Phase	8 bit	Read
145	Event Specific - Low 16 bits	16 bit	Read
146	Event Specific - Hi 16 bits	16 bit	Read
147	Event 9 (See Note 1)	8 bit	Read
148	Year	8 bit	Read
149	Month	8 bit	Read
150	Date	8 bit	Read
151	Hour	8 bit	Read
152	Minute	8 bit	Read
153	Second	8 bit	Read
154	Phase	8 bit	Read
155	Event Specific - Low 16 bits	16 bit	Read
156	Event Specific - Hi 16 bits	16 bit	Read
157	Event 10 (See Note 1)	8 bit	Read
158	Year	8 bit	Read
159	Month	8 bit	Read
160	Date	8 bit	Read
161	Hour	8 bit	Read
162	Minute	8 bit	Read
163	Second	8 bit	Read
164	Phase	8 bit	Read
165	Event Specific - Low 16 bits	16 bit	Read
166	Event Specific - Hi 16 bits	16 bit	Read
167	Long Time Trip Count	16 bit	Read
168	Short Time Trip Count	16 bit	Read
169	Instantaneous Trip Count	16 bit	Read
170	Ground Fault Sum Trip Count	16 bit	Read
172	Power Reversal Trip Count	16 bit	Read
173	Voltage Unbalance Trip Count	16 bit	Read
174	Under Voltage Trip Count	16 bit	Read
175	Current unbalance Trip Count	16 bit	Read
176	Overvoltage trip Count	16 bit	Read
181	Total Trip Count	16 bit	Read
251-258	Software Version (8-byte ascii string)	8 bytes (xx.xx.xx)	Read
259	Rating Plug bit pattern	8 bit	Read
260	Over Temperature Trip Count	16 bit	Read
261	CRC Fail Trip Count	16 bit	Read
262	Rating Plug Trip Count	16 bit	Read
263	Communication Trip Count	16 bit	Read

Note 1: The Phase and Magnitude fields for following events return 0:
1) Over Temperature Trip
2) CRC Fail Trip
3) Communication Trip
4) Invalid Rating Plug Trip

Table 29. Communication Parameters: Modbus Function 5

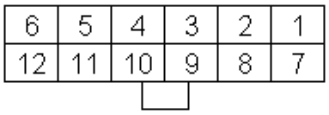
Register	Parameter	Value	Read/Write
101	Save Data		Write
103	Save Real Time Clock Registers		Write
104	Read Real Time Clock Registers		Write
106	Defeat Ground Fault	0 – OFF 1 – ON	Write
108	Trip Breaker	1 – Trip	Write
112	Relay 1 state	1 – ON 0 – OFF	Read/Write
113	Relay 2 state	1 – ON 0 – OFF	Read/Write
114	ZSI-Out	1 – ON 0 – OFF	Read/Write
115	Clear Power Demand	1 – Clear	Write
116	Clear All Events	1 – Clear	Write
117	Clear EEPROM	1 – Clear	Write
118	Clear Energy Total	1 – Clear	Write
119	Clear All Trip Counters	1 – Clear	Write
120	Clear LT Trip Counter	1 – Clear	Write
121	Clear All Pickup Counters	1 – Clear	Write
122	Clear Short Time Trip Count	1 – Clear	Write
123	Clear Instantaneous Trip Count	1 – Clear	Write
124	Clear Ground Sum and CT Fault Trip Counts	1 – Clear	Write
125	Clear Rating Plug Too Small Count	1 – Clear	Write
126	Clear Power Reversal Trip Count	1 – Clear	Write
127	Clear Voltage Unbalance Trip Count	1 – Clear	Write
128	Clear Under Voltage Trip Count	1 – Clear	Write
129	Clear Current unbalance Trip Count	1 – Clear	Write
130	Clear Overvoltage trip Count	1 – Clear	Write
131	Clear Over Temperature Trip Count	1 – Clear	Write
132	Clear ROM CRC fault count	1 – Clear	Write
135	Clear Metering Data	1 – Clear	Write
143	Trigger Waveform Capture	1 – Clear	Write
144	Clear Waveform Capture Data Buffer	1 – Clear	Write
145 148 149	Clear Preventive Maintenance data Clear STO trip count Clear Comm. trip count	1 – Clear 1 – Clear 1 – Clear	Write Write Write

Appendix C. Breaker Harness Pin-outs



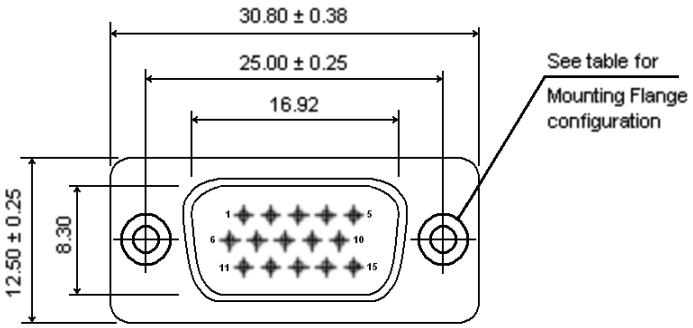
Pin	Function	Voltage	Current
1	ZSI-I+	24VDC+	
2	24VDC+	24VDC+	50mA
3	ZSI-I-	24VDC-	
4	24VDC-	24VDC-	50mA
5	ZSI-O+	Contact	
6	Modbus+	5V (Max)	
7	ZSI-O-	Contact	
8	Modbus-	5V (Max)	
9	GFA/PC1-O+	60V (AC/DC)	1A max
10	Aux Switch	24VDC+ referenced to Pin 4	0.1mA
11	GFA/PC1-O-	60V (AC/DC)	1A max
12	CTN	-	200mA @ 1X
13	RELT/PC2-O+	60V (AC/DC)	1A max
14	CTCom	-	200mA @ 1X
15	RELT/PC2-O-	60V (AC/DC)	1A max
16	PHA Voltage	5V max referenced to Pin 4.	
17	RELT-I+	24Vac or 24VDC+	5mA
18	PHB Voltage	5V max referenced to Pin 4.	
19	RELT-I-	24Vac or 24VDC+	5mA
20	PHC Voltage	5V max referenced to Pin 4.	

Figure 17. Signal Definitions 20-Pin Harness (Breaker Pigtail)



Pin	Function	Voltage	Current
1	24VDC+	24VDC+	50mA
2	24VDC-	24VDC-	50mA
3	Modbus+	5V (Max)	
4	Aux Switch (Red)	24VDC+ referenced to Pin 4	0.1mA
5	Aux Switch (White)	24VDC- referenced to Pin 2	
6	PHA Voltage	5V max referenced to Pin 4.	
7	PHB Voltage	5V max referenced to Pin 4.	
8	PHC Voltage	5V max referenced to Pin 4.	
9	Modbus-	5V (Max)	
10 (B)	CTN	-	200mA @ 1X
11 (W)	CTCom	-	200mA @ 1X
12	Distribution Cable Shield	N/C	-

Figure 18. Signal Definitions 12-Pin Harness (Breaker Pigtail)



Pin	Function	Voltage	Current
1	Reserved		
2	RS232-RX – (Data into the trip unit)	+/- 21VDC	
3	RS232-TX – (Data out of the trip unit)	+/- 9VDC	
4	N/C		
5	N/C		
6	24VDC+ From Test Kit	24VDC+	50mA
7	Reserved		
8	24VDC-	24VDC-	50mA
9	24VDC-	24VDC-	50mA
10	Reserved		
11	Reserved		
12	N/C		
13	N/C		
14	N/C		
15	N/C		

Figure 19. DB15 Connector

Appendix D. Metering

Table 30. Metering Accuracy

Value	Breaker Full-Scale Accuracy[1]	System Full-Scale Accuracy[2]
Current (A, kA)	± 4%	± 4%[3]
Voltage (V)	N/A	± 2%
Real Power (kW, MW)	N/A	± 6%[3]
Reactive Power (kVAR)	N/A	± 6%[3]
Apparent Power (kVA)	N/A	± 4%[3]
Peak Power Demand (kW)	N/A	± 4%[3]
Energy (kWh, MWh)	N/A	± 7%[3]
Frequency (Hz)	N/A	± 1 Hz[3]
Power Factor (%)	N/A	±7% max

1. Includes Trip Unit, breaker current sensors, and rating plug.
2. Includes breaker plus Voltage Module (potential transformers, control power, voltage conditioner).
3. Accuracy performance is based on a loading range of 100% of the breaker current sensors. For loads below 100% of the breaker currents sensors, add ± 3% to these values.

Appendix E. Troubleshooting

The trip unit display is blank.	External +24 VDC is absent. The load current fluctuates near 20% of the breaker sensor rating.	At least 20% of the current sensor rating, (xCT) must be flowing through the breaker to activate the display. Check that the control power supply is present and operational.
The trip unit display E03.	Memory failure.	Return the unit to GE.
The trip unit display E04.	Memory failure.	Return the unit to GE.
The trip unit display E06	Internal failure.	Return the unit to GE.
The trip unit display E08.	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 seated.
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.	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.
Instantaneous trip	Rating plug is less than 37% of sensor rating. Internal failure	Replace the rating plug with appropriate value. (unit can be tested with no rating plug installed, it will default to 37% of sensor). Return unit to GE.
The power readings are incorrect	The breaker left-right orientation is incorrect	Set the trip unit left-right orientation according to the equipment in which it is installed
Overvoltage relay caused a trip.	The voltage conditioner plate does not have a proper 24 volt DC source	Check wiring and apply a 24 volt source to the voltage conditioner plate
The date in the event log is 0.	When breaker closes into a fault without auxiliary 24 volts, the microprocessor cannot write the date information.	Use an external 24-volt source for the trip unit.

Appendix F. Replacing MicroVersaTrip® with *micro*EntelliGuard™

There are occasions when a field update or repair will require replacement of a Spectra RMS Molded Case circuit breaker with a MicroVersaTrip® Trip Unit with a Spectra RMS Molded Case circuit breaker with a *micro*EntelliGuard™ Trip Unit. There are two cases to consider when performing this replacement. The replacement procedures are described in this appendix.

For either case the first step is to identify the appropriate Molded Case circuit breaker with *micro*EntelliGuard™ Trip Unit to use in the replacement. The figure provides a conversion map from a MicroVersaTrip® (MVT) to a *micro*EntelliGuard™ (MET). This figure only helps identify an equivalent breaker. Should additional features be desired during the replacement contact a GE sales representative or distributor for assistance.

Microversatrip® vs. *micro*EntelliGuard™ Catalog Conversion

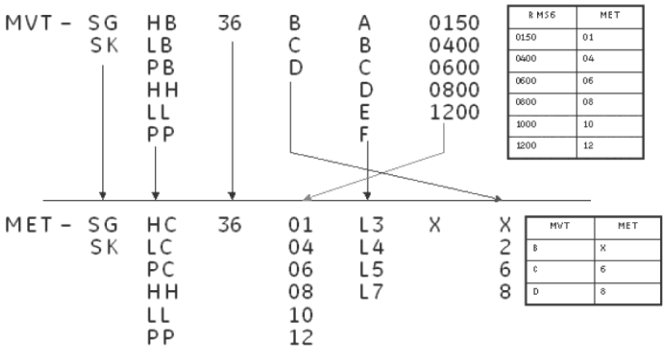


Figure 20. MicroVersaTrip® vs. *micro*EntelliGuard™ Conversion

The first case to consider is a MicroVersaTrip® unit that does not use POWERLEADER™ communications. If the trip unit does not use the Commnet communications port for POWERLEADER™ or other communications, the replacement method is strictly a physical replacement.

The new Spectra RMS Molded Case Circuit breaker with *micro*EntelliGuard™ will be a direct replacement for the old circuit breaker. A standard replacement procedure can be used following all safety procedures.

Warning - High voltage and high currents are present when working with circuit breaker replacement. Be sure all power is removed before replacing the existing circuit breaker. Before reapplying the power, be sure to check the integrity of all connections.

The second case to consider is replacement of a MicroVersaTrip® breaker that is connected to a communications port. When replacing a MicroVersaTrip® breaker that uses the communication port, minor wiring updates are required. The block diagram in Figure 21 shows the typical MicroVersaTrip® connection.

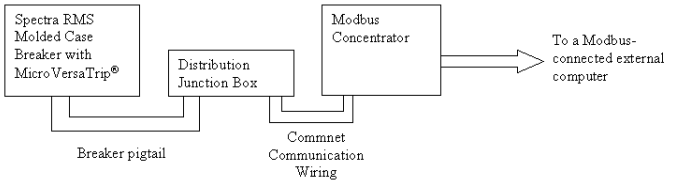


Figure 21. MicroVersaTrip® Commnet Wiring

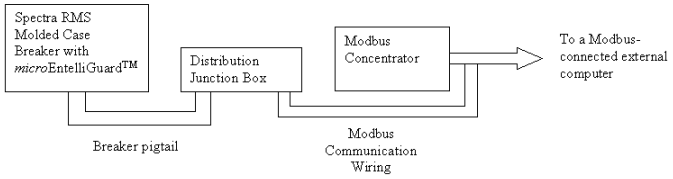


Figure 22. *micro*EntelliGuard™ Modbus Wiring

The *micro*EntelliGuard™ Trip Unit communicates directly with the Modbus. To update the wiring for use with *micro*EntelliGuard™ Trip Unit, Belden 9841 cable should be used. The COMM+ (Com TX) signal from the distribution junction box should be connected to the Modbus+ connection of the Modbus. The COMM- (Com RX) signal from the distribution junction box should be connected to the Modbus-. The shield from the distribution junction box should be connected to the Modbus shield. Figure 22 shows the modified wiring. The Modbus standard requires that communication wiring be connected using a daisy chain method with termination resistors applied to the last slave unit in the chain. If there is only one breaker or device using the Modbus concentrator, the concentrator can be removed from the system.

Once the circuit breaker is replaced in the system, some reprogramming may be necessary. Users Manual GEH-6508 contains a register map for the Spectra MicroVersaTrip®. This document will provide the register numbers that were available for various functions using the MicroVersaTrip®. The equivalent registers for the *micro*EntelliGuard™ are provided in Appendix B of this document.

Appendix G. Additional Information

Refer to these other user's manuals for more details·:

GEH-700	Spectra G Breaker w/ *micro*EntelliGuard Trip Unit
GEH-701	Spectra K Breaker w/ *micro*EntelliGuard Trip Unit
DEH-41318	Universal Rating Plug
GEH-6250	Voltage Module
GEH-6251	Power Supply Plate
GEH-6252	Voltage Conditioner Plate
GEH-6253	Power Supply Assembly
GEH-6254	Voltage Conditioner Assembly
GEH-703	MET Batter Pack Adapter
GEH-704	MET Advanced Distribution Cable Junction Box
DEH-006	Distribution Cable Junction Box
GEH-705	MET Distribution Cable Extension (20-Pin)
GEH-6256	Distribution Cable Extension (12-Pin)
GEH-6255	Distribution Cable Harness (12-Pin)
GEH-706	MET Distribution Cable Terminal Blocks (11 point & 22 point)
GEH-6257	Distribution Cable Terminal Block (11 point)
GEH-707	MET Sealable Cover kits
DEH-4568	GTU digital test kit (GTUTK20)
GEH-5551	Shunt Trip and UVR instructions
GEH-5593	Aux switch and bell alarm
GEK-64467	TIM-1 Zone Selective Interlock Module

These instructions do not cover all details or variations in equipment nor do they provide for every possible contingency that may be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise that are not covered sufficiently for the purchaser's purposes, the matter should be referred to the GE Company.

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