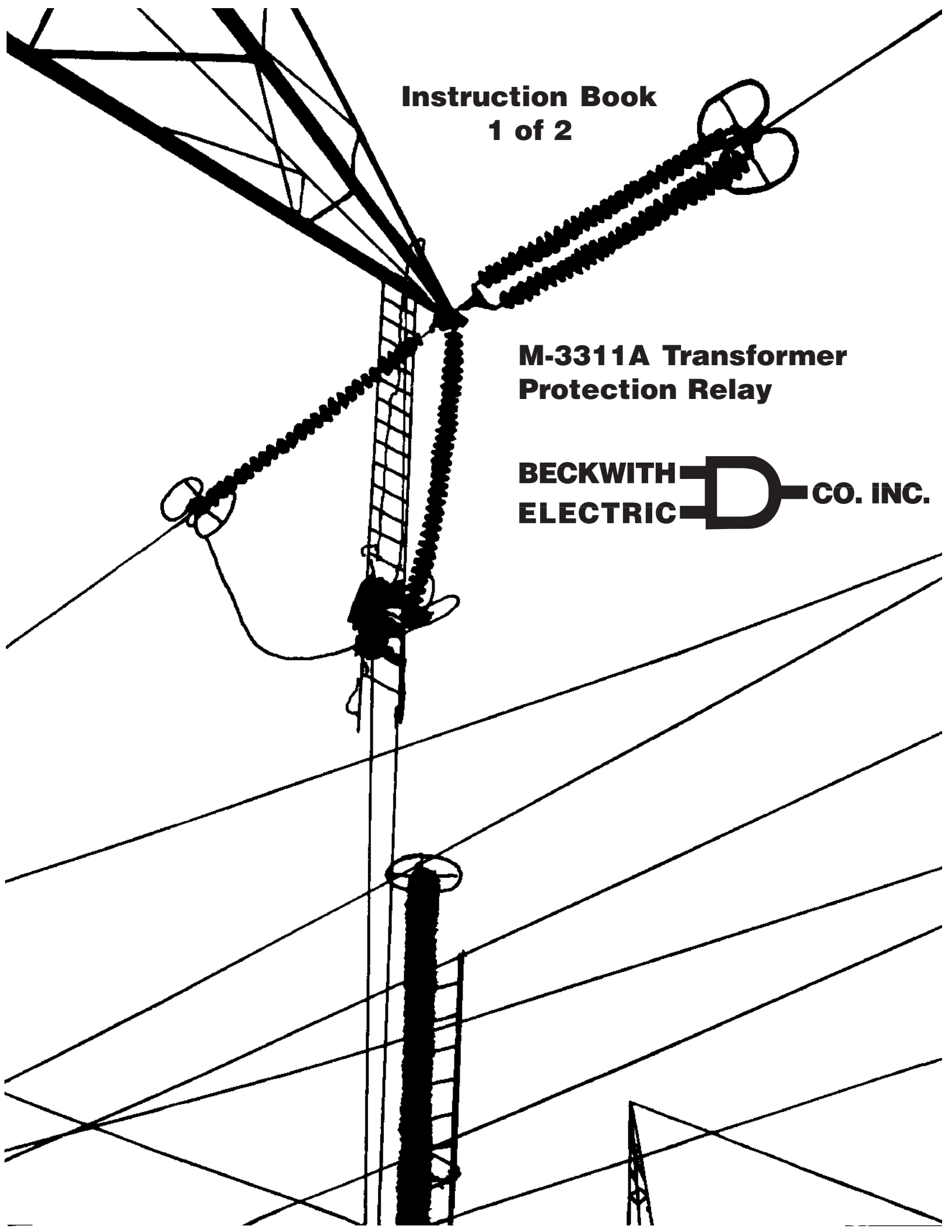


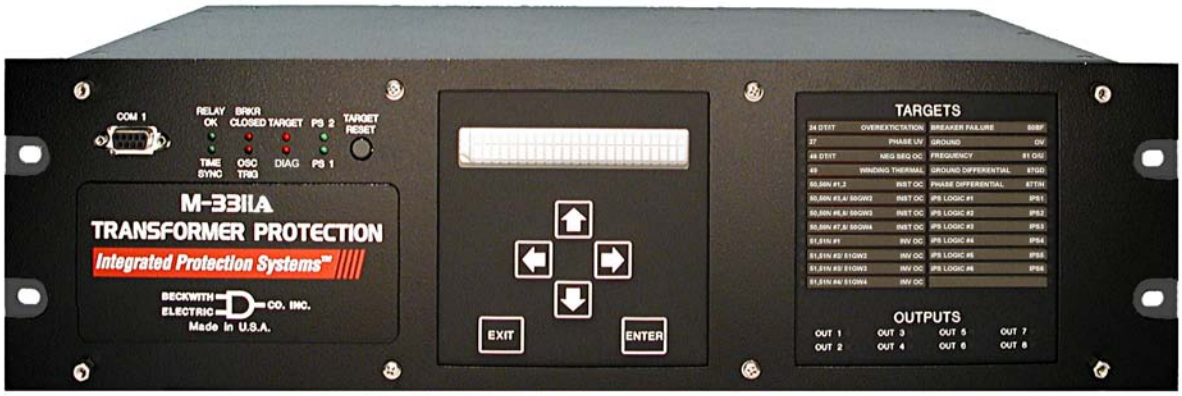
Instruction Book
1 of 2

M-3311A Transformer Protection Relay

BECKWITH ELECTRIC CO. INC.

Transformer Protection M-3311A

Integrated Protection System®



Unit shown with optional M-3931 HMI Module and M-3911 Target Module

- **For Transformers of All Sizes:**
  - **2, 3 or 4 winding Transformers for Transmission and Distribution applications**
  - **Generator-Transformer Unit Overall Differential**
  - **Unit Protection of Other Electrical Apparatus and certain Bus Arrangements (including those with a transformer in the zone)**
- **Additional Applications: System Backup Protection, Load Shedding (voltage and frequency), Bus Protection, and individual Breaker Failure Protection for each winding input**
- **Options: Ethernet Connection and Expanded I/O**

Standard Protective Functions

- Negative-sequence inverse time overcurrent (46)
- Winding thermal protection (49)
- Four winding instantaneous phase overcurrent (50)
- Breaker Failure (50BF)
- Instantaneous ground overcurrent (50G)
- Instantaneous residual overcurrent (50N)
- Four winding inverse time phase overcurrent (51)
- Inverse time ground overcurrent (51G)
- Inverse time residual overcurrent (51N)
- Two, three or four winding phase differential (87T) and high set instantaneous (87H)
- Ground differential (87GD)
- IPSlogic™

Optional Single-Phase Voltage Protection Package

- Overexcitation (24) V/Hz, two definite time and one inverse time elements
- Phase undervoltage (27) function for load shedding
- Ground Overvoltage (59G)
- Over/Underfrequency (81O/U)

Standard Features

- Eight programmable outputs and six programmable inputs
- Oscillographic recording
- Through-Fault Monitoring
- 10-target storage
- Real time metering of measured and calculated parameters, including demand currents
- Two RS-232 and one RS-485 communications ports
- Standard 19" rack-mount design
- Removable printed circuit board and power supply
- 50 and 60 Hz models available
- 1 or 5 A rated CT inputs available
- M-3826 IPScom® Communications Software
- IRIG-B time synchronization
- Sequence of Events Log
- Breaker Monitoring
- Multiple Setpoint Groups
- Trip Circuit Monitoring
- Includes MODBUS and DNP 3.0 protocols
- Summing Currents from mulitple sources for 49, 50, 51, 50N, 51N, 87 GD and Through Fault functions

Optional Features

- Redundant Power Supply
- M-3911A Target Module
- M-3931 Human-Machine Interface (HMI) Module
- M-3801D IPSplot® *Plus* Oscillograph Analysis Software
- RJ45 Ethernet port utilizing MODBUS over TCP/IP
- Expanded I/O (8 additional outputs and 12 additional inputs)

STANDARD PROTECTIVE FUNCTIONS

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Negative Sequence Overcurrent			
46	**46W2/46W3/46W4**			
	Definite Time			
	Pickup	0.10 to 20.00 A (0.02 to 4.00 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±1%
	Inverse Time			
	Pickup	0.50 to 5.00 A (0.10 to 1.00 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curves	Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.85 to 1.15 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±5%
	Winding Thermal Protection			
49	Time Constant	1.0 to 999.9 minutes	0.1 minutes	
	Maximum Overload Current	1.00 to 10.00 A	0.01 A	±0.01 A
	Winding Select	Sum1, Sum2, W1, W2, W3, or W4		
	Instantaneous Phase Overcurrent			
50	**1-8**			
	Pickup	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles or ±1%
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		
	Breaker Failure			
50 BF	**50BFW1/50BFW2/50BFW3/50BFW4**			
	Pickup (phase)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	Pickup (residual)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±2%
	Instantaneous Ground Overcurrent			
50G	**50GW2/50GW3/50GW4**			
	Pickup #1, #2	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles or ±1%

†Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Instantaneous Residual Overcurrent			
	1-8			
50N	Pickup	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles or ±1%
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		
	Inverse Time Phase Overcurrent			
	1-4			
51	Pickup	0.50 to 12.00 A (0.10 to 2.40 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		
	Characteristic Curve	Beco Definite Time/Inverse/Very Inverse/Extremely Inverse IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse IEEE Moderately Inverse/Very Inverse/Extremely Inverse		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.85 to 1.15 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±3%
	Two or three of the windings may be summed together.			
	Inverse Time Ground Overcurrent			
	51GW2/51GW3/51GW4			
51G	Pickup	0.50 to 12.00 A (0.10 to 2.40 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Beco Definite Time/Inverse/Very Inverse/Extremely Inverse IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse IEEE Moderately Inverse/Very Inverse/Extremely Inverse		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.85 to 1.15 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±3%
	Inverse Time Residual Overcurrent			
	1-4			
51N	Pickup	0.50 to 6.00 A (0.10 to 1.20 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Beco Definite Time/Inverse/Very Inverse/Extremely Inverse IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse IEEE Moderately Inverse/Very Inverse/Extremely Inverse		
	Time Dial Setting	0.5 to 11.0	0.1	±3 Cycles or ±5%
	0.05 to 1.10 (IEC curves) 0.85 to 1.15 (IEEE curves)	0.01 0.01		
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		

†Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Phase Differential Current			
	87H			
	Pickup	5.0 to 20.0 PU	0.1 PU	±0.1 PU or ±3%
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±1%
	87T			
87	Pickup	0.10 to 1.00 PU	0.01 PU	±0.02 PU or ±5%
	Percent Slope #1	5 to 100%	1%	±1%
	Percent Slope #2	5 to 200%	1%	±1%
	Slope Break Point	1.0 to 4.0 PU	0.1 PU	—
	Even Harmonics Restraint (2nd and 4th)	5 to 50%	1%	±1%or ±0.1 A
	5th Harmonic Restraint	5 to 50%	1%	±1% or ±0.1 A
	Pickup at 5th Harmonic Restraint	0.10 to 2.00 PU	0.01 PU	±0.1 PU or ±5%
	CT Tap W1/W2/W3/W4	1.00 to 100.00 (0.2 to 20)	0.01	—

Trip response for 87T and 87H (if time delay set to 1 cycle) is less than 1.5 cycles. Each restraint element may be individually disabled, enabled, or set for cross phase averaging.

	Ground Differential			
	87GDW2/87GDW3/87GDW4			
87 GD	Pickup #1, #2	0.2 to 10.00 A (0.04 to 2.00 A)	0.01 A	±0.1 A or ±5% (±0.02 A or ±5%)
	Time Delay #1, #2	1 to 8160 Cycles*	1 Cycle	–1 to +3 Cycles or ±1%
	$3I_O$ Current Selection	Sum1, Sum2, W2		
	Directional Element	Disable/Enable		
	CT Ratio Correction (R_c)	0.10 to 7.99	0.01	

**The Time Delay should not be less than 2 cycles.*
This function is selectable as either directional or non-directional. If $3I_0$ is extremely small, directional element is disabled.

	IPSlogic			
IPS	IPSlogic uses element pickups, element trip commands, control/status input state changes, output contact close signals with programmable logic array to develop schemes.			
	Reset/Droput Delay #1–#6	0 to 65500 Cycles	1 Cycle	±1 Cycle or ±1%
	Time Delay #1–#6	1 to 65500 Cycles	1 Cycle	±1 Cycle or ±1%
	Trip Circuit Monitoring			
TCM	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

The AUX input is provided for monitoring the integrity of the trip circuit. This input can be used for nominal trip coil voltages of 24 V dc, 48 V dc, 125 V dc and 250 V dc.

†Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Breaker Monitoring			
BM	Pickup	1 to 50,000 kA Cycles or kA^2 Cycles	1 kA Cycles or kA^2 Cycles	± 1 kACycles or kA^2 Cycles
	Time Delay	0.1 to 4095.9 Cycles	0.1 Cycles	±1 Cycle or ±1%
	Timing Method	IT or I^2T		
	Preset Accumulators Phase A, B, C	0 to 50,000 kA Cycles	1 kA Cycle	
	Through Fault			
TF	Through Fault Current Threshold	1.0 to 100.0 (A)	0.1A	±0.1A or ±5% (±0.02A or ±5%)
	Through Fault Count Limit	1 to 65535	1	—
	Cumulative I^2T Limit	1 to 1000000(kA^2 Cycles)	1	±1.0 kA Cycles or kA^2 Cycles
	Time Delay	1 to 8160 Cycles	1Cycle	±1 Cycle or ±1%
	Current Selection	Sum1, Sum2, W1, W2, W3 or W4	—	—
	Nominal Settings			
	Nominal Voltage	60.0 to 140.0 V	0.1 V	—
	VT Configuration	V_A, V_B, V_C, V_{AB}, V_{BC}, V_{CA}, V_G		
	Phase Rotation	ABC/ACB	—	—
	Number of Windings	2, 3, or 4		
	Transformer/CT Connection	Standard IEEE/IEC or Custom Connections		

Functions that can be Implemented with Overcurrent/Input-Output Connections

Load Shedding
Can help prevent overloading of remaining transformers when a station transformer is out of service.

Bus Fault Protection
Provides high speed bus protection by combining digital feeder relay logic and transformer protection logic.

Feeder Digital Relay Backup
Provides backup tripping of feeder relays by combining the self test alarm output of the feeder relays with the transformer relay.

LTC fault blocking
Provides limited blocking of LTC during fault conditions.

†Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.

OPTIONAL SINGLE-PHASE VOLTAGE PROTECTION PACKAGE

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Volts/Hz Overexcitation			
	Definite Time			
	Pickup #1, #2	100 to 200%	1%	±1%
	Time Delay #1, #2	30 to 8160 Cycles	1 Cycle	+25 Cycles
24	**Inverse Time**			
	Pickup	100 to 150%	1%	±1%
	Characteristic Curves	Inverse Time #1–#4	—	—
	Time Dial: Curve #1	1 to 100	1	—
	Time Dial: Curves #2–#4	0.0 to 9.0	0.1	—
	Reset Rate	1 to 999 Sec. (from threshold of trip)	1 Sec.	±.06 Seconds or ±1%

Pickup based on nominal VT secondary voltage and nominal system frequency. Accuracy applicable from 10 to 80 Hz, 0 to 180 V, and 100 to 150% V/Hz.

This function is applicable only when phase voltage input is applied.

	Phase Undervoltage			
27	Pickup	5 to 140 V	1 V	±0.5 V
	Inhibit Setting	5 to 140 V	1 V	±0.5 V
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±1%

This function is applicable only when phase voltage input is applied.

	Ground Overvoltage			
59G	Pickup #1, #2	5 to 180 V	1 V	±0.5 V or ±0.5%
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

This function is applicable only when voltage input from a broken delta VT is applied.

	Overfrequency/Underfrequency			
81 O/U	Pickup #1, #2, #3, #4	55.00 to 65.00 Hz 45.00 to 55.00 Hz*	0.01 Hz	±0.1 Hz
	Time Delay #1, #2, #3, #4	2 to 65,500** Cycles	1 Cycle	–1 to +3 Cycles or ±1%

Accuracy applies to 60 Hz models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz.
** This range applies to 50 Hz nominal frequency models.*
*** For 65,500 cycles, time delay setting phase voltage must be greater than 35 V ac.*
This function is applicable only when phase voltage of at least 27 V ac input is applied.

Configuration Options

The M-3311A Transformer Protection Relay may be purchased as a fully configured two, three or four winding Transformer Protection System. The M-3311A can also be purchased with the Optional Single-Phase Voltage Protection Package to expand the system to satisfy specific application needs.

Multiple Setpoint Profiles (Groups)

The relay supports four setpoint profiles. This feature allows multiple setpoint profiles to be defined for different power system configurations. Profiles can be switched either manually using the Human-Machine Interface (HMI), communication, or by control/status inputs.

Metering

Metering of voltage, three-phase and neutral currents, and frequency. Phase voltage and current metering include sequence components.

Real Time Demand (interval of 15, 30 or 60 minutes), and Maximum Demand (with date and time stamp) metering of current.

Metering accuracies are:

Voltage:	±0.5 V or ±0.5%, whichever is greater (range 0 to 180 V ac)
Current:	5 A rating, ±0.1 A or ±3%, whichever is greater (range 0 to 14 A) 1 A rating, ±0.02 A or ±3%, whichever is greater (range 0 to 2.8 A)
Frequency:	±0.1 Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)

Oscillographic Recorder

The oscillographic recorder provides comprehensive data recording of all monitored waveforms for Windings 1, 2, 3 and 4. The total record length is user-configurable up to 24 partitions. The amount of data stored depends on the winding configuration and number of partitions. For example; 2 windings and 1 partition configuration can store up to 311 cycles, 3 windings and 1 partition configuration can store up to 231 cycles and 4 windings and 1 partition configuration can store up to 183 cycles.

The sampling rate is 16 times the power system nominal frequency (50 or 60 Hz). The recorder is triggered by a designated status input, trip output, or using serial communications. When untriggered, the recorder continuously stores waveform data, thereby keeping the most recent data in memory. When triggered, the recorder stores pre-trigger data, then continues to store data in memory for a user-defined, post-trigger delay period. The records may be analyzed using Beckwith Electric IPSplot® *Plus* Oscillograph Analysis Software, and are also available in COMTRADE file format.

Sequence of Events Log

The Sequence Events Log records predefined relay events. The Sequence of Events Log includes 512 of the most recently recorded relay events. The events and the associated data is available for viewing utilizing the M-3826 IPScom Communications Software.

Through Fault Recorder

In addition to the Even Recorder, the M-3311A also has a separate Through Fault Recorder, which records Through Faults. Each through fault record contains the serial number of the fault, duration of the event, maximum RMS fault current magnitude for each phase during the fault, I^2t and the time stamp of the fault. In addition, it will also store the total number of through faults since last reset and total I^2t for each phase since last reset (up to 256 records).

Target Storage

A total of 8 targets can be stored. This information includes the function(s) operated, the function(s) picked up, input/output contact status, time stamp, phase and ground currents.

Calculations

Current and Voltage Values: Uses discrete Fourier Transform (DFT) algorithm on sampled voltage and current signals to extract fundamental frequency phasors for M-3311A calculations.

Power Input Options

Nominal 110/120/230/240 V ac, 50/60 Hz, or nominal 110/125/220/250 V dc. Operates properly from 85 V ac to 265 V ac and from 80 V dc to 312.5 V dc. Withstands 300 V ac or 315 V dc for 1 second. Nominal burden 20 VA at 120 V ac/125 V dc.

Nominal 24/48 V dc, operates properly from 18 V dc to 56 V dc, withstands 65 V dc for 1 second. Burden 25 VA at 24 V dc and 30 VA at 48 V dc.

An optional redundant power supply is available for units that are purchased without the I/O Expansion Module.

For those units purchased with the I/O Expansion Module the unit includes two power supplies which are required.

Sensing Inputs

Two Voltage Inputs: Rated nominal voltage of 60 V ac to 140 V ac, 50/60 Hz. Withstands 240 V continuous voltage and 360 V for 10 seconds. Voltage input may be connected to phase voltage (L-G or L-L), or to a broken delta VT. Voltage transformer burden less than 0.2 VA at 120 V.

15 Current Inputs: Rated current (I_R) of 5.0 A or 1.0 A (optional), 50/60 Hz. Withstands 3 I_R continuous current and 100 I_R for 1 second. Current transformer burden is less than 0.5 VA at 5 A (5 A option), or 0.3 VA at 1 A (1 A option).

Control/Status Inputs

The control/status inputs, INPUT1 through INPUT6, can be programmed to block any of the relay functions, trigger the oscillographic recorder, select a setpoint group, or to operate one or more outputs. The control/status inputs are designed to be connected to dry contacts and are internally wetted, with a 24 V dc power supply. To provide breaker status LED indication on the front panel, the INPUT1 status input contact must be connected to the 52b breaker status contact.

The optional Expanded I/O includes an additional 12 programmable control/status inputs.

Output Contacts

Any of the functions can be individually programmed to activate any one or more of the eight programmable output contacts OUTPUT1 through OUTPUT8. Any output contact can also be selected as pulsed or latched. IPSlogic can also be used to activate an output contact.

The optional I/O Expansion Module includes an additional 8 programmable output contacts.

The eight output contacts (six form ‘a’ and two form ‘c’), the power supply alarm output contact (form ‘b’), the self-test alarm output contact (form ‘c’) and the optional 8 I/O Expansion Module output contacts (form 'a') are all rated per ANSI/IEEE C37.90-1989 for tripping. Make 30 A for 0.2 seconds, carry 8 A, break 6 A at 120 V ac, break 0.5 A at 48 V dc; 0.3 A, 125 V dc; 0.2 A, 250 V dc with L/R=40 mSec.

Breaker Monitoring

The Breaker Monitoring function calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current (selected as I^2t or It) passing through the breaker contacts during the interruption interval. The per-phase values are summed as an accumulated total for each phase, and then compared to a user-programmed threshold value. When the threshold is exceeded in any phase, the relay can activate a programmable ouput contact. The accumulated value for each phase can be displayed as an actual value.

IPSlogic

This feature can be programmed utilizing the IPScom® Communications Software. IPSlogic takes the contact input status and function status, and by employing (OR, AND, and NOT) boolean logic and a timer can activate an output or change setting profiles.

Target/Status Indicators and Controls

The **RELAY OK** LED reveals proper cycling of the microcomputer. The **BRKR CLOSED** LED illuminates when the breaker is closed (when the 52b contact is open). The **OSC TRIG** LED indicates that oscillographic data has been recorded in the unit's memory. The corresponding **TARGET** LED will illuminate when any of the relay functions trip. Pressing and releasing the **TARGET RESET** button resets the **TARGET** LEDs if the conditions causing the operation have been removed. Pressing and holding the **TARGET RESET** button will allow elements or functions in pickup to be displayed. The **PS1** and **PS2** LEDs remain illuminated as long as power is applied to the unit and the power supply is operating properly. **TIME SYNCH** LED illuminates when valid IRIG-B signal is applied and time synchronization has been established.

Communication

Communication ports include rear RS-232 and RS-485 ports, a front RS-232 port, and a rear IRIG-B port (Ethernet port optional). The communications protocol implements serial, byte-oriented, asynchronous communication, providing the following functions when used with the Windows™-compatible M-3826 IPScom® Communications Software.

- Interrogation and modification of setpoints
- Time-stamped trip target information for the 32 most recent events
- Real-time metering of all measured and calculated quantities, real-time monitoring of percentage differential characteristics, and vector displays of compensated and uncompensated phasors.
- Downloading of recorded oscillographic data
- Downloading of Through-Fault Event Log
- MODBUS and DNP 3.0 protocols are supported

Detailed documentation on the above protocols is available on the Beckwith Electric website, at www.beckwithelectric.com

IRIG-B

The M-3311A accepts either modulated or demodulated IRIG-B time clock synchronization signals. The IRIG-B time synchronization information is used to correct the local calendar/clock and provide greater resolution for target and oscillograph time tagging.

HMI Module (optional)

Local access to the M-3311A is provided through an optional M-3931 Human-Machine Interface (HMI) Module, allowing for easy-to-use, menu-driven access to all functions via a 6-button keyboard and a 2-line by 24 character alphanumeric display. The M-3931 module includes the following features:

- User-definable access codes providing three levels of security
- Interrogation and modification of setpoints
- Time-stamped trip target information for the 8 most recent events
- Real-time metering of all measured and calculated quantities

I/O Expansion Module (optional)

An optional I/O Expansion Module provides an additional 8 form 'a' output contacts and an additional 12 control/status inputs. Output LEDs indicate the status of the output relays.

Target Module (optional)

An optional M-3911A Target Module provides 24 target and 8 output LEDs. Appropriate target LEDs illuminate when the corresponding M-3311A function trips. The targets can be reset with the M-3311A **TARGET RESET** button if the trip conditions have been removed. The **OUTPUT** LEDs illuminate when a given programmable output is actuated.

M-3801D IPSplot® *Plus* Oscillograph Analysis Software (optional)

M-3801D IPSplot *Plus* Oscillograph Analysis Software enables the plotting and printing of M-3311A waveform data downloaded from the relay to any IBM-PC compatible computer.

Tests and Standards

The relay complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

IEC 60255-5	3,500 V dc for 1 minute applied to each independent circuit to earth
	3,500 V dc for 1 minute applied between each independent circuit
	1,500 V dc for 1 minute applied to IRIG-B circuit to earth
	1,500 V dc for 1 minute applied between IRIG-B to each independent circuit
	1,500 V dc for 1 minute applied between RS-485 to each independent circuit

Impulse Voltage

IEC 60255-5	5,000 V pk, +/- polarity applied to each independent circuit to earth
	5,000 V pk, +/- polarity applied between each independent circuit
	1.2 by 50 μs, 500 ohms impedance, three surges at 1 every 5 seconds

Insulation Resistance

IEC 60255-5 > 100 Megaohms

Electrical Environment

Electrostatic Discharge Test

IEC 60255-22-2 Class 4 (8 kV)—point contact discharge

IEC 60255-22-2 Class 4 (15 kV)–air discharge

Fast Transient Disturbance Test

IEC 60255-22-4 Class A (4 kV, 2.5 kHz)

Surge Withstand Capability

ANSI/IEEE C37.90.1-1989	2,500 V pk-pk oscillatory applied to each independent circuit to earth
	2,500 V pk-pk oscillatory applied between each independent circuit
	5,000 V pk Fast Transient applied to each independent circuit to earth
	5,000 V pk Fast Transient applied between each independent circuit

ANSI/IEEE C37.90.1-2002	2,500 V pk-pk oscillatory applied to each independent circuit to earth
	2,500 V pk-pk oscillatory applied between each independent circuit
	4,000 V pk Fast Transient burst applied to each independent circuit to earth
	4,000 V pk Fast Transient burst applied between each independent circuit

■ **NOTE**: The signal is applied to the digital data circuits (RS-232, RS-485, IRIG-B, Ethernet communication port and field ground coupling port) through capacitive coupling clamp.

Radiated Susceptibility

ANSI/IEEE C37.90.2 — 25-1000 Mhz @ 35 V/m

Output Contacts

ANSI/IEEE C37.90.0 — Make 30 A for 0.2 seconds, off for 15 seconds for 2,000 operations, per Section 6.7.1, Tripping Output Performance Requirements

Atmospheric Environment

Temperature

IEC 60068-2-1 — Cold, –20° C
IEC 60068-2-2 — Dry Heat, +70° C
IEC 60068-2-3 — Damp Heat, +40° C @ 93% RH

Mechanical Environment

Vibration

IEC 60255-21-1 — Vibration response Class 1, 0.5 g
Vibration endurance Class 1, 1.0 g

IEC 60255-21-2 — Shock Response Class 1, 0.5 g
Shock Withstand Class 1, 15.0 g
Bump Endurance Class 1, 10.0g

Compliance

cULus-Listed per 508 – Industrial Control Equipment

– Industrial Control Equipment Certified for Canada CAN/USA C22.2 No. 14-M91

cULus-Listed per 508A – Table SA1.1 Industrial Control Panels

External Connections

M-3311A external connections points are illustrated in Figure 1 and 2.

Physical

Without Optional I/O Expansion Module

Size: 19.00" wide x 5.21" high x 10.20" deep (48.3 cm x 13.2 cm x 25.9 cm)

Mounting: The unit is a standard 19", semiflush, three-unit high, rack-mount panel design, conforming to ANSI/EIA RS-310C and DIN 41494 Part 5 specifications. Vertical or horizontal panel-mount options are available.

Approximate Weight: 16 lbs (7 kg)

Approximate Shipping Weight: 25 lbs (11.3 kg)

With Optional I/O Expansion Module

Size: 19.00" wide x 6.96" high x 10.2" deep (48.3 cm x 17.7 cm x 25.9 cm)

Mounting: The unit is a standard 19", semiflush, four-unit high, rack-mount panel design, conforming to ANSI/EIA RS-310C and DIN 41494 Part 5 specifications. Vertical or horizontal panel-mount options are available.

Approximate Weight: 19 lbs (8.6 kg)

Approximate Shipping Weight: 26 lbs (11.8 kg)

Recommended Storage Parameters

Temperature: 5° C to 40° C

Humidity: Maximum relative humidity 80% for temperatures up to 31° C, decreasing to 31° C linearly to 50% relative humidity at 40° C.

Environment: Storage area to be free of dust, corrosive gases, flammable materials, dew, percolating water, rain and solar radiation.

See M-3311A Instruction Book, Appendix E, Layup and Storage for additional information.

Patent & Warranty

The M-3311A Generator Protection Relay is covered by U.S. Patents 5,592,393 and 5,224,011.

The M-3311A Generator Protection Relay is covered by a five-year warranty from date of shipment.

Specification subject to change without notice.

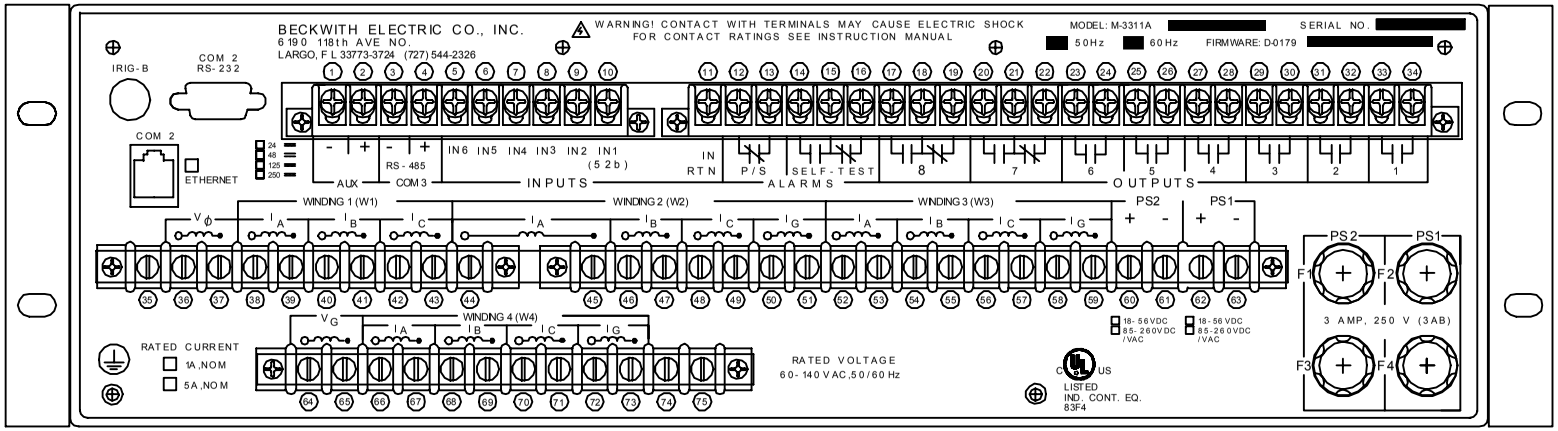


Figure 1 External Connections

■ NOTES:

1. Output contacts #1 through #4 contain special circuitry for high-speed operation, and close 4 ms faster than outputs 5 through 8. Outputs 1 through 6 are form “a” contacts (normally open) and outputs 7 and 8 are form “c” contacts (center tapped 'a' and 'b' contacts).
2. To comply with UL and CSA listing requirements, terminal block connections must be made with #12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector. Wire insulation must be rated at 60° C minimum. Terminal block connections 1 through 34 must be tightened to 12 inch-pounds torque. Terminal block connections 35 through 63 must be tightened to 8 inch-pounds torque.
3. Only dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact sensing inputs are internally wetted. **Application of external voltage on these inputs may result in damage to the unit.**
4. All relays are shown in the de-energized state, and without power applied to the relay
5. The power supply relay (P/S) is energized when the power supply is functioning properly.
6. The self-test relay is energized when the relay has performed all self-tests successfully.

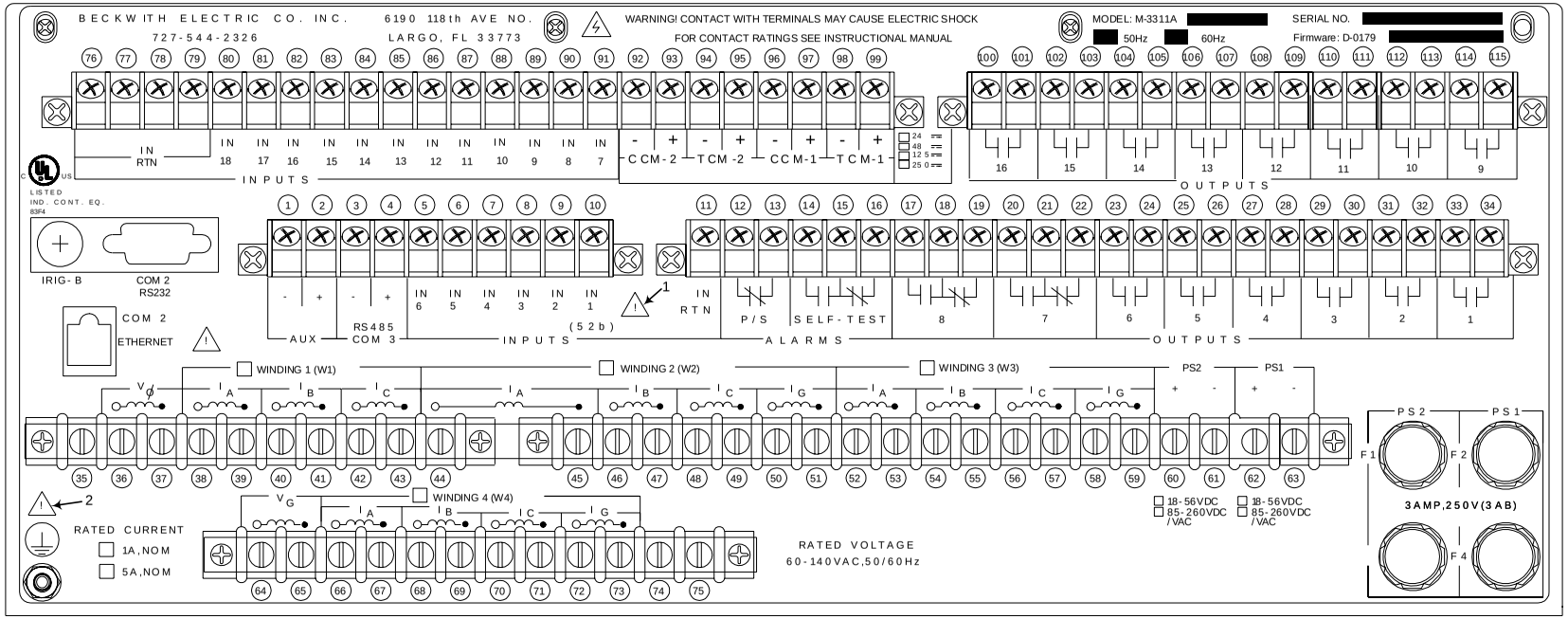


Figure 2 External Connections (With Optioanl Expanded I/0)

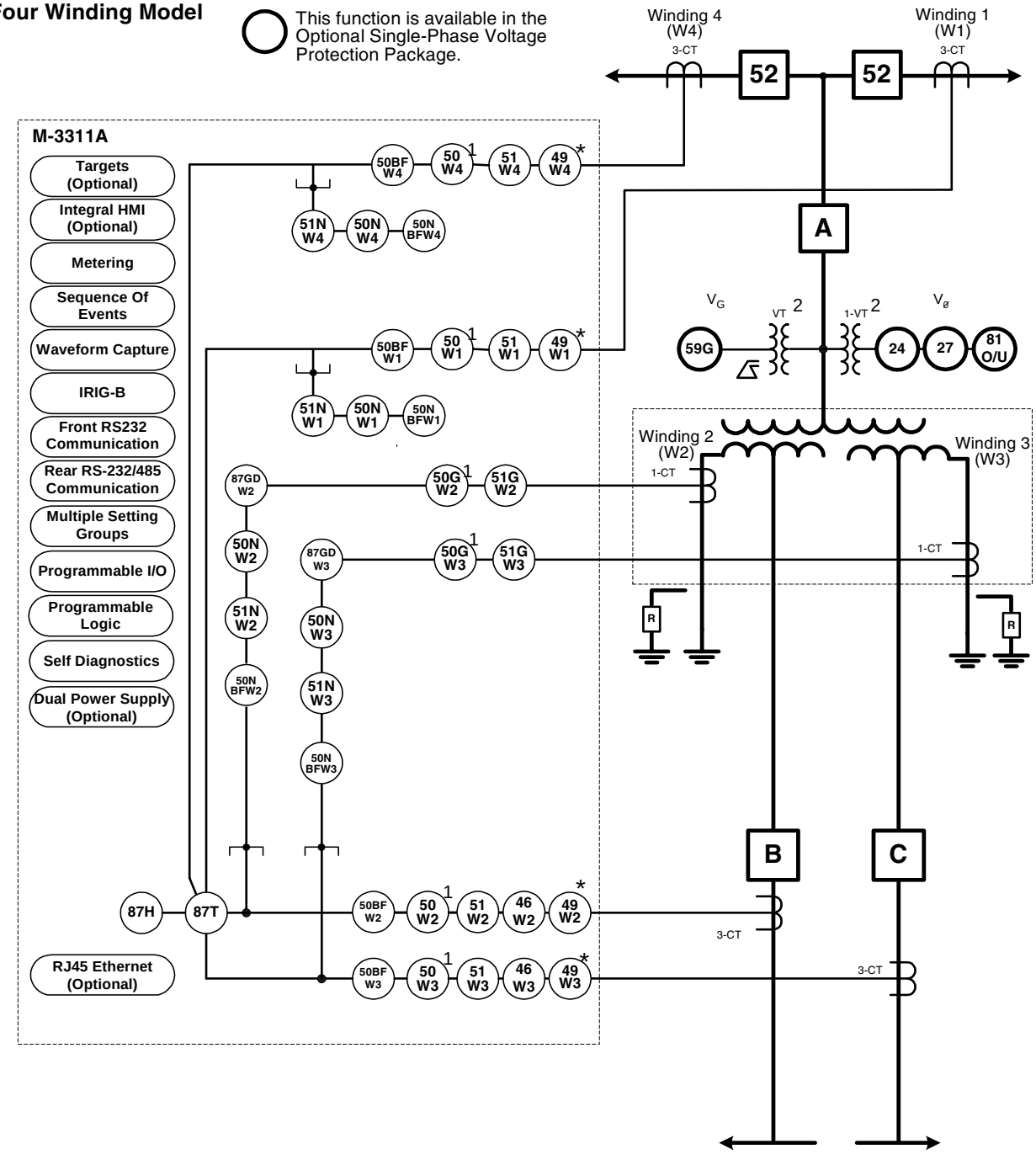
■ NOTES:

1. ● **WARNING: ONLY DRY CONTACTS must be connected to inputs (terminals 5 through 10 with 11 common and termianals 68 through 75 with 66 andf 67 common) becasue these contact inputs are internally wetted. Application of external voltage on these inputes may result in damage to the** units.
2. ● **WARNING: The protective grouinidng terminal must be connected to an earthed grouind any time external connections have been made to the unit.**

M-3311A Typical Connection Diagram Four Winding Model

This function is available as a standard protective function.

This function is available in the Optional Single-Phase Voltage Protection Package.



* 49 Function can only be enabled in one winding.

■ **NOTES:**

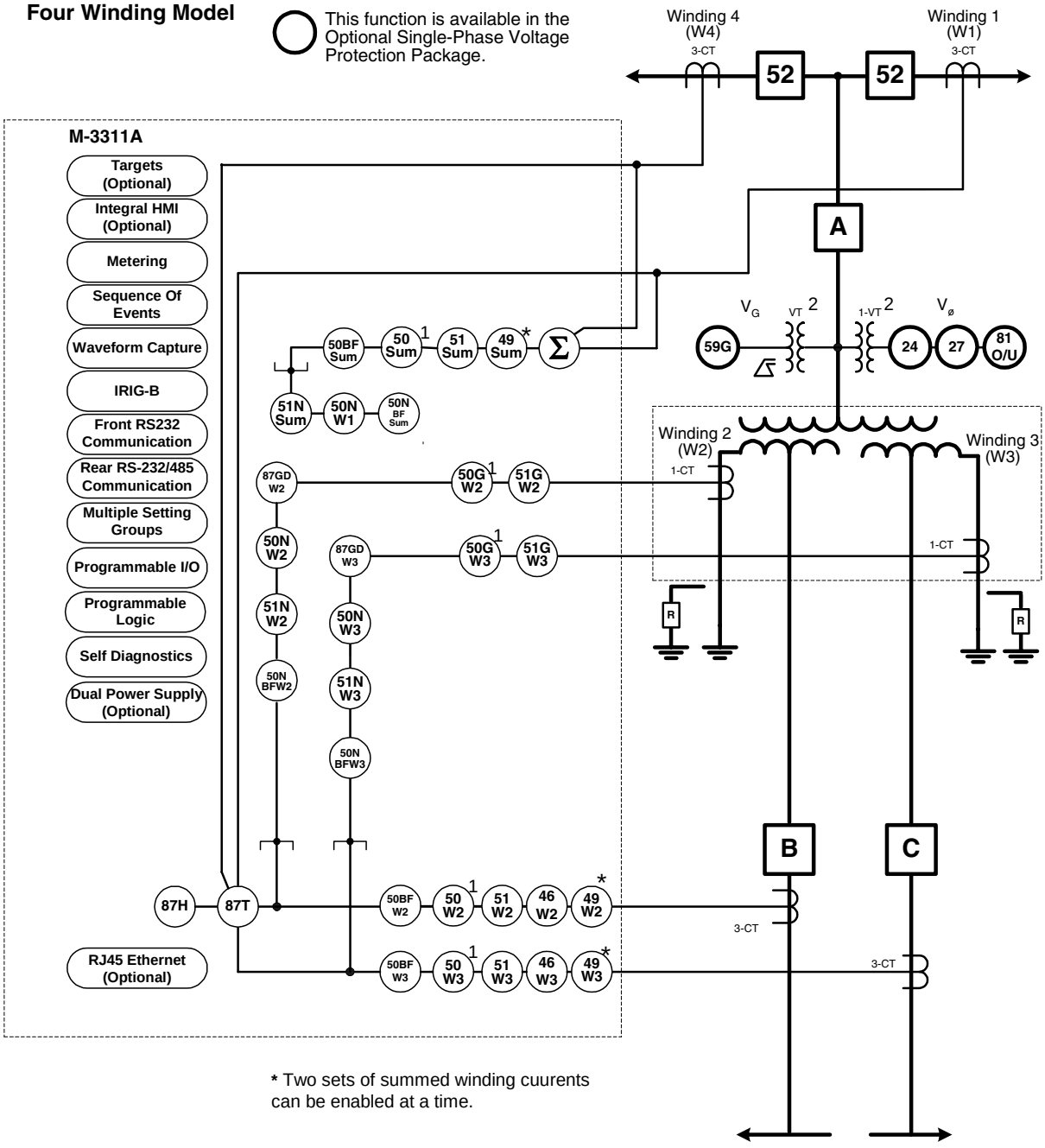
1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.
2. Two voltage inputs are available in the 4-winding model of the M-3311A. These are a phase voltage Vϕ use for the 81O/U, 27, and 24 Functions and the V_G broken delta input voltage used for the 59G function. These voltage inputs are not winding dependent.

Figure 3 M-3311A Typical One-Line Function Diagram

M-3311A Typical Connection Diagram Four Winding Model

This function is available as a standard protective function.

This function is available in the Optional Single-Phase Voltage Protection Package.



***** Two sets of summed winding cuurents can be enabled at a time.

* 49 Function can only be enabled in one winding.

■ **NOTES:**

1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.
2. Two voltage inputs are available in the 4-winding model of the M-3311A. These are a phase voltage V_ϕ use for the 81O/U, 27, and 24 Functions and the V_G broken delta input voltage used for the 59G function. These voltage inputs are not winding dependent.

Figure 4 Typical M-3311A Summing Currents One Line Functional Diagram

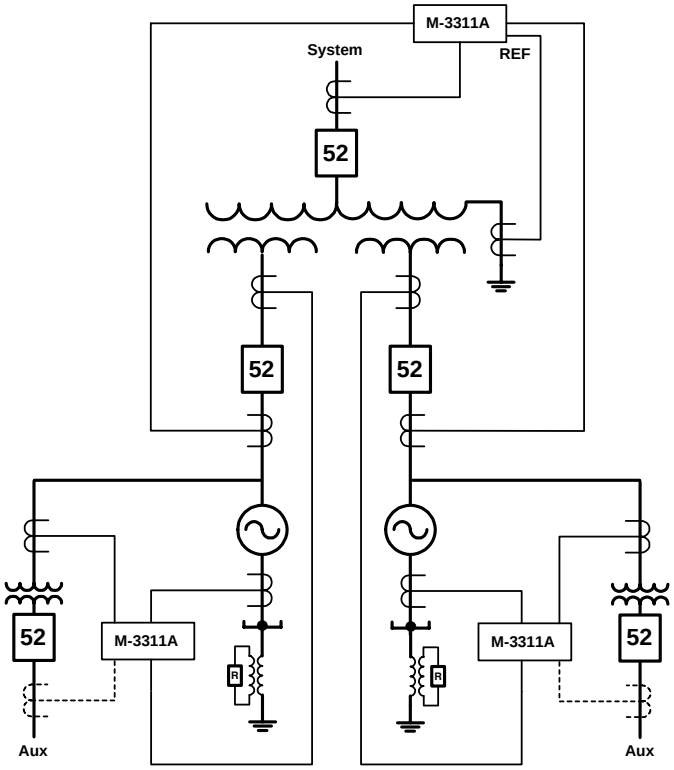


Figure 5 Dual Generator Power Plant Differential Zone of Protection

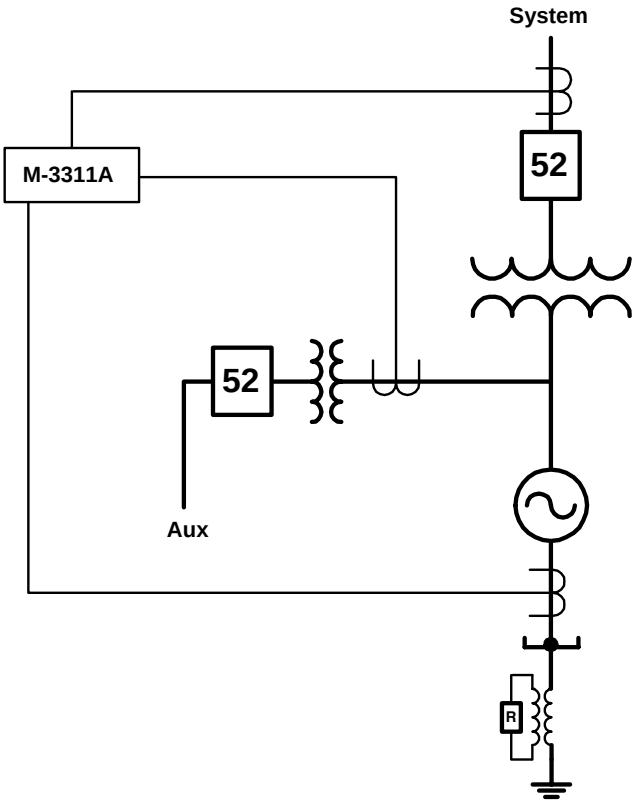


Figure 6 Generator Plant Overall Differential Zone of Protection

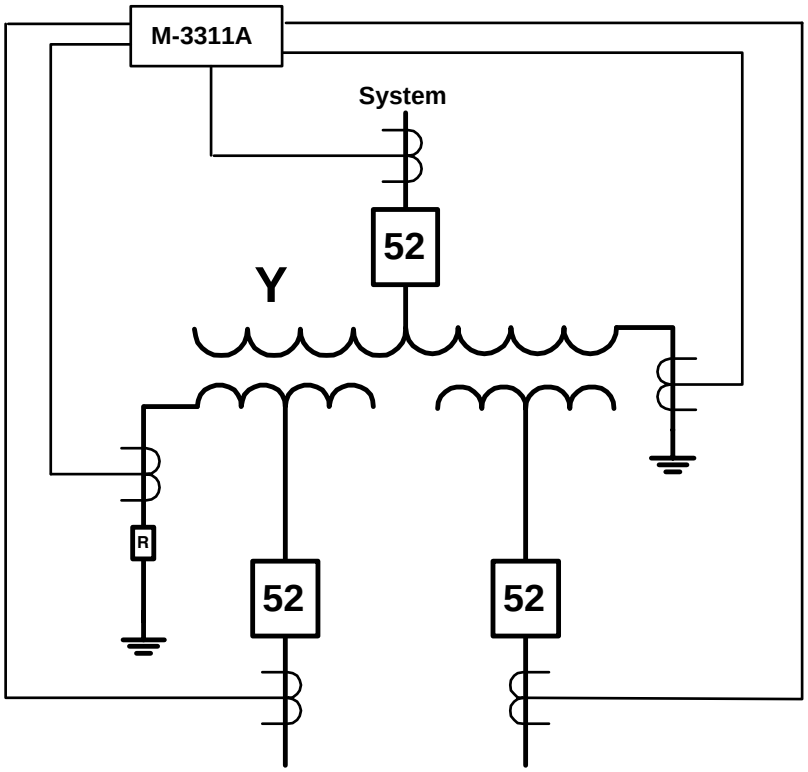


Figure 7 Three Winding Transformer with High Impedance Ground

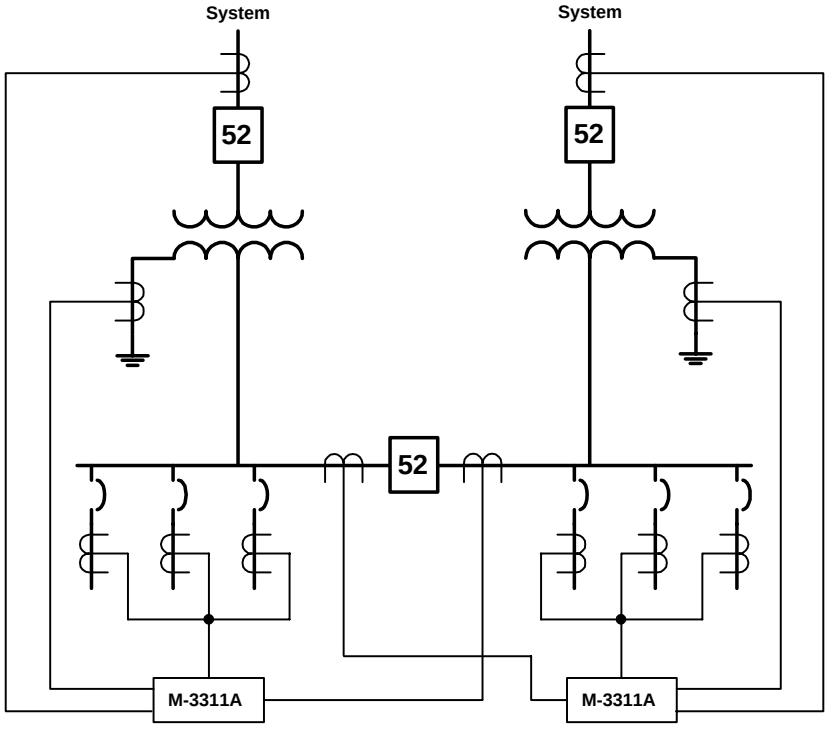
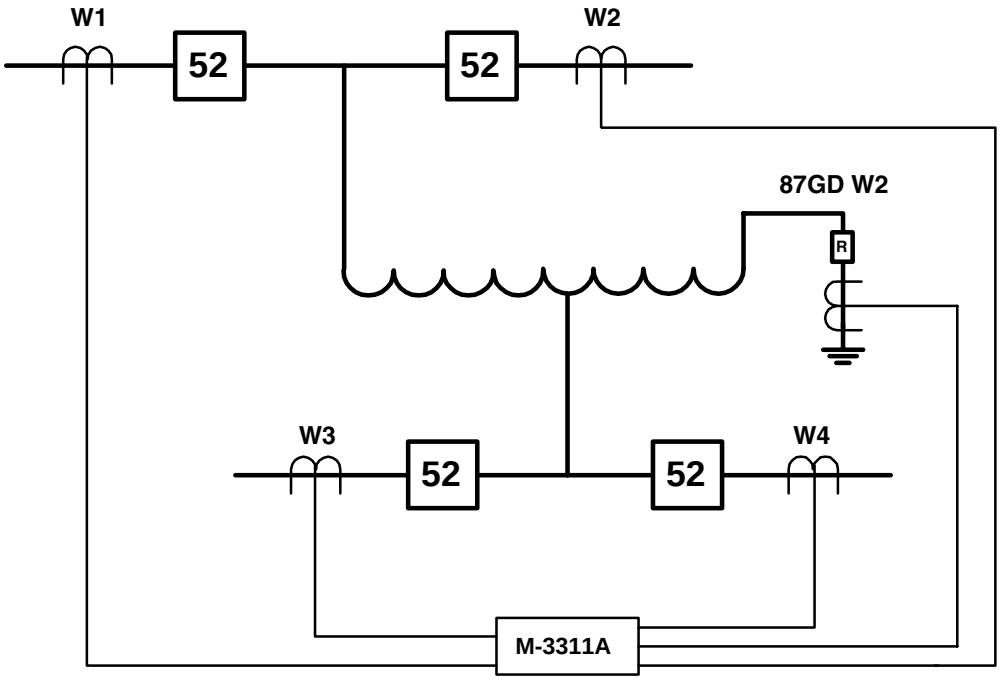


Figure 8 Dual Bank Distribution Substation



■ **NOTES:**

1. Winding 1 & 2 current summed and Winding 3 & 4 current summed for overcurrent function
2. 87GDW2 function $3I_o$ current is the sum of W1, W2, W3 and W4 currents.

Figure 9 Auto Transformer with two Circuit Breakers on High and Low Side

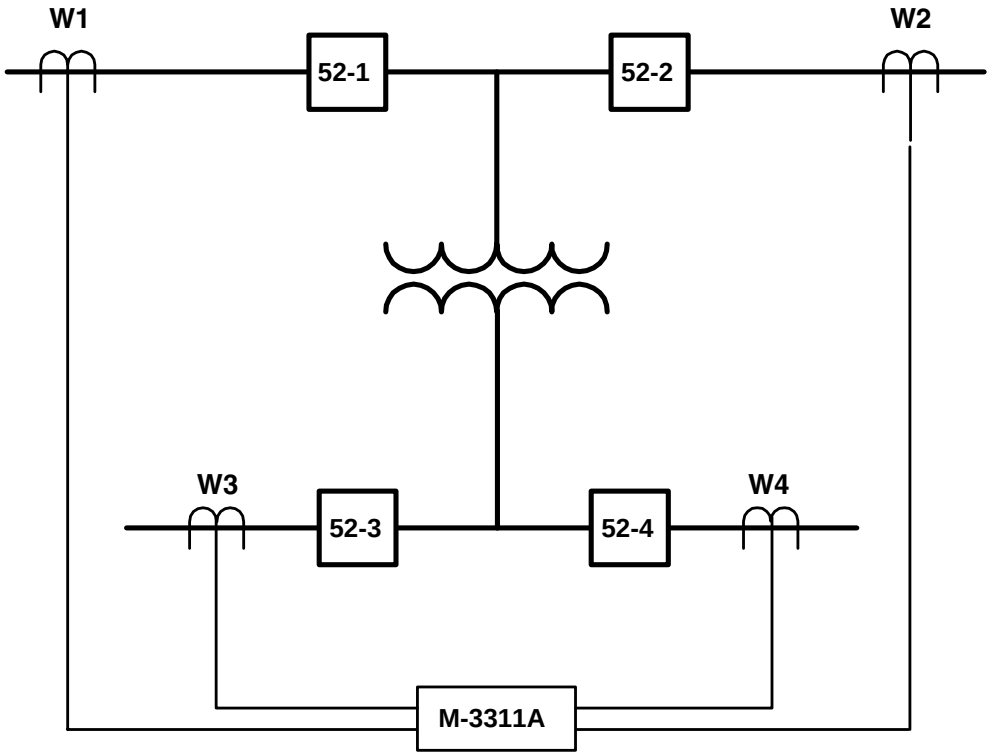


Figure 10 Two Winding Transformer with Two Circuit Breakers on High and Low Sides

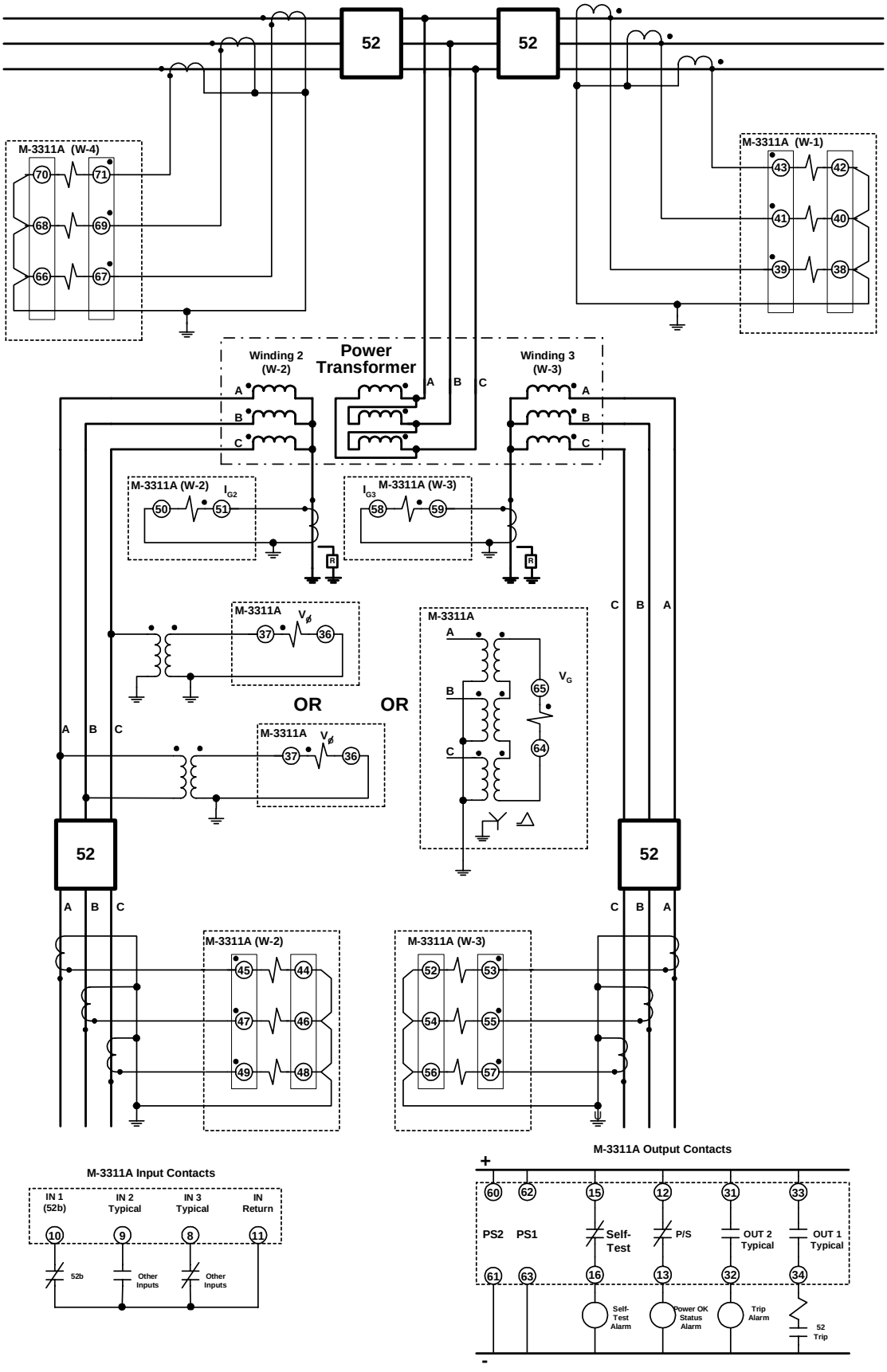
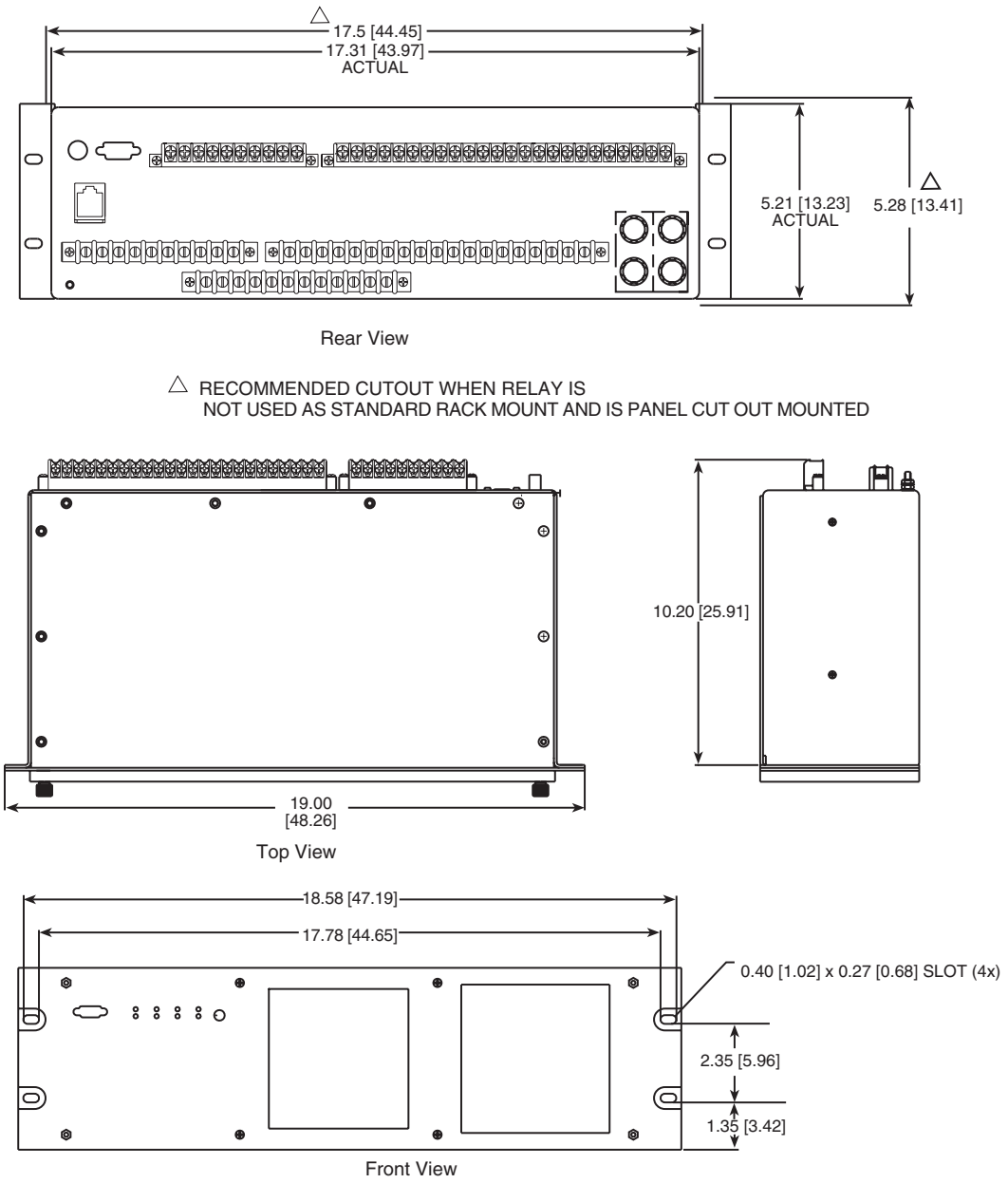


Figure 11 Typical Three-Line Connection Diagram



Standard 19" Horizontal Mount Chassis

■ **NOTE**: Dimensions in brackets are in centimeters.

Figure 12 Horizontal Mounting Dimensions

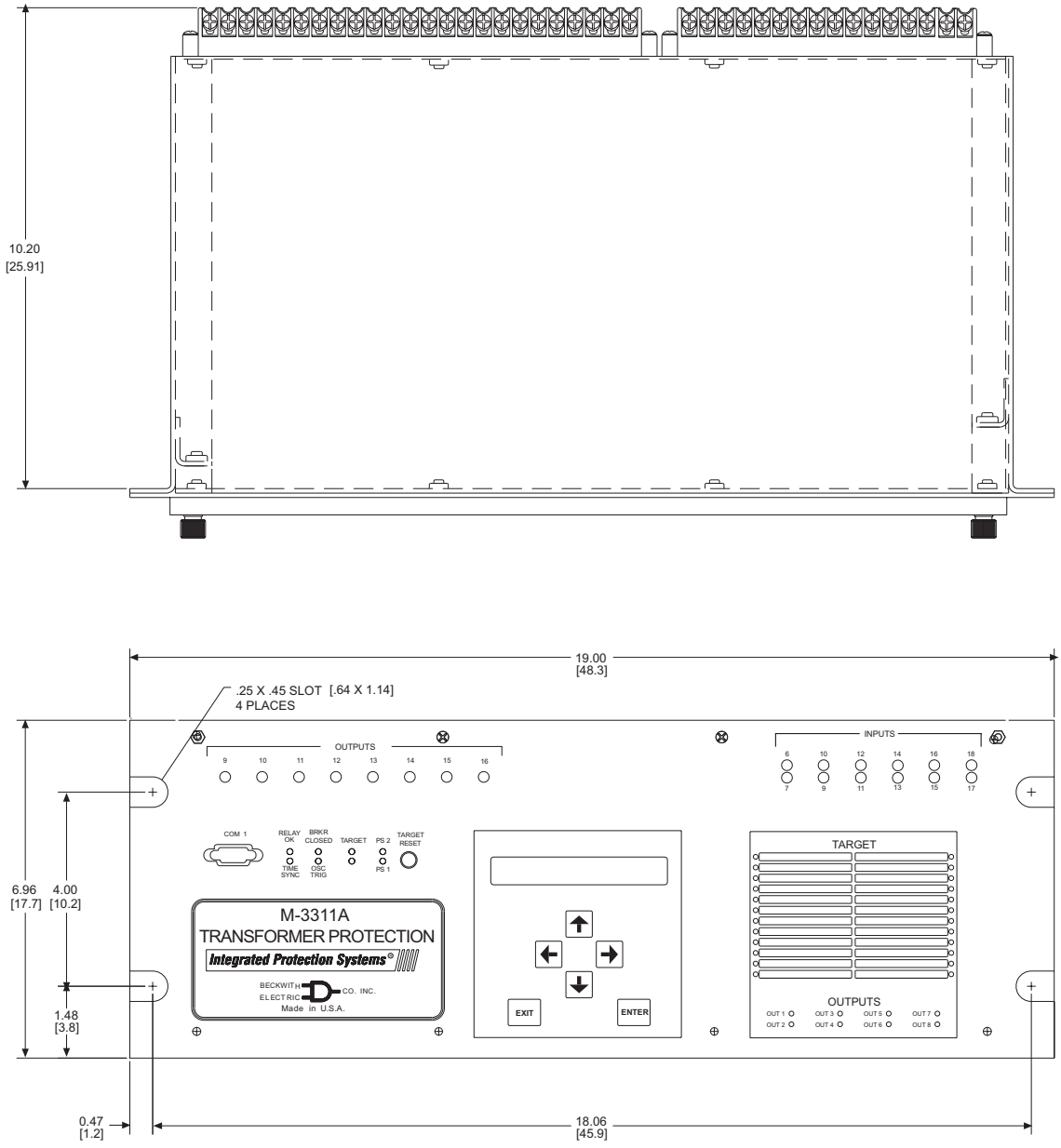
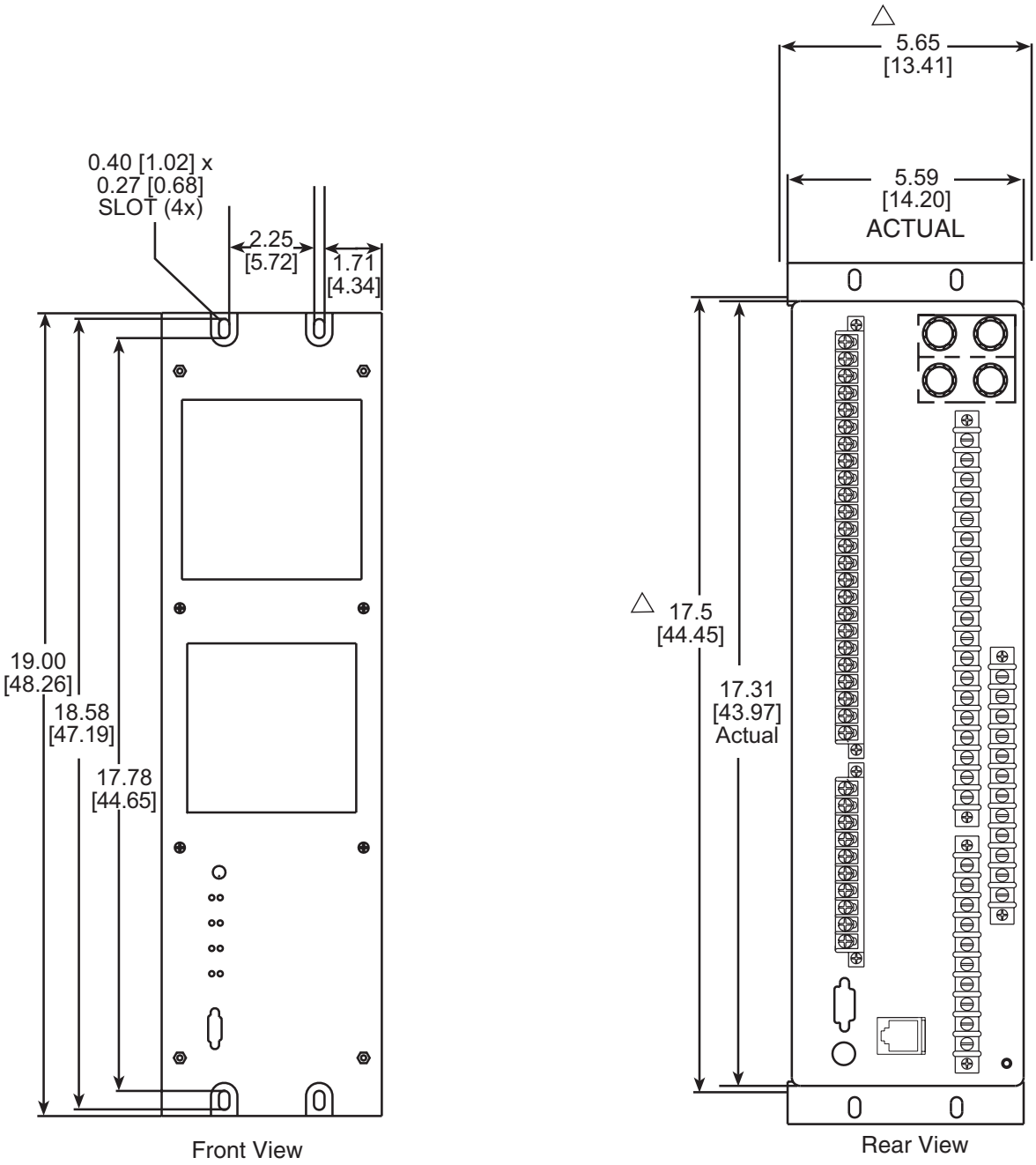


Figure 13 Horizontal Mounting Dimensions (With Expanded I/O)

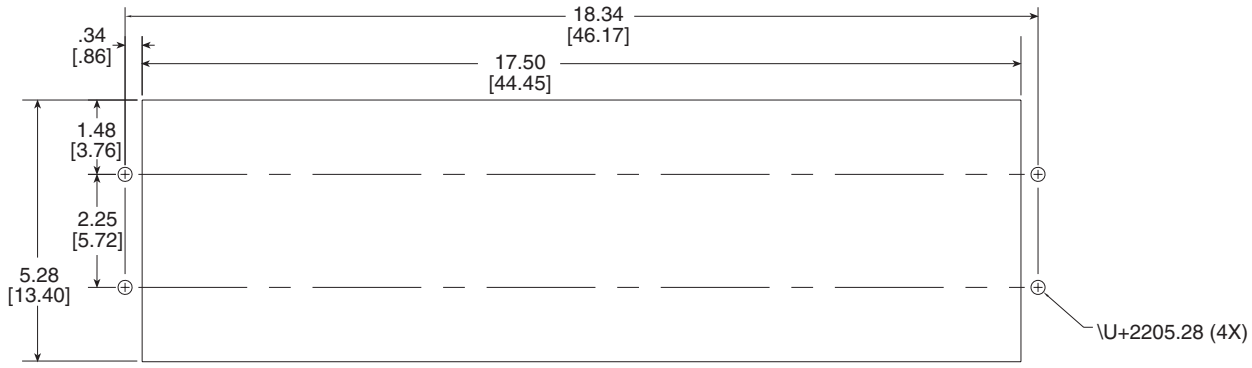


■ **NOTE**: Dimensions in brackets are in centimeters.

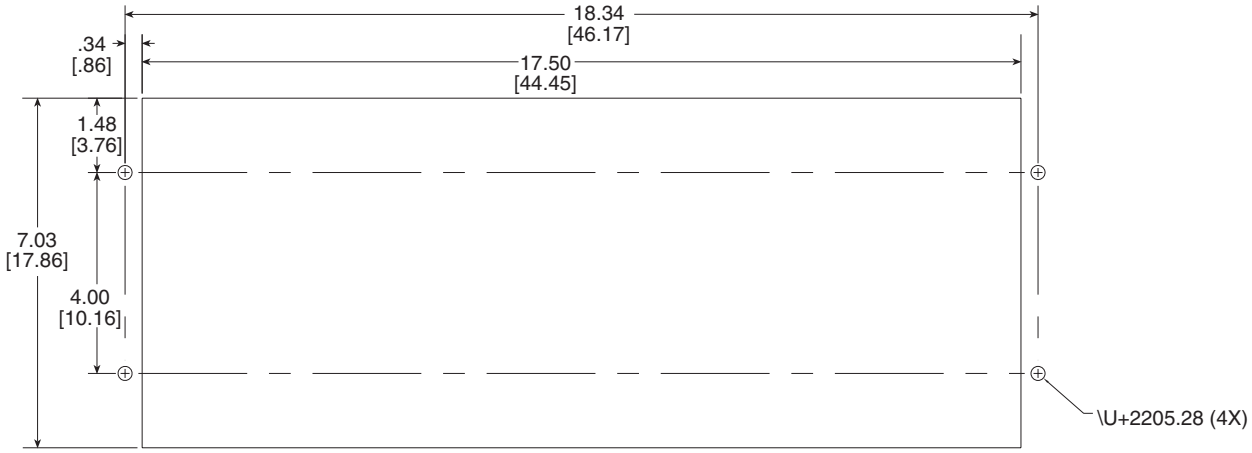
△ RECOMMENDED CUTOUT WHEN RELAY IS NOT USED AS STANDARD RACK MOUNT AND IS PANEL CUT OUT MOUNTED

Optional Vertical Mount Chassis

Figure 14 Vertical Mounting Dimensions



RECOMMENDED CUTOUT
STANDARD 3 UNIT PANEL M-3311A



RECOMMENDED CUTOUT
4 UNIT PANEL M-3311A (EXTENDED I/O)

TOLERANCE: .XX±.015

Figure 15 M3311A Panel Mount Cutout Dimensions

BECKWITH ELECTRIC CO., INC.
6190 - 118th Avenue North • Largo, Florida 33773-3724 U.S.A.
PHONE (727) 544-2326 • FAX (727) 546-0121
E-MAIL marketing@beckwithelectric.com
WEB PAGE www.beckwithelectric.com

800-3311A-SP-02MC1 03/08

WARNING

DANGEROUS VOLTAGES, capable of causing death or serious injury, are present on the external terminals and inside the equipment. Use extreme caution and follow all safety rules when handling, testing or adjusting the equipment. However, these internal voltage levels are no greater than the voltages applied to the external terminals.

DANGER! HIGH VOLTAGE

– This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

PERSONNEL SAFETY PRECAUTIONS

The following general rules and other specific warnings throughout the manual must be followed during application, test or repair of this equipment. Failure to do so will violate standards for safety in the design, manufacture, and intended use of the product. Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric Co., Inc. assumes no liability for the customer's failure to comply with these requirements.

– This sign means that you should refer to the corresponding section of the operation manual for important information before proceeding.

Always Ground the Equipment

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test area, the Protective Earth Terminal must be attached to a separate ground securely by use of a tool, since it is not grounded by external connectors.

Do NOT operate in an explosive environment

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible fire or explosion.

Keep away from live circuits

Operating personnel must not remove the cover or expose the printed circuit board while power is applied. In no case may components be replaced with power applied. In some instances, dangerous voltages may exist even when power is disconnected. To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

Exercise care during installation, operation, & maintenance procedures

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified personnel should install, operate, test, and maintain this equipment. Be sure that all personnel safety procedures are carefully followed. Exercise due care when operating or servicing alone.

Do not modify equipment

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair facility is preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure that safety features are maintained.

PRODUCT CAUTIONS

Before attempting any test, calibration, or maintenance procedure, personnel must be completely familiar with the particular circuitry of this unit, and have an adequate understanding of field effect devices. If a component is found to be defective, always follow replacement procedures carefully to that assure safety features are maintained. Always replace components with those of equal or better quality as shown in the Parts List of the Instruction Book.

Avoid static charge

This unit contains MOS circuitry, which can be damaged by improper test or rework procedures. Care should be taken to avoid static charge on work surfaces and service personnel.

Use caution when measuring resistances

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instruction Book, is likely to cause damage to the unit.

TABLE OF CONTENTS
M-3311A Transformer Protection
Instruction Book

Chapters Book 1 of 2 **Page**

Chapter 3 IPScom®

Chapter 4 System Setup and Setpoints

Chapter 4 System Setup and Setpoints (*cont*)

Chapter 6 Testing (*cont*)

Appendices

Chapter 1 Introduction

Chapter 2 Operation

Chapter 3 IPScom™

Chapter 3 IPScom™ (cont)

Chapter 4 System Setup and Setpoints

Chapter 4 System Setup and Setpoints (*cont*)

Figures Book 1 of 2 (*cont*) **Page**

Chapter 4 System Setup and Setpoints (*cont*)

Figures Book 2 of 2 **Page**

Chapter 5 Installation

Chapter 6 Testing

Appendix A

Appendix B

Appendix D

Tables Book 1 of 2 **Page**

Tables Book 2 of 2 **Page**

1 Introduction

1.1 Instruction Book Contents

This instruction book includes six Chapters and five Appendices.

Chapter 1: Introduction

Chapter One summarizes the devices' capabilities, introduces the instruction book contents and describes the application of an M-3311A.

Chapter 2: Operation

Chapter Two provides the necessary instructions regarding operation of the M-3311A. Manual operation of the M-3311A is accomplished by utilizing either the unit's front panel controls and indicators, which include the M-3931 Human Machine Interface (HMI) and M-3911 Status Module or through the M-3826 IPScom™ Communications and Oscillographic Analysis Software.

Chapter 3: IPScom

Chapter 3 provides a description of each element of the M-3826 IPScom Communications Software. The IPScom menu structure and commands are described in detail for each feature and function.

Chapter 4: System Setup and Setpoints

Chapter Four is designed for the person(s) responsible for the direct setting and configuration of the system. It describes the procedures for entering all required data into the M-3311A. Included in this chapter are functional and connection diagrams for a typical application for the system; and describes the configuration process for the unit (choosing active functions), output contact assignment and input blocking designation. It also illustrates the definition of system quantities and equipment characteristics required by the M-3311A, and describes the individual function settings.

Chapter 5: Installation

The person or group responsible for the installation of the M-3311A will find herein all mechanical information required for physical installation, equipment ratings, and all external connections in this chapter. For reference, the Three-Line Connection Diagrams are repeated from Chapter 4, **System Setup and Setpoints**. Further, a commissioning checkout procedure is outlined to check the external CT and VT connections. Additional tests which may be desirable at the time of installation are described in Chapter 6, **Testing**.

Chapter 6: Testing

This chapter provides step-by-step test procedures for each function, as well as diagnostic mode and auto-calibration procedures.

Appendix A: Configuration Record Forms

This Appendix supplies a set of forms to record and document the settings required for the proper operation of the M-3311A.

Appendix B: Communications

This Appendix describes communication port signals and various topologies and equipment required for remote communication.

Appendix C: Self-Test Error Codes

This Appendix lists all the error codes and their definitions.

Appendix D: Inverse Time Curves

This appendix contains a graph of the four families of Inverse Time Curves for V/Hz applications, the four standard and the four IEC overcurrent curves. Also included are three IEEE inverse time curves.

Appendix E: Layup and Storage

This Appendix provides the recommended storage parameters, periodic surveillance activities and layup configuration.

1.2 M-3311A Transformer Protection Relay

The M-3311A Transformer Protection Relay, is a microprocessor-based unit that uses digital signal processing technology to protect a high voltage transformer from internal winding faults, system faults (Through Faults), abnormal voltage and frequency, negative sequence current, overloading, and overexcitation (V/Hz) disturbances. The M-3311A also provides system wide protection by implementing breaker failure, load shedding, bus fault and digital feeder relay backup protection capability.

The available M-3311A Transformer Protective Functions are listed in Table 1-1. The nomenclature follows the standards of ANSI/IEEE Std. C37.2, Standard Electric Power Systems Device Function Numbers where applicable.

The control/status inputs can be programmed to block and/or to trigger the oscillograph recorder. Any of the functions or the control/status inputs can be individually programmed to activate any one or more of the programmable outputs, each with a contact.

The M-3931 Human Machine Interface (HMI) Module allows the user to access the following features and functions from the M-3311A front panel using a menu-driven, 2 line by 24 character alphanumeric display:

Settings

- Enter Comm settings
- Set Access Codes
- Set User Control Number
- Set display User Lines 1 and 2
- Set Date/Time

Functions

- Clear Alarm Counter
- Enter Diagnostic Mode
- Clear Error Codes

Status

- Metering of various quantities, including voltage, current, frequency and phase-angle
- I/O Status
- Alarm Counter
- M-3311A Unit Last Power Up Date and Time
- M-3311A Unit Firmware Version and Serial Number
- Error Codes
- Checksums

STANDARD FUNCTIONS	DESCRIPTION
46W2,3,4	Negative Sequence Overcurrent
49	Winding Thermal Protection (W1 or W2 or W3)
50 1-8	Instantaneous Phase Overcurrent
50BFW1,2,3,4	Breaker Failure
50GW2,3,4	Instantaneous Ground Overcurrent
50N1-8	Instantaneous Residual Overcurrent
51 1-8	Inverse Time Phase Overcurrent
51GW2,3,4	Inverse Time Ground Overcurrent
51N1-8	Inverse Time Residual Overcurrent
87	Phase Differential Current
87GDW2,3,4	Ground Differential
IPS	IPSlogic
OPTIONAL FUNCTIONS	**DESCRIPTION**
24	Volts per Hertz
27	Phase Undervoltage
59G	Ground Overvoltage
81O/U	Over/Under Frequency

Table 1-1 M-3311A Device Functions

The relay provides storage of time-tagged target information for the 32 most recent trip events. Also included are self-test, self-calibration and diagnostic capabilities. The M-3911A Target Module LEDs are used to provide a detailed visual indication of function operation for the most recent event.

The M-3311A retains up to 311 cycles of oscillograph waveform data assignable to up to 24 events with selectable post-trigger delay. This data can be downloaded and analyzed using the M-3801D IPSplot™ *PLUS* Oscillograph Analysis Software.

The unit is powered from a wide range switch mode power supply. An optional redundant power supply is available for units without the Expanded I/O. When expanded I/O option is selected, the unit includes the second power supply.

The M-3311A includes self-test, auto calibration, and diagnostic capabilities, in addition to IRIG-B time-sync capability for accurate time-tagging of events.

Communication Ports

The M-3311A includes three physical communication ports. If the optional RJ45 Ethernet port is purchased, then the relay includes four physical communication ports:

- COM1, located on the relay front panel, is a standard 9-pin RS-232 DTE-configured port. COM1 is used to locally set and interrogate the relay using a portable computer.
- COM2, located on the rear of the relay, is a standard 9-pin RS-232 DTE-configured port. When the optional RJ45 Ethernet Port is enabled, COM2 port is disabled for communications. The demodulated IRIG-B may still be used via the COM2 Port when ethernet is enabled.

  The RJ45 Ethernet port uses a 10Base-T type connection that accepts an RJ45 connector using CAT5 twisted pair cable. The Ethernet port supports MODBUS over TCP/IP. The IP address can be obtained automatically when using the DHCP protocol if enabled, or a static IP address can be manually entered, using the HMI.
- COM3, located on the rear terminal block of the relay, is an RS-485 communications port.

The relay may be remotely set and interrogated utilizing either a hard-wired RS-232 serial connection or modem (COM2 when activated as RS-232, or COM3), or when purchased, the ethernet connection (RJ45 activated).

Detailed information regarding the use of the relay communications ports is provided in **Appendix B, Communications**, as well as Chapter 3, **IPScom®** .

The system may be remotely set and interrogated utilizing either a hard-wired RS-232 serial connection or modem (COM2 when activated as RS-232, or COM3), or when purchased, the ethernet connection (RJ45 activated).

M-3826 IPScom Communications Software

Each M-3311A unit includes the M-3826 IPScom Communications Software. The IPScom communications software runs on an IBM PC compatible computer running under Windows 95/98 or greater, providing remote access to the relay using either direct serial connection or modem. IPScom provides the following communication functions:

- Setpoint interrogation and modification
- Real-time metering and I/O status monitoring
- Stored target interrogation
- Recorded oscillographic data downloading
- Real time Phasor display

See Chapter 3, **IPScom** for an overview of IPScom features.

1.3 Accessories

M-3911A Target Module

The optional target module shown in Figure 1-1 includes 24 individually labeled **TARGET** LEDs to target the operation of the functions on the front panel. Eight individually labeled **OUTPUT** LEDs will be illuminated as long as any output is picked up.

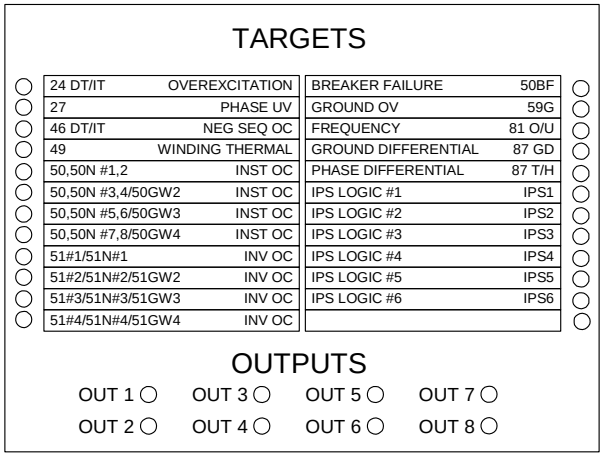


Figure 1-1 M-3911A Target Module

M-3933/M-0423 Serial Communication Cables

The M-3933 cable is a 10-foot RS-232 cable for use between the M-3311A rear panel (COM2) port and a modem. This cable includes a DB25 (25-pin) connector (modem) and a DB9 (9-pin) at the relay end.

The M-0423 cable is a 10-foot null-modem RS-232 cable for direct connection between a PC and the M-3311A front panel COM1 port, or the rear COM2 port. This cable includes a DB9 (9-pin) connector at each end.

M-3931 Human-Machine Interface (HMI) Module

The optional HMI module shown in Figure 1-2, provides a means to interrogate the relay and to input settings, access data, etc. directly from the front of the relay. Operation of the module is described in detail in Section 2.1, **Front Panel Controls and Indicators**.

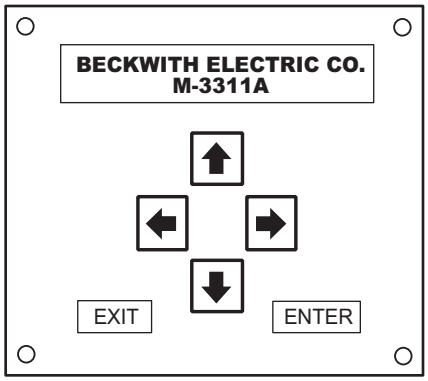


Figure 1-2 M-3931 Human-Machine Interface (HMI) Module

M-3801D IPSplot™*Plus* Oscillograph Analysis Software

The IPSplot™*Plus* Oscillograph Analysis Software runs in conjunction with IPScom software on any IBM PC-compatible computer running Windows 95/ 98 or greater, to enable the plotting and printing of waveform data downloaded from the M-3311A Transformer Protection Relay.

M-3933/M-0423 Serial Communications Cable

The M-3933 cable is a 10-foot straight-through RS-232 modem cable for use between the relay's rear-panel (COM2) port and a modem. This cable has a DB25 (25-pin) connector (modem) and a DB9 (9-pin) at the M-3311A end.

The M-0423 cable is a 10-foot null-modem RS-232 cable for direct connection between a PC and the relay's front-panel COM1 port or the rear COM2 port. This cable has DB9 (9-pin) connectors at each end.

M-3949 Redundant Low Voltage Power Supply

Redundant 24/48 V dc supply (For Non-Expanded I/O units).

M-3948 Redundant High Voltage Power Supply

Redundant 110/250 V dc supply (For Non-Expanded I/O units).

2 Operation

This chapter contains information that describes the operation of the M-3311A Transformer Protection Relay. See Chapter 4 for System Setup, Configuration and Setpoint information. M-3311A operation from either IPScom or HMI includes the following:

- Front Panel Controls and Indicators
- Status Monitoring
  - Voltage, Current, Frequency and Volts/Hz Monitoring
  - Input/Output Status
  - Timer Status
  - Counter Status (Input, Output, Alarm)
  - Time of Last Power Up
  - Error Codes
  - Checksum
- Demand
  - Demand Currents
  - Maximum Demand Current
  - Clear Maximum Demand Current
- Target History
  - View Target History
  - Clear Target History
- Oscillograph Recorder
  - View Recorder Status
  - Retrieve Records
  - Trigger Oscillograph
  - Clear Records
- Miscellaneous
  - Software Version
  - Serial Number
  - Alter User Access Codes
  - Clear Output Counters
  - Clear Alarm Counters
  - Reset Counters
  - Clear Error Codes
- Through Fault Recorder
  - Retrieve Records
  - View Records
  - Clear Records
- Sequence of Events Recorder
  - Retireve Records
  - View Records
  - Clear Records

2.1 Front Panel Controls and Indicators

This section describes the operation of the M-3311A as a function of the M-3931 Human Machine Interface Module (HMI) and the M-3911A Target Module.

The M-3311A can be interrogated locally with the HMI panel. An integral part of the design is the layout and function of the front panel indicators and controls, illustrated in Figure 2-1.

Alphanumeric Display

The HMI module consists of a 2 x 24-character alphanumeric display. To assist the operator in operating and interrogating the relay locally, the HMI displays menus which guide the operator to the desired function or status value. These menus consist of two lines. The bottom line lists lower case abbreviations of each menu selection with the chosen menu selection shown in uppercase. The top menu line provides a description of the chosen menu selection.

Screen Blanking

The display will automatically blank after exiting from the Main Menu, or from any screen after five (5) minutes of unattended operation. To wake up the display, the user must press any key except **EXIT**.

Arrow Pushbuttons

The left and right arrow pushbuttons are used to choose among the displayed menu selections. When entering values, the left and right arrow pushbuttons are used to select the digit (by moving the cursor) of the displayed setpoint that will be increased or decreased by the use of the up and down pushbuttons.

The up and down arrow pushbuttons increase or decrease input values or change between upper and lower case inputs. If the up or down pushbutton is pressed and held when adjusting numerical values, the speed of increment or decrement is increased.

If the up or down arrow pushbutton is held in the depressed position when adjusting numerical values, the speed of the increment or decrement is increased, after a small delay.

EXIT Pushbutton

The **EXIT** pushbutton is used to exit from a displayed screen and move up the menu tree. Any changed setpoint in the displayed screen will *not* be saved if the selection is aborted using the **EXIT** pushbutton.

ENTER Pushbutton

The **ENTER** pushbutton is used to choose a highlighted menu selection, to replace a setting or other programmable value with the currently displayed value, or to move down within the menu tree.

RELAY OK LED

The Green **RELAY OK** LED is controlled by the unit's microprocessor. A flashing **RELAY OK** LED indicates proper program cycling. The LED can also be programmed to be continuously illuminated to indicate proper program cycling.

Time Sync LED

The green **TIME SYNC** LED illuminates to indicate that the IRIG-B time signal is being received and validated.

Breaker Closed (BRKR CLOSED) LED

The red **BRKR CLOSED** LED illuminates when the breaker status input (52b) is open.

Diagnostic LED (DIAG)

The diagnostic LED flashes upon the occurrence of a detectable self-test error. The LED will flash the Error Code Number. For example, for error code 32, the LED will flash 3 times, followed by a short pause, and then 2 flashes, followed by a long pause, and then repeat. For units equipped with the HMI, the Error Code Number is also displayed on the screen.

Power Supply (PS1) and (PS2) LEDs

The green power LED indicator (for the appropriate power supply) will be illuminated whenever power is applied to the unit and the power supply is functioning properly. Power supply PS2 is available as an option, for units without expanded I/O.

Target LED

When a condition exists that causes the operation of Outputs 1 through 8 (1 through 16 for units with expanded I/O), the **TARGET** LED will illuminate, indicating a relay operation. The **TARGET** LED will remain illuminated until the condition causing the trip is cleared, and the operator presses the **TARGET RESET** pushbutton.

Detailed information about the cause of the last 8 operations is retained in the unit's memory for access through the alphanumeric display from the **VIEW TARGET HISTORY** menu.

M-3911A Target Module and Target Reset Pushbutton

For units equipped with the optional M-3911A Target Module, additional targeting information is available. The Target module includes an additional 24 target LEDs, and 8 output status LEDs. LEDs corresponding to the particular operated function as well as the present state of the outputs are available.

Pressing and holding the **TARGET RESET** pushbutton will display the present pickup status of all functions available on the target module. This is a valuable diagnostic tool which may be used during commissioning and testing.

Detailed information about the cause of the last 32 operations is retained in the unit's memory for access through the alphanumeric display from the **VIEW TARGET HISTORY** menu.

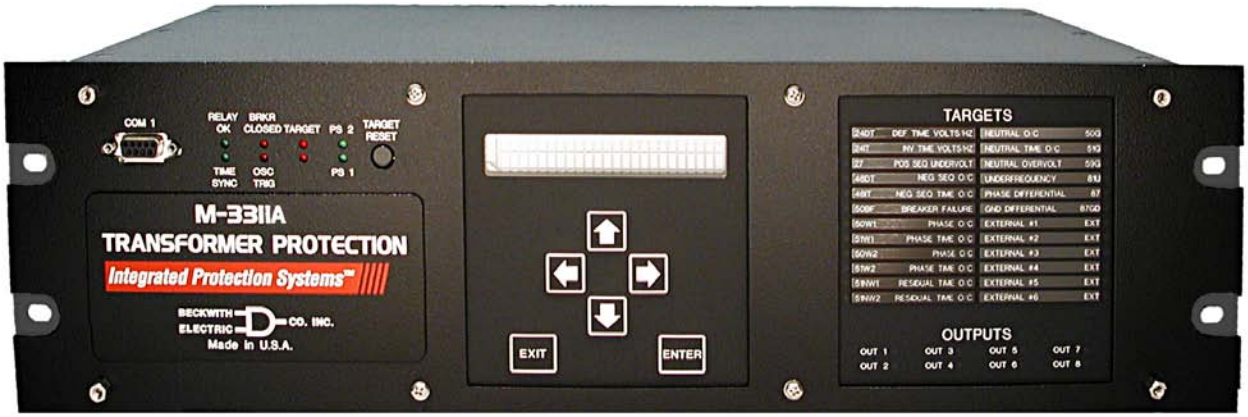


Figure 2-1 M-3311A Front Panel

2.2 Operation (HMI/PC)

The purpose of this section is to describe the steps that are necessary to interrogate the M-3311A utilizing either the optional M-3931 HMI or a PC running M-3826 IPScom® Communications software through COM1 the front RS-232 serial port. These instructions assume that the following conditions exist:

- The unit is energized from an appropriate power supply.

  See Chapter 5, **Installtion**, Section 5.3, External Connections, for power supply connection details.

- For PC communications, IPScom is installed on the host PC.

  See Chapter 5, **Installtion**, Section 5.6, IPScom Communications Software Installation, if IPScom is not installed.

- For PC communication, intital PC communication has been estabilised with the unit.

  If this is the first attempt to establish communications with the unit, then see See Chapter 5, **Installtion**, Section 5.7, Activating Initial Local Communications.

HMI Operation Overview

Whenever power is applied to the unit the Power On Self Test sequence is intitated (Figure 2-2).

Default Message Screens

When the M-3311A is energized and unattended, the user logo lines are blank.

If a protective function has operated and has not been reset, the HMI will display the target(s) with the time and date of the operation and automatically cycle through target screen for each applicable target. This sequence is illustrated in Figure 2-2.

In either case, pressing the **ENTER** pushbutton will begin local mode operation by displaying the access code entry screen, or if access codes are disabled, the first level menu will be displayed (Figure 2-3).

HMI Security

To prevent unauthorized access to the relay functions, the relay includes the provision for assigning access codes. If access codes have been assigned, the access code entry screen will be displayed after **ENTER** is pressed from the default message screen. The relay is shipped with the access code feature disabled.

The relay includes three levels of access codes. Depending on the access code each level holds, users have varying levels of access to the relay functions.

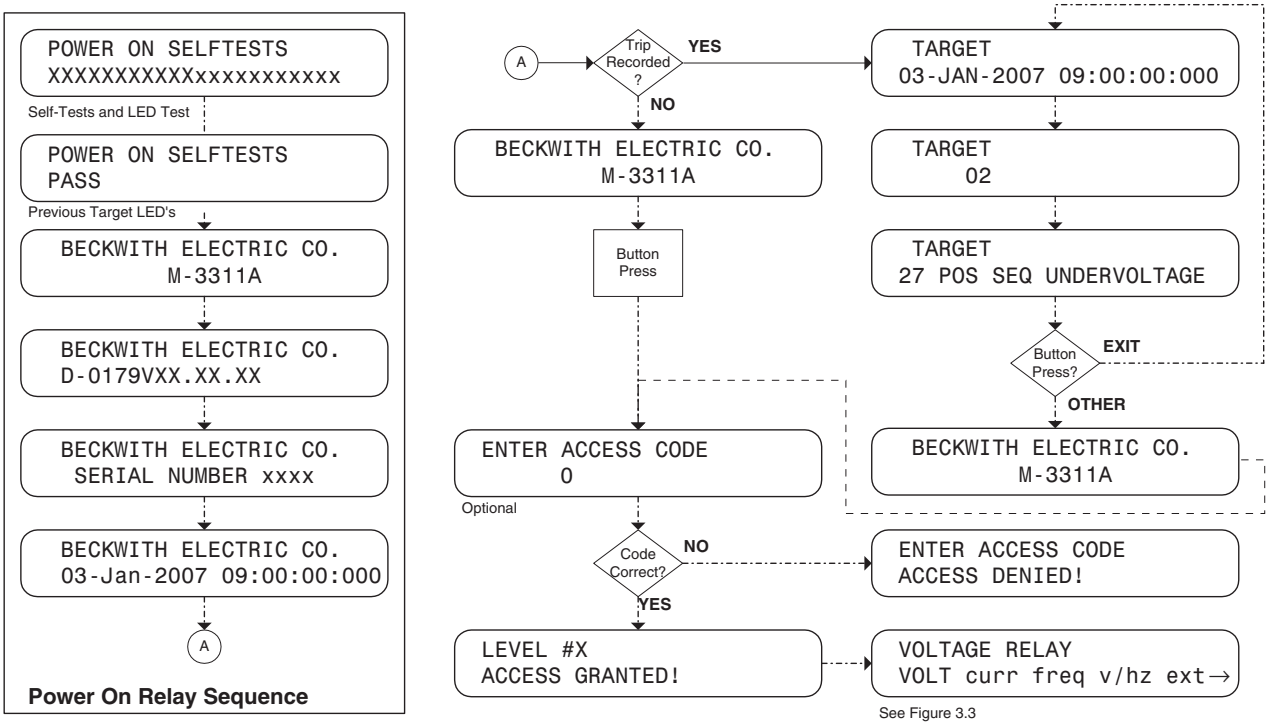


Figure 2-2 Screen Message Menu Flow

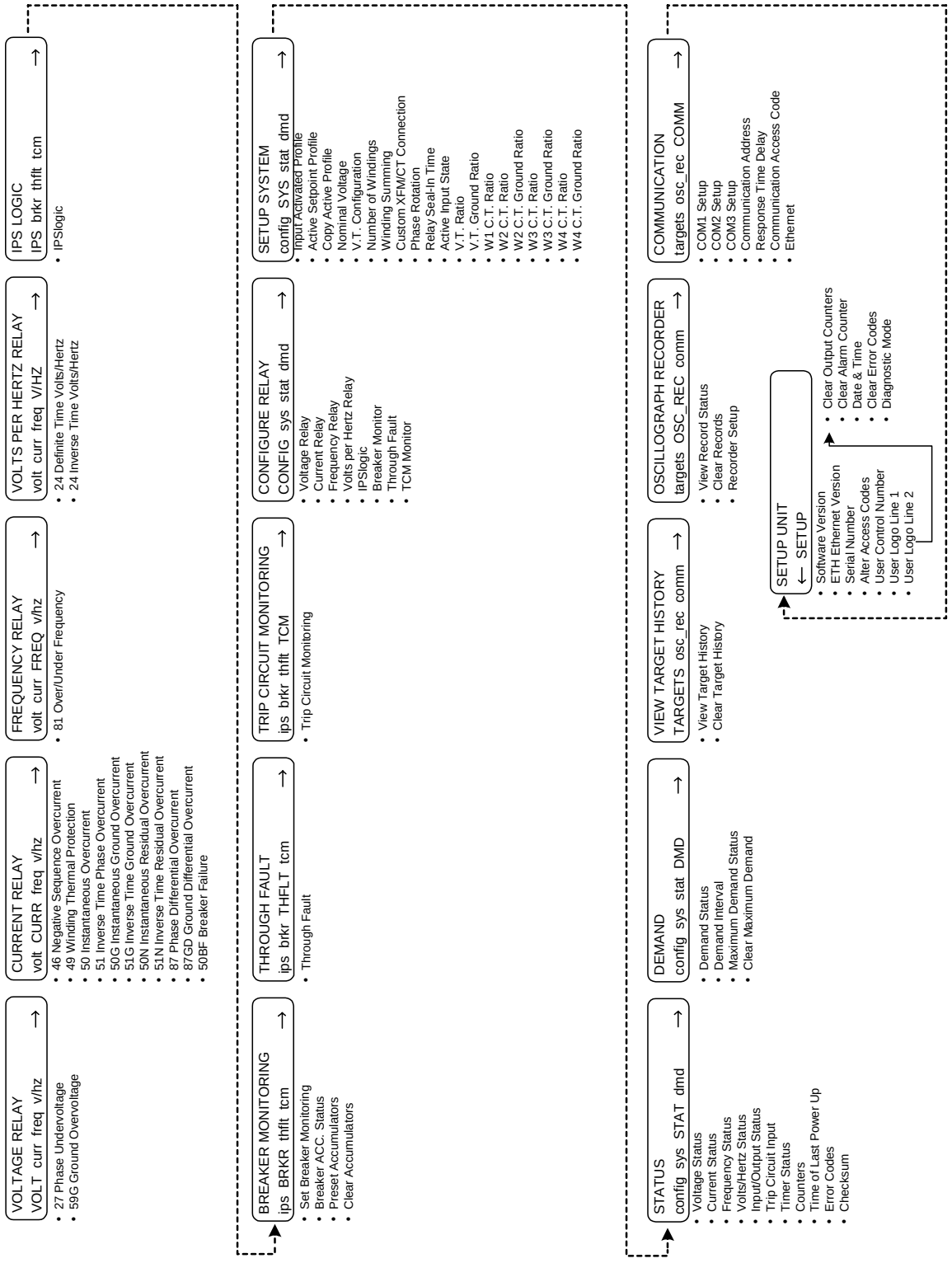


Figure 2-3 Main HMI Menu Flow

Level 3 Access: provides access to all M-3311A configuration functions and settings.

Level 2 Access:provides access to read & change setpoints, monitor status and view target history.

Level 1 Access: provides access to read setpoints, monitor status and view target history.

Each access code is a user defined 1 to 4 digit number. If the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access screens are bypassed. Access codes are altered by choosing the **ALTER ACCESS CODES** menu under **SETUP UNIT** menu. (These codes can only be altered by a level 3 user).

Status Monitoring (From Relay Front Panel)

The HMI menu categories for monitored values are:

- **Voltage Status** (V_A and V_G phase voltages)
- **Current Status (Secondary)**

  Phase Currents, W1 — W4

  Ground Current, W2 — W4

  Restraint Current (PU), Phase A/B/C

  Differential Current Fund. (PU), Phase A/B/C

  Differential Current (PU), 2nd, 4th and 5th Harmonic

  Ground Differential Current, W2 — W4

  Positive Sequence Current, W1 — W4

  Negative Sequence Current, W1 — W4

  Zero Sequence Current, W1 — W4

  Function 49 Thermal Current, Phase A/B/C
- **Frequency Status**
- **Volts/Hz Status**
- **I/O Status** (Input and Output Contacts)
- **Trip Circuit Monitor**
- **Timer Status**
- **Counter Status** (Input, Output, Alarm)
- **Time of Last Power up**
- **Error Codes**
- **Checksums** (Setpoints, Calibration, ROM)

To access the **STATUS** menu and begin monitoring, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
STATUS
config sys STAT dmd
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
VOLTAGE STATUS
VOLT curr freq v/hz
```

6. Press the Right or Left arrow pushbutton until the desired parameter is selected (upper case), then press **ENTER**. The HMI will display the selected parameter.
7. Press the **ENTER** pushbutton to move down within the **STATUS** menu to the desired category. To exit a specific category and continue to the next menu category, press the **EXIT** pushbutton.

Status Monitoring (From IPScom®)

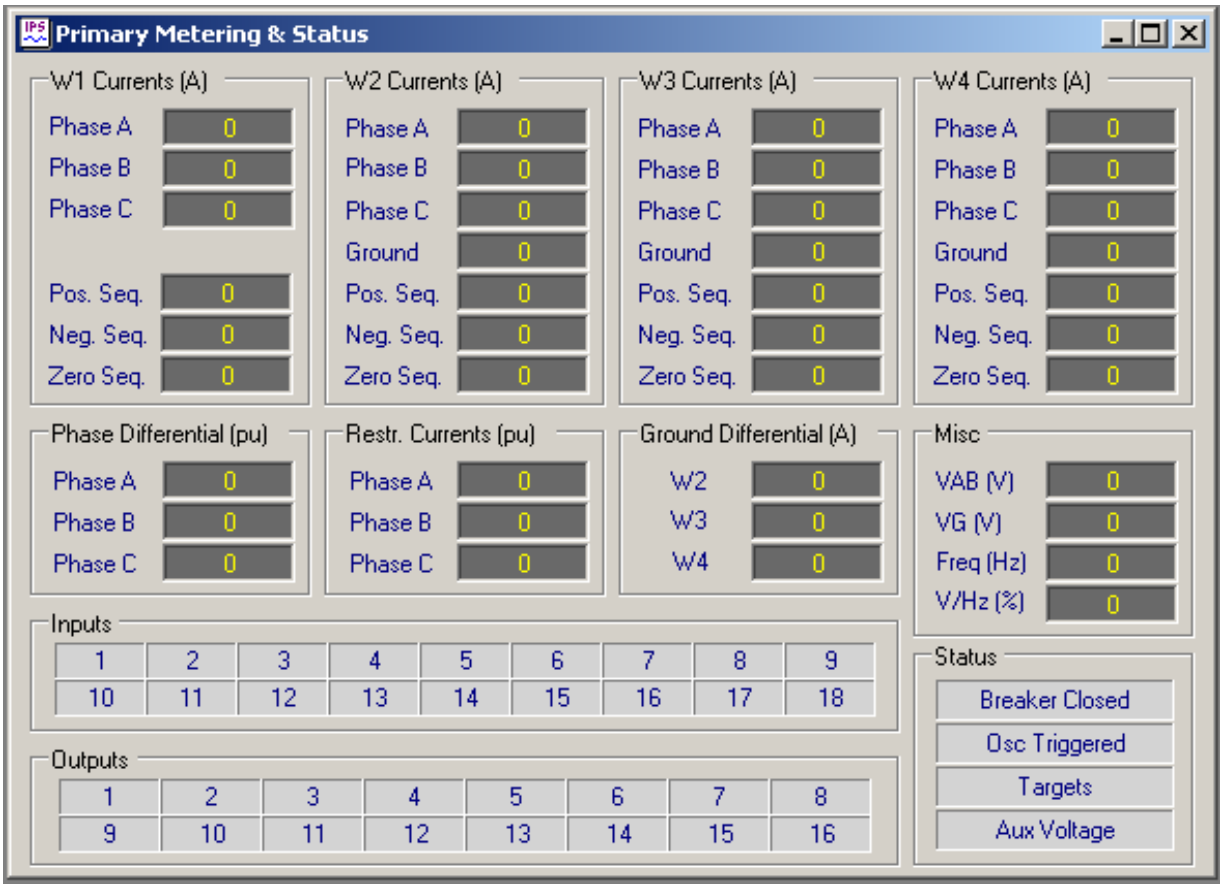
PRIMARY METERING AND STATUS

To access the **PRIMARY METERING AND STATUS** parameters utilizing IPScom, select **Monitor/Primary Metering and Status** from the IPScom Main Screen drop down menu. IPScom will display the Primary Metering & Status dialog screen (Figure 2-4) which includes the following **PRIMARY** parameters:

- Voltage (V_A and V_G phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current (W1 — W4)
- Ground Current (W2 — W4)
- Positive Sequence Current (W1 — W4)
- Negative Sequence Current (W1 — W4)
- Zero Sequence Current (W1 — W4)
- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current (W2 — W4)

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- Aux Voltage



Path: Monitor / Primary Metering & Status

Figure 2-4 Primary Metering & Status Screen

SECONDARY METERING AND STATUS

To access the **SECONDARY METERING AND STATUS** parameters utilizing IPScom®, select **Monitor/Secondary Metering and Status** from the IPScom Main Screen drop down menu.

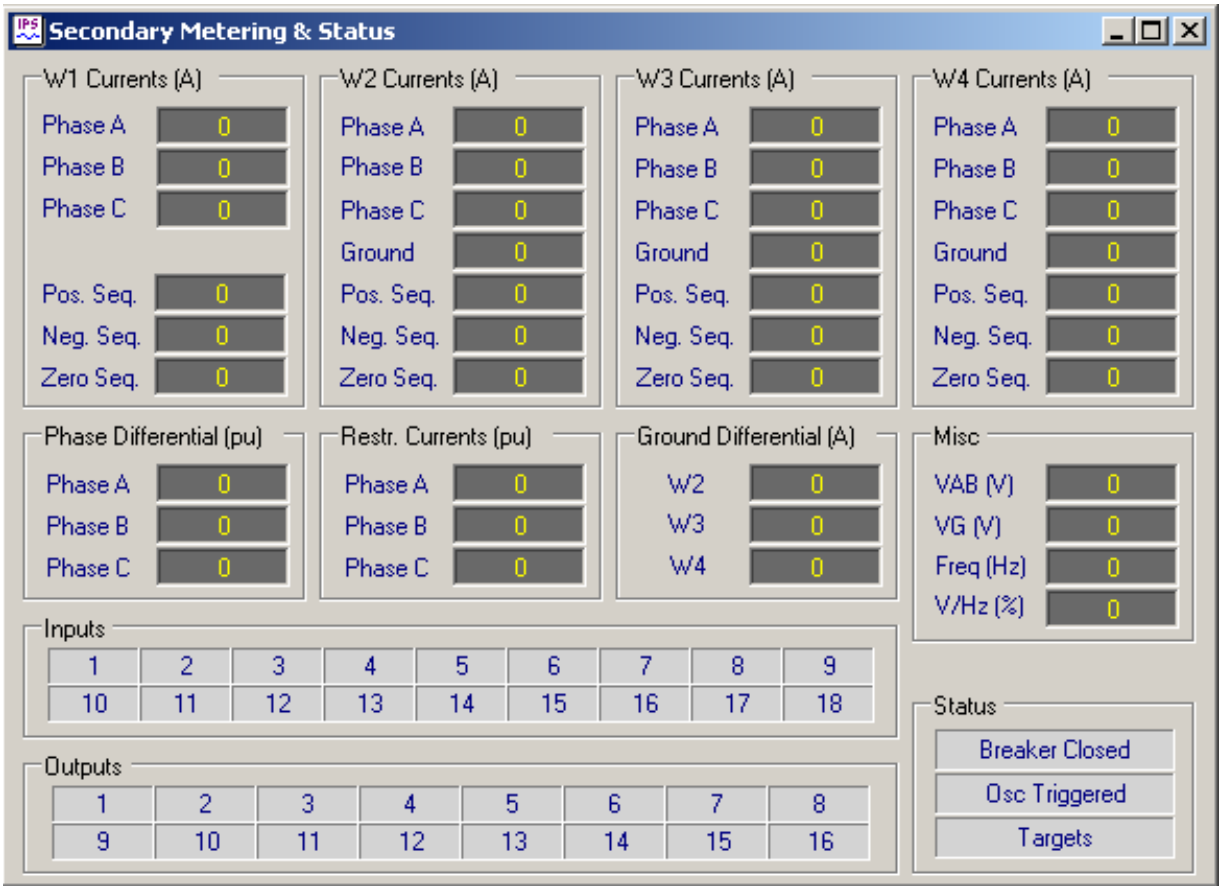
Monitor/Secondary Metering and Status

The Secondary Metering & Status screen (Figure 2-5) includes the following **SECONDARY** parameters:

- Voltage (V_A and V_G phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current (W1 — W4)
- Ground Current (W2 — W4)
- Positive Sequence Current (W1 — W4)
- Negative Sequence Current (W1 — W4)
- Zero Sequence Current (W1 — W4)
- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current (W2 — W4)

Also included on the Secondary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- Aux Voltage



Path: Monitor / Secondary Metering & Status

Figure 2-5 Secondary Metering & Status Screen

METERING II

To access the **METERING II** parameters utilizing IPScom®, select **Monitor/ Metering II** from the IPScom Main Screen drop down menu.

Monitor/Metering II

The Metering II screen (Figure 2-6) includes the following parameters:

- 2nd, 4th and 5th Harmonic Differential Currents (PU), (Phase A/B/C)
- Thermal Currents (Phase A/B/C) for W1 or W2 or W3 or W4

Also included on the Metering II screen are:

■ **NOTE**: These parameters are described in their respective sections of this chapter.

- Breaker Monitor Accumulators (Phase A/B/C) Winding 1, 2, 3, & 4 A Cycles
- Demand Phase Currents, Winding 1, 2, 3, & 4
- Demand Ground Currents, Winding 2, 3, & 4
- Cumulative Through Currents (kA^2 Cycles)
- Through Fault Counter

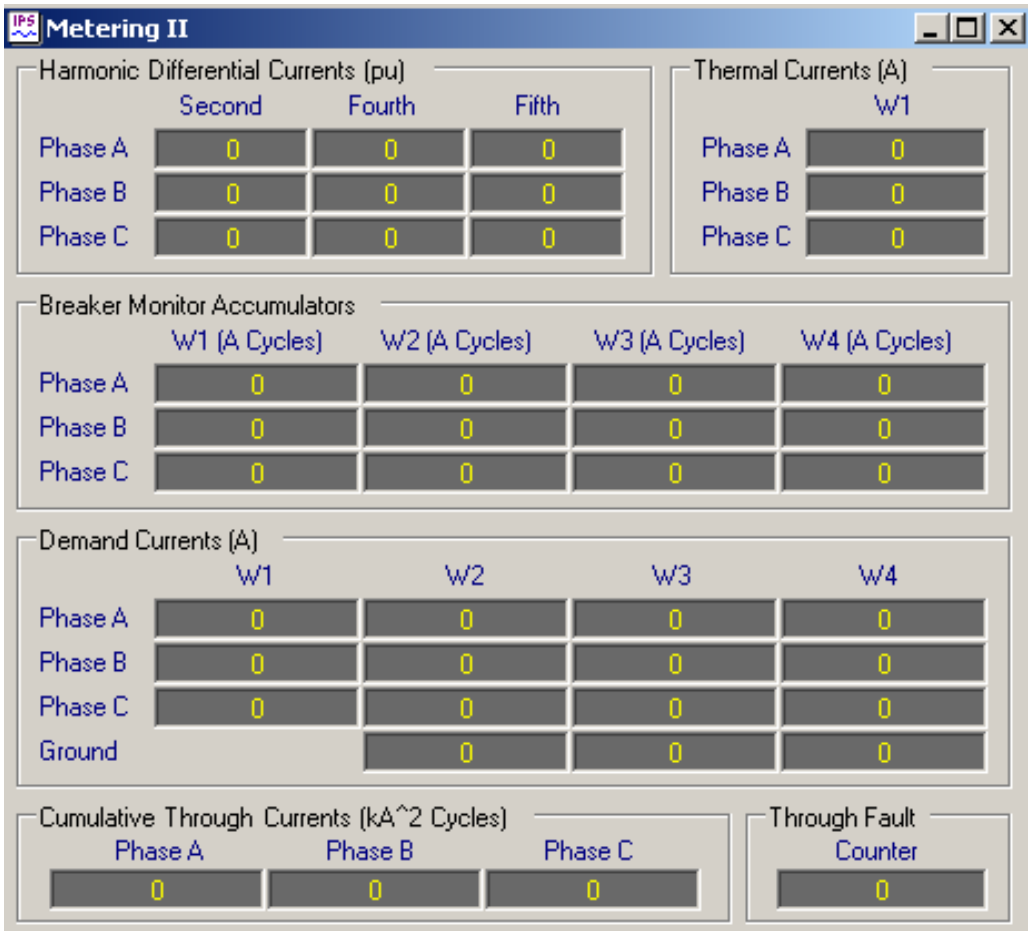
Demand Status

Monitored Primary Demand values include:

- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current

Maximum Demand Current

Maximum values include time-tagged values for all the above quantities.



Path: Monitor / Metering II

Figure 2-6 Metering II Screen

Demand Interval

Time integrated primary metering values, based on the chosen demand integration interval (15 min, 30 min, or 60 min), as well as the time-tagged peak reading are available for viewing.

Demand (From Relay Front Panel)

The HMI menu items for Demand are:

- **Demand Currents**
- **Demand Interval** (See Chapter 4, System Setup and Setpoints)
- **Maximim Demand Current**
- **Clear Maximum Demand Current**

To access the **DEMAND CURRENTS**, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not Active**,** then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
DEMAND
config sys stat DMD
```

5. Press the **ENTER** pushbutton**,** the following will be displayed:

```
DEMAND STATUS
STAT int mstat clear
```

6. Press **ENTER**. The HMI will display W1 Demand Phase Current.

```
W1 DEMAND PHASE CURRENT
   X.XX   X.XX   X.XX A
```

7. Press the **ENTER** pushbutton to view W2, W3 and W4 Demand Phase Current values. To exit a specific winding and continue to the next **DEMAND CURRENT** menu category, press the **EXIT** pushbutton.

To access the **MAXIMUM DEMAND CURRENT**, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If you are already in the **DEMAND STATUS** menu, then go to Step 5.
4. If Level Access is not Active**,** then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

5. Press the Right arrow pushbutton until the following is displayed:

```
DEMAND
config sys stat DMD
```

6. Press the **ENTER** pushbutton**,** the following will be displayed:

```
DEMAND STATUS
STAT int mstat clear
```

7. Press the Right arrow pushbutton until the following is displayed:

```
MAXIMUM DEMAND STATUS
stat int MSTAT clear
```

8. Press **ENTER**. The HMI will display the following:.

```
W1 MAX IA     X.XXX Amp
DD-MM-YYYY  hh:mm:ss
```

9. Continuing to press the **ENTER** pushbutton will display the "B" and "C" Phase Values for W1 and then display the W2, W3 and W4 values.

   To exit a specific winding and continue to the next **DEMAND CURRENT** menu category, press the **EXIT** pushbutton.

To access the **CLEAR MAXIMUM DEMAND CURRENT**, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 5.

3. If you are already in the **DEMAND STATUS** menu, then go to Step 5.
4. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

5. Press the Right arrow pushbutton until the following is displayed:

```
DEMAND
config sys stat DMD
```

6. Press the **ENTER** pushbutton, the following will be displayed:

```
DEMAND STATUS
STAT int mstat clear
```

7. Press the Right arrow pushbutton until the following is displayed:

```
CLEAR MAXIMUM DEMAND
stat int mstat CLEAR
```

8. Press **ENTER**. The HMI will display the following:.

```
CLEAR MAXIMUM DEMAND
PRESS ENTER KEY TO CLEAR
```

9. Press **ENTER**. The HMI will display the following:.

```
CLEAR MAXIMUM DEMAND
– MAX VALUES CLEARED –
```

   To exit a specific winding and continue to the next **DEMAND CURRENT** menu category, press the **EXIT** pushbutton.

Demand Status (From IPScom®)

Demand Currents

To display Demand Currents select **Monitor/ Metering II**. IPScom will display the Metering II screen (Figure 2-6). The Metering II screen includes the following **Demand Currents**:

- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current

Max Demand Status

To display Max Demand Status values select **System/Demand Status**. IPScom will display the Demand Status screen (Figure 2-7).

The Demand Status screen includes the following information:

- Max Demand Current values for Winding 1, 2, 3, & 4 Phase Currents
- Max Demand Current values for Winding 2, 3, and 4 Ground Current
- Date and Time of each Max Phase current event

The Demand Status dialog screen also includes the capabilty to reset individual or reset all Max Demand Status values.

VIEW TARGET HISTORY

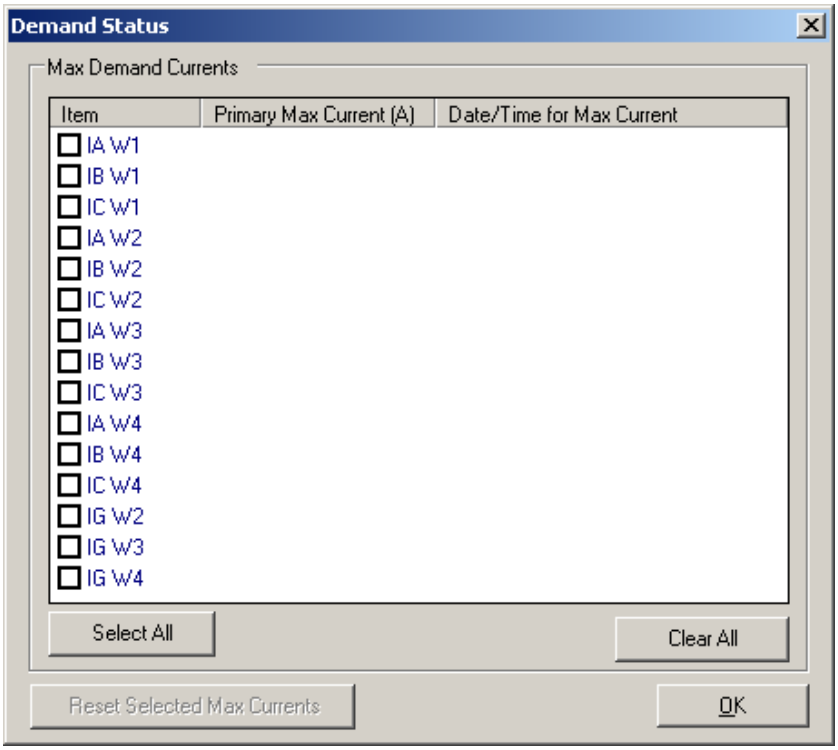
Detailed information about the cause of the last 32 operations is retained in the unit's memory for access through the alphanumeric display from the **VIEW TARGET HISTORY** menu.

To access the **VIEW TARGET HISTORY** feature, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.



Path: System / Demand Status

Figure 2-7 Demand Status Screen

b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
VIEW TARGET HISTORY
TARGETS osc_rec comm
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
VIEW TARGET HISTORY
TRGT  clear
```

6. Press **ENTER**. The HMI will display the following:.

```
VIEW TARGET HISTORY
      X  Target Number
```

7. Pressing the Up or Down arrow pushbutton moves to the next target. Detailed target information will then be dispalyed until the next target is selected.

8. To exit press the **EXIT** pushbutton. The display will return to the following:

```
VIEW TARGET HISTORY
TRGT  clear
```

To access the **CLEAR TARGET HISTORY** feature, proceed as follows:

1. Press the **ENTER** pushbutton.

2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

a. Input the required Access Code, then press **ENTER**.

b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
VIEW TARGET HISTORY
TARGETS osc_rec comm
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
VIEW TARGET HISTORY
TRGT  clear
```

6. Press the Right arrow pushbutton until the following is displayed:

```
VIEW TARGET HISTORY
trgt  CLEAR
```

7. Press the **ENTER** pushbutton, the following will be displayed:

```
VIEW TARGET HISTORY
–  TARGETS CLEARED –
```

8. To exit press the **EXIT** pushbutton.

View Target History (From IPScom®)

View Targets

To View Targets select **System/Targets/View**. IPScom will display the View Targets screen (Figure 2-8). The View Targets screen includes the following target information:

- Target Number
- Target Date/Time
- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current
- Active Functions
- Function Status (Picked up/Operated)
- Active Inputs and Outputs

The View Targets screen also includes the ability to Save the target information to file and Print the target information.

Clear Targets

To Clear Targets perform the following:

1. Select **System/Targets/Clear**. IPScom will display the Clear Targets confirmation dialog screen (Figure 2-9).

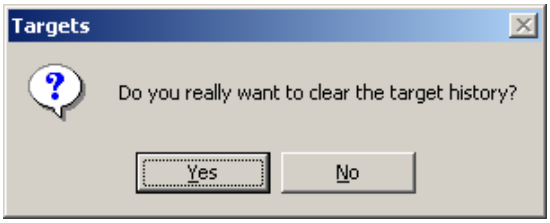
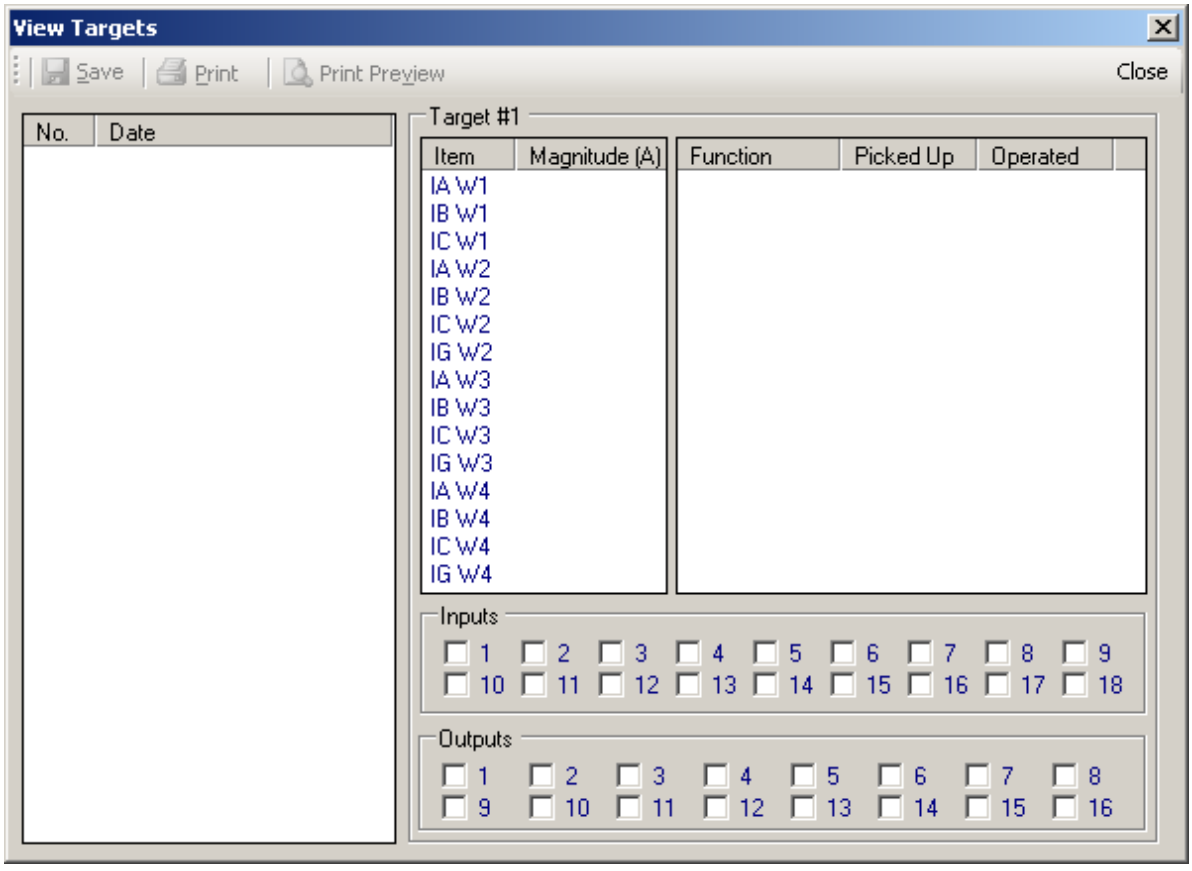


Figure 2-9 Clear Targets Confirmation Dialog Screen



Path: System / Targets / View

Figure 2-8 View Targets Screen

2. Select **Yes**. IPScom® will display the Clear Targets dialog screen (Figure 2-10).

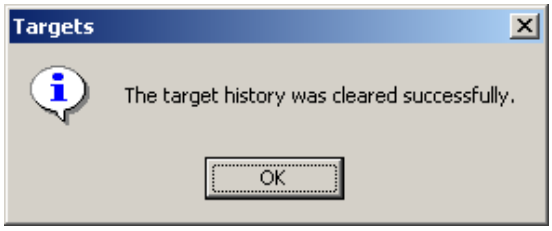


Figure 2-10 Clear Targets Dialog Screen

3. Select **OK**. IPScom will return to the Main screen.

Oscillograph Recorder Data

The Oscillograph Recorder provides comprehensive data recording (voltage, current, and status input/output signals) for all monitored waveforms (at 16 samples per cycle). Oscillograph data can be downloaded using the communications ports to any IBM compatible personal computer running the M-3826 IPScom Communications Software. Once downloaded, the waveform data can be examined and printed using the optional M-3801D IPSplot® *PLUS* Oscillograph Data Analysis Software.

▲ **CAUTION:** Oscillograph records are not retained if power to the relay is interrupted.

The general information required to complete the input data of this section includes:

- **Recorder Partitions**: When untriggered, the recorder continuously records waveform data, keeping the data in a buffer memory. The recorder's memory may be partitioned into 1 to 24 partitions.

  When triggered, the time stamp is recorded, and the recorder continues recording for a user-defined period. The snapshot of the waveform is stored in memory for later retrieval using IPScom Communications Software. The **OSC TRIG** LED on the front panel will indicate a recorder operation (data is available for downloading).
- **Trigger Inputs and Outputs**: The recorder can be triggered remotely through serial communications using IPScom, or automatically using programmed status inputs or outputs.
- **Post-Trigger Delay**: A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pretrigger data, and 80% post-trigger data.

Number of Partitions	Windings 1, 2, 3, 4	Windings 1, 2, 3	Windings 1, 2
1	183	231	311
2	122	154	207
3	91	115	155
4	73	92	124
5	61	77	103
6	52	66	89
7	45	57	77
8	40	51	69
9	36	46	62
10	33	42	56
11	30	38	51
12	28	35	47
13	26	33	44
14	24	30	41
15	22	28	38
16	21	27	36
17	20	25	34
18	19	24	32
19	18	23	31
20	17	22	29
21	16	21	28
22	15	20	27
23	15	19	25
24	14	18	24

Table 2-1 Recorder Partitions

■ **NOTE:** Oscillograph recorder settings are not considered part of the Setpoint Profile. Recorder settings are common to all profiles.

■ **NOTE:** Oscillograph Recorder Setup (See Chapter 4, System Setup and Setpoints)

To access the Oscillograph Recorder **VIEW RECORDER STATUS** feature, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
OSCILLOGRAPH RECORDER
targets  OSC_REC  comm
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
VIEW RECORDER STATUS
STAT  clear  setup
```

6. Press **ENTER**. The HMI will cycle through and display the following for each active record :

```
RECORD #1  ACTIVE
dd-mmm-yyyy  hh:mm:ss:ms
```

   For those records that are not active the following will be displayed:

```
RECORD #1
--RECORD CLEARED--
```

7. To exit press the **EXIT** pushbutton. The display will return to the following:

```
VIEW RECORDER STATUS
STAT  clear  setup
```

To access the Oscillograph Recorder **CLEAR RECORDS** feature, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
OSCILLOGRAPH RECORDER
targets  OSC_REC  comm
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
VIEW RECORDER STATUS
STAT  clear  setup
```

6. Press the right arrow pushbutton until the following is displayed:

```
VIEW RECORDER STATUS
stat  CLEAR  setup
```

7. Press the **ENTER** pushbutton, the following will be displayed:

```
CLEAR RECORDS
-RECORDS CLEARED-
```

8. To exit press the **EXIT** pushbutton. The display will return to the following:

```
VIEW RECORDER STATUS
stat  CLEAR  setup
```

Oscillograph Recorder (From IPScom)

■ **NOTE:** Oscillograph Recorder Setup (See Chapter 4, System Setup and Setpoints)

Retrieve Oscillograph Records

To retrieve Oscillograph Records perform the following:

1. Select **System/Oscillograph/Retrieve**. IPScom® will display the Retrieve Oscillograph Record dialog screen (Figure 2-11).
2. Select the desired oscillograph record.
3. Select the desired File Format, then select **Retrieve**, IPScom will display the **Save As** dialog screen.
4. Input the desired File Name and location, then select **Save**. IPScom will display the Download Status screen (Figure 2-12).

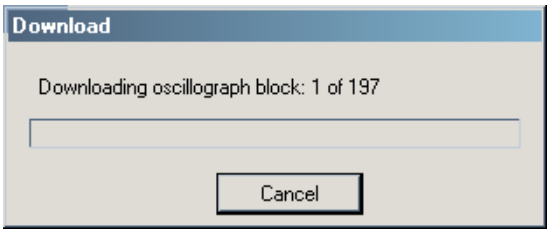


Figure 2-12 Oscillograph Record Download Dialog Screen

5. Upon completion of the oscillograph file download, IPScom will display the Download Successful confirmation screen (Figure 2-13).

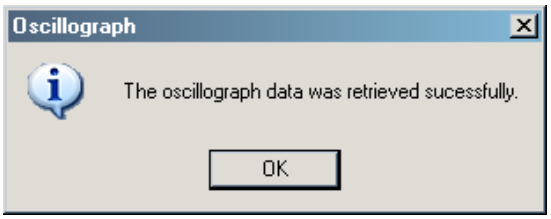
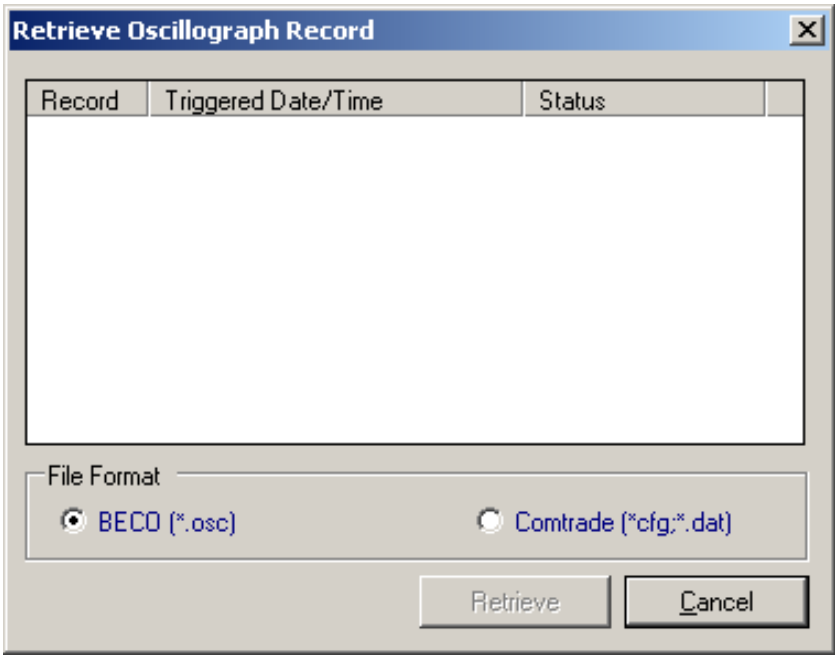


Figure 2-13 Oscillograph Download Successful Confirmation Screen

6. Select **OK,** IPScom will return to the Main screen.



Path: System / Oscillograph / Retrieve

Figure 2-11 Retrieve Oscillograph Record Dialog Screen

Trigger Oscillograph

To manually Trigger the Oscillograph perform the following:

1. Select **System/Oscillograph/Trigger**. IPScom® will display the Trigger Oscillograph confirmation screen (Figure 2-14).

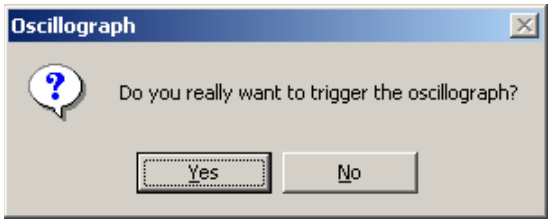


Figure 2-14 Trigger Oscillograph Confirmation Screen

2. Select **Yes,** IPScom will display the Oscillograph Successfully Triggered Dialog Screen.(Figure 2-15)

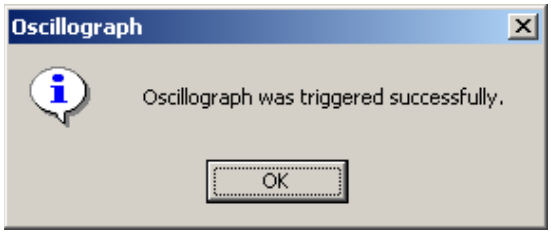


Figure 2-15 Oscillograph Successfully Triggered Dialog Screen

3. Select **OK,** IPScom will return to the Main screen.

Clear Oscillograph Records

To Clear Oscillograph Records perform the following:

1. Select **System/Oscillograph/Clear**. IPScom will display the Clear Oscillograph Records confirmation screen (Figure 2-16).

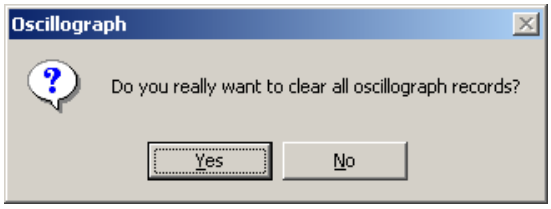


Figure 2-16 Clear Oscillograph Records Confirmation Screen

2. Select **Yes,** IPScom will display the Clear Oscillograph Records Successfull Dialog Screen.(Figure 2-17)

Figure 2-17 Oscillograph Successfully Cleared Records Dialog Screen

3. Select **OK,** IPScom will return to the Main screen.

Software Version (Relay Front Panel only)

To determine the software version installed on the relay, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
  SETUP
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
SOFTWARE VERSION
VERS eth sn access
```

6. Press the **ENTER** pushbutton, the following will be displayed:

```
SOFTWARE VERSION
D-0179VXX.YY.ZZ    AAAA
```

7. To exit press the **EXIT** pushbutton.

Serial Number (Relay Front Panel only)

To determine the serial number of the relay, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not Active, then the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
  SETUP
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
SOFTWARE VERSION
VERS eth sn access
```

6. Press the Right arrow pushbutton until the following is displayed:

```
SERIAL NUMBER
vers eth SN access
```

7. Press the **ENTER** pushbutton, the following will be displayed:

```
SERIAL NUMBER
 XXXXXXXXXX
```

8. To exit press the **EXIT** pushbutton.

Alter Access Codes (From Relay Front Panel)

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```

5. If User Access Codes are to be set, then use the RIGHT arrow pushbutton to select ALTER ACCESS CODES. The following will be displayed:

```
ALTER ACCESS CODES
vers eth sn ACCESS
```

6. Press **ENTER,** the following will be displayed:

```
ENTER ACCESS CODE
LEVEL#1 level#2 level#3
```

7. Press **ENTER**, the following will be displayed:

```
LEVEL #1
      9999
```

8. Input the desired User Access Code as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Access Code.
   c. When the desired Access Code has been input, then press **ENTER**. The following will be displayed:

```
ENTER ACCESS CODE
LEVEL#1 level#2 level#3
```

9. To set User Access Code Level #2 press the RIGHT arrow pushbutton to select LEVEL #2, then press **ENTER** the following will be displayed:

```
LEVEL #2
      9999
```

10. Repeat Step 8 to enter the desired Level #2 User Access Code.
11. To set User Access Code Level #3 press the RIGHT arrow pushbutton to select LEVEL #3, then press **ENTER** the following will be displayed:

```
LEVEL #3
      9999
```

12. Repeat Step 8 to enter the desired Level #3 User Access Code.
13. Press the **EXIT** pushbutton will return to the previous selection screen:

```
ALTER ACCESS CODES
vers sn ACCESS number
```

Alter User Access Codes (From IPScom®)

Comm Access Codes

To set the relay Comm Access Code perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **Tools/Security/Change Comm Access Code**. IPScom will display the Change Comm Access Code dialog screen (Figure 4-1).

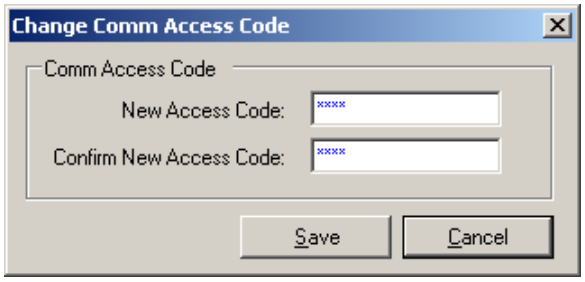


Figure 2-18 Change Comm Access Code Dialog Screen

2. Enter the desired New Comm Access Code (1-9999), then re-enter (confirmation) the New Access Code.
3. Select **Save**, IPScom will display a Comm Access Code change Confirmation Screen (Figure 2-19).

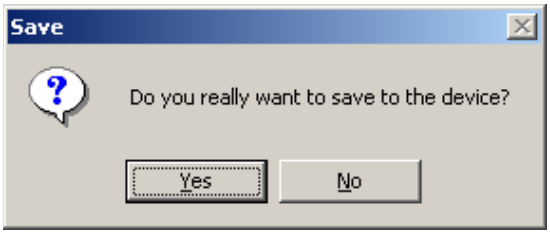


Figure 2-19 Comm Access Code Change Confirmation Screen

4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 2-20).

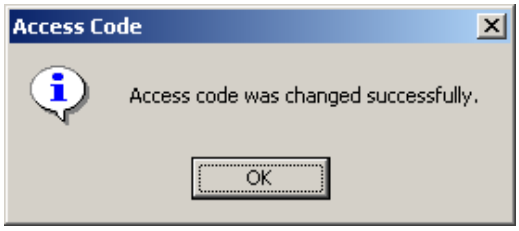


Figure 2-20 Access Code Changed Confirmation Screen

5. Select **OK**, ISScom will return to the Main Screen.

   The new Comm Access Code will not be in affect until communications have been closed with the relay for approximately 2.5 minutes.

User Access Codes

The relay includes three levels of access codes. Depending on their assigned code, users have varying levels of access to the installed functions.

1. **Level 1 Access** = Read setpoints, monitor status, view status history.
2. **Level 2 Access** = All of level 1 privileges, plus read & change setpoints, target history, set time clock.
3. **Level 3 Access** = All of level 2 privileges, plus access to all configuration functions and settings.

Each access code is a user-defined one-to four-digit number. Access codes can only be altered by a level 3 user.

If the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access screens are bypassed, and all users have full access to all the relay menus. The device is shipped from the factory with the access code feature disabled.

User Access Codes

To change the relay User Access Codes perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom® Main Screen menu select **Tools/Security/Change User Access Code**. IPScom will display the Change User Access Code dialog screen (Figure 2-21).

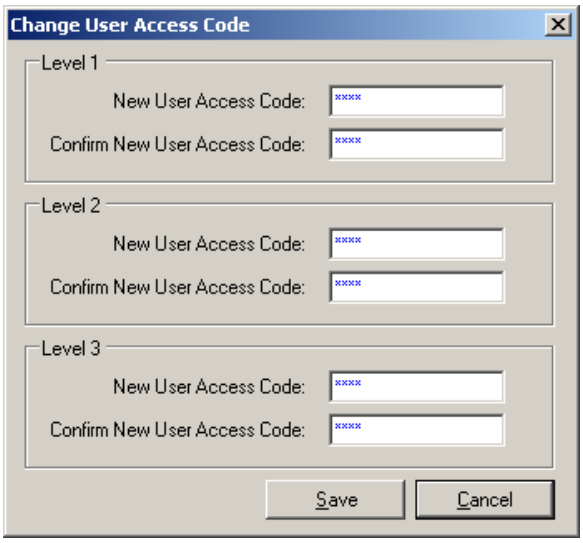


Figure 2-21 Change User Access Code Dialog Screen

2. Enter the desired New User Access Code (1-9999), then re-enter (confirmation) the New User Access Code.
3. Select **Save**, IPScom will display a User Access Code change Confirmation Screen (Figure 2-19).
4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 2-20).
5. Select **OK**, ISScom will return to the Main Screen.

System Error Codes, Output and Alarm Counters

The System Error Codes, Output and Alarm Counters feature provides the user with the ability to view and clear system Error Codes, Processor Resets, Alarm Counters, Power Loss Counter and Output Counters. Also, Checksums can be viewed (IPScom) for Calibration and Setpoints.

Clear Output Counters (Relay Front Panel)

To clear Output Counters from the Front Panel perform the following:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
  SETUP
```

5. Press **ENTER,** the following will be displayed:

```
SOFTWARE VERSION
VERS eth sn access
```

6. Press the Right arrow pushbutton until the following is displayed:

```
CLEAR OUTPUT COUNTER
logo1 logo2 OUT alrm
```

7. Press **ENTER,** the following will be displayed:

```
CLEAR OUTPUT COUNTERS
PRESS ENTER KEY TO CLEAR
```

8. Press **ENTER,** the following will be displayed:

```
CLEAR ALARM COUNTER
-OUT COUNTERS CLEARED-
```

9. Press **EXIT** as necessary to return to the main menu.

Clear Alarm Counters (Relay Front Panel)

To clear Alarm Counters from the Front Panel perform the following:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
  SETUP
```

5. Press **ENTER,** the following will be displayed:

```
SOFTWARE VERSION
VERS sn access number
```

6. Press the Right arrow pushbutton until the following is displayed:

```
CLEAR OUTPUT COUNTER
logo1 logo2 out ALRM
```

7. Press **ENTER,** the following will be displayed:

```
CLEAR ALARM COUNTERS
PRESS ENTER KEY TO CLEAR
```

8. Press **ENTER,** the following will be displayed:

```
CLEAR ALARM COUNTER
-ALARM COUNTERS CLEARED-
```

9. Press **EXIT** as necessary to return to the main menu.

Clear Error Codes (Relay Front Panel)

To clear Error Codes from the Front Panel perform the following:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
  SETUP
```

5. Press **ENTER,** the following will be displayed:

```
SOFTWARE VERSION
VERS eth sn access
```

6. Press the Right arrow pushbutton until the following is displayed:

```
CLEAR ERROR CODES
time ERROR diag
```

7. Press **ENTER,** the following will be displayed:

```
CLEAR ERROR CODES
PRESS ENTER KEY TO CLEAR
```

8. Press **ENTER,** the following will be displayed:

```
CLEAR ERROR CODES
-ERROR CODES CLEARED-
```

9. Press **EXIT** as necessary to return to the main menu.

Resetting Counters (From IPScom)

Tools/Counters and Error Codes

To view and/or Reset System Error Codes and Output Counters utilizing IPScom® perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu bar select **Tools/Counters and Error Codes**. IPScom will display the System Error Codes and Output Counters dialog screen (Figure 2-22).
2. Select the desired Error Code, Alarm Counter, Power Loss Counter to be reset, then select **OK**. IPScom will return to the Main Menu.

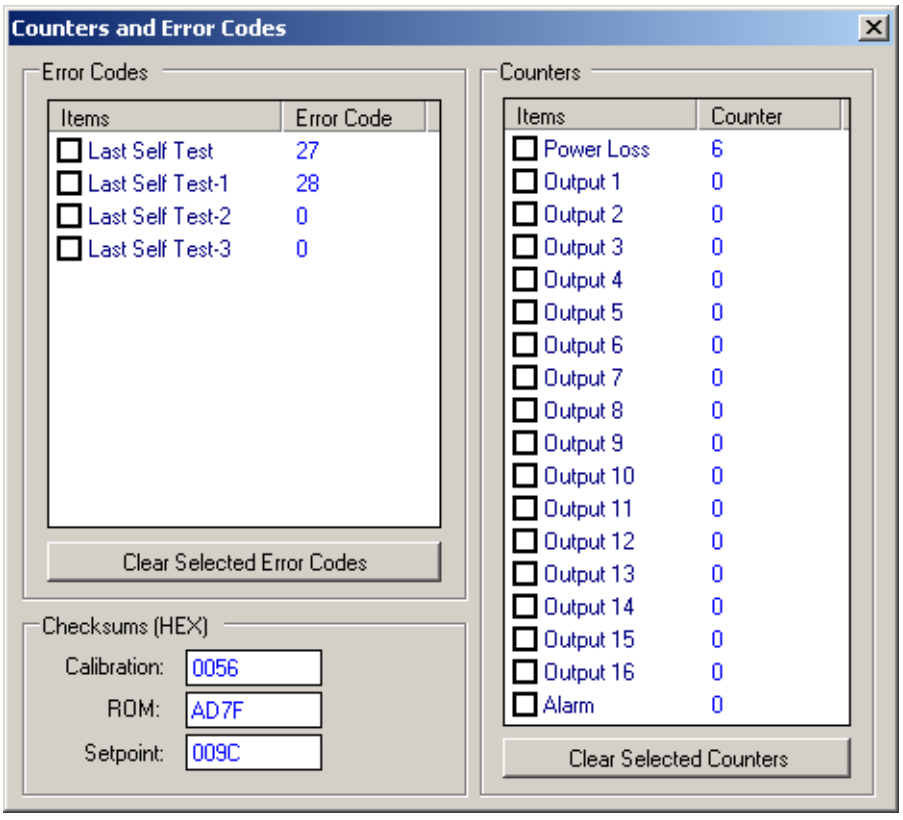


Figure 2-22 Counters and Error Codes Dialog Screen

Through Fault Recorder (From IPScom®)

System/Through Fault/Retrieve

To download available Through Fault records perform the following:

1. From the IPScom Main Screen menu select **System/Through Fault/Retrieve**.

   The Through Fault Download screen will display a bar indicating the status of the download. When the download is complete the **Save As** screen will be displayed with a default ".tfe" file extension.

3. Select the destination folder and name the file, then select **Save** to save the Through Fault Record or **Cancel**.

System/Through Fault/View

To view available Through Fault records perform the following:

1. From the IPScom Main Screen menu select **System/Through Fault/View**. IPScom will display the View Through Fault Record screen (Figure 2-23).
2. Select **Open**. IPScom will display the **Open** screen with a default ".tfe" file extension.
3. Select the location of the ".tfe" files, then select the file to be viewed.
4. Select **Open**. IPScom will **Open** the target file in the View Through Fault Record screen.
5. Select Close to return to the IPScom Main screen.

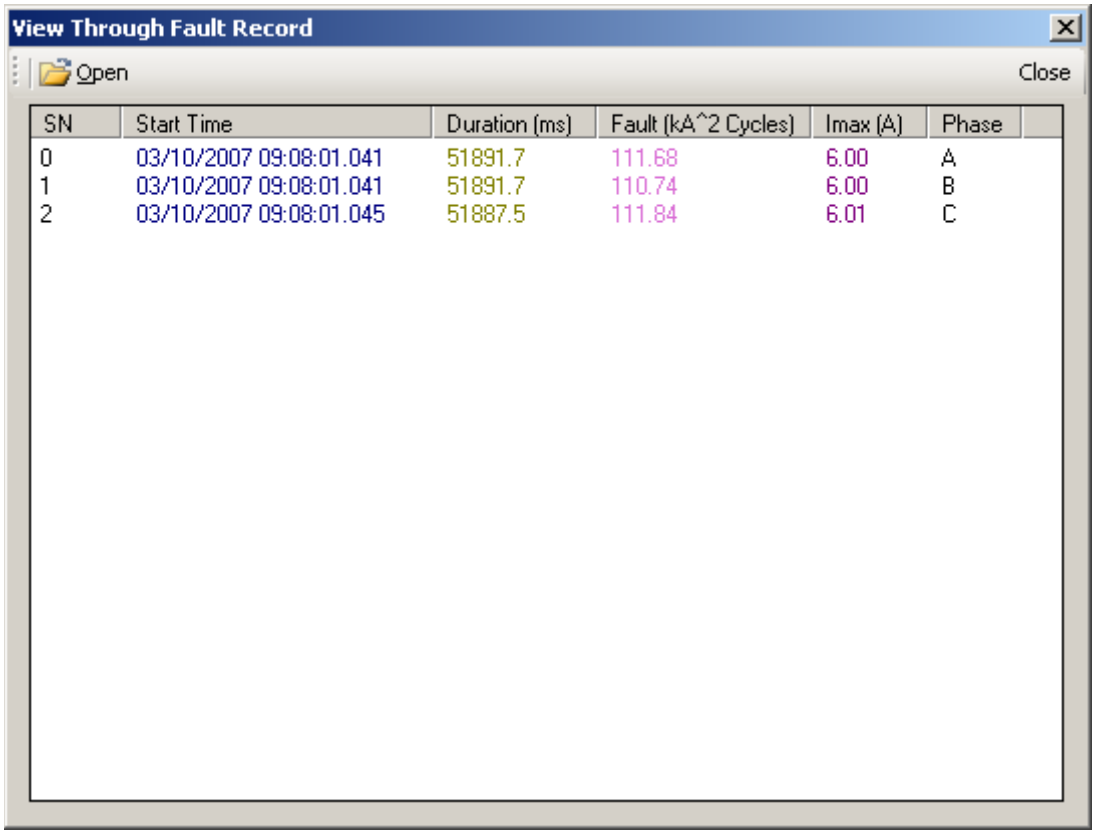


Figure 2-23 View Through Fault Record Screen

System/Through Fault/Clear

To Clear the relay Through Fault records perform the following:

1. From the IPScom® Main Screen menu select **System/Through Fault/Clear**. IPScom will display the Clear Through Fault record confirmation screen (Figure 2-24).

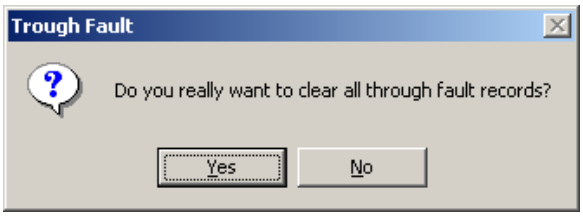


Figure 2-24 Clear Through Fault Record Confirmation Screen

2. Select **YES**, IPScom will respond with the Through Fault Record Cleared Successfully screen (Figure 2-25).

Figure 2-25 Through Fault Record Cleared Successfully Screen

3. Select **OK**, IPScom will return to the IPScom Main Screen.

System/Sequence of Events/Retrieve

The **Retrieve** selection downloads the events from the currently connected relay (events must be retrieved from the relay and stored in a file in order to view them).

To download available Sequence of Events perform the following:

1. From the IPScom Main Screen menu select **System/Sequence of Events/ Retrieve**. IPScom will display the Sequence of Events Recorder Download screen (Figure 2-26) and indicate the number of Sequence of Events Recorder Events being downloaded.

Figure 2-26 Sequence of Events Retireve/ Download Screen

2. When the download is complete the **Save As** screen will be displayed with a default ".evt" file extension.
3. Select the destination folder and name the file, then select **Save** to save the Sequence of Events Record or **Cancel**.

System/Sequence of Events/View

The Sequence of Events viewer screen includes the commands **Open**, **Close**, **Print Summary**, and **Printl**. **Open** opens a saved sequence of events file. **Close** closes the print file. **Print Summary** prints an event summary, and **Print** prints the event report. **Clear** deletes event history from the control.

To view available Sequence of Events Records perform the following:

1. From the IPScom Main Screen menu select **System/Sequence of Events/ View**. IPScom will display the View Sequence of Events Record screen (Figure 2-27).
2. Select **Open**. IPScom will display the **Open** screen with a default ".evt" file extension.
3. Select the location of the ".evt" files, then select the file to be viewed.
4. Select **Open**. IPScom will **Open** the target file in the View Sequence of Events Record screen (Figure 2-27).

System/Sequence of Events/Clear

The Clear feature clears all Sequence of Events Records stored on the relay.

To Clear all Sequence of Events Records perform the following:

1. From the IPScom Main Screen menu select **System/Sequence of Events/ Clear**. IPScom will display the Clear Sequence of Events Records confirmation screen (Figure 2-28).

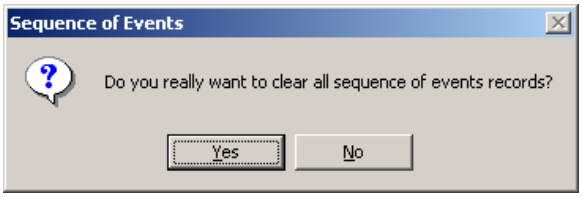


Figure 2-28 Clear Sequence of Events Record Command Confirmation Screen

2. Select **YES**, IPScom will respond with the Sequence of Events Records Cleared confirmation Screen (Figure 2-29).

Figure 2-29 Sequence of Events Record Cleared Confirmation Screen

3. Select **OK**, IPScom will return to the IPScom Main Screen.

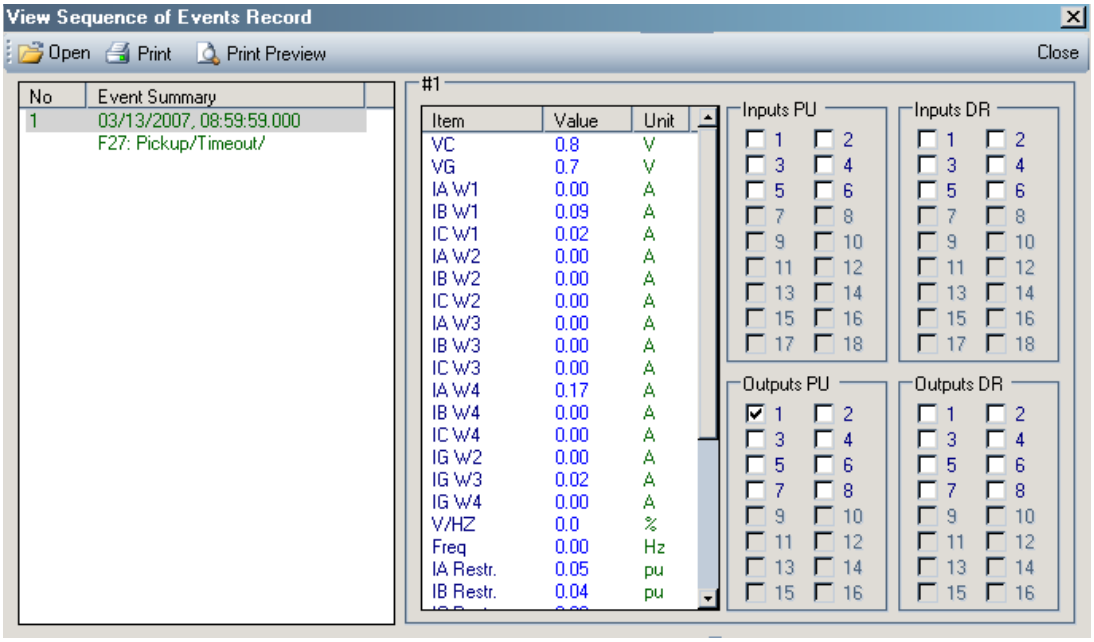


Figure 2-27 View Sequence of Events Record Screen

This Page Left Intentionally Blank

3 IPScom®

This chapter is designed for the person or group responsible for the operation and setup of the M-3311A. The M-3826 IPScom Communications Software can be used to successfully communicate system settings and operational commands to the M-3311A as well as access the extensive monitoring and status reporting features. Figure 3-3, represents the IPScom Main Screen menu structure. This chapter provides a general overview of each IPScom menu selection and command in the same order as they are displayed in the software program. Those IPScom features and functions that are covered in other sections of this Instruction Book will be noted and referenced.

3.1 IPScom Functional Description

The IPScom installation and establishing initial local communications are covered in Section 5.6, IPScom Communications Software Installation, and Section 5.7, Activating Initial Local Communications.

Selecting the IPScom Program from the Becoware Folder or selecting the IPScom Program Icon (Figure 3-1) from the Desktop will open the program and display the IPScom Main Screen (Figure 3-2).

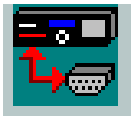


Figure 3-1 IPScom Program Icon

IPScom Main Screen Menu Bar

The IPScom Main Screen Menu Bar includes (when the program is initially opened) the **File**, **Connect** and **Help** menu selections. This menu bar includes the additional selections; **Communication**, **Monitor**, **System**, **Tools** and **Windows** when IPScom is in either the file mode or has open communications established with a relay.

Shortcut Command Buttons

Before IPScom has entered either the file mode or communications have been opened, the new and open shortcut commands are available. When IPScom is in the **New File**, **Existing File**, or **Communication Mode**, the main screen includes the **Save**, **Secondary Metering**, **Phasor Diagram** and **Setpoints** shortcut command buttons. These shortcuts allow direct access to these functions.

IPScom Main Screen Status Line

The IPScom status line indicates the source of the information that is displayed. Sources include New File, Existing File, Serial Port, TCP/IP or Modem. Also included on the IPScom Main Screen at the bottom, are the Type of Unit IPScom is connected to, the Firmware Version of the unit and Status of the Communication connection, or if not connected, it will indicate that IPScom is in the File Mode.

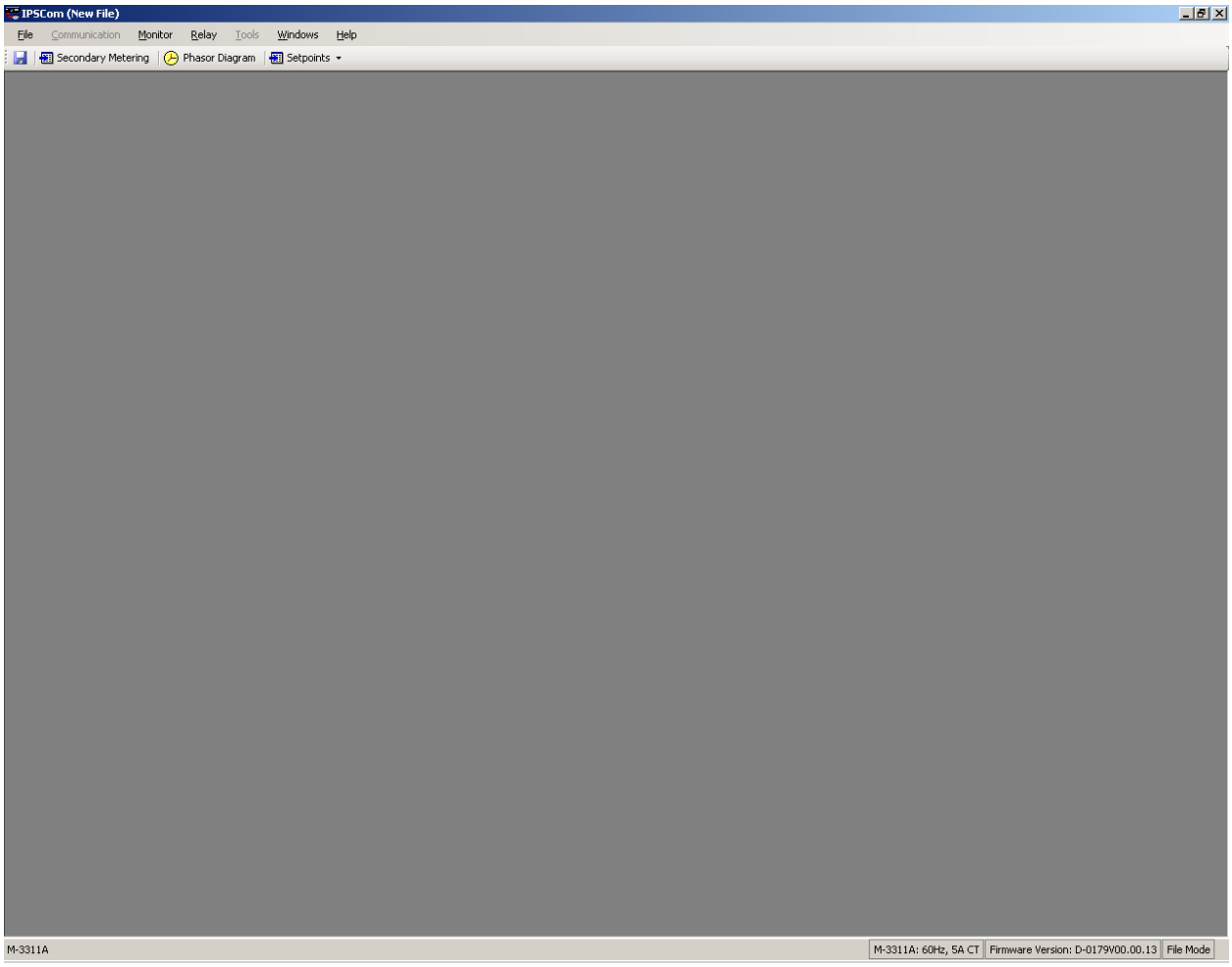


Figure 3-2 IPScom Main Screen

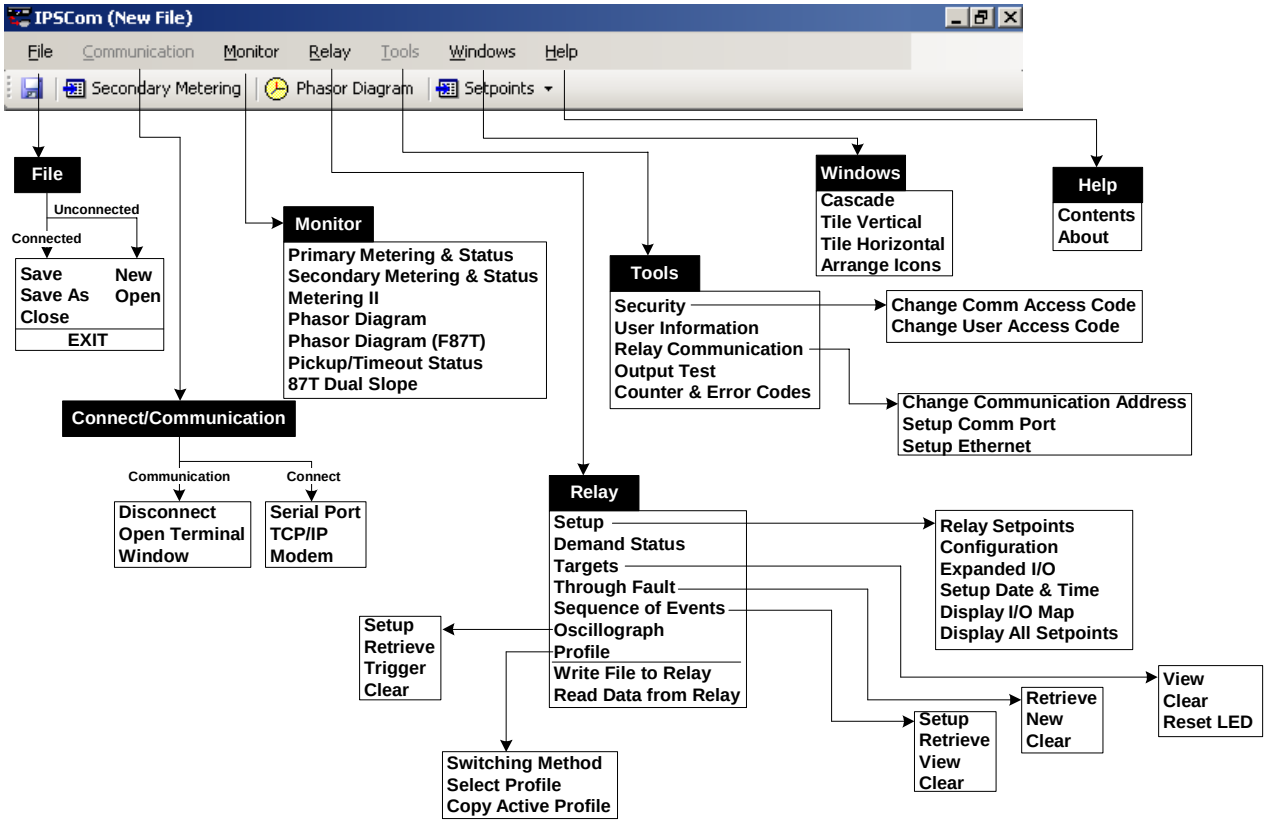
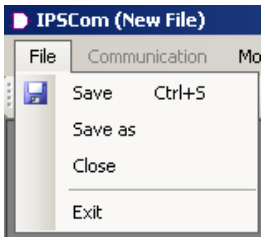


Figure 3-3 M-3826 IPScom Menu Selection

File Menu

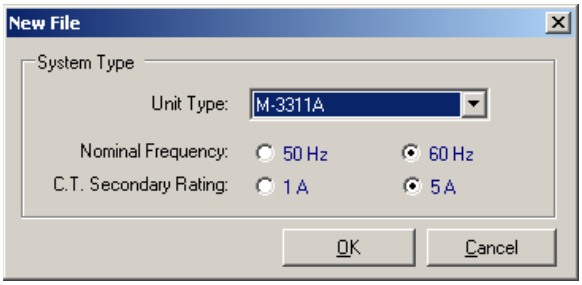


The **File** menu enables the user to create a new data file, open a previously created data file, close, save and save as. The IPScom® program can also be exited through the **File** menu.

File/New Command

When not connected to the M-3311A, using the **New** command, a new file is established with the New System dialog screen (Figure 3-4). Selecting **Save** allows the new data file to be named by using the **Save** or **Save As**... commands.

■ **NOTE**: By choosing the **NEW** command, unit and setpoint configuration values are based on factory settings.



Path: File menu / New command

Figure 3-4 New System Dialog Screen

COMMAND BUTTONS

OK Allows the file to be created using the currently displayed information.

Cancel Returns to the IPScom main screen; any changes to the displayed information are lost.

File/Save and Save As Command

The Save and Save As... commands allow saving a file or renaming a file, respectively.

File/Open Command

The open command allows opening a previously created data file. With an opened data file, use the System... Setup... menu items to access the setpoint windows.

If communication can be established with a relay, it is always preferred to use the **Read Data From System** command in the System menu to update the PC's data file with the relay data. This file now contains the proper system type information, eliminating the need to set the information manually.

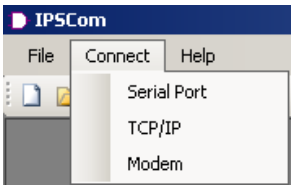
File/Close Command

Closes the open file without saving.

File/Exit Command

The Exit command quits the IPScom program.

Connect\Communication Menu



The Connect dialog screens allow selection of the IPScom communication parameters to coordinate with the relay. Selecting "Serial Port" displays the PC Comm Port and device Settings (Figure 3-5). Selecting "TCP/IP" displays the PC TCP/IP and device Settings (Figure 3-6) for Ethernet communication. Selecting "Modem" displays a modem Dialog screen (Figure 3-7), to establish contact with remote locations. The Modem Dialog screen also includes a "Bring up terminal window after dialing" option. When selected IPScom will open a terminal window (Figure 3-8) to allow modem commands to be sent to the target modem. When communicating by way of a fiber optic loop network, echo cancelling is available by checking the Echo Cancel box. This command masks the sender's returned echo.

If the modem was not used to establish communication (direct connection), select **Connect** to start. If the relay has a default communication access code of 9999, a message window will be displayed showing Access Level #3 was granted. Otherwise, another dialog screen will be displayed to prompt the user to enter the access code in order to establish communication.**Communication/Disconnect** discontinues communication.

Communication\Open Terminal Window

Opens the IPScom Terminal Window (Figure 3-8).

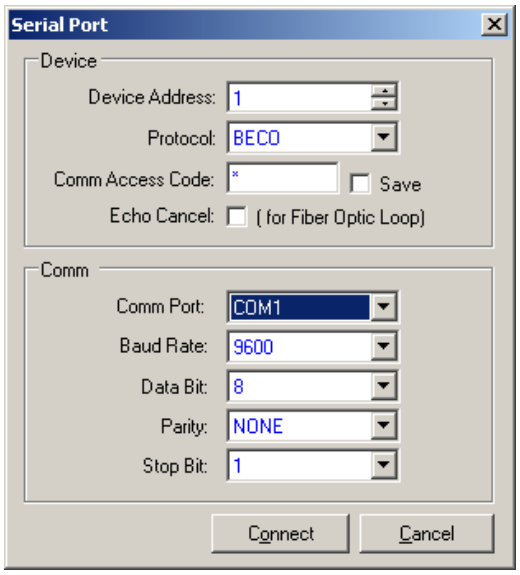


Figure 3-5 IPScom Serial Communication Dialog Screen

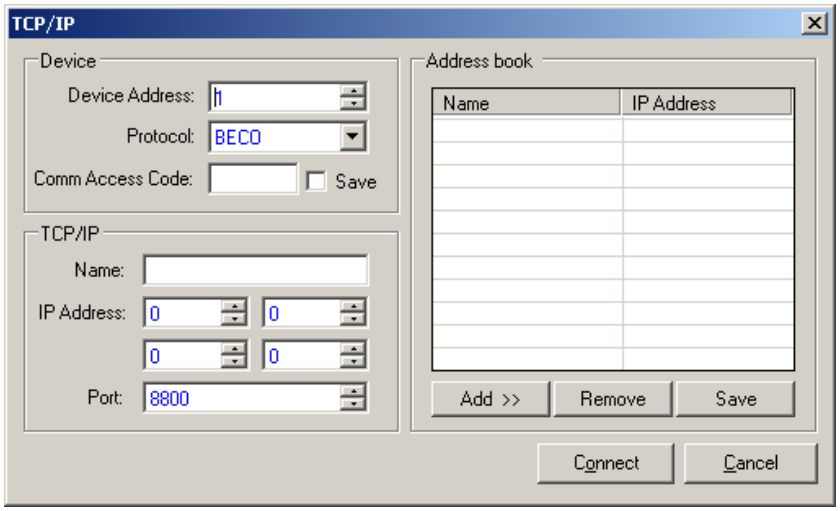


Figure 3-6 IPScom TCP/IP Ethernet Communication Dialog Screen

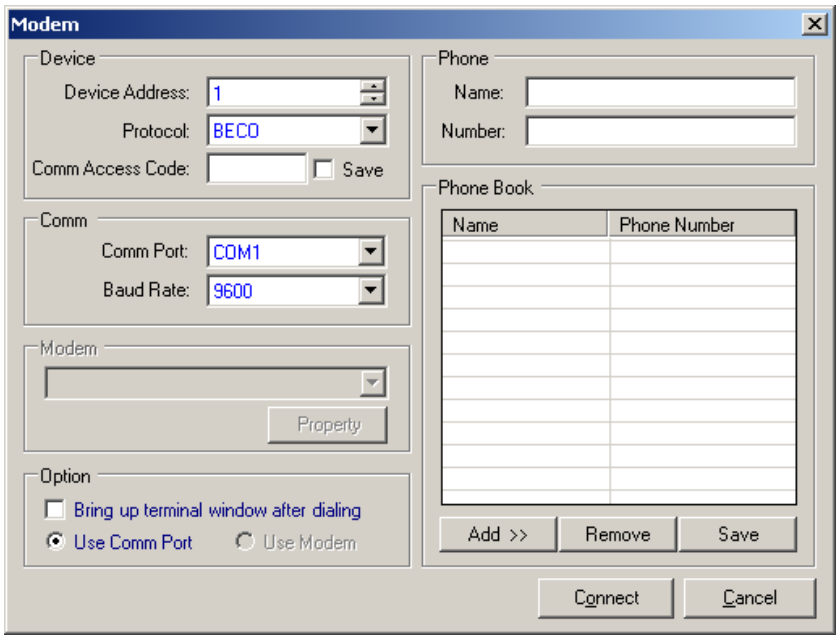


Figure 3-7 IPScom Modem Communication Dialog Screen

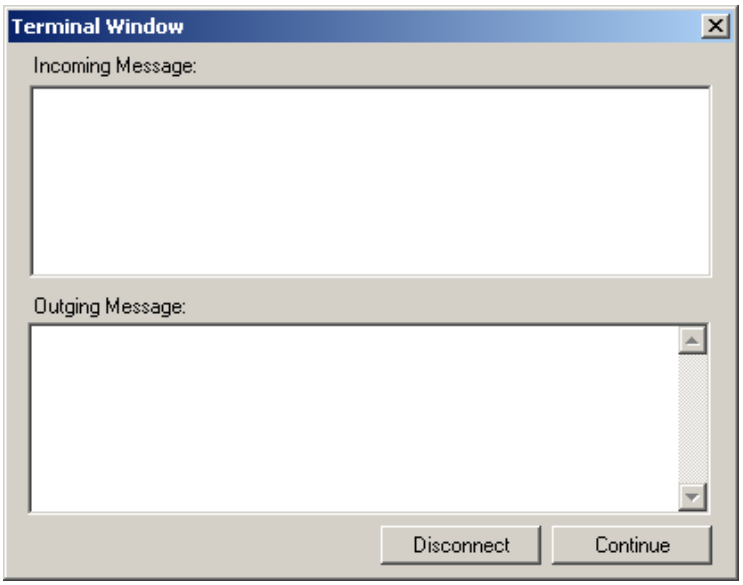
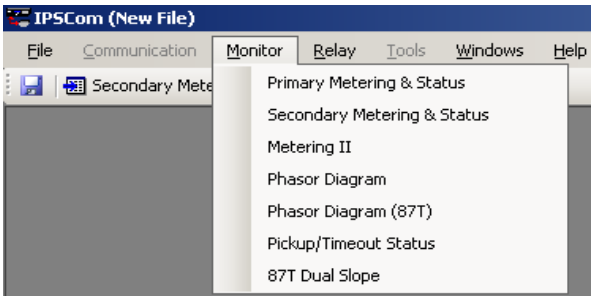


Figure 3-8 Terminal Window

Monitor Menu

The **Monitor** Menu provides access to the screens used to monitor relay parameters. Seven submenus are provided: **Primary Metering and Status**, **Secondary Metering and Status**, **Metering II**, **Phasor Diagram**, **Phasor Diagram (87T)**, **Pickup/ Timeout Status**, and **87T Dual Scope**.



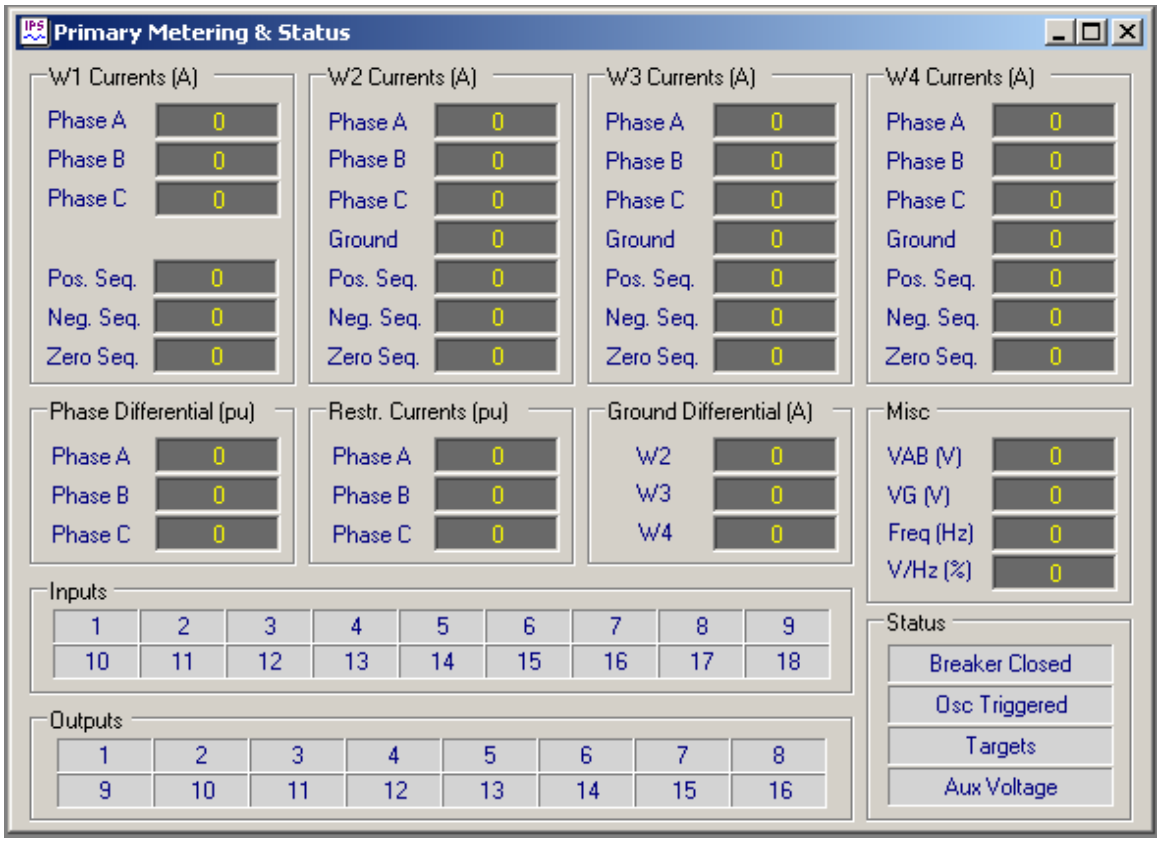
Monitor/Primary Metering & Status

The Primary Metering screen (Figure 3-9) allows the user to review the following PRIMARY parameters:

- Voltage (V_A and V_G phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current (W1 — W4)
- Ground Current (W2 — W4)
- Positive Sequence Current (W1 — W4)
- Negative Sequence Current (W1 — W4)
- Zero Sequence Current (W1 — W4)
- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current (W2 — W4)

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- Aux Voltage



Path: Monitor / Primary Metering and Status

Figure 3-9 Primary Metering Status Screen

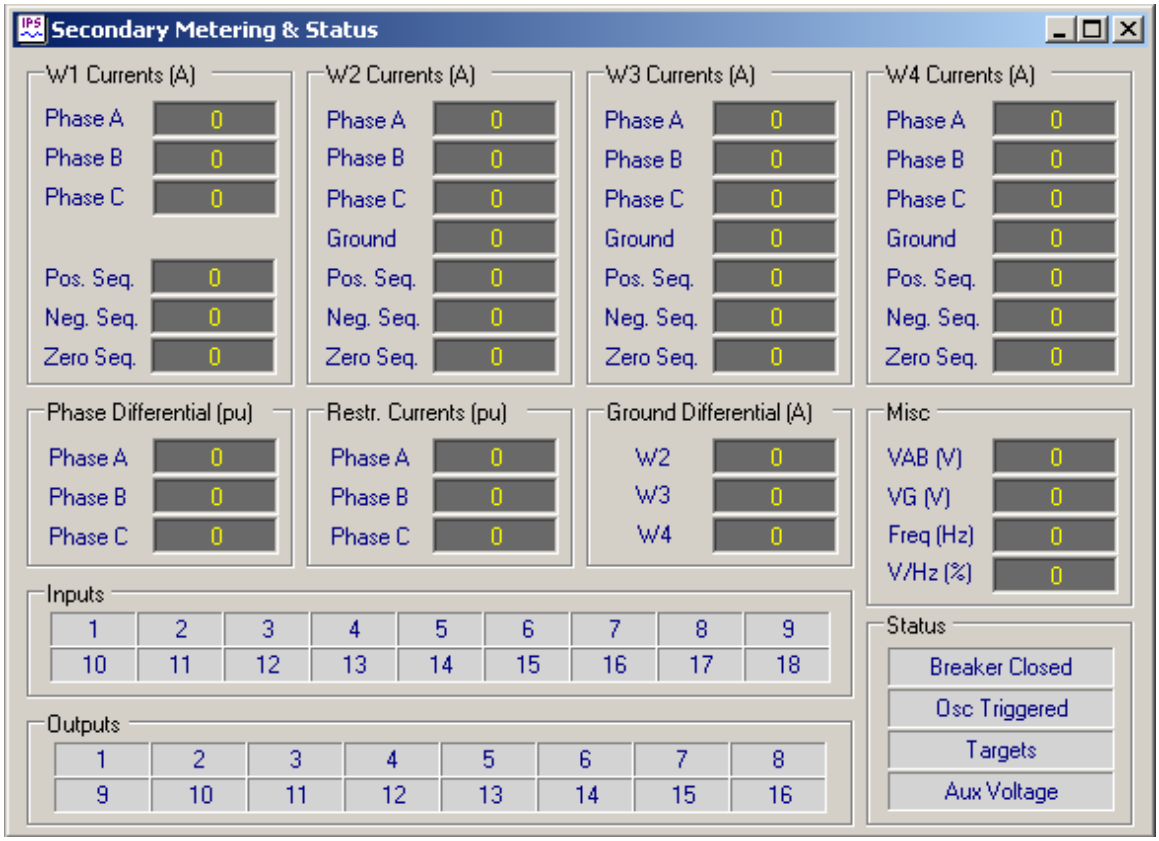
Monitor/Secondary Metering & Status

The Secondary Metering and Status screen (Figure 3-10) allows the user to review the following **SECONDARY** parameters:

- Voltage (V_A and V_G phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current (W1 — W4)
- Ground Current (W2 — W4)
- Positive Sequence Current (W1 — W4)
- Negative Sequence Current (W1 — W4)
- Zero Sequence Current (W1 — W4)
- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current (W2 — W4)

Also included on the Secondary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- Aux Voltage



Path: Monitor / Secondary Metering and Status

Figure 3-10 Secondary Metering Status Screen

Monitor/Metering II

The Metering II screen (Figure 3-11) includes the following parameters:

- 2nd, 4th and 5th Harmonic Differential Currents (PU), (Phase A/B/C)
- Thermal Currents (Phase A/B/C) for W1 or W2 or W3 or W4

Also included on the Metering II screen are:

■ **NOTE**: These parameters are described in their respective sections of this chapter.

- Breaker Monitor Accumulators (Phase A/B/C) Winding 1, 2, 3, & 4 A Cycles
- Demand Phase Currents, Winding 1, 2, 3, & 4
- Demand Ground Currents, Winding 2, 3, & 4
- Cumulative Through Currents (kA² Cycles)
- Through Fault Counter

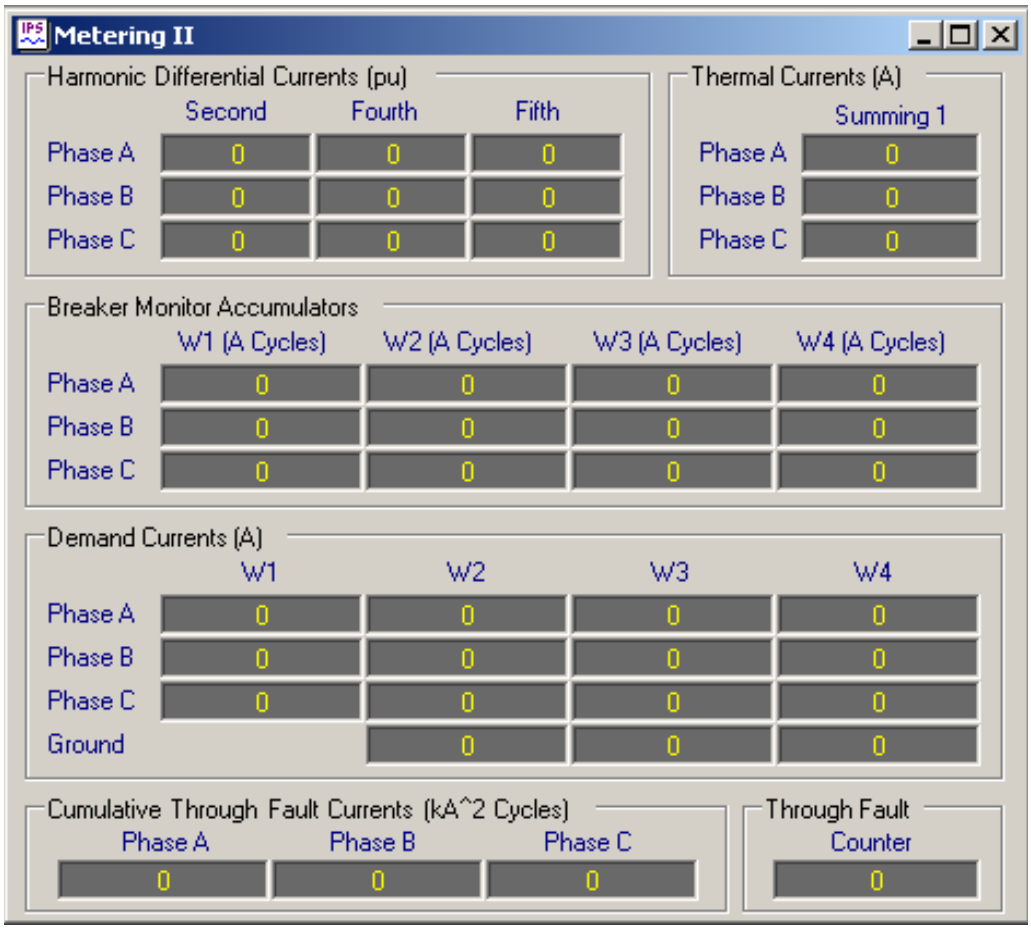
Demand Status

Monitored Primary Demand values include:

- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current

Maximum Demand Current

Maximum values include time-tagged values for all the above quantities.

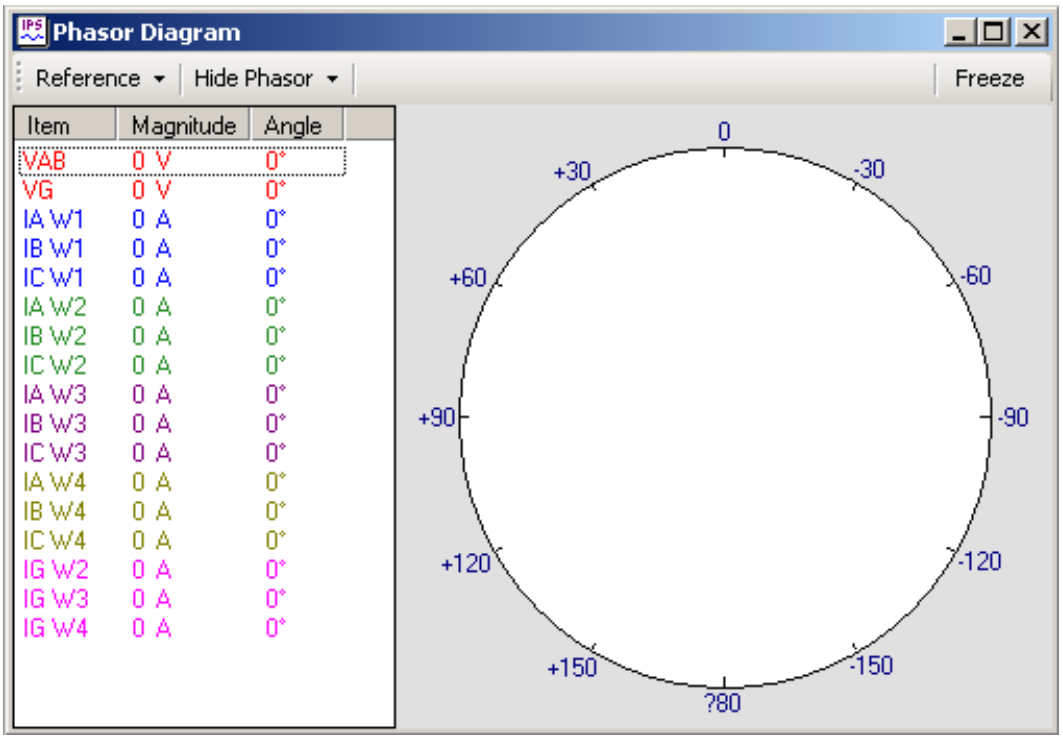


Path: Monitor / Metering II

Figure 3-11 Metering II Screen

Monitor/Phasor Diagram

The Phasor Diagram (Figure 3-12) provides the user with the ability to evaluate a reference Phase Angle to Phase Angle data from other windings. The Phasor Diagram also includes a menu that allows the user to select/deselect sources to be displayed and Freeze capability to freeze the data displayed on the Phasor Diagram.



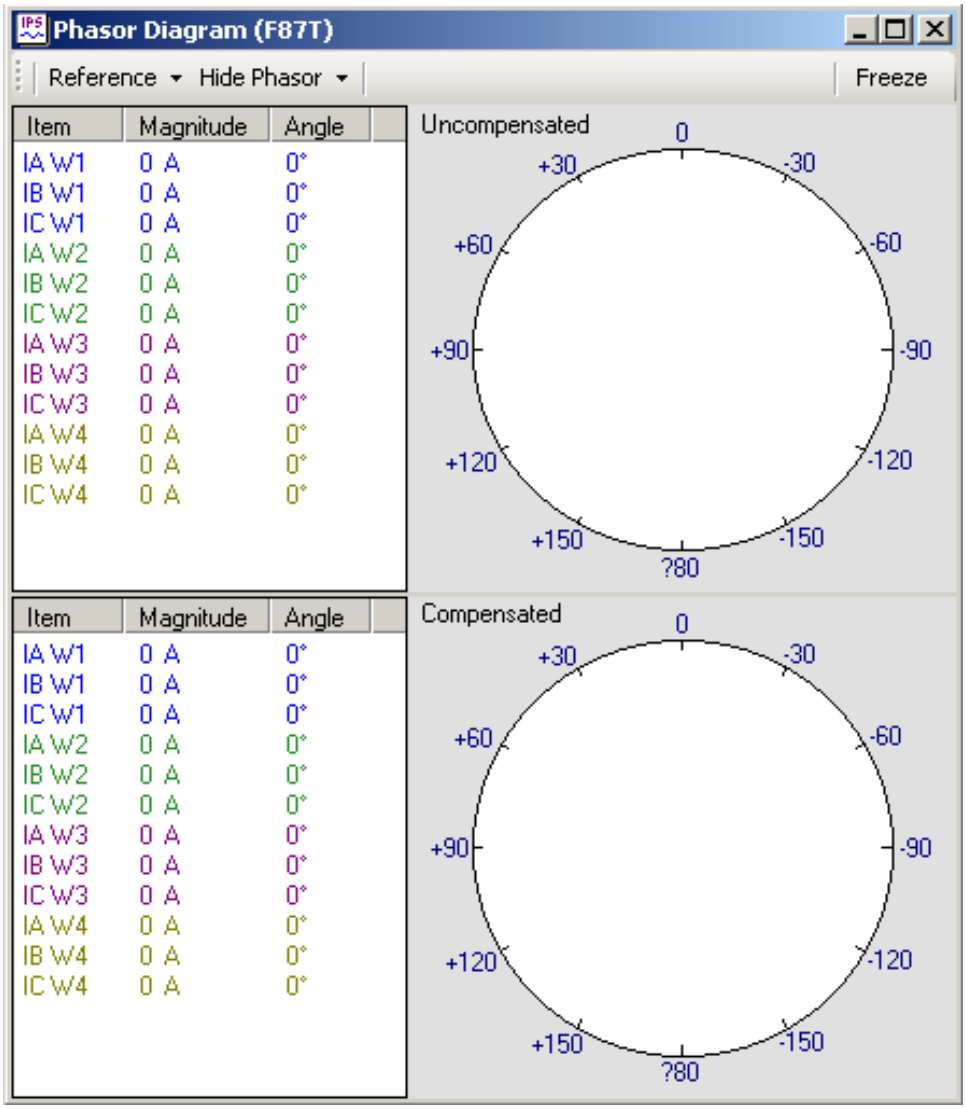
Path: Monitor / Phasor Diagram

■ **NOTE**: When connections specifying delta-connected CTs are used, Functions 87T and 87H use the Phasor Diagram values (currents actually entering the relay) and not the calculated values displayed on the Secondary Metering and status screen.

Figure 3-12 Phasor Diagram

Monitor/Phasor Diagram (F87T)

The Phasor Diagram (F87T) (Figure 3-13) provides the user with the ability to evaluate compensated and uncompensated 87 Function parameters.

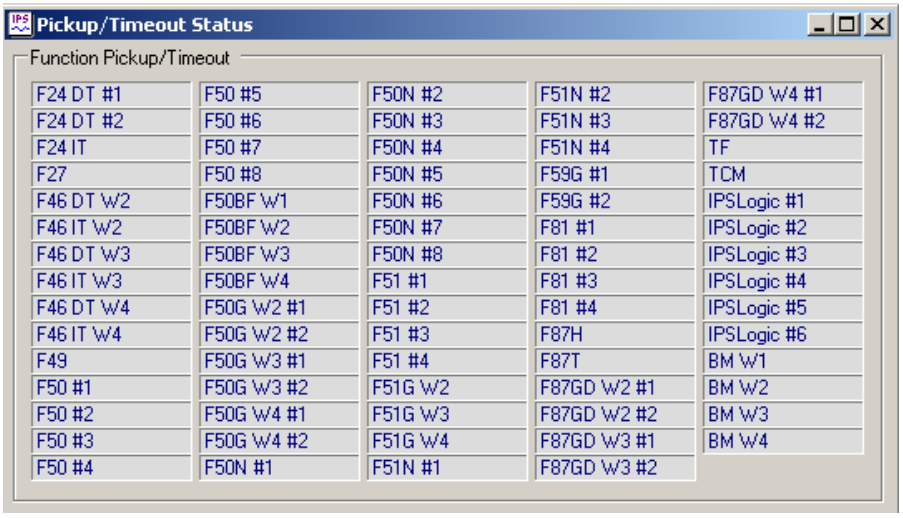


Path: Monitor / Phasor Diagram (F87T)

Figure 3-13 Phasor Diagram (F87T)

Monitor/Pickup/Timeout Status

The Pickup/Timeout Status screen (Figure 3-14) displays the extended status information of relay functions and Input/Output contact information.

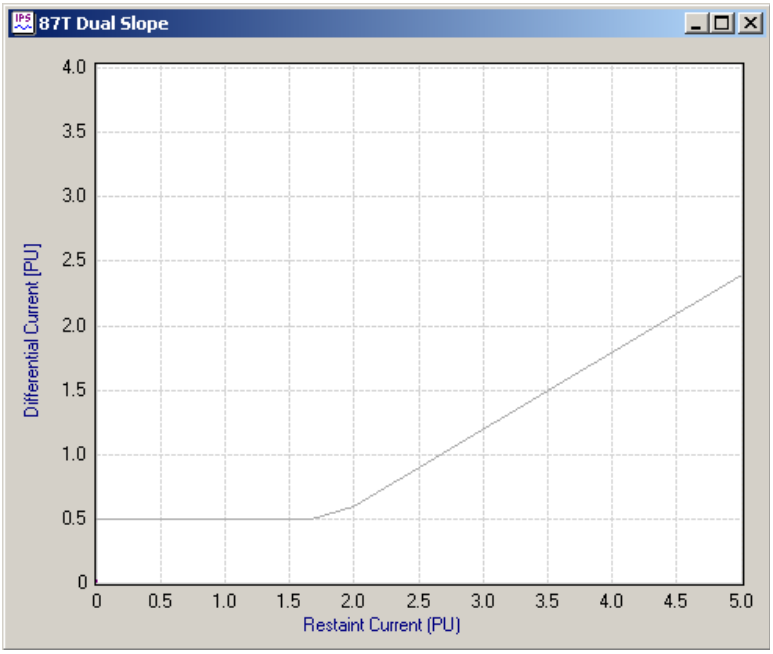


Path: Monitor / Pickup/Timeout Status

Figure 3-14 Pickup/Timeout Status

Monitor/87T Dual Slope

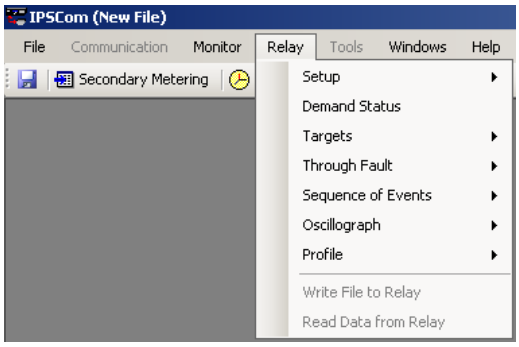
The 87T Dual Slope display allows the user to display a graphical representation of the 87T programmable Dual Slope Percentage Restraint Characteristic. See Section 4.4, System Setpoints for detailed information.



Path: Monitor / 87TDual Slope

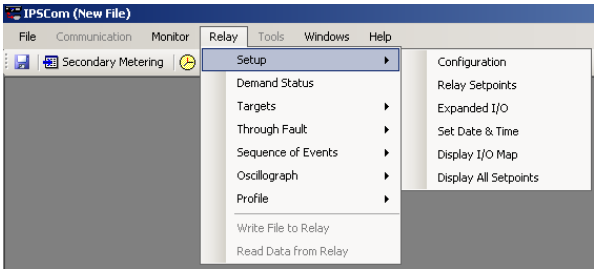
Figure 3-15 87T Function Dual Slope Display

Relay Menu



The **Relay** menu provides access to the screens used to set, monitor, or interrogate the relay. Six submenus are provided: **Setup, Demand Status, Targets**, **Through Fault, Sequence of Events**, **Oscillograph** and **Profile** as well as two commands, **Write File to Relay,** and **Read Data From Relay**.

Relay/Setup



The **Setup** submenu includes the **Configuration, Relay Setpoints Expanded I/O, Set Date &Time, Display I/O Map** and **Display All Setpoints** selections.

Relay/Setup/Configuration

The **Configuration** selection displays the Configuration System dialog screen (Figure 3-16) allowing the user to input the pertinent information regarding the system on which the relay is applied (see Section 4.2, **Configuration**, for detailed information regarding the specific elements of the Configuration dialog screen).

■ **NOTE:** Checking the inputs for the Active Input Open parameter designates the "operated" state established by an *opening* rather than a closing external contact.

COMMAND BUTTONS

Save — When connected to a relay, sends the currently displayed information to the unit. Otherwise, saves the currently displayed information to file and returns to the IPScom Main screen.

Cancel — Returns to the IPScom Main screen; any changes to the displayed information are lost.

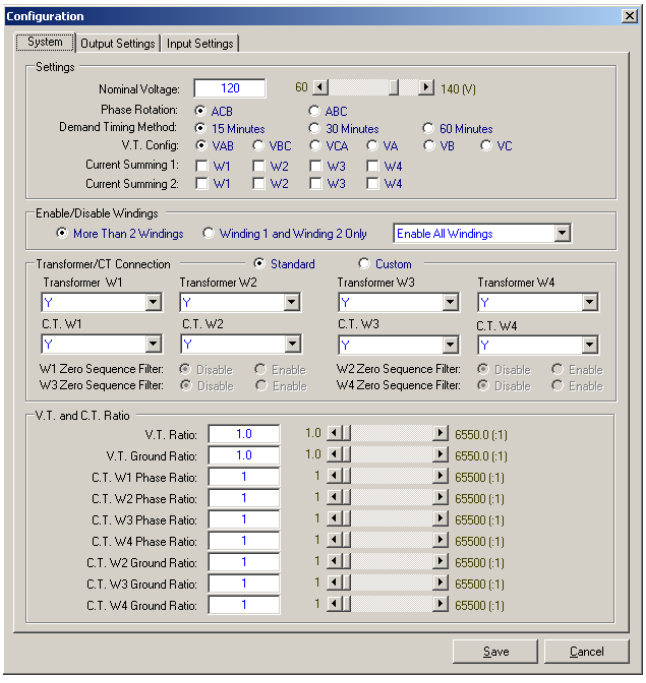


Figure 3-16 M-3826 IPScom Configuration Dialog Screen

Relay/Setup/Relay Setpoints

The **Relay Setpoints** menu selection displays the Relay Setpoints dialog screen (Figure 3-17) from which the individual Function Setting dialog screens can be accessed. Selecting a Function Setting button will display the corresponding function dialog screen (See Figure 3-18 as an example).

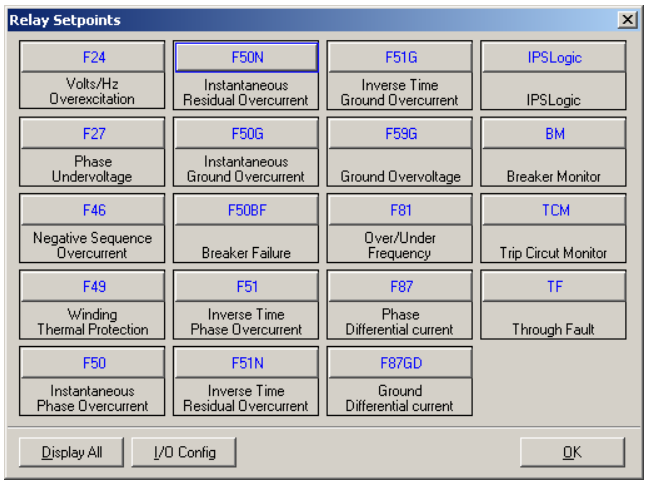


Figure 3-17 Relay Setpoints Dialog Screen

COMMAND BUTTONS

Display All Opens the All Setpoints Table dialog screen for the specified range of functions.

I/O Configure Opens the I/O Map dialog screen (Figure 3-21)

OK Exits the screen and returns to the IPScom® main screen.

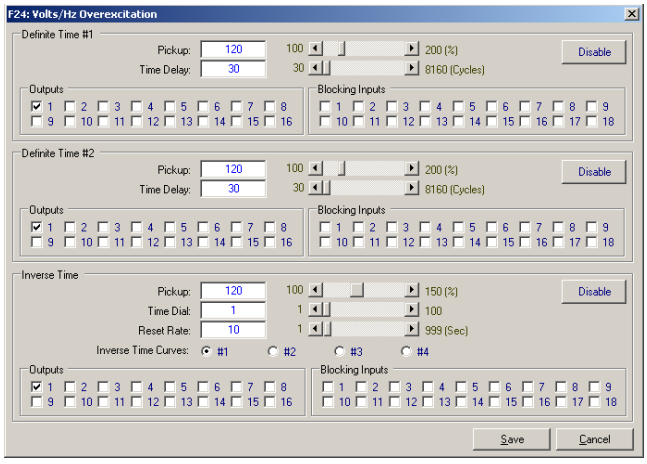


Figure 3-18 Example Function Dialog Screen

COMMAND BUTTONS

Save When connected to a relay, sends the currently displayed information to the unit. Otherwise, saves the currently displayed information and returns to the System Setpoints screen or All Setpoints Table.

Cancel Returns to the System Setpoints screen or All Setpoints Table; any changes to the displayed information are lost.

Relay/Setup/Expanded I/O

The Expanded I/O feature under Relay/Setup allows the user to enable/disable extended I/O if the unit is so equipped.

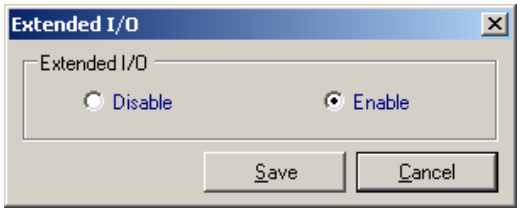


Figure 3-19 Expanded I/O Enable/Disable Screen

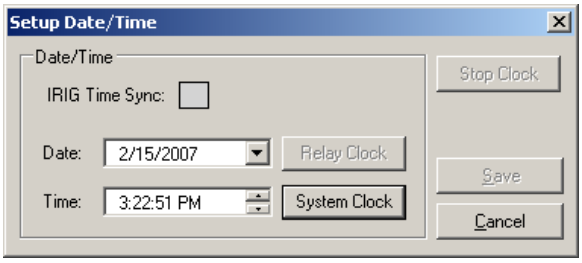
Relay/Setup/Set Date & Time

The **Setup Date & Time** command (Figure 3-20) allows the system date and time to be set, or system clock to be stopped. This dialog screen also displays an LED mimic to identify when the Time Sync is in use (preventing date/time from being changed by user).

The time field in the dialog box is not updated continuously. The time at which the dialog box was opened is the time that is displayed and remains as such. This is true whether the relay is synchronized with the IRIGB signal or not.

There is a green Time Sync LED mimic in this dialog box (the LED is displayed as different shading on a monochrome monitor). When this LED is green, the relay is synchronized with the IRIG-B signal and the Time field is grayed out, indicating that this field can't be changed. But the Date field can be changed (by editing and selecting **Save**).

When the LED is *not* blue, the relay is not time-synchronized and therefore, both the Date and Time fields can be changed.



Path: System/ Setup Date & Time

Figure 3-20 Date/Time Dialog Screen

SETUP DATE AND TIME COMMAND BUTTONS

Start/Stop Clock	This toggles between start/stop, the relay clock. 'Stop' pauses, 'Start' resumes.
Save	Saves Time and Date settings to the relay when applicable.
Cancel	Returns to the IPScom main window. Any changes to the displayed information is lost.

Relay/Setup/Display/I/O Map

Selecting the **I/O Map** button displays the I/O Map dialog screen (Figure 3-21), which contains a chart of programmed input and output contacts, in order to allow scrolling through all relay output and blocking input configurations.

Both the Relay Setpoints dialog screen and the I/O Map screen include the Display All Setpoints feature and Jump Command Buttons which allow the user to jump from a scrolling dialog screen to an individual relay function dialog screen and return to the scrolling dialog screen. All available parameters can be reviewed or changed when jumping to a relay I/O Map screen from either scrolling dialog screen.

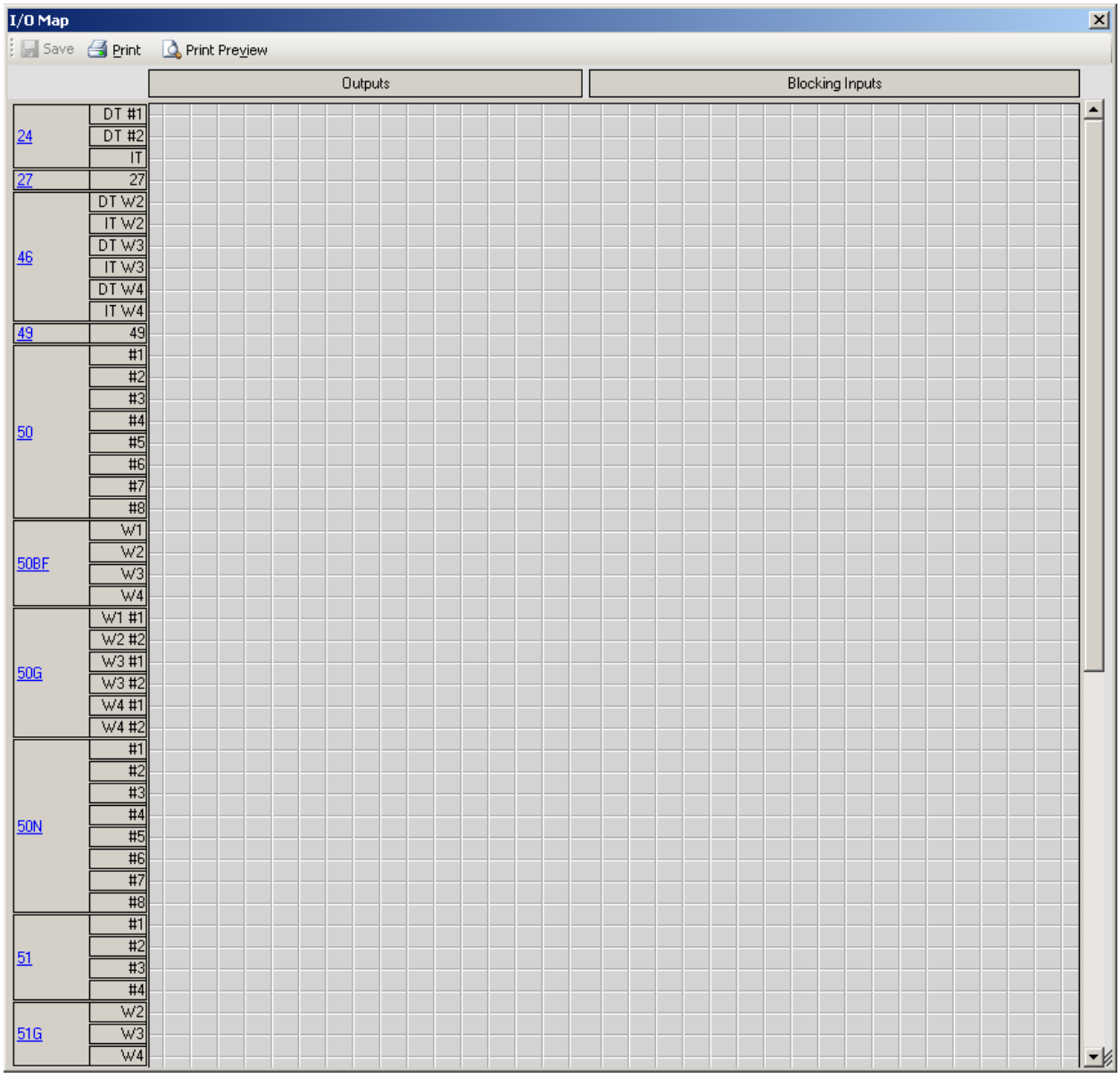


Figure 3-21 I/O Map Screen

Relay/Setup/Display All Setpoints

Selecting the **Display All Setpoints** button displays the **All Setpoints** dialog screen (Figure 3-22). This dialog screen contains the settings for each relay function within a single window to allow scrolling through all relay setpoint and configuration values.

The individual Feature and Function selection buttons are described in the applicable sections.

The All Setpoint Table includes Jump Command Buttons which allow the user to jump from a scrolling dialog screen to an individual relay function dialog screen and return to the scrolling dialog screen. All available parameters can be reviewed or changed when jumping to a configuration dialog screen.

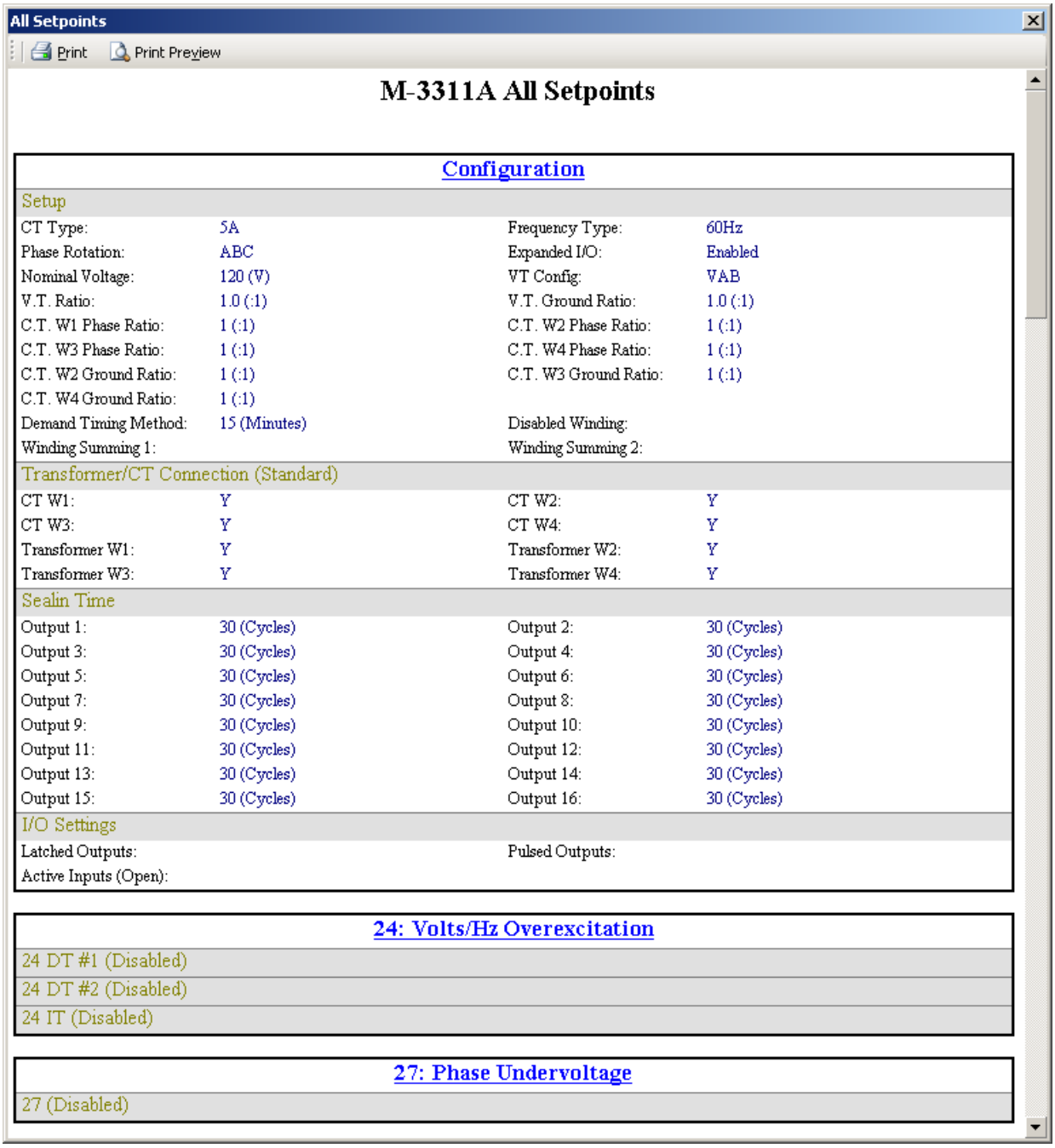


Figure 3-22 Display All Setpoints Screen

Relay/Demand Status

The **Demand Status** feature allows the user to access Primary Demand Values. See Chapter 2, **Operation** for detailed information.

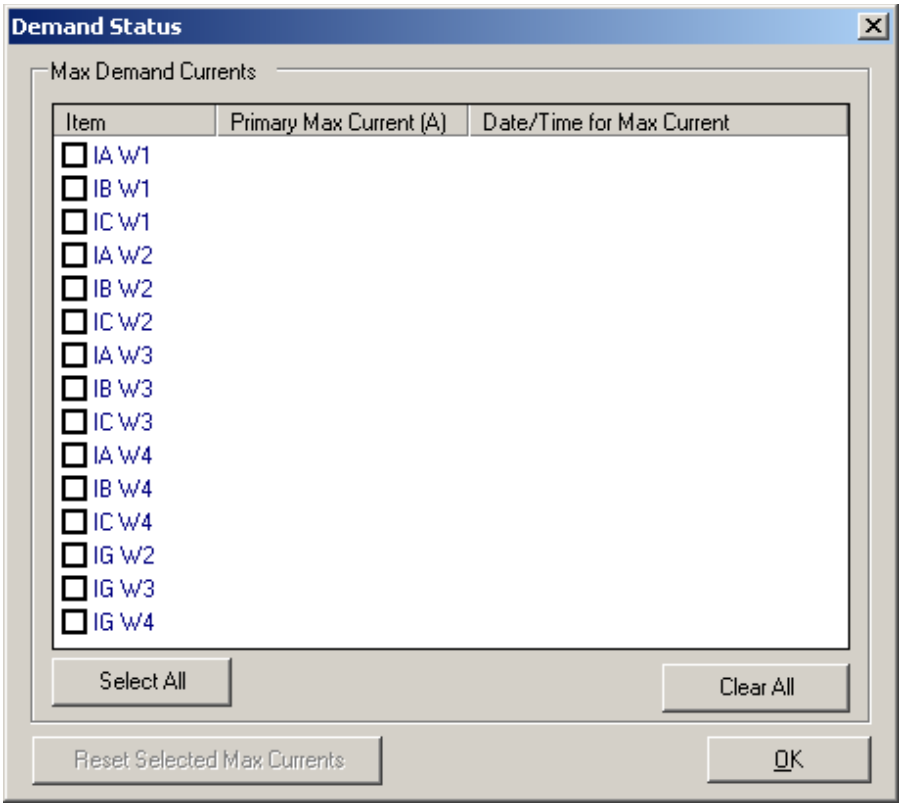
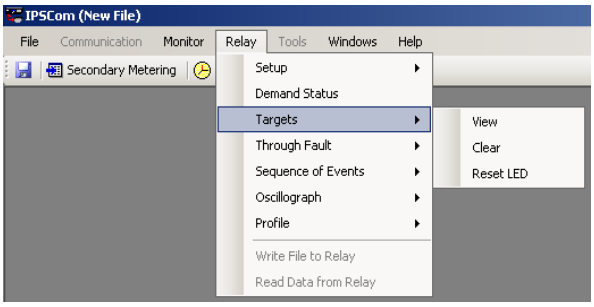


Figure 3-23 Demand Status Dialog Screen

Relay/Targets



The **Targets** submenu provides three command options: **View, Clear** and **Reset LED**. The **View** command displays Target dialog (see Figure 3-24, View Targets Dialog Screen). This dialog box provides detailed data on target events including time, date, function status, phase current values, and IN/OUT contact status at the time of trip. Individually recorded events may be selected within the dialog box and saved into a text file, or be printed out with optional added comments. The **Reset LED** is similar to pushing the **Target Reset** button on the relay itself. This command resets current target displayed on the relay. This command does not reset any target history. The **Clear** command clears all stored target history. See Chapter 2, **Operation** for detailed information.

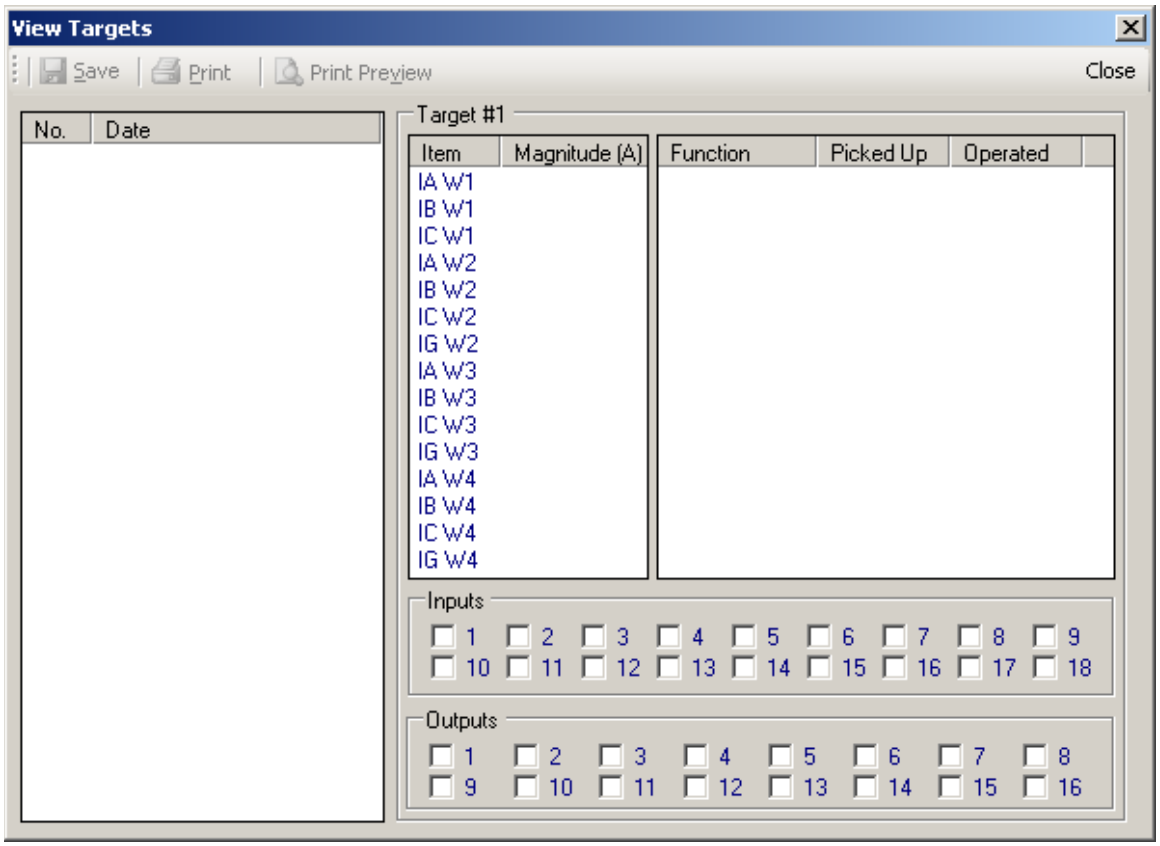
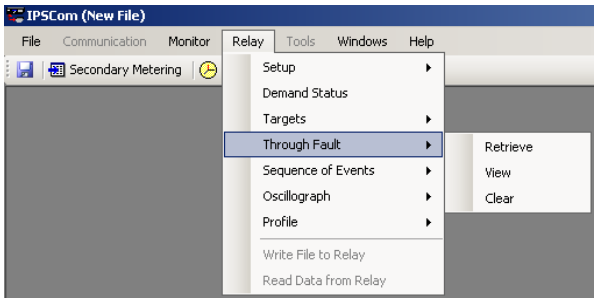


Figure 3-24 View Targets Dialog Screen

Relay/Through Fault



The Through Fault submenu provides three command options: **Retrieve**, **View** and **Clear**. The **Retrieve** command initiates the retrieval of any Through Faults present in the relay. The **View** command displays the View Through Fault Record dialog screen (Figure 3-25). This screen provides detailed information about each Through Fault record. The information includes the Record Serial Number, Start Time, Duration, Fault Current, Max Current and Phase. The submenu also includes the **Clear** command which clears all Through Fault records in the relay. See Chapter 4, **System Setup and Setpoints** and Chapter 2, **Operation**, for detailed information.

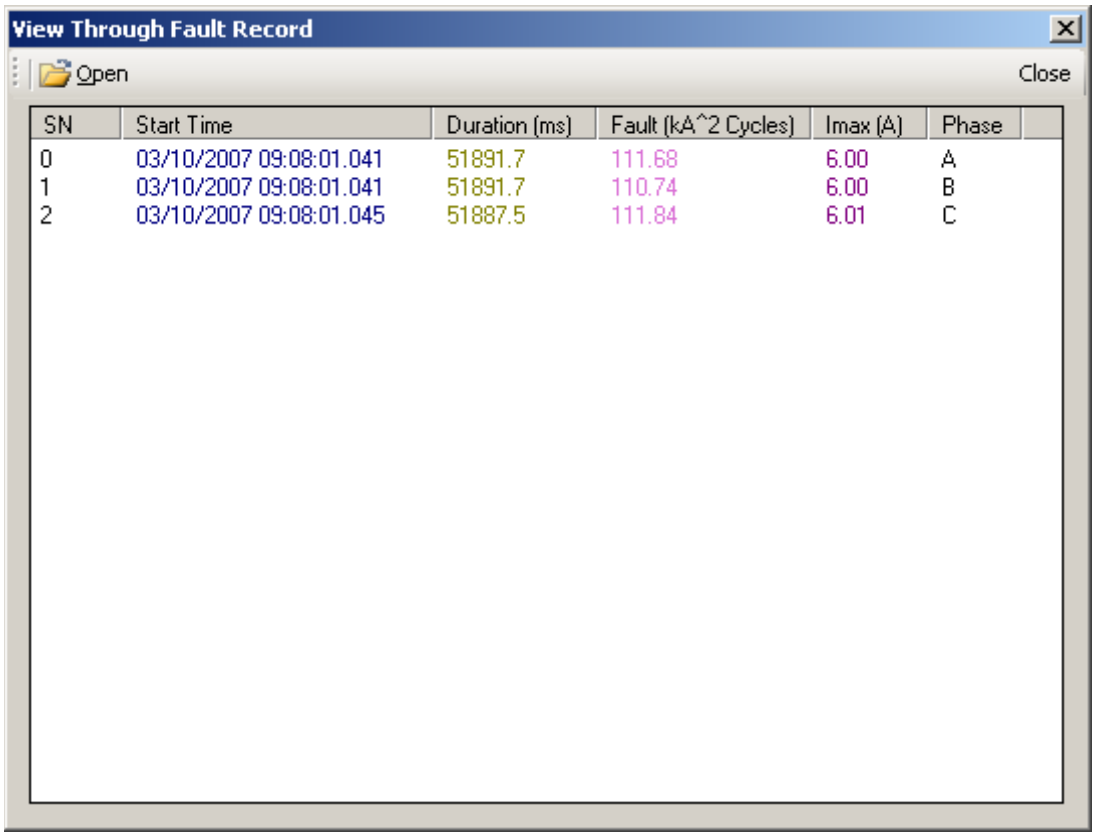
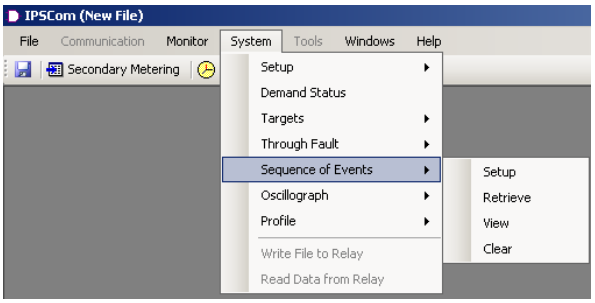


Figure 3-25 View Through Fault Record Screen

Relay/Sequence of Events



The Sequence of Events submenu allows the user to **Setup**, **Retrieve**, **View** and **Clear** Sequence of Events records. The **Setup** command displays the **Setup Sequence of Events Recorder** dialog screen (Figure 3-26). Function Pickup, Trip and Drop can be selected to initiate the recorder as well as Input Pickup, Output Pickup, Inputs Drip and Outputs Drip. The **Retrieve** command downloads and saves the record to file (Figure 3-27). The **View** command displays the View Sequence of Events Record screen (Figure 3-28) which allows the user to open and print Sequence of Events files. The **Clear** command clears all Sequence of Events records in the relay. See Chapter 4, **System Setup and Setpoints** and Chapter 2, **Operation**, for detailed information.

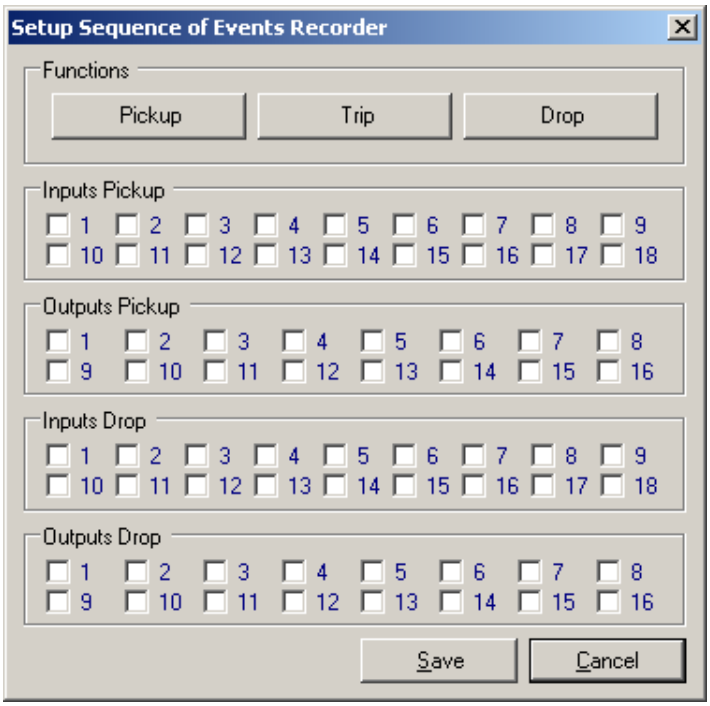


Figure 3-26 Sequence of Events Recorder Setup Screen

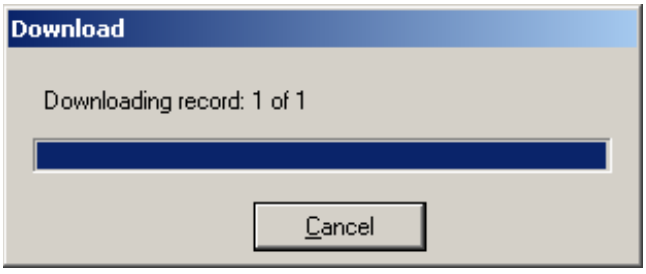


Figure 3-27 Sequence of Events Recorder Retrieve Screen

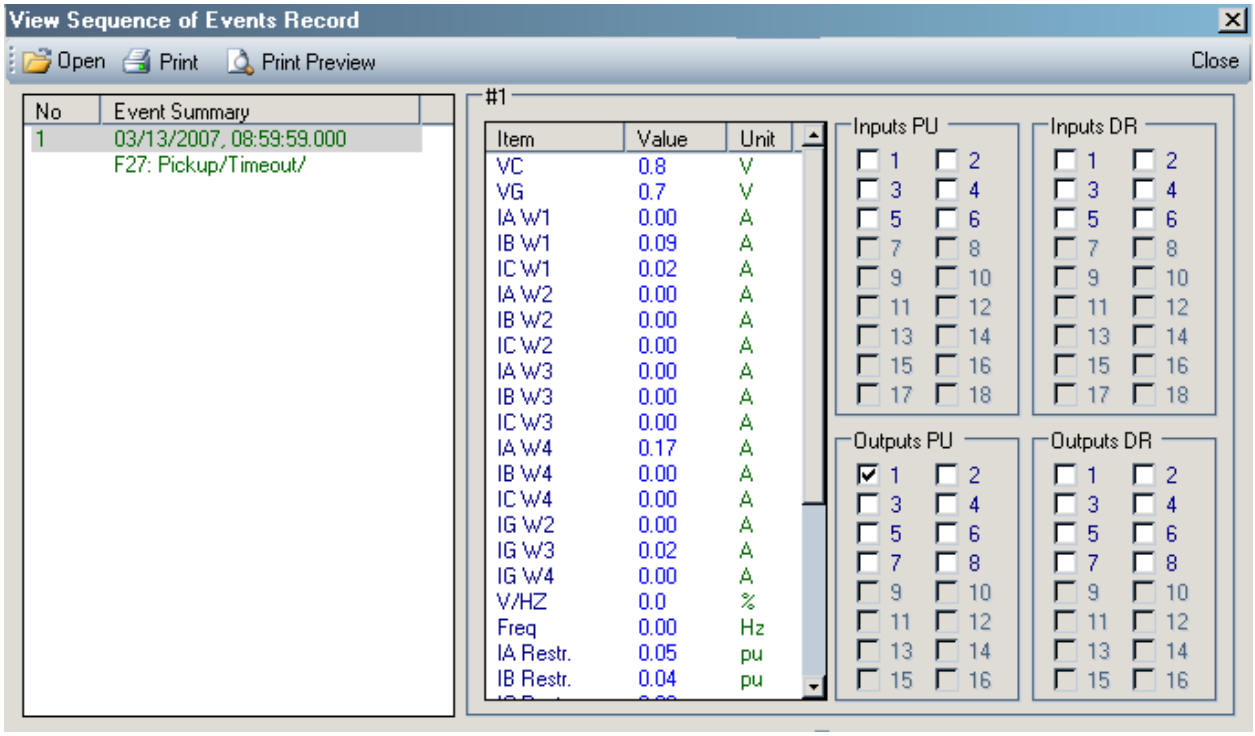
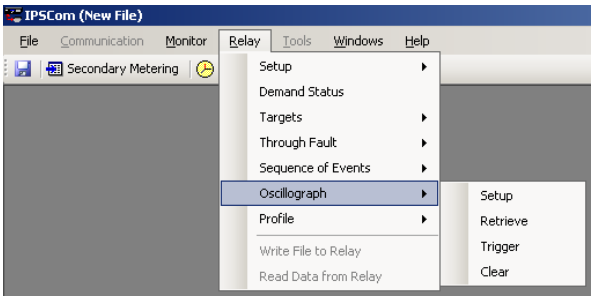


Figure 3-28 View Sequence of Events Recorder Screen

Relay/Oscillograph



The **Oscillograph** submenu allows setting and control over the relay's oscillograph recorder. The **Setup** command allows the user to set the number of partitions and triggering designations to be made (Figure 3-29), **Retrieve** downloads and save data to a file (Figure 3-30). **Trigger** sends a command to the realy to capture a waveform. This is the same as issuing a manual oscillograph trigger. **Clear** erases all existing records. The optional M-3801D IPSplot®*PLUS* Oscillograph Analysis Software program is required to view the downloaded oscillograph files.

See Chapter 4, **System Setup and Setpoints** and Chapter 2, **Operation**, for detailed information.

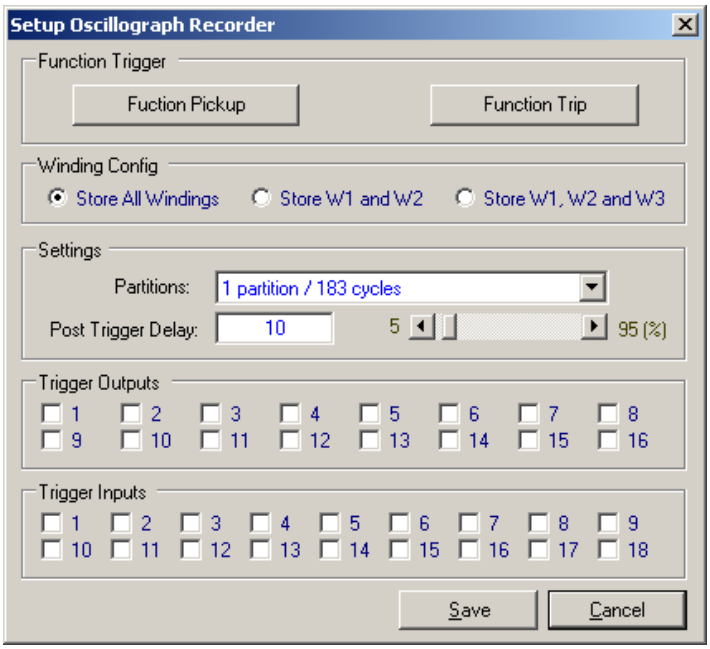


Figure 3-29 Setup Oscillograph Recorder Dialog Screen

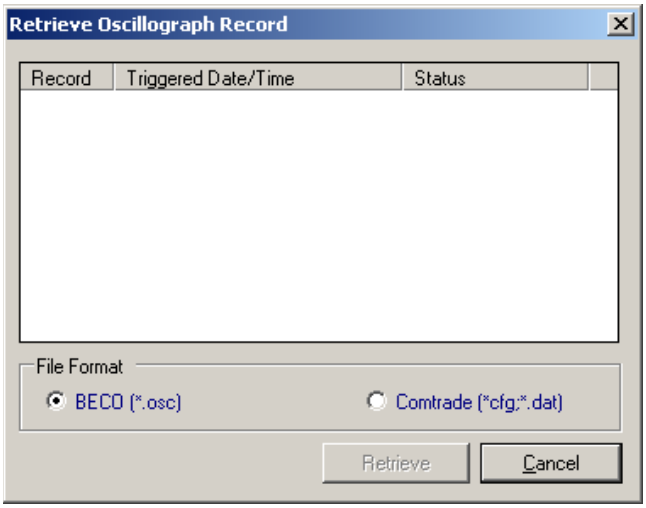
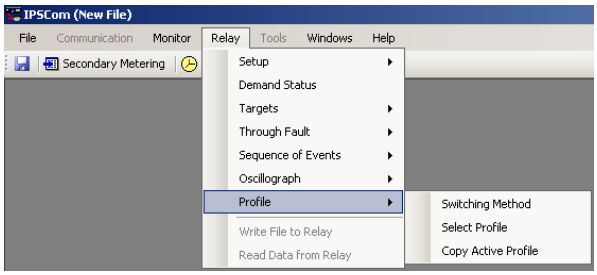


Figure 3-30 Oscillograph Recorder Retrieve Dialog Screen

Relay/Profile



CAUTION: If relay is online, be sure to switch the active profile. If the wrong profile is selected, it may cause unexpected operation.

The **Profile** submenu provides three command options: **Switching Method**, **Select Profile**, and **Copy Active Profile**.

Switching Method command allows selection of either Manual or Input contact (Figure 3-31). **Select Profile** allows user to designate active profile (Figure 3-32). **Copy Active Profile** copies active profile to one of four profiles (user should allow approximately 15 seconds for copying) (Figure 3-33).

See Chapter 4, **System Setup and Setpoints** for detailed information.

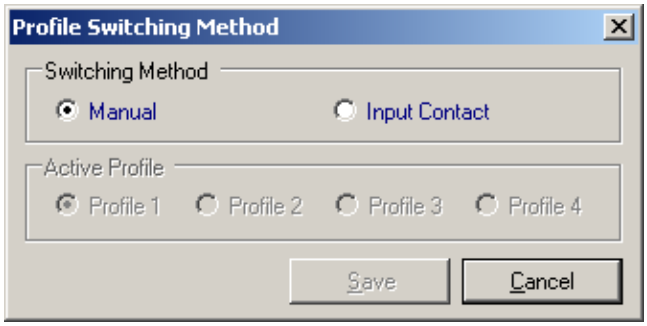


Figure 3-31 Profile Switching Method Dialog Screen

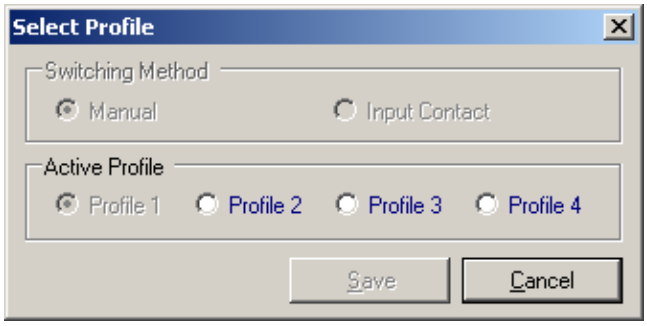


Figure 3-32 Select Profile Dialog Screen

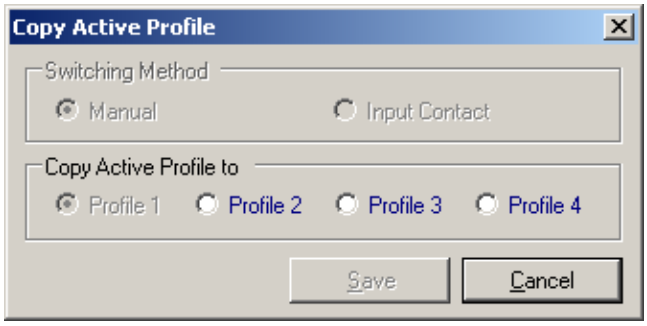
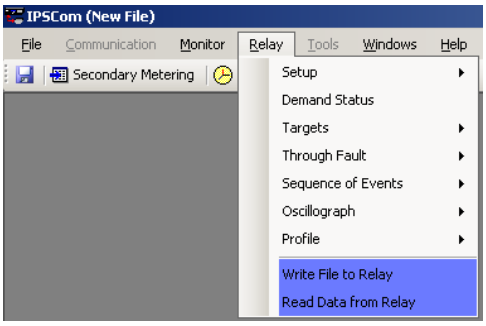


Figure 3-33 Copy Active Profile Dialog Screen

Relay/Write File to Relay

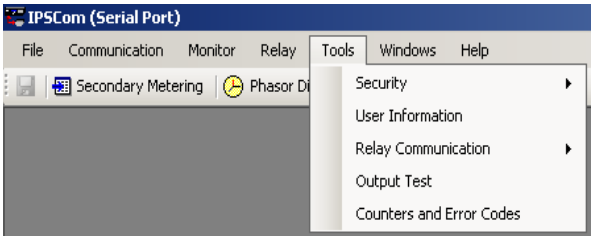


The **Write File to Relay** command sends a predefined setpoint data file to the Relay.

Relay/Read Data From Relay

The **Read Data from Relay** command updates the PC data image with the relay's latest data.

Tools Menu



The **Tools** menu provides the user with access to IPScom® relay support features and functions.

Tools/Security

The Security menu item includes the **Change Comm Access** and **Change User Access** code submenus.

Tools/Security/ Change Comm Access Code

The **Change Comm Access** code selection displays the Change Comm Access Code screen (Figure 3-34) which allows the user to change the Comm Access Code. See Section 4.1, **Unit Setup** for detailed setup instructions.

If additional link security is desired, a communication access code can be programmed. Like the user access codes, if the communication access code is set to 9999 (default), communication security is disabled.

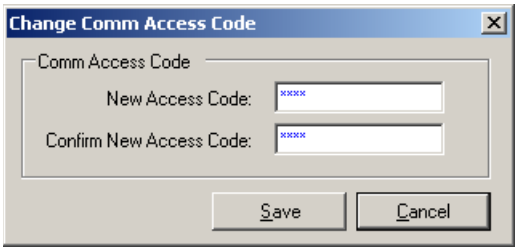


Figure 3-34 Change Comm Access Code Dialog Screen

Tools/Security/Change User Access Code

The **Change User Access Code** selection displays the Change User Access Code screen (Figure 3-35) which allows the user to change the relay User Access Code. See Section 4.1, **Unit Setup** for detailed setup instructions.

The relay includes three levels of access codes. Depending on their assigned code, users have varying levels of access to the installed functions.

1. **Level 1 Access** = Read setpoints, monitor status, view status history.
2. **Level 2 Access** = All of level 1 privileges, plus read & change setpoints, target history, set time clock.
3. **Level 3 Access** = All of level 2 privileges, plus access to all configuration functions and settings.

Each access code is a user-defined one-to four-digit number. Access codes can only be altered by a level 3 user.

If the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access screens are bypassed, and all users have full access to all the relay menus. The device is shipped from the factory with the access code feature disabled.

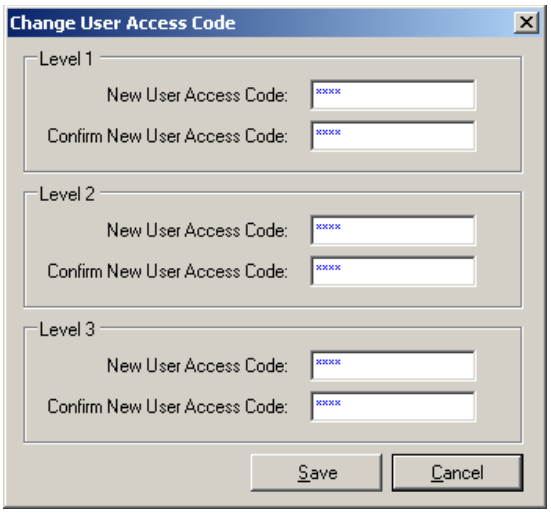


Figure 3-35 Change User Access Code Dialog Screen

Tools/User Information

The User Information menu selection displays the User Information screen (Figure 3-36) which provides the user with the ability to edit/input the User Logo lines of the HMI display, enter/edit the User Control Number and set the operating mode of the System OK LED. See Section 4.1, **Unit Setup** for detailed setup instructions.

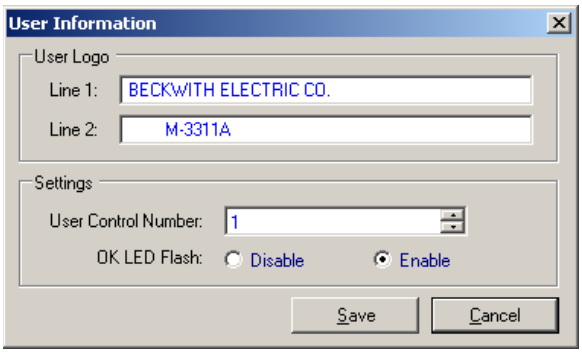


Figure 3-36 User Information Screen

Tools/User Information/User Logo Line

The user logo is a programmable, two-line by 24-character string, which can be used to identify the relay, and which is displayed locally during power up after Self Test completion. This information is also available in IPScom.

User Control Number

The User Control Number is a user-defined value which can be used for inventory or identification. The unit does not use this value, but it can be accessed through the HMI or the communications interface, and can be read remotely.

System OK LED

The green SYSTEM OK LED is controlled by the unit's microprocessor. A flashing SYSTEM OK LED indicates proper program cycling. The LED can also be programmed to be continuously illuminated.

Tools/Relay Communication

The Relay Communication menu selection provides the user with the ability to change the relay Communication Address (Figure 3-37), set the relay's COM Port communication parameters (Figure 3-38) and setup the Ethernet Port (Figure 3-39). See Section 4.1, **Unit Setup** for detailed communication setup instructions.

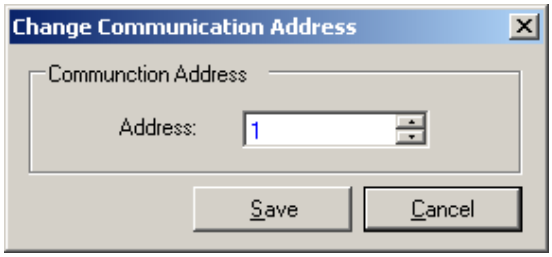


Figure 3-37 Change Relay Communication Address Dialog Screen

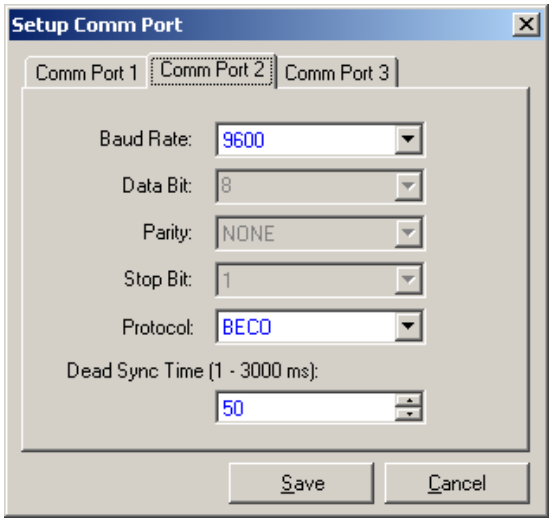


Figure 3-38 Setup Relay Comm Port Dialog Screen

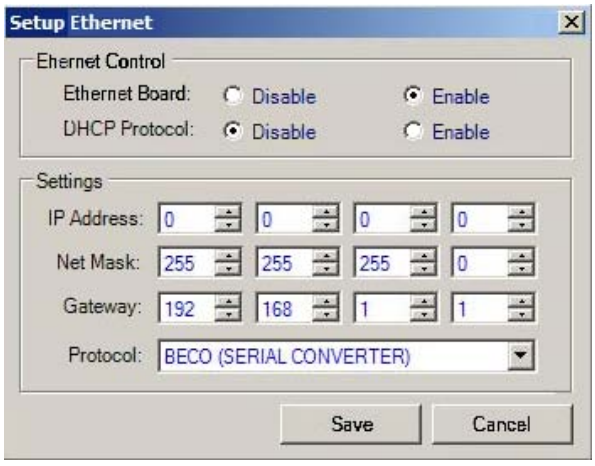


Figure 3-39 Setup Relay Ethernet Port Dialog Screen

Tools/Output Test

The Output Test menu selection displays the Output Test screen (Figure 3-40) which provides the user with the ability to test each ouput relay. See Section 6, **Testing** for detailed testing instructions.

Tools/Counters and Error Codes

The Counters and Error Codes menu selection displays the Counters and Error Codes screen (Figure 3-41) which provides the user with the ability to view and clear system Error Codes, Alarm Counters, Power Loss Counter and Output Counters. Also, Checksums can be viewed for Calibration and Setpoints. See Chapter 2, **Manual Operation** for detailed instructions.

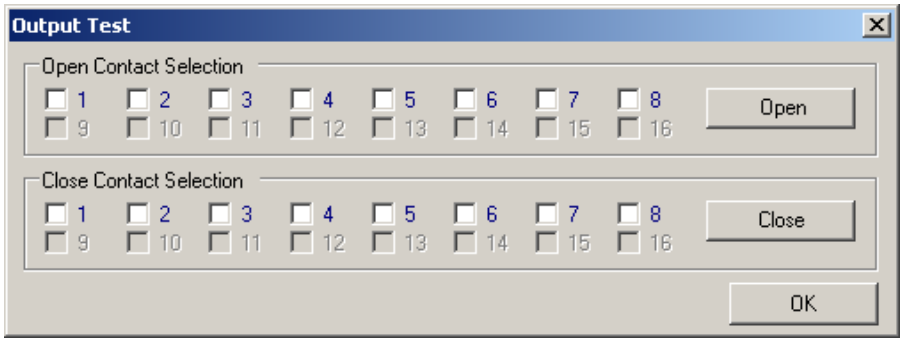


Figure 3-40 Output Test Dialog Screen

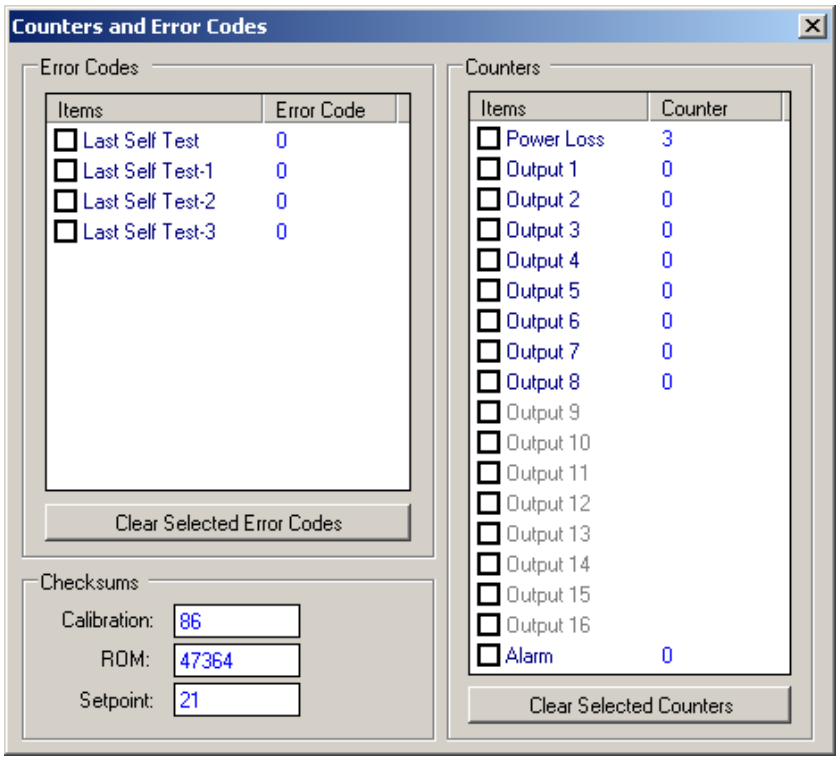
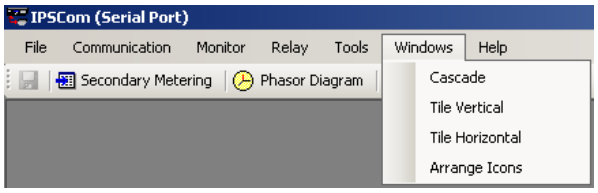


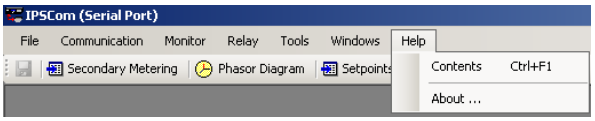
Figure 3-41 Counters and Error Codes Dialog Screen

Window Menu



The **Window** menu enables positioning and arrangement of IPScom® windows so that there is better access to available functions. This feature allows the display of several windows at the same time. Clicking on an inactive yet displayed window activates that window.

Help Menu



The **Help** menu provides four commands. The **Contents** command initiates a link to a PDF (Portable Document File) version of this instruction book for easy reference. An Adobe Acrobat® reader is required to view this document.

The M-3311A Instruction Book has been indexed to its table of contents. By selecting the 'Navigator pane' in Adobe Acrobat Reader, the user can directly access selected topics.

Using Help is currently unavailable, and will appear greyed-out in display. The **About** command displays IPScom version and development information. **Profile Info** displays user information for input and editing.

4 System Setup and Setpoints

Chapter four is designed for the person or group responsible for the Unit Setup, Configuration and System Setpoints of the M-3311A Transformer Protection Relay.

Chapter 4 consists of:

- Functional and connection diagrams for a typical application of the relay.
- The Unit Setup Section, which consists of general unit setup information, Communications setup, Oscillograph, Sequence of Events, Through Fault Recorder and Demand Interval setup.
- The Configuration Section provides the definitions of system quantities and equipment characteristics required by the relay which include CT, VT configuration selection and Input and Output assignments.
- A System Setpoints Section which describes the unit transfer settings, enabling functions and setpoints, output contact assignments and digital input assignments.

The selection of the M-3311A System Setup parameters and Setpoints can be performed using either the M-3826 IPScom® Communications Software from the unit's M-3931 Front Panel Human Machine Interface (HMI), and will be included where applicable.

4.1 Unit Setup

■ **NOTE**: Setup Record Forms are contained in **Appendix A**. The Setup Record Form tables list the relay parameter settings choices for each feature and function.

GENERAL UNIT SETUP

The General Unit setup consists of the setup of the following features and functions:

- Comm Access Code
- User Access Codes
- User Logo Lines
- User Control Number
- OK LED Flash
- Time and Date

COMM ACCESS CODE

If additional link security is desired, a communication access code can be programmed. Like the user access codes, if the communication access code is set to 9999 (default), communication security is disabled.

IPScom Comm Access Code Setup

To set the relay Comm Access Code perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

To set the relay Comm Access Code perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **Tools/Security/Change Comm Access Code**. IPScom will display the Change Comm Access Code dialog screen (Figure 4-1).

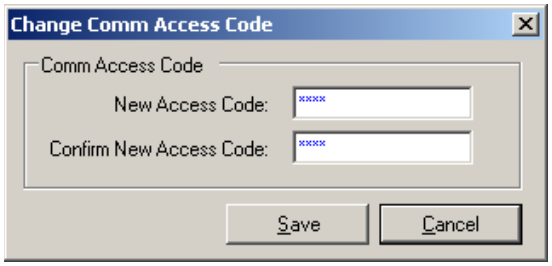


Figure 4-1 Change Comm Access Code Dialog Screen

2. Enter the desired New Comm Access Code (1-9999), then re-enter (confirmation) the New Access Code.
3. Select **Save**, IPScom will display a Comm Access Code change Confirmation Screen (Figure 4-2).

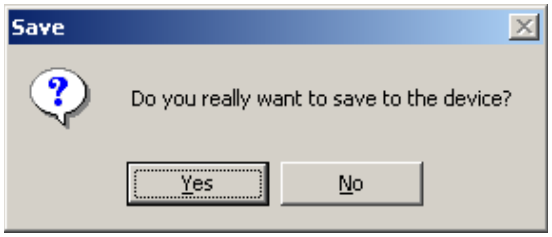


Figure 4-2 Comm Access Code Change Confirmation Screen

4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 4-3).

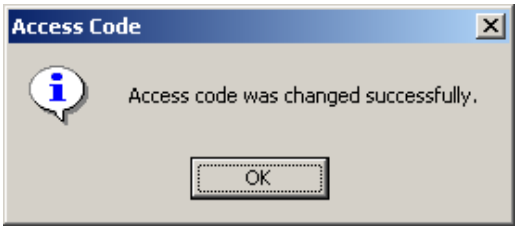


Figure 4-3 Access Code Changed Confirmation Screen

5. Select **OK**, ISScom will return to the Main Screen.

   The new Comm Access Code will not be in affect until communications have been closed with the relay for approximately 2.5 minutes.

HMI Comm Access Code Setup

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
COMMUNICATION
stat COMM setup
```

5. Press **ENTER,** the following will be displayed:

```
COM1 SETUP
COM1 com2 com3 com_adr
```

6. Press the Right arrow pushbutton until the following is displayed:

```
COMM ACCESS CODE
ACCSS eth eth_ip
```

7. Press **ENTER,** the following will be displayed:

```
COMM ACCESS CODE
      9999
```

8. Input the desired Comm Access Code as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Comm Access Code digits.
   c. When the desired Comm Access Code has been input, then press **ENTER**. The following will be displayed:

```
COMM ACCESS CODE
ACCESS eth eth_ip
```

9. Press **Exit.**

IPScom User Access Code Setup

The relay includes three levels of access codes. Depending on their assigned code, users have varying levels of access to the installed functions.

1. **Level 1 Access** = Read setpoints, monitor status, view status history.
2. **Level 2 Access** = All of level 1 privileges, plus read & change setpoints, target history, set time clock.
3. **Level 3 Access** = All of level 2 privileges, plus access to all configuration functions and settings.

Each access code is a user-defined one-to-four digit number. Access codes can only be altered by a level 3 user.

If the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access screens are bypassed, and all users have full access to all the relay menus. The device is shipped from the factory with the access code feature disabled.

Setup User Access Codes

To setup the relay User Access Codes perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **Tools/Security/Change User Access Code**. IPScom will display the Change User Access Code dialog screen (Figure 4-4).

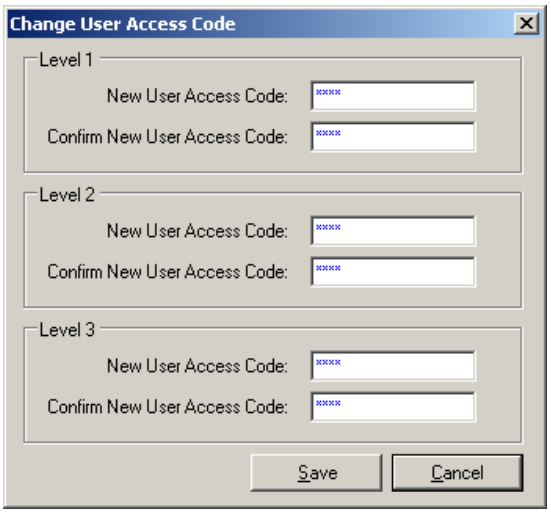


Figure 4-4 Change User Access Code Dialog Screen

2. Enter the desired User Access Code (1-9999), then re-enter (confirmation) the desired User Access Code.
3. Select **Save**, IPScom will display a User Access Code change Confirmation Screen (Figure 4-2).
4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 4-3).
5. Select **OK**, IPScom will return to the Main Screen.

HMI User Access Codes Setup

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```

5. If User Access Codes are to be set, then use the RIGHT arrow pushbutton to select ALTER ACCESS CODES. The following will be displayed:

```
ALTER ACCESS CODES
vers sn ACCESS number
```

6. Press **ENTER,** the following will be displayed:

```
ENTER ACCESS CODE
LEVEL#1 level#2 level#3
```

7. Press **ENTER**, the following will be displayed:

```
LEVEL #1
      9999
```

8. Input the desired User Access Code as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Access Code.
   c. When the desired Access Code has been input, then press **ENTER**. The following will be displayed:

```
ENTER ACCESS CODE
LEVEL#1 level#2 level#3
```

9. To set User Access Code Level #2 press the RIGHT arrow pushbutton to select LEVEL #2, then press **ENTER** the following will be displayed:

```
LEVEL #2
      9999
```

10. Repeat Step 8 to enter the desired Level #2 User Access Code.
11. To set User Access Code Level #3 press the RIGHT arrow pushbutton to select LEVEL #3, then press **ENTER** the following will be displayed:

```
LEVEL #3
      9999
```

12. Repeat Step 8 to enter the desired Level #3 User Access Code.
13. Press the **EXIT** pushbutton will return to the previous selection screen:

```
ALTER ACCESS CODES
vers sn ACCESS number
```

USER LOGO LINE

The user logo is a programmable, two-line by 24-character string, which can be used to identify the relay, and which is displayed locally when the unit is idle. This information is also available in IPScom®.

USER CONTROL NUMBER

This is a user-defined value which can be used for inventory or identification. The unit does not use this value, but it can be accessed through the HMI or the communications interface, and can be read remotely.

SYSTEM OK LED

The green **SYSTEM OK** LED is controlled by the unit's microprocessor. A flashing **SYSTEM OK** LED indicates proper program cycling. The LED can also be programmed to be continuously illuminated.

IPScom User Logo Line, User control Number and System OK LED Setup

To set the relay User Logo Line, User Control Number and System OK LED perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **Tools/User Information**. IPScom will display the User Information dialog screen (Figure 4-5).

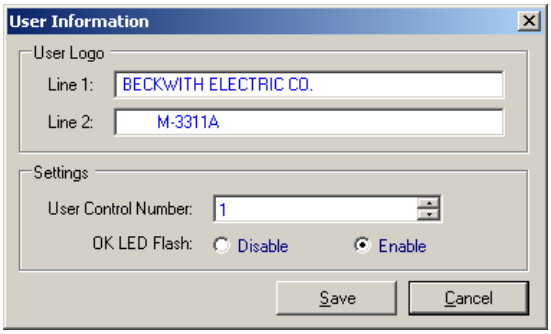


Figure 4-5 User Information Dialog Screen

2. If entering/editing the User Logo lines, then enter the desired User Logo Lines.
3. If changing the User Control Number, then enter the desired User Control Number.
4. If enabling/disabling the System OK LED Flash operation, then select either **Enable** of **Disable**.
5. Select **Save**, IPScom will return to the Main Screen.

HMI User Logo Line Setup

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```

5. Press **ENTER**, the following will be displayed:

```
SOFTWARE VERSION
VERS eth sn access
```

6. Press the Right arrow pushbutton until the following is displayed:

```
USER LOGO LINE 1
LOGO 1 logo 2 alrm
```

7. Press **ENTER,** the following will be displayed:

```
USER LOGO LINE 1
_BECKWITH ELECTRIC CO.
```

8. Input the desired User Logo Line 1 as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first letter/symbol/digit/blank space.
   b. Press the Right arrow pushbutton once, then repeat the previous step as necessary to input the desired User Logo Line 1.
   c. When the desired User Logo Line 1 has been input, then press **ENTER**. The following will be displayed:

```
USER LOGO LINE 1
—WAIT—
```

```
USER LOGO LINE 1
LOGO 1 logo 2 alrm
```

9. To enter a User Logo Line 2 press the RIGHT arrow pushbutton once, the following will be displayed:

```
USER LOGO LINE 2
logo 1 LOGO 2 alrm
```

10. Press **ENTER,** the following will be displayed:

```
USER LOGO LINE 2
_        M-3311A
```

11. Input the desired User Logo Line 2 as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first letter/symbol/digit/blank space.
   b. Press the RIGHT arrow pushbutton once, then repeat the previous step as necessary to input the desired User Logo Line 2.
   c. When the desired User Logo Line 2 has been input, then press **ENTER**. The following will be displayed:

```
USER LOGO LINE 2
—WAIT—
```

```
USER LOGO LINE 2
logo 1 LOGO 2 alrm
```

12. Press **Exit.**

HMI User Control Number Setup

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.
3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```

5. Press **ENTER**, the following will be displayed:

```
SOFTWARE VERSION
VERS sn access number
```

6. Press the Right arrow pushbutton until the following is displayed:

```
USER CONTROL NUMBER
vers sn access NUMBER
```

7. Press **ENTER**, the following will be displayed:

```
USER CONTROL NUMBER
      1
```

8. Input the desired User Control Number as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired User Control Number.
   c. When the desired User Control Number has been input, then press **ENTER**. The following will be displayed:

```
USER CONTROL NUMBER
vers sn access NUMBER
```

9. Press **Exit.**

HMI System OK LED Setup

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

▲ **CAUTION:** Do not enter DIAGNOSTIC MODE when protected equipment is in service. Entering DIAGNOSTIC MODE when protected equipment is in service removes all protective functions of the relay.

4. Press the right arrow pushbutton until the following is displayed:

```
SETUP UNIT
←  stat comm SETUP →
```

5. Press **ENTER,** the following will be displayed:

```
SOFTWARE VERSION
VERS sn access number →
```

6. Press the right arrow pushbutton until the following is displayed:

```
DIAGNOSTIC MODE
←  time error eth DIAG
```

7. Press **ENTER**, the following warning will be displayed:

```
PROCESSOR WILL RESET!
ENTER KEY TO CONTINUE
```

▲ **CAUTION:** Do not enter DIAGNOSTIC MODE when protected equipment is in service. Entering DIAGNOSTIC MODE when protected equipment is in service removes all protective functions of the relay.

8. Press **ENTER**, the relay will reset and **DIAGNOSTIC MODE** will be temporarily displayed followed by:

```
OUTPUT TEST (RELAY)
OUTPUT input led module →
```

9. Press the Right arrow pushbutton until the following is displayed:

```
FLASH SYS OK LED
com3  clock  LED  cal →
```

10. Press **ENTER**, the following will be displayed:

```
FLASH SYS OK LED
off  ON
```

11. Utilizing the Right or Left arrow pushbuttons select either ON or OFF.

12. Press **ENTER**, the following will be displayed:

```
FLASH SYS OK LED
—DONE—
```

13. Press **ENTER**, the following will be displayed:

```
FLASH SYS OK LED
com3  clock  LED  cal  →
```

14. Press **EXIT**, the following will be displayed:

```
PRESS EXIT TO
EXIT DIAGNOSTIC MODE
```

15. Press **EXIT**, the unit will cycle through the Power Self Tests.

SYSTEM CLOCK

This feature allows the user to set the relay internal clock. The clock is used to time stamp system events and oscillograph operations.

The clock is disabled when shipped from the factory (indicated by "80" seconds appearing on the clock) to preserve battery life. If the relay is to be unpowered for an extended length of time, the clock should be stopped (from Diagnostic Mode or IPScom Figure 4-6). If the IRIG-B interface is used, the hours, minutes, and seconds information in the clock will be synchronized with IRIG-B time information every hour.

The relay can accept a modulated IRIG-B signal using the rear panel BNC connector, or a demodulated TTL level signal using extra pins on the rear panel COM2 RS-232 interface connector (see Figure B-4 for COM2 pinout.) If the TTL signal is to be used, then Jumper 5 will be required to be positioned (see Section 5.5, Circuit Board Switches and Jumpers).

IPScom Set Date/Time

To set the relay Date/Time perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **System/Setup/Setup Date & Time**. IPScom will display the Setup Date/Time dialog screen (Figure 4-6).

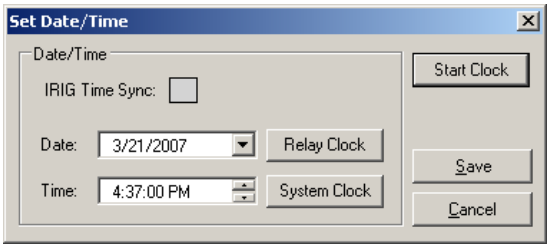


Figure 4-6 Setup Date/Time Dialog Screen

2. Enter the desired Date and/or Time.
3. Select **SAVE**, IPScom will return to the Main Screen.

HMI SET DATE and TIME

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the RIGHT arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```

5. Press **ENTER**, then press the RIGHT arrow pushbutton until the following is displayed:

```
DATE & TIME
← TIME error eth diag
```

6. Press **ENTER**, the following will be displayed:

```
DATE & TIME
08-Jan-2001 00:00:80
```

7. Press **ENTER**, the following will be displayed:

```
DATE & TIME
     01 Year
```

8. Input the desired Year as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Year.
   c. When the desired Year has been input, then press **ENTER**. The following will be displayed:

```
DATE & TIME
JAN feb mar apr may →
```

9. Input the desired Month as follows:
   a. Utilizing the Right or Left arrow pushbuttons select the desired Month.
   b. When the desired Month has been selected, then press **ENTER**. The following will be displayed:

```
DATE & TIME
      8 Date
```

10. Input the desired Date as follows:
    a. Utilizing the Up and Down arrow pushbuttons select the desired Date first digit.
    b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired date.
    c. When the desired Date has been input, then press **ENTER**. The following will be displayed:

```
DATE & TIME
SUN mon tue wed thu →
```

11. Input the desired Day as follows:
    a. Utilizing the Right or Left arrow pushbuttons select the desired Day.
    b. When the desired Day has been selected, then press **ENTER**. The following will be displayed:

```
DATE & TIME
     01 Hour
```

12. Input the desired Hour as follows:
    a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
    b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Hour.
    c. When the desired Hour has been input, then press **ENTER**. The following will be displayed:

```
DATE & TIME
     13 Minutes
```

13. Input the desired Minutes as follows:
    a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
    b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Minute(s).
    c. When the desired Minutes have been input, then press **ENTER**. The following will be displayed:

```
DATE & TIME
     16 Seconds
```

14. Input the desired Seconds as follows:
    a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.

b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Seconds.

c. When the desired Seconds have been input, then press **ENTER**. The following will be displayed:

```
DATE & TIME
← TIME error eth diag
```

COMMUNICATION SETUP

Communication setup can be accomplished utilizing either IPScom® or the HMI. The Communication setup consists of the setup of the following features and functions:

- COM Port definitions and Device Address
- Ethernet Port Settings
- Installing Modems

Serial Ports (RS-232)

Two serial interface ports, COM1 and COM2, are standard 9-pin, RS-232, DTE-configured ports. The front-panel port, COM1, can be used to locally set and interrogate the relay using a temporary connection to a PC or laptop computer. The second RS-232 port, COM2, is provided at the rear of the unit. COM2 is unavailable for communications when the optional ethernet port is enabled. However, the Demodulated IRIG-B may still be used through the COM2 Port when Ethernet is enabled.

Serial Port (RS-485)

COM3 located on the rear terminal block of the M-3311A is an RS-485, 2-wire connection. **Appendix B**, Figure B-3 illustrates a 2-wire RS-485 network.

Individual remote addressing also allows for communications through a serial multidrop network. Up to 32 relays can be connected using the same 2 wire RS-485 communications line.

Direct Connection

In order for IPScom to communicate with the relay using direct serial connection, a serial “null modem” cable is required, with a 9-pin connector (DB9P) for the system, and an applicable connector for the computer (usually DB9S or DB25S). Pin-outs for a null modem adapter are provided in Appendix B, **Communications**.

An optional 10 foot null modem cable (M-0423) is available from the factory, for direct connection between a PC and the relay’s front panel COM port, or the rear COM2 port.

When fabricating communication cables, every effort should be made to keep cabling as short as possible. Low capacitance cable is recommended. The RS-232 standard specifies a maximum cable length of 50 feet for RS-232 connections. If over 50 feet of cable length is required, other technologies should be investigated.

Other communication topologies are possible using the M-3311A Transformer Proetection System. An Application Note, “*Serial Communication with Beckwith Electric’s Integrated Protection System Relays*” is available from the factory or from our website at www.beckwithelectric.com.

Device Address

Individual relay Device Addresses should be between 1 and 255. The default Device Address is 1.

IPScom COM Port Definitions and System’s Communication Address

To setup the COM Ports and Communication Addresses perform the following:

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **Tools/Relay Communcation**. IPScom will display the Setup Comm Port dialog screen (Figure 4-7).

   The System COM Port that is in use will be indicated at the top of the display.

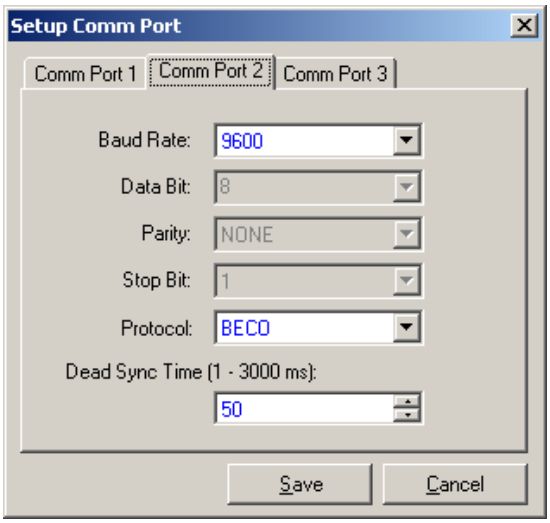


Figure 4-7 Setup Comm Port Dialog Screen

2. Select the desired COM Port to be setup (1, 2 or 3).
3. Enter the desired “Baud Rate” (1200 to 9600). COM2 and COM3 share the same baud rate (see Section 5.5, **Circuit Board Switches and Jumpers**).
4. Enter the desired “Parity” (None, odd or even).
5. Enter the desired “Stop Bits” value (1 or 2).

Baud Rate	Dead-Sync Time
9600	4 ms
4800	8 ms
2400	16 ms
1200	32 ms

Table 4-1 Dead-Sync Time

6. Enter the desired communications Protocol (MODBUS, 2179, DNP3.0).
7. Enter the desired “System’s Communication Address” (1 to 255).

   The individual addressing capability of IPScom and the relay allows multiple systems to share a direct or modem connection when connected through COM2 using a communications-line splitter (Figure 4-8). One such device enables 2 to 6 units to share one communications line. Appendix B, Figure B2 illustrates a setup of RS-232 Fiber Optic network.
8. Enter the desired “Dead Sync Time” (2 to 3000 msec).

   This delay establishes the line idle time to re-sync packet communication. Dead sync time should be programmed based on the channel’s baud rate.
9. When the COM Port settings have been entered, then select **Save**. IPScom will display the COM Port Settings Warning Screen (Figure 4-2).
10. Select **OK**, IPScom will return to the Main Screen.

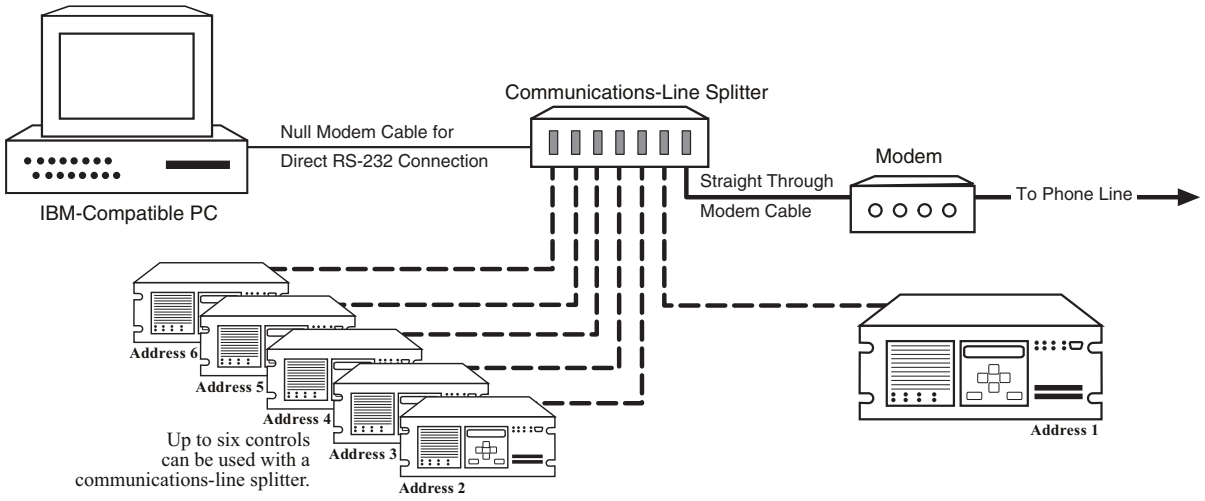


Figure 4-8 Setup Comm Port Dialog Screen

HMI COM Port Definitions and Device Address

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
Communication
stat COMM setup
```

5. Press ENTER, the following will be displayed:

```
COM1 SETUP
COM1 com2 com3 com_adr
```

6. Press **ENTER** and the following is displayed:

```
COM1 BAUD RATE
baud_4800 BAUD_9600
```

7. Press the Left or Right arrow pushbutton as necessary to select the desired baud rate.
8. Press **ENTER**. If setting up COM1, the screen will return to the beginning of the Comm menu. If setting up COM2 or 3, the following will be displayed:

```
COM2 DEAD SYNC TIME
      50 ms
```

9. Input the desired Dead Sync Time as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Dead Sync Time.
   c. When the desired Dead Sync Time has been input, then press **ENTER**. The following will be displayed:

```
COM2  PROTOCOL
beco 2200 modbus dnp3
```

10. Utilizing the Left and Right arrow pushbuttons, select the desired protocol, then press **ENTER**. The following will be displayed:

```
COM2  PARITY
NONE odd even
```

11. Press the Left or Right arrow pushbutton as necessary to select the desired Parity setting.
12. Press **ENTER**, the following will be displayed:

```
COM2 STOP BITS
      1
```

13. Utilizing the Up or Down arrow pushbuttons select the desired Stop Bits.
14. Press ENTER, the following will be displayed:

```
COM1 SETUP
com1 COM2 com3 com_adr
```

15. Selecting COM 3 will activate the same menu choices as displayed with the selection of COM1/2. Repeat as necessary to setup the remaining COM Ports.

ETHERNET COMMUNICATION SETTINGS

The optional RJ45 ethernet port can be enabled utilizing either IPScom® from the Ethernet Settings menu or from the HMI Communication menu. When the ethernet port is enabled the COM2 Serial Port is not available for communications. The demodulated IRIG-B may still be used via the COM2 Port when ethernet is enabled.

The following parameters must be set for proper ethernet communication:

DHCP PROTOCOL

ENABLE: If the network server supports the DHCP protocol the network server will assign the IP Address, Net Mask and Gateway Address.

DISABLE: If the network server does not support the DHCP protocol or the user chooses to manually input ethernet settings, then obtain the IP Address, Net Mask and Gateway address from the Network Administrator and enter the settings.

ETHERNET PROTOCOLS

SERCONV:To utilize the BECO2200 protocol over a TCP/IP connection select the SERCONV (BECO2200 TCP/IP) protocol. The IP Address of the relay must be entered in the IPScom Communication screen. Also, ensure that the COM2 protocol is selected to BECO2200 and the baud rate is set to 9600 bps.

The Standard Port Number for the BECO2200 over TCP/IP protocol is 8800. The master device may require the entry of the Standard Port Number.

MODBUS:To utilize the MODBUS protocol over a TCP/IP connection select the MODBUS (MODBUS over TCP/IP) protocol. The IP Address of the relay must be entered in the IPScom® Communication screen. Also, ensure that the COM2 protocol is selected to MODBUS, baud rate is set to 9600 bps, 1 stop bit and no parity selected.

The Standard Port Number for the MODBUS over TCP/IP protocol is 502. The master device may require the entry of the Standard Port Number.

IPScom Ethernet Port Setup with DHCP

■ **NOTE**: Communication must be established with the target MBTS for this procedure.

1. From the IPScom Main Screen menu select **Tools/Ethernet Setup**. . IPScom will display the Setup Ethernet screen (Figure 4-9).

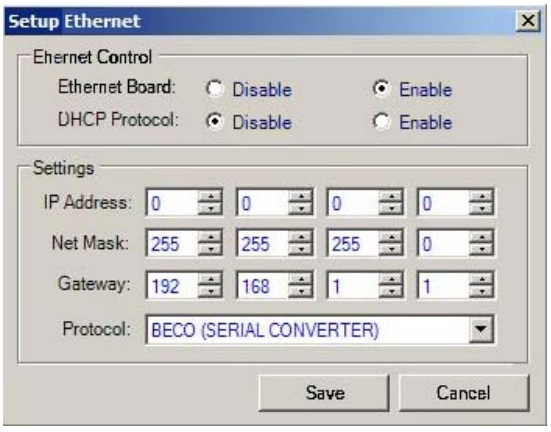


Figure 4-9 Setup Ethernet Screen

2. Select Ethernet **Enable**.
3. Select DHCP Protocol **Enable**.
4. Select the desired protocol.
5. Select **Save.** The ethernet board is now configured for use and may be accessed through a network.

IPScom® Ethernet Port Setup without DHCP

■ **NOTE**: Communication must be established with the target relay for this procedure.

1. From the IPScom Main Screen menu select **Tools/Ethernet Setup**. . IPScom will display the Ethernet Setup screen (Figure 4-9).
2. Select Ethernet **Enable**.
3. Select DHCP Protocol **Disable**.
4. Enter values for IP Address, Net Mask and Gateway.
5. Select the desired protocol.
6. Select **Save**. The ethernet board is now configured for use and may be accessed through a network.

HMI Ethernet Port Setup

1. Ensure that the Communication Menu is selected to COMM (upper case).

```
COMMUNICATION
←  targets osc_rec COMM →
```

   If COMM is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select COMM.

2. Press **ENTER**, the following will be displayed:

```
COM1 SETUP
COM1 com2 com3 com_adr →
```

3. Use the Right arrow pushbutton to select ETH (Upper Case).

```
ETHERNET SETUP
←  access  ETH  eth_ip
```

4. Press **ENTER**, the following will be displayed:

```
ETHERNET
DISABLE enable
```

5. Use the Right arrow pushbutton to select ENABLE (Upper Case), then press **ENTER**, the following will be displayed:

```
TCP/IP SETTINGS
TCP prot
```

6. Ensure that TCP is selected (Upper Case).

   If TCP is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select TCP.

7. Press **ENTER**, the following will be displayed:

```
DHCP PROTOCOL
DISABLE enable
```

8. If the network does not support the DHCP protocol, then go to Manual Configuration of Ethernet Board (following page) to manually configure the ethernet board.
9. If the DHCP Protocol is to be enabled, then use the Right/Left arrow pushbutton to select ENABLE (Upper Case), then press **ENTER**, the following will be displayed:

```
TCP/IP SETTINGS
TCP prot
```

10. Ensure that PROT is selected (Upper Case).

    If PROT is not selected (Upper Case), then use the Right arrow pushbutton to select PROT.

11. Press **ENTER**, the following will be displayed:

```
SELECT PROTOCOL
modbus  serconv
```

12. Use the Right/Left arrow pushbuttons to select the desired protocol (Upper Case), then press **ENTER**, the following will be displayed:

```
TCP/IP SETTINGS
tcp PROT
```

13. Press **EXIT**, the ethernet board will reconfigure and the following will be displayed:

```
CONFIGURING ETH...
```

If the ethernet board successfully obtains an IP Address the following will be displayed for approximately 2 seconds:

```
ETHERNET IP ADDRESS
XX.XX.XX.XX
```

The ethernet board is now configured for use and may be accessed through a network.

Then the display will return to the following:

```
ETHERNET SETUP
← access  ETH  eth_ip
```

If the ethernet board fails to obtain an IP Address within 15 seconds the following will be displayed (for approximately 2 seconds):

```
CONFIGURING ETH...
ETH BOARD ERROR
```

Contact the Network Administrator to determine the cause of the configuration failure.

Manual Configuration of Ethernet Board

1. Ensure that DISABLE is selected (Upper Case).

   If DISABLE is not selected (Upper Case), then use the Left arrow pushbutton to select DISABLE.

2. Press **ENTER**, the following will be displayed:

```
IP ADDRESS
XX.XX.XX.XX
```

3. Enter the desired IP Address, then press **ENTER**, the following will be displayed:

```
NET MASK
XX.XX.XX.XX
```

4. Enter the desired Net Mask, then press **ENTER**, the following will be displayed:

```
GATEWAY
XX.XX.XX.XX
```

5. Enter the desired Gateway, then press **ENTER**, the following will be displayed:

```
TCP/IP SETTINGS
tcp prot
```

6. Ensure that PROT is selected (Upper Case).

   If PROT is not selected (Upper Case), then use the Right arrow pushbutton to select PROT.

7. Press **ENTER**, the following will be displayed:

```
SELECT PROTOCOL
modbus  serconv
```

8. Use the Right/Left arrow pushbuttons to select the desired protocol (Upper Case), then press **ENTER**, the following will be displayed:

```
TCP/IP SETTINGS
tcp PROT
```

9. Press **EXIT**, the ethernet board will reconfigure and the following will be displayed:

```
CONFIGURING ETH...
```

   If the ethernet board is successfully configured, then the entered IP Address will be displayed for approximately 2 seconds:

```
ETHERNET IP ADDRESS
XX.XX.XX.XX
```

   The ethernet board is now configured for use and may be accessed through a network.

INSTALLING THE MODEMS

Using IPScom® to interrogate, set or monitor the relay using a modem requires both a remote modem connected at the relays location and a local modem connected to the computer with IPScom installed.

■ **NOTE**: Any compatible modem may be used; however, the unit only communicates at 1200 to 9600 baud.

In order to use IPScom to communicate with the relay using a modem, the following must be provided with the relay:

- An external modem (1200 baud or higher), capable of understanding standard AT commands.
- Serial modem cable with 9-pin connector for the relay and the applicable connector for the modem.

Similarly, the computer running IPScom must also have access to a compatible internal or external modem.

Connecting the PC Modem

1. If the computer has an external modem, then use a standard straight-through RS-232 modem cable (M-3933) to connect the computer to the modem.
2. If the computer has an internal modem, then refer to the modem's instruction book to determine which communications port should be selected.
3. Verify that the modem is attached to (if external) or assigned to (if internal) the same serial port as assigned in IPScom.

   While IPScom can use any of the 255 serial ports (COM1 through COM255), most computers support only COM1 and COM2.
4. Connect the modem to a telephone line, then energize the modem.

Initializing the PC Modem

1. Verify that the modem is connected as described in "Connecting the PC Modem".
2. Open IPScom, then select the **Connect/ Modem** menu item.

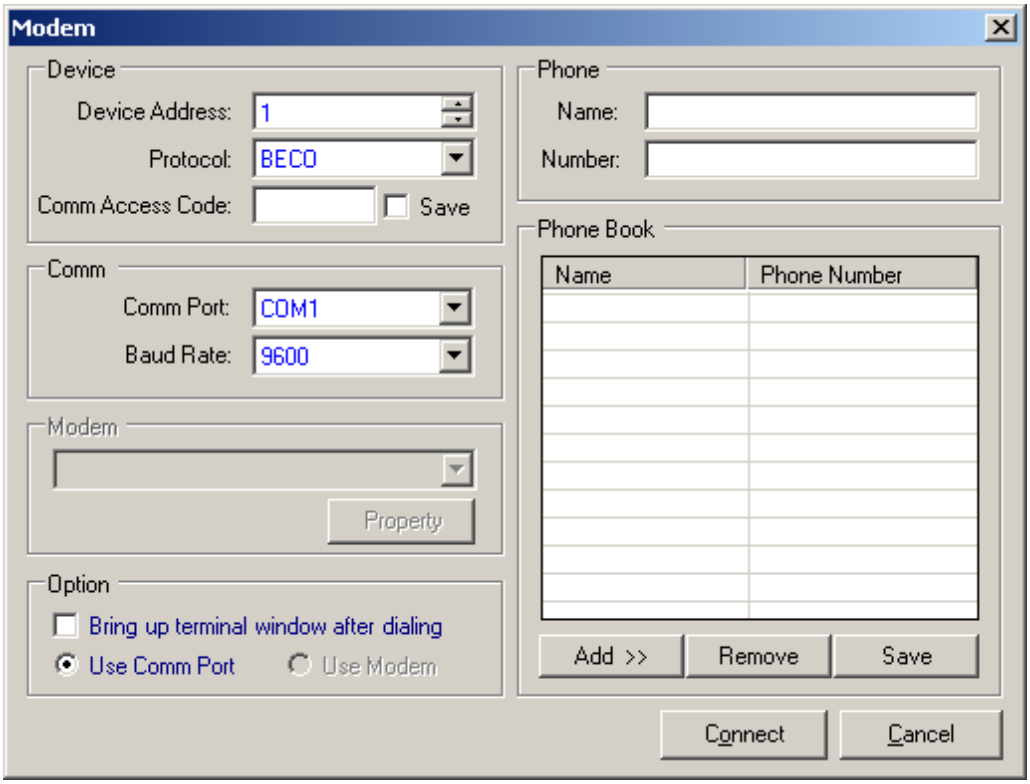


Figure 4-10 Modem Dialog Screen

3. IPScom will display the Modem Dialog screen (Figure 4-10).
4. Enter the required information in the Modem Settings section of the screen, then select **Connect**.

COMMAND BUTTONS

Add	Allows you to review and change the user lines (unit identifier), phone number, and communication address of a selected entry.
Remove	Deletes a selected entry.
Save	Saves any changes to the displayed information
Connect	Dials the entry selected from the directory.
Cancel	Ends modem communication, allowing the user to dial again.

Connecting the Local Modem to the Relay

Setup of the modem attached to the relay may be slightly complicated. It involves programming parameters (using the AT command set), and storing this profile in the modem's nonvolatile memory.

After programming, the modem will power up in the proper state for communicating with the relay. Programming may be accomplished by using the "Bring Up Terminal Window after dialing" selection (Figure 4-11). Refer to your modem manual for further information.

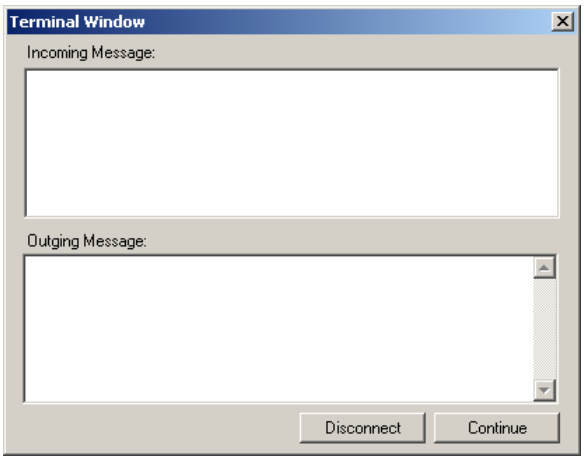


Figure 4-11 Terminal Window

■ **NOTE:** The relay does not issue or understand any modem commands. It will not adjust the baud rate and should be considered a "dumb" peripheral. It communicates with 1 start, 8 data, and 0, 1 or 2 stop bits.

Connect the Modem to the relay as follows:

1. Connect the unit to an external modem by attaching a standard RS-232 modem cable to the appropriate serial communications port on both the unit and the modem.
2. Connect the modem to a telephone line, then energize the modem.

The modem attached to the relay must have the following AT command configuration:

E0	No Echo
Q1	Don't return result code
&D3	On to OFF DTR, hangup and reset
&S0	DSR always on
&C1	DCD ON when detected
S0=2	Answer on second ring

The following commands may also be required at the modem:

&Q6	Constant DTE to DCE
N0	Answer only at specified speed
W	Disable serial data rate adjust
\Q3	Bidirectional RTS/CTS relay
&B1	Fixed serial port rate
S37	Desired line connection speed

When connected to another terminal device, the Terminal Window allows the user to send messages or commands. Outgoing communications are displayed in the top pane and incoming messages are displayed in the bottom two panes, in ASCII text and HEX format.

There are some variations in the AT commands supported by modem manufacturers. Refer to the hardware user documentation for a list of supported AT commands and direction on issuing these commands.

OSCILLOGRAPH SETUP

The Oscillograph Recorder provides comprehensive data recording (voltage, current, and status input/output signals) for all monitored waveforms (at 16 samples per cycle). Oscillograph data can be downloaded using the communications ports to any IBM compatible personal computer running the M-3826 IPScom® Communications Software. Once downloaded, the waveform data can be examined and printed using the optional M-3801D IPSplot® *PLUS* Oscillograph Data Analysis Software and are also available in COMTRADE file format.

▲ **CAUTION:** Oscillograph records are not retained if power to the relay is interrupted.

The general information required to complete the input data of this section includes:

- **Recorder Partitions**: When untriggered, the recorder continuously records waveform data, keeping the data in a buffer memory. The recorder's memory may be partitioned into 1 to 24 partitions. Table 4-2 illustrates the number of cycles of waveform data per partition with various numbers of windings

  When triggered, the time stamp is recorded, and the recorder continues recording for a user-defined period. The snapshot of the waveform is stored in memory for later retrieval using IPScom Communications Software. The **OSC TRIG** LED on the front panel will indicate a recorder operation (data is available for downloading).
- **Trigger Inputs and Outputs**: The recorder can be triggered remotely through serial communications using IPScom, or automatically using programmed status inputs or outputs.
- **Post-Trigger Delay**: A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pretrigger data, and 80% post-trigger data.

■ **NOTE:** Oscillograph recorder settings are not considered part of the Setpoint Profile. Recorder settings are common to all profiles.

Number of Partitions	Windings 1, 2, 3, 4	Windings 1, 2, 3	Windings 1, 2
1	183	231	311
2	122	154	207
3	91	115	155
4	73	92	124
5	61	77	103
6	52	66	89
7	45	57	77
8	40	51	69
9	36	46	62
10	33	42	56
11	30	38	51
12	28	35	47
13	26	33	44
14	24	30	41
15	22	28	38
16	21	27	36
17	20	25	34
18	19	24	32
19	18	23	31
20	17	22	29
21	16	21	28
22	15	20	27
23	15	19	25
24	14	18	24

Table 4-2 Recorder Partitions

IPScom Setup Oscillograph Recorder

■ **NOTE**: Communication must be established with the target relay for this procedure. When not connected to the relay the Send selection does not save the Oscillograph Recorder settings to an open file.

To setup the Oscillograph Recorder perform the following:

1. From the IPScom Main Screen menu select **Relay/Oscillograph/Setup**. IPScom will display the Setup Oscillograph Recorder dialog screen (Figure 4-12).
2. Select the **Number of Partitions**.

   The recorder's memory may be partitioned into 1 to 24 partitions. The relay Oscillograph Recorder memory buffer is fixed and contains room for a finite number of cycles of recorded data. Consider Table 4-2 when determining the number of Oscillograph records, The number of cycles of recorded data is directly related to the number of records selected.
3. Select the desired **Trigger Inputs** and **Trigger Outputs**.

   The recorder can be triggered remotely through serial communications using IPScom, or automatically using programmed status inputs or outputs.
4. Select the **Post Trigger Delay**.

   A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pre-trigger data, and 80% post-trigger data.
5. Select **Save**, IPScom will display a save to device Confirmation Screen (Figure 4-2).
6. Select **YES**, IPScom will return to the Main Screen.

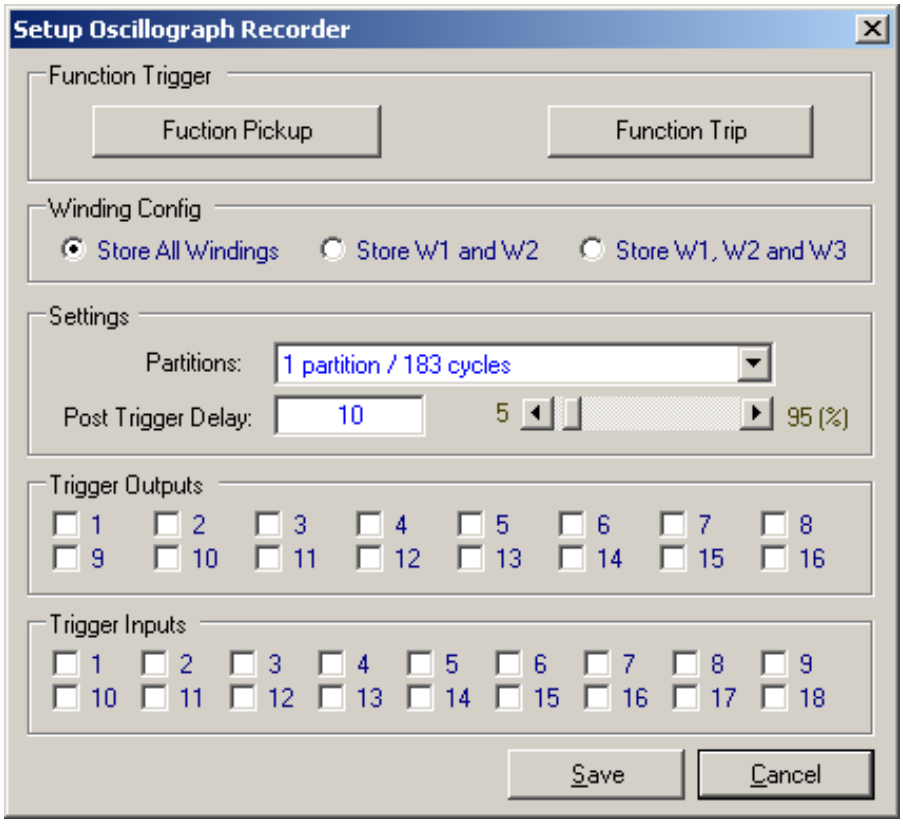


Figure 4-12 Setup Oscillograph Recorder

HMI Setup Oscillograph Recorder

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
OSCILLOGRAPH RECORDER
targets OSC_REC comm
```

5. Press **ENTER**, the following will be displayed:

```
VIEW RECORDER STATUS
STAT  clear  setup
```

6. Press the Right arrow pushbutton until the following is displayed:

```
OSCILLOGRAPH RECORDER SETUP
stat  clear  SETUP
```

7. Press **ENTER**, the following will be displayed:

```
RECORDER PARTITIONS
      1
```

8. Input the desired number of Recorder Partitions.
9. Press **ENTER**, the following will be displayed:

```
TRIGGER INPUTS
I6 i5 i4 i3 i2 i1
```

10. Press the Right or Left arrow pushbutton as necessary to select the desired Trigger Input, then press **ENTER**, the following will be displayed:

```
TRIGGER OUTPUTS
o8 o7 o6 o5 o4 o3 o2 o1
```

11. Press the Right or Left arrow pushbutton as necessary to select the desired Trigger Output, then press **ENTER**, the following will be displayed:

```
POST TRIGGER DELAY
      5 %
```

12. Press the Right or Left arrow pushbutton as necessary to select the desired digit and the Up or Down arroe pushbutton to incrementthe Post Trigger Relay, then press **ENTER**, the following will be displayed:

```
OSCILLOGRAPH RECORDER SETUP
stat  clear  SETUP
```

13. Press **Exit.**

IPScom Setup Sequence of Events Recorder

Protective function Pickup, Trip, Dropout and/or Output/Input Pickup or Dropout are selected to trigger the Sequence of Events Recorder.

■ **NOTE**: Communication must be established with the target relay for this procedure. When not connected to the relay the Save selection does not save the Sequence of Event settings to the open file.

To setup the Sequence of Events Recorder perform the following:

1. From the IPScom Main Screen menu select **Relay/Sequence of Events/ Setup**. IPScom will display the Setup Sequence of Events Recorder dialog screen (Figure 4-13).
2. Select the desired Inputs and Outputs, then select **Save**. IPScom will display a save to device confirmation (Figure 4-2).
3. Select **YES**, IPScom will return to the Main Screen.

HMI Setup Through Fault Recorder

The Through Fault Recorder captures separate Through Faults. Each Through Fault record contains the serial number of the fault, duration of the event, maximum RMS fault current magnitude for each phase during the fault, I^2t and the time stamp of the fault. In addition, it will also store the total number of through faults since last rest and total I^2t for each pahse since lase reset (up to 256 records).

To Setup the relay Through Fault recorder perform the following:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to step 4.

3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
THROUGH FAULT
ips brkr THFLT tcm
```

5. Press **ENTER**, the following will be displayed:

```
THFLT CURRENT THRESHOLD
      __ Amps
```

6. Utilizing the Up or Down arrow pushbutton set the Through Fault Current Threshold setting, then press **ENTER**, the following is displayed:

```
THFLT CUM. I^2T LIMIT
      __ kA^2-cycles
```

7. Utilizing the Up or Down arrow pushbutton set the Through Fault Cumulative i^2t Limit setting, then press **ENTER**, the following is displayed:

```
THFLT PU OPERATIONS LIM.
      __ Records
```

8. Utilizing the Up or Down arrow pushbutton set the Through Fault PU Operations Limt setting, then press **ENTER**, the following is displayed:

```
THFLT WINDING SELECT
sum1 sum2 w1 w2 w3 w4
```

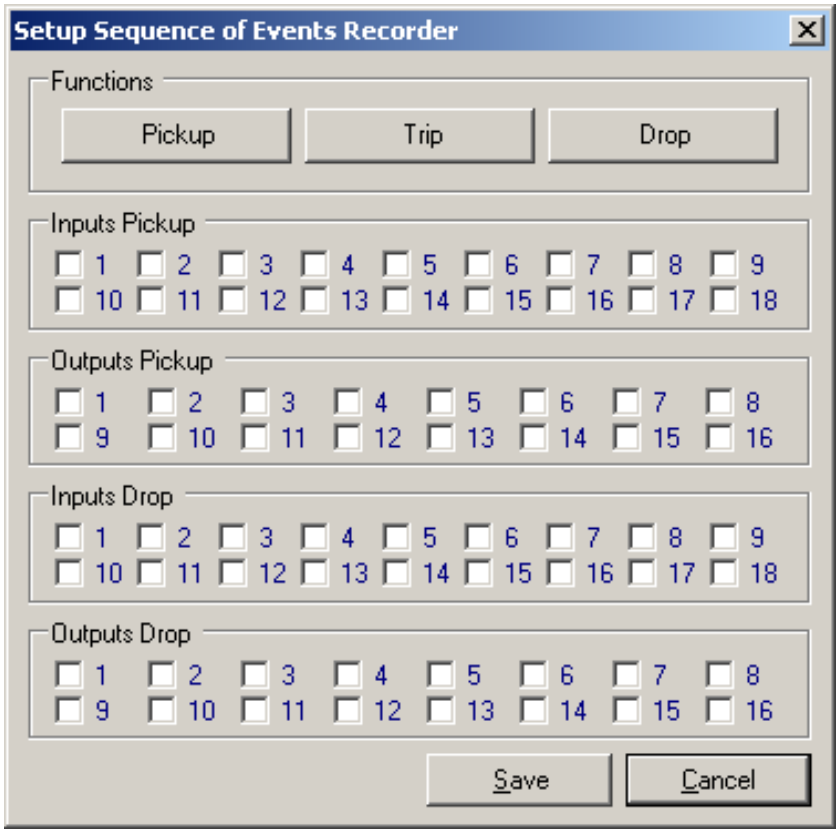


Figure 4-13 Setup Sequence of Events Recorder Dialog Screen

9. Utilizing the Right or Left arrow pushbutton select the target winding, then press **ENTER**, the following is displayed:

```
THFLT DELAY
      ___ Cycles
```

10. Utilizing the Up or Down arrow pushbutton set the Through Fault Time Delay setting, then press **ENTER**, the following is displayed:

```
THROUGH FAULT
ips brkr THFLT tcm
```

11. Press **Exit.**

HMI Demand Interval Setup

The Demand Interval setting determines the demand integration interval (15 min, 30 min or 60 min). Demand time-tagged peak values are stored for display and printing. See Chapter 2, **Operation** for detailed information.

To setup the **DEMAND INTERVAL**, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
      0
```

   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

```
LEVEL #(1,2 or 3)
Access Granted!
```

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

   c. Go to Step 4.

3. Press the **ENTER** pushbutton, the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq  v/hz
```

4. Press the Right arrow pushbutton until the following is displayed:

```
DEMAND
config sys stat DMD
```

5. Press the **ENTER** pushbutton, the following will be displayed:

```
DEMAND STATUS
STAT int mstat clear
```

6. Press the Right arrow pushbutton until the following is displayed:

```
DEMAND INTERVAL
stat INT mstat clear
```

7. Press **ENTER**. The HMI will display W1 Demand Phase Current.

```
DEMAND INTERVAL
   15min  30min  60min
```

8. Utilizing the Right or Left arrow pushbutton select the desired Demand Interval, then press **ENTER**, the following is displayed:

```
DEMAND
config sys stat DMD
```

9. Press **Exit.**

4.2 Configuration

The Configuration consists of defining common information like CT and VT ratios, nominal voltage rating, transformer connections, and which profile is the Active Profile, etc. Values are entered similar to other setpoints. Configuration information is common to all profiles, and should be entered before setpoint and time settings.

When INPUT ACTIVATED PROFILES are disabled, the Active Profile can be selected using the HMI or remote communication. When enabled, the Active profile is selected by the external connections of Input 5 and 6.

■ **NOTE:** Table 4-3 assumes ACTIVE INPUT STATE set to default setting (close circuit = TRUE).

Input 5	Input 6	SELECTION
Open	Open	Profile 1
Closed	Open	Profile 2
Open	Closed	Profile 3
Closed	Closed	Profile 4

Table 4-3 Input Activated Profile Logic

```
INPUT ACTIVATED PROFILES
disable ENABLE
```

If INPUT ACTIVATED PROFILES is disabled this screen allows manual selection of the Active Profile using the front panel or through communications.

```
ACTIVE SETPOINT PROFILE
 ____________________   1
```

Allows the user to manually select the Active Profile.

```
COPY ACTIVE PROFILE
TO_PROFILE_2          →
```

This screen initiates a copy of the Active Profile to any one of the other profiles.

```
NOMINAL VOLTAGE
120 Volts
```

The secondary VT voltage when primary voltage is equal to the rated transformer voltage (V trans rated/VT ratio). Range = 60–140 V; Increment 1 V.

```
V.T. CONFIGURATION
VAB vbc vac va vb vc vg
```

Indicates VT connection.

```
NUMBER OF WINDINGS
two three four
```

If two winding is selected, then one of the three available windings must be disabled:

```
DISABLE WINDING
win1 win2 win3 win4
```

The disabled winding will be removed from the differential calculation. However, the disabled winding may be utilized for other non-differential protection. See Section 4.5, Transformer Connections, for additional information.

```
CUSTOM XFM/CT CONNECTION
disable enable
```

▲ **CAUTION:** Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

If Custom XFM/CT Connection is DISABLED (standard transformer and CT configurations used), the relay automatically computes the phase and magnitude compensation required for the differential currents.

If Custom XFM/CT Connection is ENABLED, then the HMI will prompt the user to enter Transformer Phase Comp Type and CT PH/Mag Comp Type values for each winding. Zero Seq Comp will also be required to be enabled or disabled for each winding to complete this setting. See Section 4.5, Transformer Connections, for additional information.

```
W1 XFM PHASE COMP TYPE
     0
```

```
W2 XFM PHASE COMP TYPE
     0
```

```
W3 XFM PHASE COMP TYPE
     0
```

```
W4 XFM PHASE COMP TYPE
     0
```

```
W1 CT PH/MAG COMP TYPE
     0
```

```
W2 CT PH/MAG COMP TYPE
     0
```

```
W3 CT PH/MAG COMP TYPE
     0
```

```
W4 CT PH/MAG COMP TYPE
     0
```

```
W1 ZERO SEQ COMP
disable enable
```

```
W2 ZERO SEQ COMP
disable enable
```

```
W3 ZERO SEQ COMP
disable enable
```

```
W4 Zero Seq Comp
disable enable
```

```
CT CONNECTION W1
←CON_W1 con_w2 con_w3→
```

```
CT CONNECTION W1
Y dab dac inv_y →
← inv_dab inv_dac
```

```
CT CONNECTION W2
←con_w1 CON_W2 con_w3→
```

```
CT CONNECTION W2
Y dab dac inv_y →
← inv_dab inv_dac
```

```
CT CONNECTION W3
←con_w1 con_w2 CON_W3→
```

```
CT CONNECTION W3
Y dab dac inv_y →
← inv_dab inv_dac
```

```
CT CONNECTION W4
←con_w1 con_w2 CON_W3→
```

```
CT CONNECTION W4
Y dab dac inv_y →
← inv_dab inv_dac
```

▲ **CAUTION:** Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

■ **NOTE**: When CT connection is chosen as delta, the relay calculates line currents using delta CT currents and the ground currents (for W2 and W3 only). The line currents (not delta currents) are displayed on the status screens (metering). The line currents are also used for 50, 51, and 46 functions.

The Standard configuration requires the CT connection to be defined as Wye, Delta-ab, Delta-ac, Inverse Wye, Inverse Delta-ab, or Inverse Delta-ac. See Section 4.5, Transformer Connection, for additional information.

```
XFM CONNECTION W1
←XFM_W1 xfm_w2 xfm_w3→
```

```
XFM CONNECTION W1
Y dab dac inv_y →
← inv_dab inv_dac
```

```
XFM CONNECTION W2
←xfm_w1 XFM_W2 xfm_w3→
```

```
XFM CONNECTION W2
Y dab dac inv_y →
← inv_dab inv_dac
```

▲ **CAUTION:** Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

The Standard configuration requires the Transformer Winding Connection to be defined as Wye, Delta-ab, Delta-ac, Inverse Wye, Inverse Delta-ab, or Inverse Delta-ac. See Section 4.5, Transformer Connection for additional information.

```
XFM CONNECTION W3
←xfm_w1 xfm_w2 XFM_W3→
```

```
XFM CONNECTION W3
Y dab dac inv_y →
← inv_dab inv_dac
```

```
XFM CONNECTION W4
←xfm_w1 xfm_w2 XFM_W3→
```

```
XFM CONNECTION W4
Y dab dac inv_y →
← inv_dab inv_dac
```

```
PHASE ROTATION
← PHASE seal in vt →
```

```
PHASE ROTATION
a-c-b A-B-C
```

Indicates the phase rotation.

```
RELAY SEAL-IN TIME
← phase SEAL IN vt →
```

```
RELAY SEAL-IN TIME OUT1
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT2
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT3
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT4
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT5
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT6
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT7
 _____ Cycles
```

```
RELAY SEAL-IN TIME OUT8
 _____ Cycles
```

Seal-in time for output relays. Eight individual seal-in delays can be specified for each output relay (OUT1-OUT16 for expanded I/O units).

```
ACTIVE INPUT OPEN/CLOSE
i6 i5 i4 i3 i2 I1
```

Selects the active state for the six control/status inputs. When highlighted (upper case), an open circuit activates the input. When lowercase, a closed circuit activates the input (default).

```
V.T. RATIO
←phase seal in VT→
```

```
V.T. RATIO
 _________________ :1
```

VT Ratio

```
V.T.g RATIO
←VTϕ VTG CT_W1 CT_W2→
```

```
V.T.g RATIO
 _________________ :1
```

VT Ground Ratio

```
W1 C.T. RATIO
←CT_W1 ct_w2 ct_w3→
```

```
W1 C.T. RATIO
 _________________ :1
```

```
W2 C.T. RATIO
←ct_w1 CT_W2 ct_w3→
```

```
W2 C.T. RATIO
 _________________ :1
```

```
W3 C.T. RATIO
←ct_w1 ct_w2 ct_w3→
```

```
W3 C.T. RATIO
←ct_w1 ct_w2 ct_w3→
```

```
W4 C.T. RATIO
←ct_w1 ct_w2 ct_w3→
```

```
W4 C.T. RATIO
←ct_w1 ct_w2 ct_w3→
```

CT Ratios

```
W2 C.T. GROUND RATIO
←CT_W2G ct_w3g→
```

```
W2 C.T. GROUND RATIO
 _________________ :1
```

```
W3 C.T. GROUND RATIO
←ct_w2g CT_W3G→
```

```
W3 C.T. GROUND RATIO
 _________________ :1
```

```
W4 C.T. GROUND RATIO
←ct_w2g CT_W3G→
```

```
W4 C.T. GROUND RATIO
 _________________ :1
```

CT Ground Ratios

The relay will calculate the W2 and W3 line currents when a delta CT configuration is selected, as follows:

For Delta ab CTs:

Line Current $I_A = (I_{ab} - I_{ca} + (I_g/CTCF))/3$

Line Current $I_B = (I_{bc} - I_{ab} + (I_g/CTCF))/3$

Line Current $I_C = (I_{ca} - I_{bc} + (I_g/CTCF))/3$

where I_{ab}, I_{bc}, I_{ca} are the currents that enter the relay, and I_g is the measured ground current.

CTCF is given by $\dfrac{\text{CT Phase Ratio}}{\text{CT Ground Ratio}}$

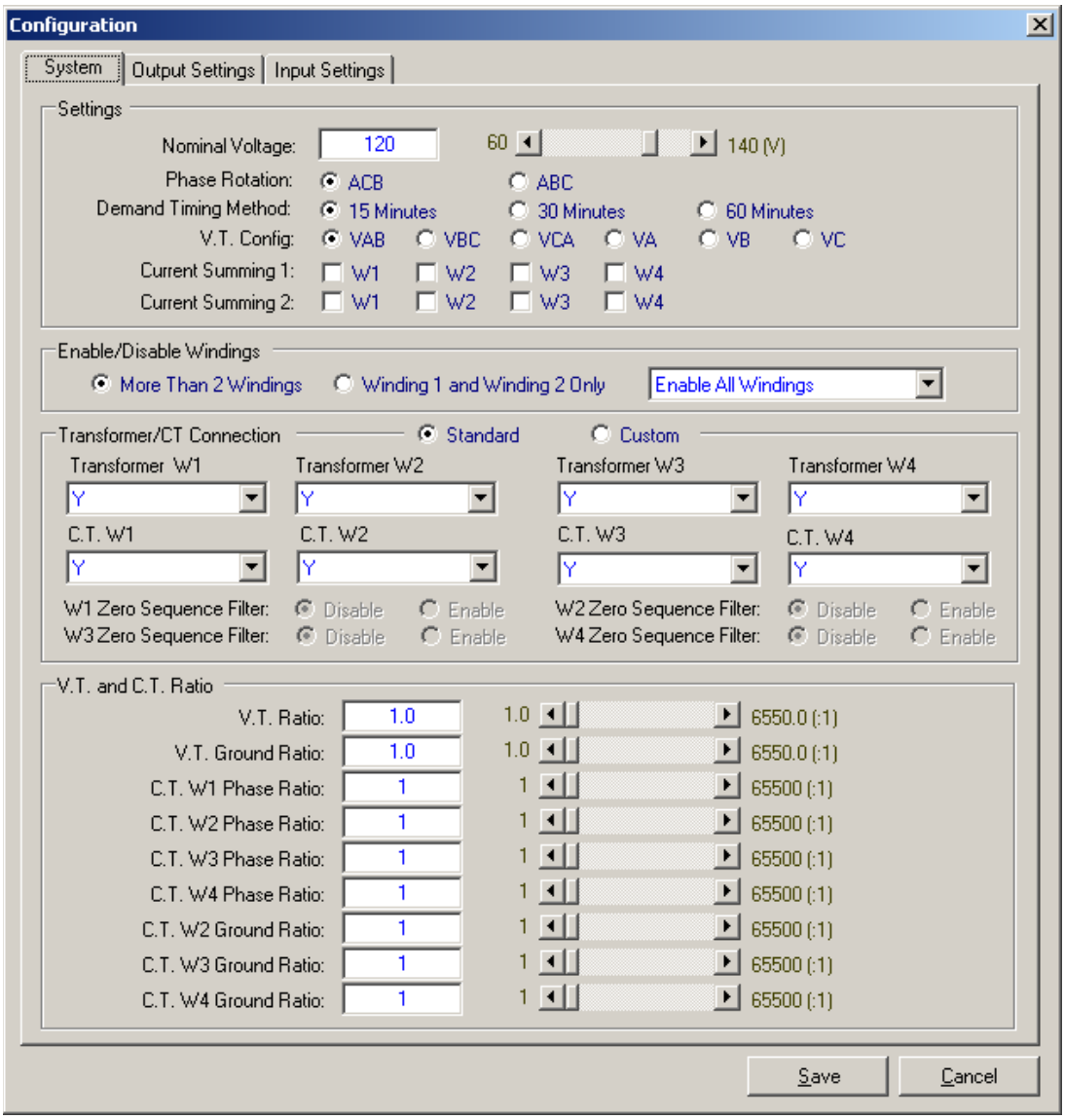


Figure 4-14 IPScom® Relay Configuration Dialog

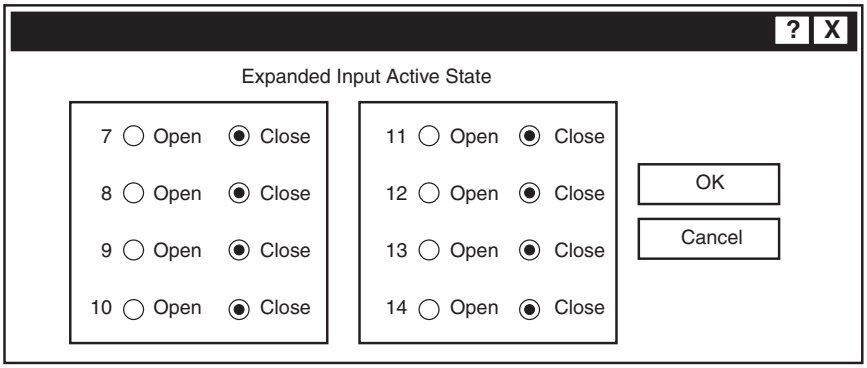


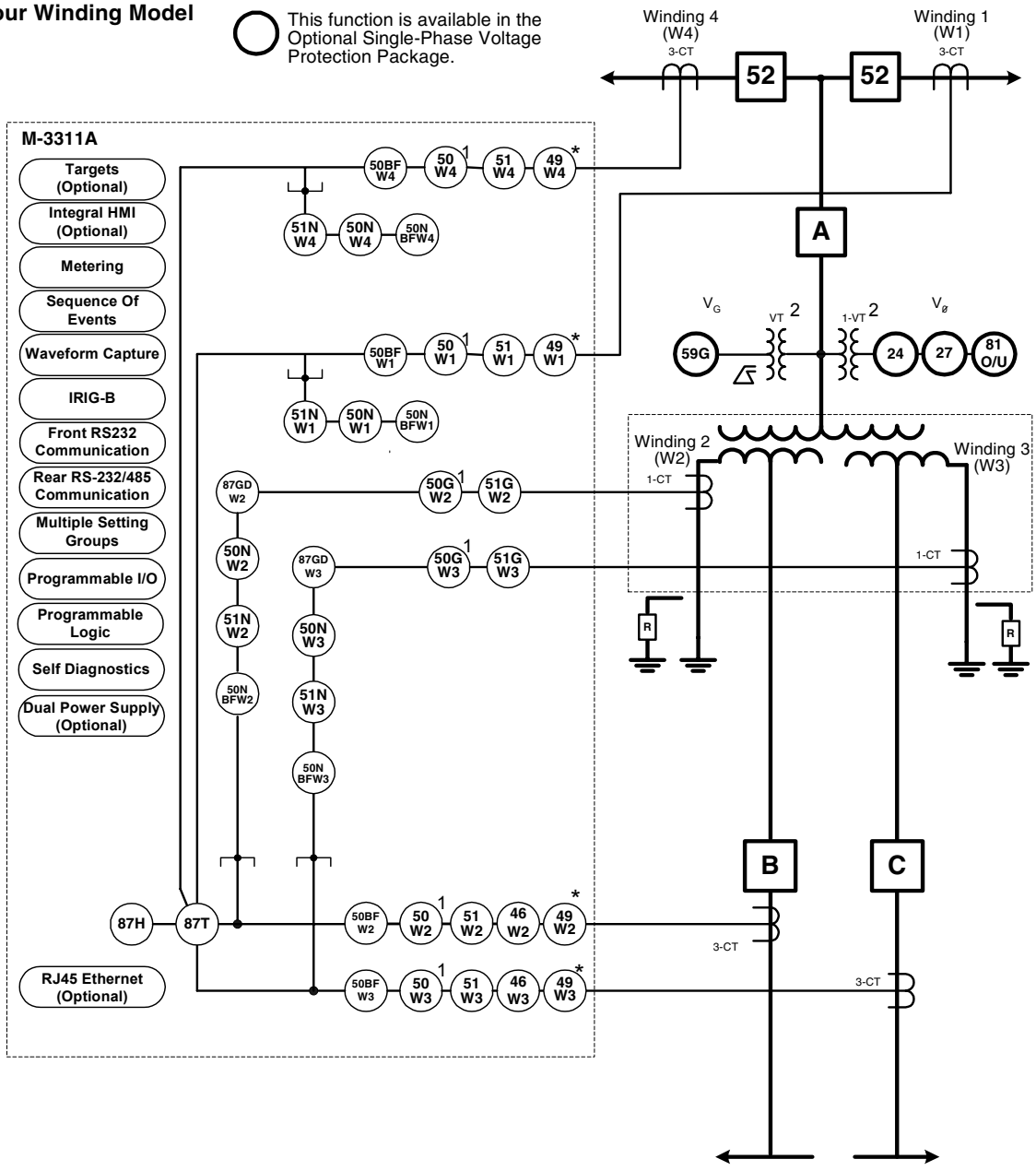
Figure 4-15 Selection Screen for Expanded Input

4.3 System Diagrams

M-3311A Typical Connection Diagram Four Winding Model

This function is available as a standard protective function.

This function is available in the Optional Single-Phase Voltage Protection Package.

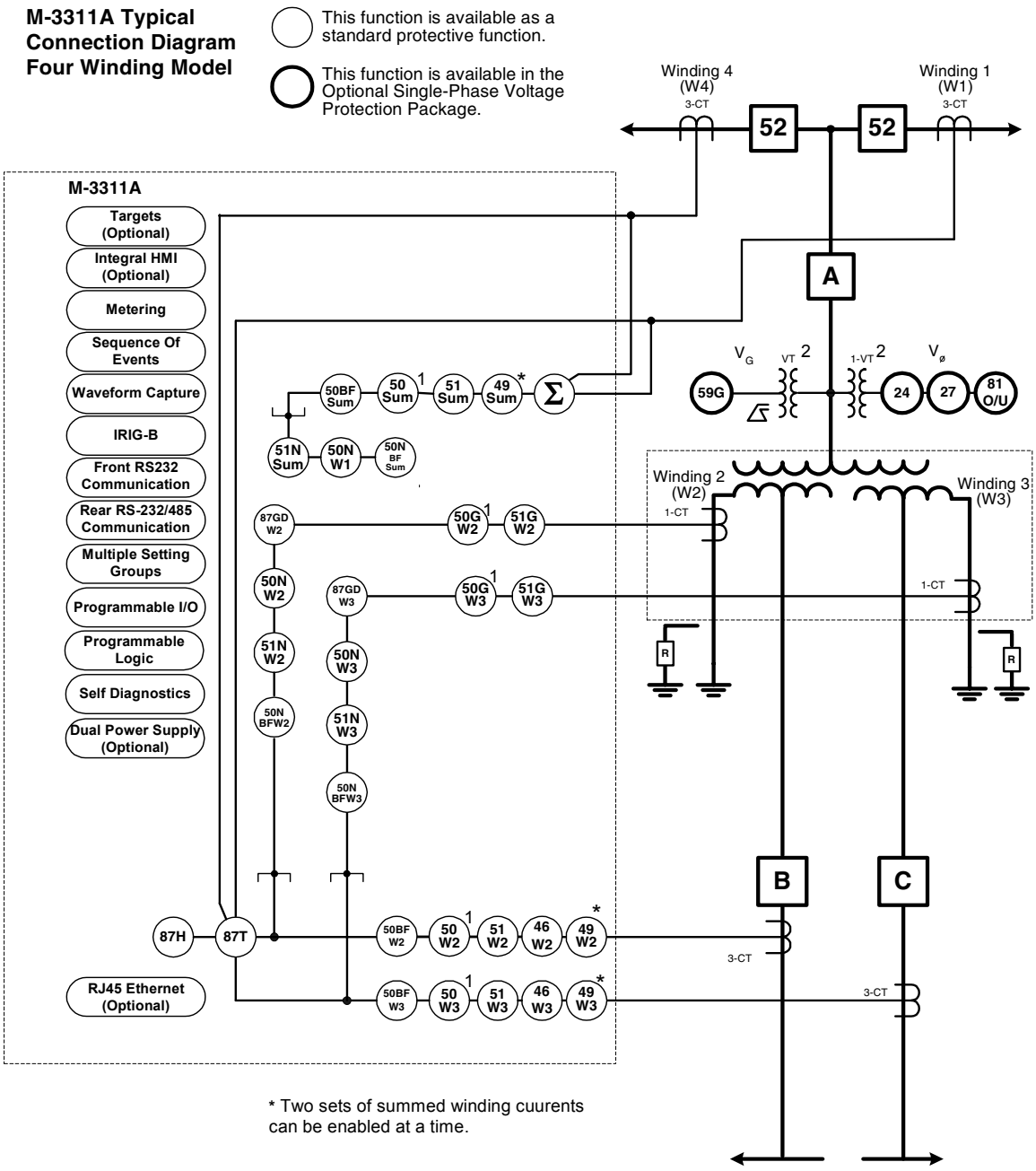


* 49 Function can only be enabled in one winding.

■ **NOTES:**

1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.
2. Two voltage inputs are available in the 4-winding model of the M-3311A. These are a phase voltage Vϕ use for the 81O/U, 27, and 24 Functions and the V_G broken delta input voltage used for the 59G function. These voltage inputs are not winding dependent.

Figure 4-16 A Typical One-Line Functional Diagram



* 49 Function can only be enabled in one winding.

■ **NOTES:**

1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.
2. Two voltage inputs are available in the 4-winding model of the M-3311A. These are a phase voltage V_ϕ use for the 81O/U, 27, and 24 Functions and the V_G broken delta input voltage used for the 59G function. These voltage inputs are not winding dependent.

Figure 4-17 M-3311A Typical Summing Currents One-Line Functional Diagram

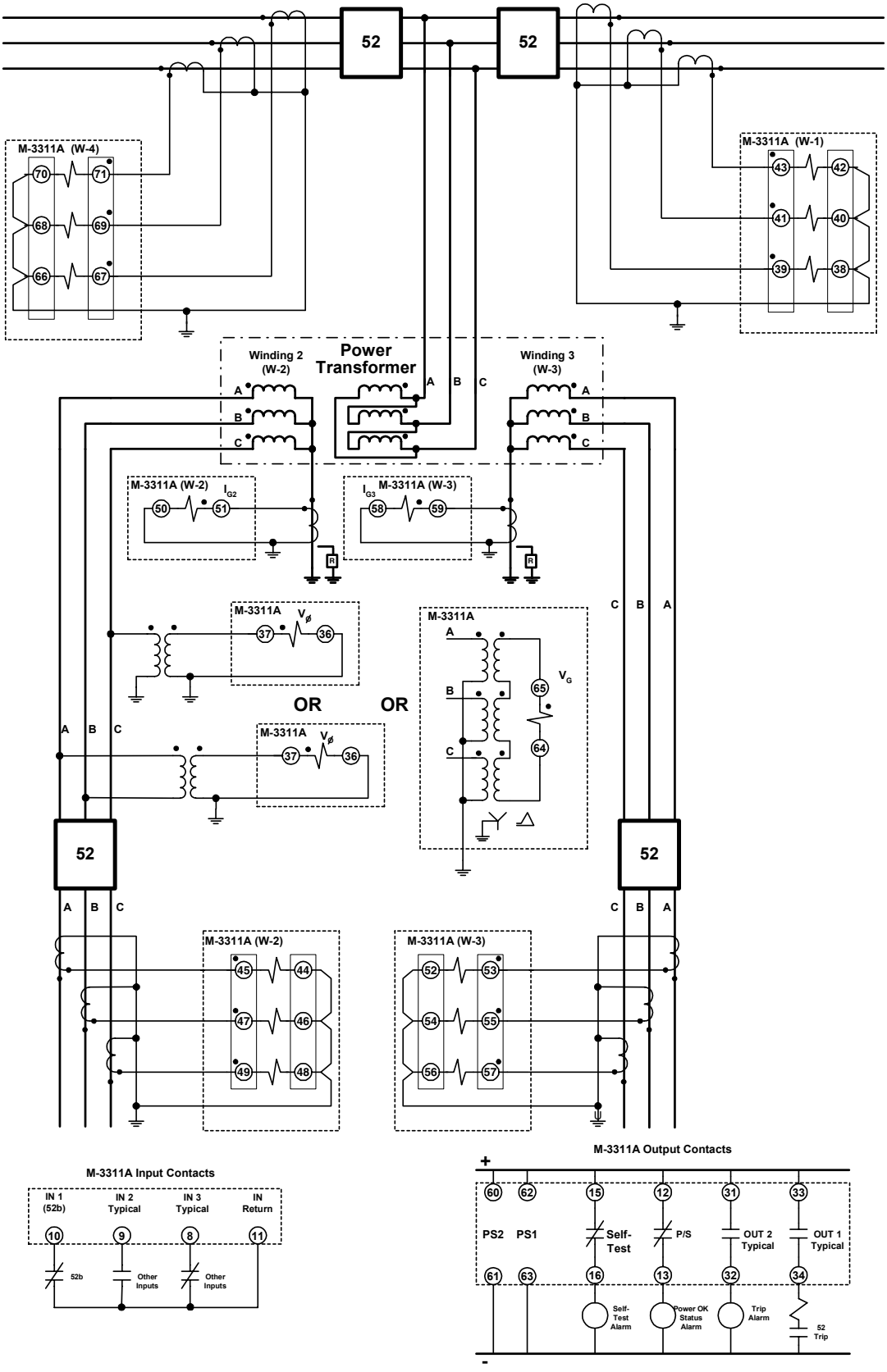


Figure 4-18 Typical Three-Line Connection Diagram

4.4 System Setpoints

Setpoint Profiles (Setting Groups)

Up to four setpoint profiles may be used. Each profile contains a function configuration and associated settings. One of the four profiles may be designated as the Active Profile which will contain the parameters that the relay will actively use. Only the Active Profile may be edited.

The **Active Profile** may be designated either manually using the HMI interface, by control/status input activation (input activated profiles enabled, see Table 4-3) or by remote communication.

A **Copy Profile** feature is available that copies an image of the Active Profile to any one of the other three profiles. This feature can speed up the configuration process. Consider, for example, a situation where a breaker will be removed from service. Two profiles will be used: an “In Service” profile (Profile 1) and an “Out of Service” profile (Profile 2).

Profile 2 will be identical to the “In Service” profile, with the exception of the overcurrent settings. Profile 1 is set to be the Active profile, and all setpoints entered. An image of Profile 1 will then be copied to Profile 2 with the Copy Active Profile command. Profile 2 is then selected as the Active Profile and the overcurrent setpoints modified.

▲ **CAUTION:** During profile switching, relay operation is disabled for approximately 1 second.

Following the above procedure not only accelerates the configuration process, but also removes the possibility of errors if all setpoints are re-entered manually.

Functions

Configuration of the relay consists of enabling the functions for use in a particular application, designating the output contacts each function will operate, and which control/status inputs will block the function. The choices include eight programmable output contacts (OUT1–OUT8) and six control/status inputs (IN1–IN6)/(OUT1–OUT16 and IN1–IN18 for expanded I/O units).

Control/status inputs may also initiate actions, such as Breaker Failure Initiate, Trigger Oscillograph Recorder, Switch Setpoint Profile, or initiate an IPSlogic function. The control/status inputs and output contacts need to be chosen before configuring the individual functions. Both can be recorded on the Relay Configuration Table in Appendix A, **Forms**.

Special Considerations

Status input IN1 is pre-assigned to be the 52b breaker contact. IN5 and IN6 may be used to select setpoint profiles (with input activated profiles enabled).

Outputs 1–6 and 9–23 are form “a” contacts (normally open), and outputs 7 and 8 are form “c” contacts (center tapped “a” and “b” normally closed) contacts. Output contacts 1–4 contain special circuitry for high-speed operation and pick up 4 ms faster than outputs 5–8. Function 87 outputs are recommended to be directed to OUT1 through OUT4 contacts.

The following functions can be configured using enable/disable output, and status input blocking designations:

+ 24 Volts/Hz Overexcitation: Definite Time #1, #2, Inverse Time
+ 27 Phase Undervoltage
- 46W2/W3/W4 Negative Sequence Overcurrent: Definite Time, Inverse Time
- 49 Winding Thermal Protection (W1, W2,W3,W4)
- 50 Instantaneous Phase Overcurrent, #1, #2, #3, #4, #5, #6, #7, #8
- 50BFW1/W2/W3/W4 Breaker Failure
- 50GW2/W3/W4 Instantaneous Ground Overcurrent, #1, #2
- 50N Instantaneous Residual Overcurrent, #1, #2, #3, #4, #5, #6, #7, #8
- 51 Inverse Time Phase Overcurrent #1, #2, #3, #4
- 51GW2/W3/W4 Inverse Time Ground Overcurrent
- 51 Inverse Time Residual Overcurrent #1, #2, #3, #4
+ 59G Ground Overvoltage, #1, #2
+ 81 Over/Under Frequency: #1,#2,#3, #4
- 87H Phase Differential Current, High-set
- 87T Phase Differential Current, Harmonic Restrained Percentage Differential
- 87GDW2/W3/W4 Ground Differential: #1, #2
- Through Fault Monitoring
- TCM Trip Circuit Monitoring
- BM Breaker Monitoring: W1, W2, W3, W4
- IPSlogic: #1,#2,#3,#4,#5,#6

(+) = Denotes the Optional Single-Phase Voltage Protection Package Functions

24 Volts/Hz Overexcitation

■ **NOTE:** Two voltage inputs are available for the M-3311A. They can be either a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.

The 24 Volts-Per-Hertz (V/Hz) function provides over-excitation protection for the transformer. As the volts per hertz level rises above a transformer's limit, leakage flux increases. The leakage flux induces current in the transformer support structure causing rapid localized heating.

In power plant applications, over-excitation can occur due to sudden tripping of the generator as a result of faults and other abnormal conditions.

In Extra High Voltage (EHV) applications, an incorrectly switched line can lead to over-excitation at tapped transformers due to combined capacitance.

In transmission and distribution applications, sudden loss of load or improper capacitor/reactor switching may result in overexcitation.

This function provides two Definite Operating Time setpoints, four families of Inverse Time curves widely used in the industry (see Appendix D, Figures D1 to D4), and a linear reset rate programmable to match specific cooling characteristics of the transformer. The V/Hz function provides reliable measurements of V/Hz for a frequency range of 10–80 Hz.

When applied for generator and unit transformer protection, the first task in setting this relay function is to determine the desired protective levels and times. This can be accomplished by combining the V/Hz limit curves of the transformer and the associated generator on one graph and simplifying the result into one curve to coordinate with the protection.

Example of Transformer limits:

- Full Load V/Hz = 1.05 PU (HV terminals)
- No Load V/Hz = 1.10 PU (HV terminals)

■ **NOTE:** The curves must be on the same voltage base to be combined on one graph. An example is shown in Figure 4-20, Example of Capability and Protection Curves. The manufacturer of the generator and transformer will provide these over-excitation capability limits.

Depending on these characteristics, they can best be matched by one of the four families of inverse time curves, alone or in conjunction with definite time setpoints. Coordination of capabilities and protection is achieved when the time between the relay operation and the capability limit is sufficient for the breakers to open and de-energize the units. This coordination time is read vertically *between* the two curves at any given V/Hz value.

Figure 4-21, Example of Capability and Protection Curves, illustrates a composite graph of generator limits, transformer limits, a chosen inverse time curve, inverse time pickup, and definite time setpoint. While inverse time curve selection may provide more selective and sensitive protection, a traditional two-step protection scheme may be realized by using the two definite time functions (24DT #1 and #2), and disabling the inverse (24IT) element.

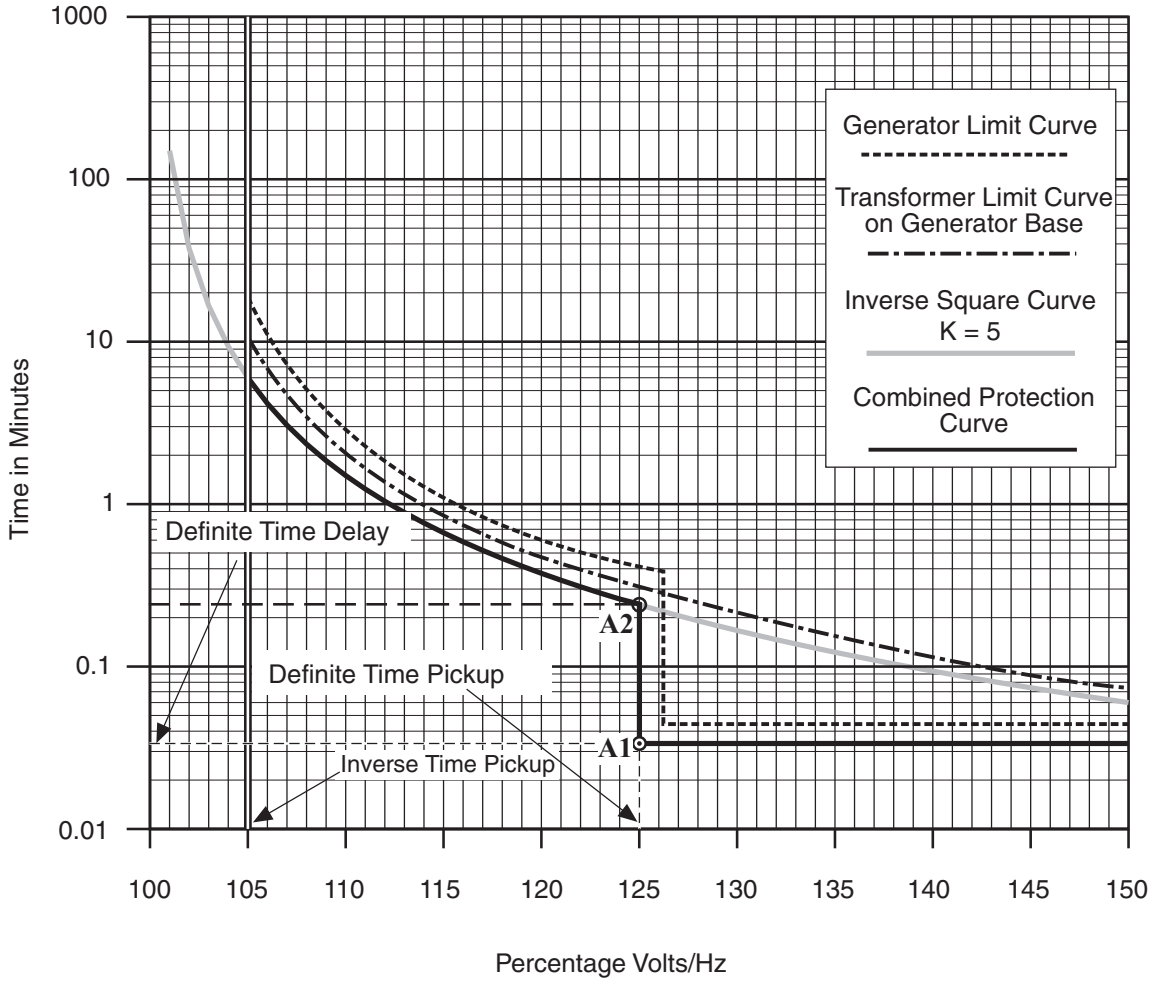


Figure 4-19 Example of V/Hz Capability and Protection Curves

If this function is enabled, the following settings are applicable:

```
24DT#1 PICKUP
 _____________ 110%
```

Definite time setpoint #1 establishes the V/Hz level above which the protection operating time will be fixed at the definite time delay #1 (See Figure 4-19). 100% is equal to nominal voltage at nominal frequency (50/60Hz). See Section 4.2, **Configuration**.

```
24DT#1 DELAY
360 Cycles
```

Delay time #1 establishes the operation time of the protection for all V/Hz values above the level set by definite time setpoint #1. Note that delay time #1 (A.1 in Figure 4-19) must be less than the operating time of the selected inverse curve at the definite time setpoint #1 V/Hz level (A.2 in Figure 4-19). Delay time A.1 becomes the definite minimum time for the inverse curve which prevents misoperation during transients. It is highly recommended that 24DT #1 be enabled along with 24IT function.

```
24DT#2 PICKUP
 _____________ 110%
```

```
24DT#2 DELAY
360 Cycles
```

Definite time setpoint #2 could be programmed to alarm, alerting the operator to take proper control action to possibly avoid tripping (may be used to trip). Time to operation at any V/Hz value exceeding Definite time setting #2.

```
24IT PICKUP
 _____________ 105%
```

As shown in Figure 4-19, the pickup value is the V/Hz value (in %) that the chosen inverse curve begins protective operation. Typical value is 105%.

```
24IT CURVE
CRV#1 crv#2 crv#3 crv#4
```

The appropriate curve *family* for this protection application is designated by circling the CRV #. These curves are shown in Appendix D, **Inverse Time Curves**. Note that the operating times are constant above 150% V/Hz values.

```
24IT TIME DIAL
 _________________ 9
```

The appropriate *curve* in the family is designated by the associated “K” value of the curve. These are shown in Appendix D, **Inverse Time Curves**.

```
24IT RESET RATE
200 Seconds
```

After any V/Hz excursion, cooling time must also be taken into account. If the unit should again be subjected to high V/Hz before it has cooled to normal operating levels, damage could be caused before the V/Hz trip point is reached. For this reason, a linear reset characteristic, adjustable to take into account the cooling rate of the unit, is provided. If a subsequent V/Hz excursion occurs before the reset characteristic has timed out, the time delay will pick up from the equivalent point (as a %) on the curve. The value entered here should be the time needed for the unit to cool to normal operating temperature if the V/Hz excursion time was just under the trip time.

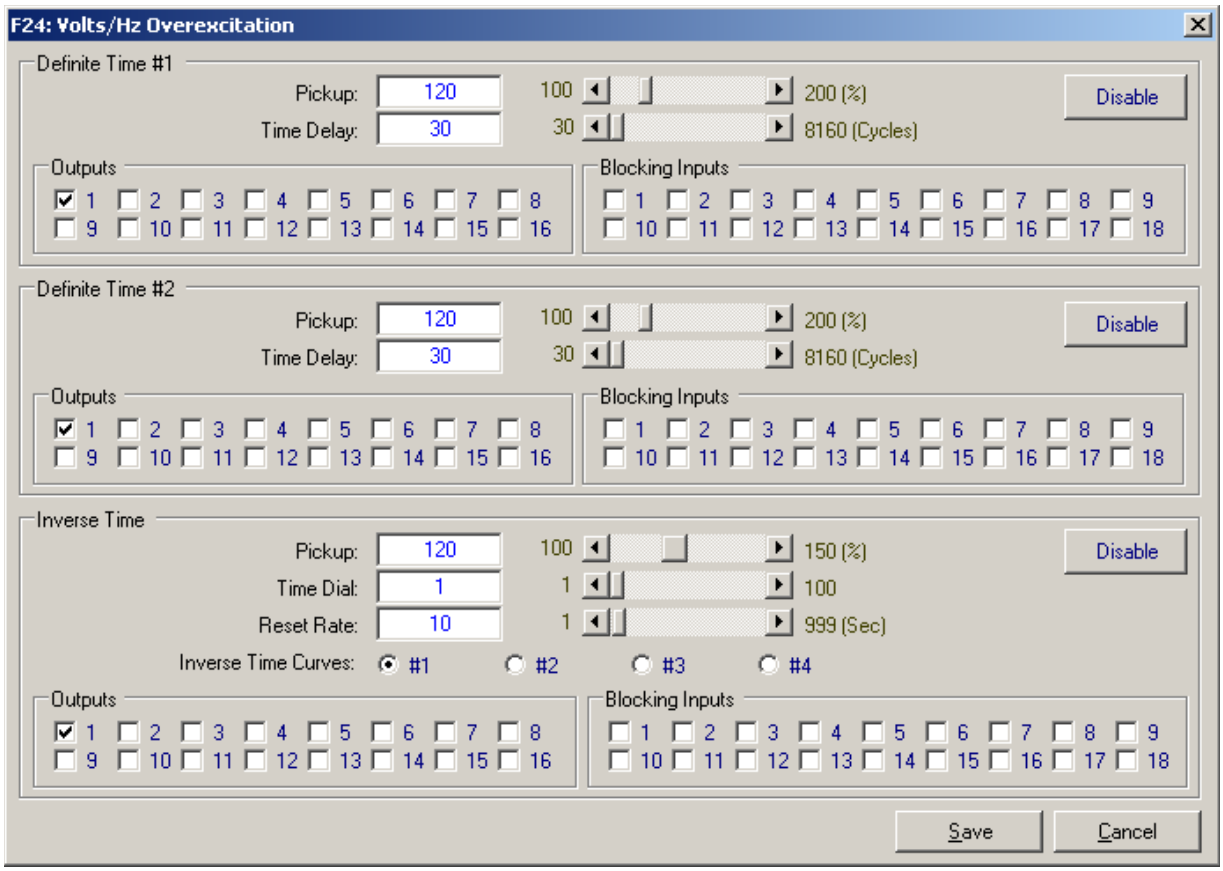


Figure 4-20 M-3826 IPScom® (24) Volts/Hertz Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F24 Volts/HZ Overexcitation

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

27 Phase Undervoltage

■ **NOTE:** Two voltage inputs are available for the M-3311A. They can be either a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.

The 27 Undervoltage function may be used to detect any condition causing long term undervoltage

This function is used to shed the transformer load when the power system does not have enough reactive support, similar to the Over/Underfrequency (81O/U) function.

The Inhibit setting of this function prevents it from operating during fault conditions.

If this function is enabled, the following settings are applicable:

```
27 PICKUP
    108 Volts
```

Undervoltage pickup establishes the voltage level below which the function timer will start.

```
27 INHIBIT
disable ENABLE
```

Enables or disables the undervoltage inhibit feature.

```
27 INHIBIT
    108 Volts
```

Undervoltage inhibit establishes the voltage level below which the function will be disabled.

```
27 DELAY
    30 Cycles
```

The operating time of the function.

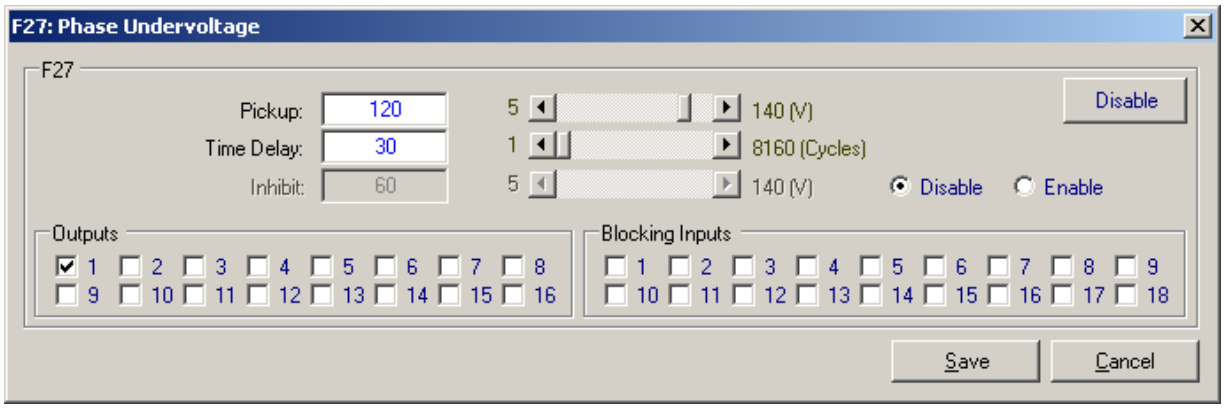


Figure 4-21 M-3826 IPScom® (27) Undervoltage Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F27 Phase Undervoltage

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

46 Negative Sequence Overcurrent

The 46 Negative Sequence Overcurrent function provides protection against possible damage due to unbalanced faults and open conductors.

The pickup setting of this function can be set below the system load for increased sensitivity for phase-to-phase fault backup of feeder protective relays.

This function has a definite time element and an inverse time element. The definite time pickup value and definite operating time are typically associated with an alarm function. The inverse time element is typically associated with a trip function.

The inverse time function can be selected as one of the eleven curve families: definite, inverse, very inverse, extremely inverse, and four IEC curves. The operator selects the pickup and time dial settings.

This protection must *not* operate for system faults that will be cleared by feeder/line relaying. This requires coordination with feeder line protection, bus differential, and breaker failure backup protections.

If this function is enabled, the following settings are applicable:

```
46DTW2 PICKUP
    0.50 Amps
```

Winding 2 negative sequence overcurrent pickup establishes the negative sequence overcurrent level above which the definite time function timer will start.

```
46DTW2 DELAY
    120 Cycles
```

This setting is the operating time of the definite time function.

```
46ITW2 PICKUP
    1.00 Amps
```

Negative sequence overcurrent pickup establishes the negative sequence overcurrent level above which the inverse time function timer will start.

```
46ITW2 CURVE
BEDEF beinv bevinv beeinv→
```

This setting selects one of eleven families of curves, as shown in Appendix D, Figures D-5 through D-15.

```
46ITW2 TIME DIAL
    5.0
```

The appropriate curve in the selected family of curves is chosen here.

```
46DTW3 PICKUP
    0.50 Amps
```

These screens are the same for Winding 4.

```
46DTW3 DELAY
    120 Cycles
```

```
46ITW3 PICKUP
    1.00 Amps
```

```
46ITW3 CURVE
BEDEF beinv bevinv beeinv →
```

```
46ITW3 TIME DIAL
    5.0
```

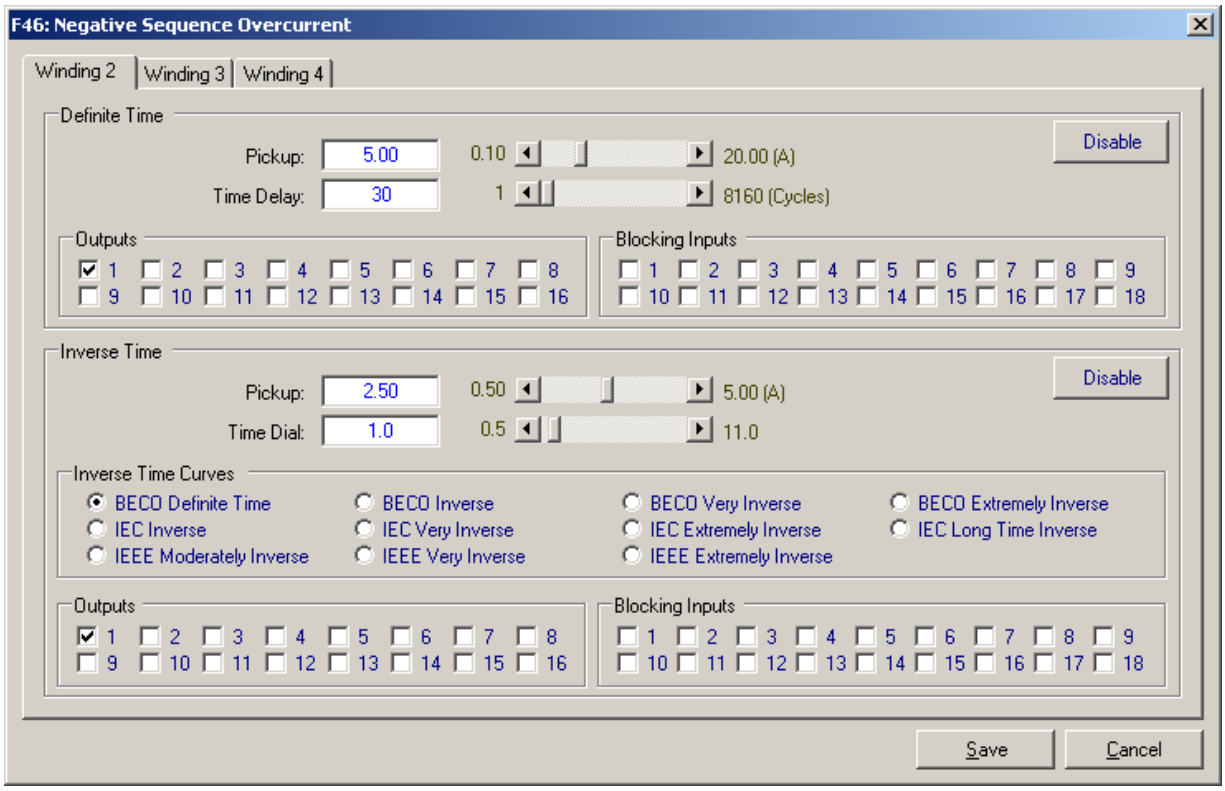


Figure 4-22 M-3826 IPScom® (46) Negative Sequence Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F46 Negative Sequence Overcurrent

COMMAND BUTTONS

Save **Save**s all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

49 Winding Thermal Protection

The thermal overload function provides protection against possible damage during overload conditions. Temperature and overload monitoring of oil-filled transformers are carried out with the use of indicating thermostats (standard). The oil thermometer, which measures the top oil temperature, cannot be relied upon to detect short-time overloads beyond permissible limits.

Transformers without winding thermometers should have a thermal current protection with operating current/time characteristics that correspond to the current overload characteristic of the transformer windings. For transformers with winding thermometers, a thermal current protection will provide a back-up function for this monitoring device.

The 49 function uses the demand current as pre-load current, to protect the transformer following the IEC-255-8 standard:

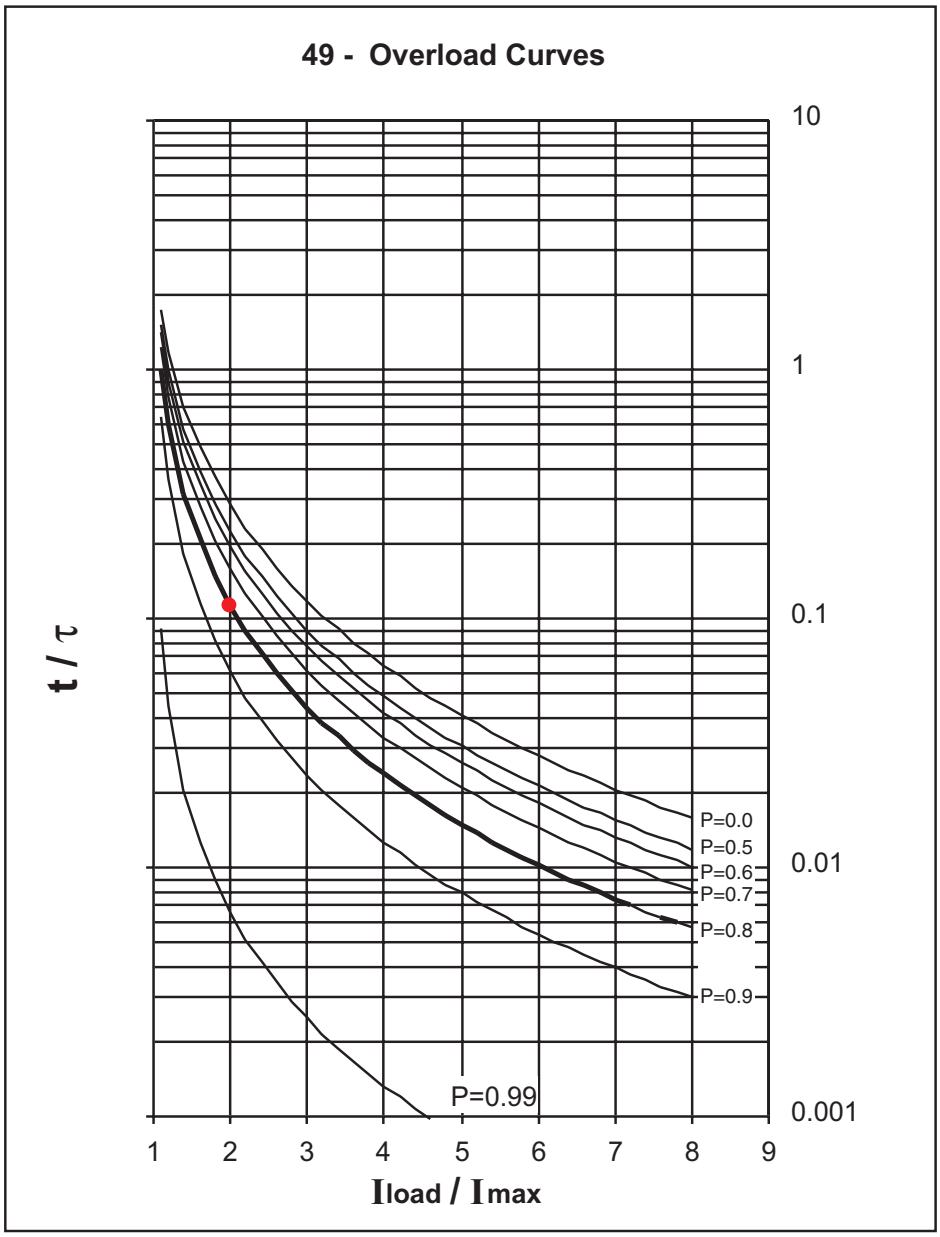
$$t = \tau \times I_n \quad \frac{(I_{load}/I_{max})^2 - (I_{preload}/I_{max})^2}{(I_{load}/I_{max})^2 - 1}$$

Where: t = time to trip
τ = time constant
I_{load} = relay current
$I_{preload}$ = pre-load current
I_{max} = maximum allowed continuous overload current

The pre-load current "$I_{pre\text{-}load}$" is the previous average current for the last 15 minutes, 30 minutes, or 60 minutes programmable into the demand metering.

The M-3311A includes four setpoint groups that can accommodate a power transformer's different MVA requirements. One setpoint group can be used for basic rating setpoints and others can be used to change to a second group of setpoints for use with higher ratings when forced cooling is required.

Example: If we consider that the transformer was working with 80% of its rating power prior to overload, then the current goes up to 2.0 times the maximum current (Iload/Imax=2.0). Selecting the curve P=0.8 (see Figure 4-23), we have t/τ=0.1133. If τ=30 minutes, then the time delay for this condition would be: t=0.1133 x 30=3.3999 minutes.



where: $P = \frac{I_{preload}}{I_{max}}$

Figure 4-23 49 Function Overload Curves

If this function is enabled, the following settings are applicable:

49 TIME CONSTANT 5.0 Min	Selects the time constant, 'τ'
49 MAX OVERLOAD CURRENT 2.00 Amps	Selects the maximum allowed continuous overload current.
49 CURRENT SELECTION sum1 sum2 w1 w2 w3 w4	Select the winding current to be used as the input.

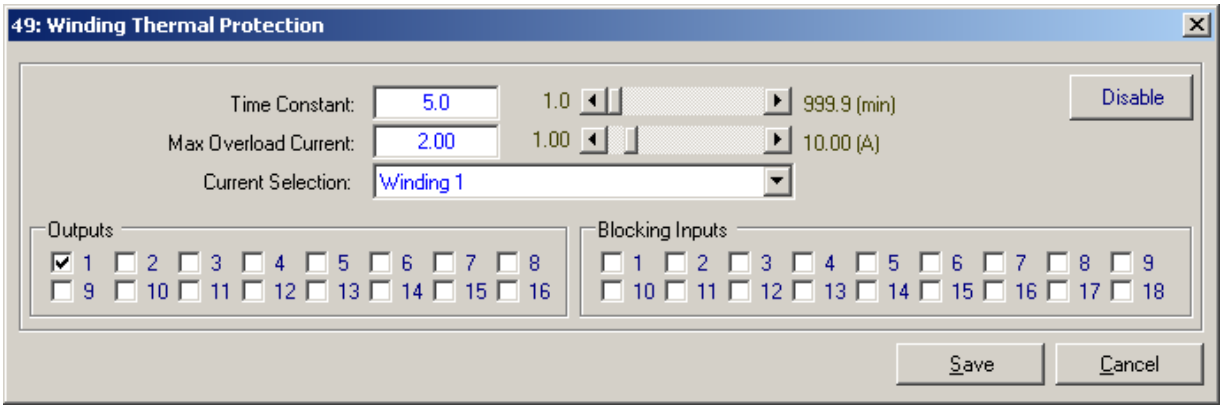


Figure 4-24 M-3826 IPScom® (49) Winding Thermal Protection Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F49 Winding Thermal Protection

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

50BF Breaker Failure

The 50BF function is applicable when a transformer breaker is present. If enabled, the 50BF-Ph phase detector element is used for breaker failure and the 50BF-N provides breaker flashover protection (see Figure 4-25). This provides an additional Breaker Failure Initiate, which is active only when the breaker is open.

50BF-Phase Breaker Failure

When the M-3311A Transformer Protection Relay detects an internal transformer fault or an abnormal operating condition, it closes an output contact to trip the transformer breakers. Protection output contacts must be connected to trip the breakers required to isolate the transformer from the system. The breaker failure condition is detected by the continued presence of current in any one or more phases after a breaker trip command is issued.

Implementation of the transformer breaker failure function is illustrated in Figure 4-25. The breaker failure timer will be started whenever any one of the designated output contacts or the external programmed breaker failure initiate control/status inputs are activated. The breaker failure (TDOE) timer continues to time if any one of the phase currents is above the 50BF-Ph pickup setting.

50BF-Residual Element

This overcurrent relay is energized from the residual current, see Figure 4-16, One-Line Functional Diagram. This function is internally identical to the 50BF-Ph element and operates using residual (triple zero sequence) current.

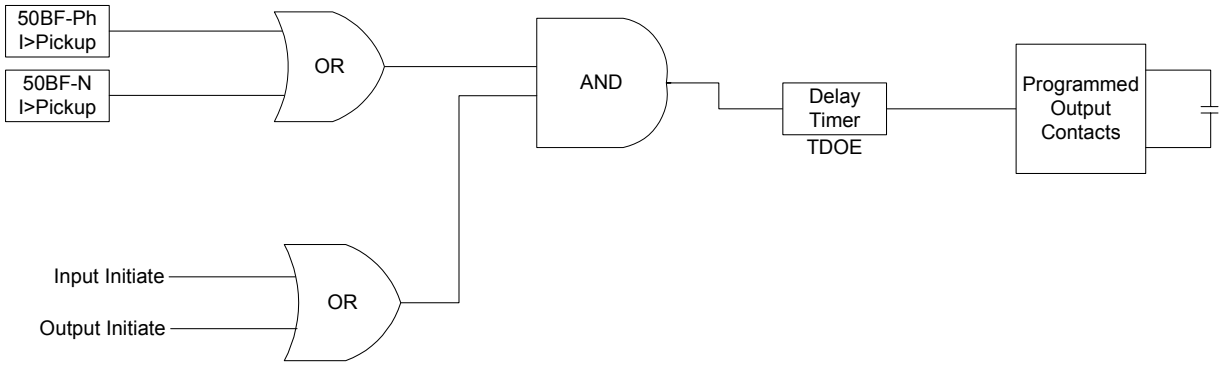


Figure 4-25 Breaker Failure Logic Diagram

If this function is enabled, the following settings are applicable:

50BFW1 PICKUP RESIDUAL 1.00 Amps	Sets 50BFW1 residual current pickup. 0.5A is a typical setting.
50BFW1 PICKUP PHASE 1.00 Amps	Sets 50BFW1 phase current pickup. 0.3 A is a typical setting.
50BFW1 INPUT INITIATE i6 i5 i4 i3 i2 I1	Designates the control/status inputs which will initiate the breaker failure timer.
50BFW1 OUTPUT INITIATE o8 o7 o6 o5 o4 o3 o2 O1	Designates the relay outputs which will initiate the breaker failure timer.
50BFW1 DELAY 30 Cycles	For transformer breaker failure use, the time delay should be set to allow for breaker operating time plus margin.

■ **NOTE:** These screens are also applicable for Windings 2, 3 and 4.

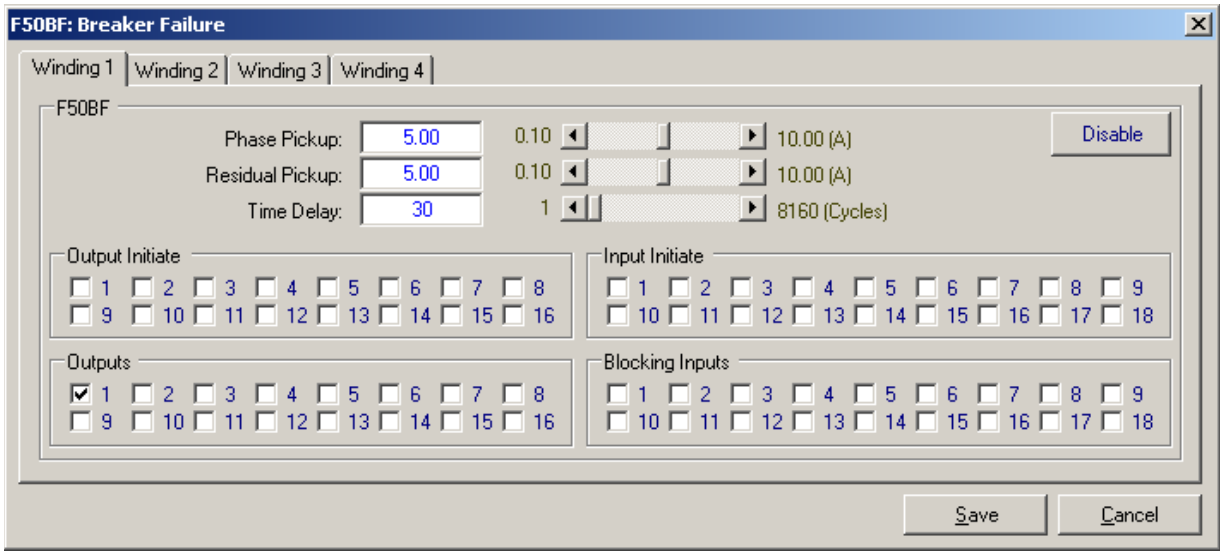


Figure 4-26 M-3826 IPScom® (50BF) Breaker Failure Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F50BF Breaker Failure

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

50/50G Instantaneous Overcurrent, Phase & Ground

The Instantaneous phase 50 and Instantaneous Ground 50G overcurrent functions provide fast tripping for high fault currents. The settings of both functions must be set such that they will not pickup for faults or conditions outside the immediate protective zone. Two phase elements (#1 and #2) are available on Winding 2, 3, and 4 for the 50G function for phase overcurrent functions, output is initiated when any individual phase A, B or C exceeds the pickup. These elements also allow the user to program several logic schemes described in Section 4.6, **System Aplication an Logic Schemes.**

```
50#1 PICKUP
      1.00 Amps
```

Sets ground pickup for instantaneous ground overcurrent.

```
50#1 DELAY
  30 Cycles
```

Sets delay for instantaneous ground overcurrent.

```
50#1 CURRENT SELECTION
  sum1 sum2 w1 w2 w3 w4
```

Sets the current input for instantaneous ground overcurrent.

■ **NOTE:** These screens are the same for 50#2 thru 50#8

```
50GW2#1 PICKUP
      1.00 Amps
```

Sets ground pickup for instantaneous ground overcurrent.

```
50GW2#1 DELAY
  30 Cycles
```

Sets delay for instantaneous ground overcurrent.

```
50GW2#2 PICKUP
      1.00 Amps
```

Sets ground pickup for instantaneous ground overcurrent.

```
50GW2#2 DELAY
  30 Cycles
```

Sets delay for instantaneous ground overcurrent.

■ **NOTE:** These screens are also applicable for Windings 3 and 4 (Function 50G).

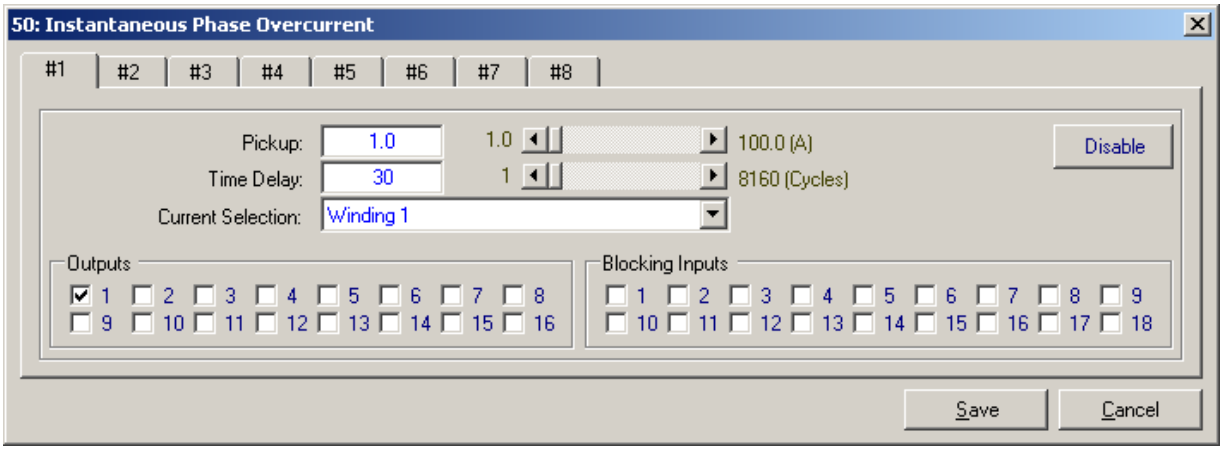


Figure 4-27 M-3826 IPScom®(50) Instantaneous Phase Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F50 Instantaneous Phase Overcurrent

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

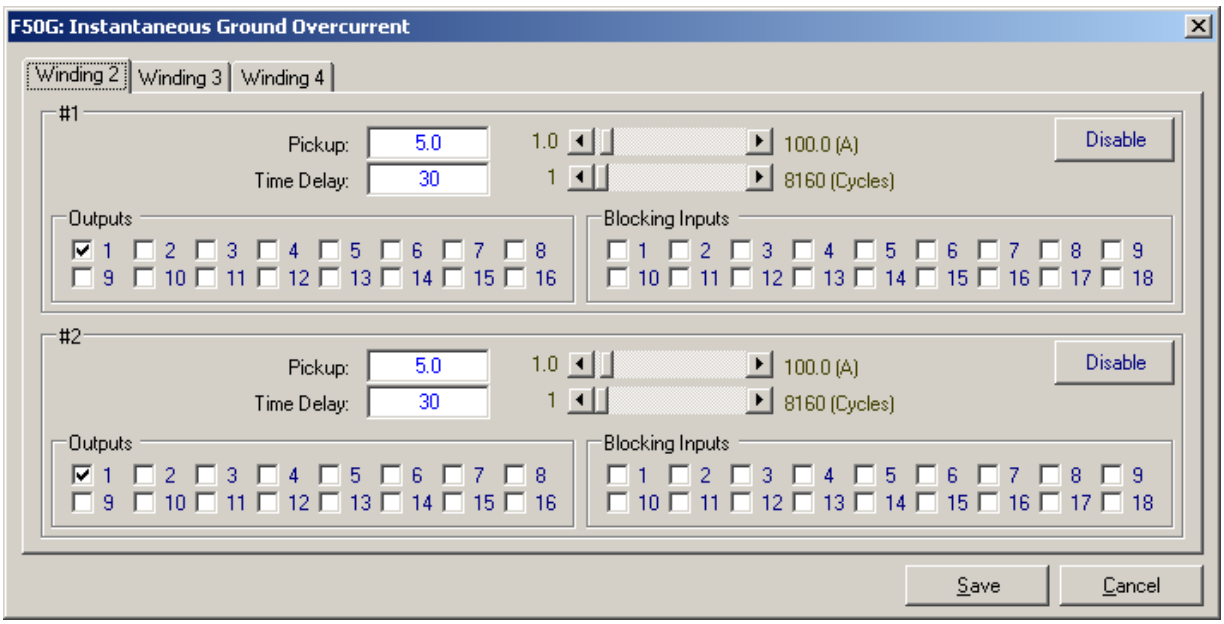


Figure 4-28 M-3826 IPScom® (50G) Instantaneous Ground Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F50G Instantaneous Ground Overcurrent

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

50N Instantaneous Residual Overcurrent

The Instantaneous Residual (50N) overcurrent function provides fast tripping for high fault currents. Settings must be made in such a way as to prevent pickup for fault or conditions outside the immediate protective zone.

If this function is enabled, the following settings are applicable:

50N#1 PICKUP 1.00 Amps	Sets pickup for instantaneous residual overcurrent.
50N#1 CURRENT SELECTION sum1 sum2 w1 w2 w3 w4	Sets current input for instantaneous overcurrent.
50N#1 DELAY 30 Cycles	Sets delay for instantaneous residual overcurrent.

■ **NOTE:** These screens are also applicable for 50N#2 through 50N#8

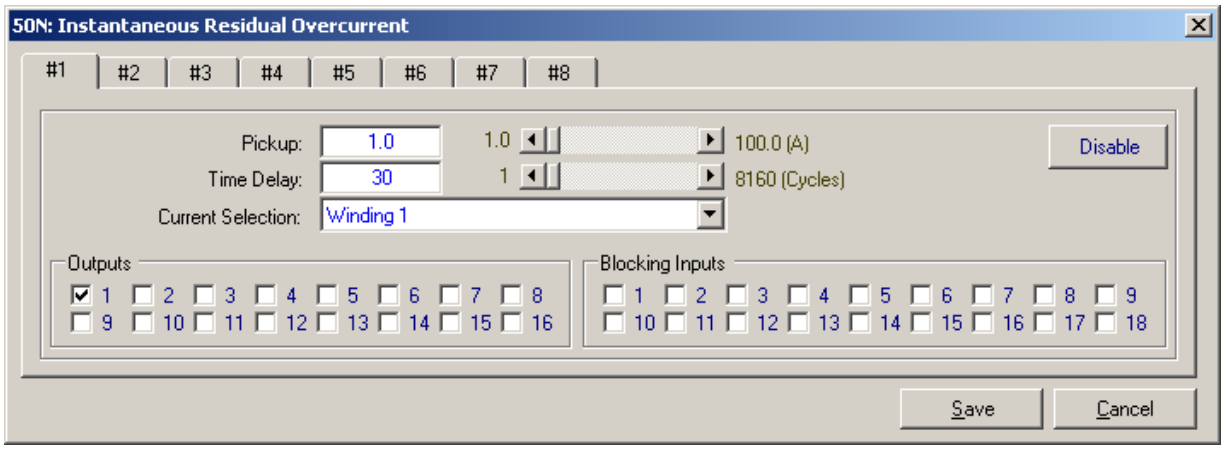


Figure 4-29 M-3826 IPScom®(50N) Instantaneous Residual Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F50N Instantaneous Residual Overcurrent

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

51 Inverse Time Phase Overcurrent

The 51 Inverse Time Phase Overcurrent function, one set per winding are used to trip circuits selectively and to time coordinate with up or down stream relays. For this function, eight complete series of inverse time tripping characteristics are included. The eight curve families to be chosen are definite, inverse, very inverse, extremely inverse, and four IEC curves. The time dial within each family setting and tap setting is selected through the relay menu.

The curves available for use are shown in Appendix D, **Inverse Time Curves**, Figures D-5 through D-15. They cover a range from 1.5 to 20 times the tap. For currents beyond 20 times the pickup setting, the relay operating time will remain the same as the time at 20 times pickup setting.

If this function is enabled, the following settings are applicable:

```
51#1 PICKUP
    1.00 Amps
```

Sets phase current pickup for 51W1.

```
51#1 CURVE
BEDEF beinv bevinv beeinv →
```

Selects one of the eleven inverse time curves as shown in Appendix D, Figures D-5 through D-15.

```
51#1 TIME DIAL
    5.0
```

The appropriate curve in the selected family of curves is chosen here.

```
51#1 CURRENT SELECTION
sum1 sum2 w1 w2 w3 w4
```

Sets current input for inverse time overcurrent.

■ **NOTE:** These screens are also applicable for 51#2 through 51#4.

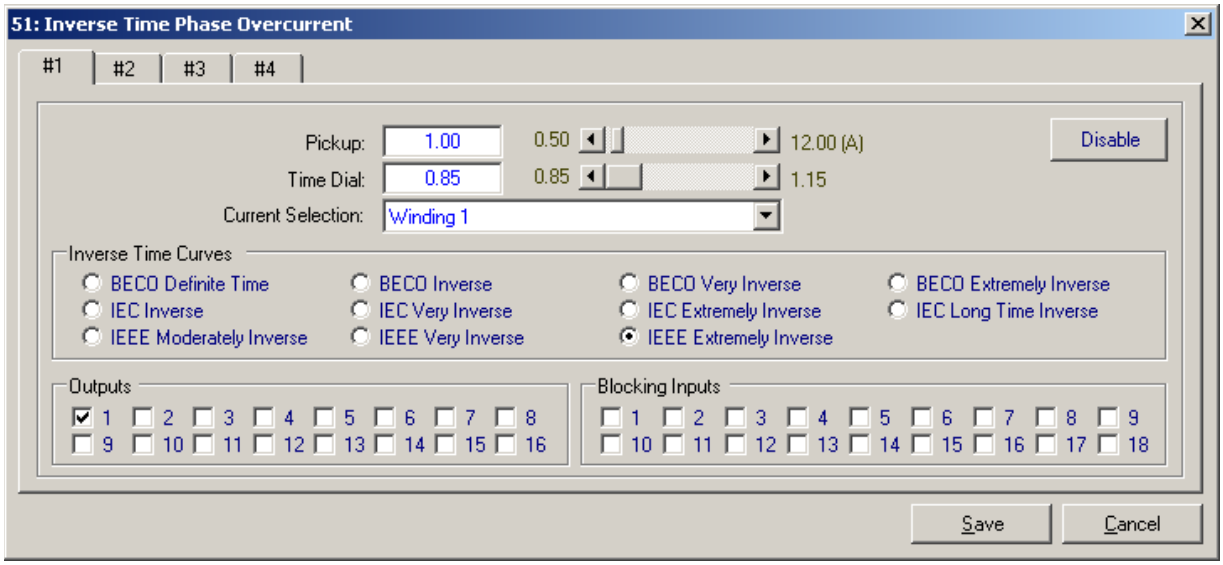


Figure 4-30 M-3826 IPScom® (51) Inverse Time Phase Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F51 Inverse Time Phase Overcurrent

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

51N Inverse Time Residual Overcurrent

The 51 Inverse Time Residual Overcurrent provides protection against ground faults. Since normal residual current is usually much lower than the full load phase current, this function can be set more sensitively than the phase overcurrent protection.

The curves available for use are shown in Appendix D, **Inverse Time Curves**, Figures D-5 through D-15. They cover a range from 1.5 to 20 times tap. For currents beyond 20 times the pickup setting, the relay operating time will remain the same as the time at 20 times pickup setting.

If this function is enabled, the following settings are applicable:

```
51N#1 PICKUP
    1.00 Amps
```

Sets phase current pickup for 51N#1.

```
51N#1 CURVE
BEDEF beinv bevinv beinv →
```

Selects one of the eleven inverse time curves, as shown in Appendix D, Figures D-5 through D-15.

```
51N#1 TIME DIAL
    5.0
```

The appropriate curve in the selected family of curves is chosen here.

```
51N#1 CURRENT SELECTION
sum1 sum2 w1 w2 w3 w4
```

Sets current input for inverse time residual overcurrent.

■ **NOTE:** These screens are also applicable for 51N#2, 3 and 4.

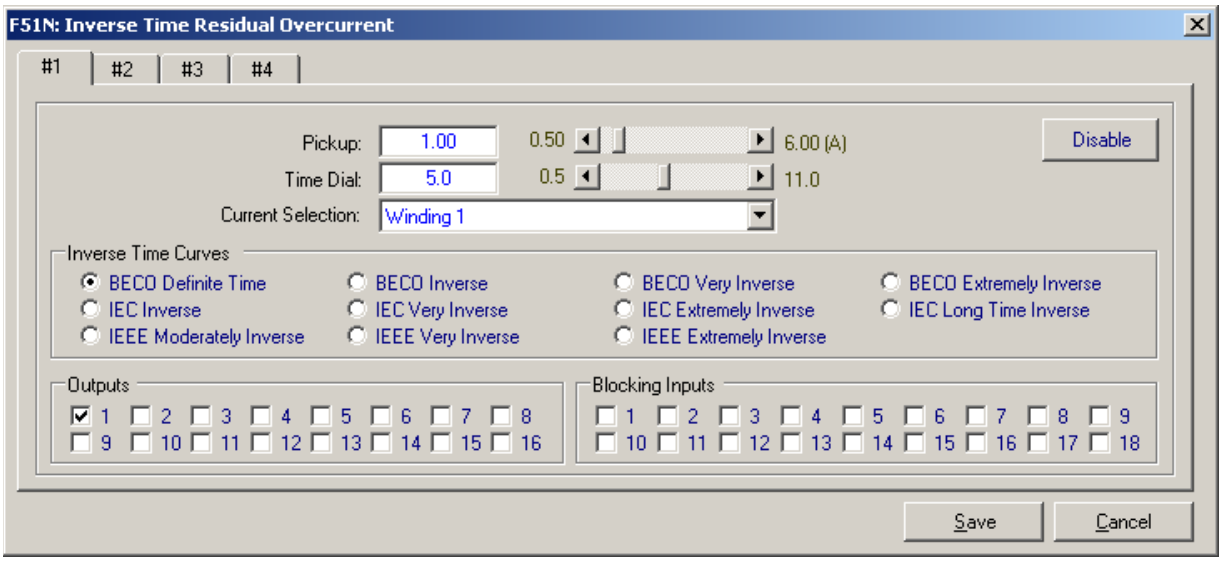


Figure 4-31 M-3826 IPScom® (51N) Inverse Time Residual Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F51N Inverse Time Residual Overcurrent

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

51G Inverse Time Ground Overcurrent

The 51G Inverse Time Ground Overcurrent function is used to trip circuits selectively and to time coordinate with up or downstream relays. For this function, eight complete series of inverse time neutral tripping characteristics are included. The four curve families to be chosen are definite, inverse, very inverse, extremely inverse, four IEC and three IEEE curves. The operator selects the time dial within each family setting and tap setting through the relay menu.

The curves available for use are shown in Appendix D, **Inverse Time Curves**, Figures D-5 through D-15. They cover a range from 1.5 to 20 times the tap. For currents beyond 20 times the pickup setting, the relay operating time will remain the same as the time at 20 times pickup setting.

If this function is enabled, the following settings are applicable:

```
51GW2 PICKUP
    1.00 Amps
```

Sets residual pickup for 51G.

```
51GW2 CURVE
BEDEF beinv bevinv beinv →
```

Selects one of the eleven inverse time curves, as shown in Appendix D, **Inverse Time Curves**, Figures D-5 through D-15.

```
51GW2 TIME DIAL
    5.0
```

The appropriate curve in the selected family of curves is chosen here.

■ **NOTE:** These screens are also applicable for Windings 3 and 4.

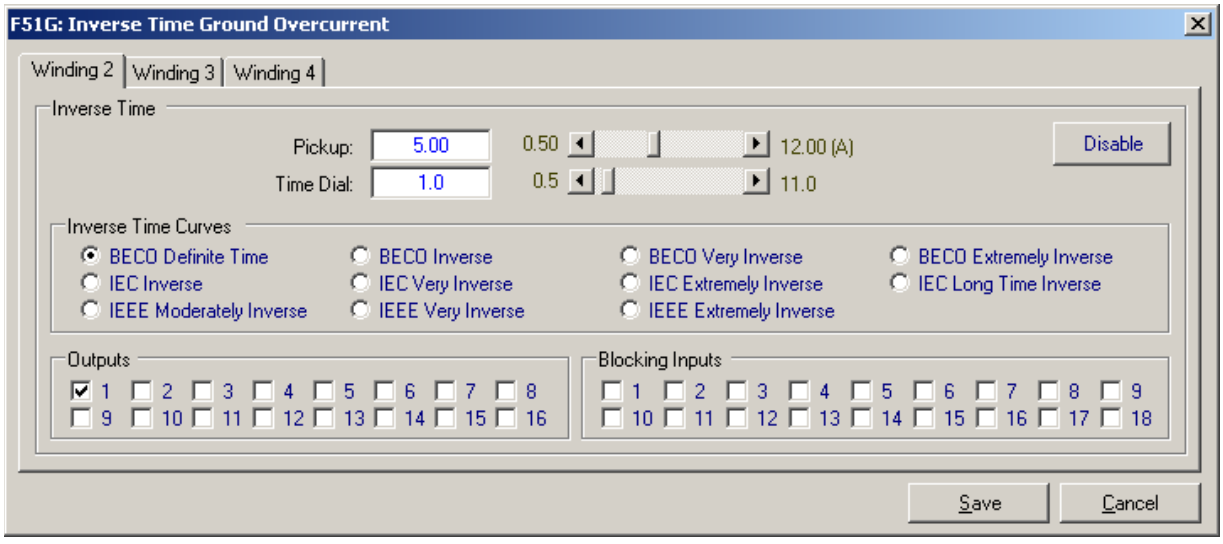


Figure 4-32 M-3826 IPScom®(51G) Inverse Time Ground Overcurrent Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F51G Inverse Time Ground Overcurrent

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

59G Ground Overvoltage

■ **NOTE:** Two voltage inputs are available for the M-3311A. They can be either a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.

The 59G Ground Overvoltage function provides protection for ground faults on the system.

Pickup setting for 59G should be set in such a way that it is higher than normal neutral voltage during unbalanced conditions. The time delay should be set to coordinate with downstream ground relaying.

If this function is enabled, the following settings are applicable:

```
59G#1 PICKUP
    10 Volts
```
Sets voltage pickup for ground overvoltage.

```
59G#1 DELAY
    30 Cycles
```
Sets delay for ground overvoltage.

```
59G#2 PICKUP
    10 Volts
```
Sets voltage pickup for ground overvoltage.

```
59G#2 DELAY
    30 Cycles
```
Sets delay for ground overvoltage.

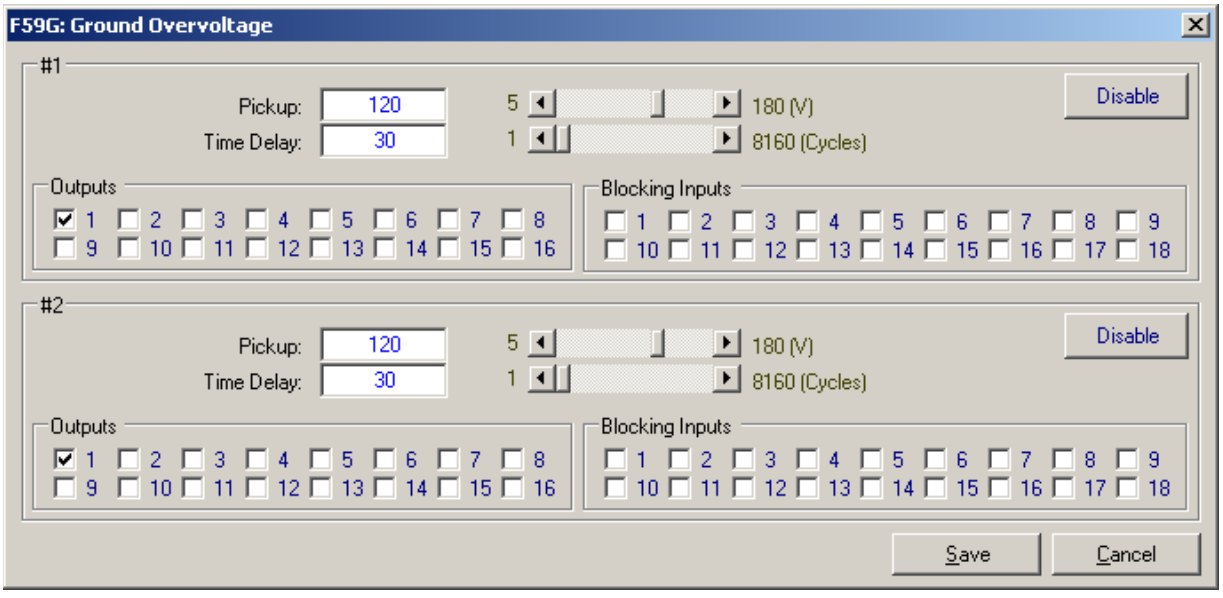


Figure 4-33 M-3826 IPScom® (59G) Ground Overvoltage Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F59G Ground Overvoltage

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

81O/U Over/Underfrequency

■ **NOTE:** Two voltage inputs are available for the M-3311A. They can be either a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.

The 81O/U Over/Underfrequency function provides protection against abnormal frequency. The Underfrequency function is typically used for load shedding applications. The frequency functions are automatically disabled when the input voltage is less than 5 volts.

When the frequency setpoint is selected as below the nominal frequency, the function operates as an underfrequency, otherwise, it operates as an overfrequency function.

If this function is enabled, the following settings are applicable:

```
81#1 PICKUP
    56.00 Hz
```

```
81#1 DELAY
    30 Cycles
```

```
81#2 PICKUP
    56.00 Hz
```

```
81#2 DELAY
    30 Cycles
```

```
81#3 PICKUP
    56.00 Hz
```

```
81#3 DELAY
    30 Cycles
```

```
81#4 PICKUP
    56.00 Hz
```

```
81#4 DELAY
    30 Cycles
```

The pickup and time delay setting for load shedding should be selected based on load frequency characteristics of the system.

A minimum time delay of 6 cycles is recommended to prevent relay operation during switching transients.

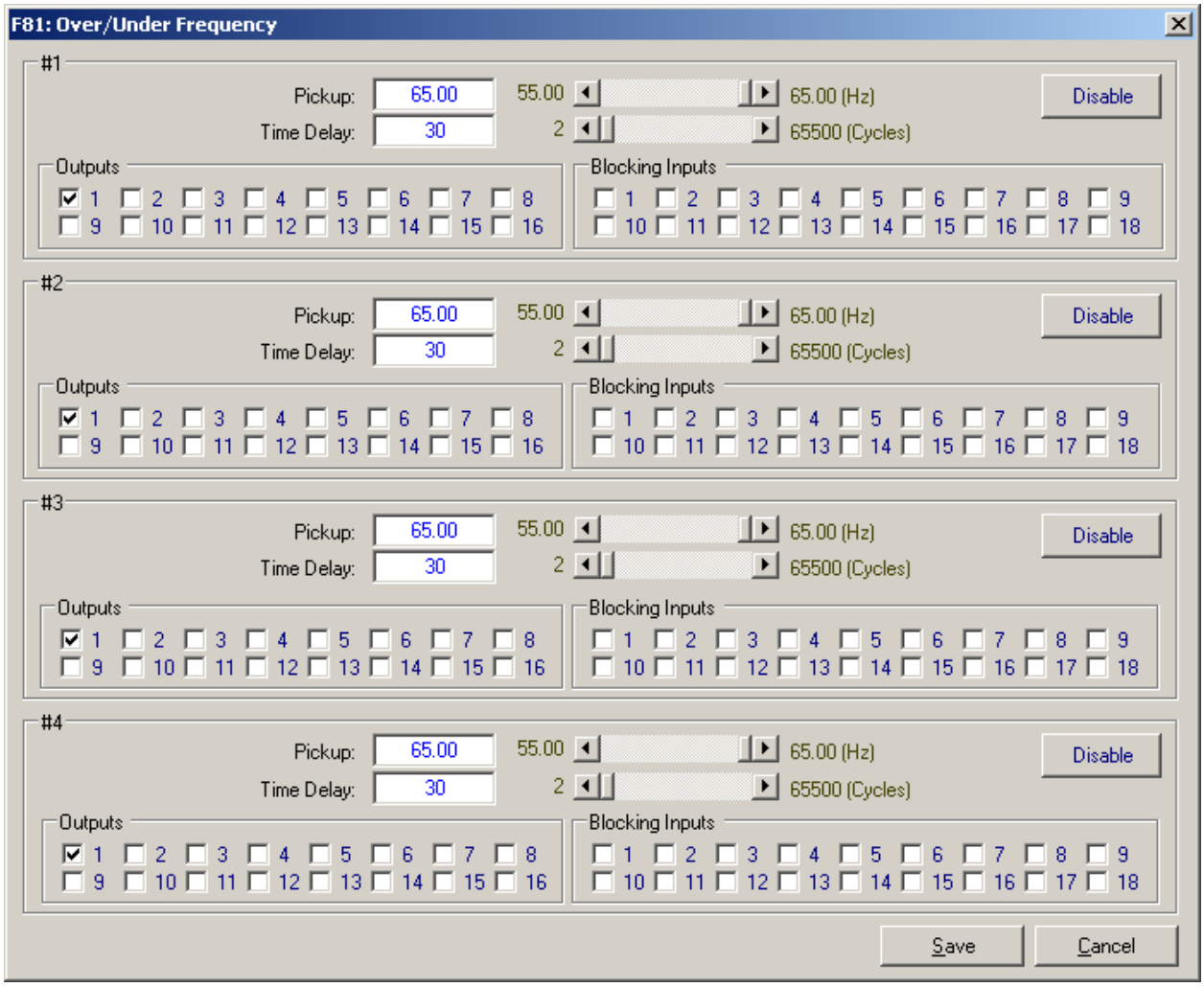


Figure 4-34 IPScom® (81O/U) Over/Underfrequency Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F81 Over/Under Frequency

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

87 Phase Differential

87H Phase Differential Unrestrained High Set Overcurrent

The 87H Phase Differential Unrestrained High Set Overcurrent function is used to detect transformer internal winding faults with high currents. Unlike the 87T function, the 87H function is not blocked by harmonic restraint. The pickup for this function should be set above the worst case first peak of the inrush current. This prevents misoperation of the function due to magnetizing inrush current during switching on of the transformer. Typical pickup setting is between 8 to 12 PU. The per unit is based on the CT tap setting. The 87H is typically set with no intentional time delay (one cycle time delay setting corresponds to no intentional time delay).

If this function is enabled, the following settings are applicable:

```
87H PICKUP
    20.0 PU
```

High-set pickup setting.

```
87H DELAY
    2 Cycles
```

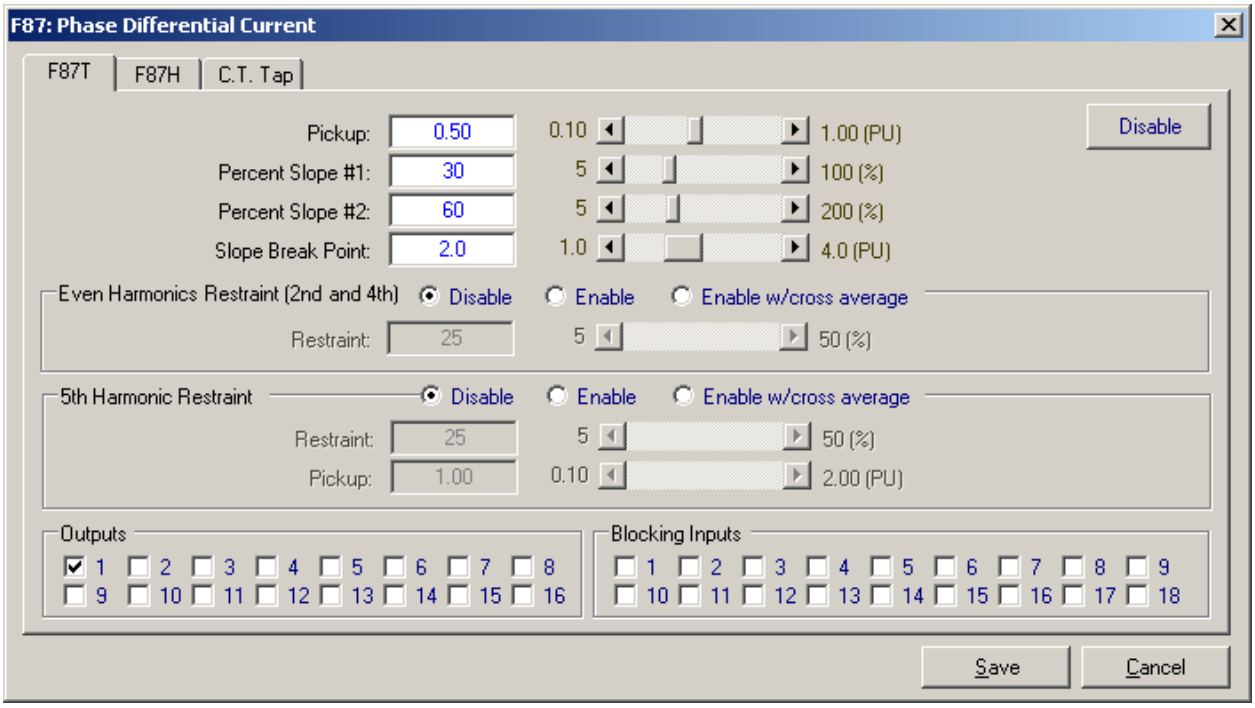


Figure 4-35 M-3826 IPScom®(87) Phase Differential Current Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F87 Phase Differential Current

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

87 Phase Differential

■ **NOTE**: See Section 4.6, Transformer Connections for detailed discussion on transformer connection applications for 87 function differential.

87T Phase Differential Restrained Overcurrent

The 87T Phase Differential function is a percentage differential function with dual adjustable slope characteristics (see Figure 4-37). This function provides protection for the transformer from internal winding faults. This function offers sensitive differential protection at low fault currents and tolerates larger mismatch of currents that can occur during high through fault current for greater security.

The 87T minimum pickup setting should be set to prevent operation of the 87T function due to transformer excitation current. Typical setting is 0.2 to 0.4 PU of tap setting.

Slope 1

The setting of Slope #1 should be set according to various possible errors:

1. Tapchanger operations in the power transformer (worst case ± 10%).
2. CT mismatch due to ratio errors. Errors can be as high as ± 10%.

A typical Slope #1 setting of 30 to 40% prevents misoperation due to above errors.

Slope 2

For heavy faults outside the differential zone, CT saturation can occur. Factors such as residual magnetism in the CT core, CT characteristic mismatch and burden mismatch can contribute large differential currents during this condition. Slope #2 should be set higher than Slope #1. It can provide security against misoperation during high through fault currents. A typical Slope #2 setting is 60 to 100%.

Even Harmonic Restraint

Transformer magnetizing inrush currents contain significant amounts of 2nd and some 4th harmonic currents. This inrush can cause undesirable trips and delay putting a transformer into service. The even harmonic restraint keeps it from operating during a magnetizing inrush condition. Magnetizing inrush current is distinguishable from fault current by harmonic components. The M-3311A Transformer Protection Relay can be set to restrain if the level of even harmonic current is above a set percentage of fundamental.

The harmonic currents are calculated from the differential current in the windings. The amount of even harmonic current (Id_{24}) in PU can be found by using the formula:

$$Id_{24} = \sqrt{Id_2{}^2 + Id_4{}^2}$$

where Id_2 and Id_4 are second and fourth harmonic currents in PU, respectively.

The percentage of even harmonics is found by the ratio Id_{24}/Id_1: If this number is above the even harmonic restraint setpoint, function 87T will restrain from operation.

The amount of even harmonics present in the transformer inrush currents depends upon the magnetizing characteristics of the transformer core and residual magnetism present in the core. A setting in the range of 10 to 15% can provide security against misoperations during magnetizing inrush conditions.

Modern transformers tend to have low core losses and very steep magnetizing characteristics. When the relay is applied to this type of transformers, the even harmonic setting should be set around 10% (in some cases, the setting may be lower than 10%). Older transformer designs tend to have higher amounts of even harmonics, where a setting of 15% or greater can provide security against misoperation during magnetizing inrush conditions.

The setting of the even harmonic restraint should be set to a low enough value to provide security against misoperation during transformer magnetizing inrush current and it should not be lower than the amount of even harmonics generated during internal fault conditions with CT saturation so as not to compromise reliability for heavy internal fault detection.

Fifth Harmonic Restraint

Transformer over-excitation produces a high amount of excitation current, which will appear as a differential current to the 87T function. The Fifth Harmonic restraint function can prevent misoperation of the 87T function by shifting the minimum pickup to a higher value (typically set at 150 to 200% of 87T minimum pickup), during transformer over-excitation conditions.

The over-excitation condition is detected by the presence of Fifth Harmonic component as a percentage of fundamental component of differential current above a set value.

The amount of Fifth Harmonic depends on the transformer core magnetizing characteristics. A setting of 30% is adequate to discriminate over-excitation from other conditions.

Cross Phase Averaging

Cross phase averaging is used to average the harmonics of all three phases to provide restraint of phases which may not have enough harmonics. Cross phase average, when enabled, provides security against misoperation during magnetizing inrush. However, it may slightly delay the relay operation for internal faults. The level of cross phase average current may be found using the following equations.

Even Harmonic Cross Phase Average:

$$Id_{CPA24} = \sqrt{IAd_{24}^2 + IBd_{24}^2 + ICd_{24}^2}$$

Fifth Harmonic Cross Phase Average:

$$Id_{CPA5} = \sqrt{IAd_5^2 + IBd_5^2 + ICd_5^2}$$

When enabled, the above averages are used along with fundamental component of differential current in each of the phases to calculate the harmonic percentages.

It is recommended to enable the cross phase average for even harmonic restraint, and disable the cross phase average for 5th harmonic restraint.

87T CT Tap Settings

The 87TW1, W2, W3 and W4 CT tap settings are used to convert the W1, W2, W3 and W4 current in terms of P.U. These settings are provided to compensate for CT ratio mismatch for 87T and 87H functions. The example calculation is for a three winding application. These should be calculated as follows:

87T CT Tap Settings For W1, W2, W3 and W4

$$87\ CT\ Tap_{WN} = \frac{MVA \times 10^3}{\sqrt{3} \times kVL\text{-}L \times CTR_{WN}}$$

where W_N is the winding number.

CT Tap Setting Calculation Example

Based on the transformer example in Figure 4-37, the CT tap calculations are presented below.

Since the $\sqrt{3}$ magnitude compensation for Delta connected CT's is already taken into account in the relay calculation, the same equation is used to calculate each CT Tap setting.

$$87\ CT\ Tap_{W1} = \frac{392.8\ MVA \times 10^3}{\sqrt{3} \times 17.1\ kV \times 1600} = 8.29$$

$$87\ CT\ Tap_{W2} = \frac{392.8\ MVA \times 10^3}{\sqrt{3} \times 17.1\ kV \times 1600} = 8.29$$

$$87\ CT\ Tap_{W3} = \frac{392.8\ MVA \times 10^3}{\sqrt{3} \times 161\ kV \times 400} = 3.52$$

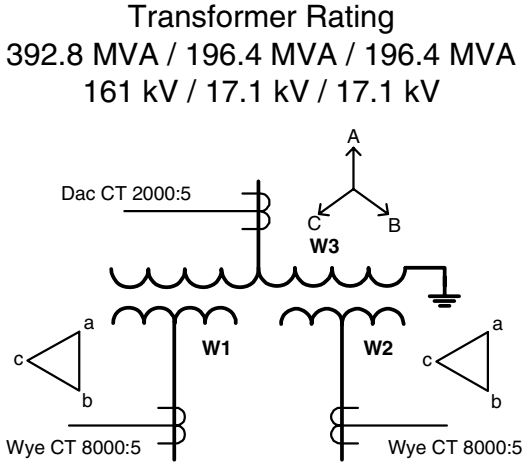
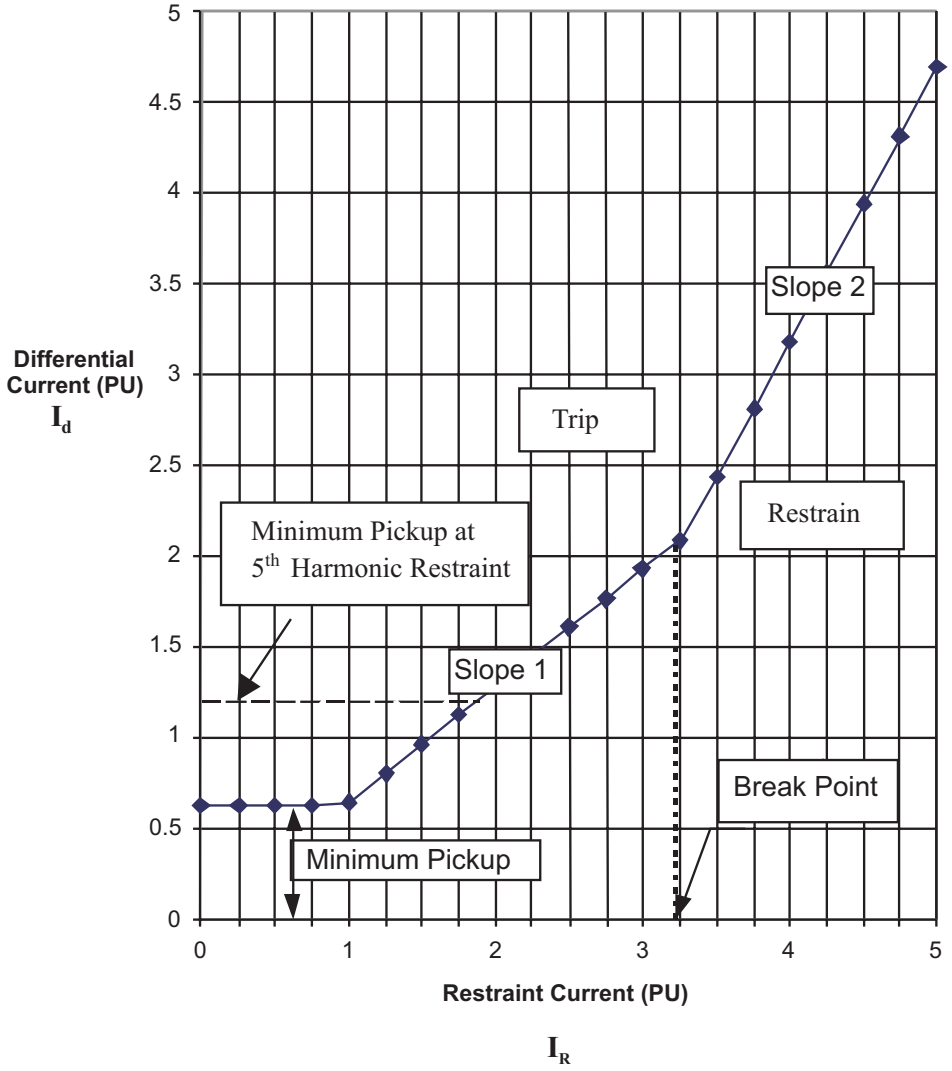


Figure 4-36 Transformer CT Tap Setting Example

F87T Dual Slope



where

$$I_R = \Sigma \frac{|I_{AW1}| + |I_{AW2}| + |I_{AW3}| \quad |I_{AW4}|}{2}$$

$$I_d = \Sigma \left| \bar{I}_{AW1} + \bar{I}_{AW2} + \bar{I}_{AW3} + \bar{I}_{AW4} \right|$$

Figure 4-37 87T Programmable Dual Slope Percentage Restraint Characteristic

If this function is enabled, the following settings are applicable:

See previous pages for more information on these settings.

```
87T PICKUP
    0.50 PU
```

```
87T SLOPE #1
    25%
```

```
87T SLOPE #2
    75%
```

```
87T SLOPE BREAKPOINT
    2.0 PU
```

```
87T EVEN RESTRAINT
disable enable CROSS_AVG
```

```
87T EVEN RESTRAINT
    10%
```

```
87T 5TH RESTRAINT
disable enable CROSS_AVG
```

```
87T 5TH RESTRAINT
    10%
```

```
87T PICKUP@5TH RESTRAINT
    0.75 PU
```

```
87 W1 C.T.TAP
    1.00
```

```
87 W2 C.T. TAP
    1.00
```

```
87 W3 C.T. TAP
    1.00
```

```
87 W4 C.T. TAP
    1.00
```

87GD Ground Differential

■ **NOTE:** This function is not provided on Winding One.

The 87GD ground differential element may provide sensitive ground fault protection on winding 2, 3 or winding 4.

The relay provides a CT Ratio Correction which removes the need for auxiliary CTs when the phase, winding 2, 3 or winding 4 and their ground CT ratios are different.

The directional element calculates the product ($-3I_0I_G\text{Cos}\phi$) for directional indication. The relay will operate only if I_0 (zero sequence current derived from the phase CTs) and I_G (Ground current from the Ground CT) have the opposite polarity, which is the case for internal transformer faults.

The advantage of directional element is that it provides security against ratio errors and CT saturation during faults external to the protected transformer.

The directional element is inoperative if the residual current ($3I_0$) is approximately less than 140 mA (approx., based on 5 A CT rating). For this case, the algorithm automatically disables the directional element and the 87GD function becomes non-directional differential. The pickup quantity is calculated as the difference between the corrected triple zero sequence current (CTRCFX $3I_0$) and the ground current (I_G). The magnitude of the difference (CTRCF X $3I_0$- I_G) is compared to the function pickup setting.

In order to use the 87GD function, Winding 2, 3 and Winding 4 CTs must be connected wye.

The 87GD function is automatically disabled if the ground current is less than 200 mA (based on a 5 A rating).

For security purposes during external phase fault currents causing CT saturation, this function is disabled any time the value of I_G is less than approximately 0.20 amps.

If this function is enabled, the following settings are applicable:

```
87GDW2#1 PICKUP
   0.2 Amps
```

```
87GDW2#1 DELAY
   6 Cycles
```

```
87GDW2#2 PICKUP
   0.2 Amps
```

```
87GDW2#2 DELAY
   6 Cycles
```

```
87GDW2 C.T. RATIO CORR.
   1.00
```

```
87GDW2 DIR ELEMENT
disable enable
```

```
87GDW2 WINDING SELECT
sum1 sum2 SNGL_win
```

■ **NOTE:** These screens are also applicable for Windings 3 and 4.

■ **NOTE:** For higher values of CT Ratio correction, noise may create substantial differential current making higher settings desirable.

▲**CAUTION:** DO NOT set the Delay to less than 2 cycles. In order to prevent mis-operation during external faults with CT saturation conditions, a time delay of 6 cycles or higher is recommended.

CT (CTRCF) Ratio Correction Factor = $\dfrac{\textit{Phase C.T. Ratio}}{\textit{Ground C.T. Ratio}}$

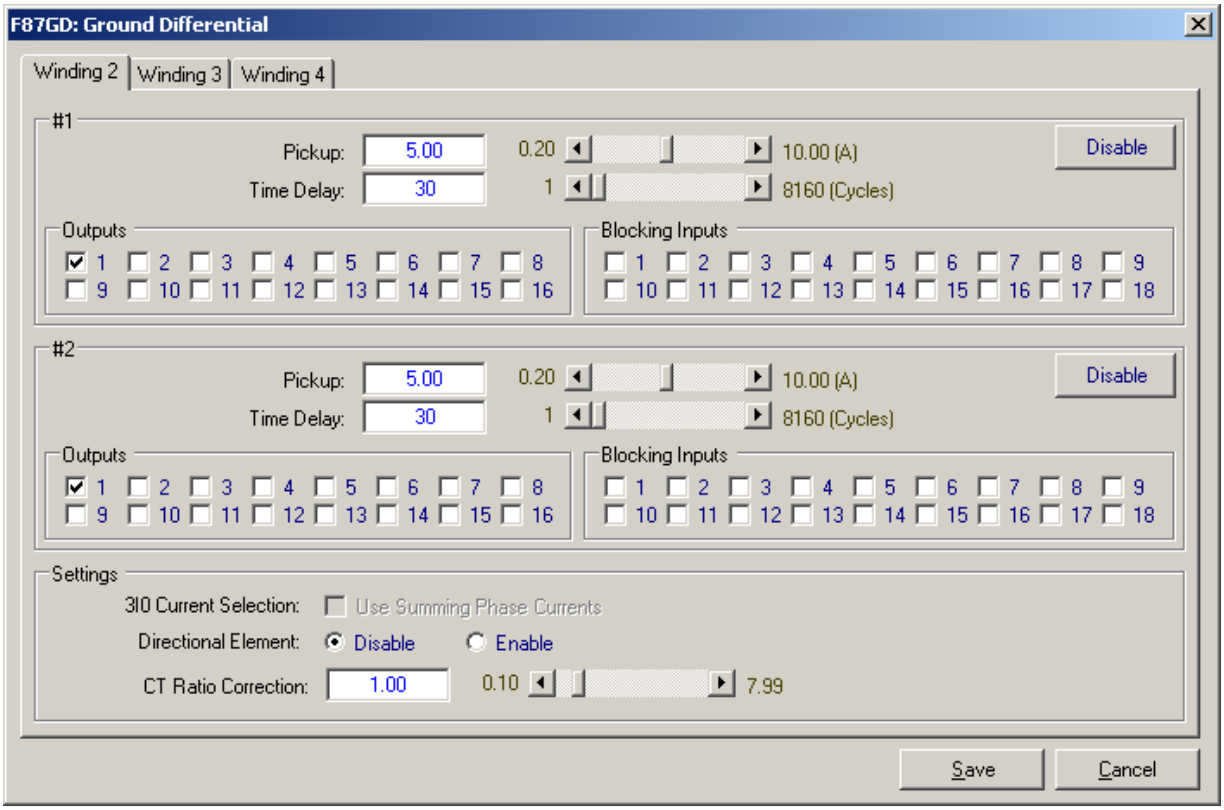


Figure 4-38 M-3826 IPScom® (87GD) Ground Differential Current Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/F87GD Ground Differential current

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

Trip Circuit Monitoring

External connections for the Trip Circuit Monitoring function are shown in Figure 4-39. The default Trip Circuit Monitor input voltage is 250 V dc. See Section 5.5, **Circuit Board Switches and Jumpers**, Table 5-3 for other available trip circuit input voltage selections.

This function should be programmed to block when the breaker is open, as indicated by 52b contact input (IN1). If the TCM is monitoring a lockout relay, a 86 contact input (INx) should be used to block when the lockout relay is tripped.

When the Output Contact is open, and continuity exists in the Trip Circuit, a small current flows that activates the Trip Circuit Monitoring Input. If the Trip Circuit is open, and the output contact is open, no current flows and the Trip Circuit Monitoring Input is deactivated. An Output Contact that is welded closed would also cause the Trip Circuit Monitoring Input to deactivate, indicating failure of the Output Contact.

When the Output Contact is closed, no current flows in the Trip Circuit Monitoring Input. If the M-3311A has issued a trip command to close the Output Contact and Trip Circuit Monitoring Input remains activated, this is an indication that the Output Contact failed to close.

The output of the Trip Circuit Monitoring function can be programmed as an alarm to alert maintenance personnel.

```
TCM DELAY
_____ Cycles
```

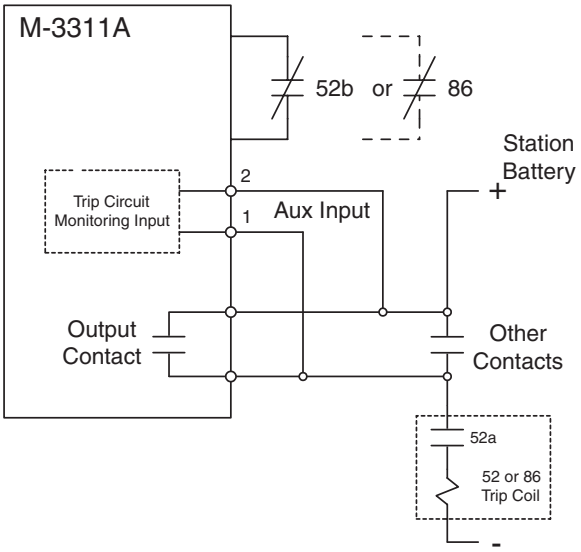


Figure 4-39 Trip Circuit Monitoring Input

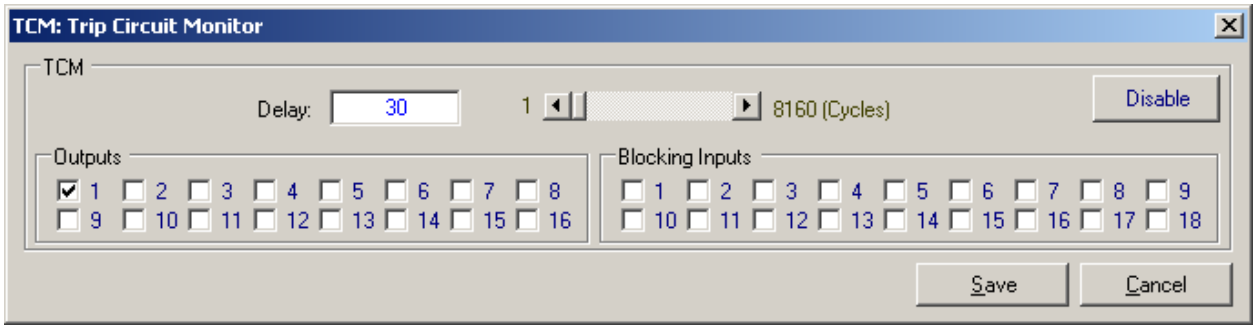


Figure 4-40 Trip Circuit Monitor (TC) Setpoint Ranges

Path: **Path**: Relay/Setup/Relay Setpoints/TCM Trip Circuit Monitor

Breaker Monitoring

The Breaker Monitoring feature calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current or current squared passing through the breaker contacts during the interruption period. The per-phase values are added to an accumulated total for each phase, and then compared to a user-programmed threshold value. When the threshold is exceeded in any phase, the relay can set a programmable output contact. The accumulated value for each phase can be displayed as an actual value. The integration starts after a set time delay from the initiate point to account for the time it takes for the breaker to start opening its contacts. The integration continues until the current drops below 0.1 PU or 10 cycles, whichever occurs first.

If this function is enabled, the following settings are applicable:

`BRKRW1 PICKUP` `1000 kA^2-cycles`	Pickup setting for BM W1.
`BRKRW1 INPUT INITIATE` `i6 i5 i4 i3 i2 i1`	
`BRKRW1 OUTPUT INITIATE` `08 07 06 05 04 03 02 01`	
`BRKRW1 DELAY` `10.0 Cycles`	Time delay until breaker contacts start to open.
`BRKRW1 TIMING METHOD` `it i2t`	Selects integration timing method. (IT or I^2t)

■ **NOTE:** These screens are also applicable for BRKRW2,W3 and W4.

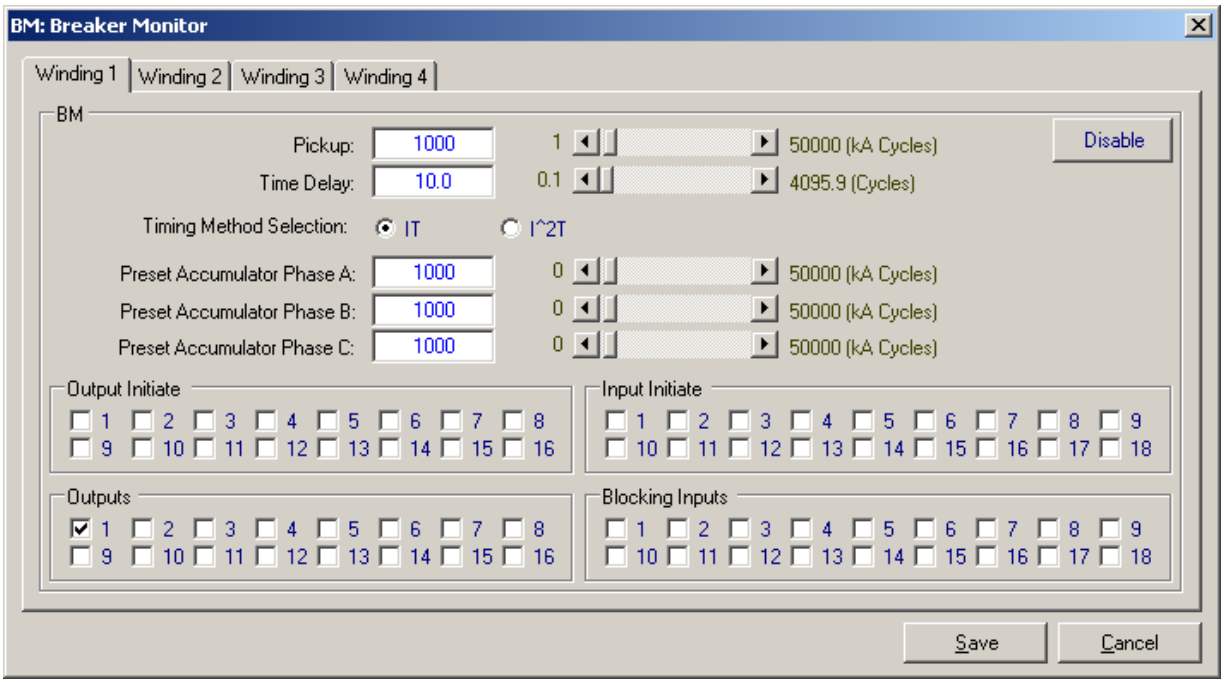


Figure 4-41 M-3826 IPScom® Breaker Monitor Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/BM Breaker Monitor

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

Through Fault

The Through Fault Monitor feature of the relay provides the user with the means to capture time-stamped Through Fault current information. A “through fault” is defined as an overcurrent event where the overcurrent passes through a transformer and supplies a connected circuit that is faulted. Power transformers may be subjected to Through Fault currents, which can cause mechanical stresses and thermal stress to winding insulation.

The Through Fault monitor data can be used to predict transformer failures facilitating corrective action. Recording the number and severity of Through Faults experienced by a transformer can aid in determining predictive maintenance practices.

The Through Fault monitor is triggered when current in any one of the phases exceeds the set value of the Through Fault Current Threshold for greater than the Time Delay setting.

```
THFLT CURRENT THRESHOLD
        Amps
```

The Through Fault Threshold value is chosen to be above the maximum expexted load current and below the minimum expected Through Fault current.

```
THFLT CUM. I^2T LIMIT
      kA^2-cycles
```

The Through Fault Current Limit and I^2t Threshold Limits are set based on the capability of the transformer. The transfomer manufacturer may be consulted for guidance.

```
THFLT PU OPERATIONS LIM.
          Records
```

```
THFLT WINDING SELECT
win1 WIN2 win3 win4
```

```
THFLT DELAY
    1      Cycles
```

The Through Fault Time Delay is typically set at one Cycle

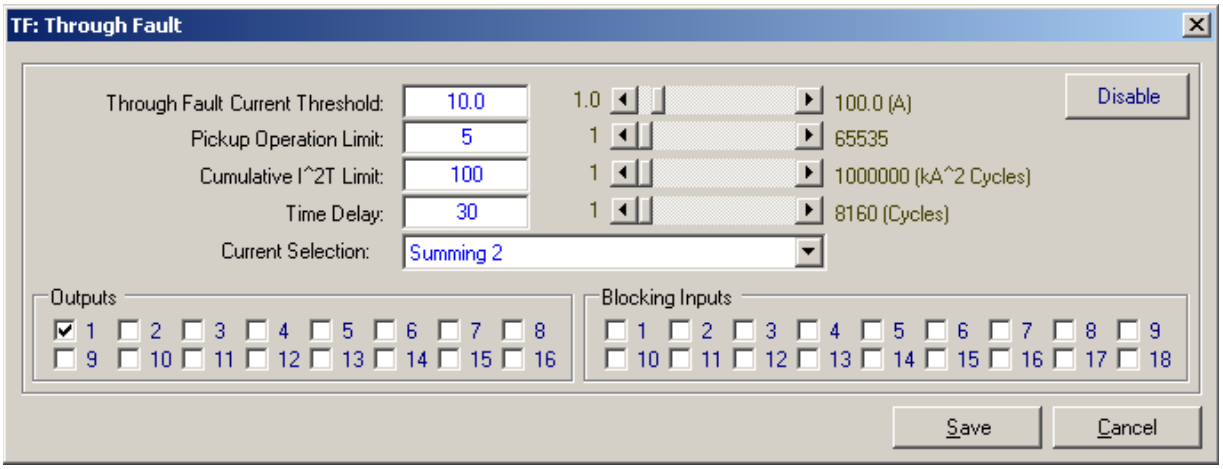


Figure 4-42 M-3826 IPScom Through Fault Function Setpoint Ranges

Path: **Path**: Relay/Setup/Relay Setpoints/Through Fault

IPSlogic

The relay provides six IPSlogic Functions. IPSlogic Functions can be used to allow external devices to trip through the relay, providing additional target information for the external device. More importantly, these functions can be used in conjunction with IPSlogic to expand the capability of the relay by allowing the user to define customized operating logic.

Programming the IPSlogic can only be implemented through IPScom®. IPSlogic cannot be programmed using the Human-Machine Interface (HMI). The six IPSlogic Functions can be activated using the HMI, but with limited logic capability. When activated using the HMI, the settings indicated below are applicable. The initiating input can be any external device connected to IN1*–IN6.

■ **NOTE**: *IN1 is pre-designated as the Breaker contact input.

Settings applicable when this function is enabled using the HMI:

```
IPS#1 INPUT INITIATE
    i6 i5 i4 i3 i2 i1
```

The initiating inputs are user designated for each enabled IPSlogic function. The activation of one or more of the external contacts will start operation of the IPSlogic function timer.

```
IPS#1 OUTPUT INITIATE
08 o7 o6 o5 o4 o3 o2 o1
```

The initiating outputs can also be set to start the IPSlogic functions timer. This aids in setting up special logic schemes as the output contact does not have to be routed back to the input. This also saves inputs as well as speeds up the triggering process as the output contact delay and input de-bounce delay no longer enter the equation.

```
IPS#1 DELAY
    30 Cycles
```

Each enabled IPSlogic function requires a time delay setting. Complete settings for each of the 5 remaining IPSlogic contacts (screens not shown).

■ **NOTE:** These screens are also applicable for IPSlogic Functions #2, 3, 4, 5, and 6.

The following is an example of how to program an IPSlogic function, when programming using the HMI (see Figure 4-43):

- Initiating inputs are IN2 or IN5
- Initiating output is OUT4
- Blocking input is IN3
- IPSlogic function output is OUT6
- Time Delay of 30 cycles

The only logical limitation is that the same status input cannot be designated as both an initiating input and a blocking input. The connection for the external device to the input contacts is illustrated in Chapter 5, Figure 5-5, M-3311A External Connections, and Chapter 6, Table 6-2, Input Contacts.

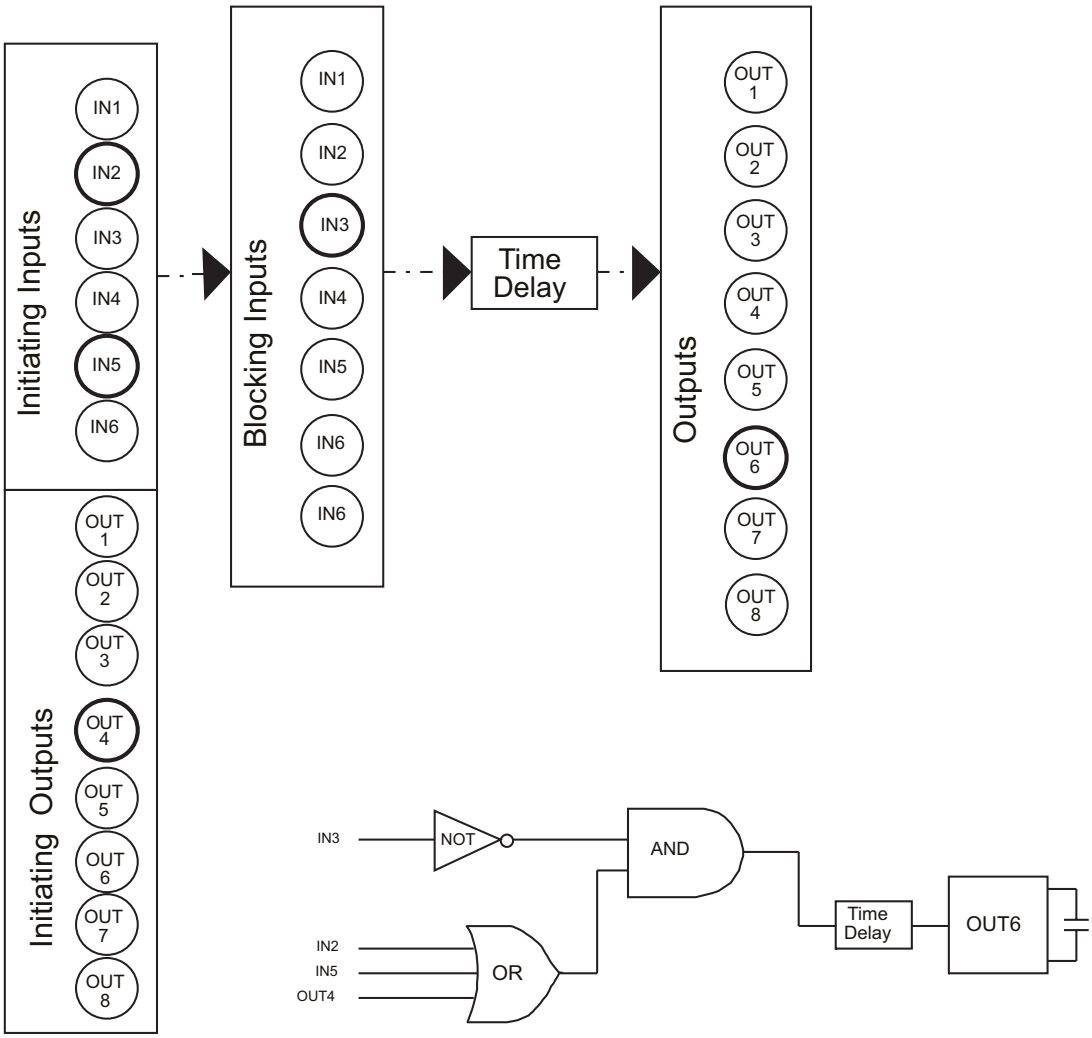


Figure 4-43 IPSlogic Function Setup

Settings and Logic Applicable when IPSlogic Function(s) programmed using IPScom®

There are four initiating input sources: Initiating Outputs, Initiating Function Trips (including the IPSlogic Functions themselves), Initiating Inputs, and initiation using the Communication Port. The only limitation is that an IPSlogic Function may not be used to initiate itself. There are two blocking input sources: Blocking Inputs and blocking using the Communication Port.

The IPScom IPSlogic Function programming screen and Initializing Function Trip Selection screens are shown in Figure 4-44 and 4-45, respectively.

The activation state of the input function selected in the Initiating Function Trip dialog (Figure 4-44) is the Tripped state, not Pickup. If the user requires an initiating input that indicates a Pickup status, this can be achieved. Since most functions have multiple setpoints, the second setpoint can be set with no intentional time delay, and used as the initiating input. The desired time delay for security considerations can be obtained in the IPSlogic Function time delay setting.

The IPSlogic Function can be programmed to perform any or all of the following tasks:

- Change the Active Setting Profile
- Close an Output Contact
- Be activated for use as an input to another External Function

Since there are six IPSlogic Functions per setting profile, depending on the number of different relay settings defined, the scheme may provide up to 24 different logic schemes. The IPSlogic is illustrated in Figure 4-45, and the IPScom® IPSlogic Function programming screen is shown in Figure 4-46.

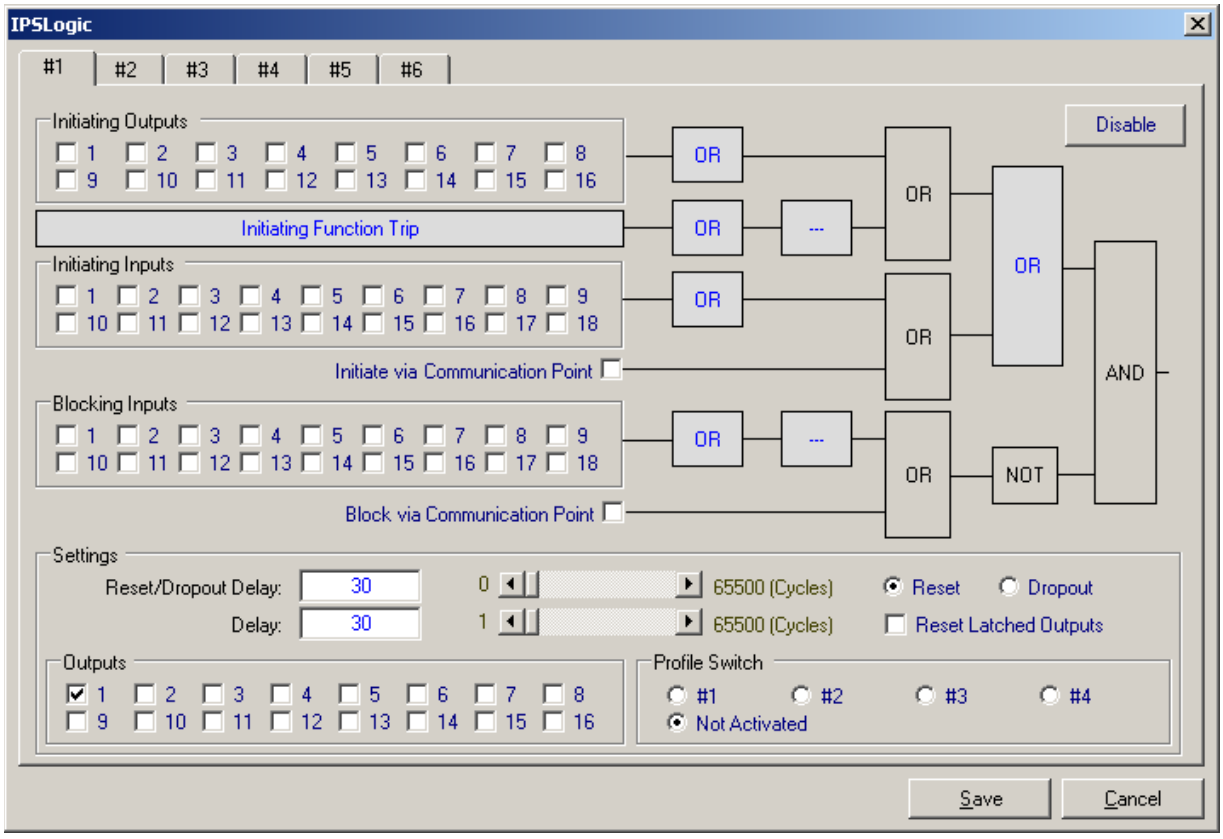


Figure 4-44 M-3826 IPScom®(IPS) IPSlogic Functions Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/IPSLogic

COMMAND BUTTONS

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.

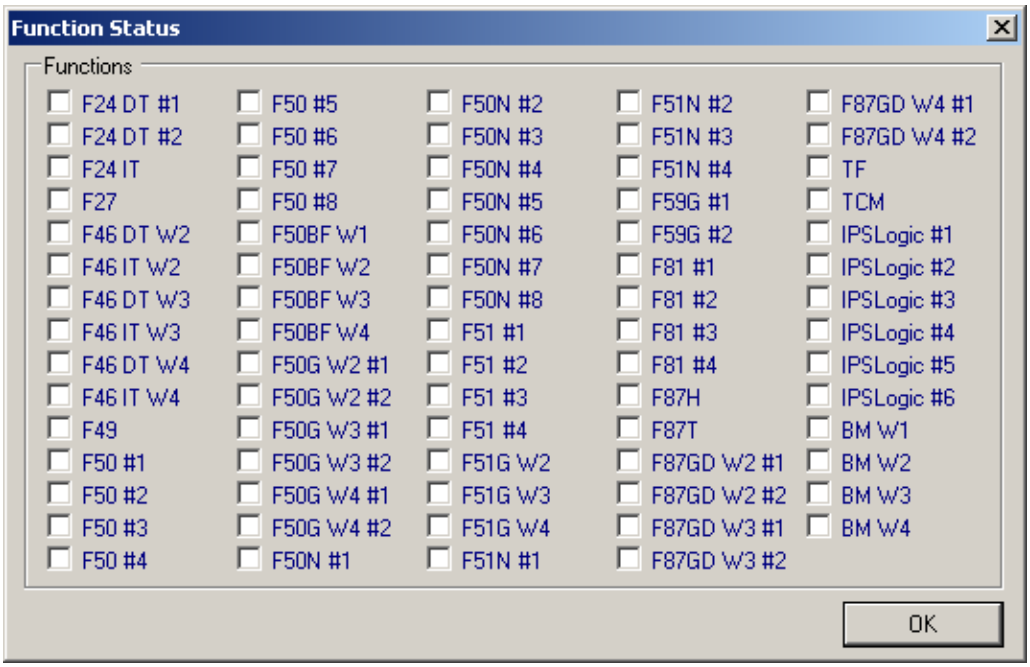


Figure 4-45 Select Initiating Functions Screen

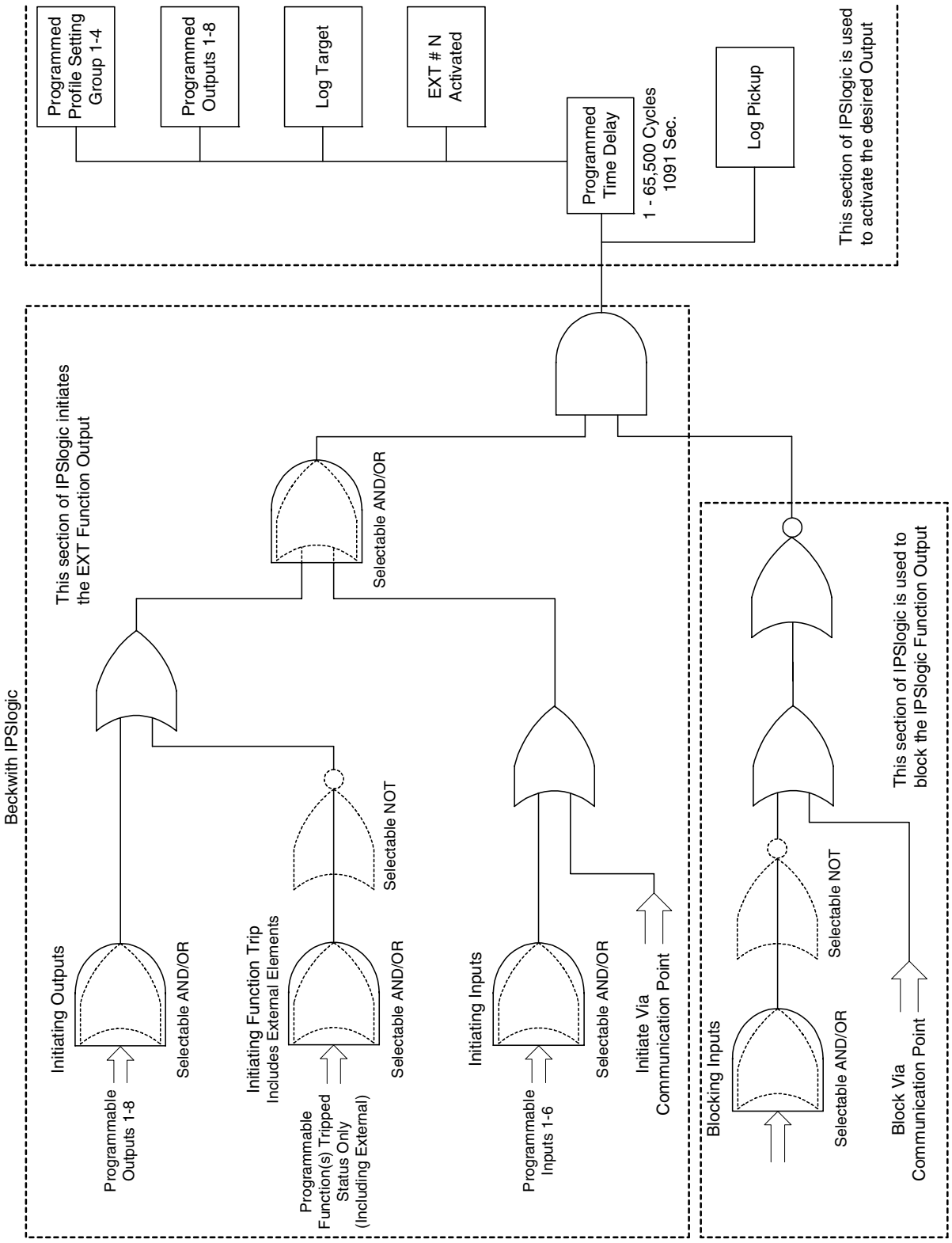


Figure 4-46 IPSlogic® Function Setup

4.5 System Applications and Logic Schemes

Bus Fault Protection

Digital feeder and transformer protection logic can be combined together to provide high-speed bus fault protection. The 50W2 function will act as a delayed overcurrent detector (see Figure 4-47). A fault detected from any feeder relay will activate a programmable input on the relay. This input will block the 50W2 function from operating under normal feeder trip conditions. If a fault occurs on the bus connected to winding 2 and none of the feeder relays have tripped, the 50W2 function will then proceed to trip the breaker after the specified time delay.

Example

Function 50W2 #1 is programmed with the following I/O settings: trip Output #2, time delay setting of 7 cycles for proper coordination, and IN4 is set as a Blocking Input. This application requires no special logic. In this configuration all feeder relay output contacts will be in parallel on IN4.

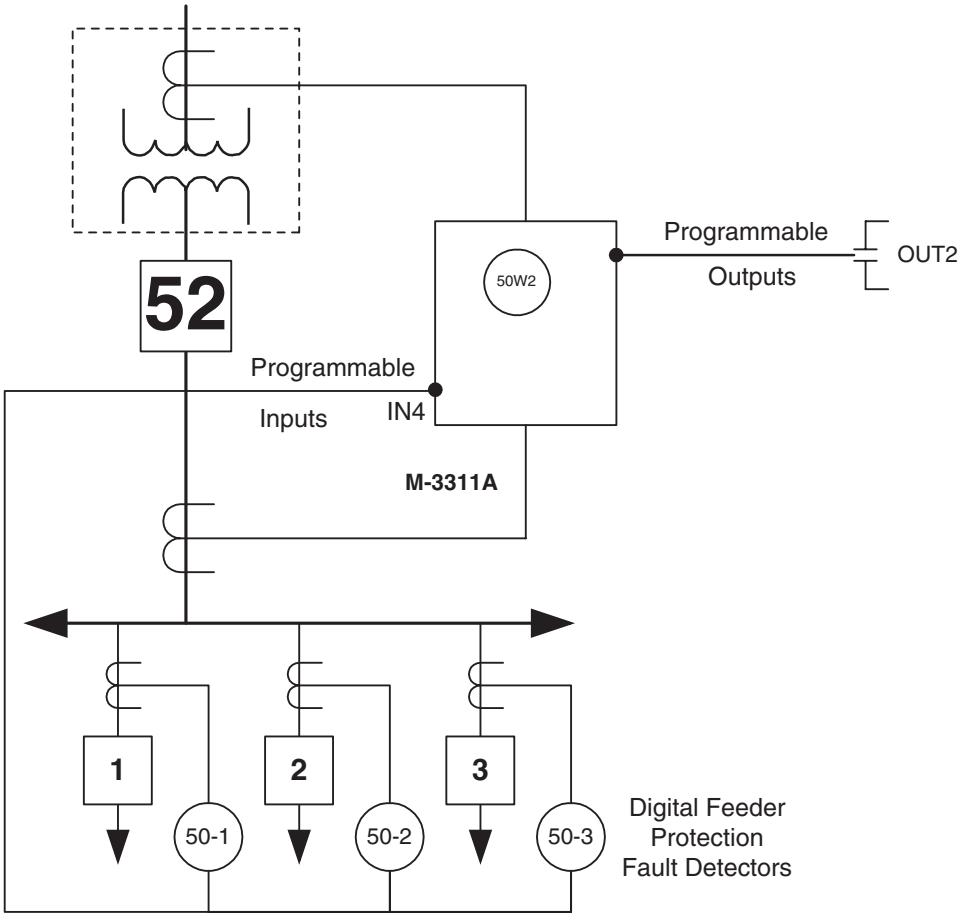


Figure 4-47 Bus Fault Protection Scheme

Backup for Digital feeder Relay Failure

The M-3311A Transformer Protection Relay can provide backup for digital feeder relays (see Figures 4-48 and 4-49). The backup feature is initiated by the closure of a feeder relay's self-test error contact. This scheme assumes that some sort of contact multiplying is done on the self-test outputs. A multiplied, normally open self-test contact can be paralleled with all feeder relays to initiate the backup feature.

Example

In this example, the Negative Sequence Overcurrent (46) Function is used to provide the backup protection. Use of the 46 Function allows for sensitive backup protection independent of the load current. If the 51 Function is used, it must be set to coordinate with the load current and results in less sensitive protection.

This application requires no special logic to implement. The scheme is enabled using the 46 Function basic settings through a user-selected control input, configured such that the 46 Function is blocked by an open contact. The parallel contacts from the feeder self-test are wired to that input (see Figure 4-49). The negative sequence function is set to coordinate with the downstream devices of the feeders on the protected bus.

With no feeder alarms, the paralleled self-test alarm contacts will all be open, and the Negative Sequence Overcurrent function blocked. When a feeder relay fails and its self-test contact closes, the Negative Sequence overcurrent function is enabled (unblocked), and the contact stream establishes a trip path to the failed relay breaker trip circuit. The Negative Sequence relay will then provide backup protection to the failed relay circuit.

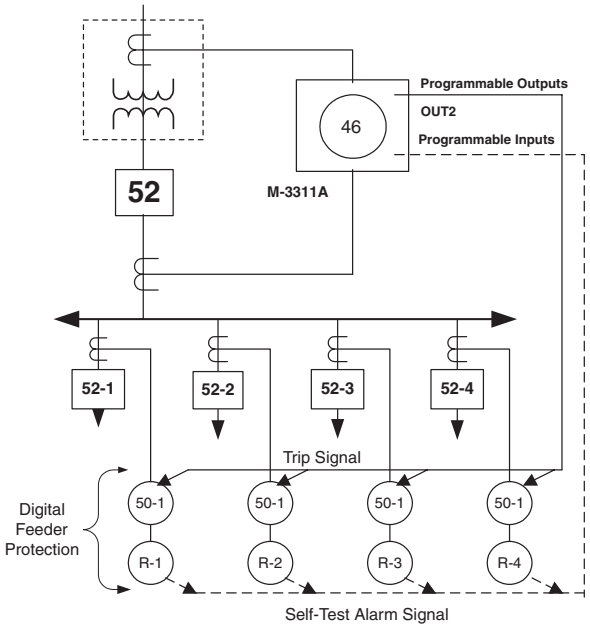


Figure 4-48 Digital Feeder Relay Backup Scheme

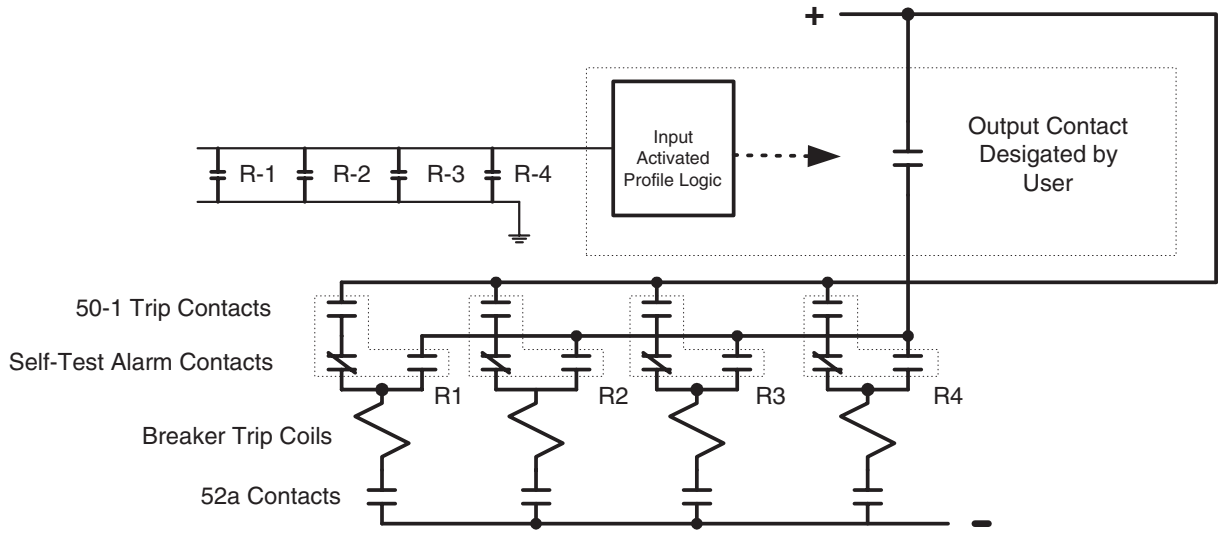


Figure 4-49 Feeder Backup Logic

Load Shedding

Description

In stations where there are two or more transformers (see Figure 4-50), usually there is a normally open tie breaker on the secondary side. If one of the transformers is removed from the system, the tie breaker closes and the remaining transformers will pick up the entire load. To prevent the remaining transformer(s) from overloading, an overcurrent load shedding is used to remove some of the load if it exceeds a predefined level.

The IPSlogic functions can provide a cascading time delay feature that can be used for this load shedding configuration. The 52b contact is wired to a relay input, which is programmed to block the 50W2 Function. The output of the 50W2 Function is programmed to initiate the IPSlogic functions that are associated with the load shedding configuration. Each IPSlogic function output is used to trip a corresponding feeder load or initiate voltage reduction.

Example

The Function 50W2 #1 basic settings provide the first load shedding step. The tie CB 52b contact wired in parallel with the 52a contacts of the low side transformer breakers are programmed as a control input (IN2). They are configured such that the 50W2 #1 Function is blocked by the closed contacts. Closing of the Bus Tie Breaker (opens 52b contact) in conjunction with the opening of one of the low side breakers (opens a 52a contact) enables (unblocks) the 50W2 #1 function.

The 50W2 #1 is programmed to Output #2, providing the first load shedding step. Output #2 is programmed as an “Initiating Output” in the IPSlogic Function providing additional load shedding steps (See Figure 4-51). Each IPSlogic function is programmed with a different time delay setting.

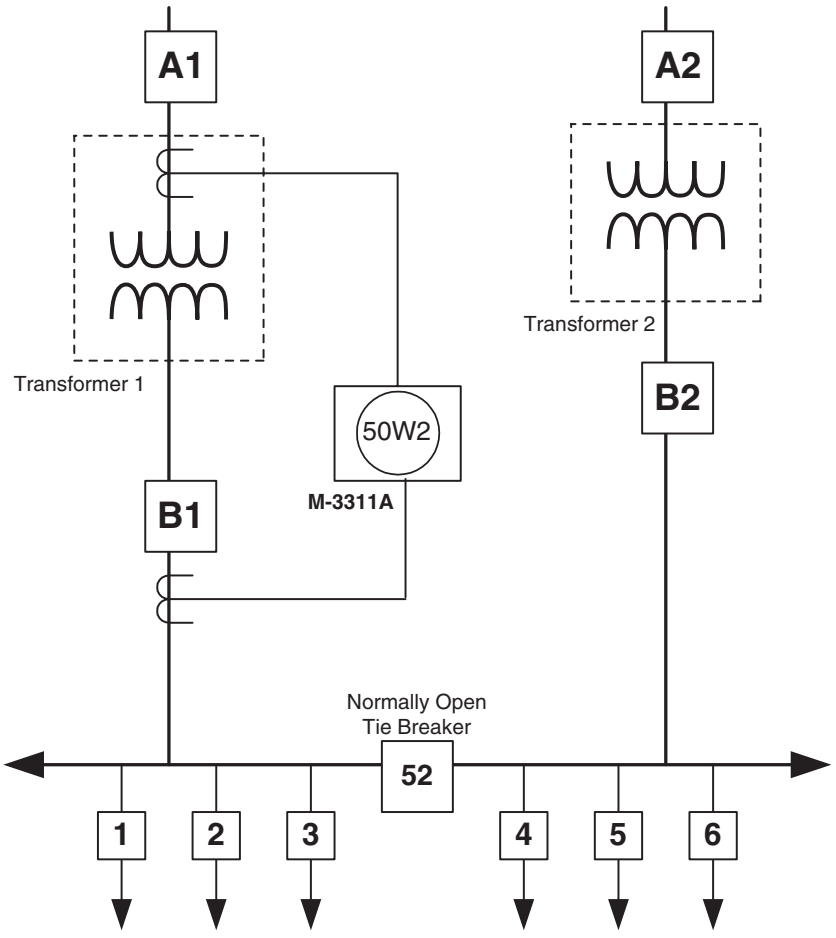


Figure 4-50 Two Bank Load Shedding Scheme

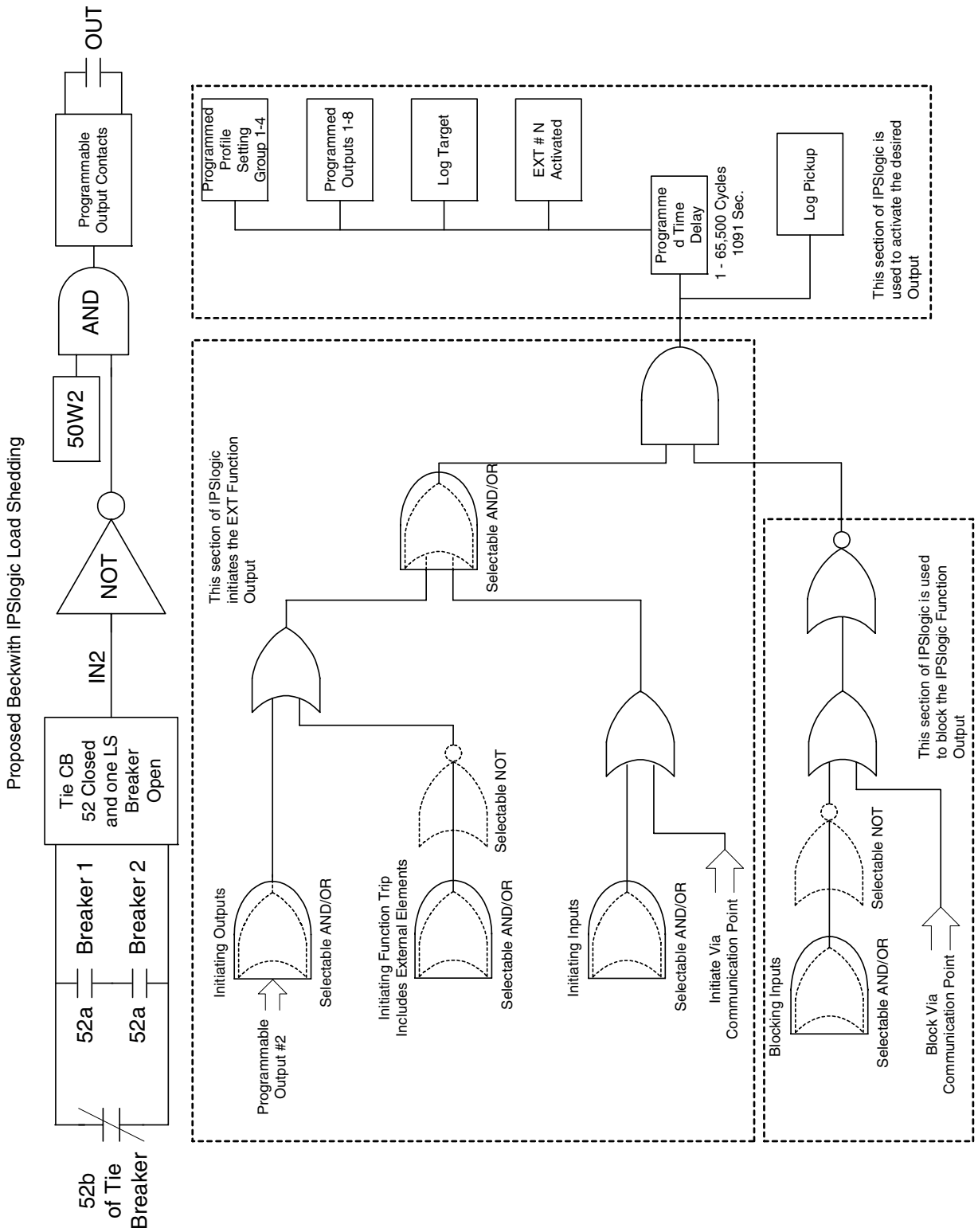


Figure 4-51 Load Shedding Logic

LTC Blocking During Faults

Description

The relay contains logic to block load Tapchangers from operating during feeder fault conditions (see Figure 4-52). Blocking LTC operation during feeder faults can prevent excessive tap changes, reduce contact wear and provide more predictable trip coordination. The blocking contact can be wired to the Auto Disable input (Beckwith M-2270B/M-2001C Tapchanger control, for example) or wired in series with the motor power for the Tapchanger.

Example

Function 50W1 #2 is programmed to trip on OUT7 with a pickup of 2X transformer nameplate rated current. The seal-in delay of OUT7 is programmed to 3000 cycles (50 seconds). The normally closed contact of OUT7 is wired to the Auto Disable input of a Beckwith Electric M-2270B/M-2001C Tapchanger control. This application requires no special logic.

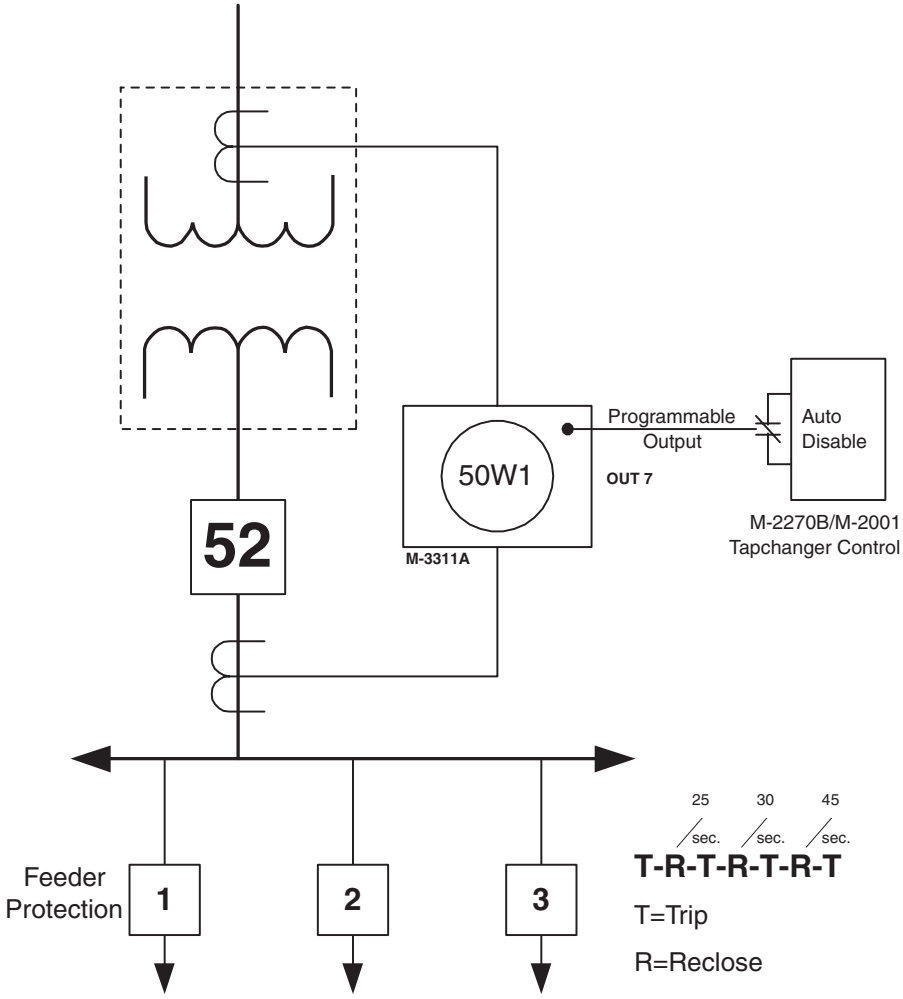


Figure 4-52 LTC Blocking Scheme During Faults

4.6 Transformer Connections

Transformer Winding Selection

The M-3311A can be applied in either a two or three winding transformer differential application. For applications where a two winding differential is required, the user can set the relay system configuration for **Two Winding** and designate the winding current that will be disabled in the 87 Phase Differential Current function.

Only the current input to the 87 function of the disabled winding is not functional. All other functions associated with the disabled winding may be enabled if desired. If the application requires a separate overcurrent function, the user may enable the desired overcurrent functions.

Transformer and CT Configuration

The M-3311A includes Standard and Custom methods of defining the transformer winding and CT configurations. The Standard and Custom Configuration options are made available by selecting either **Disable** or **Enable** for the **Custom Mode for Transformer and CT Connection**.

Standard Transformer and CT Configuration

The standard transformer and CT configuration selections consist of six connections for each transformer winding and CT configuration. The selectable configurations are:

- Wye
- Delta-ab
- Delta-ac
- Inverse Wye
- Inverse Delta-ab
- Inverse Delta-ac

When the user selects from these connection combinations, the relay automatically computes the phase and magnitude compensation required for the differential currents. The general expression for the compensation is given below.

$$\begin{pmatrix} I_A\,CompW_n \\ I_B\,CompW_n \\ I_C\,CompW_n \end{pmatrix} = \text{Connect Type (WN)} \begin{pmatrix} I_AW_n \\ I_BW_n \\ I_CW_n \end{pmatrix}$$

Where:

- I_AW_n, I_BW_n, and I_CW_n are the uncompensated currents entering/exiting winding “n” of the transformer.
- $I_A\,CompW_n$, etc. are the compensated phase currents after being multiplied by the 3x3 matrix ConnectType(N).
- The ConnectType(N) is a discrete number representing the number of 30 degree increments a balanced set of currents with abc phase rotation will be rotated in a counterclockwise rotation.

  Types 0–11 correspond to phase shifts of; 0°, 30°, 60°, …, 330° with a magnitude gain of 1.

  Types 13–23 correspond to phase shifts of; 0°, 30°, 60°, …, 330° with a magnitude gain of 1/S3.

The compensation calculation uses a counter clockwise rotation from zero. Therefore a Delta-ab transformer (defined as 30 degree leading) has a compensation phase angle shift of 330°, (11x30°). The Delta-ac transformer (defined as 30° lagging) has a compensation phase angle shift of 30°, (1x30°). For a system with acb phase rotation, the compensation calculation uses a counterclockwise rotation. For users more familiar with the IEC transformer configuration nomenclature, a comparison between the IEC definitions and the Beckwith connections is provided in Table 4-4. An example of a ConnectType(1) or 30° compensation matrix is illustrated below.

$$\begin{pmatrix} I_A\,CompW_n \\ I_B\,CompW_n \\ I_C\,CompW_n \end{pmatrix} = \begin{pmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ -1 & 0 & 1 \end{pmatrix} \begin{pmatrix} I_AW_n \\ I_BW_n \\ I_CW_n \end{pmatrix}$$

Phase Angle Shift - Standard Connections

All inputs are compensated against a Reference Vector of zero degrees. The six standard connections referenced previously result in 6 compensation types for each transformer winding and 12 compensation types for each CT. The transformer compensation types are; 0, 1, 5, 6, 7, and 11, which correspond to 30 degree phase shift multiples of; 0°, 30°, 150°, 180°, 210°, and 330°, all with a gain of one.

The CT compensation types consist of those compensation types listed above and types 13, 17, 19, and 23. Type 13, 17, 19 and 23 correspond to 30 degree phase shift multiples of; 30°, 150°, 210°, and 330°, but with a magnitude gain of $1/\sqrt{3}$.

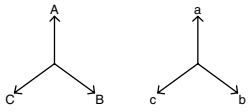
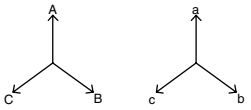
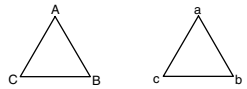
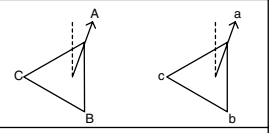
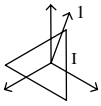
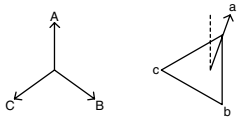
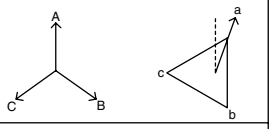
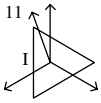
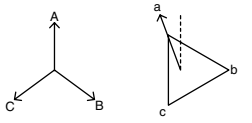
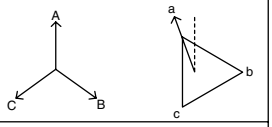
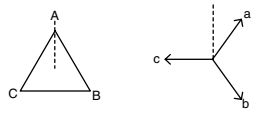
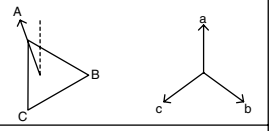
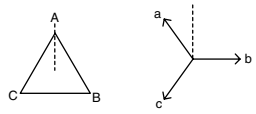
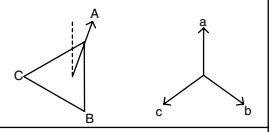
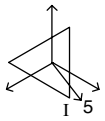
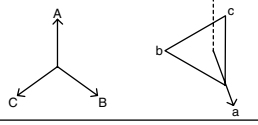
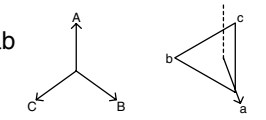
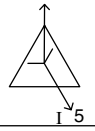
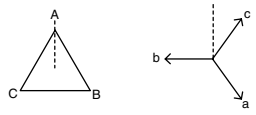
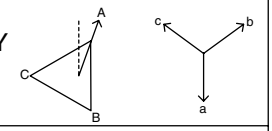
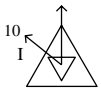
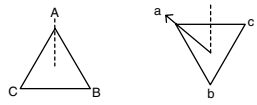
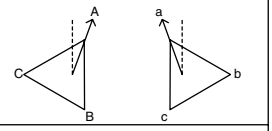
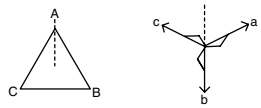
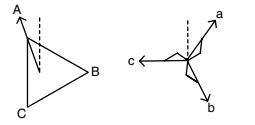
IEC Connection Description	Symbol	Beckwith Standard Connection Description	Symbol	Beckwith Custom Input Value	Symbol
Yy0		YY		Y Y 0 0	
Dd0		Dac Dac		Dac Dac 1 1	
Yd1		Y Dac		Y Dac 0 1	
Yd11		Y Dab		Y Dab 0 11	
Dy1		Dab Y		Dab Y 11 0	
Dy11		Dac Y		Dac Y 1 0	
Yd5		Y Inverse Dab		Y Inverse Dab 0 5	
Dy5		Dac Inverse Y		Dac Inverse Y 1 5	
Dd10		Dac Dab		Dac Dab 1 11	
Dz2		Dab Custom		Dab Wye 11 1	

Table 4-4 Transformer Connections

When the standard connection options are used, the transformer and CT phase angle shifts are combined and the **ConnectType** returns the correct combined phase angle shift. The MagnitudeCT will compensate for the $\sqrt{3}$ associated with delta connected CT's. The shift and magnitude compensation is defined in Table 4-5. Using a reference angle of zero degrees, the Phase A Winding phase angle shift is obtained as follows:

ConnectType (W_n) = ConnectXfm (Type) + ConnectCT (Type)

MagnitudeCT (W_n) = ConnectCT (Type)

Where:

ConnectXfm is the connection of any transformer winding

ConnectCT is the connection of any CT

If the transformer connection is a Delta-ac/Delta-ab/Inverse wye with Wye/Delta-ab/Delta-ac CT's, the resulting phase angle compensation shifts and CT magnitude compensation are:

ConnectType (W1) = ConnectXfm (Delta-ac) + ConnectCT (Wye)

ConnectType (W1) = 1 + 0 = 1 connect type 1 or 30°

ConnectType (W2) = ConnectXfm (Wye) + ConnectCT (Delta-ab)

ConnectType (W2) = 0 + 11 = 11 connect type 11 or 330°

MagnitudeCT(W2) = ConnectCT (Delta-ab)

MagnitudeCT(W2) = 23 = $1/\sqrt{3}$

ConnectType (W3) = ConnectXfm (Inverse Wye) + ConnectCT (Delta-ac)

ConnectType (W3) = 6 + 1 = 7 connect type 7 or 210°

MagnitudeCT(W3) = ConnectCT (Delta-ac)

MagnitudeCT(W3) = 13 = $1/\sqrt{3}$

If any transformer winding is a wye with a wye CT, the ConnectType is returned as 0, (or 0°), the relay automatically eliminates the zero sequence current.

Phase Angle Shift - Custom Connections

For configurations not available in the standard six selections, a Custom Configuration selection is available. The transformer phase compensation is similar to the Standard Configuration selection. However, the transformer phase shift compensation angle does not include the CT compensation phase shift. In the Custom Mode For Transformer and CT Connection, the user must input the actual compensation number as defined in the Custom Configuration Table. The CT phase and magnitude compensation are entered as one input using the selection from Table 4-6. For reference, examples of the transformer phase shift ConnectType numbers are indicated in Table 4-4, under the Custom column.

Transformer & CT Phase Compensation			CT Phase/Magnitude Compensation		
CCW Increment #	Compensation	Beckwith Connection	CCW Increment #	Compensation	Beckwith Connection
0	$1 \angle 0^o$	Wye	13	$1/\sqrt{3}$	Delta-ac
1	$1 \angle 30^o$	Delta-ac	17	$1/\sqrt{3}$	Inverse Delta-ab
5	$1 \angle 150^o$	Inverse Delta-ab	19	$1/\sqrt{3}$	Inverse Delta-ac
6	$1 \angle 180^o$	Inverse Wye	23	$1/\sqrt{3}$	Delta-ab
7	$1 \angle 210^o$	Inverse Delta-ac			
11	$1 \angle 330^o$	Delta-ab			

Table 4-5 Standard Transformer and CT Configuration Options

Transformer Phase Compensation			CT Phase/Magnitude Compensation		
CCW Increment #	Compensation	Beckwith Connection	CCW Increment #	Compensation	Beckwith Connection
0	$1 \angle 0^{o}$	Wye	0	$1 \angle 0^{o}$	Wye
1	$1 \angle 30^{o}$	Delta-ac	1	$1 \angle 30^{o}$	
2	$1 \angle 60^{o}$		2	$1 \angle 60^{o}$	
3	$1 \angle 90^{o}$		3	$1 \angle 90^{o}$	
4	$1 \angle 120^{o}$		4	$1 \angle 120^{o}$	
5	$1 \angle 150^{o}$	Inverse Delta-ab	5	$1 \angle 150^{o}$	
6	$1 \angle 180^{o}$	Inverse Wye	6	$1 \angle 180^{o}$	Inverse Wye
7	$1 \angle 210^{o}$	Inverse Delta-ac	7	$1 \angle 210^{o}$	
8	$1 \angle 240^{o}$		8	$1 \angle 240^{o}$	
9	$1 \angle 270^{o}$		9	$1 \angle 270^{o}$	
10	$1 \angle 300^{o}$		10	$1 \angle 300^{o}$	
11	$1 \angle 330^{o}$	Delta-ab	11	$1 \angle 330^{o}$	
			12	$1/\sqrt{3} \angle 0^{o}$	
			13	$1/\sqrt{3} \angle 30^{o}$	Delta-ac
			14	$1/\sqrt{3} \angle 60^{o}$	
			15	$1/\sqrt{3} \angle 90^{o}$	
			16	$1 \sqrt{3} \angle 120^{o}$	
			17	$1/\sqrt{3} \angle 150^{o}$	Inverse Delta-ab
			18	$1/\sqrt{3} \angle 180^{o}$	
			19	$1/\sqrt{3} \angle 210^{o}$	Inverse Delta-ac
			20	$1/\sqrt{3} \angle 240^{o}$	
			21	$1/\sqrt{3} \angle 270^{o}$	
			22	$1/\sqrt{3} \angle 300^{o}$	
			23	$1/\sqrt{3} \angle 330^{o}$	Delta-ab

Table 4-6 Custom Transformer and CT Configuration

Calculation of Differential & Restraint Currents

The M-3311A uses the following algorithms for calculating the restraint and differential currents.

I restraint: $$I_R = \frac{\Sigma \left| I_{AW1} \right| + \left| I_{AW2} \right| + \left| I_{AW3} \right| + \left| I_{AW4} \right|}{2}$$

I differential: $$I_d = \Sigma \left| \bar{I}_{AW1} + \bar{I}_{AW2} + \bar{I}_{AW3} + \bar{I}_{AW4} \right|$$

The differential current (I_d) under normal load conditions should equal zero. As indicated by the operate equation, the currents must be correctly defined as entering/exiting the relay terminals. When the transformer CT polarity markings are located away from the transformer input terminals, the correct connection of the CT leads to the relay has the CT leads with the polarity mark connected to the relay input terminals with polarity mark. If a transformer CT polarity marking is toward the transformer input terminals, the Inverse CT connection should be chosen, or the CT leads should be reversed at the relay terminals. Illustrations of the proper CT input connections marking are provided in the following examples.

M-3311A Connection Examples

Figure 4-53 illustrates a typical transformer differential application in a power plant. The connections and input settings required for the GSU, (Generator Step Up) and Auxiliary transformers are reviewed in detail.

Auxiliary Transformer Example (Three Windings)

The Auxiliary Transformer is a Delta/Wye/Wye with resistance grounded wye windings, and Wye/Wye/Wye CT's. The IEC definition of the windings is Dy11y11. The Beckwith standard connection is a Delta-ac/Wye/Wye. The correct connection of the CT leads is shown in Figure 4-54. If the transformer CT polarity markings are located away from the transformer input terminals, the correct connection of the CT leads to the relay has the CT leads with the polarity mark connected to the relay input terminals with polarity mark.

If the standard transformer configuration option is selected the configuration input selections are:

Transformer Configuration W1 = Delta-ac

Transformer Configuration W2 = Wye

Transformer Configuration W3 = Wye

CT Configuration W1 = Wye

CT Configuration W2 = Wye

CT Configuration W3 = Wye

If the custom configuration option is selected, the input settings are illustrated in Figure 4-55. The settings are:

Transformer W1 Setting = 1

Transformer W2 Setting = 0

Transformer W3 Setting = 0

CT W1 Setting = 0

CT W2 Setting = 0

CT W3 Setting = 0

GSU Transformer Example

The GSU transformer illustrated in the example is a Wye/Delta/Delta with a resistance grounded wye winding and Delta-ac/Wye/Wye CT's. The IEC definition of the transformer is Yd1d1. The Beckwith standard connection is a Wye/Delta-ac/Delta-ac. The application requires an 87GD (Ground Differential) function for the wye winding. Since only Winding 2 and Winding 3 in the M-3311A have an 87GD the wye winding must be assigned to one of these winding inputs.

In the example illustrated in Figure 4-56, the wye winding was assigned to the M-3311A winding number 3. Any transformer winding may be assigned to any relay input winding as long as the polarity marking criteria discussed previously is followed.

If the standard transformer configuration option is selected the configuration input selections are:

Transformer Configuration W1 = Delta-ac

Transformer Configuration W2 = Delta-ac

Transformer Configuration W3 = Wye

CT Configuration W1 = Wye

CT Configuration W2 = Wye

CT Configuration W3 = Delta-ac

If the custom configuration option is selected, the input settings are illustrated in Figure 4-57. The settings are:

Transformer W1 Setting = 1

Transformer W2 Setting = 1

Transformer W3 Setting = 0

CT W1 Setting = 0

CT W2 Setting = 0

CT W3 Setting = 13

CONNECTION EXAMPLES

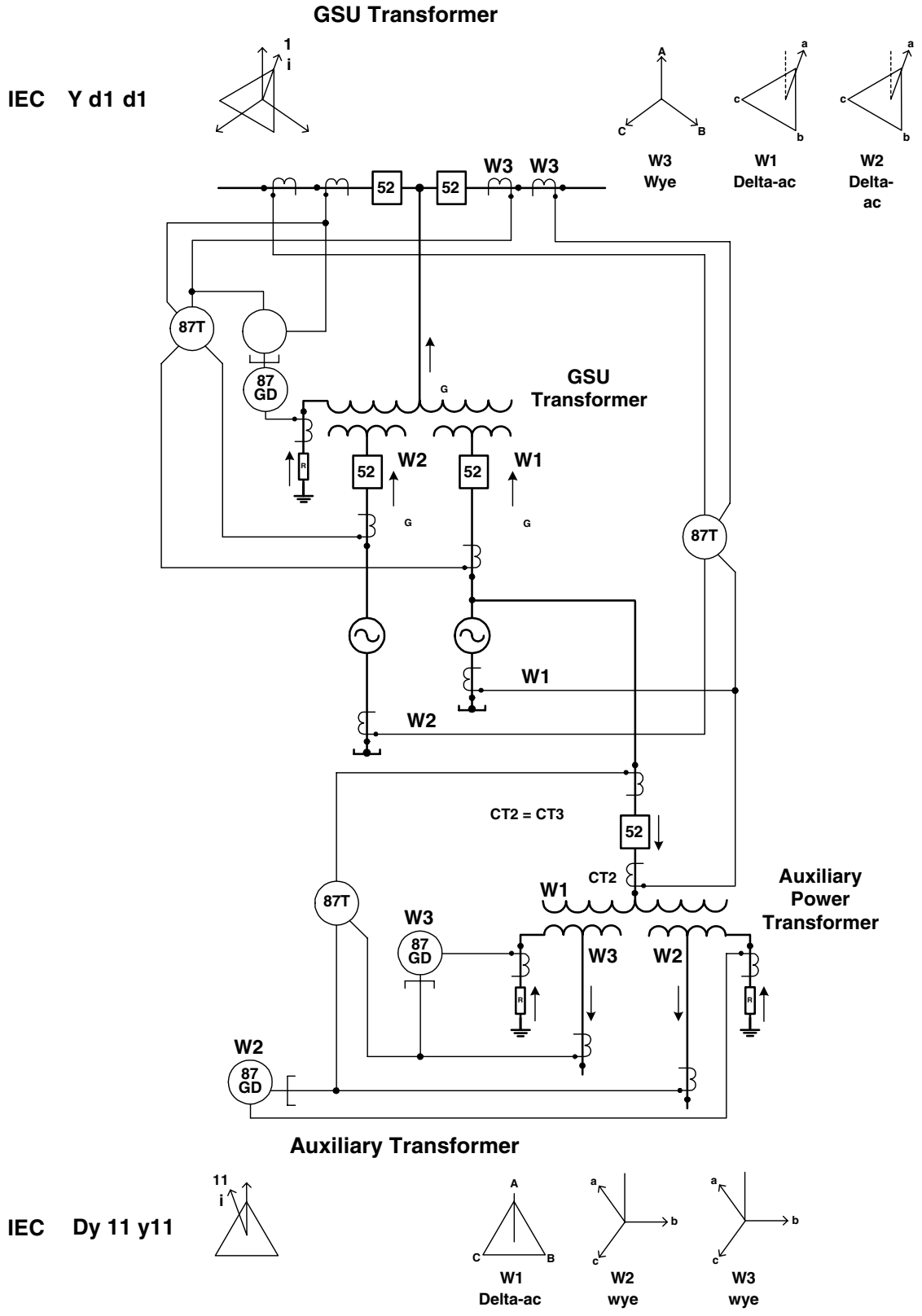


Figure 4-53 Typical Transformer Differential Application

AUXILIARY TRANSFORMER EXAMPLE

Beckwith Delta-ac/Wye/Wye with Wye/Wye/Wye CTs

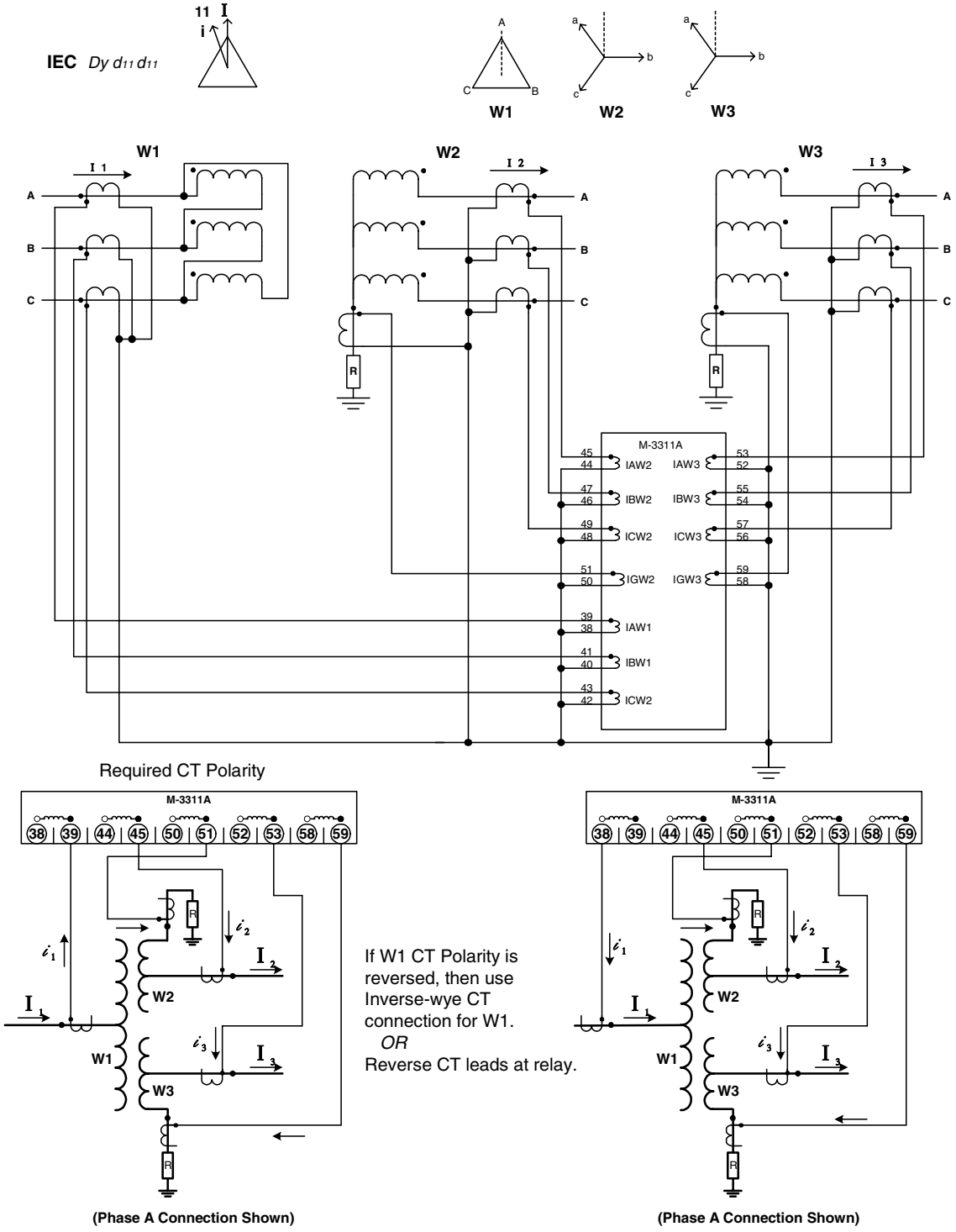


Figure 4-54 Delta-ac/Wye/Wye CT Connection Diagram

AUXILIARY TRANSFORMER EXAMPLE

Winding	#1	#2	#3
Winding Type	Dac	y	y
CT Type	Y	Y	Y
Line Current in Degrees ∠°	30°	0°	0°
Phase Compensation	To ref winding		
CCW Rotation	30°	0°	0°
Relay Phase Setting	1	0	0
CT Compensation			
Phase Degrees	0°	0°	0°
Magnitude	no	no	no
Combined Compensation	1 ∠ 0°	1 ∠ 0°	1 ∠ 0°
Relay CT Setting	0	0	0
Zero Sequence Filter	Enable ☒	Disable ☐	
Zero Sequence Filtering is applicable for grounded wye winding with wye connected CTs. Otherwise, zero sequence currents could appear in this input to relay but in no other, causing possible false trip during an external fault.			

Figure 4-55 Custom Settings for Delta-ac/Wye/Wye

GSU TRANSFORMER EXAMPLE

Beckwith Wye/Delta-ac/Delta-ac with Delta-ac/Wye/Wye CTs

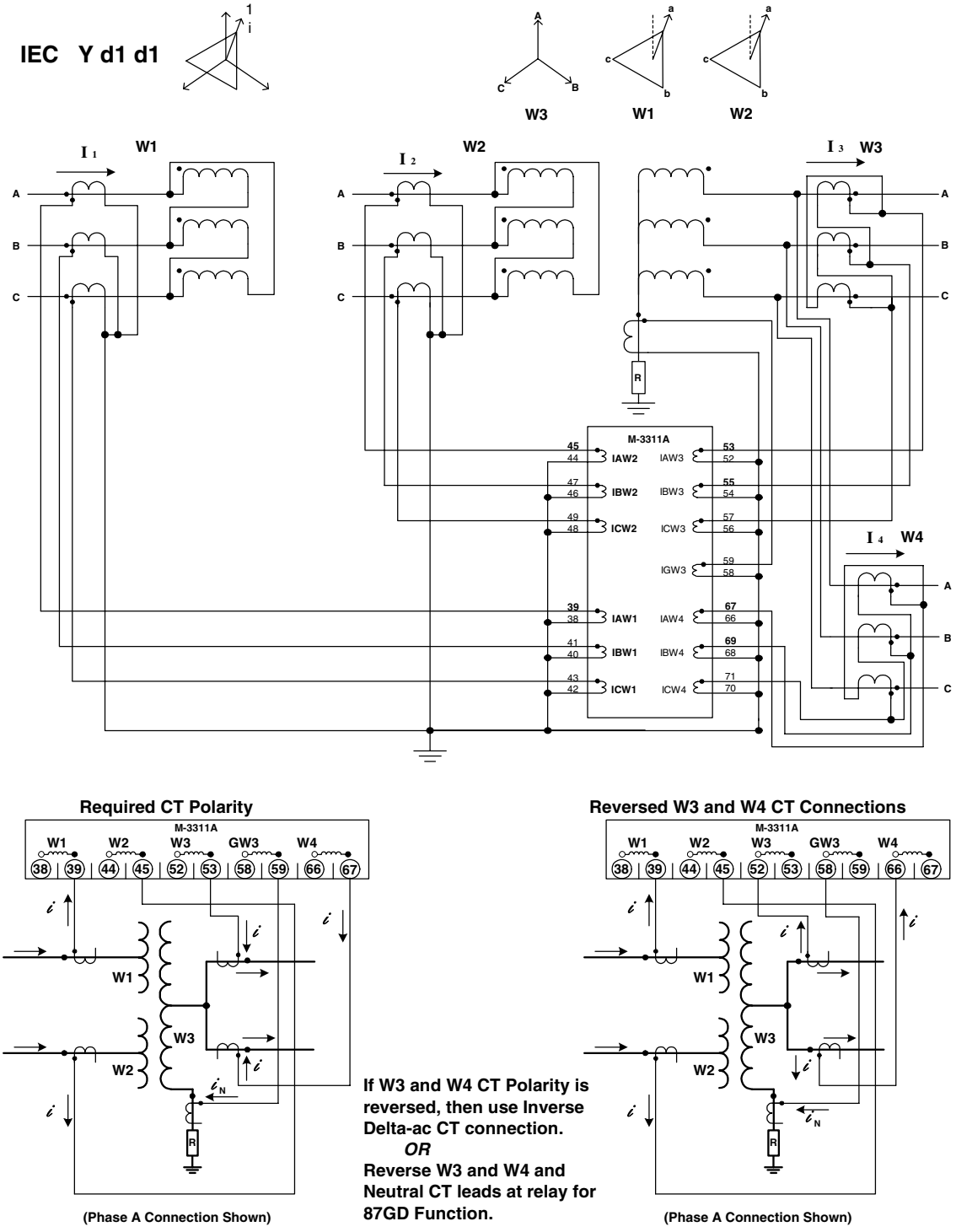
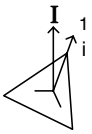


Figure 4-56 Wye/Delta-ac/Delta-ac CT Connection Diagram

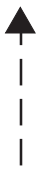
GSU TRANSFORMER EXAMPLE
Breaker and a half application

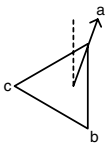
Beckwith: Y/Delta-ac/Delta-ac

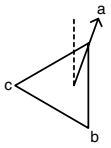


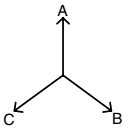
IEC Description: Y d1 d1

REF Winding









Winding	#1	#2	#3	#4
Winding Type	dl	dl	Y0	Y0
CT Type	Y	Y	Dac	Dac
Line Current in Degrees $\angle^{o}$	30^0	0^0	0^0	0^0
Phase Compensation	To ref winding			
CCW Rotation	30^0	30^0	0^0	0^0
Relay Phase Setting	1	1	0	0
CT Compensation				
Phase Degrees	0^0	0^0	30^0	30^0
Magnitude	no	no	$1/\sqrt{3}$	$1/\sqrt{3}$
Combined Compensation	$1\angle 0^0$	$1\angle 0^0$	$1/\sqrt{3}\angle 30^0$	$1/\sqrt{3}\angle 30^0$
Relay CT Setting	0	0	13	13
Zero Sequence Filter	Enable ☐	Disable ☒		
Zero Sequence Filtering is applicable for grounded wye winding with wye connected CTs. Otherwise, zero sequence currents could appear in this input to relay but in no other, causing possible false trip during an external fault.				

Figure 4-57 Custom Settings for Wye/Delta-ac/Delta-ac

Legal Information

Patent

The units described in this manual are covered by U.S. Patents, with other patents pending.

Buyer shall hold harmless and indemnify the Seller, its directors, officers, agents, and employees from any and all costs and expense, damage or loss, resulting from any alleged infringementof United States Letters Patent or rights accruing thereform or trademarks, whether federal, state, or common law, arising from the Seller's compliance with Buyer's designs, specifications, or instructions.

Warranty

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used herein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of five years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to peform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided, however, that Buyers shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to replacement value of the equipment furnished under this contract.

Seller makes no warranties expressed or implied other than those set out above. Seller specifically excludes the implied warranties of merchantibility and fitness for a particular purpose. There are no warranties which extend beyond the description contained herein. In no event shall Seller be liable for consequential, exemplary, or punitive damages of whatever nature.

Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

Indemnification

The Seller shall not be liable for any property damages whatsoever or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary, or consequential damages, including but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence, or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

It is agreed that when the equipment furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site, and all premises used for such operations.

Notice:

Any illustrations and descriptions by Beckwith Electric Co., Inc. are for the sole purpose of identification.

The drawings and/or specifications enclosed herein are the proprietary property of Beckwith Electric Co., Inc., and are issued in strict confidence; therefore, shall not be used as a basis of reproduction of the apparatus described therein without written permission of Beckwith Electric Co., Inc.

No illustration or description contained herein shall be construed as an express warranty of affirmation, promise, description, or sample, and any and all such express warranties are specifically excluded nor shall such illustration or description imply a warranty that the product is merchantable or fit for a particular purpose. There shall be no warranties which extend beyond those contained in the Beckwith Electric Co., Inc. terms of sale.

BECKWITH ELECTRIC CO., INC.
6190 - 118th Avenue North • Largo, Florida 33773-3724 U.S.A.
PHONE (727) 544-2326 • FAX (727) 546-0121
E-MAIL marketing@beckwithelectric.com
WEB PAGE www.beckwithelectric.com

800-3311A-IB-00MC2 03/08