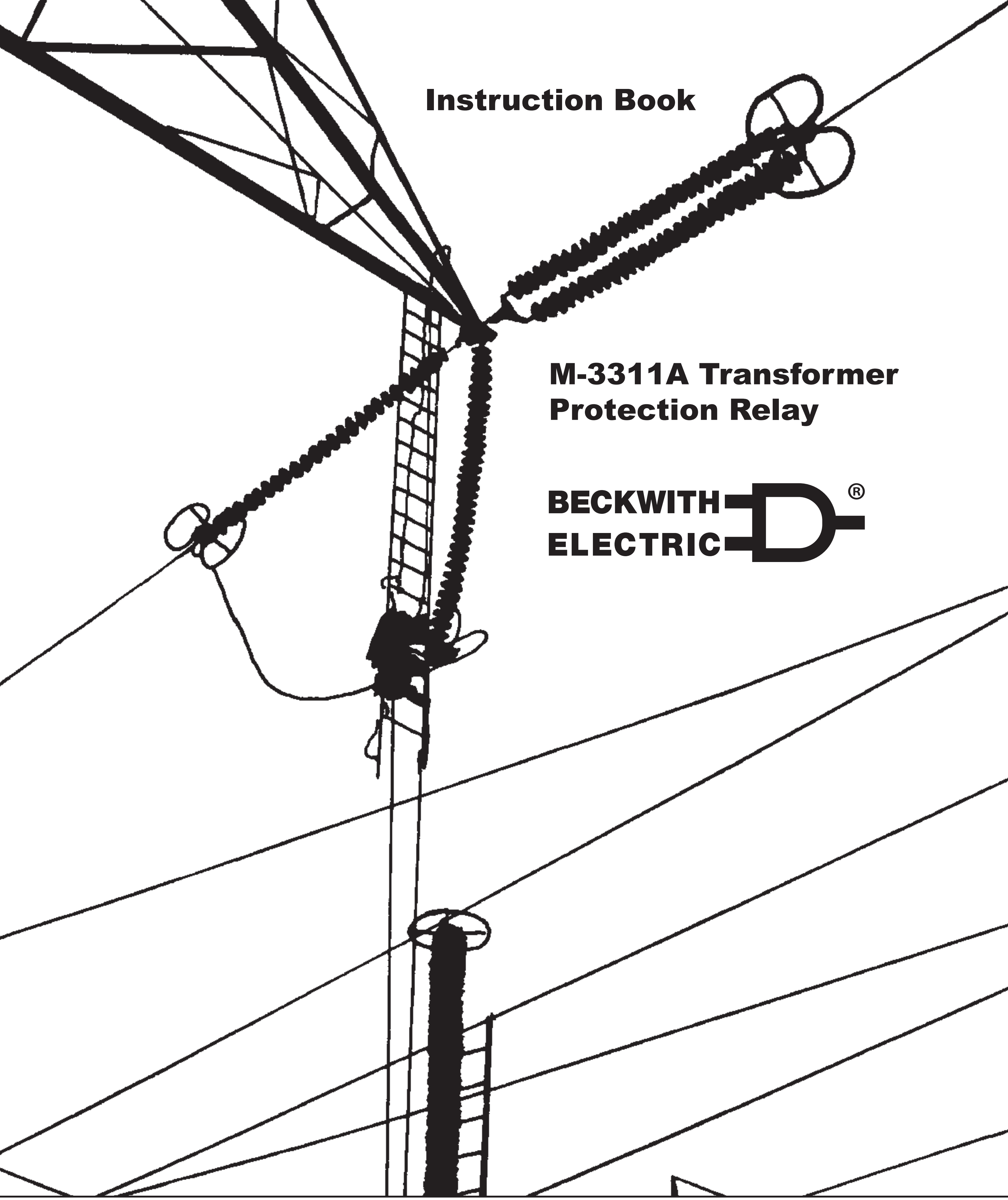


Instruction Book

M-3311A Transformer Protection Relay

BECKWITH ELECTRIC®

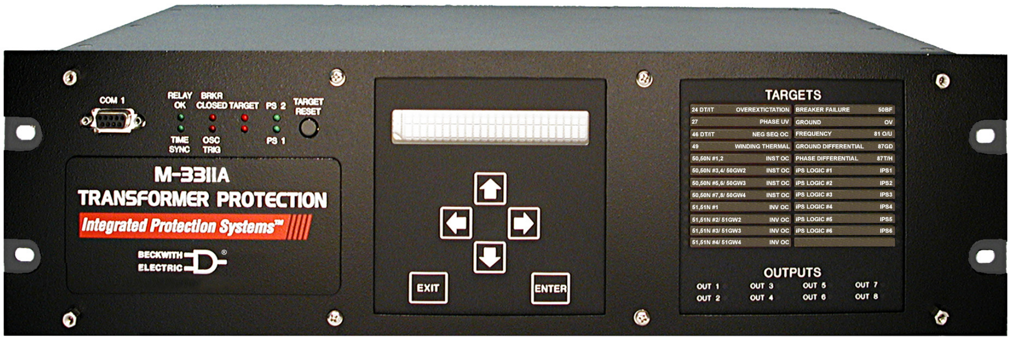
A proud member of the Hubbell family.

TRADEMARKS

BECKWITH ELECTRIC®

Transformer Protection M-3311A

Integrated Protection System®



- **For Transformers of All Sizes:**
  - **Two-, Three- or Four-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**
- **Available voltage configurations include zero, two or four voltage inputs**
- **Ground Differential configurations include one, two or three current inputs**
- **Optional Ethernet Connection and Expanded I/O**
- **Optional Voltage Package includes, 24 Volts/Hz Overexcitation, 27 Phase Undervoltage, 59G Ground Overvoltage and 81O/U Over/Under Frequency**

HUBBELL®

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 Voltage Protection Package

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

Standard Features

- Target Module
- Human-Machine Interface (HMI) Module
- Eight programmable outputs and six programmable inputs
- Oscillographic recording
- Through-Fault Monitoring
- 8-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
- S-3300 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 multiple sources for 49, 50, 51, 50N, 51N, 87 GD and Through Fault functions

Optional Features

- Redundant Power Supply
- Ethernet Port RJ-45 10/100 Base-T (MODBUS over TCP/IP)
- Ethernet Port RJ-45 10/100 Base-T (DNP over TCP/IP)
- Serial Port TIA-232 with RJ-45 Connector (DNP)
- Serial Port TIA-485 with RJ-45 Connector (DNP)
- Ethernet Port RJ-45 10/100 Base-T (IEC 61850 Protocol)
- M-3801D IPSplot® Plus Oscillograph Analysis Software
- Expanded I/O (8 additional outputs and 12 additional inputs)
- Standard and Expanded I/O Models available in vertical panel mount
- Close Circuit Monitoring on Expanded I/O units

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/IEEE		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±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 (0.2 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±3%)
	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	0.01 A	±0.1 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			
50N	**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		
	Inverse Time Phase Overcurrent			
51	**1-4**			
	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 Delay	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±3%

Two or three of the windings may be summed together.

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Inverse Time Ground Overcurrent			
51G	**51GW2/51GW3/51GW4**			
	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 Delay	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±3%
	Inverse Time Residual Overcurrent			
51N	**1-4**			
	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 Delay	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±3%
	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†
	Instantaneous Residual Overcurrent			
87	**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			
	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.

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Ground Differential			
87 GD	**87GDW2/87GDW3/87GDW4**			
	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**, W3**, W4**		
	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.

***Individual windings are selectable only for the same winding ground differential element. For example, you may select W4 for 87GDW4 but not for 87GDW2 or 87GDW3.*

†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†
	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/Dropout 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 (Aux Input) Circuit Monitor			
TCM	**Trip Circuit Monitor**			
	TCM Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	TCM Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

TCM via the "Aux Input" is the only available Trip Circuit monitor on non-expanded I/O units.

The TCM input is provided for monitoring the continuity of trip circuits. The input can be used for nominal trip coil voltages of 24 Vdc – 250 Vdc. Trip circuit monitoring is performed in the active breaker status only (trip circuit supervision when breaker is closed). Both the DC supply and continuity for the circuit is monitored.

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 kA Cycles 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	

The Breaker Monitor feature calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current (or current squared) through the breaker contacts as an arc.

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.

The Breaker Monitoring feature requires an initiating contact to begin accumulation, and the accumulation begins after the set time delay.

†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†
	Through Fault			
TF	Through Fault Current Threshold	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±5% (±0.02 A 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	1 Cycle	±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 VOLTAGE PROTECTION PACKAGE

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

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Phase Undervoltage			
27	Pickup #1, #2*, #3*	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.
* Elements #2 and #3 are not available in four-winding applications.

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Phase Overvoltage			
59	**1-3**			
	Pickup	5 to 180 V	1 V	±0.5 V or ±0.5%
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Input Voltage Selection	Phase, Positive Sequence, Negative Sequence		
	Ground Overvoltage			
59G	Pickup #1, #2, #3*	5 to 180 V	1 V	±0.5 V or ±0.5%
	Time Delay #1, #2, #3*	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Zero Sequence Voltage**	V_G or $3V_0$ (Only for Two- / Three-Windings, 4 Voltage Inputs)		

This function is available when the V_G voltage input is connected to broken delta VTs or for 4V, Two- / Three-W M-3311A relays with the phase voltage inputs wired to (3) Yg/Vg VTs with VT config = LG, which allows 59G to use a calculated $3V_0$ quantity.

** Element #3 is not available in four-winding applications.*

*** This selection is only available in two- / three-winding, 4 voltage M-3311A relays with firmware version V02.03.01 and later.*

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

OPTIONAL VOLTAGE PROTECTION PACKAGE (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	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 Vac.*
This function is applicable only when phase voltage of at least 27 Vac input is applied.

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Trip and Close Circuit Monitor (Expanded I/O Units)			
TCM	**Trip Circuit Monitor**			
	TCM-1 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	TCM-1 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	TCM-2 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	TCM-2 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM	**Close Circuit Monitor**			
	CCM-1 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	CCM-1 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	CCM-2 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	CCM-2 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

The CCM/TCM inputs are provided for monitoring the continuity of trip and close circuits. The input(s) can be used for nominal trip/close coil voltages of 24 Vdc – 250 Vdc. Trip and closing circuit monitoring are performed in the active breaker status only (trip circuit supervision when breaker is closed and close circuit supervision when breaker is open). Both the DC supply and continuity for each of the circuits are monitored.

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

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 Voltage Protection Package to expand the system to satisfy specific application needs.

<table>
<tr><th colspan="3">M-3311A Configuration Options</th></tr>
<tr><th>Windings</th><th>Ground Inputs</th><th>Voltage Inputs</th></tr>
<tr><td rowspan="3">Two</td><td rowspan="3">One</td><td>Zero</td></tr>
<tr><td>Two</td></tr>
<tr><td>Four</td></tr>
<tr><td rowspan="3">Three</td><td rowspan="3">Two</td><td>Zero</td></tr>
<tr><td>Two</td></tr>
<tr><td>Four</td></tr>
<tr><td rowspan="2">Four</td><td rowspan="2">Three</td><td>Zero</td></tr>
<tr><td>Two</td></tr>
</table>

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 Vac)
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)
Power:	±0.01 PU or ±2% of VA applied, whichever is greater
Frequency:	±0.1 Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)
Volts/Hz:	±1%

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.

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

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 S-3300 IPScom Communications Software. The sequence of events log is stored in RAM and will be erased if power to the relay is removed.

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

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).

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

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. The sequence of events log is stored in RAM and will be erased if power to the relay is removed.

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 Vac, 50/60 Hz, or nominal 110/125/220/250 Vdc. UL rating, 85 Vac to 265 Vac and from 80 Vdc to 288 Vdc. Burden 20 VA at 120 Vac/125 Vdc. Withstands 300 Vac or 300 Vdc for 1 second.

Nominal 24/48 Vdc, operating range from 18 Vdc to 56 Vdc. Burden 20 VA at 24 Vdc and 20 VA at 48 Vdc. Withstands 65 Vdc for 1 second.

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

Up to Four Voltage Inputs: Rated nominal voltage of 60 Vac to 140 Vac, 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.

Up to 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 Vdc 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 minimum current value to initiate/pickup an input is $\geq$25 mA.

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 IEEE C37.90/UL (See Tests and Standards section for details).

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 output 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 S-3300 IPScom® Communications Software.

- 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, 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
- Downloading Sequence of Events
- MODBUS and DNP3.0 protocols are supported
- The optional Ethernet port can be purchased with MODBUS over TCP/IP, BECO2200 over TCP/IP, DNP 3.0 protocol or with the IEC 61850 protocol

Optional Ethernet Port

The RJ-45 Ethernet port supports 10/100 Base-T fast Ethernet standard with auto negotiable speed. Additionally, MDI-X capability is provided to eliminate the need of a crossover cable when two similar devices are connected.

The optional RJ-45 Ethernet port may be purchased with the following communication protocols:

- MODBUS/BECO2200 over TCP/IP
- DNP over TCP/IP
- IEC 61850: up to 4 concurrent sessions, to monitor all metering values, change settings and generate unsolicited reports. Refer to M-3311A Instruction Book, Section 4.1 Unit Setup for detailed information.

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

IRIG-B

The M-3311A accepts either modulated (B-122) using the BNC Port or demodulated (B-002) using the RS-232 Port 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

Local access to the M-3311A is provided through the 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 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

Target Module

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

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.

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 Microsoft® Windows® PC compatible computer.

Tests and Standards

The relay complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

IEC 60255-27	2,000 Vac/3,500 Vdc for 1 minute applied to each independent circuit to earth 2,000 Vac/3,500 Vdc for 1 minute applied between each independent circuit 1,500 Vdc for 1 minute applied to IRIG-B circuit to earth 1,500 Vdc for 1 minute applied between IRIG-B to each independent circuit 1,500 Vdc for 1 minute applied between RS-485 to each independent circuit

Impulse Voltage

IEC 60255-27	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 60255-27	> 10 G Ω

Voltage Interruptions Immunity

IEC 61000-4-11	(AC) 5 cycles, (DC) 30 ms - max

Electrical Environment

Electrostatic Discharge Test

IEC 61000-4-2	Level 4 (8 kV)–point contact discharge
IEC 61000-4-2	Level 4 (15 kV)–air discharge

Fast Transient Disturbance Test

IEC 61000-4-4	Level 4 (4 kV, 5 kHz) Ethernet Port (2 kV, 2.5 kHz)

Emissions

EN 55022	Class A Limits	
	Conducted Emissions	150 kHz–30 MHz CISPR22
	Radiated Emissions	30 MHz–1000 MHz CISPR22

Surge Withstand Capability

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
IEEE C37.90.1-2012	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:** Digital data circuits (RS-232, RS-485, IRIG-B, Ethernet communication port and field ground coupling port) through capacitive coupling clamp.

IEC 61000-4-5	±4,000 V pk, 12 Ω / 40 Ω

Radiated Susceptibility

IEEE C37.90.2	80-1000 MHz @ 35 V/m
IEC 61000-4-3	1000-6000 MHz @ 10 V/m

Output Contacts

IEEE C37.90	30 A make for 0.2 seconds at 250 Vdc Resistive
cULus 508	8 A carry at 120 Vac, 50/60 Hz
	6 A break at 120 Vac, 50/60 Hz
	0.5 A break at 48 Vdc, 24 VA
	0.3 A break at 125 Vdc, 37.5 VA
	0.2 A break at 250 Vdc, 50 VA

Atmospheric Environment

Temperature

IEC 60068-2-1	Cold, -20° C (-4° F) – Operating
IEC 60068-2-30	Damp Heat Condensation Cycle +25° C, +55° C @ 95%$_{RH}$ – Operating
IEC 60068-2-2	Dry Heat, +70° C (+158° F) – Operating
IEC 60068-2-78	Damp Heat, +40° C @ 95%$_{RH}$ – Operating

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, 10.0 g

Compliance

cULus-Listed per 508	– NRGU.E128716 Industrial Control Equipment
	– NRGU7.E128716 Industrial Control Equipment Certified for Canada CAN/USA C22.2 No. 14-M91
cULus-Listed per 508A	– Table SA1.1 Industrial Control Panels
Product Safety	– IEC 60255-27, CAT III, Pollution Degree 2
CE (EMC)	– IEC 60255-26

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.

Environmental: For flat surface mounting on a Type 1 enclosure, rated to 70°C surrounding air ambient.

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.

Environmental: For flat surface mounting on a Type 1 enclosure, rated to 70°C surrounding air ambient.

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.

Disposal and Recycling

Disposal of E-Waste for Beckwith Electric Products

The customer shall be responsible for and bear the cost of ensuring all governmental regulations within their jurisdiction are followed when disposing or recycling electronic equipment removed from a fixed installation.

Equipment may also be shipped back to Beckwith Electric for recycling or disposal. The customer is responsible for the shipping cost, and Beckwith Electric shall cover the recycling cost. Contact Beckwith Electric for an RMA # to return equipment for recycling.

Patent & Warranty

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

Trademarks

All brand or product names referenced in this document may be trademarks or registered trademarks of their respective holders.

Specification subject to change without notice. Beckwith Electric has approved only the English version of this document.

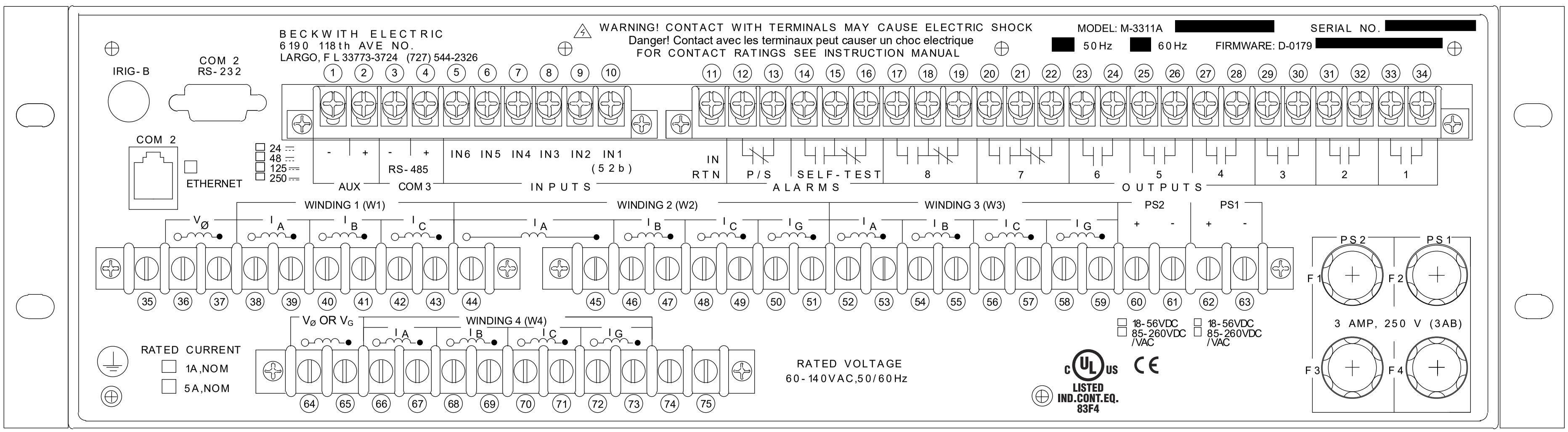


Figure 1 Typical External Connections (See Instruction Book Chapter 5, for Details)

■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 listing requirements, terminal block connections must be made with #22–12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector. Wire insulation must be rated at 75°C minimum. Terminal block connections 1 through 34 must be tightened to 12 in-lbs torque. Terminal block connections 35 through 75 must be tightened to 8.0 in-lbs, minimum, 9.0 in-lbs, maximum torque. **Over torquing may result in terminal damage**.

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.

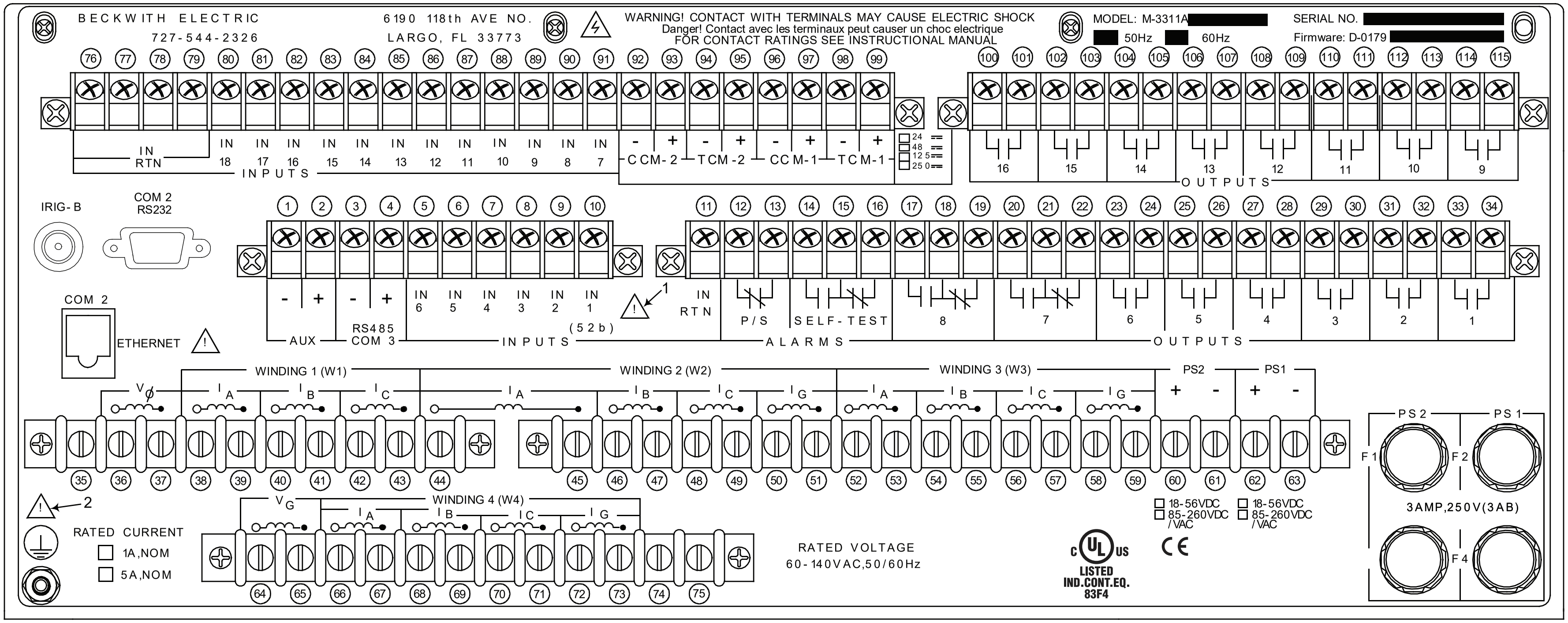
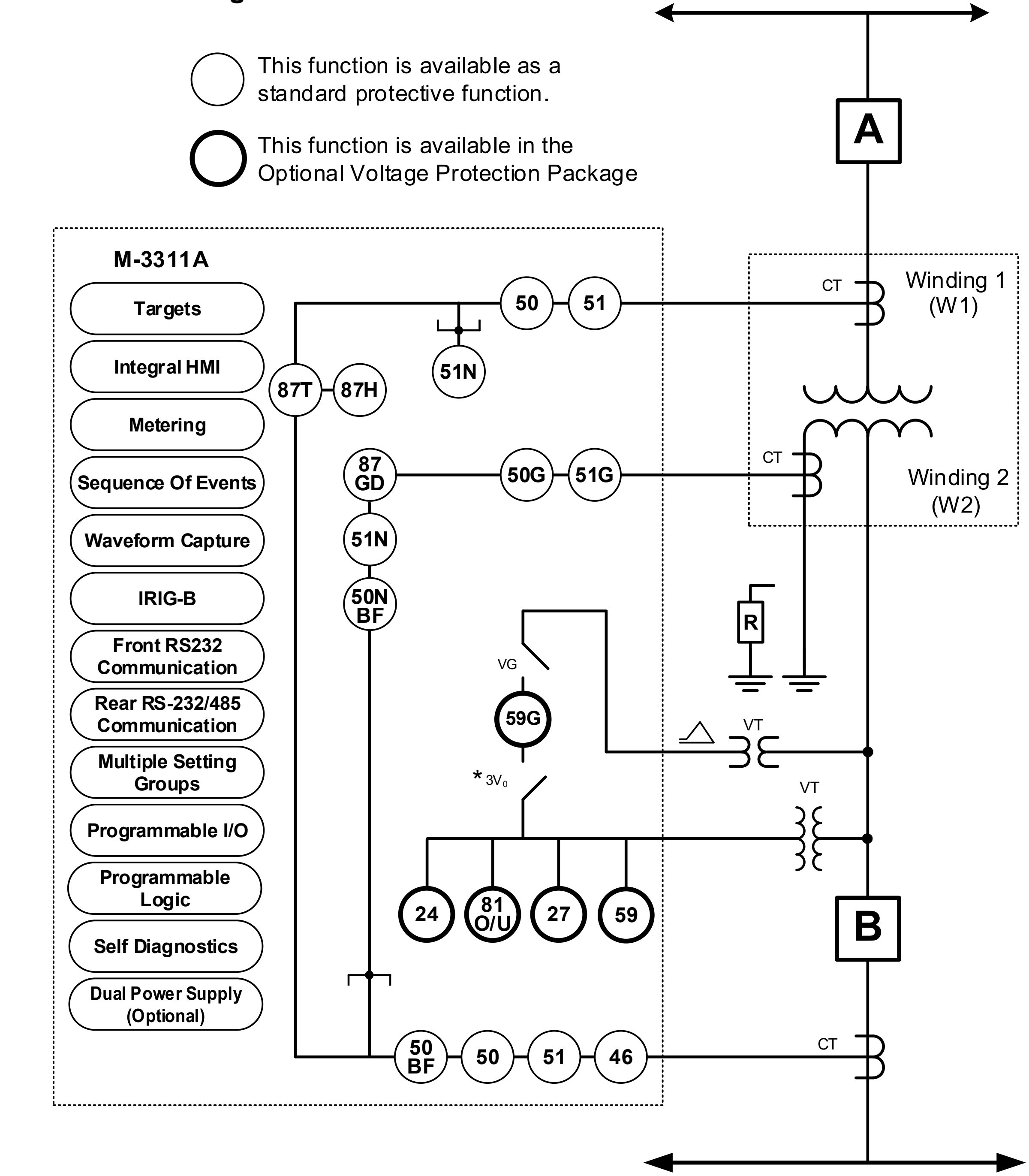


Figure 2 Typical External Connections With Optional Extended I/O (See Instruction Book Chapter 5, for Details)

■ **NOTES:**

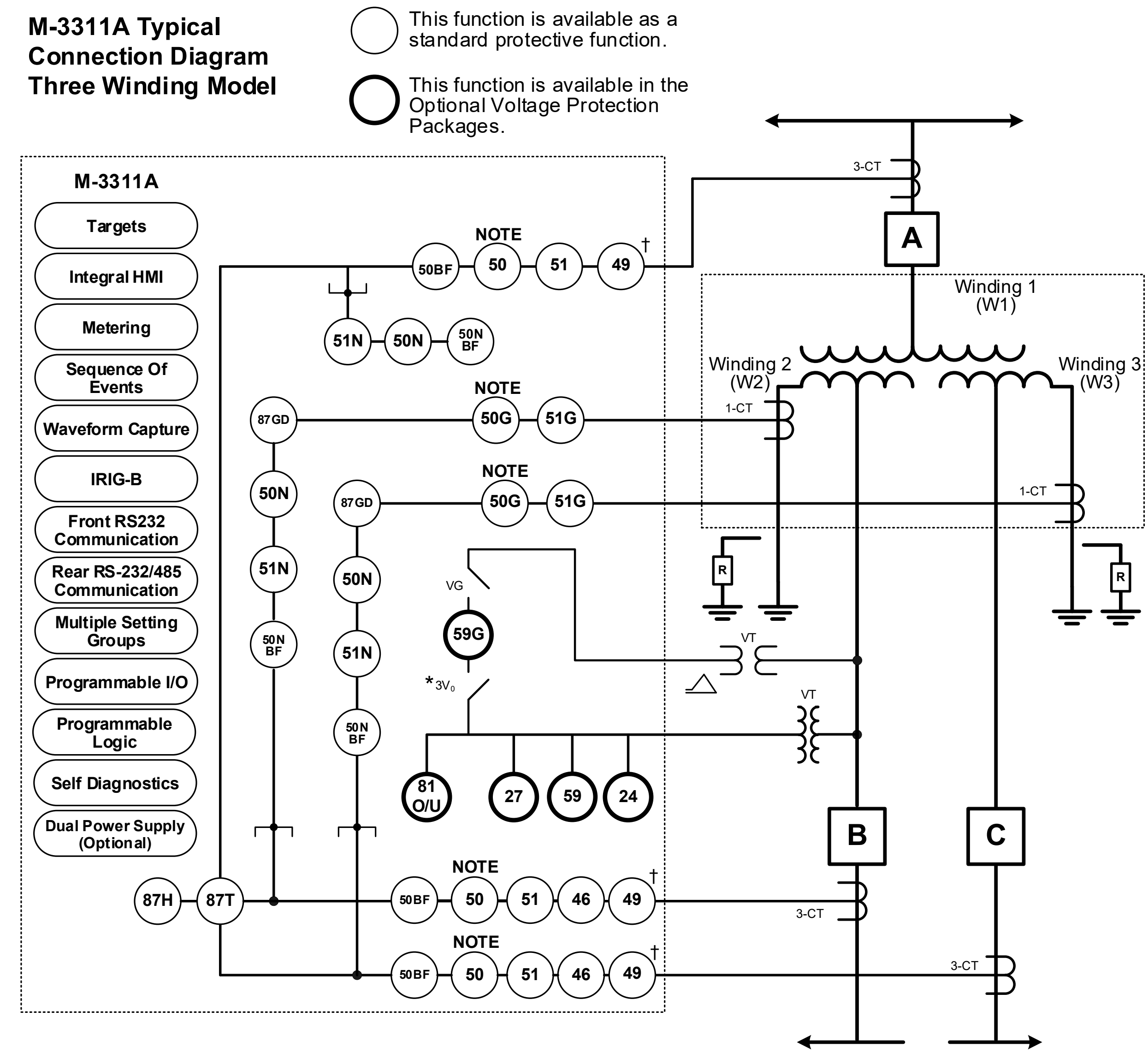
1. Output contacts #1 through #4 contain special circuitry for high-speed operation, and close 4 ms faster than outputs 5 through 8. Outputs 1 through 6 are form "a" contacts (normally open) and outputs 7 and 8 are form "c" contacts (center tapped 'a' and 'b' contacts).
2. To comply with UL listing requirements, terminal block connections must be made with #22–12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector. Wire insulation must be rated at 75°C minimum. Terminal block connections 1 through 34 and 76 through 115 must be tightened to 12 in-lbs torque. Terminal block connections 35 through 75 must be tightened to 8.0 in-lbs, minimum, 9.0 in-lbs, maximum torque. Over torquing may result in terminal damage.
3. ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact 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.

M-3311A Typical Connection Diagram Two Winding Model



* Available with Four Voltage option and VT Config = LG

Figure 3 M-3311A (Two Winding – Zero, Two or Four Voltage Inputs) Typical One-Line Function Diagram

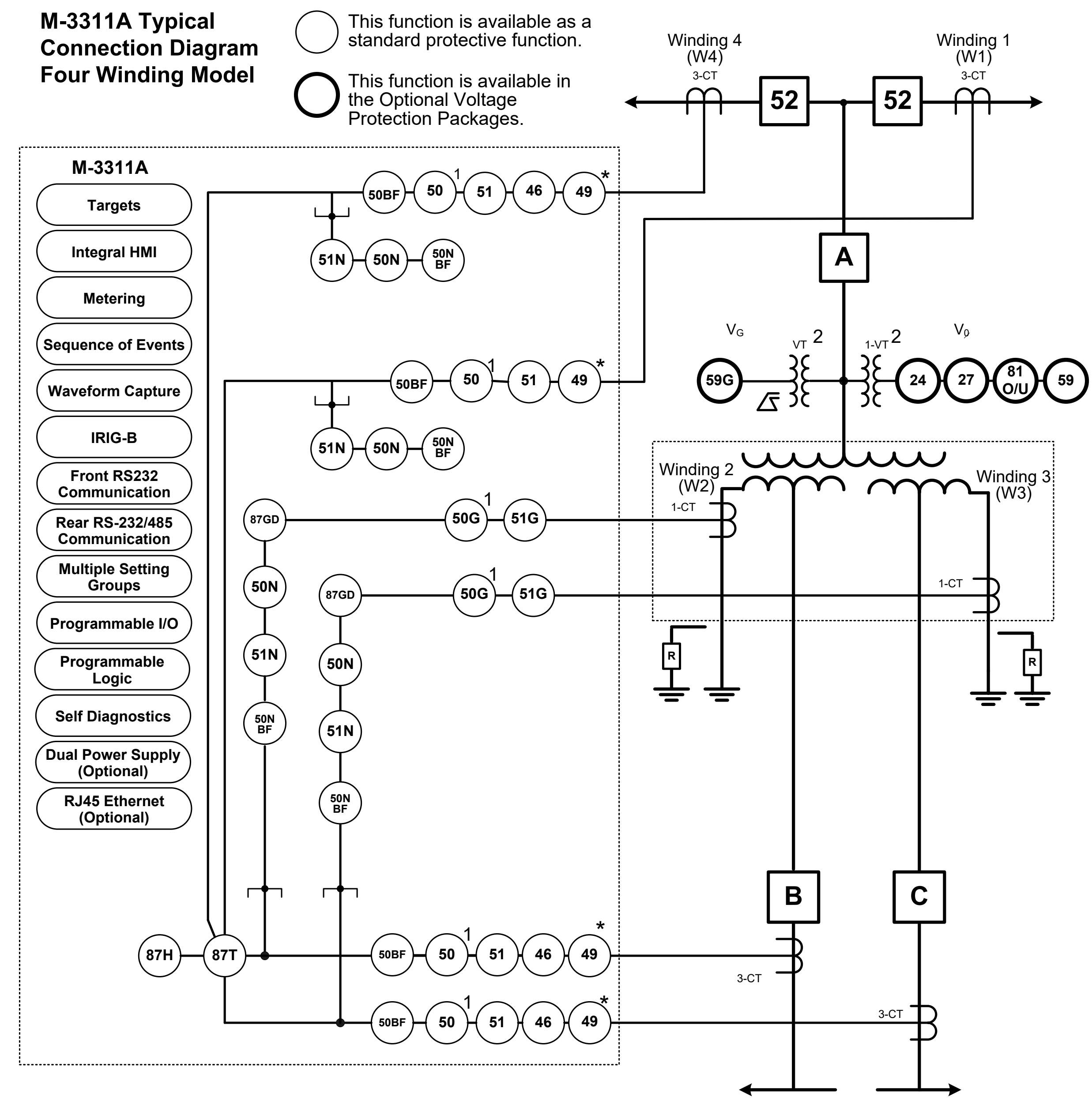


* Available with 4 Voltage option and VT Config = LG

† 49 Function can only be enabled in one winding.

■ **NOTE:** 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.

Figure 4 M-3311A (Three Winding – Zero, Two or Four Voltage Inputs) Typical One-Line Function Diagram

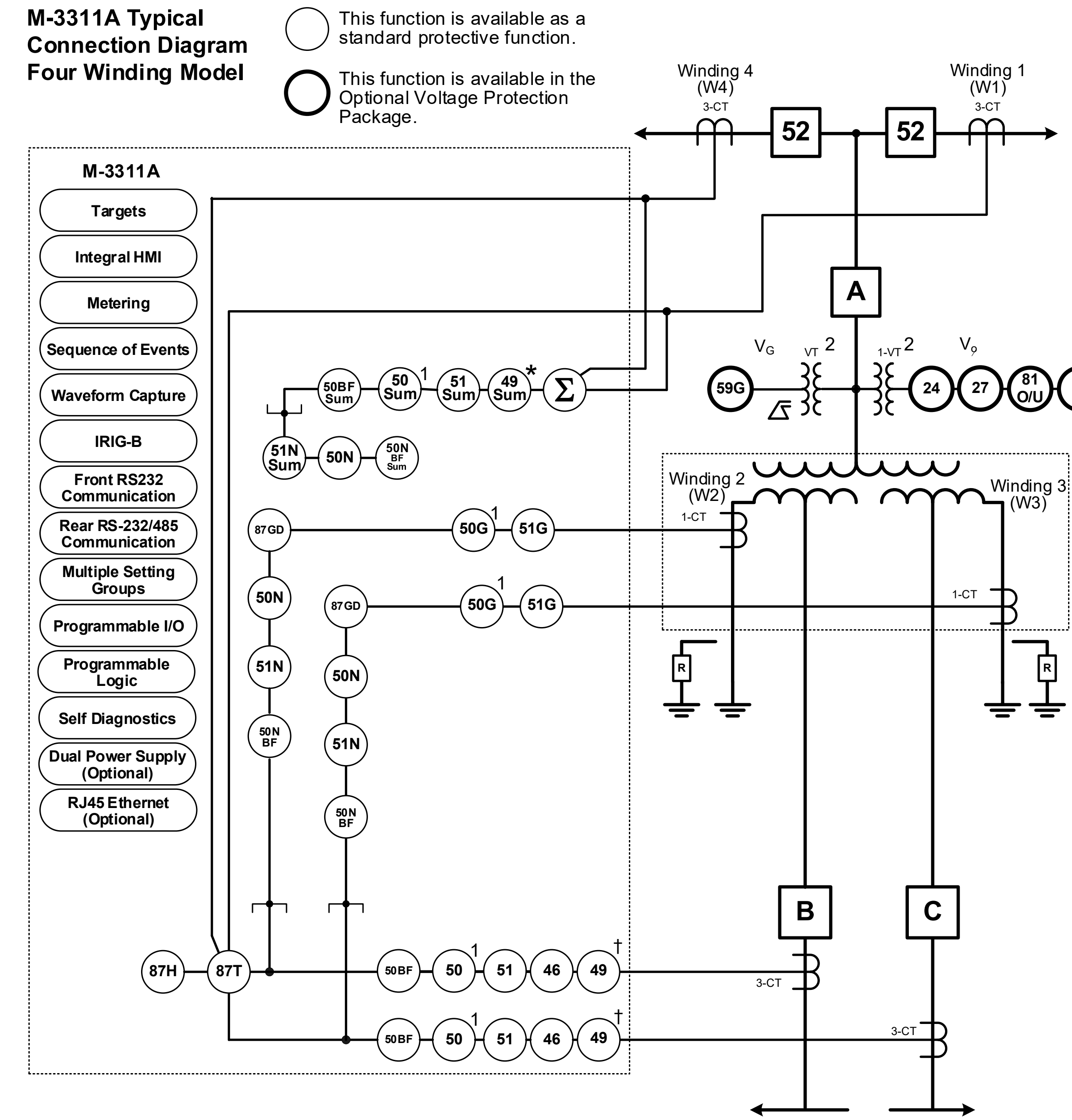


* 49 Function can only be enabled in one winding.

■ 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 four-winding model of the M-3311A. These are a phase voltage Vϕ use for the 59, 81O/U, 27, and 24 Functions and the Vk$_G$ broken delta input voltage used for the 59G function. These voltage inputs are not winding dependent.

Figure 5 M-3311A (Four Winding – Two Voltage Inputs) Typical One-Line Function Diagram



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

† 49 function can only be enabled in one winding or multiple windings via Current Summing.

■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 four-winding model of the M-3311A. These are a phase voltage Vϕ use for the 59, 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 6 Typical M-3311A (Four Winding – Two Voltage Inputs) Summing Currents One Line Functional Diagram

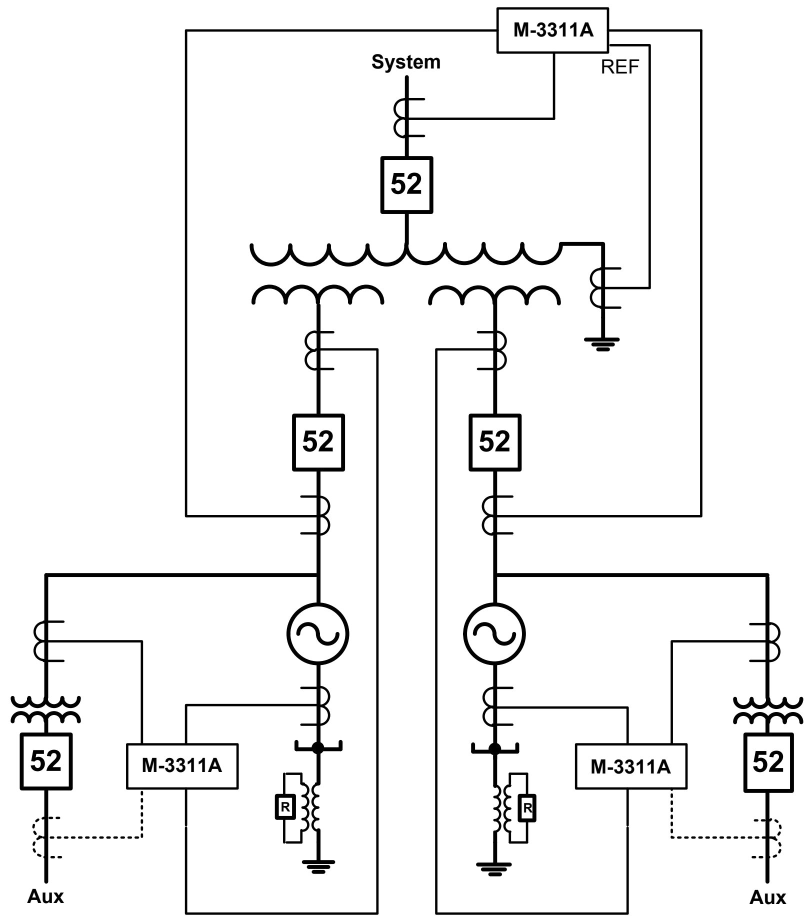


Figure 7 Dual Generator Power Plant Differential Zone of Protection

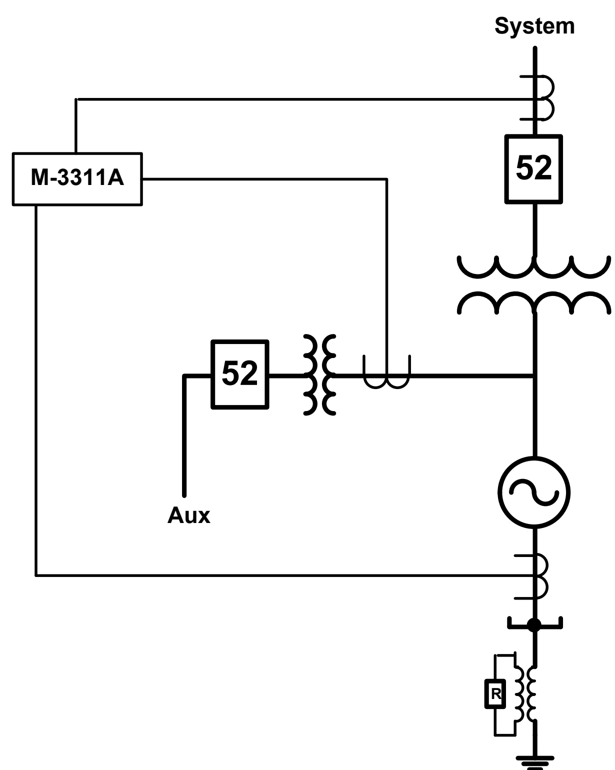


Figure 8 Generator Plant Overall Differential Zone of Protection

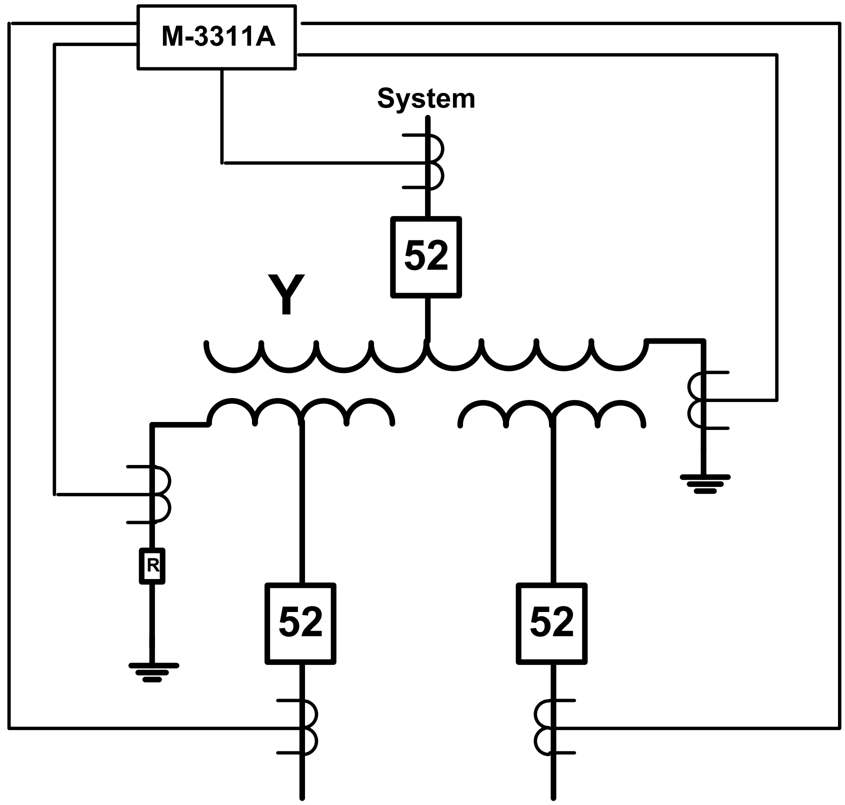


Figure 9 Three Winding Transformer with High Impedance Ground

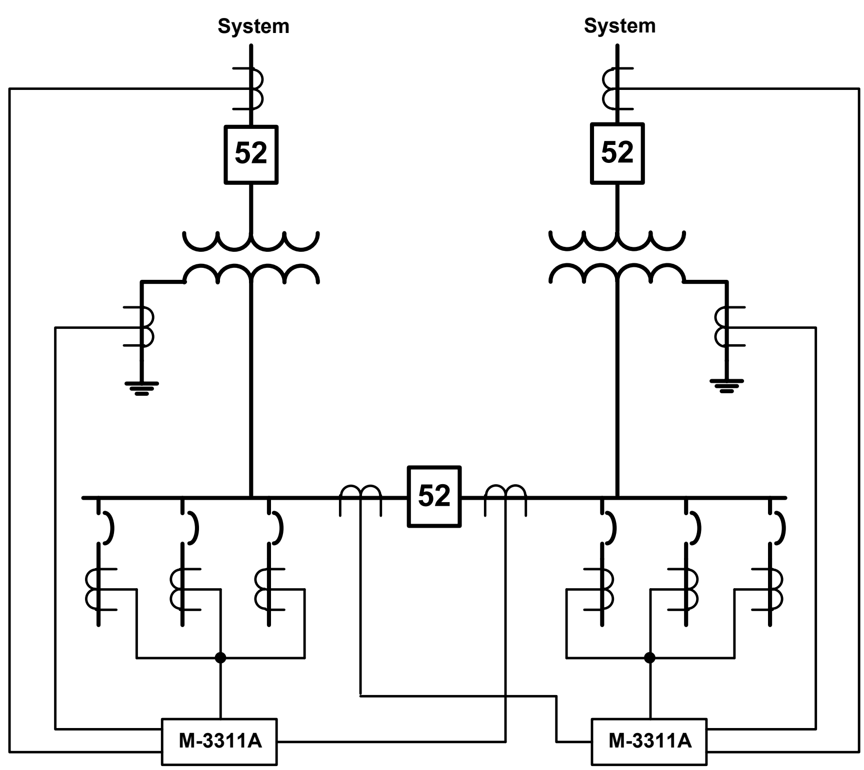
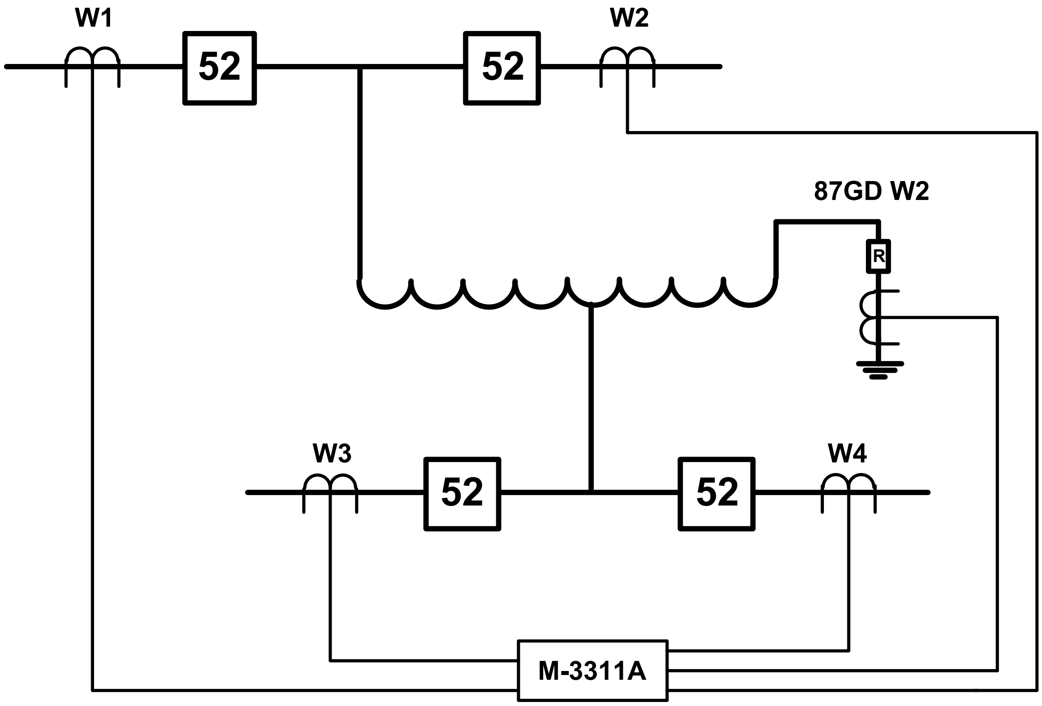


Figure 10 Dual Bank Distribution Substation



■ **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 11 Auto Transformer with two Circuit Breakers on High and Low Side

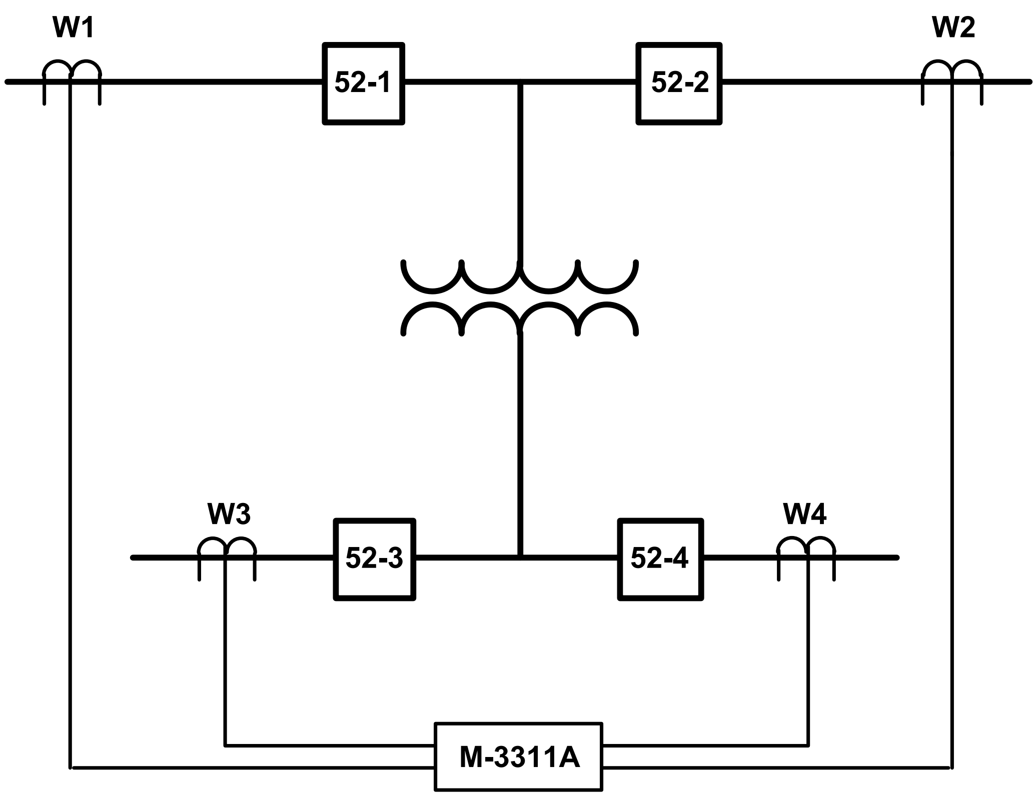
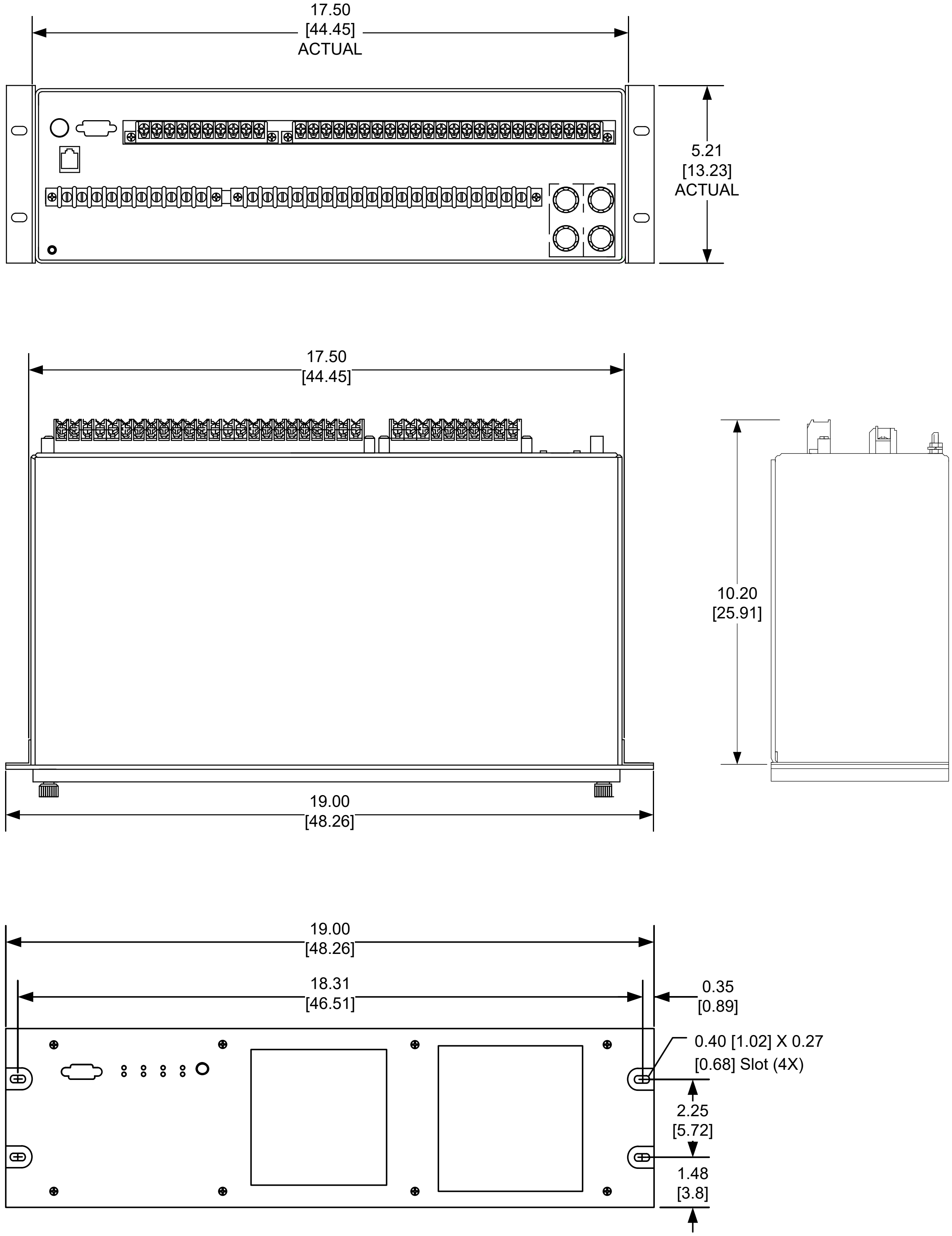


Figure 12 Two Winding Transformer with Two Circuit Breakers on High and Low Sides

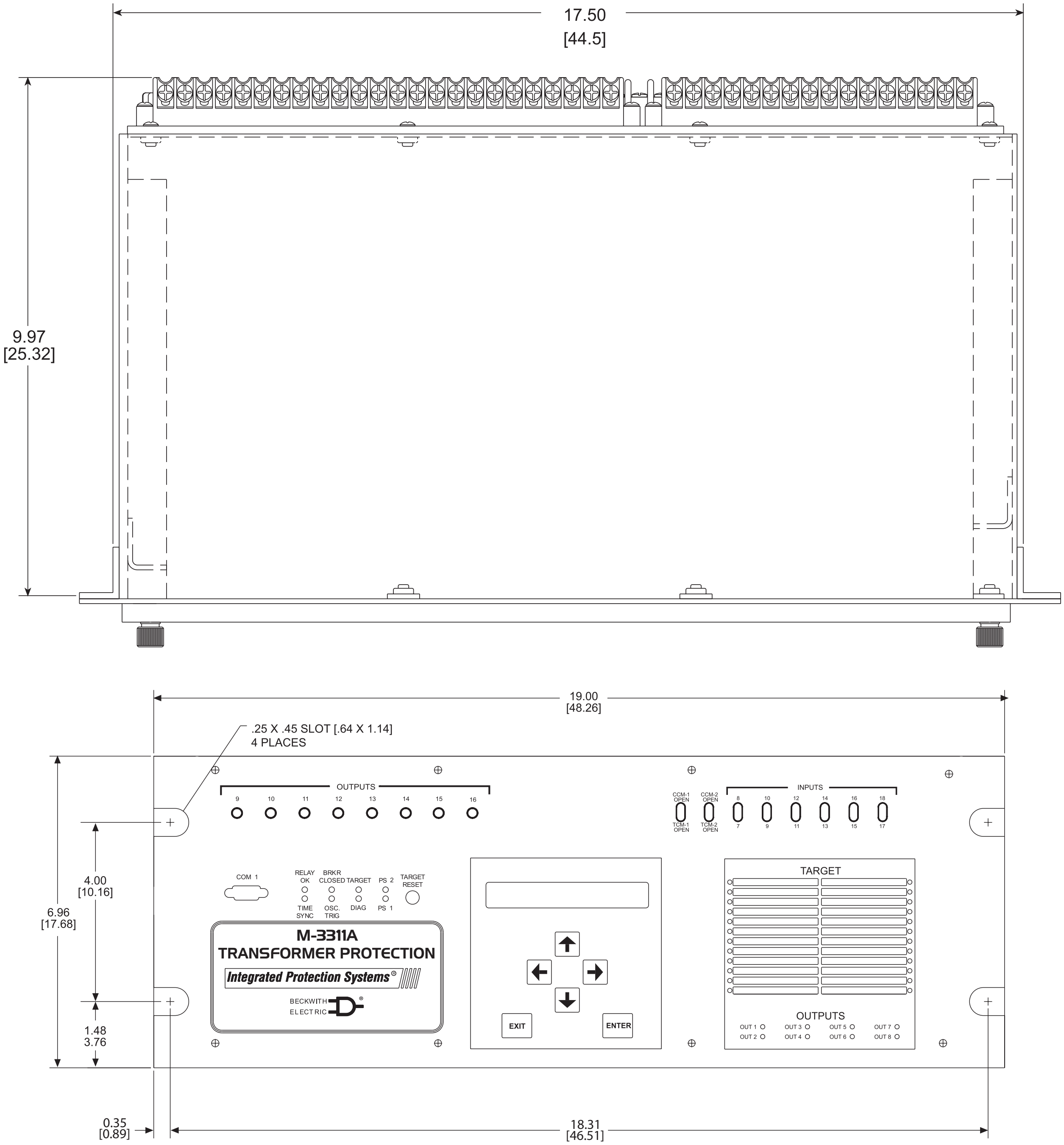


Standard 19" Horizontal Mount Chassis

■ **NOTES:**

1. Dimensions in brackets are in centimeters.
2. See Instruction Book Chapter 5 for Mounting and Cutout information.

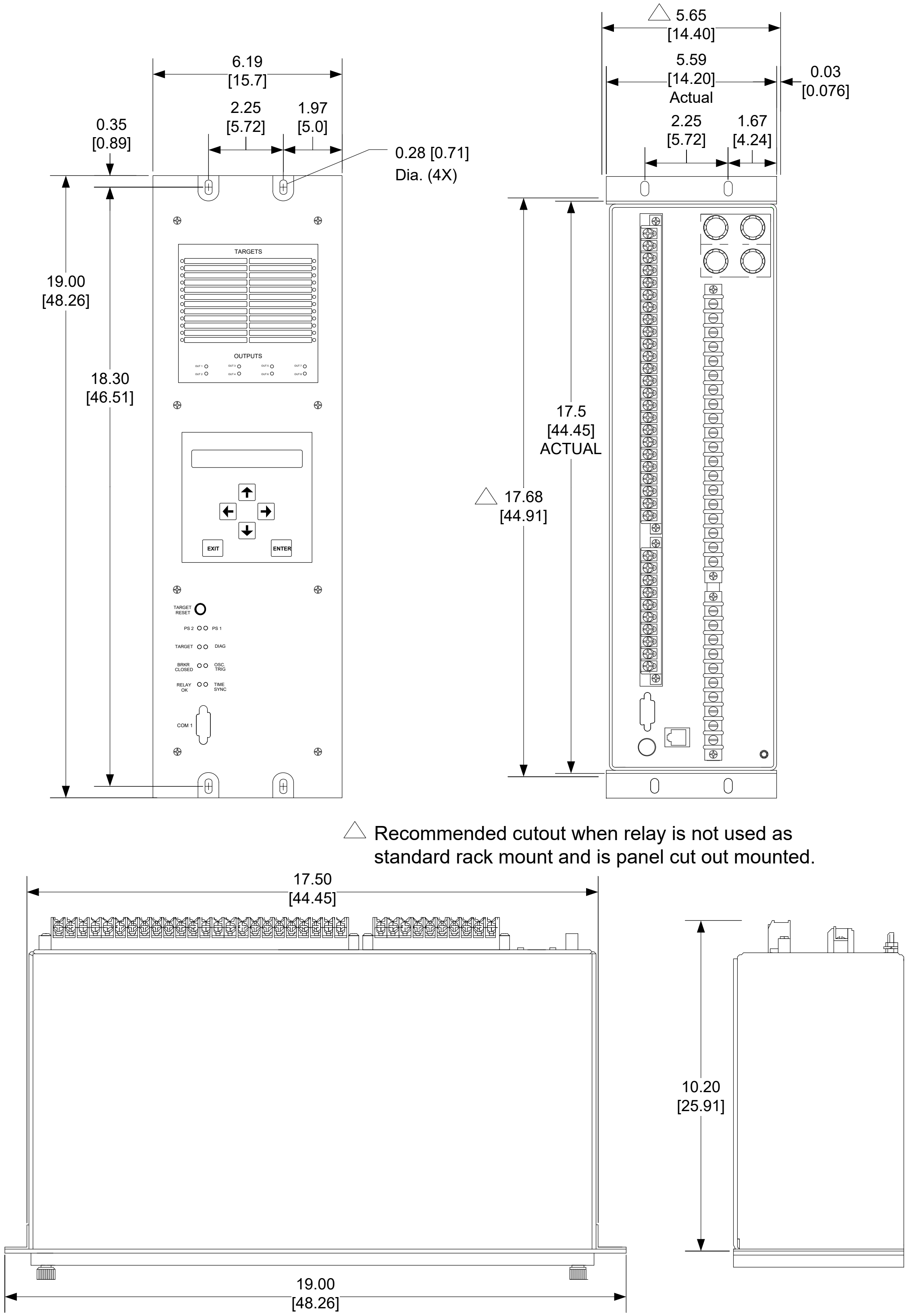
Figure 13 Horizontal Unit Dimensions Without Expanded I/O (H1)



NOTES:

1. Dimensions in brackets are in centimeters.
2. See Instruction Book Chapter 5 for Mounting and Cutout information.

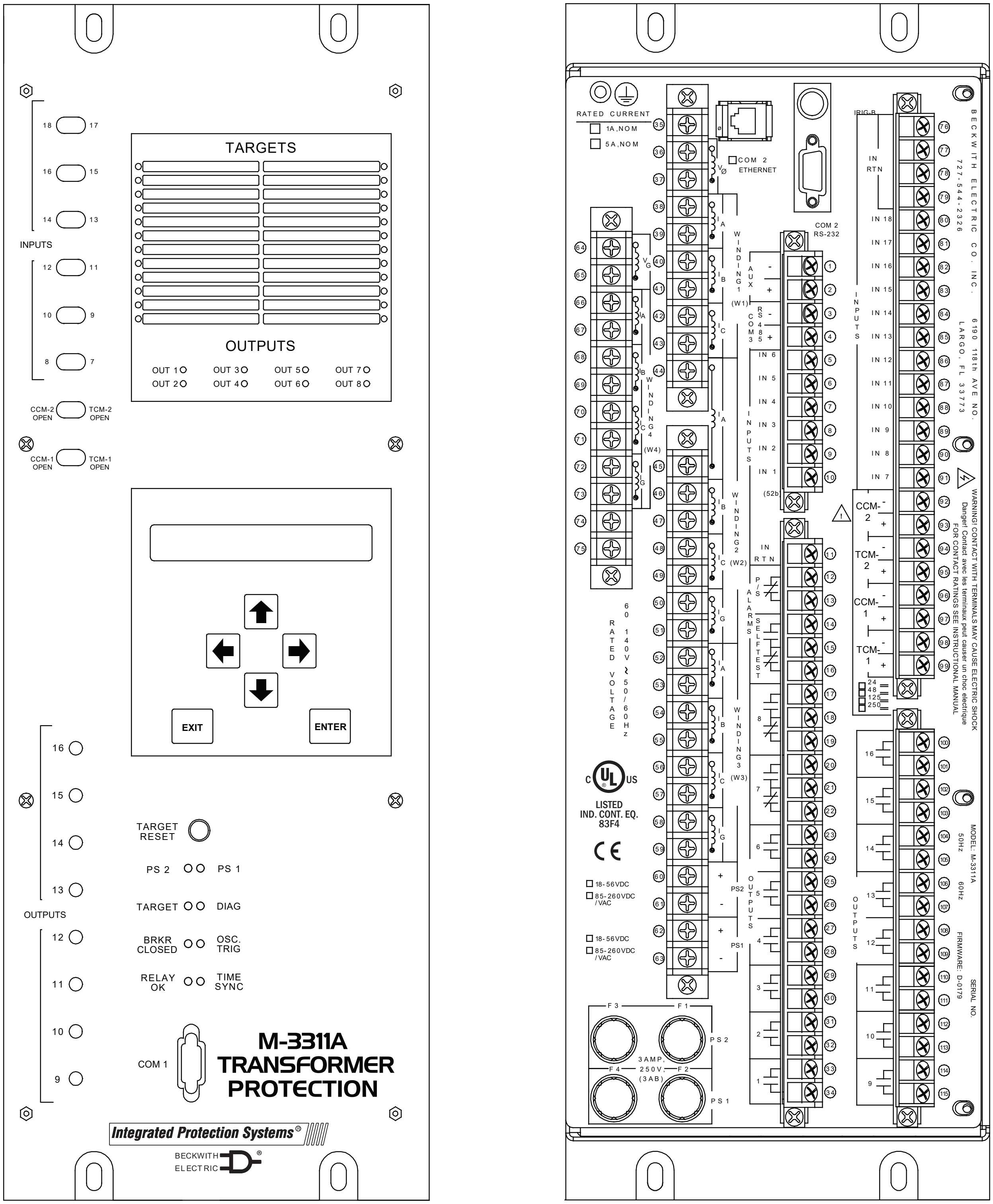
Figure 14 Horizontal Unit Dimensions With Expanded I/O



NOTES:

1. Dimensions in brackets are in centimeters.
2. See Instruction Book Chapter 5 for Mounting and Cutout information.

Figure 15 Vertical Unit Dimensions (H2)



NOTES:

1. The M-3311A Expanded I/O vertical panel is the same physical size as the M-3311A Expanded I/O horizontal panel. See Figure 14 for dimensions.
2. See Instruction Book Chapter 5 for Mounting and Cutout information.

Figure 16 M3311A Vertical Mount Front and Rear View with Expanded I/O (H6)

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beckwithelectricsupport@hubbell.com
www.beckwithelectric.com
ISO 9001:2015

A proud member of the Hubbell family.

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 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.

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1 Introduction

1.1 Instruction Book Contents

This instruction book includes six Chapters and seven 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 Human Machine Interface (HMI) and Status Module or through the S-3300 IPScom Communications and Oscillographic Analysis Software.

Chapter 3: IPScom

Chapter Three provides a description of each element of the S-3300 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.

Appendix F: HMI Menu Flow

This Appendix includes the M-3311A HMI Flow diagrams to aide the user in navigating the menu system.

Appendix G: Index

This Appendix includes the Index for the M-3311A Instruction Book.

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 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
50N 1-8	Instantaneous Residual Overcurrent
51 1-8	Inverse Time Phase Overcurrent
51GW2, 3, 4	Inverse Time Ground Overcurrent
51N 1-8	Inverse Time Residual Overcurrent
87	Phase Differential Current
87GDW2, 3, 4	Ground Differential
IPS *CCM *TCM	IPSlogic Close Circuit Monitor Trip Circuit Monitor
OPTIONAL FUNCTIONS	DESCRIPTON
24	Volts per Hertz
27	Phase Undervoltage
59G	Ground Overvoltage
81O/U	Over/Under Frequency

*Two Close Circuit Monitor inputs are available with Expanded I/O models.

**One Trip Circuit Monitor input available on Standard I/O models and two available on Expanded I/O modes.

Table 1-1 M-3311A Device Functions

The relay provides storage of time-tagged target information for the 8 most recent trip events. Also included are self-test, self-calibration and diagnostic capabilities. The 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 COM2 is not available:

- 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 can support MODBUS over TCP/IP, BECO2200 over TCP/IP, DNP 3.0 or IEC 61850. 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).

S-3300 IPScom Communications Software

Each M-3311A unit includes the S-3300 IPScom Communications Software. The IPScom communications software runs on an IBM PC compatible computer running under Windows 2000 or later, 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-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-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 2000 or later, 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 Vdc supply (For Non-Expanded I/O units).

M-3948 Redundant High Voltage Power Supply

Redundant 110/250 Vdc 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
  - Retrieve Records
  - View Records
  - Clear Records

2.1 Front Panel Controls and Indicators

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.

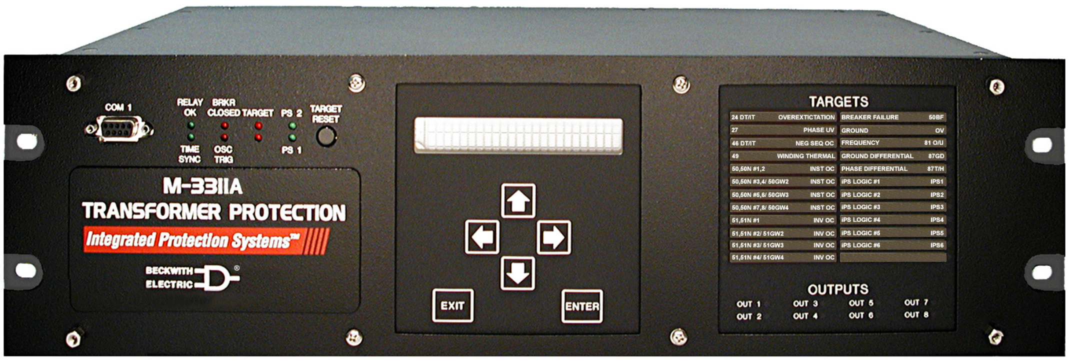


Figure 2-1 M-3311A Front Panel

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.

Target Module and Target Reset Pushbutton

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 8 operations is retained in the unit's memory for access through the alphanumeric display from the **VIEW TARGET HISTORY** menu.

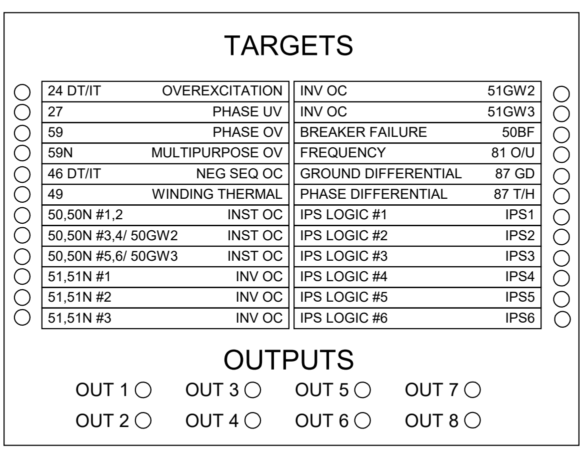


Figure 2-2 Typical Two- / Three-Winding Target Module

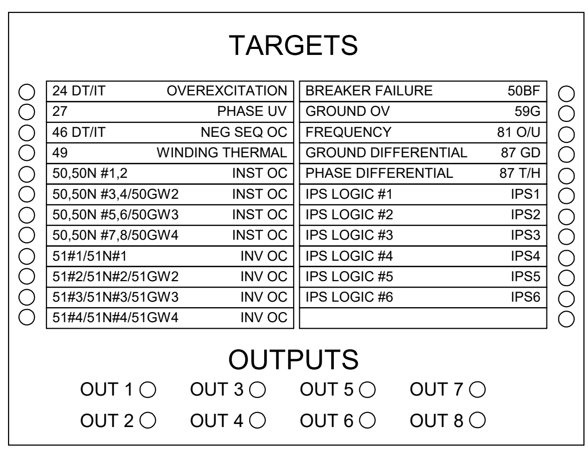


Figure 2-3 Typical Four-Winding Target Module

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 HMI or a PC running S-3300 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**, **Installation**, Section 5.3, **External Connections**, for power supply connection details.
- For PC communications, IPScom is installed on the host PC.
  See **Chapter 5**, **Installation**, Section 5.6, **IPScom Communications and Analysis Software Installation**, if IPScom is not installed.
- For PC communication, initial PC communication has been established with the unit.
  If this is the first attempt to establish communications with the unit, then see **Chapter 5**, **Installation**, Section 5.7, **Activating Initial Local Communications**.

HMI Operation Overview

Whenever power is applied to the unit the Power On Self Test sequence is initiated (Figure 2-4).

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 2-4.

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 2-5).

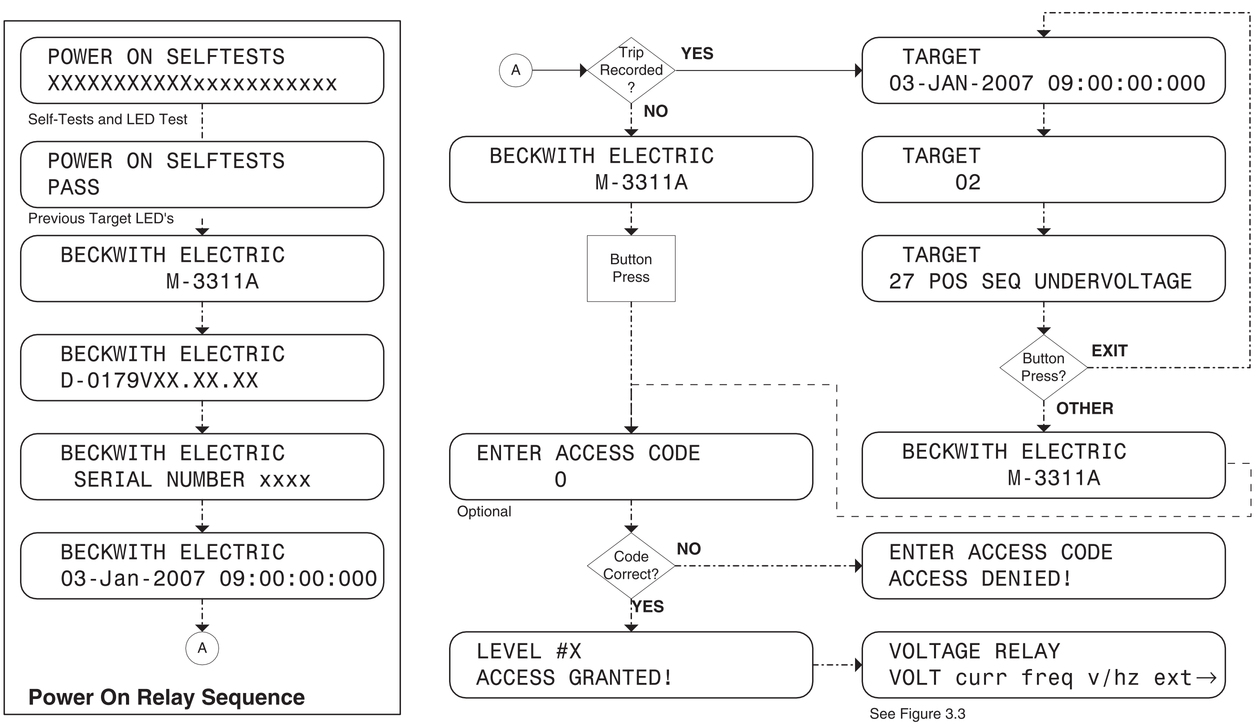
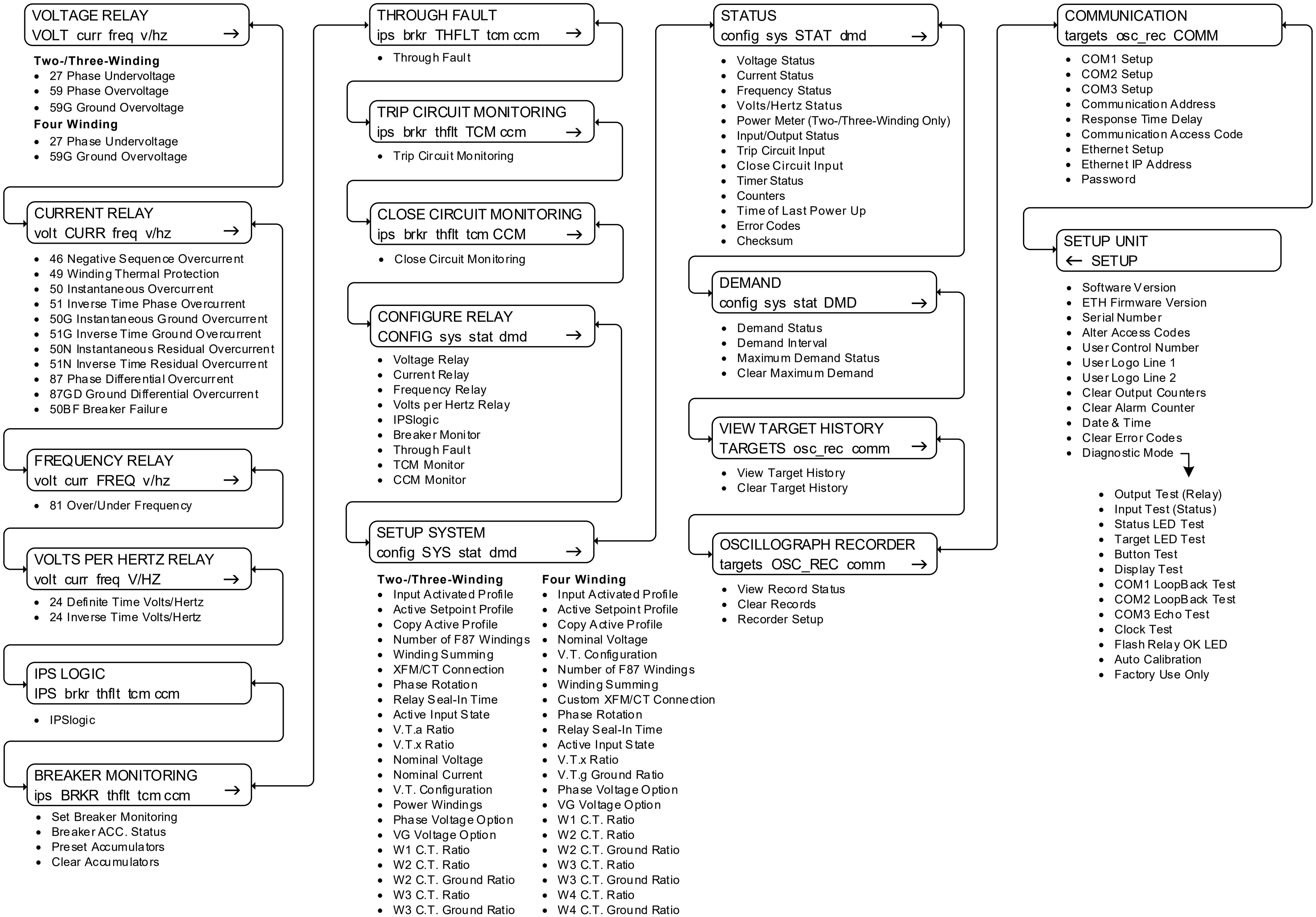


Figure 2-4 Screen Message Menu Flow



■**NOTE:** See **Appendix F**, **HMI Menu Flow** for menu item details.

Figure 2-5 Main HMI Menu Flow

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.

Level 1 Access: Read setpoints, monitor status, view status history.

Level 2 Access: All of level 1 privileges, plus read & change setpoints, target history, set time clock.

Level 3 Access: All of level 2 privileges, plus access to all configuration functions and settings.

Classic and Extended Access Codes

Classic – Each level access code is a user defined 1 to 4 digit number. When the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access code entry screens are bypassed.

Extended – For additional security, the Extended access code feature adds the capability to use up to 20 ASCII characters for each level access code. When the level 3 Extended access code is set to 9999, the access code feature is disabled. Before extended access codes can be used, this feature must first be enabled in the HMI. Select COMMUNICATION/PASSWORD from the HMI menu. The unit will display "CLASSIC   Extended". Select "EXTENDED" to enable the 20 character access code feature. Exit the COMM menu before using IPScom to enter the new access codes.

Changing Level Access Codes

■**NOTE:** Level Access Codes can only be changed by a Level 3 user.

Access codes may be changed in the HMI, by selecting **ALTER ACCESS CODES** under the **SETUP UNIT** menu. Access codes may be changed in IPScom, by selecting **Tools/Security/Change User Access Code**.

Status Monitoring (from Relay Front Panel)

The HMI menu categories for monitored values are:

- **Voltage Status** (V_A, V_B, V_C and V_G or $V_Ø$ 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**
- **Power Meter** (Two- / Three-Winding)
  - Real Power (PU, Watts)
  - Reactive Power (PU, VAr)
  - Apparent Power (PU, VA)
  - Power Factor
- **I/O Status** (Input and Output Contacts)
- **Trip Circuit Monitor**
- **Timer Status**
- **Counter Status** (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

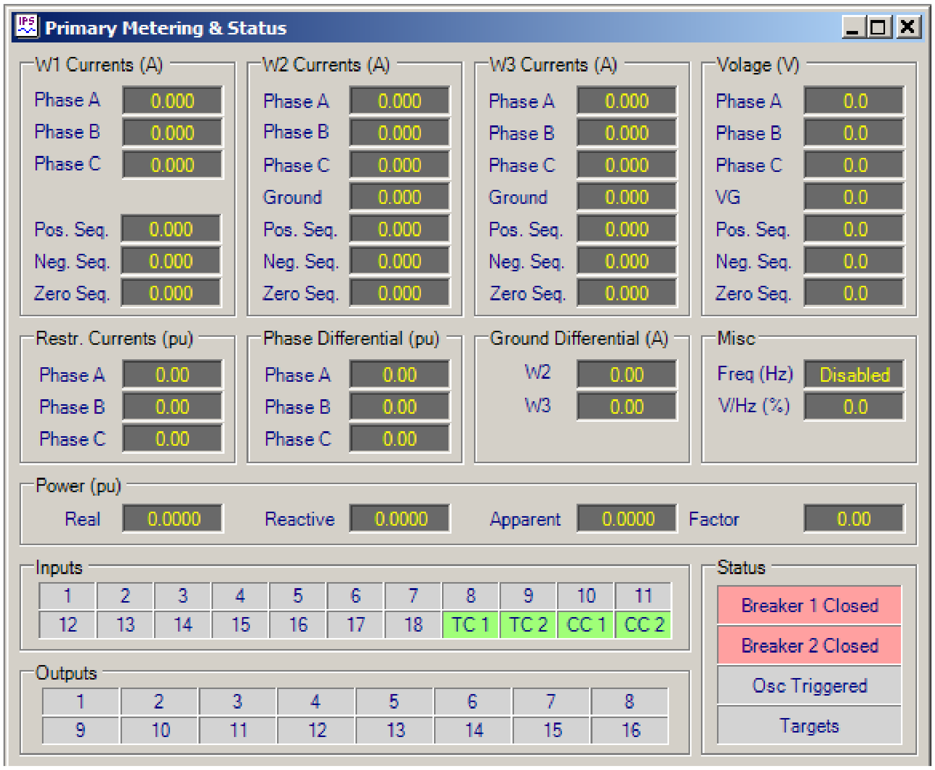
PRIMARY METERING AND STATUS

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 2-6 and Figure 2-7) which include the following **PRIMARY** parameters:

- Voltage (V_A, V_B, V_C and V_G or $V_Ø$ 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)
- Power (PU) Real, Reactive and Apparent (Two- / Three-Winding)

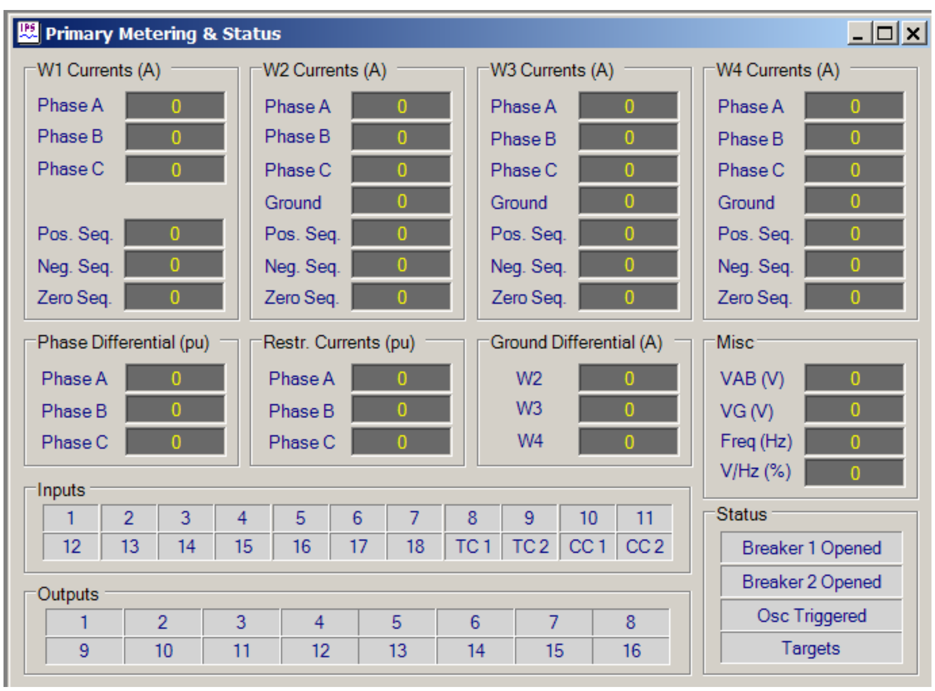
Also included on the Primary Metering & Status screen are:

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



Path: Monitor / Primary Metering & Status

Figure 2-6 Primary Metering & Status Screen (Two- / Three-Winding)



Path: Monitor / Primary Metering & Status

Figure 2-7 Primary Metering & Status Screen (Four-Winding)

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.

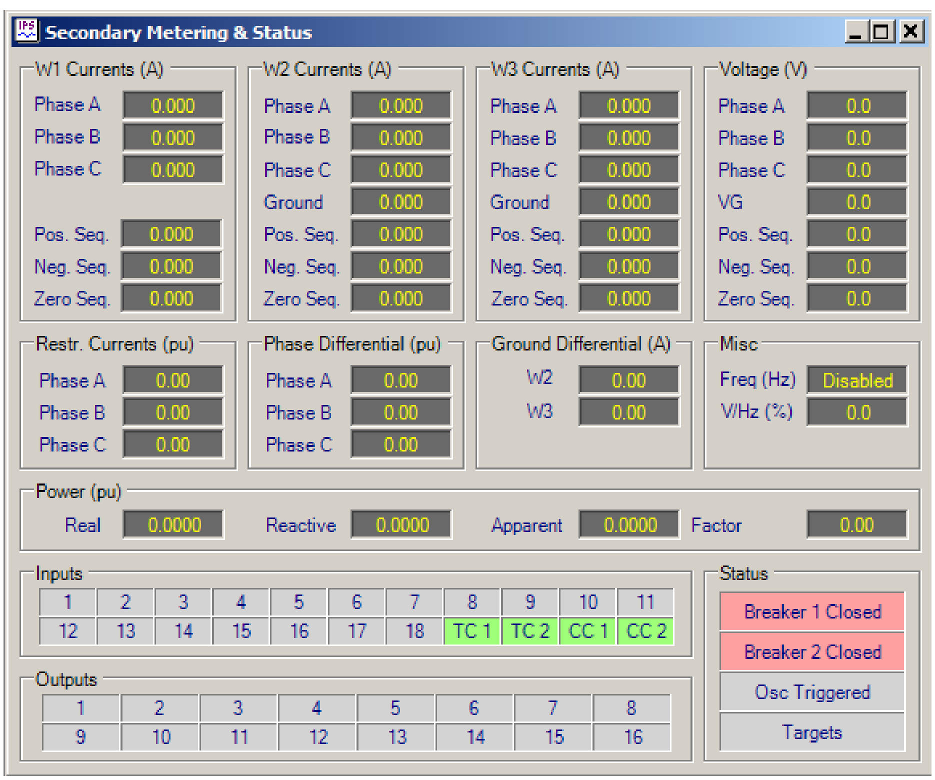
Monitor/Secondary Metering and Status

The Secondary Metering & Status screen (Figure 2-8 and Figure 2-9) include the following **SECONDARY** parameters:

- Voltage (V_A, V_B, V_C and V_G or $V_Ø$ 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)
- Power (PU) Real, Reactive and Apparent (Two- / Three-Winding)

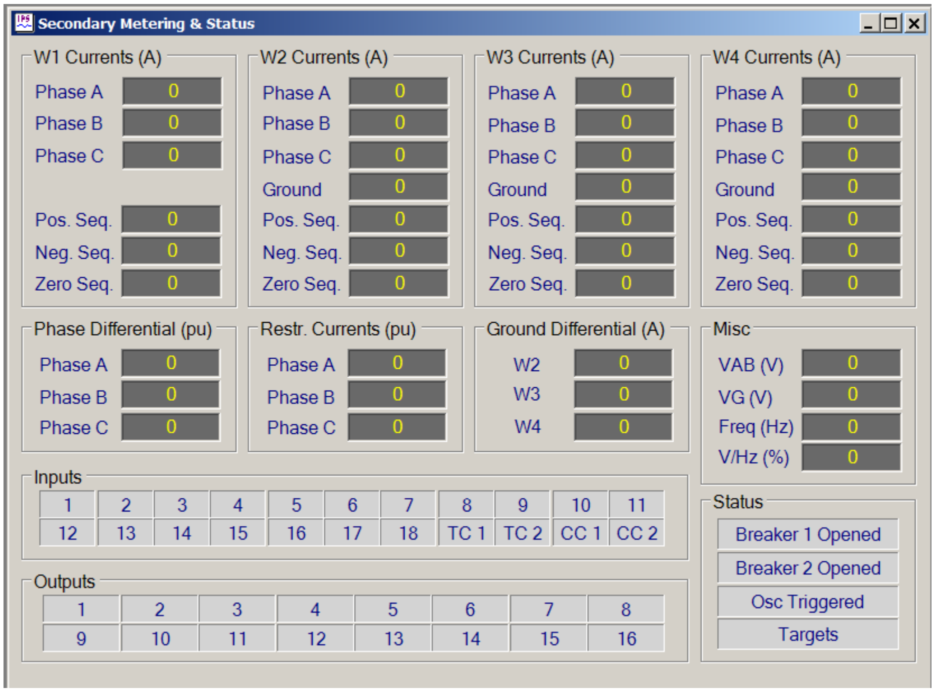
Also included on the Secondary Metering & Status screen are:

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



Path: Monitor / Secondary Metering & Status

Figure 2-8 Secondary Metering & Status Screen (Two- / Three-Winding)



Path: Monitor / Secondary Metering & Status

Figure 2-9 Secondary Metering & Status Screen (Four-Winding)

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

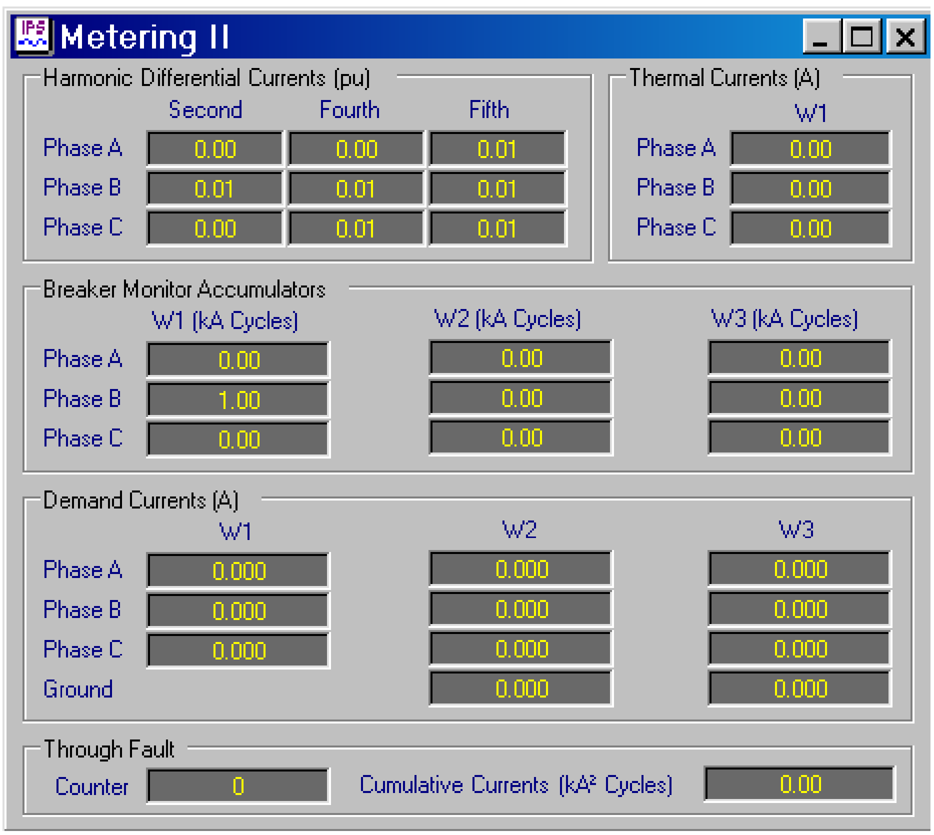
The Metering II screen (Figure 2-10 and Figure 2-11) includes the following parameters:

- 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:

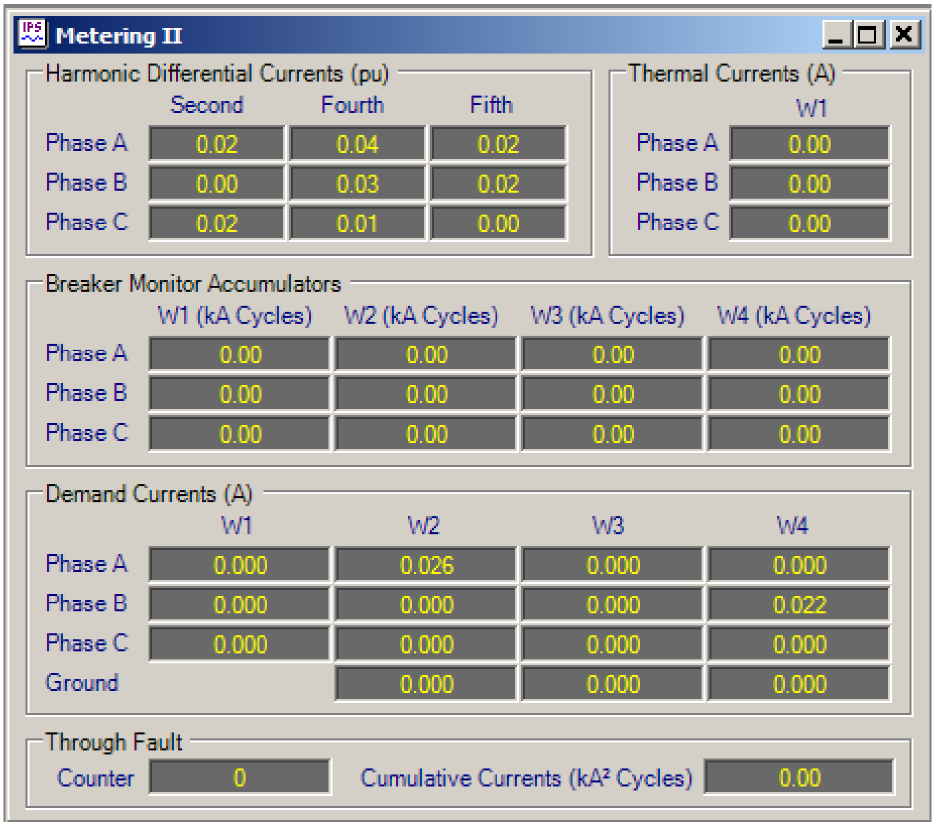
> ■**NOTE:** These parameters are described in their respective sections of this chapter.

- 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
- Through Fault Counter
- Cumulative Through Currents (kA^2 Cycles)



Path: Monitor / Metering II

Figure 2-10 Metering II Screen (Two- / Three-Winding)



Path: Monitor / Metering II

Figure 2-11 Metering II Screen (Four-Winding)

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.

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 readings 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**)
- **Maximum 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 2-10 and Figure 2-11). The Metering II screen includes the following **Demand Currents**:

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

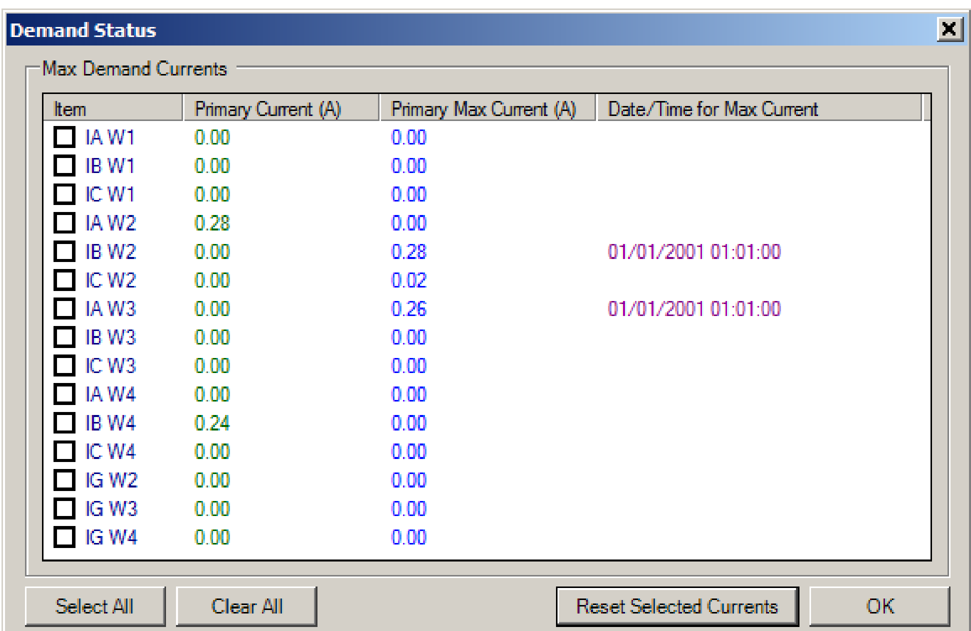
Max Demand Status

To display Max Demand Status values select **Relay/Demand Status**. IPScom will display the Demand Status screen (Figure 2-12).

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 capability to reset individual or reset all Max Demand Status values.



Path: Relay / Demand Status

Figure 2-12 Demand Status Screen

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**.

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, the HMI will advance directly to:

```
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 displayed 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 –
```

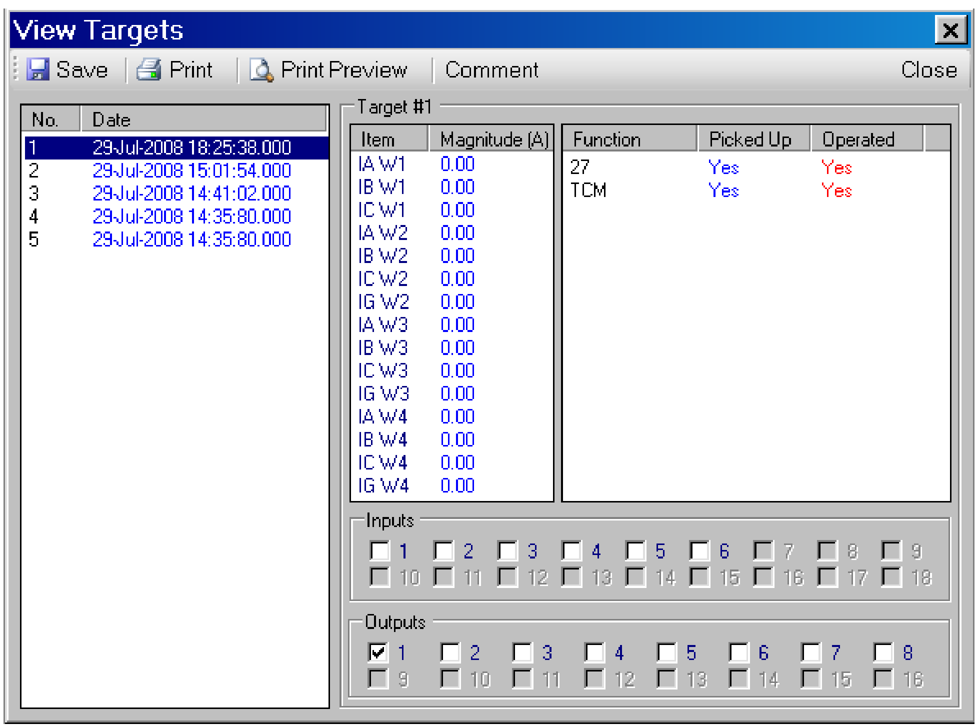
8. To exit press the **EXIT** pushbutton.

View Target History from IPScom

View Targets

To View Targets select **Relay/Targets/View**. IPScom will display the View Targets screen (Figure 2-13). 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



Path: Relay / Targets / View

Figure 2-13 View Targets Screen

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 **Relay/Targets/Clear**. IPScom will display the Clear Targets confirmation dialog screen (Figure 2-14).

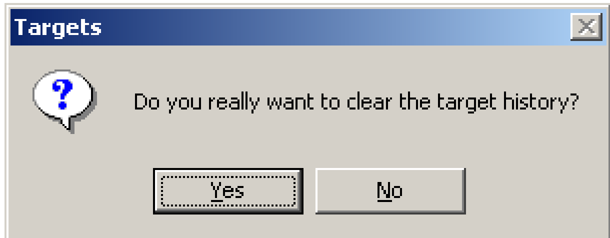


Figure 2-14 Clear Targets Confirmation Dialog Screen

2. Select **Yes**. IPScom will display the Clear Targets dialog screen (Figure 2-15).

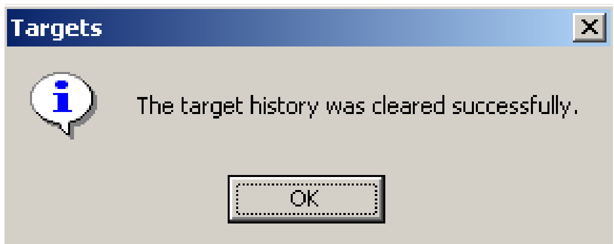


Figure 2-15 Clear Targets Dialog Screen

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 Windows based computer running the S-3300 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% pre-trigger 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.

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

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 Four-Winding Recorder Partitions

Number of Partitions	3 Windings 4 Windings	2 Windings 4 Voltages	3 Windings 2 Voltages	2 Windings 2 Voltages	3 Windings Zero Voltages	2 Windings Zero Voltages
1	204	265	231	311	265	377
2	136	176	154	207	176	251
3	102	132	115	155	132	188
4	81	106	92	124	106	150
5	68	88	77	103	88	125
6	58	75	66	89	75	107
7	51	66	57	77	66	94
8	45	58	51	69	58	83
9	40	53	46	62	53	75
10	37	48	42	56	48	68
11	34	44	38	51	44	62
12	31	40	35	47	40	58
13	29	37	33	44	37	53
14	27	35	30	41	35	50
15	25	33	28	38	33	47
16	24	31	27	36	31	44
17	22	29	25	34	29	41
18	21	27	24	32	27	39
19	20	26	23	31	26	37
20	19	25	22	29	25	35
21	18	24	21	28	24	34
22	17	23	20	27	23	32
23	17	22	19	25	22	31
24	16	21	18	24	21	30

Table 2-2 Two- / Three-Winding Recorder Partitions

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
–  TARGETS CLEARED –
```

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

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

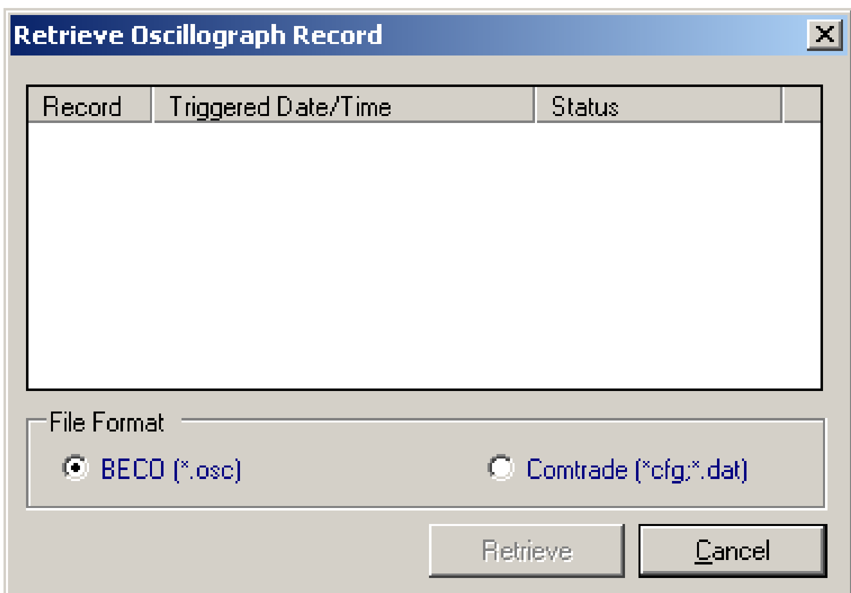
Oscillograph Recorder from IPScom

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

Retrieve Oscillograph Records

To retrieve Oscillograph Records perform the following:

1. Select **Relay/Oscillograph/Retrieve**. IPScom will display the Retrieve Oscillograph Record dialog screen (Figure 2-16).



Path: Relay / Oscillograph / Retrieve

Figure 2-16 Retrieve Oscillograph Record Dialog Screen

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 2-17).

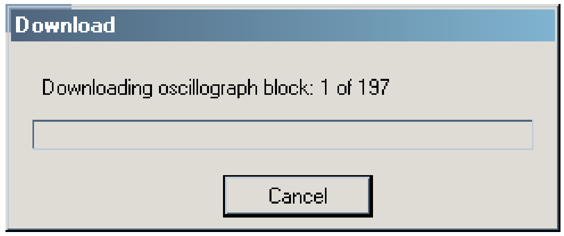


Figure 2-17 Oscillograph Record Download Dialog Screen

5. Upon completion of the oscillograph file download, IPScom will display the Download Successful confirmation screen (Figure 2-18).

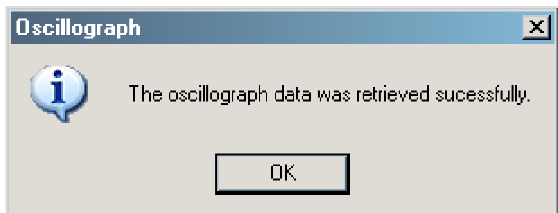


Figure 2-18 Oscillograph Download Successful Confirmation Screen

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

Trigger Oscillograph

To manually Trigger the Oscillograph perform the following:

1. Select **Relay/Oscillograph/Trigger**. IPScom will display the Trigger Oscillograph confirmation screen (Figure 2-19).

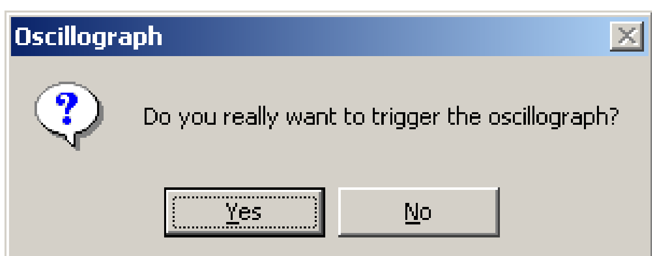


Figure 2-19 Trigger Oscillograph Confirmation Screen

2. Select **Yes**, IPScom will display the Oscillograph Successfully Triggered Dialog Screen. (Figure 2-20)

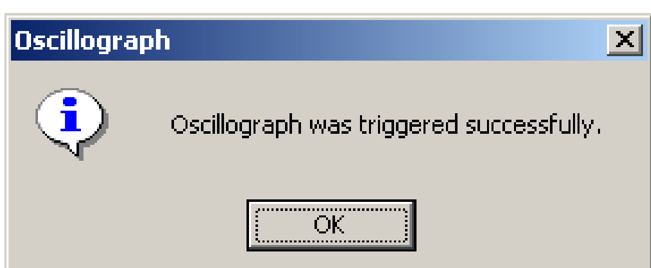


Figure 2-20 Oscillograph Successfully Triggered Dialog Screen

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

Clear Oscillograph Records

To Clear Oscillograph Records perform the following:

1. Select **Relay/Oscillograph/Clear**. IPScom will display the Clear Oscillograph Records confirmation screen (Figure 2-21).

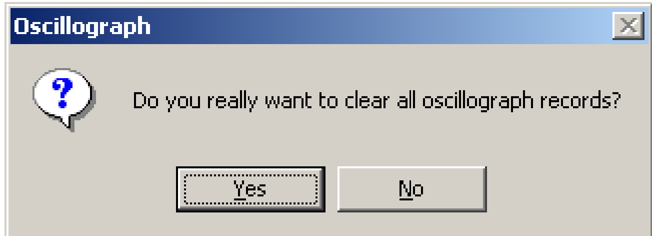


Figure 2-21 Clear Oscillograph Records Confirmation Screen

2. Select **Yes**, IPScom will display the Clear Oscillograph Records Successful Dialog Screen. (Figure 2-22)

Figure 2-22 Oscillograph Records Successfully Cleared Dialog Screen

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

OSC to ComTrade

To convert an Oscillograph file ".osc" to ComTrade format perform the following:

1. Select **Relay/Oscillograph/Osc to ComTrade**. IPScom will display the "Open" dialog screen with a default ".osc" file extension.
2. Select the ".osc" file to convert, then select Open. IPScom will display the convert dialog screen indicating that the .osc file was converted to a .cfg file.

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 (1 to 9999- Classic, up to 20 ASCII characters- Extended Mode):
    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 2-23).

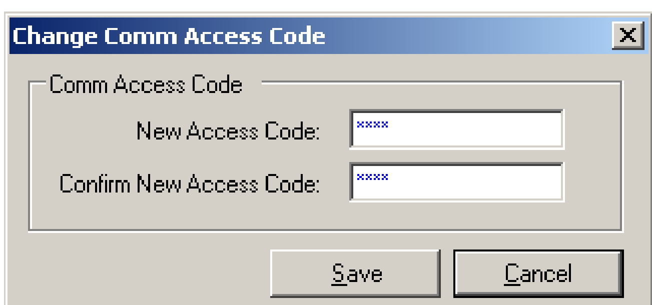


Figure 2-23 Change Comm Access Code Dialog Screen

2. Enter the desired New Comm Access Code (1 to 9999- Classic, up to 20 ASCII characters- Extended Mode), then re-enter (confirmation) the New Access Code.
3. Select **Save**, IPScom will display an Access Code change Confirmation Screen (Figure 2-24).

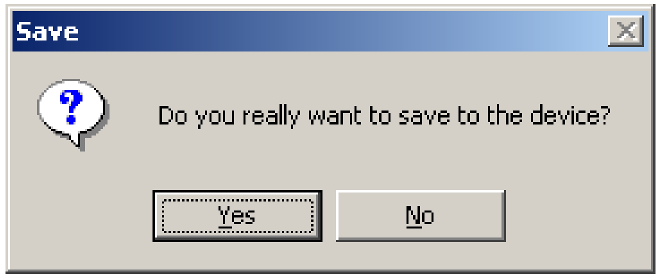


Figure 2-24 Access Code Change Confirmation Screen

4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 2-25).

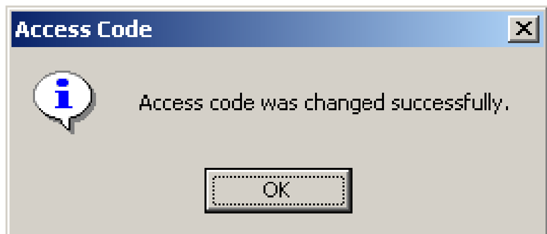


Figure 2-25 Access Code Changed Confirmation Screen

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

   The new Comm Access Code will not be in effect 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.

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.

See the previous section "**HMI Security**" for detailed information regarding Classic and Extended access codes.

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 Access Level Code dialog screen (Figure 2-26).

■**NOTE:** Level Access Codes can only be changed by a Level 3 user.

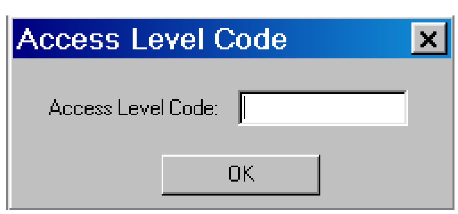


Figure 2-26 Access Level Code Dialog Screen

2. Enter a valid Level 3 User Access Code, then select **OK**. IPScom will display the Change User Access Code dialog screen (Figure 2-27).

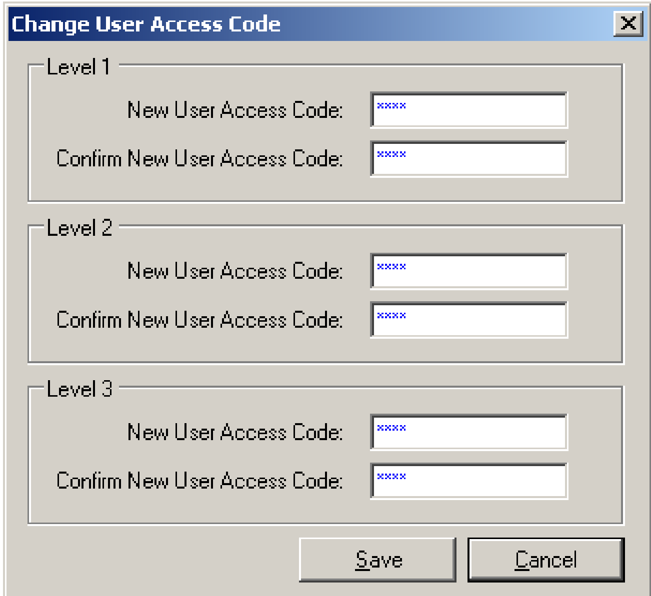


Figure 2-27 Change User Access Code Dialog Screen

3. Enter the desired New User Access Code (1 to 9999- Classic, up to 20 ASCII characters- Extended Mode), then re-enter (confirmation) the New User Access Code.
4. Select **Save**, IPScom will display an Access Code change Confirmation Screen (Figure 2-24).
5. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 2-25).
6. Select **OK**, IPScom 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 AND ERROR CODES 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 Counters and Error Codes dialog screen (Figure 2-28).
2. Select the desired Error Code, Alarm Counter, Power Loss Counter to be reset, then select **OK**. IPScom will return to the Main Menu.

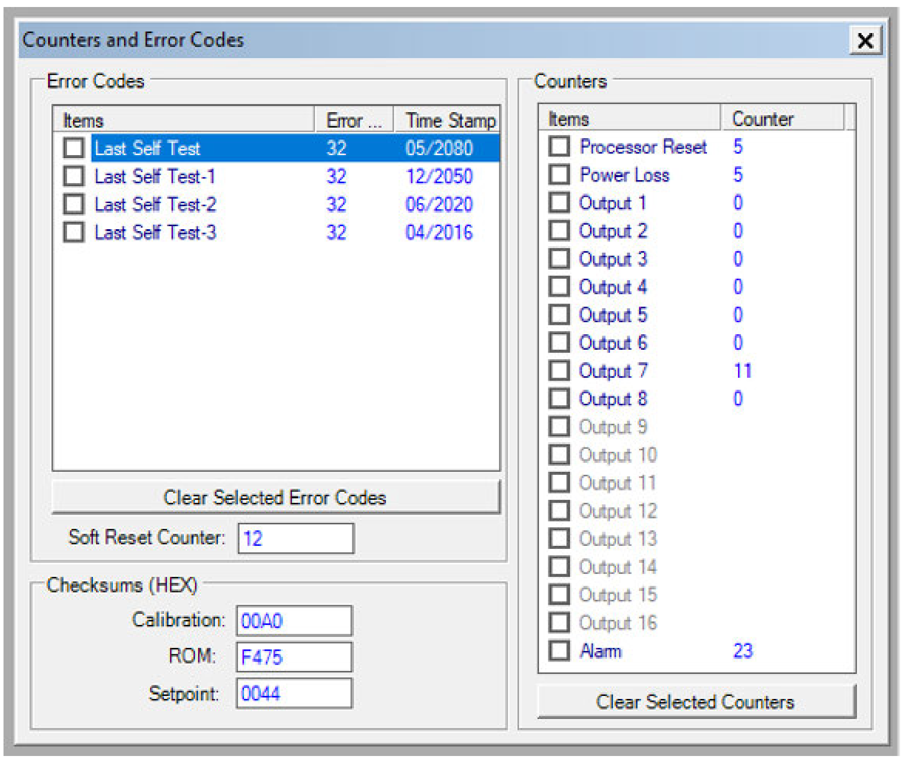


Figure 2-28 Counters and Error Codes Dialog Screen

THROUGH FAULT RECORDER FROM IPSCOM

Relay/Through Fault/Retrieve

To download available Through Fault records perform the following:

1. From the IPScom Main Screen menu select **Relay/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.

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

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

Relay/Through Fault/View

To view available Through Fault records perform the following:

1. From the IPScom Main Screen menu select **Relay/Through Fault/View**. IPScom will display the View Through Fault Record screen (Figure 2-29).
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.

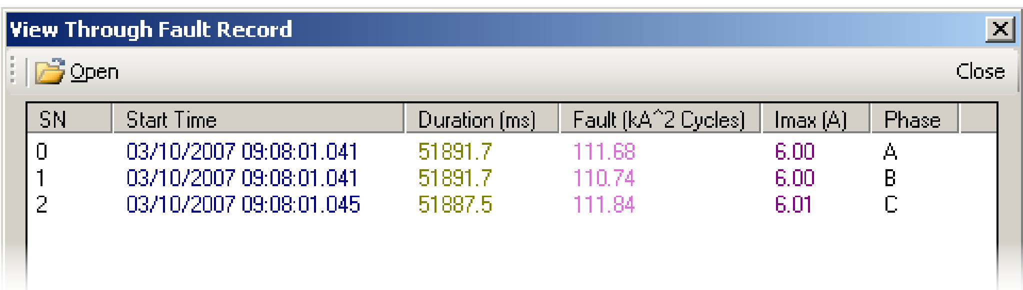


Figure 2-29 View Through Fault Record Screen

Relay/Through Fault/Clear

To Clear the relay Through Fault records perform the following:

1. From the IPScom Main Screen menu select **Relay/Through Fault/Clear**. IPScom will display the Clear Through Fault record confirmation screen (Figure 2-30).

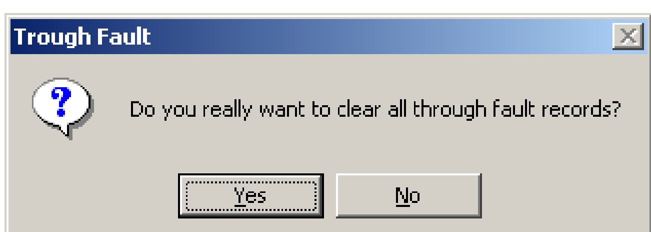


Figure 2-30 Clear Through Fault Record Confirmation Screen

2. Select **YES**, IPScom will respond with the Through Fault Record Cleared Successfully screen (Figure 2-31).

Figure 2-31 Through Fault Record Cleared Successfully Screen

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

Relay/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 **Relay/Sequence of Events/Retrieve**. IPScom will display the Sequence of Events Recorder Download screen (Figure 2-32) and indicate the number of Sequence of Events Recorder Events being downloaded.

Figure 2-32 Sequence of Events Retrieve/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**.

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

Relay/Sequence of Events/View

The Sequence of Events viewer screen includes the commands **Open**, **Close**, **Print Summary**, and **Print**. **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 **Relay/Sequence of Events/View**. IPScom will display the View Sequence of Events Record screen (Figure 2-33).
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 2-33).

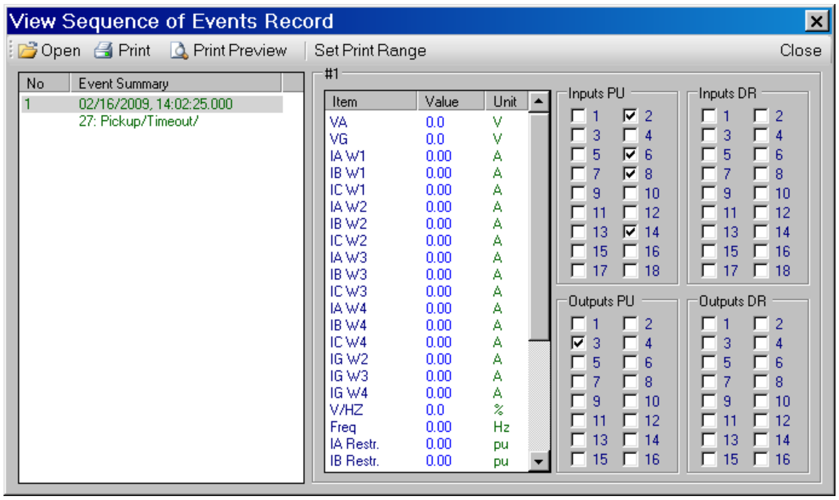


Figure 2-33 View Sequence of Events Record Screen

Relay/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 **Relay/Sequence of Events/Clear**. IPScom will display the Clear Sequence of Events Records confirmation screen (Figure 2-34).

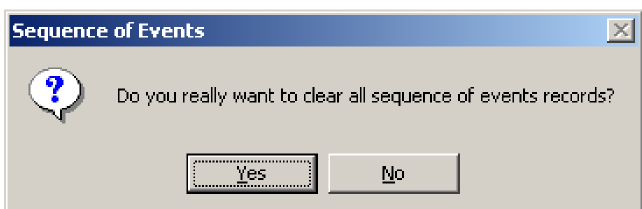


Figure 2-34 Clear Sequence of Events Record Command Confirmation Screen

2. Select **YES**, IPScom will respond with the Sequence of Events Records Cleared confirmation Screen (Figure 2-35).

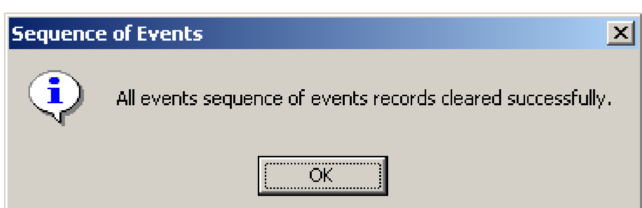


Figure 2-35 Sequence of Events Record Cleared Confirmation Screen

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

3 IPScom

This chapter is designed for the person or group responsible for the operation and setup of the M-3311A. The S-3300 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 and Analysis 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).

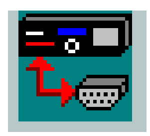


Figure 3-1 IPScom Program Icon

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

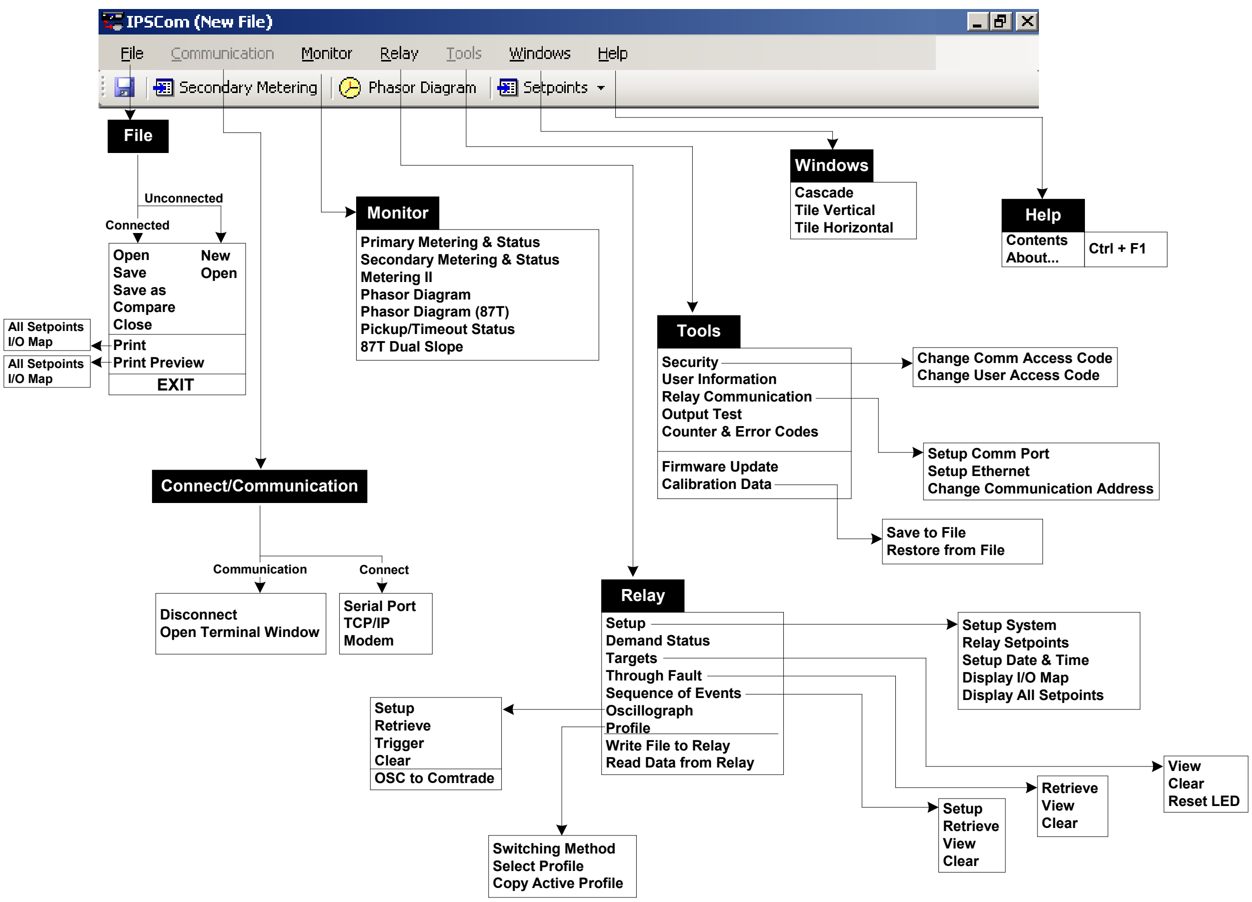
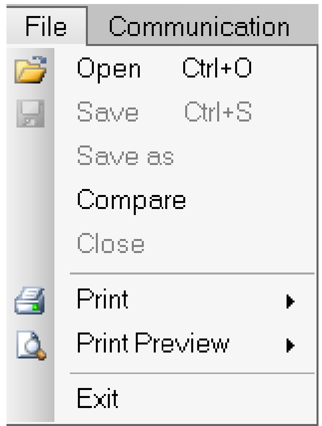


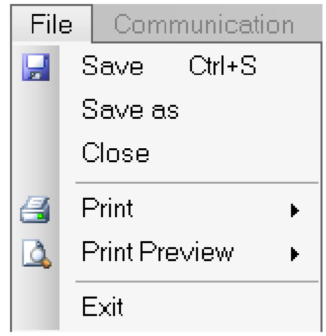
Figure 3-3 S-3300 IPScom Menu Selection

FILE MENU

Initial File Menu



File Menu Dropdown When Connected



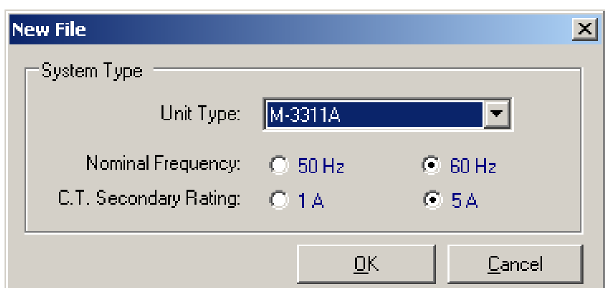
File Menu in File Mode

The **File** menu enables the user to create a **New** data file, **Open** a previously created data file, **Close**, **Save**, **Save as** and **Exit** the IPScom program. The user can also perform **Print** and **Print Preview** of the open file and **Compare** two files.

File/New Command

When not connected to a 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.

Comparing Setpoint Files

Comparing Setpoint Files does not require IPScom to be connected to a relay as long as the files to be compared are present on the PC. The **File/Compare** menu is available in the IPScom initial startup screen.

Select **File/Compare** and select ".ips Files". IPScom will display the "Open – File to Edit or Both Files" screen. If the files to be compared are located in the same directory, both files may be selected and opened in one step. Select the desired file(s) and then select **Open**.

If only one file was selected, IPScom will display the "Open – Reference File or Older File" screen. Select the desired Reference File and then select **Open**. IPScom will perform a comparison of the selected files and display the results (Figure 3-5). The Reference File is displayed with a yellow background.

The File Compare results screen includes the following features:

- Edit the newer file settings by selecting the setting hyperlink to display the corresponding settings screen. Changes can then be saved into the newer Setpoint File.
- Save – the changes will be saved into the newer File.
- Options/Show if Equal – will display any setting hyperlinks that are the same in both files. By default, hyperlinks are hidden for settings that are equal.
- Options/Clone Next Function Clicked – clones the selected function (by clicking on the function header) from the "Reference" file to the "Edit" file.
- Options/Clone Profiles and Functions – clones ALL Setpoint settings from the "Reference" file to the "Edit" file.

■**NOTE:** System Settings and Communication Settings cannot be cloned.

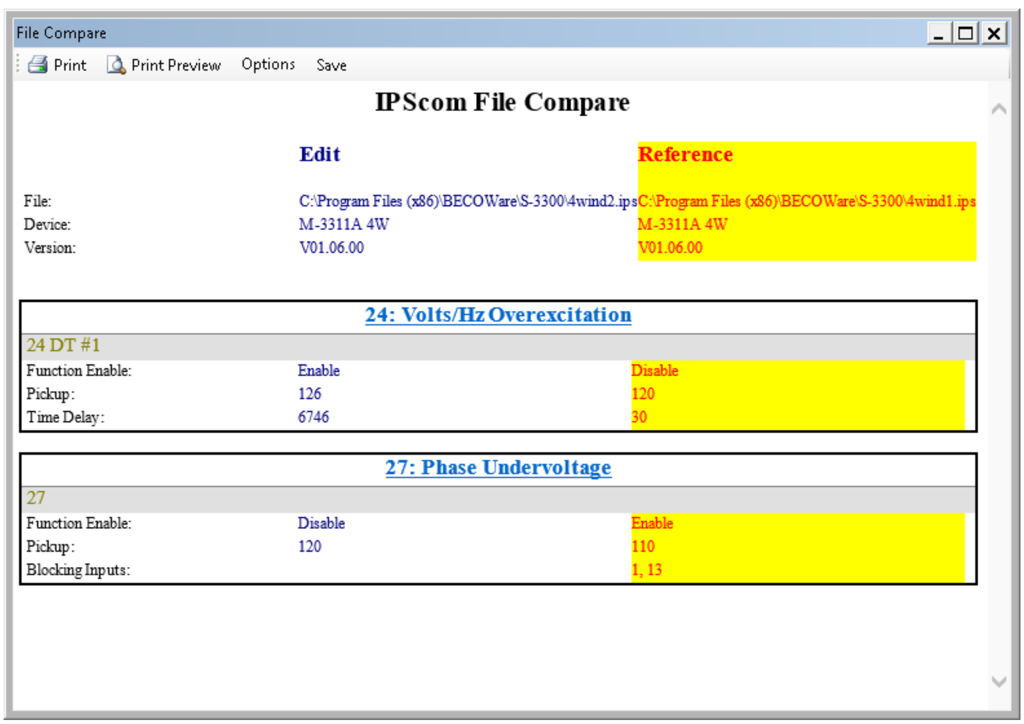
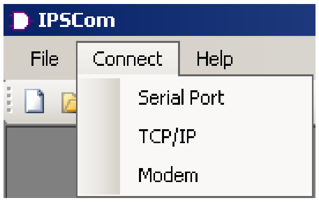


Figure 3-5 IPScom Setpoint File Compare Results Screen

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 3-6).

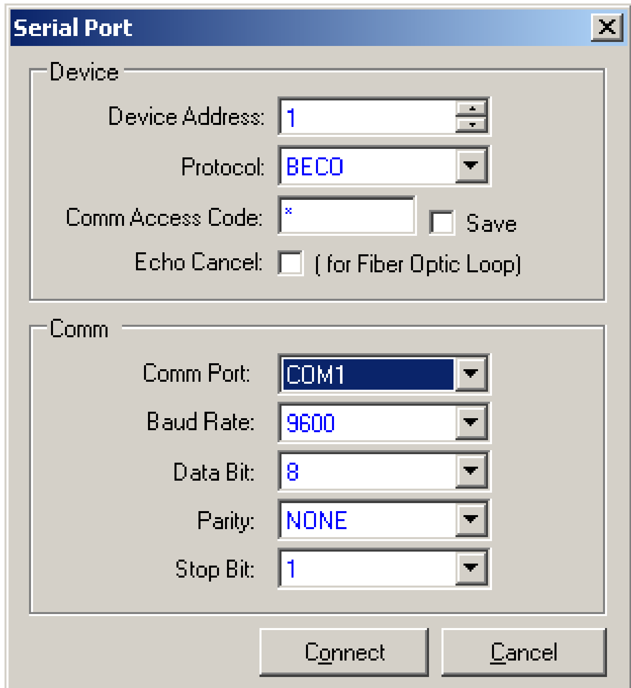


Figure 3-6 IPScom Serial Communication Dialog Screen

Selecting "TCP/IP" displays the PC TCP/IP and device Settings (Figure 3-7) for Ethernet communication. Selecting "Modem" displays a modem Dialog screen (Figure 3-8), 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 3-9) 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.

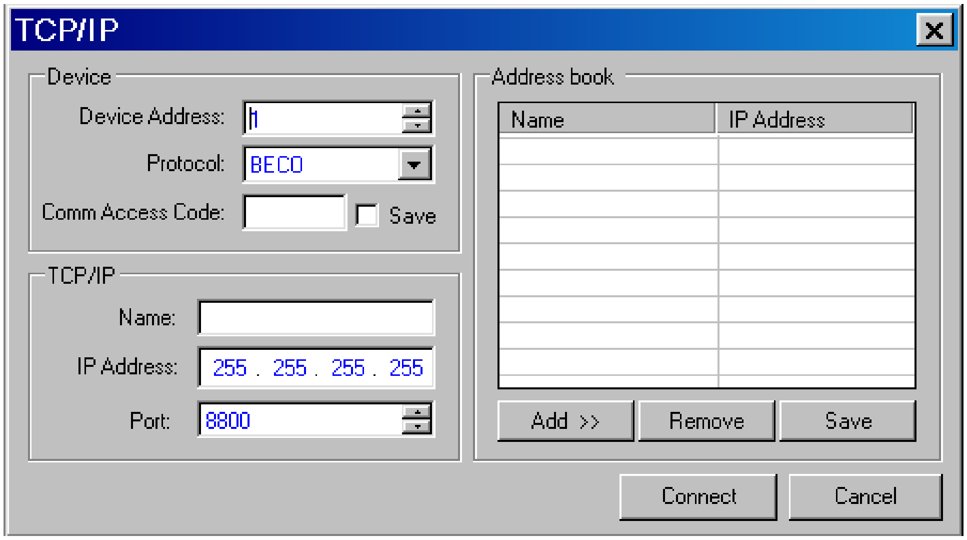


Figure 3-7 IPScom TCP/IP Ethernet Communication Dialog Screen

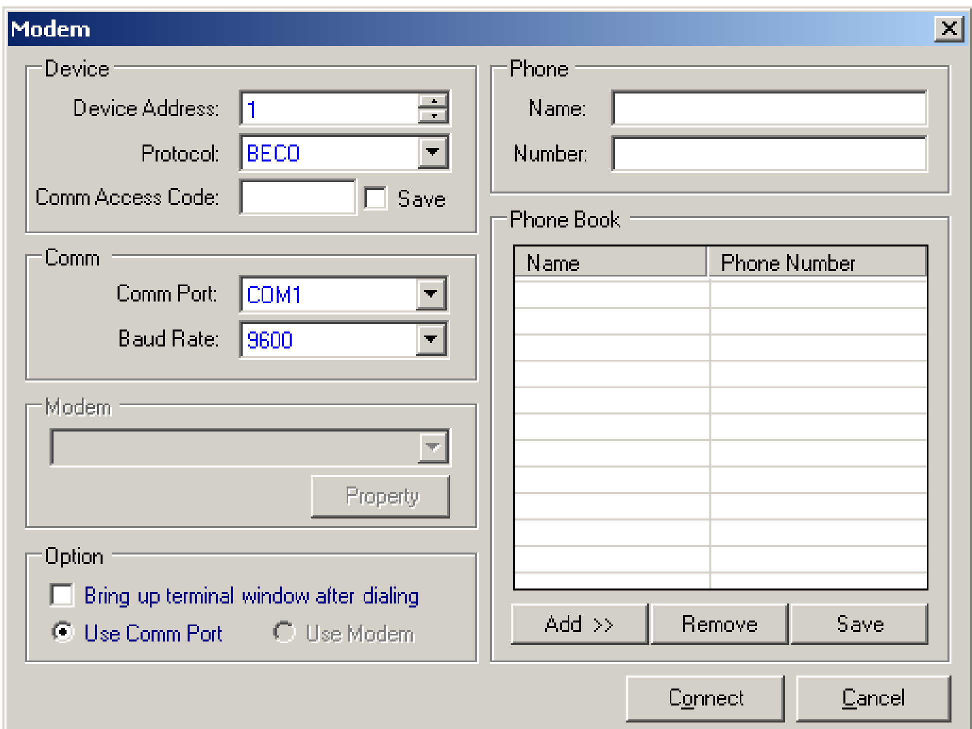


Figure 3-8 IPScom Modem Communication Dialog Screen

Communication/Open Terminal Window

Opens the IPScom Terminal Window (Figure 3-9).

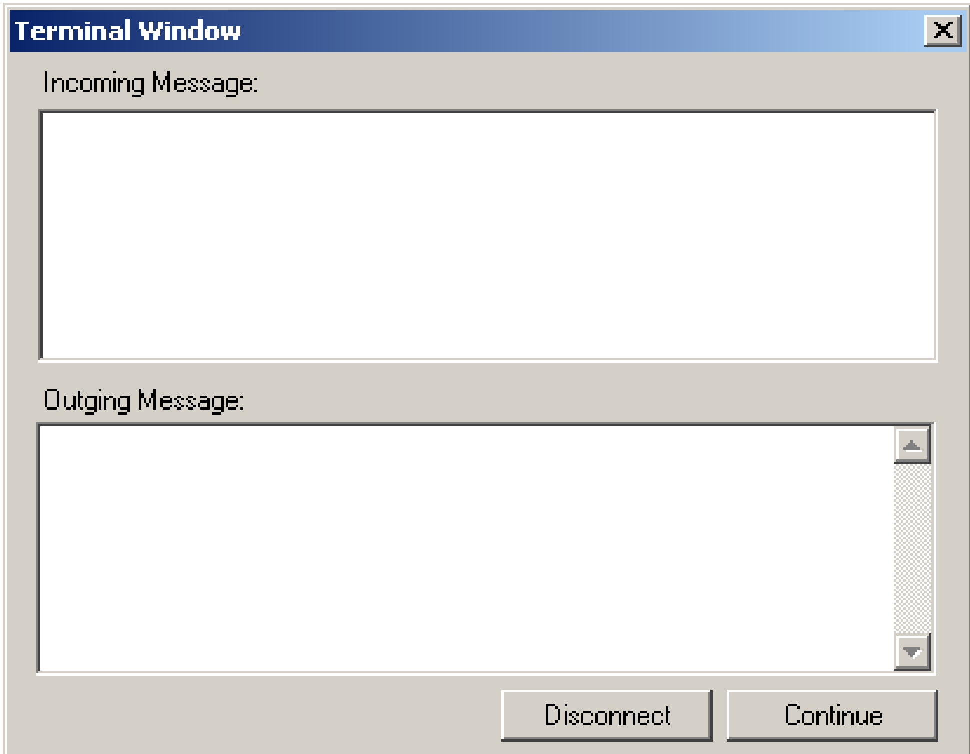
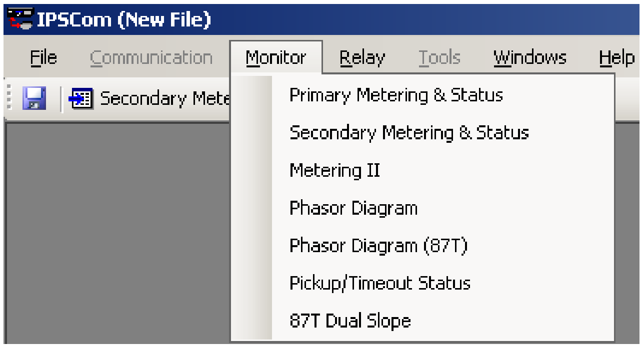


Figure 3-9 Terminal Window

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**.



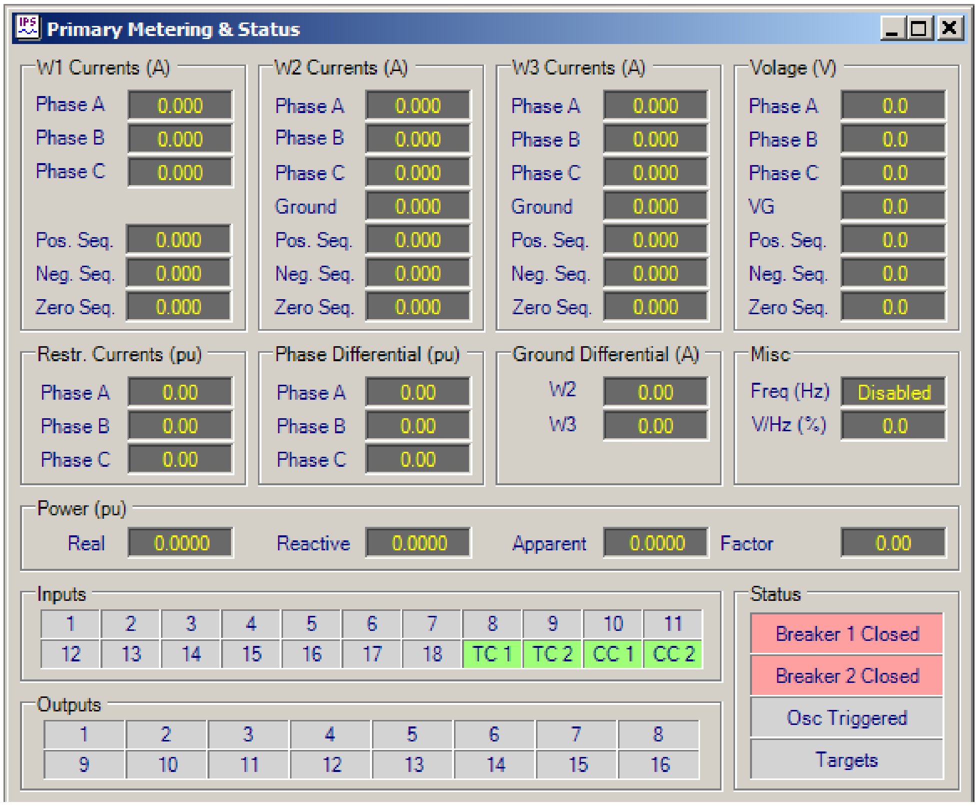
Monitor/Primary Metering & Status

The Primary Metering screen (Figure 3-10 and Figure 3-11) allow the user to review the following PRIMARY parameters:

- Voltage (V_A, V_B, V_C and V_G or $V_Ø$ 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)

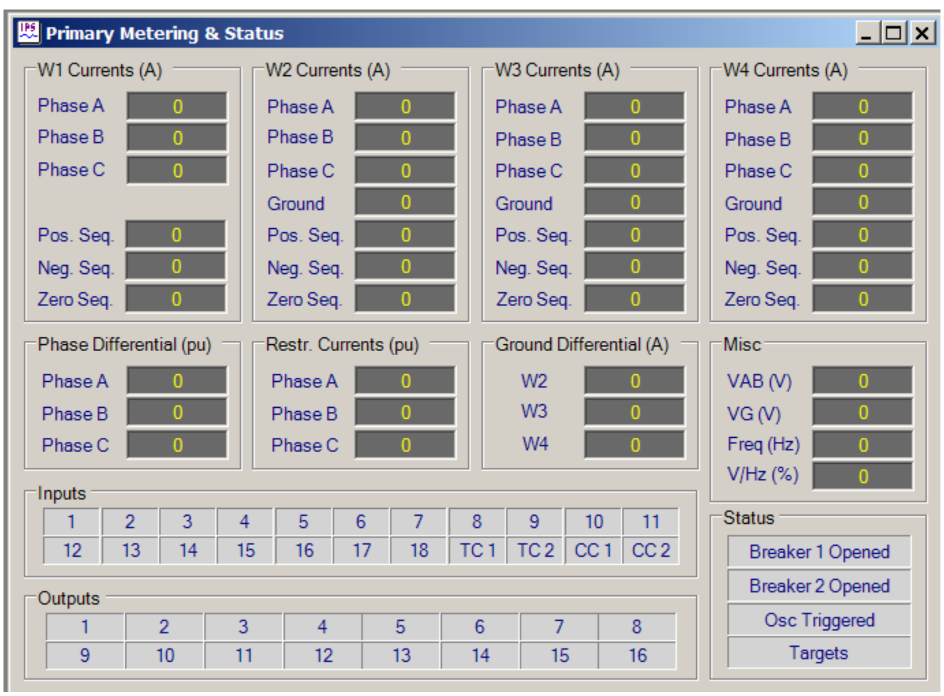
Also included on the Primary Metering & Status screen are:

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



Path: Monitor / Primary Metering and Status

Figure 3-10 Primary Metering Status Screen (Two-/Three-Winding)



Path: Monitor / Primary Metering and Status

Figure 3-11 Primary Metering Status Screen (Four-Winding)

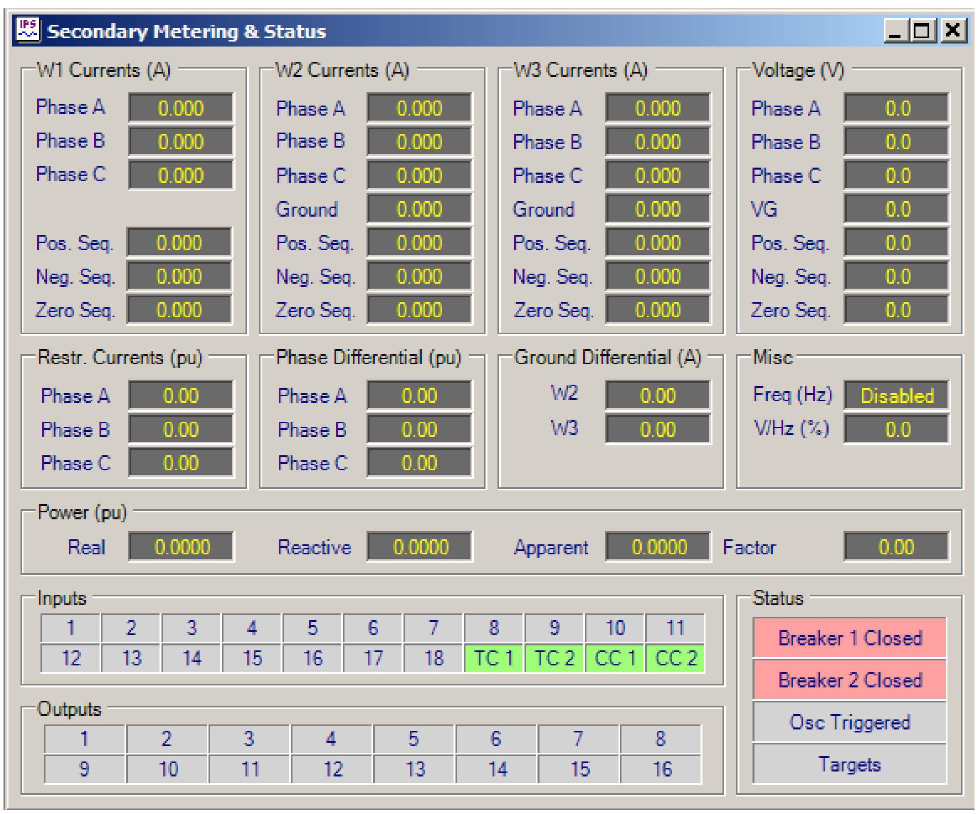
Monitor/Secondary Metering & Status

The Secondary Metering and Status screen (Figure 3-12 and Figure 3-13) allow the user to review the following **SECONDARY** parameters:

- Voltage (V_A, V_B, V_C and V_G or $V_Ø$ 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)

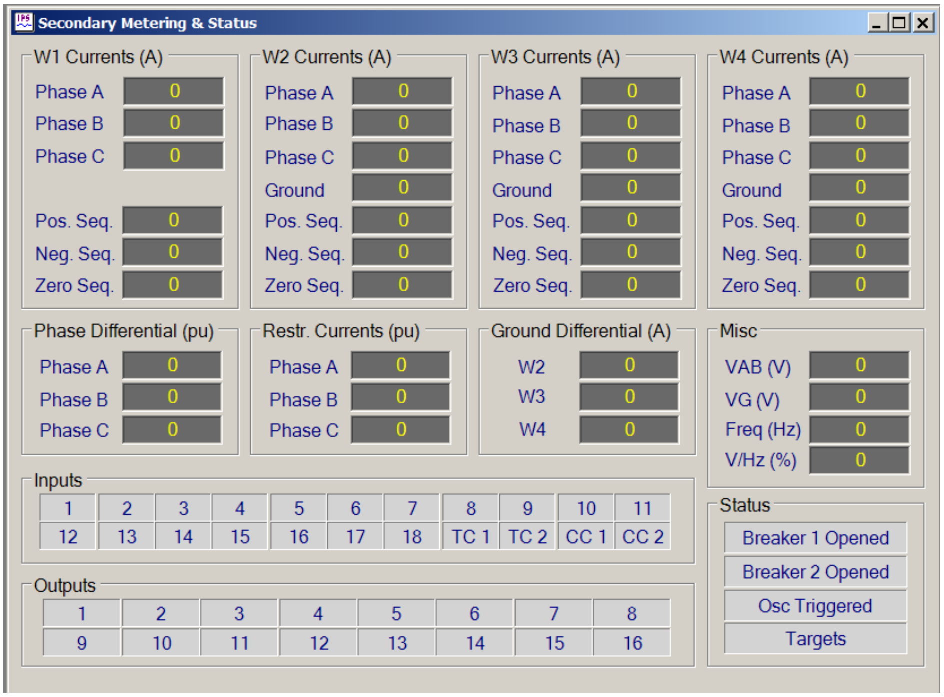
Also included on the Secondary Metering & Status screen are:

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



Path: Monitor / Secondary Metering and Status

Figure 3-12 Secondary Metering Status Screen (Two-/Three-Winding)



Path: Monitor / Secondary Metering and Status

Figure 3-13 Secondary Metering Status Screen (Four-Winding)

Monitor/Metering II

The Metering II screen (Figure 3-14 and Figure 3-15) include 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

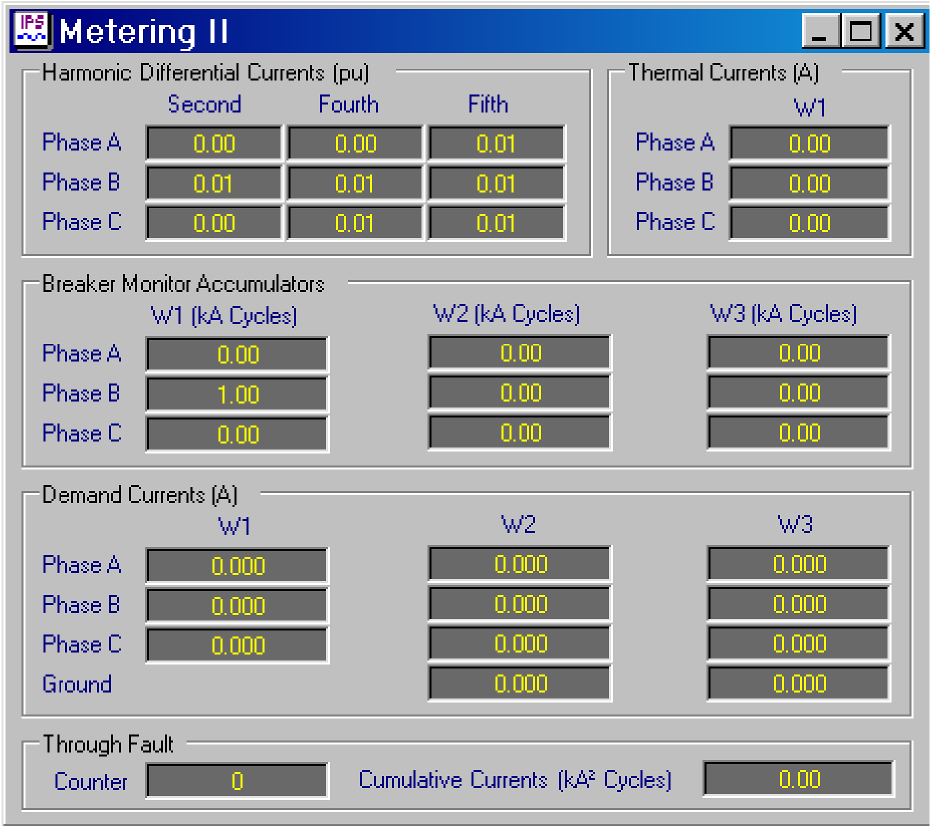
Demand Status

Monitored Primary Demand values include:

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

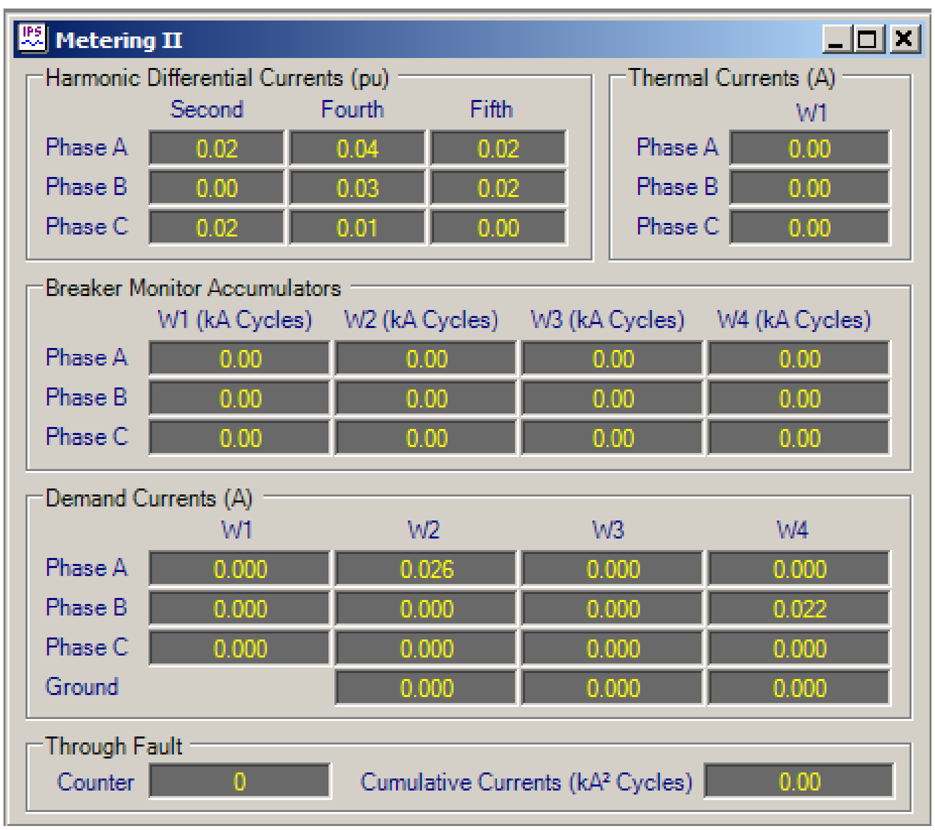
Maximum Demand Current

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



Path: Monitor / Metering II

Figure 3-14 Metering II Screen (Two-/Three-Winding)

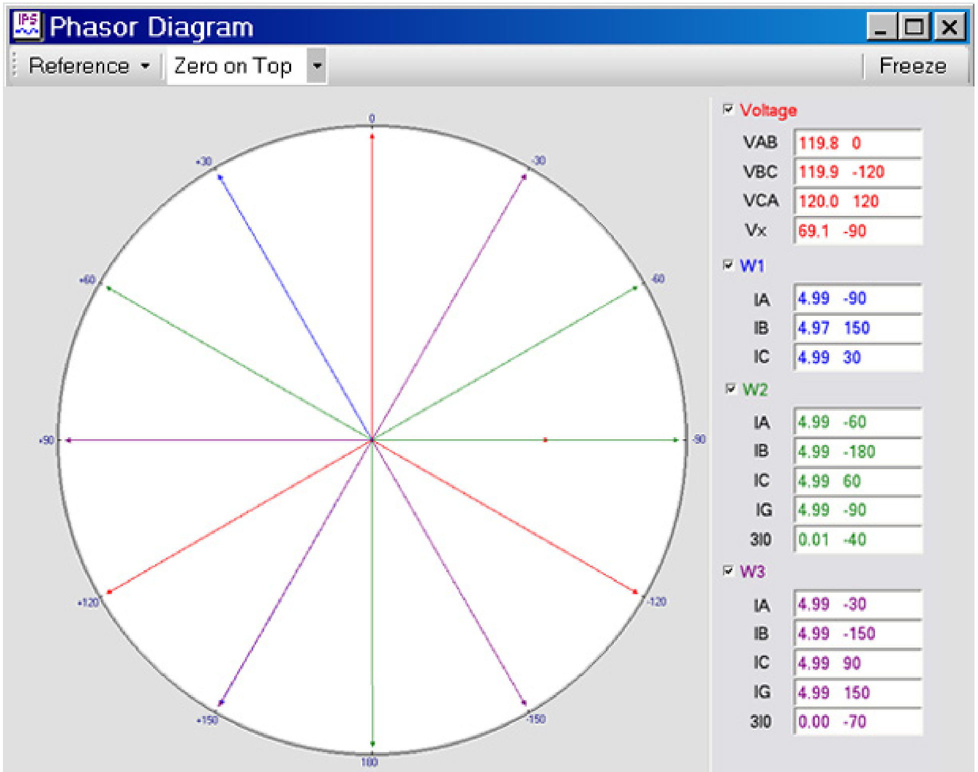


Path: Monitor / Metering II

Figure 3-15 Metering II Screen (Four-Winding)

Monitor/Phasor Diagram

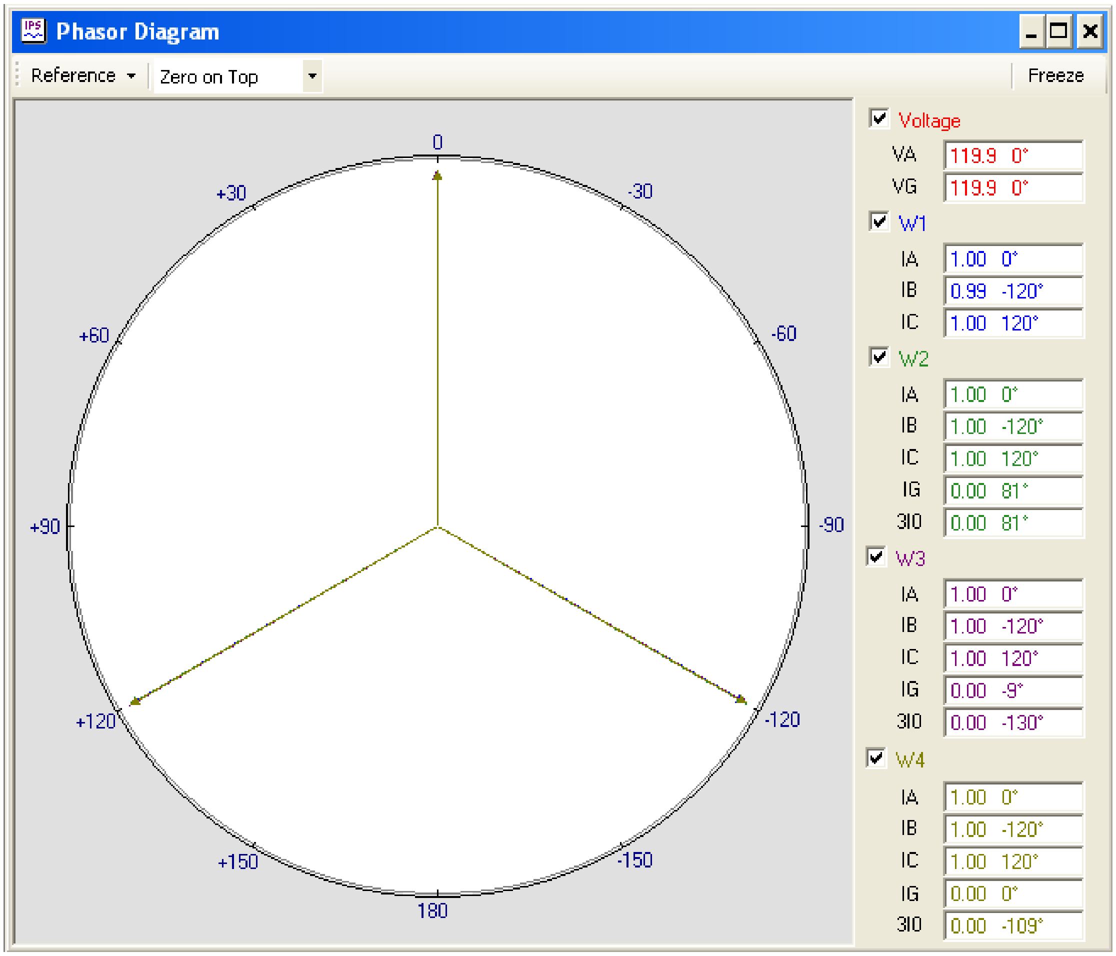
The Phasor Diagram (Figure 3-16 and Figure 3-17) provide the user with the ability to evaluate a reference Phase Angle to Phase Angle data from other windings. The Phasor Diagram also includes a menu that allows the user to select/deselect sources to be displayed and Freeze capability to freeze the data 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 3-16 Phasor Diagram (Two-/Three-Winding)



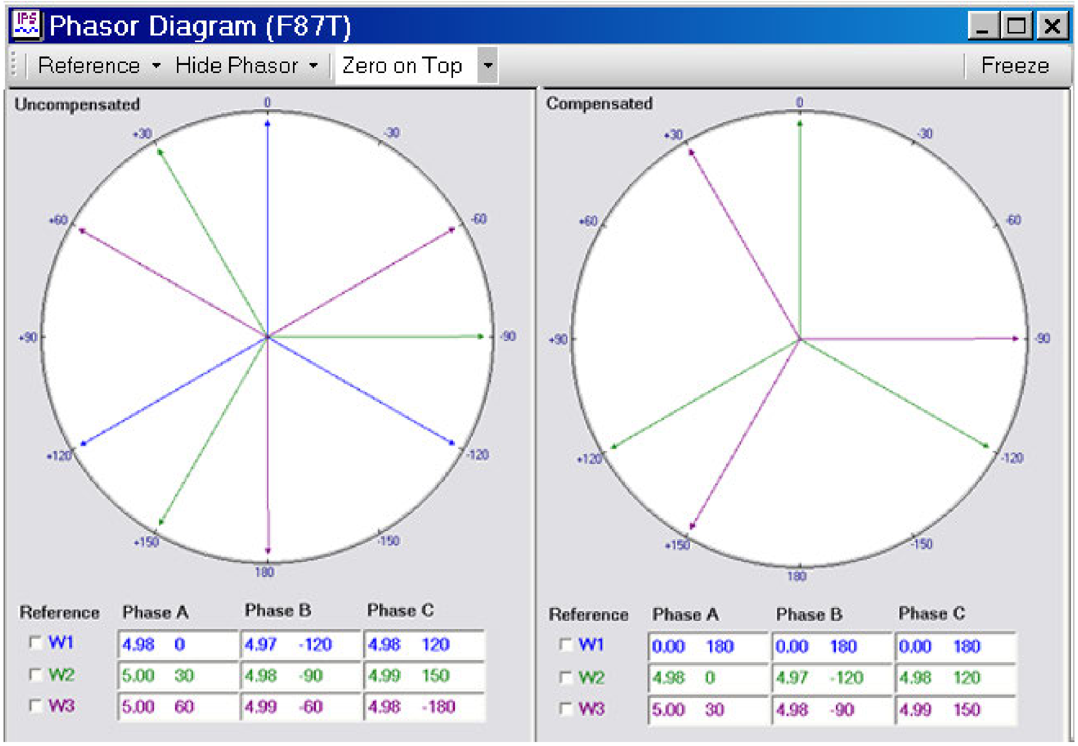
Path: Monitor / Phasor Diagram

■**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 3-17 Phasor Diagram (Four-Winding)

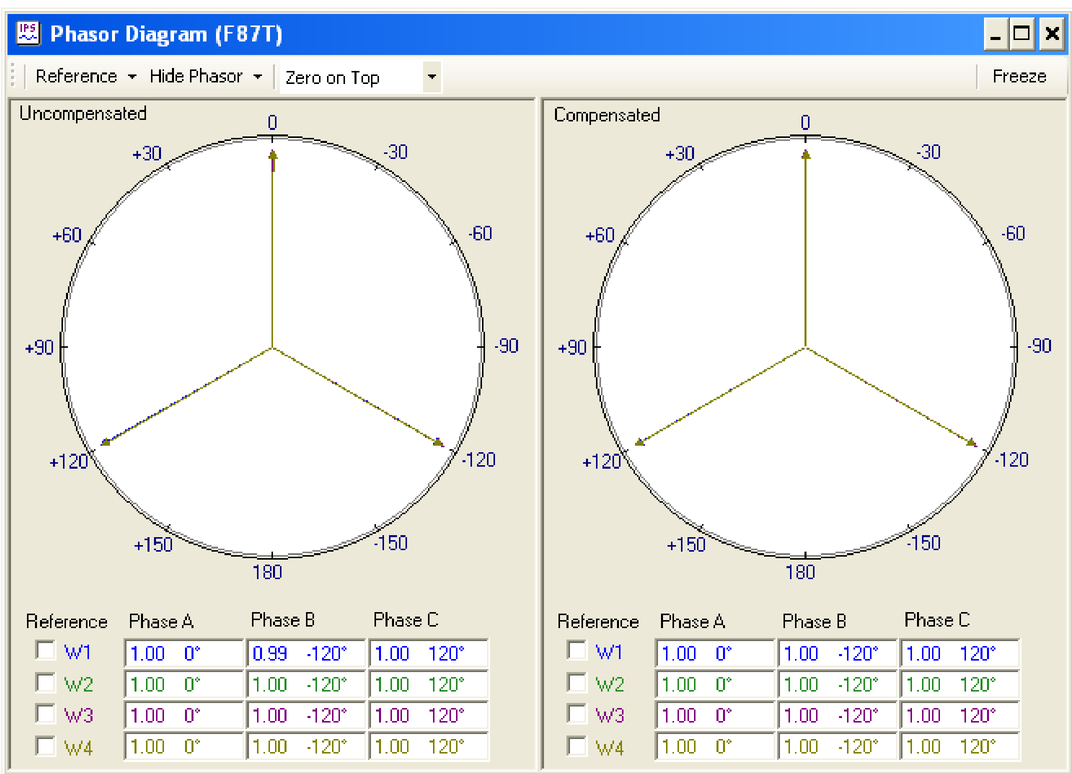
Monitor/Phasor Diagram (F87T)

The Phasor Diagram (F87T) (Figure 3-18 and Figure 3-19) provide the user with the ability to evaluate compensated and uncompensated 87 Function parameters.



Path: Monitor / Phasor Diagram (F87T)

Figure 3-18 Phasor Diagram (F87T) (Two-/Three-Winding)

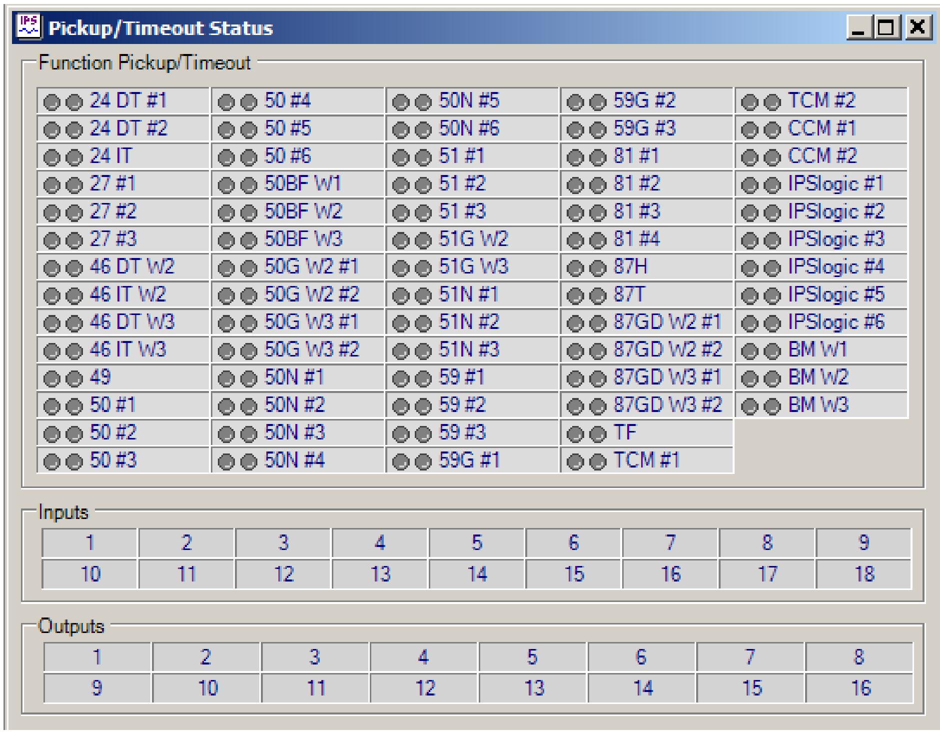


Path: Monitor / Phasor Diagram (F87T)

Figure 3-19 Phasor Diagram (F87T) (Four-Winding)

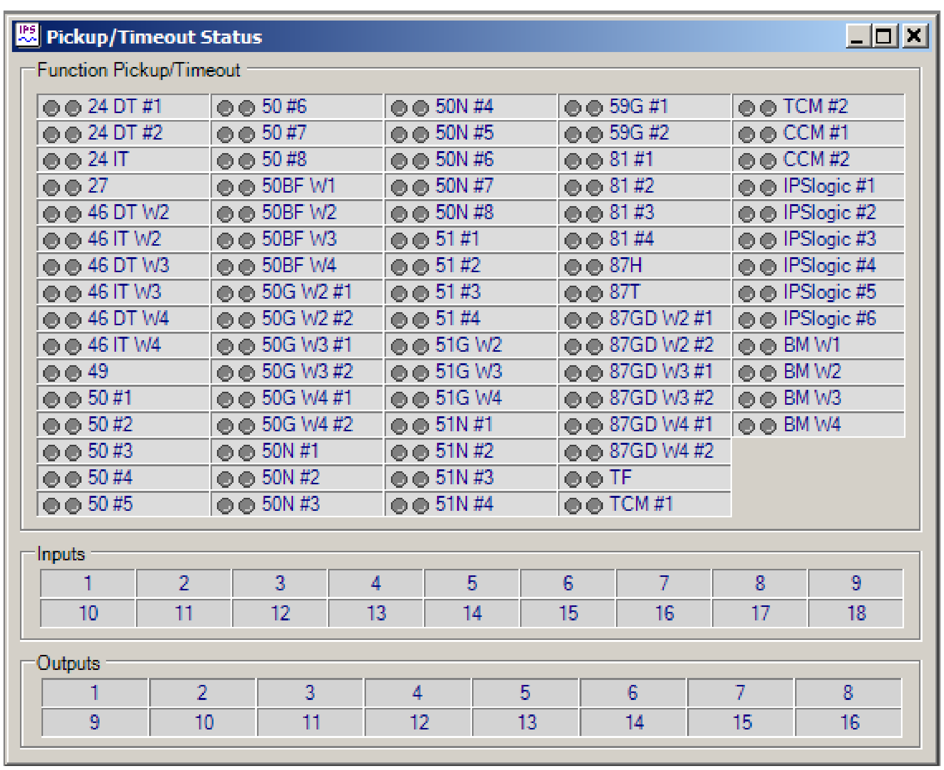
Monitor/Pickup/Timeout Status

The Pickup/Timeout Status screen (Figure 3-20 and Figure 3-21) display the extended status information of relay functions and Input/Output contact information.



Path: Monitor / Pickup / Timeout Status

Figure 3-20 Pickup/Timeout Status (Two-/Three-Winding)

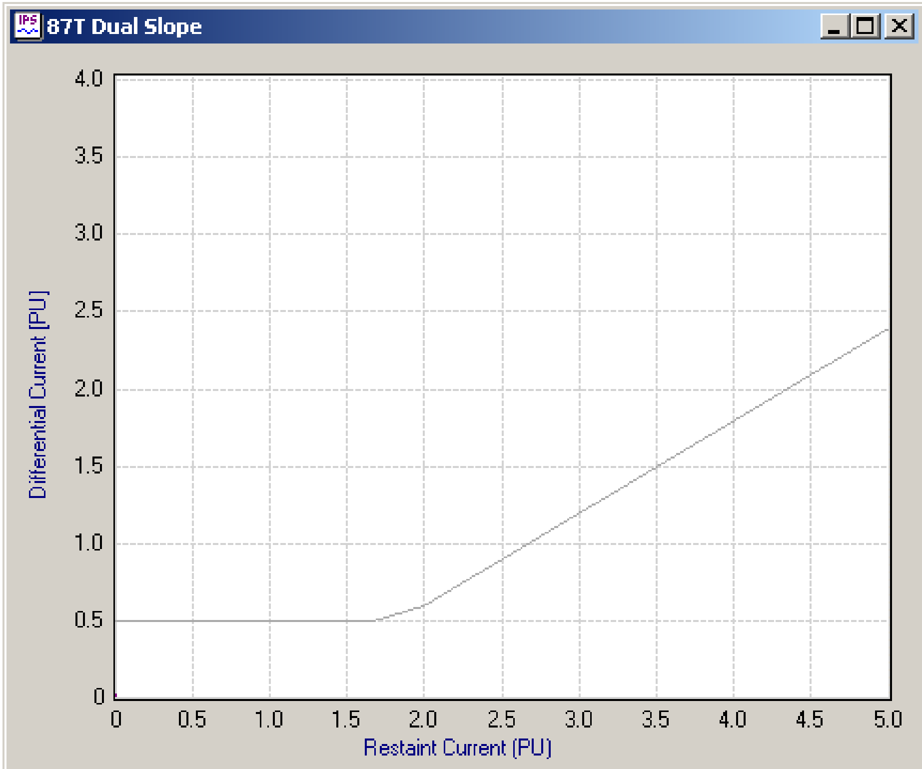


Path: Monitor / Pickup / Timeout Status

Figure 3-21 Pickup/Timeout Status (Four-Winding)

Monitor/87T Dual Slope

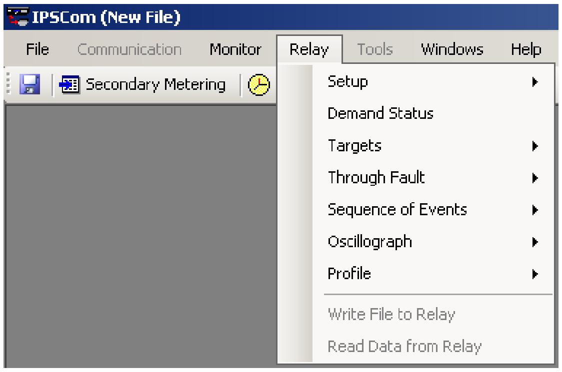
The 87T Dual Slope display allows the user to display a graphical representation of the 87T programmable Dual Slope Percentage Restraint Characteristic. See **Section 4.4**, **System Setpoints** for detailed information.



Path: Monitor / 87T Dual Slope

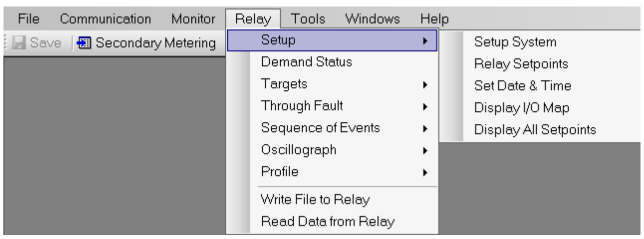
Figure 3-22 87T Function Dual Slope Display

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 **Setup System, Relay Setpoints, Set Date &Time, Display I/O Map** and **Display All Setpoints** selections.

Relay/Setup/Setup System

The **Setup System** selection displays the Setup System dialog screen (Figure 3-23 and Figure 3-24) allowing the user to input the pertinent information regarding the system on which the relay is applied (see **Section 4.2**, **Setup System**, for detailed information regarding the specific elements of the Setup System 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.

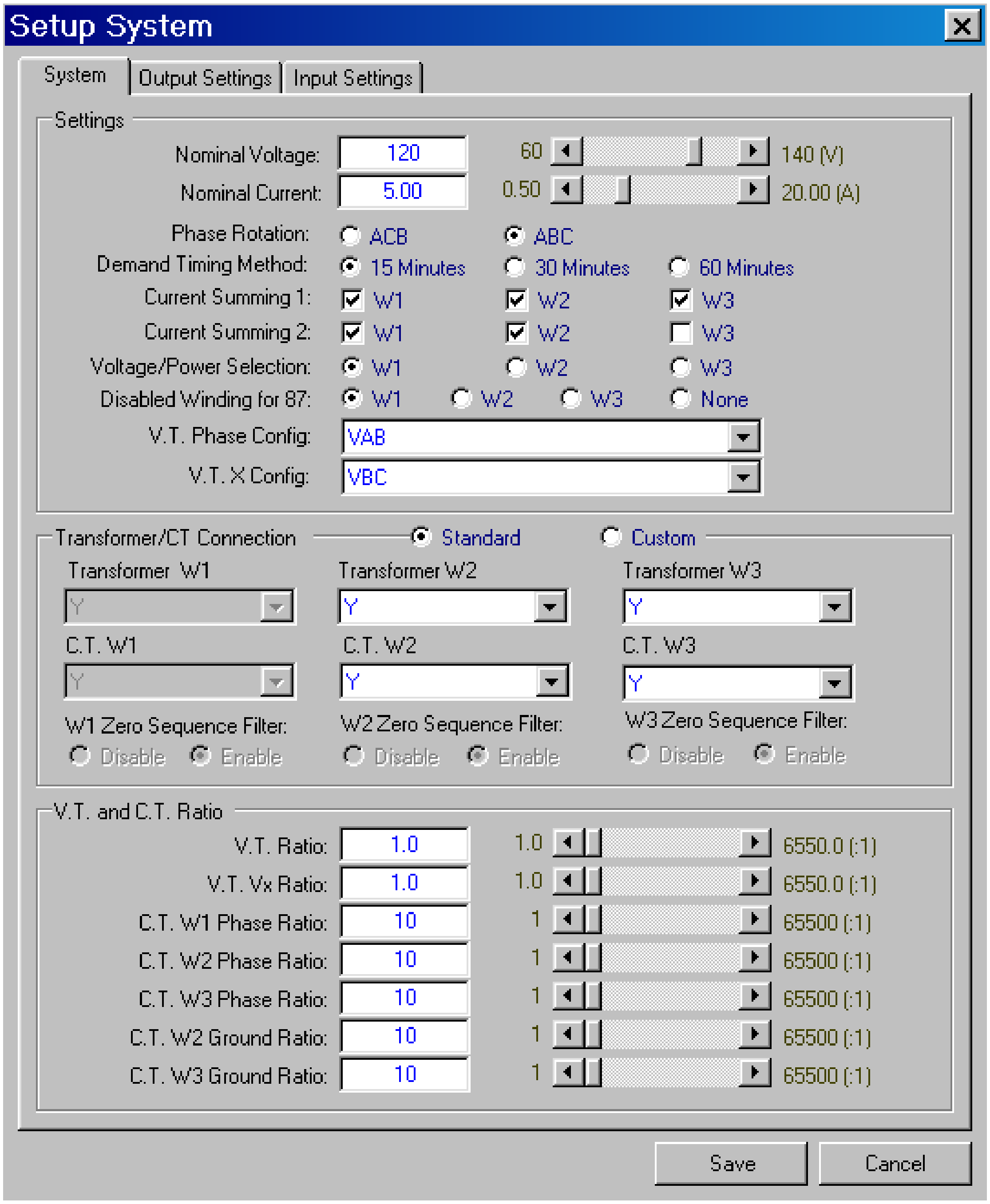


Figure 3-23 Setup System Dialog Screen (Two-/Three-Winding)

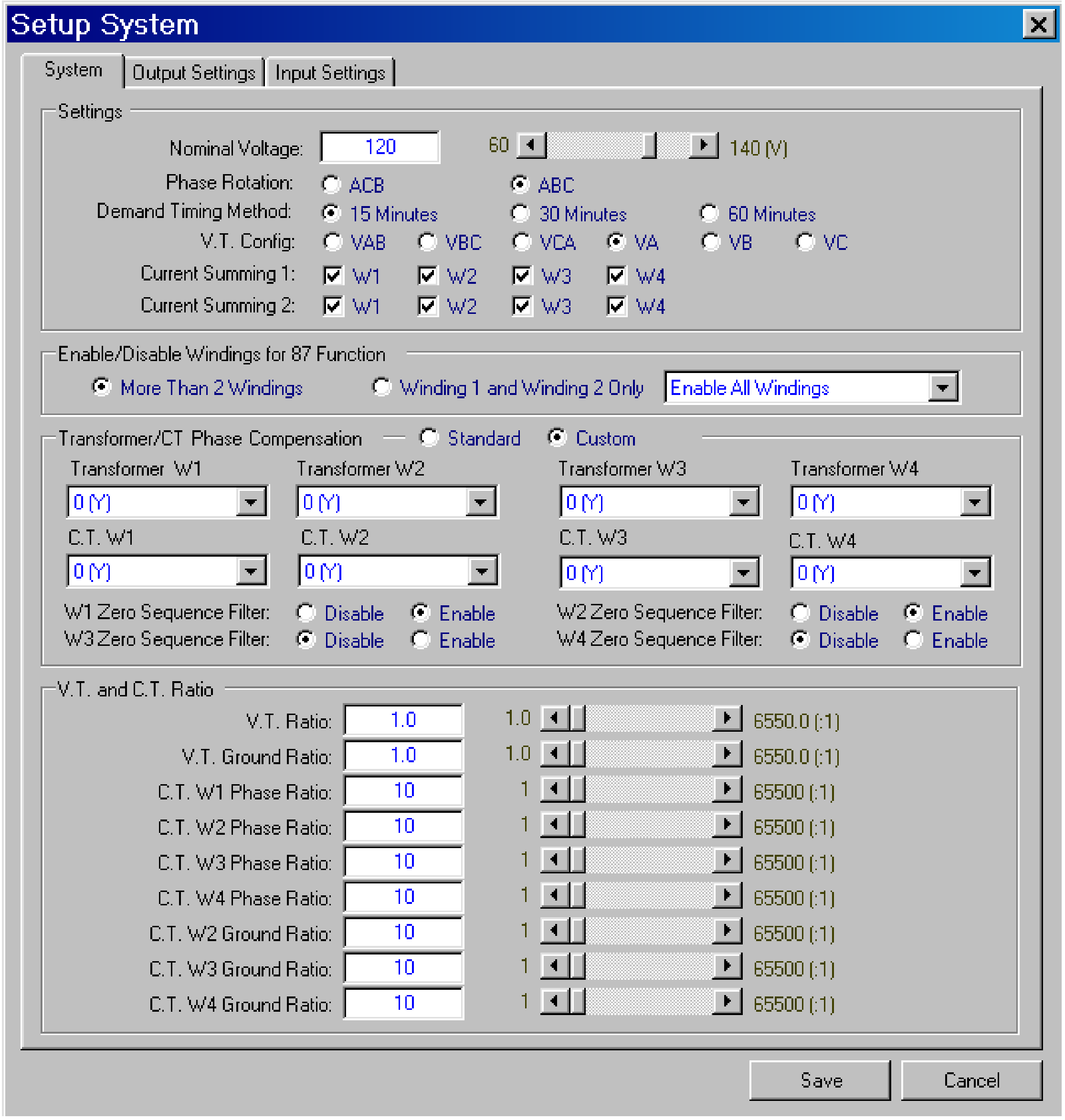


Figure 3-24 Setup System Dialog Screen (Four-Winding)

Relay/Setup/Relay Setpoints

The **Relay Setpoints** menu selection displays the Relay Setpoints dialog screen (Figure 3-25 and Figure 3-26) 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 3-27 as an example).

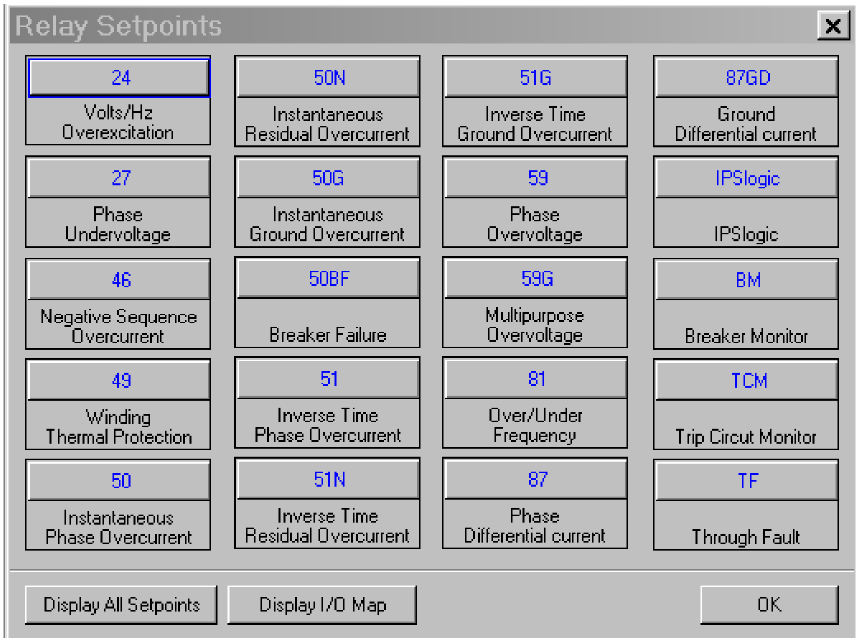


Figure 3-25 Relay Setpoints Dialog Screen (Two-/Three-Winding)

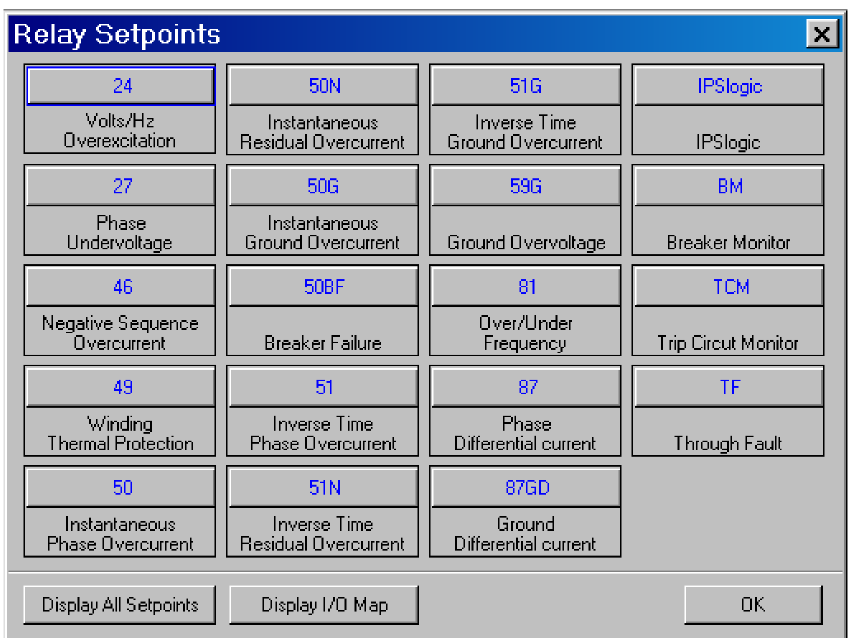


Figure 3-26 Relay Setpoints Dialog Screen (Four-Winding)

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 3-29 and Figure 3-30)

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

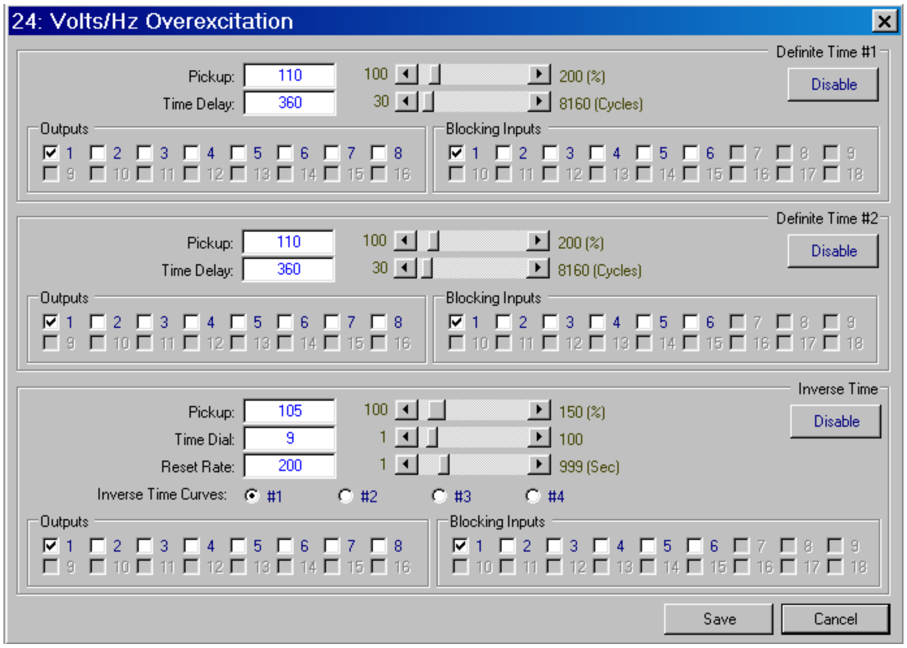


Figure 3-27 Example Function Dialog Screen

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.

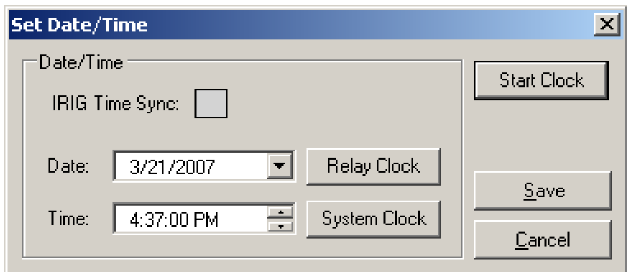
Relay/Setup/Set Date & Time

The **Setup Date & Time** command (Figure 3-28) 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 IRIG-B 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: Relay / Setup Date & Time

Figure 3-28 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 3-29 and Figure 3-30), which contain 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.

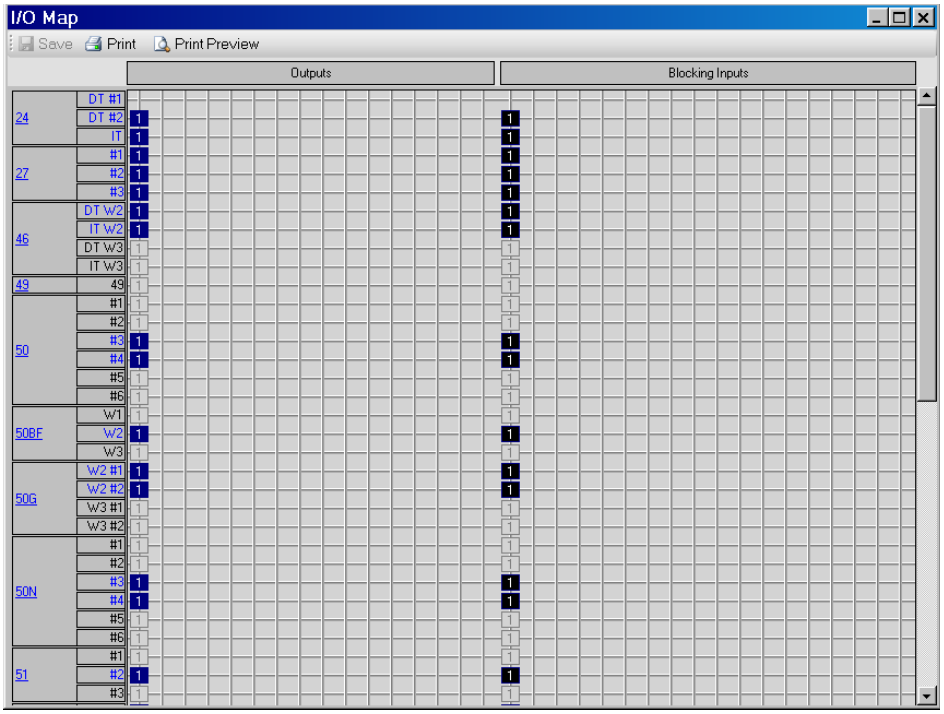


Figure 3-29 I/O Map Screen (Two-/Three-Winding)

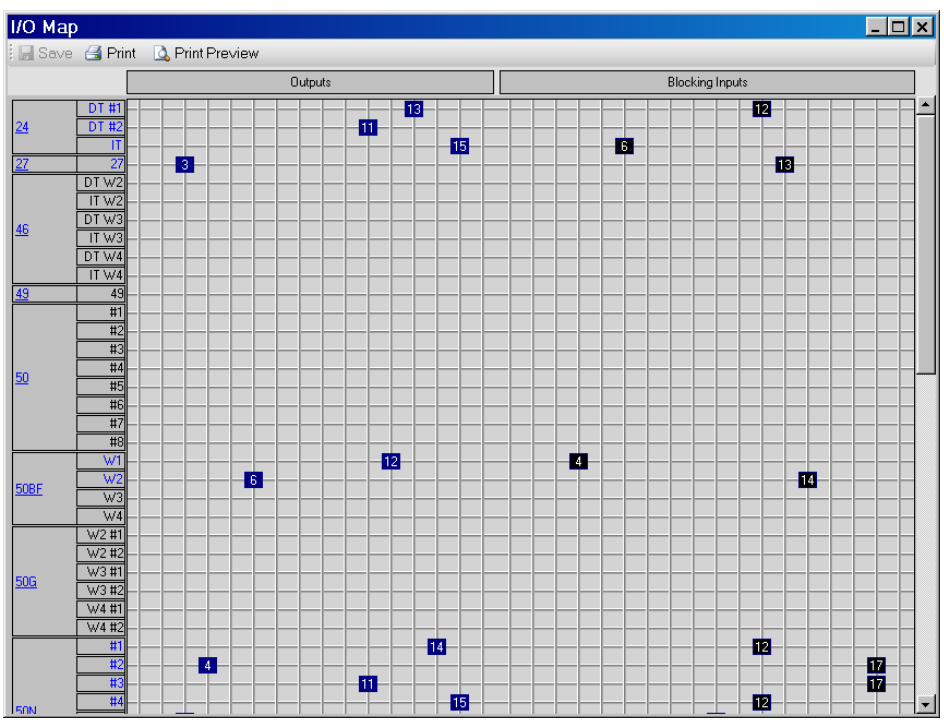


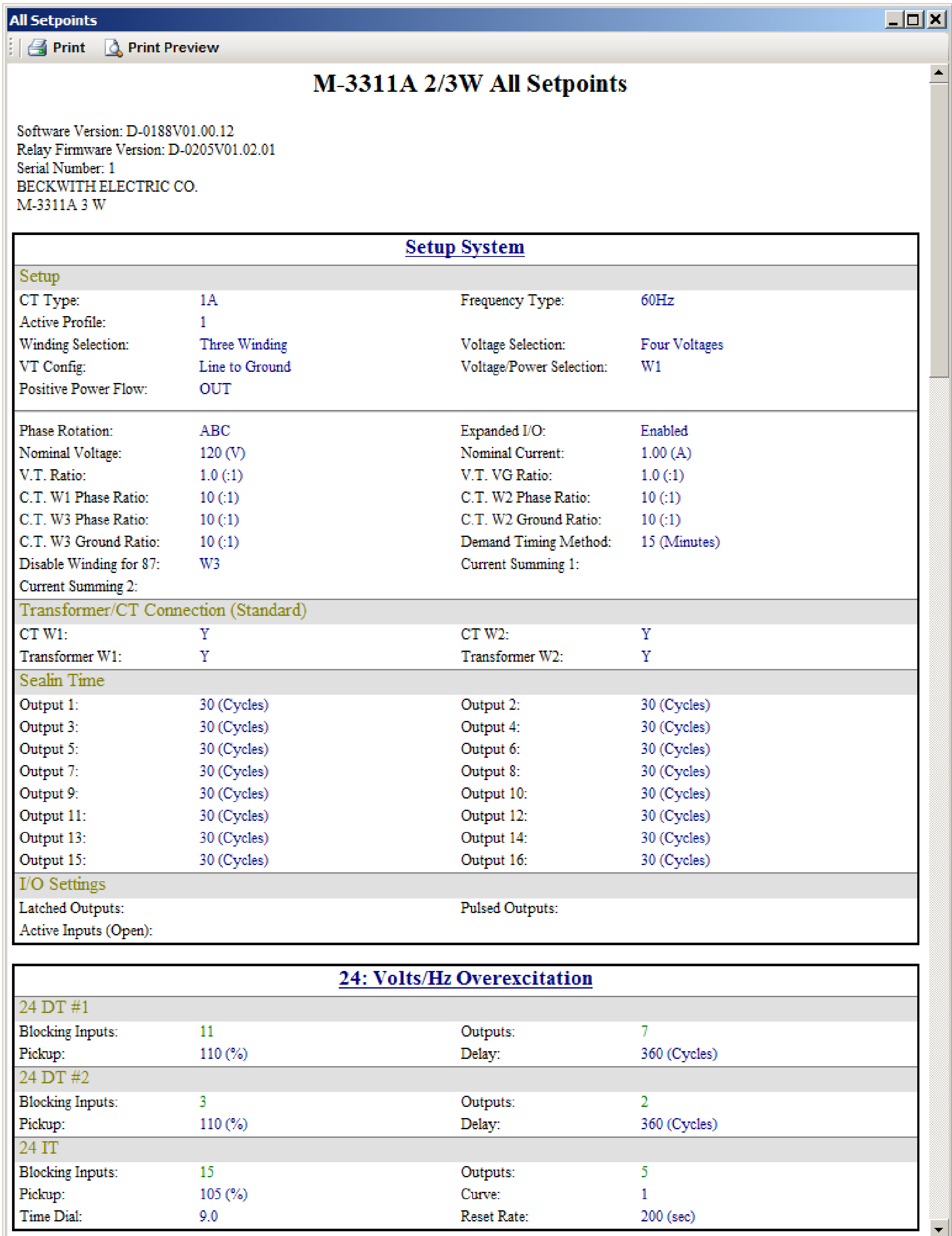
Figure 3-30 I/O Map Screen (Four-Winding)

Relay/Setup/Display All Setpoints

Selecting the **Display All Setpoints** button displays the **All Setpoints** dialog screen (Figure 3-31 and Figure 3-32). 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.


All Setpoints

Print Print Preview

M-3311A 2/3W All Setpoints

Software Version: D-0188V01.00.12
Relay Firmware Version: D-0205V01.02.01
Serial Number: 1
BECKWITH ELECTRIC CO.
M-3311A 3 W

Setup System

Setup			
CT Type:	1A	Frequency Type:	60Hz
Active Profile:	1		
Winding Selection:	Three Winding	Voltage Selection:	Four Voltages
VT Config:	Line to Ground	Voltage/Power Selection:	W1
Positive Power Flow:	OUT		
Phase Rotation:	ABC	Expanded I/O:	Enabled
Nominal Voltage:	120 (V)	Nominal Current:	1.00 (A)
V.T. Ratio:	1.0 (:1)	V.T. VG Ratio:	1.0 (:1)
C.T. W1 Phase Ratio:	10 (:1)	C.T. W2 Phase Ratio:	10 (:1)
C.T. W3 Phase Ratio:	10 (:1)	C.T. W2 Ground Ratio:	10 (:1)
C.T. W3 Ground Ratio:	10 (:1)	Demand Timing Method:	15 (Minutes)
Disable Winding for 87:	W3	Current Summing 1:	
Current Summing 2:			
Transformer/CT Connection (Standard)			
CT W1:	Y	CT W2:	Y
Transformer W1:	Y	Transformer W2:	Y
SealIn Time			
Output 1:	30 (Cycles)	Output 2:	30 (Cycles)
Output 3:	30 (Cycles)	Output 4:	30 (Cycles)
Output 5:	30 (Cycles)	Output 6:	30 (Cycles)
Output 7:	30 (Cycles)	Output 8:	30 (Cycles)
Output 9:	30 (Cycles)	Output 10:	30 (Cycles)
Output 11:	30 (Cycles)	Output 12:	30 (Cycles)
Output 13:	30 (Cycles)	Output 14:	30 (Cycles)
Output 15:	30 (Cycles)	Output 16:	30 (Cycles)
I/O Settings			
Latched Outputs:		Pulsed Outputs:	
Active Inputs (Open):			

24: Volts/Hz Overexcitation

24 DT #1			
Blocking Inputs:	11	Outputs:	7
Pickup:	110 (%)	Delay:	360 (Cycles)
24 DT #2			
Blocking Inputs:	3	Outputs:	2
Pickup:	110 (%)	Delay:	360 (Cycles)
24 IT			
Blocking Inputs:	15	Outputs:	5
Pickup:	105 (%)	Curve:	1
Time Dial:	9.0	Reset Rate:	200 (sec)

Figure 3-31 Display All Setpoints Screen (Two-/Three-Winding)

Print   Print Preview

M-3311A All Setpoints

IPScom Version: D-0188V01.00.12
Relay Firmware Version: D-0205V01.02.01
Serial Number: 1
BECKWITH ELECTRIC CO.

Software Version: D-0188V01.00.12
Relay Firmware Version: D-0205V01.03.01

Setup

CT Type:	5A	Frequency Type:	60Hz
Phase Rotation:	ABC	Expanded I/O:	Enabled
Nominal Voltage:	120 (V)	VT Config:	VA
V.T. Ratio:	1.0 (:1)	V.T. Ground Ratio:	1.0 (:1)
C.T. W1 Phase Ratio:	10 (:1)	C.T. W2 Phase Ratio:	10 (:1)
C.T. W3 Phase Ratio:	10 (:1)	C.T. W4 Phase Ratio:	10 (:1)
C.T. W2 Ground Ratio:	10 (:1)	C.T. W3 Ground Ratio:	10 (:1)
C.T. W4 Ground Ratio:	10 (:1)		
Demand Timing Method:	15 (Minutes)	Disabled Winding:	
Winding Summing 1:	W1 W2	Winding Summing 2:	W1 W2

Transformer/CT Connection (Standard)

CT W1:	Y	CT W2:	Y
CT W3:	Y	CT W4:	Y
Transformer W1:	Y	Transformer W2:	Y
Transformer W3:	Y	Transformer W4:	Y

SealIn Time

Output 1:	30 (Cycles)	Output 2:	30 (Cycles)
Output 3:	30 (Cycles)	Output 4:	30 (Cycles)
Output 5:	30 (Cycles)	Output 6:	30 (Cycles)
Output 7:	30 (Cycles)	Output 8:	30 (Cycles)
Output 9:	30 (Cycles)	Output 10:	30 (Cycles)
Output 11:	30 (Cycles)	Output 12:	30 (Cycles)
Output 13:	30 (Cycles)	Output 14:	30 (Cycles)
Output 15:	30 (Cycles)	Output 16:	30 (Cycles)

I/O Settings

Latched Outputs:		Pulsed Outputs:	
Active Inputs (Open):			

24: Volts/Hz Overexcitation

24 DT #1 (Disabled)
24 DT #2 (Disabled)
24 IT (Disabled)

27: Phase Undervoltage

27

Blocking Inputs:	1	Outputs:	1
Pickup:	108 (V)	Inhibit Voltage:	108 (V)
Inhibit	Disabled	Delay:	30 (Cycles)

Figure 3-32 Display All Setpoints Screen (Four-Winding)

Relay/Demand Status

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

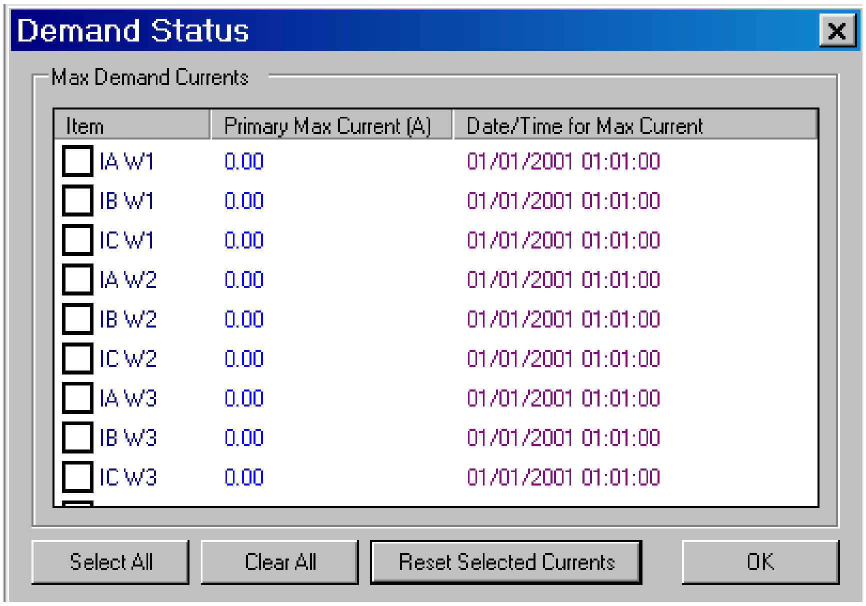


Figure 3-33 Demand Status Dialog Screen (Two-/Three-Winding)

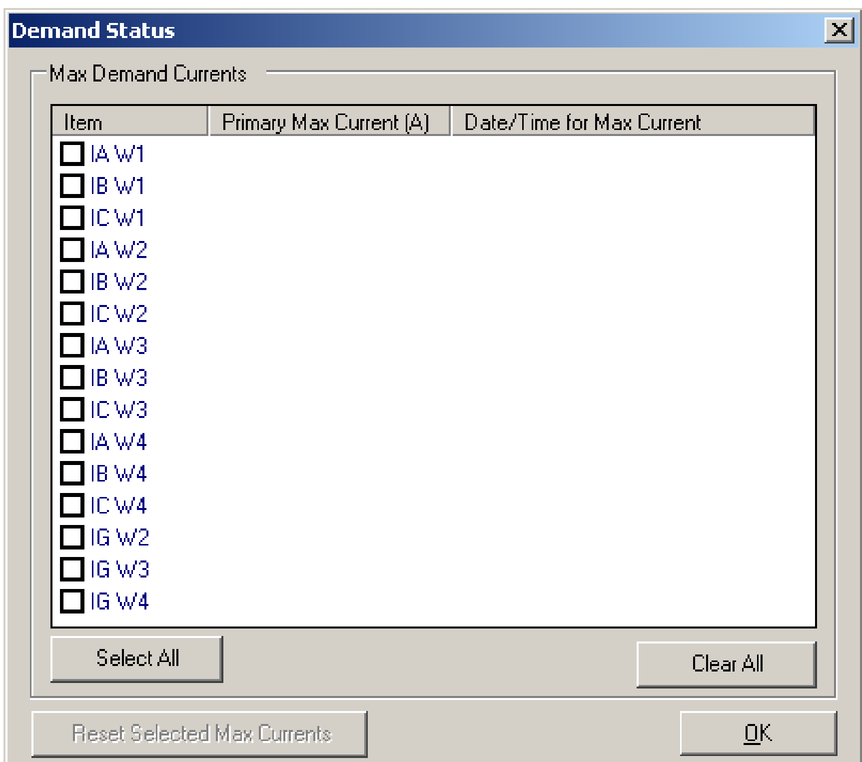
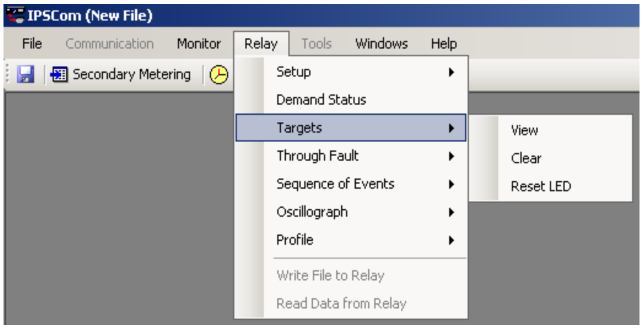


Figure 3-34 Demand Status Dialog Screen (Four-Winding)

Relay/Targets



The **Targets** submenu provides three command options: **View, Clear** and **Reset LED**. The **View** command displays the View Targets Dialog Screen (see Figure 3-35). This dialog screen 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 and saved to a text file, or be printed out with optional added comments. The **Reset LED** selection is similar to pressing the **Target Reset** button on the relay Front Panel. This command resets current targets 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.

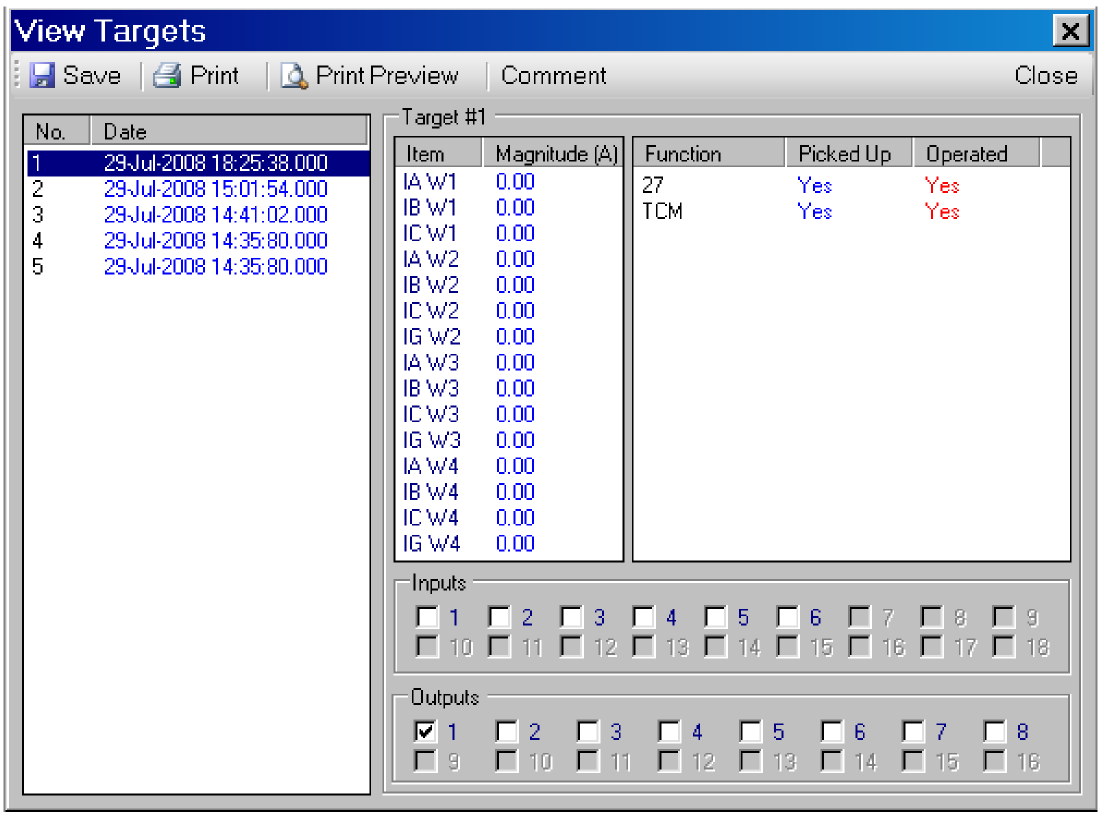
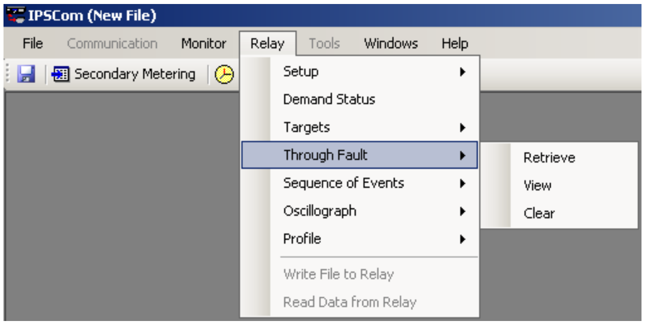


Figure 3-35 View Targets Dialog Screen

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 3-36). 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.

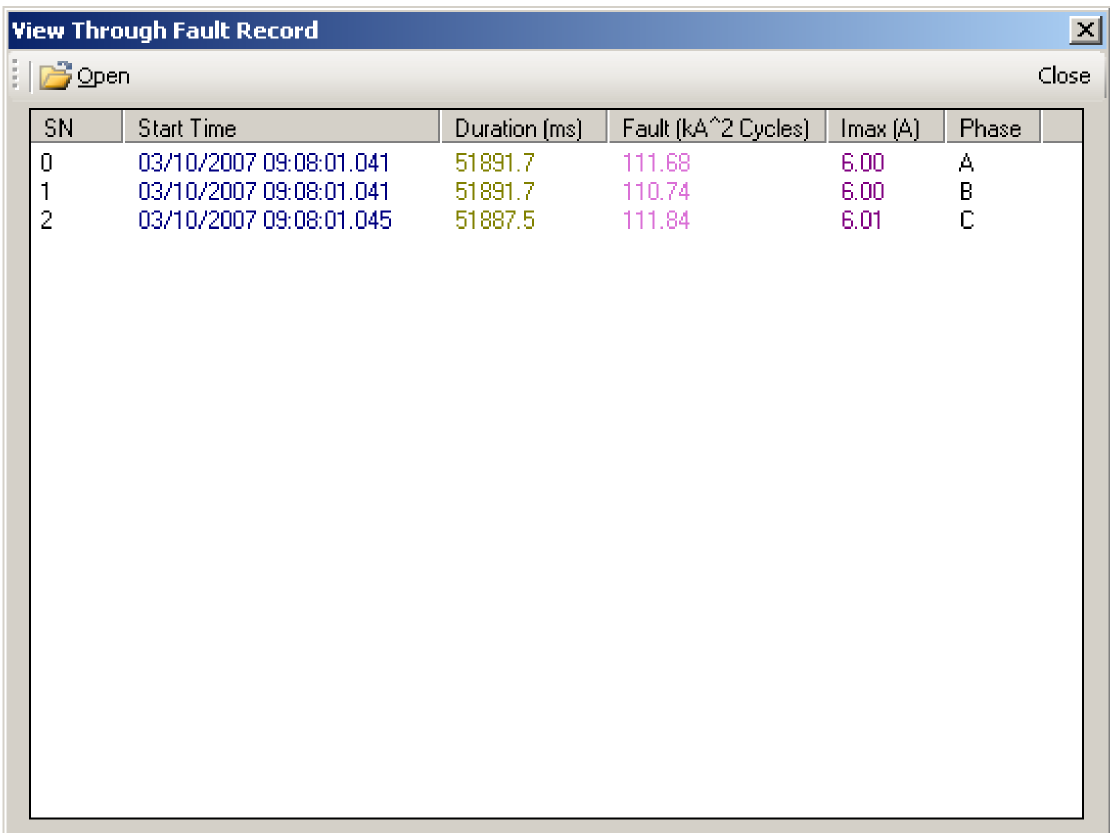
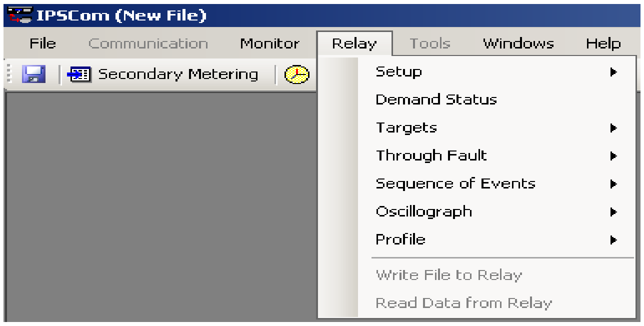


Figure 3-36 View Through Fault Record Screen

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

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 3-37). Function Pickup, Trip and Dropout can be selected to initiate the recorder as well as Input Pickup, Output Pickup, Inputs Drop and Outputs Drop. The **Retrieve** command downloads and saves the record to file (Figure 3-38). The **View** command displays the View Sequence of Events Record screen (Figure 3-39) 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.

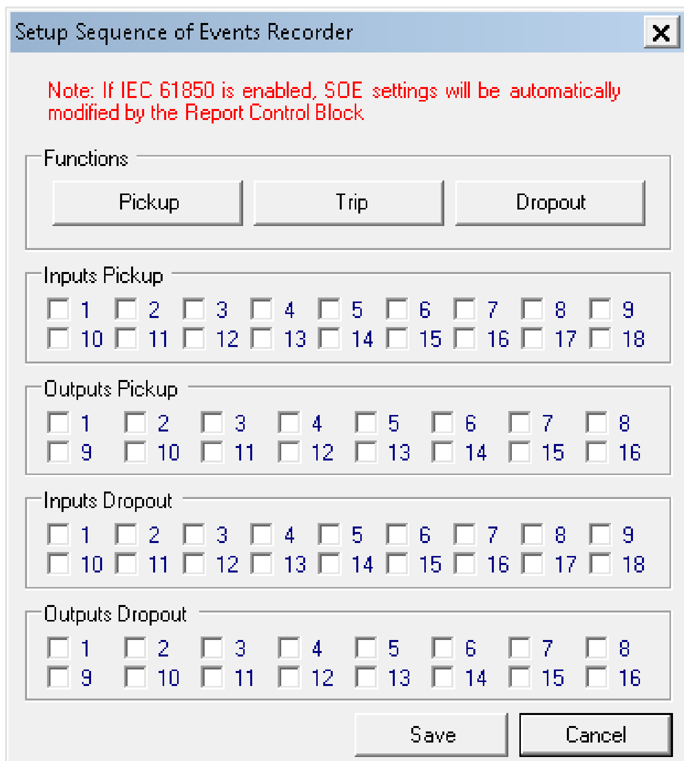


Figure 3-37 Sequence of Events Recorder Setup Screen

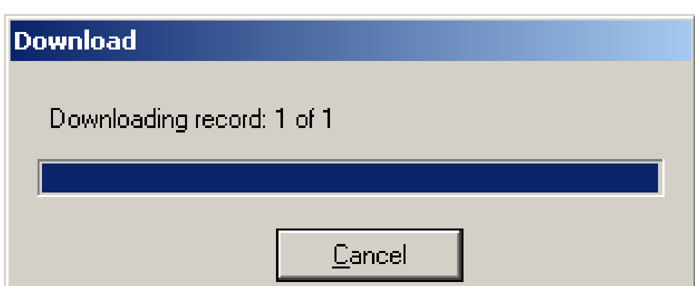


Figure 3-38 Sequence of Events Recorder Retrieve Screen

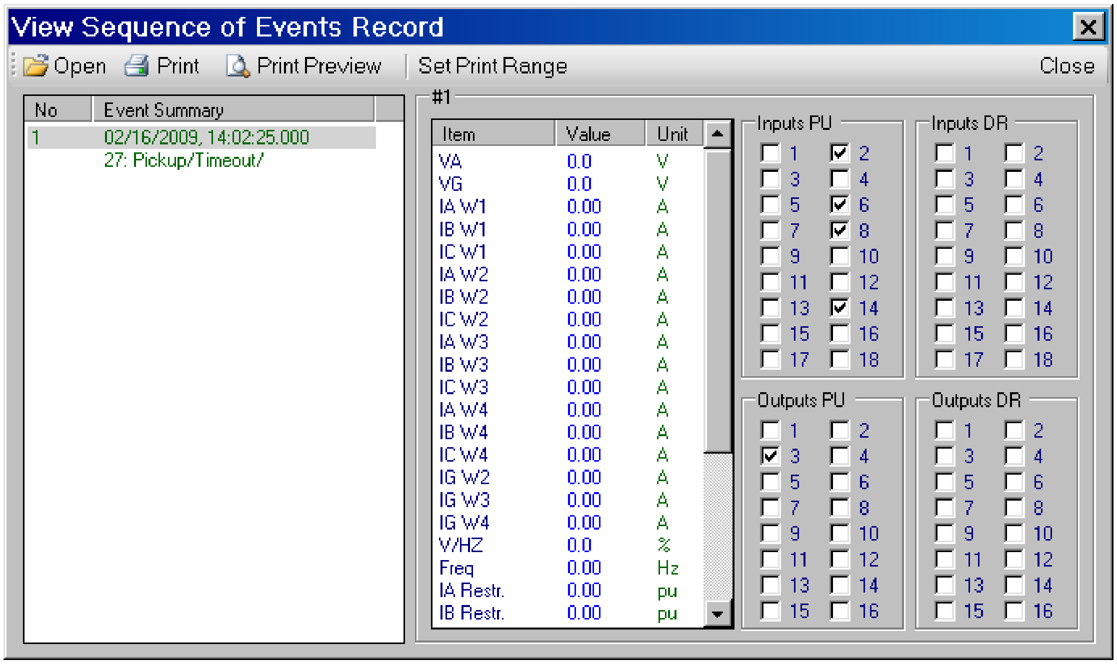
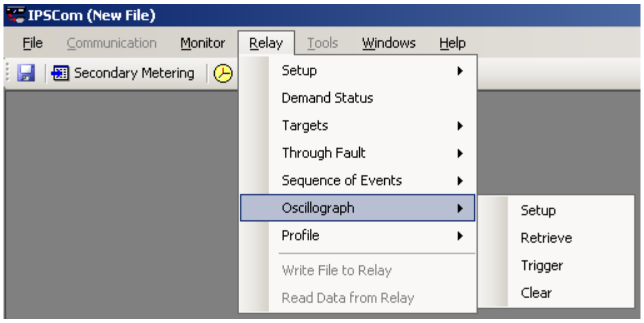


Figure 3-39 View Sequence of Events Recorder Screen

▲CAUTION: Sequence of Events records are not retained if power to the relay is interrupted.

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 3-40 and Figure 3-41), **Retrieve** downloads and save data to a file (Figure 3-42). **Trigger** sends a command to the relay 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 or the files can be converted to ComTrade format.

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

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

Figure 3-40 Setup Oscillograph Recorder Dialog Screen (Two-/Three-Winding)

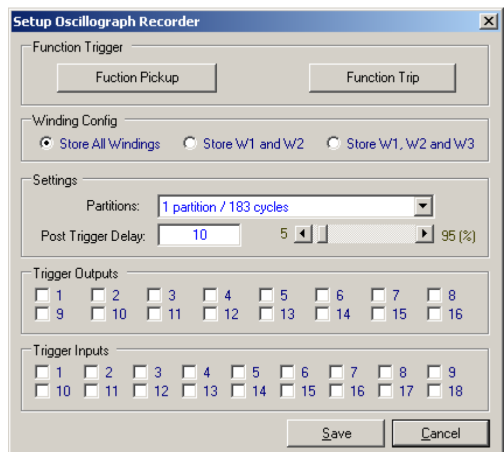


Figure 3-41 Setup Oscillograph Recorder Dialog Screen (Four-Winding)

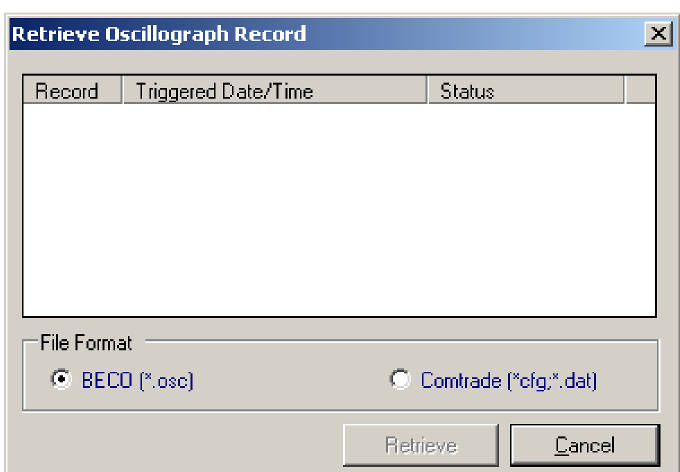
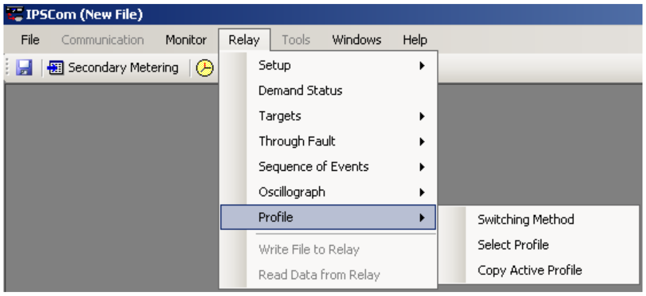


Figure 3-42 Oscillograph Recorder Retrieve Dialog Screen

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**.

The Switching Method command allows selection of either Manual or Input contact (Figure 3-43). **Select Profile** allows the user to designate the active profile (Figure 3-44). **Copy Active Profile** copies the active profile to one of four profiles (user should allow approximately 15 seconds for copying) (Figure 3-45).

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

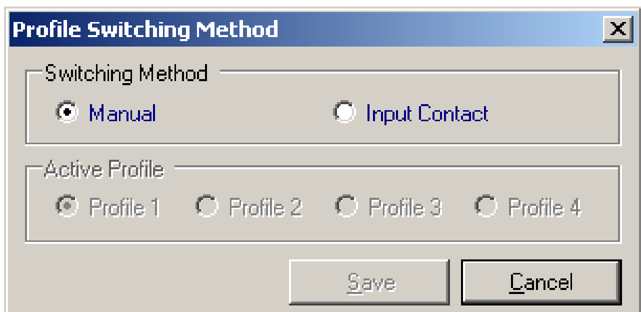


Figure 3-43 Profile Switching Method Dialog Screen

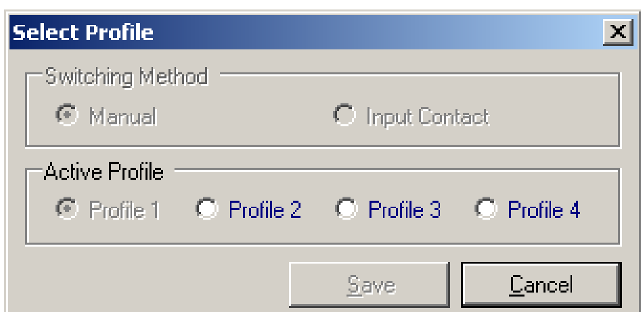


Figure 3-44 Select Profile Dialog Screen

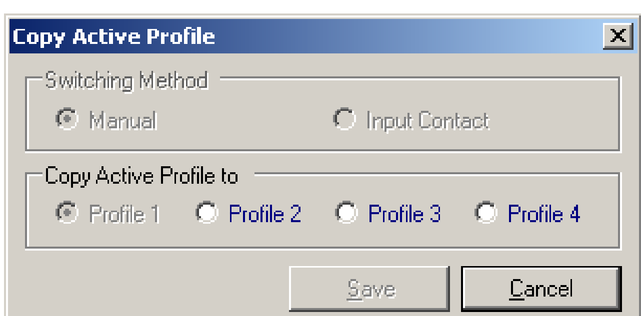
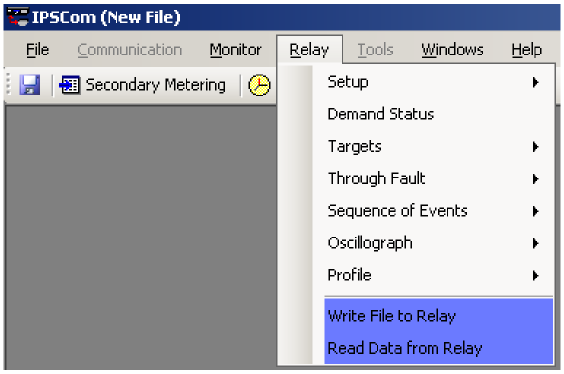


Figure 3-45 Copy Active Profile Dialog Screen

Relay/Write File to Relay

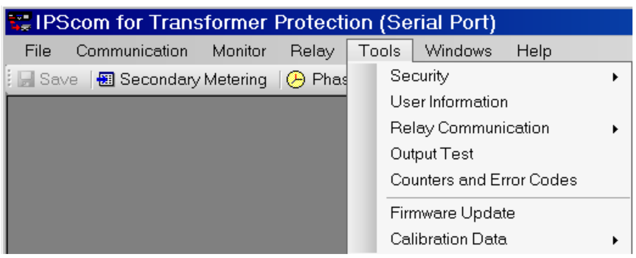


The **Write File to Relay** command sends a predefined setpoint data file to the Relay.

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 3-46) 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.

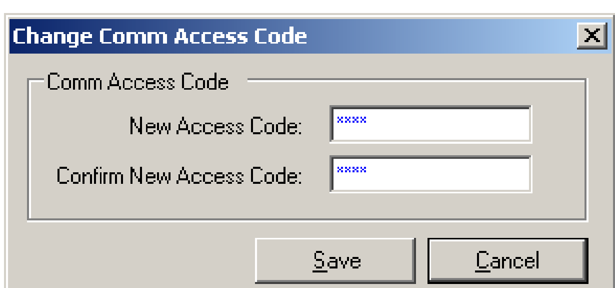


Figure 3-46 Change Comm Access Code Dialog Screen

Tools/Security/Change User Access Code

The **Change User Access Code** selection displays the Access Level Code dialog screen (Figure 3-47). After entering a valid Level 3 Access Code IPScom will display Figure 3-48 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.

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.

Refer to **Chapter 2**, **HMI Security** for detailed information regarding Classic and Extended access codes.

■**NOTE:** Level Access Codes can only be changed by a Level 3 user.

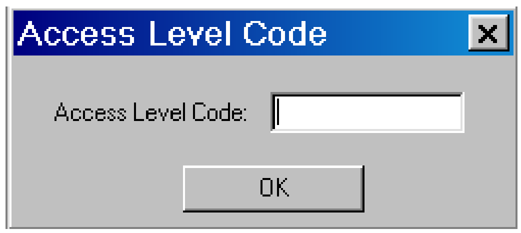


Figure 3-47 Access Level Code Dialog Screen

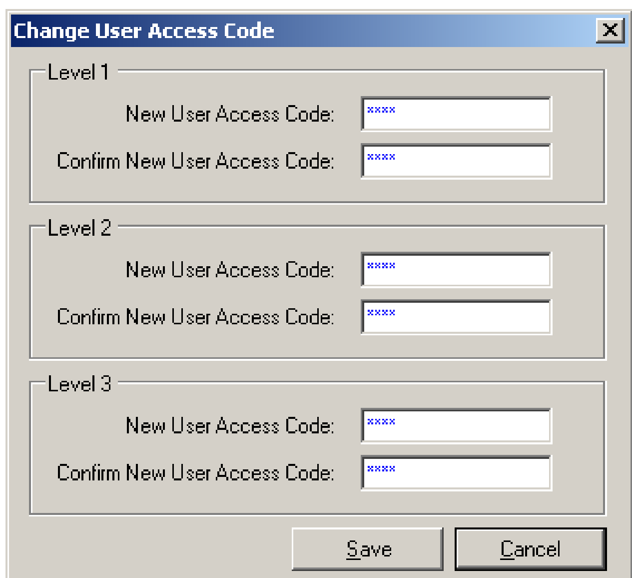


Figure 3-48 Change User Access Code Dialog Screen

Tools/User Information

The User Information menu selection displays the User Information screen (Figure 3-49) 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.

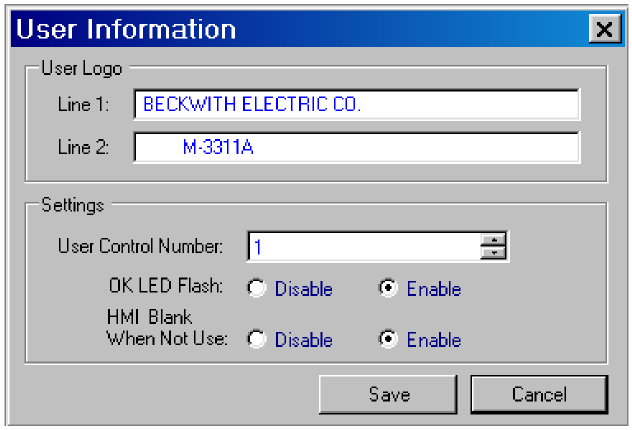


Figure 3-49 User Information Screen

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 3-50), set the relay's COM Port communication parameters (Figure 3-51) and setup the Ethernet Port (Figure 3-52). See **Section 4.1**, **Unit Setup** for detailed communication setup instructions.

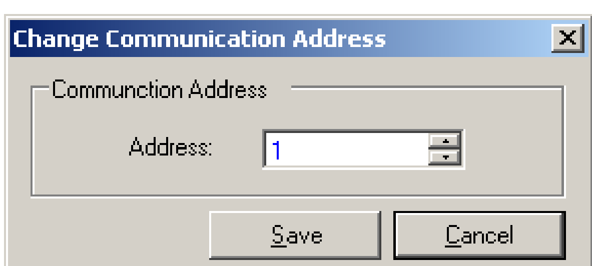


Figure 3-50 Change Relay Communication Address Dialog Screen

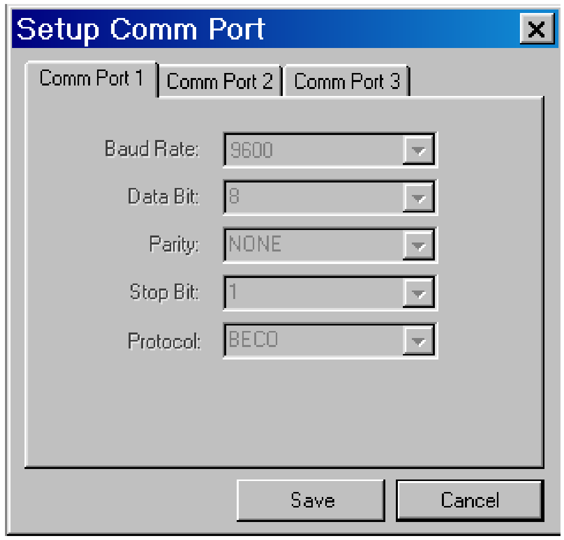


Figure 3-51 Setup Relay Comm Port Dialog Screen

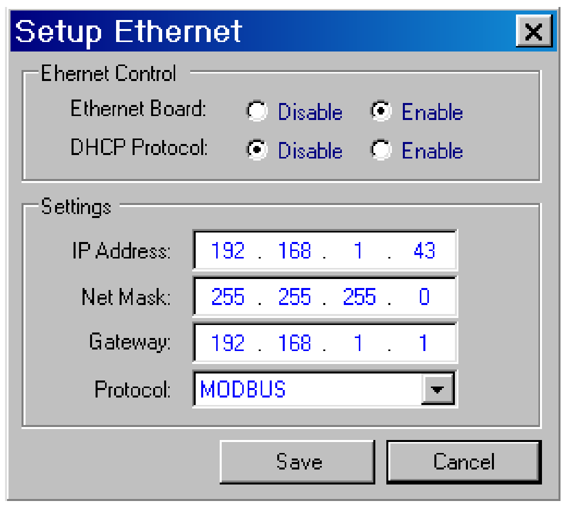


Figure 3-52 Setup Relay Ethernet Port Dialog Screen

Tools/Output Test

The Output Test menu selection displays the Output Test screen (Figure 3-54) which provides the user with the ability to test each output 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 3-55) 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.

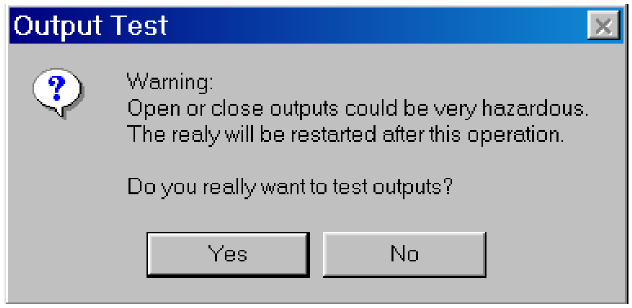


Figure 3-53 Output Test Warning Dialog Screen

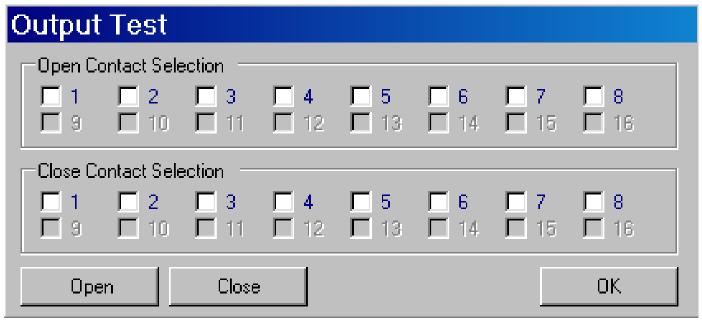


Figure 3-54 Output Test Dialog Screen

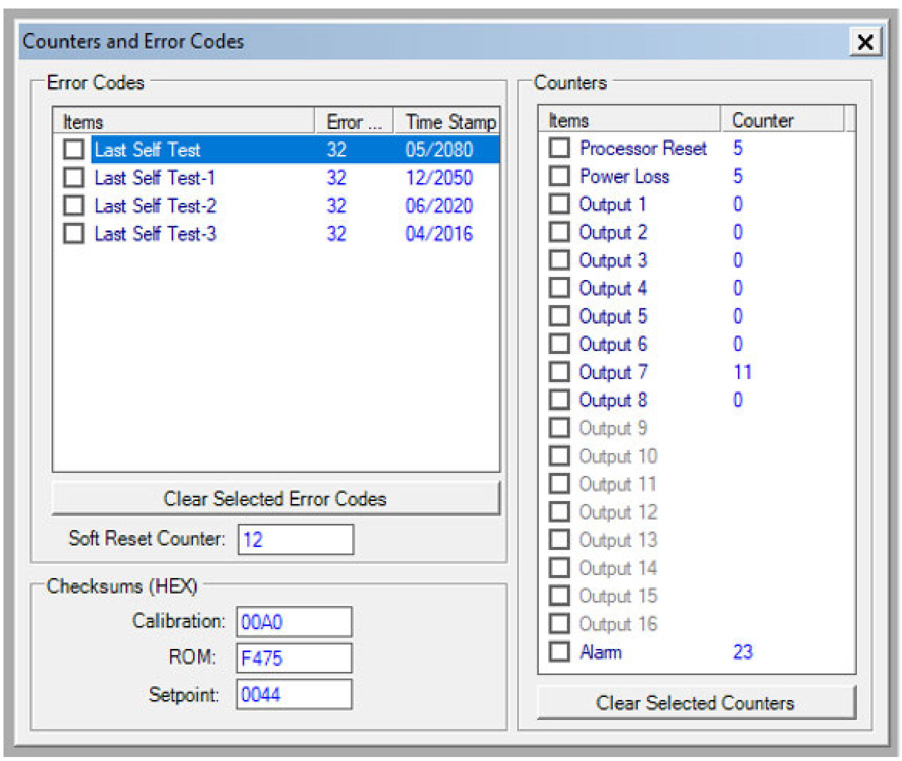


Figure 3-55 Counters and Error Codes Dialog Screen

Tools/Firmware Update

The Firmware Update feature allows the user to perform M-3311A Firmware updates. Firmware update files and instructions are provided by Beckwith Electric.

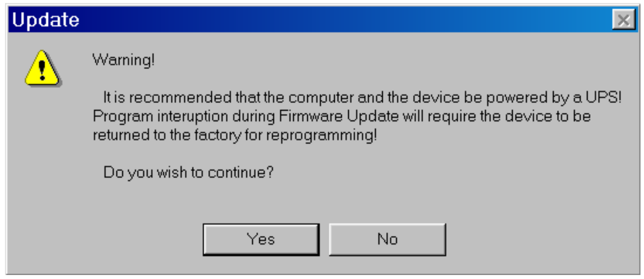


Figure 3-56 Firmware Update Warning Dialog Screen

Tools/Calibration Data

The Calibration Data feature allows the user to retrieve calibration data from M-3311A relays. It also allows relay calibration data to be restored to the relay.

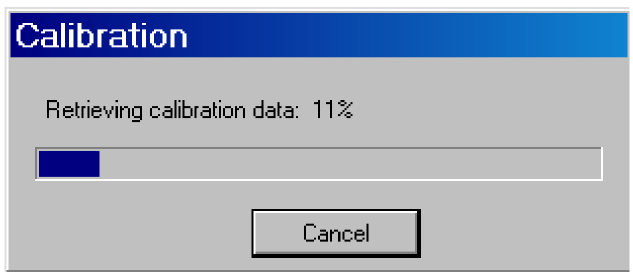


Figure 3-57 Calibration Data Retrieve Dialog Screen

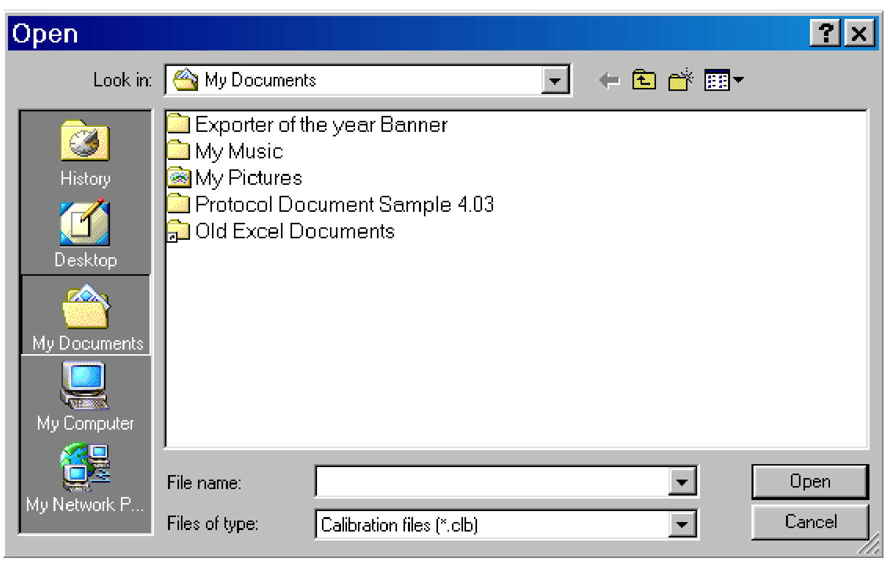
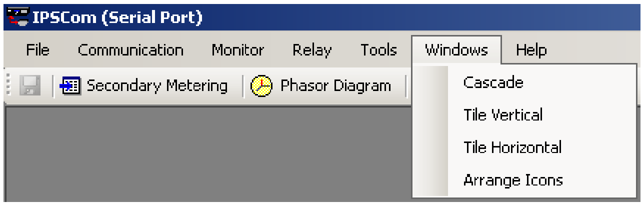


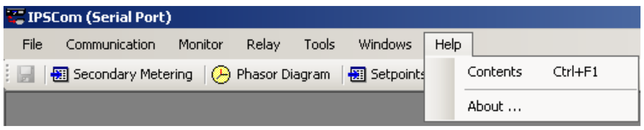
Figure 3-58 Calibration Data Restore Dialog Screen

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 two 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.

The **About** command displays IPScom and firmware version.

4 System Setup and Setpoints

Chapter 4 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 enabling of 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 S-3300 IPScom Communications Software or from the unit's 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.

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).

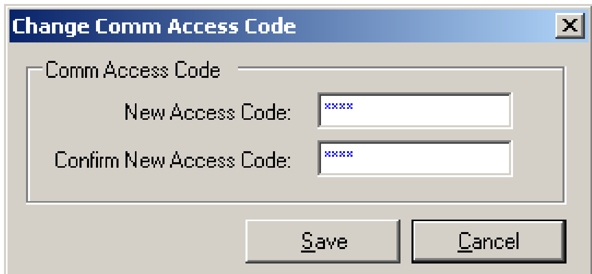


Figure 4-1 Change Comm Access Code Dialog Screen

2. Enter the desired New Comm Access Code (1 to 9999- Classic, up to 20 ASCII characters- Extended Mode), then re-enter (confirmation) the New Access Code.
3. Select **Save**, IPScom will display an Access Code change Confirmation Screen (Figure 4-2).

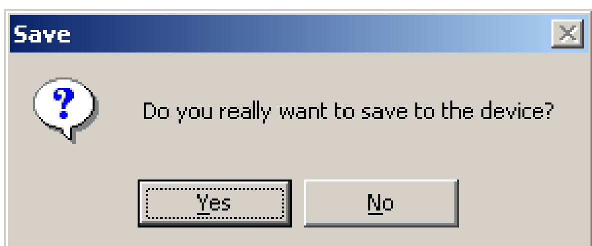


Figure 4-2 Access Code Change Confirmation Screen

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

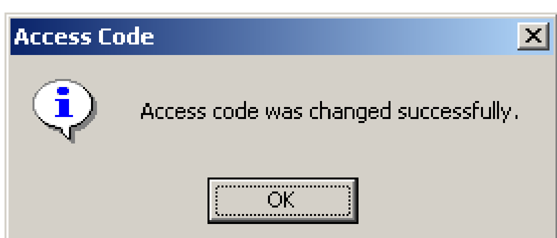


Figure 4-3 Access Code Changed Confirmation Screen

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

   The new Comm Access Code will not be in effect 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
dly 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 relay features and 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.

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.

Refer to **Chapter 2**, **HMI Security** for detailed information regarding Classic and Extended access codes.

■**NOTE:** Level Access Codes can only be changed by a Level 3 user.

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 "Access Level Code" screen. Enter a valid Level 3 Access Code. IPScom will display the Change User Access Code dialog screen (Figure 4-4).

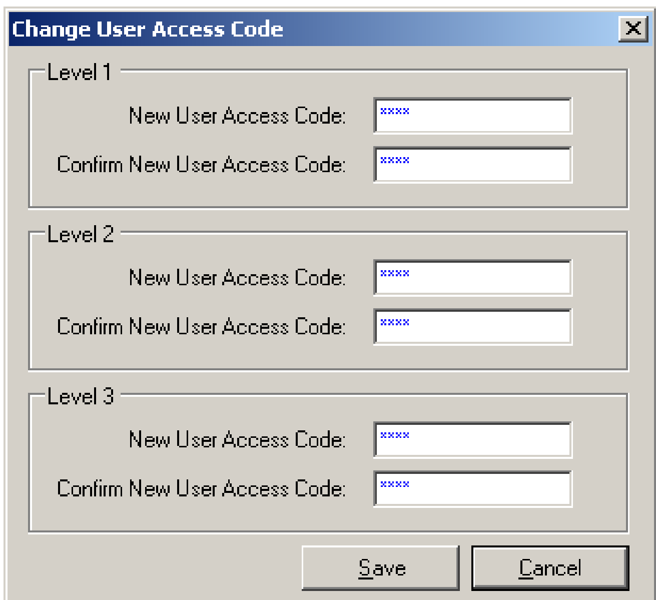


Figure 4-4 Change User Access Code Dialog Screen

2. Enter the desired User Access Code(s) (1 to 9999- Classic, up to 20 ASCII characters- Extended Mode), then re-enter (confirmation) the desired User Access Code(s).
3. Select **Save**, IPScom will display an 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
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 eth sn ACCESS
```

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

The User Control Number is a user-defined value which can be used for inventory or identification. The unit does not use this value, however, it can be accessed through the HMI or the communications interface, and can also 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 indicating proper program cycling.

IPScom User Logo Line, User Control Number, System OK LED Setup and HMI Blanking

To set the relay User Logo Lines, User Control Number, System OK LED and HMI Blanking 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).

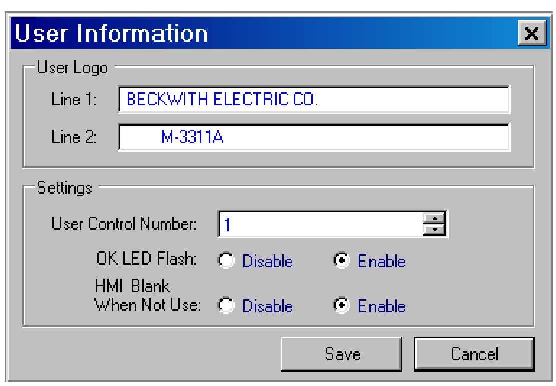


Figure 4-5 User Information Dialog Screen

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** or **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
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
```

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
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 CONTROL NUMBER
UNUM logo1 logo2 out
```

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
UNUM logo1 logo2 out
```

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 eth sn access  →
```

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

```
DIAGNOSTIC MODE
← alrm time error 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 target →
```

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-2 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 **Relay/Setup/Setup Date & Time**. IPScom will display the Setup Date/Time dialog screen (Figure 4-6).

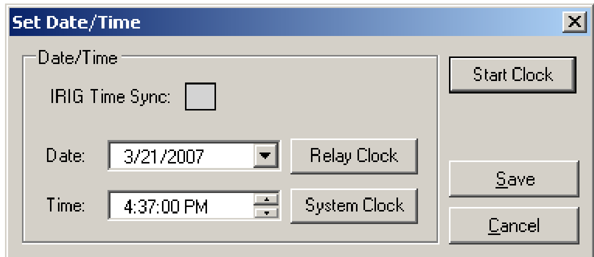


Figure 4-6 Setup Date/Time Dialog Screen

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

1. From the IPScom Main Screen menu select **Tools/Relay Communication**. 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.

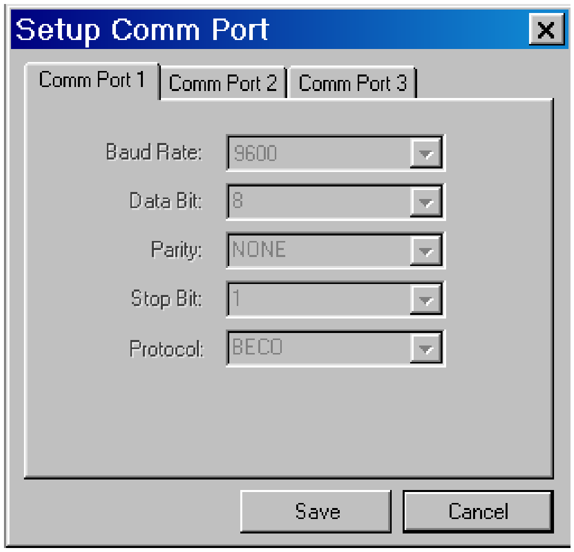


Figure 4-7 Setup Comm Port Dialog Screen

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, 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 B-2 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.

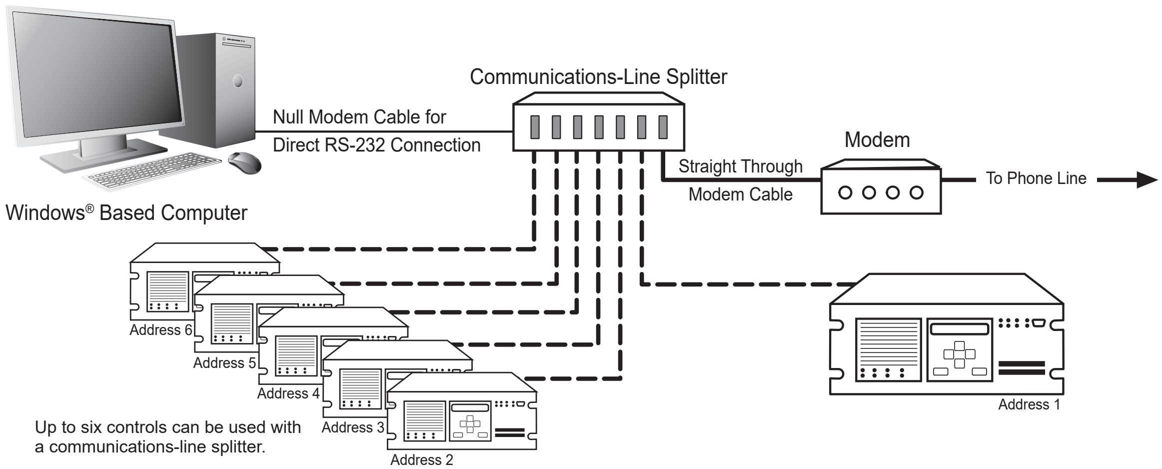


Figure 4-8 Setup Comm Port Dialog Screen

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
targets osc-rec COMM
```

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.

IEC 61850 – The Ethernet option with IEC 61850 protocol has the capability of 4 concurrent sessions of IEC 61850 communication. When Ethernet is purchased with IEC 61850 protocol, no other protocol may be selected. The services provided by the IEC 61850 protocol include:

- **DynAssociation –** dynamic building of data association
- **GetDirectory –** service to read the contents of a server
- **GetDataObjectDefinition –** service to retrieve data definitions
- **DataObjectDirectory –** service to get data defined in a logical node
- **GetDataSetValue –** service to retrieve all data values of a data set
- **SetDataSetValue –** service to write data
- **DataSetDirectory –** service to write data information of the members of a data set
- **ReadWrite –** basic Read and Write to get data, set data and operate
- **ConfReportControl –** report configuration
- **GetCBValues –** read values of a control block

These services allow a user to monitor all metering values, change settings and also generate unsolicited reports. The metering values are reported in the metering and measurement nodes data classes (MMTR, MMXU), the setpoints and configuration settings are viewed and modified in the protection function nodes and system logical nodes data classes (PTOV, PTUV, etc.). These data classes are defined by the 61850-7-4 document. Furthermore, the M-3311A is compatible with the IEC 61850 substation configuration language (SCL), making the data set for the report control block highly configurable. In addition to the generation of reports due to a change in a data value, e.g., a change in pickup status of a protective function, the M-3311A also supports an integrity period, where a report control block is transmitted to the connected SCADA system at the expiration of the integrity period.

IPScom Ethernet Port Setup with 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 Setup Ethernet screen (Figure 4-9).

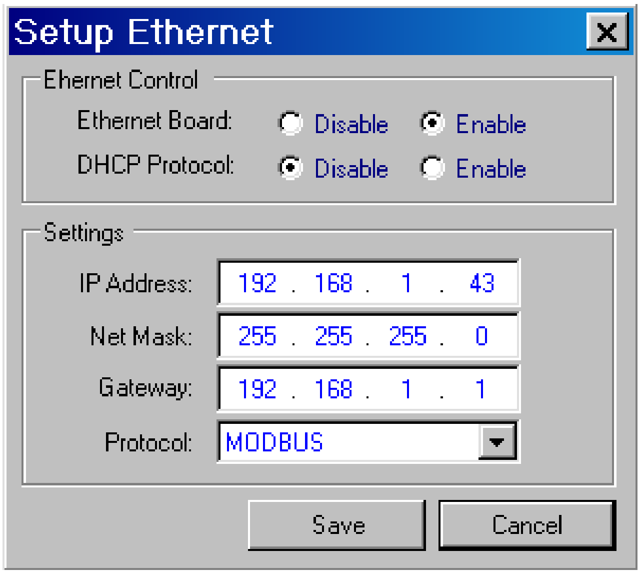


Figure 4-9 Setup Ethernet Screen

2. Select Ethernet Board **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.

    Press **ENTER**, depending on the Ethernet board that is installed one of the following screens will be displayed:

```
SELECT PROTOCOL
modbus  serconv
```

```
SELECT PROTOCOL
IEC 61850
```

11. 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
```

12. 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**, depending on the Ethernet board that is installed one of the following screens will be displayed:

```
SELECT PROTOCOL
modbus  serconv
```

```
SELECT PROTOCOL
IEC 61850
```

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.
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**.

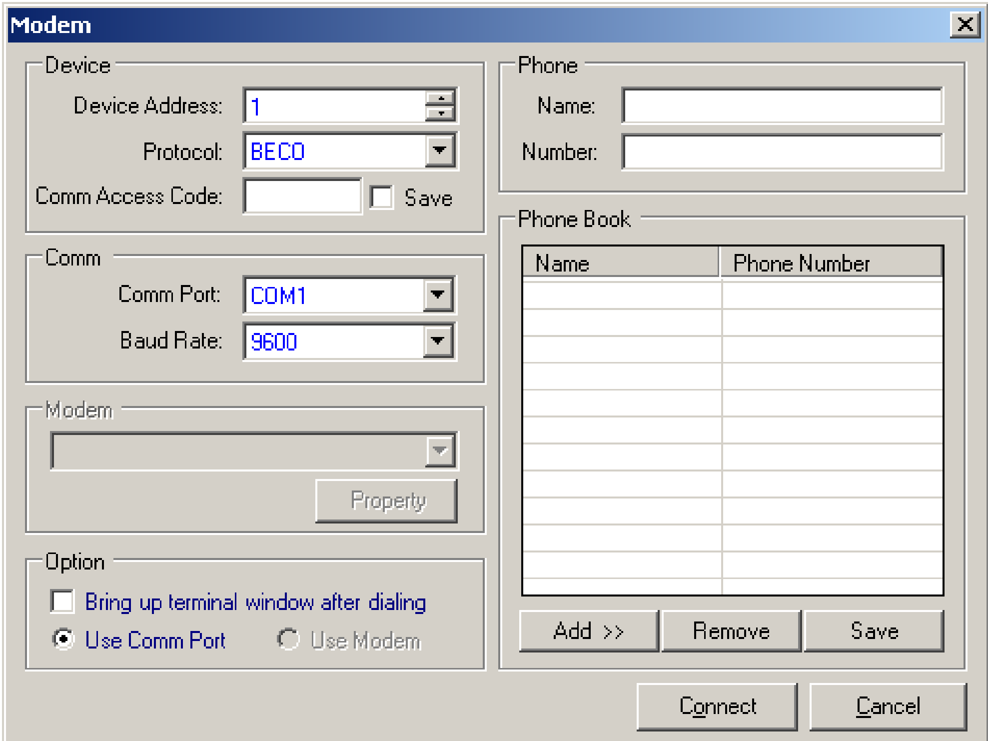


Figure 4-10 Modem Dialog Screen

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.

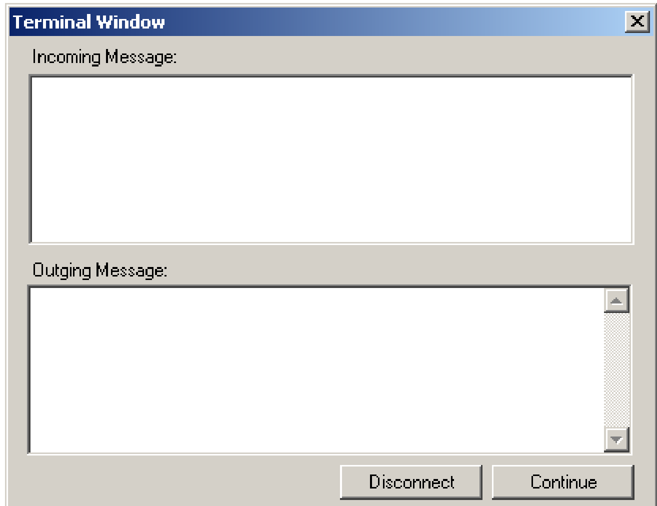


Figure 4-11 Terminal Window

■ **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 S-3300 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 Partition	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 Four-Winding Recorder Partitions

Number of Partitions	3 Windings 4 Windings	2 Windings 4 Voltages	3 Windings 2 Voltages	2 Windings 2 Voltages	3 Windings Zero Voltages	2 Windings Zero Voltages
1	204	265	231	311	265	377
2	136	176	154	207	176	251
3	102	132	115	155	132	188
4	81	106	92	124	106	150
5	68	88	77	103	88	125
6	58	75	66	89	75	107
7	51	66	57	77	66	94
8	45	58	51	69	58	83
9	40	53	46	62	53	75
10	37	48	42	56	48	68
11	34	44	38	51	44	62
12	31	40	35	47	40	58
13	29	37	33	44	37	53
14	27	35	30	41	35	50
15	25	33	28	38	33	47
16	24	31	27	36	31	44
17	22	29	25	34	29	41
18	21	27	24	32	27	39
19	20	26	23	31	26	37
20	19	25	22	29	25	35
21	18	24	21	28	24	34
22	17	23	20	27	23	32
23	17	22	19	25	22	31
24	16	21	18	24	21	30

Table 4-3 Two- / Three-Winding 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 Save 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 and Figure 4-13).

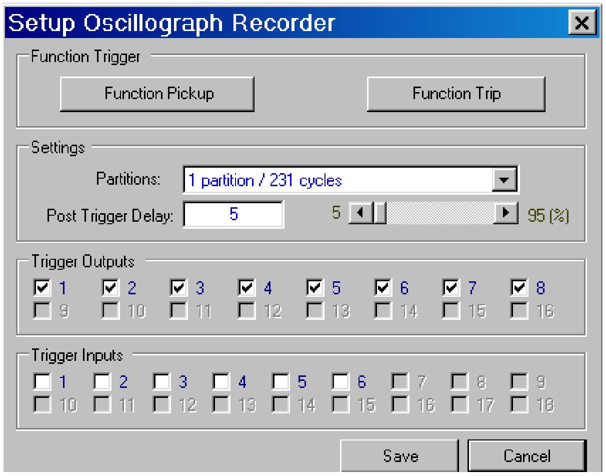


Figure 4-12 Setup Oscillograph Recorder (Two- / Three-Winding)

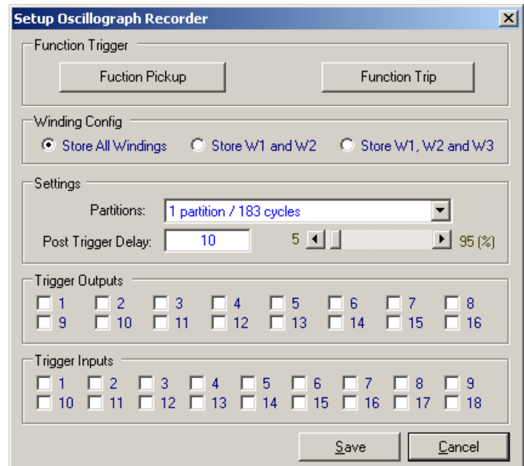


Figure 4-13 Setup Oscillograph Recorder (Four-Winding)

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.

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 arrow pushbutton to increment the 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.

> ▲**CAUTION:** Sequence of Events records are not retained if power to the relay is interrupted.

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 4-14).

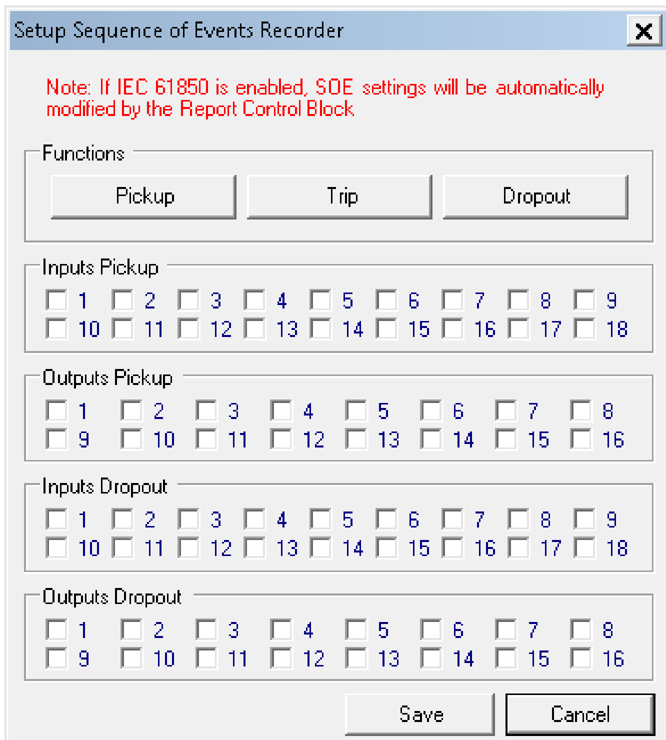


Figure 4-14 Setup Sequence of Events Recorder Screen

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, I2t and the time stamp of the fault. In addition, it will also store the total number of through faults since last rest and total I2t for each phase 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 Limit setting, then press **ENTER**, the following is displayed:

```
THFLT WINDING SELECT
sum1 sum2 w1 w2 w3 w4
```

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**.

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

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 the following:

```
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 Setup System

The Setup System 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 4-4 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 4-4 Input Activated Profile Logic

Two- / Three-Winding Setup

```
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_1          →
```

This screen initiates a copy of the Active Profile to any one of the other profiles.

```
NUMBER OF F87 WINDINGS
TWO three
```

Allows the user to select the number of windings used to calculate differential functions.

The disabled winding will be removed from the differential calculation. However, the disabled winding may be utilized for other non-differential protection. See **Section 4.6**, **Transformer Connections**, for additional information.

Winding Summing

```
W1 INCLUDE IN WIN SUM#1
no yes
```

```
W2 INCLUDE IN WIN SUM#1
no yes
```

```
W3 INCLUDE IN WIN SUM#1
no yes
```

```
W1 INCLUDE IN WIN SUM#2
no yes
```

```
W2 INCLUDE IN WIN SUM#2
no yes
```

```
W3 INCLUDE IN WIN SUM#2
no yes
```

Two- / Three-Winding Setup (Cont.)

```
XFM/CT CONNECTION
standard custom
```

▲ **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 are 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 4.6, **Transformer Connections**, for additional information.

```
W1 XFM Phase Comp Type
         0
```

```
W2 XFM Phase Comp Type
         0
```

```
W3 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
```

```
W1 ZERO SEQ COMP
disable enable
```

```
W2 ZERO SEQ COMP
disable enable
```

```
W3 ZERO SEQ COMP
disable enable
```

```
CT CONNECTION W1
←CON_W1 xfm_w1 con_w2 xfm_w2→
```

▲ **CAUTION:** Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

```
CT CONNECTION W1
Y dab dac inv_y →
----------------------------------
← inv_dab inv_dac
```

■ **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.

Two- / Three-Winding Setup (Cont.)

```
CT CONNECTION W2
←xfm_w1 con_w2 xfm_w2→
```

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 4.6, **Transformer Connections**, for additional information.

```
CT CONNECTION W2
Y dab dac inv_y →
----------------------------------
← inv_dab inv_dac
```

```
CT CONNECTION W3
←con_w2 xfm_w2 con_w3→
```

```
CT CONNECTION W3
Y dab dac inv_y →
----------------------------------
← inv_dab inv_dac
```

```
XFM CONNECTION W1
←con_w1 Xfm_w1 con_w2 xfm_w2→
```

▲ **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 4.6, **Transformer Connections**, for additional information.

```
XFM CONNECTION W1
Y dab dac inv_y →
----------------------------------
← inv_dab inv_dac
```

```
XFM CONNECTION W2
←con_w2 XFM_W2 con_w3→
```

```
XFM CONNECTION W2
Y dab dac inv_y →
----------------------------------
← inv_dab inv_dac
```

```
XFM CONNECTION W3
←xfm_w2 con_w3 XFM_W3→
```

```
XFM CONNECTION W3
Y dab dac inv_y →
----------------------------------
← inv_dab inv_dac
```

```
PHASE ROTATION
← PHASE seal in vt →
```

Indicates the phase rotation.

```
PHASE ROTATION
a-c-b  A-B-C
```

```
RELAY SEAL-IN TIME
← conn phase SEAL IN →
```

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).

```
RELAY SEAL-IN TIME OUT01
______________ Cycles
```

Two- / Three-Winding Setup (Cont.)

```
RELAY SEAL-IN TIME OUT02
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT03
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT04
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT05
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT06
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT07
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT08
______________ Cycles
```

```
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).

```
PULSE RELAY
o8 o7 o6 o5 o4 o3 o2 o1
```

If Pulse Relay operation is selected, output will dropout after the seal-in delay expires, even if the condition which caused the relay to pick up is still out of band. When selected, latching outputs are not available.

```
LATCHED OUTPUTS
o8 o7 o6 o5 o4 o3 o2 o1
```

If any of the outputs are selected as latched, then after tripping, this output will stay activated, even when the tripping condition is removed. The Latched Output can be reset using the TARGET RESET pushbutton. When selected, Pulse Relay is not available.

If neither Pulsed or Latched Output is enabled, the output contact will default to the normal mode. In this mode, the output contact will stay energized as long as the abnormal condition which caused it to operate persists. After the abnormal condition is cleared, the contact will reset after the programmed seal-in time has elapsed.

■ **NOTE:** See Figure 4-17 for Relay Setup of outputs (Latched or Pulsed).

```
V.T.Phase RATIO
←VTP vtg volt curr→
```

VT Phase Ratio

```
V.T.Phase RATIO
__________________ :1
```

```
V.T.Gnd/Phase RATIO
←vtp VTG volt curr→
```

VT Ground/Phase Ratio

```
V.T.Gnd/Phase RATIO
__________________ :1
```

Two- / Three-Winding Setup (Cont.)

```
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.

```
NOMINAL CURRENT
5.00 Amps
```

```
V.T. CONFIGURATION
line_to_line line_to_gnd
```

Indicate VT Configuration is either Line-to-Line, Line-to-Ground or Line-to-Ground-to-Line-to-line.

```
POWER WINDING
pr_w1 pr_w2 pr_w3
```

```
Positive Power Flow
in  OUT
```

If two voltages are enabled, then the Phase Voltage and VG Voltage Options are available.

With two voltage inputs, power measurement and sequence voltage measurement are available. However, the user must select one voltage, Vab in VT Phase config, and Vbc in VT Phase or Grnd config, in both options. (Not the same voltage).

```
W1 C.T. RATIO
←CT_W1 ct_w2 ct_w2g→
```

CT Ratios

```
W1 C.T. RATIO
___________________:1
```

```
W2 C.T. RATIO
←ct_w1 CT_W2 ct_w2g→
```

```
W2 C.T. RATIO
___________________:1
```

```
W2 C.T. GROUND RATIO
←ct_w1 ct_w2 CT_W2G →
```

CT Ground Ratios

```
W2 C.T. GROUND RATIO
___________________:1
```

The relay will calculate the W2 and W3 line currents when a delta CT configuration is selected, as follows:

```
W3 C.T. RATIO
←  CT_W3  ct_w3g →
```

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 $I_C = (I_{ca} - I_{bc} + (I_g/CTCF))/3$

```
W2 C.T. GROUND RATIO
___________________:1
```

where I_{ab}, I_{bc}, I_{ca} are the currents that enter the relay, and I_g is the measured ground current.

```
W3 C.T. GROUND RATIO
← ct_3  CT_W3G →
```

CTCF is given by

$$\frac{\text{CT Phase Ratio}}{\text{CT Ground Ratio}}$$

```
W3 C.T. GROUND RATIO
___________________:1
```

Four-Winding Setup

```
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_1          →
```

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
```

Indicates VT connection.

```
NUMBER OF WINDINGS
three four
```

Allows the user to select the number of windings used to calculate differential functions.

```
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 4.6, **Transformer Connections**, for additional information.

Winding Summing

```
W1 INCLUDE IN WIN SUM#1
no yes
```

```
W2 INCLUDE IN WIN SUM#1
no yes
```

```
W3 INCLUDE IN WIN SUM#1
no yes
```

```
W1 INCLUDE IN WIN SUM#2
no yes
```

```
W1 INCLUDE IN WIN SUM#2
no yes
```

```
W2 INCLUDE IN WIN SUM#2
no yes
```

```
W3 INCLUDE IN WIN SUM#2
no yes
```

```
W4 INCLUDE IN WIN SUM#2
no yes
```

Four-Winding Setup

```
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 4.6**, **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
```

Four-Winding Setup (Cont.)

```
CT CONNECTION W1
←CON_W1 xfm_w1 con_w2 xfm_w2→
```

▲ **CAUTION:** Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

```
CT CONNECTION W1
Y dab dac inv_y →
---------------------------------
← inv_dab inv_dac
```

■ **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.

```
CT CONNECTION W2
←xfm_w1 CON_W2 xfm_w2→
```

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 4.6**, **Transformer Connections**, for additional information.

```
CT CONNECTION W2
Y dab dac inv_y →
---------------------------------
← inv_dab inv_dac
```

```
CT CONNECTION W3
←con_w2 xfm_w2 CON_W3→
```

```
CT CONNECTION W3
Y dab dac inv_y →
---------------------------------
← inv_dab inv_dac
```

```
CT CONNECTION W4
←con_w1 Xfm_w1 con_w2 CON_W2→
```

```
CT CONNECTION W4
Y dab dac inv_y →
---------------------------------
← inv_dab inv_dac
```

```
XFM CONNECTION W1
←con_w1 XFM_W1 con_w2 xfm_w2→
```

▲ **CAUTION:** Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

```
XFM CONNECTION W1
Y dab dac inv_y →
---------------------------------
← inv_dab inv_dac
```

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 4.6**, **Transformer Connections**, for additional information.

```
XFM CONNECTION W2
←con_w2 xfm_w2 con_w3→
```

```
XFM CONNECTION W2
Y dab dac inv_y →
---------------------------------
← inv_dab inv_dac
```

Four-Winding Setup (Cont.)

```
XFM CONNECTION W3
←xfm_w2 con_w3 XFM_W3→
```

```
XFM CONNECTION W4
←con_w2 XFM_W4→
```

```
XFM CONNECTION W3
Y dab dac inv_y →
-----------------------------------
← inv_dab inv_dac
```

```
XFM CONNECTION W4
Y dab dac inv_y →
-----------------------------------
← inv_dab inv_dac
```

```
PHASE ROTATION
← PHASE seal in vt →
```

Indicates the phase rotation.

```
PHASE ROTATION
a-c-b  A-B-C
```

```
RELAY SEAL-IN TIME
← conn phase SEAL IN →
```

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).

```
RELAY SEAL-IN TIME OUT01
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT02
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT03
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT04
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT05
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT06
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT07
______________ Cycles
```

```
RELAY SEAL-IN TIME OUT08
______________ Cycles
```

```
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).

```
PULSE RELAY
o8 o7 o6 o5 o4 o3 o2 o1
```

If Pulse Relay operation is selected, output will dropout after the seal-in delay expires, even if the condition which caused the relay to pick up is still out of band. When selected, latching outputs are not available.

Four-Winding Setup (Cont.)

```
LATCHED OUTPUTS
o8 o7 o6 o5 o4 o3 o2 o1
```

If any of the outputs are selected as latched, then after tripping, this output will stay activated, even when the tripping condition is removed. The Latched Output can be reset using the TARGET RESET pushbutton. When selected, Pulse Relay is not available.

If neither Pulsed or Latched Output is enabled, the output contact will default to the normal mode. In this mode, the output contact will stay energized as long as the abnormal condition which caused it to operate persists. After the abnormal condition is cleared, the contact will reset after the programmed seal-in time has elapsed.

■ **NOTE**:See Figure 4-17 for Relay Setup of outputs (Latched or Pulsed).

VT Ratio

```
V.T.x RATIO
←VTX vtg ct_w1 ct_w2→
```

```
V.T.x RATIO
__________________ :1
```

VT Ground Ratio

```
V.T.g RATIO
←vtx VTG ct_w1 ct_w2→
```

```
V.T.g RATIO
__________________ :1
```

CT Ratios

```
W1 C.T. RATIO
←vtx vtg CT_W1 ct_w2→
```

```
W1 C.T. RATIO
__________________ :1
```

```
W2 C.T. RATIO
←vtx vtg ct_w1 CT_W2→
```

```
W2 C.T. RATIO
__________________ :1
```

```
W2 C.T. GROUND RATIO
←CT_W2G ct_3 ct_w3g→
```

```
W2 C.T. GROUND RATIO
__________________ :1
```

```
W3 C.T. RATIO
←ct_w2g CT_W2 ct_w3g→
```

```
W3 C.T. RATIO
__________________ :1
```

Four-Winding Setup (Cont.)

```
W3 C.T. GROUND RATIO
←ct_w2g ct_3 CT_W3G→
```

```
W3 C.T. GROUND RATIO
______________ :1
```

```
W4 C.T. RATIO
←CT_W4 ct_w4g
```

```
W4 C.T. RATIO
______________ :1
```

```
W4 C.T. GROUND RATIO
←ct_w4g CT_W4G→
```

```
W4 C.T. GROUND RATIO
______________ :1
```

CT Ground Ratios

The relay will calculate the W2, W3 and W4 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

$$\frac{\text{CT Phase Ratio}}{\text{CT Ground Ratio}}$$

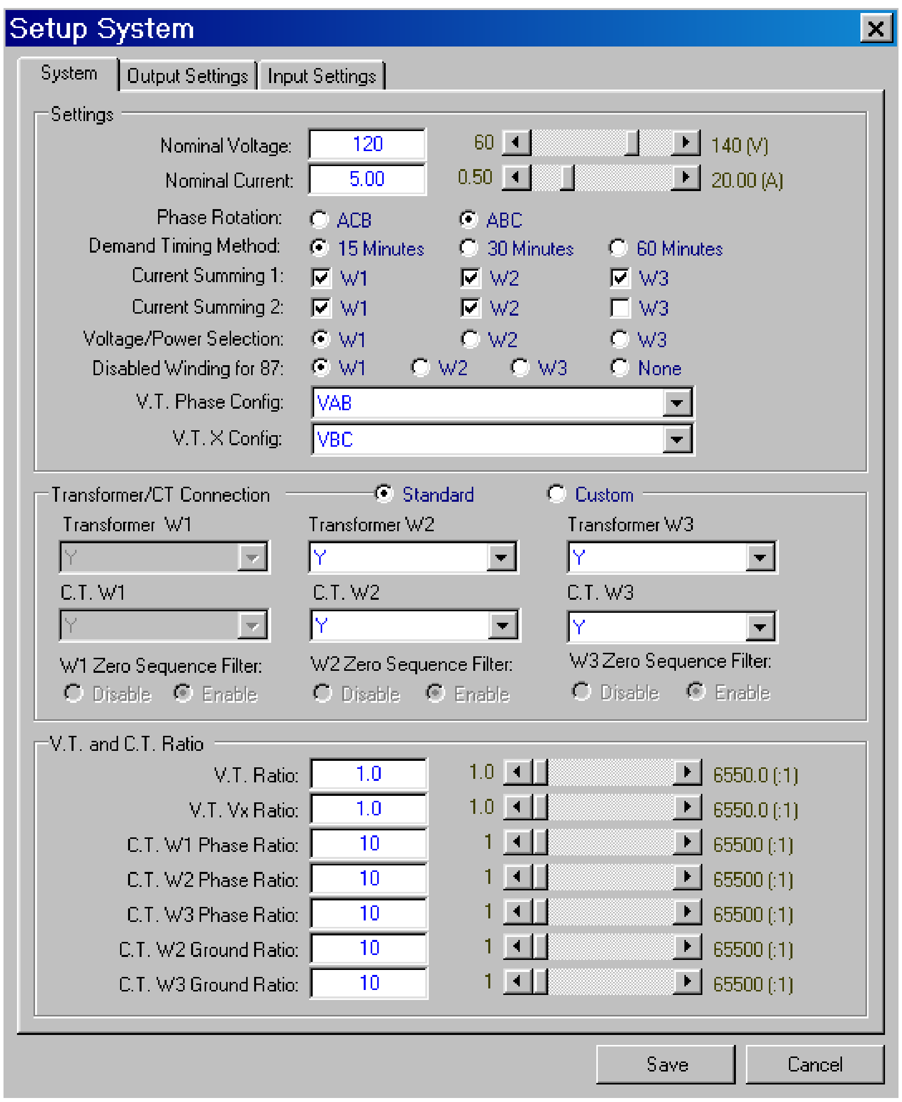


Figure 4-15 IPScom Relay Setup System Dialog Screen (Two- / Three-Winding)

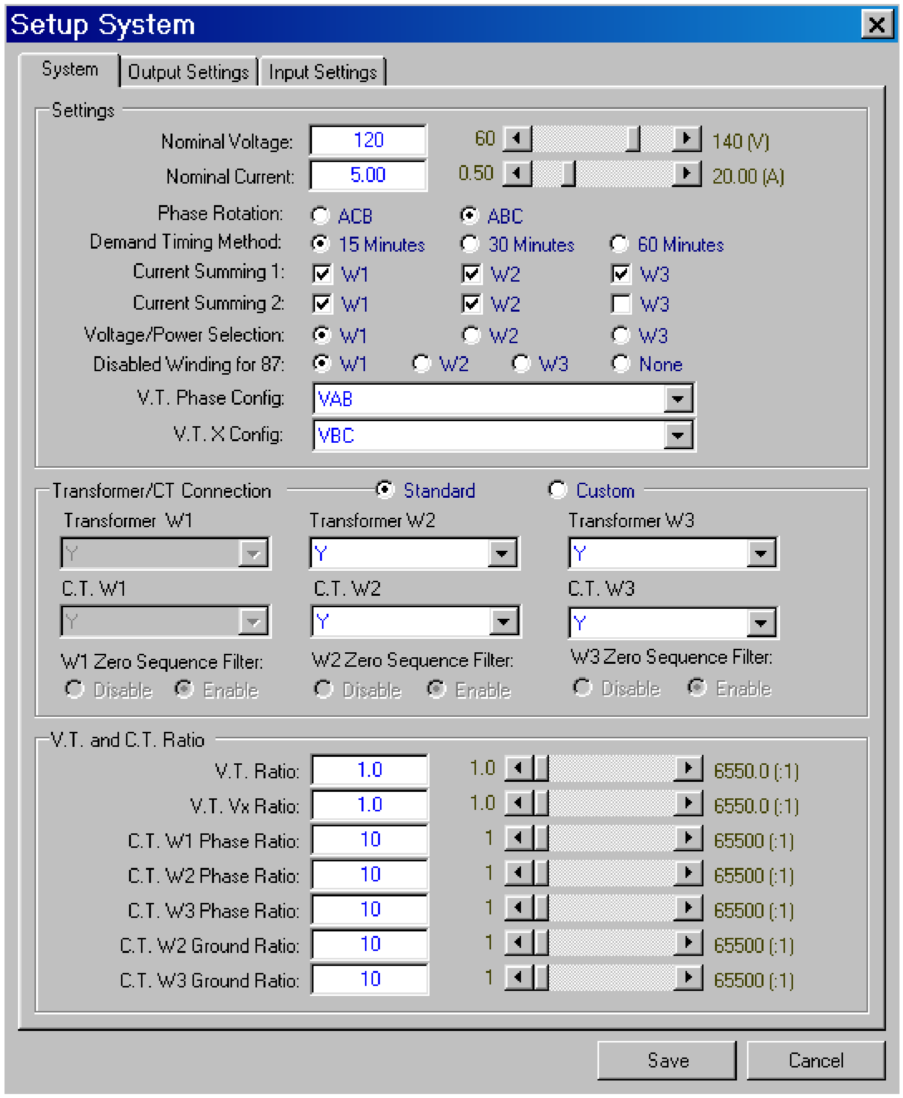


Figure 4-16 IPScom Relay Setup System Dialog Screen (Four-Winding)

If neither Pulsed or Latched Output is enabled, the output contact will default to the normal mode. In this mode, the output contact will stay energized as long as the abnormal condition which caused it to operate persists. After the abnormal condition is cleared, the contact will reset after the programmed seal-in time has elapsed.

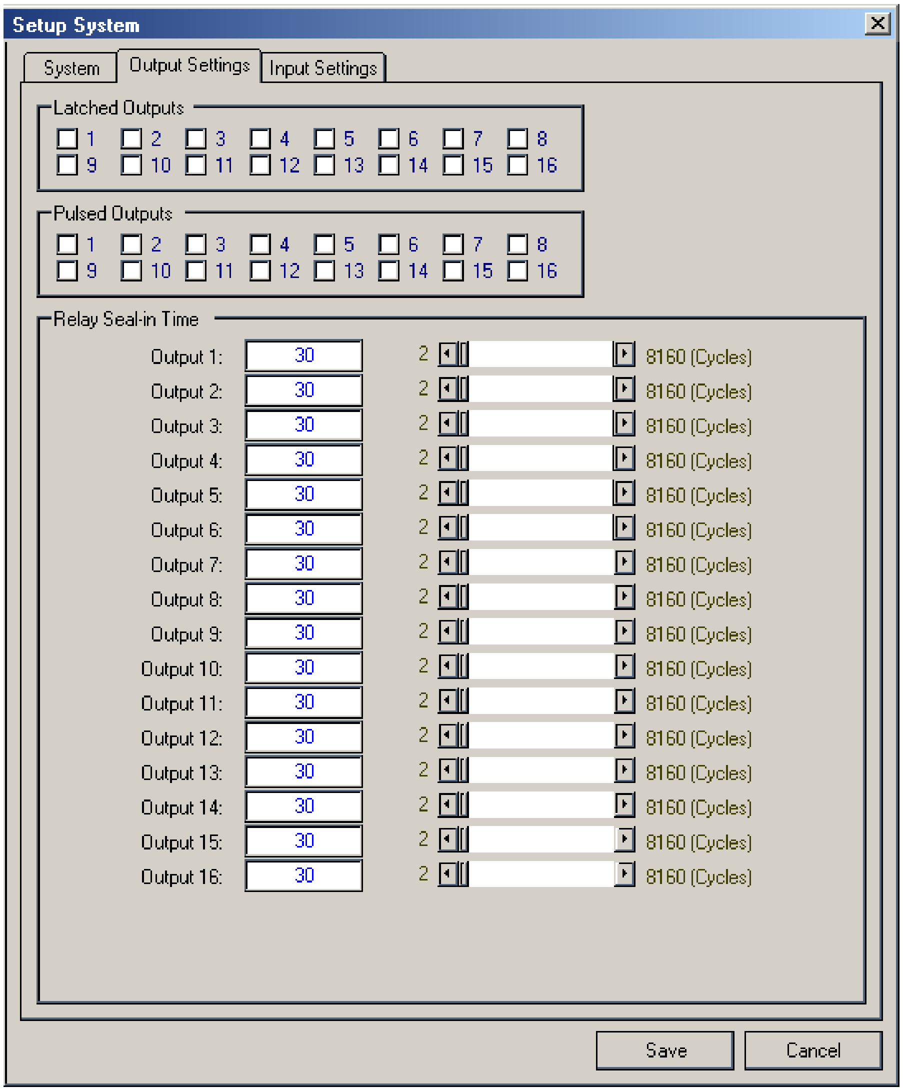


Figure 4-17 IPScom Selection Screen for Output Settings

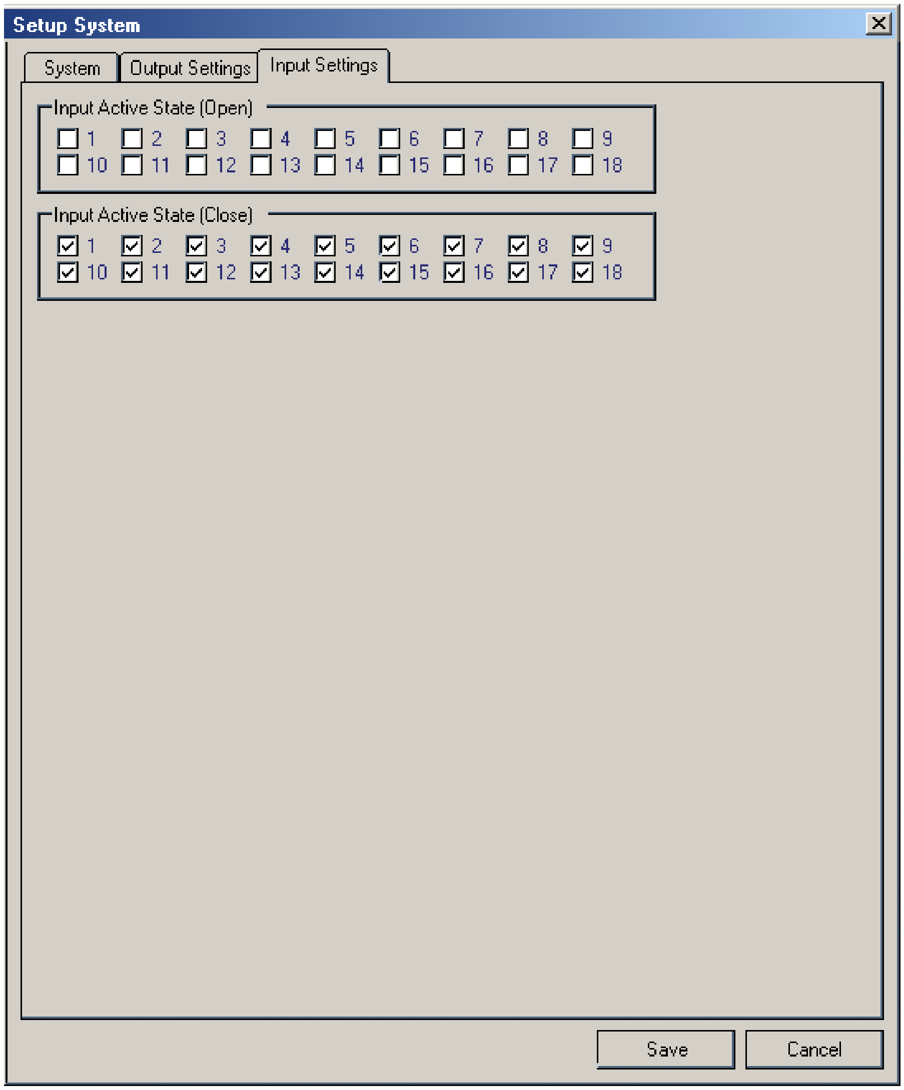
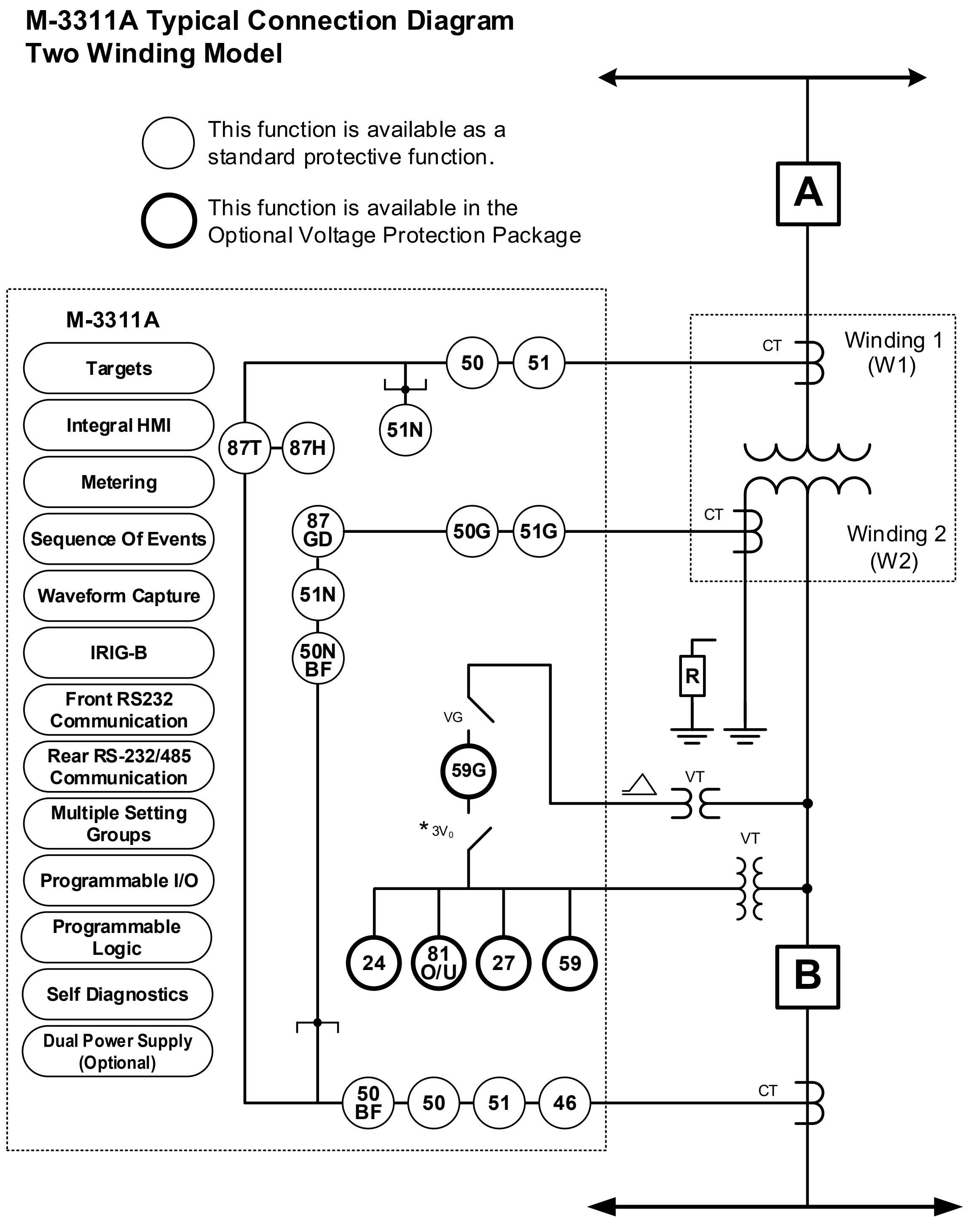


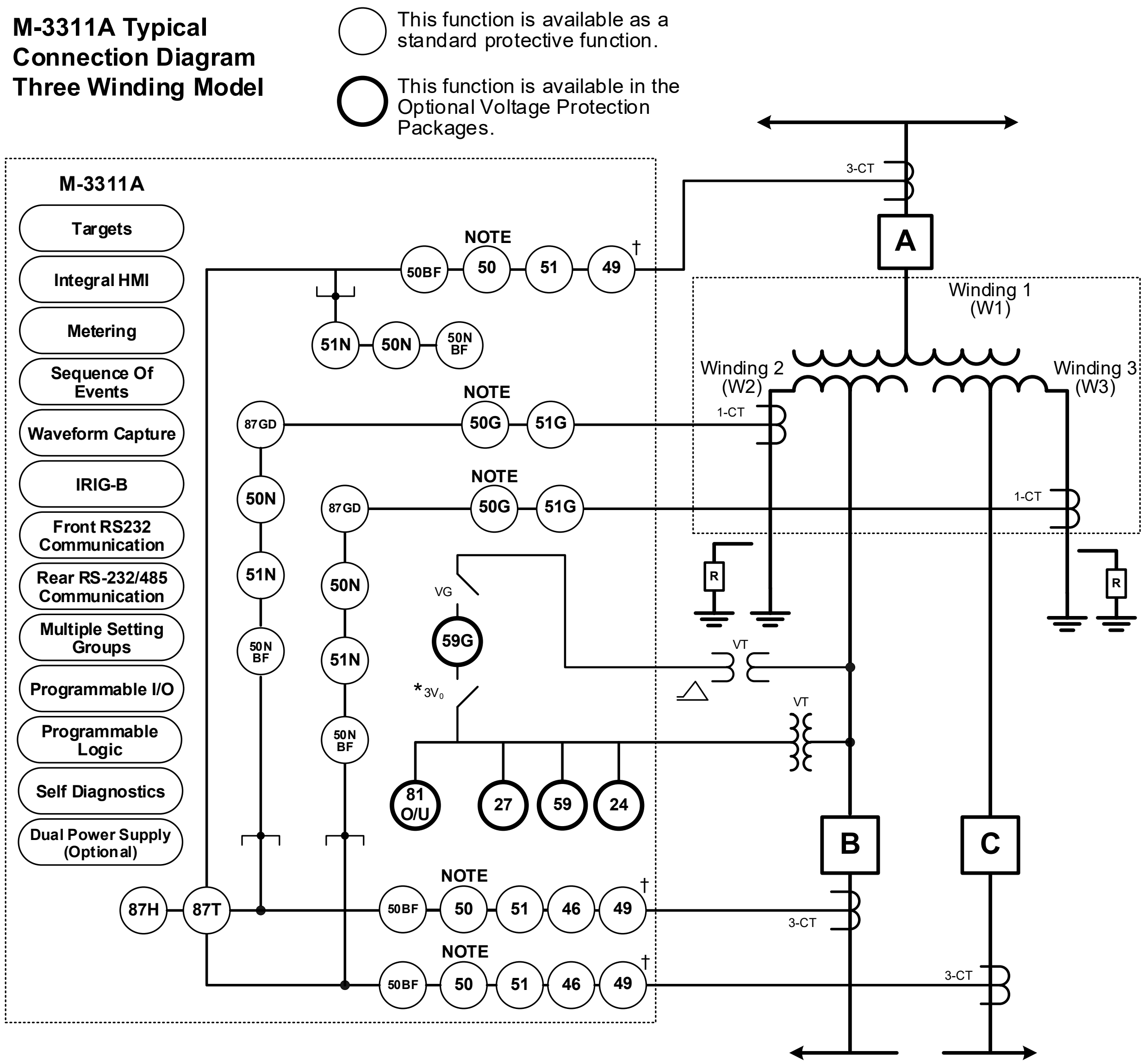
Figure 4-18 IPScom Selection Screen for Input Settings

4.3 System Diagrams



* Available with Four Voltage option and VT Config = LG

Figure 4-19 M-3311A (Two Winding – Zero, Two or Four Voltage Inputs) Typical One-Line Function Diagram

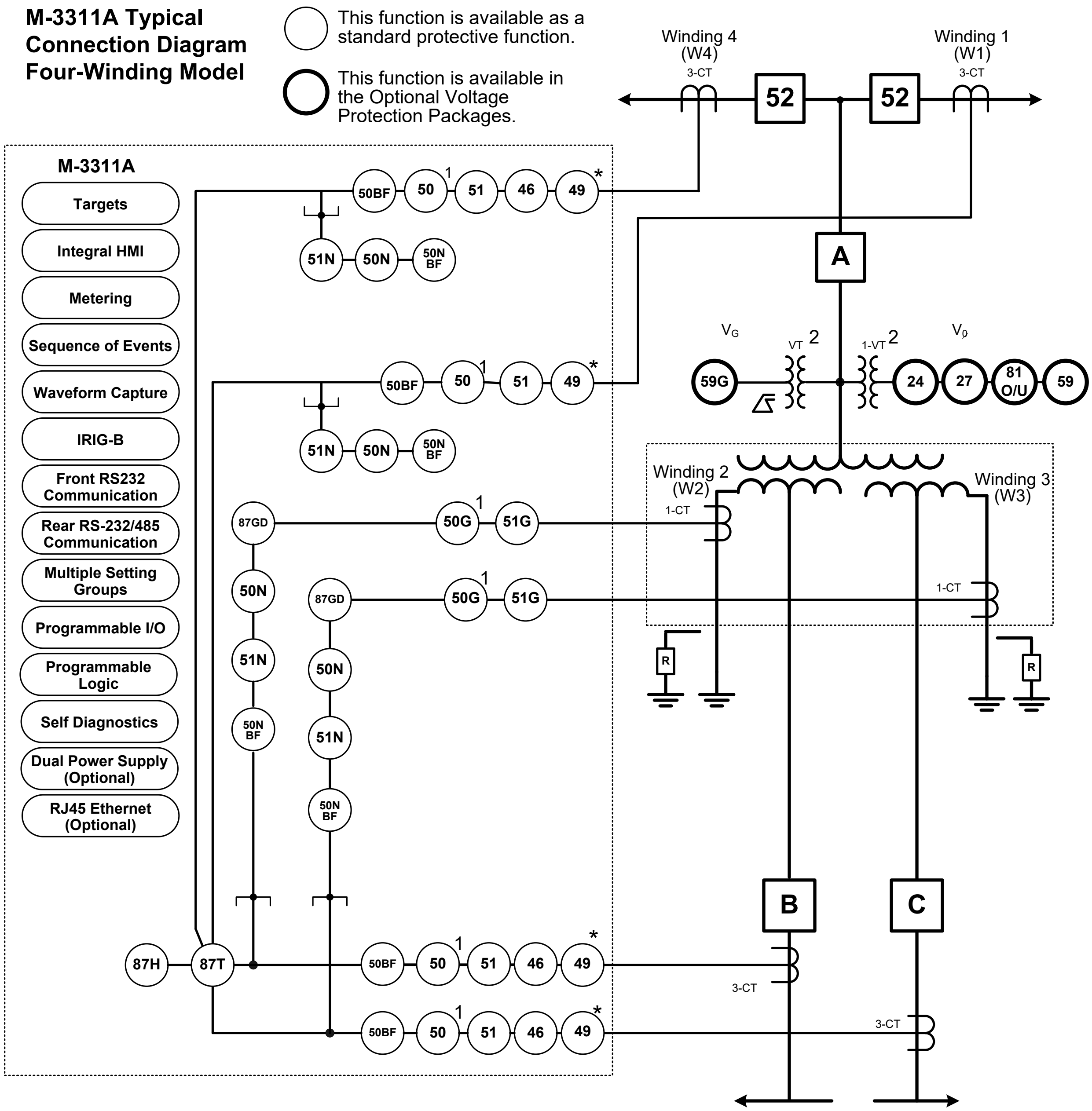


* Available with Four Voltage option and VT Config = LG

† 49 Function can only be enabled in one winding.

■**NOTE:** 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.

Figure 4-20 M-3311A (Three Winding – Zero, Two or Four Voltage Inputs) Typical One-Line Function Diagram

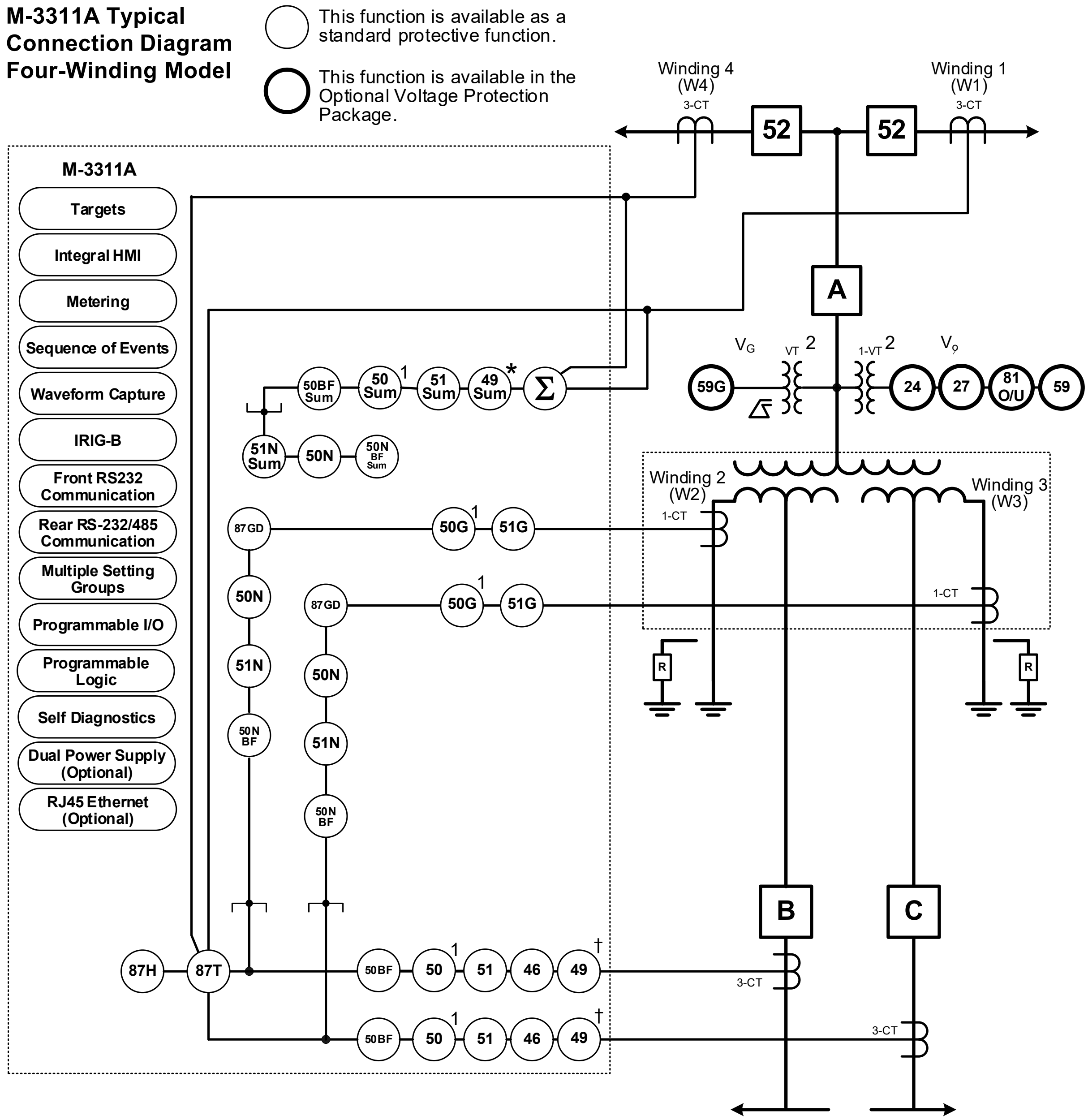


* 49 Function can only be enabled in one winding.

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 four-winding model of the M-3311A. These are a phase voltage $V_{\text{Ø}}$ 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 4-21 M-3311A (Four-Winding – Two Voltage Inputs) Typical One-Line Function Diagram



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

† 49 function can only be enabled in one winding or multiple windings via Current Summing.

■ **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 four-winding model of the M-3311A. These are a phase voltage $V_Ø$ 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 4-22 M-3311A (Four-Winding – Two-Voltage Inputs) Summing Currents One-Line Function Diagram

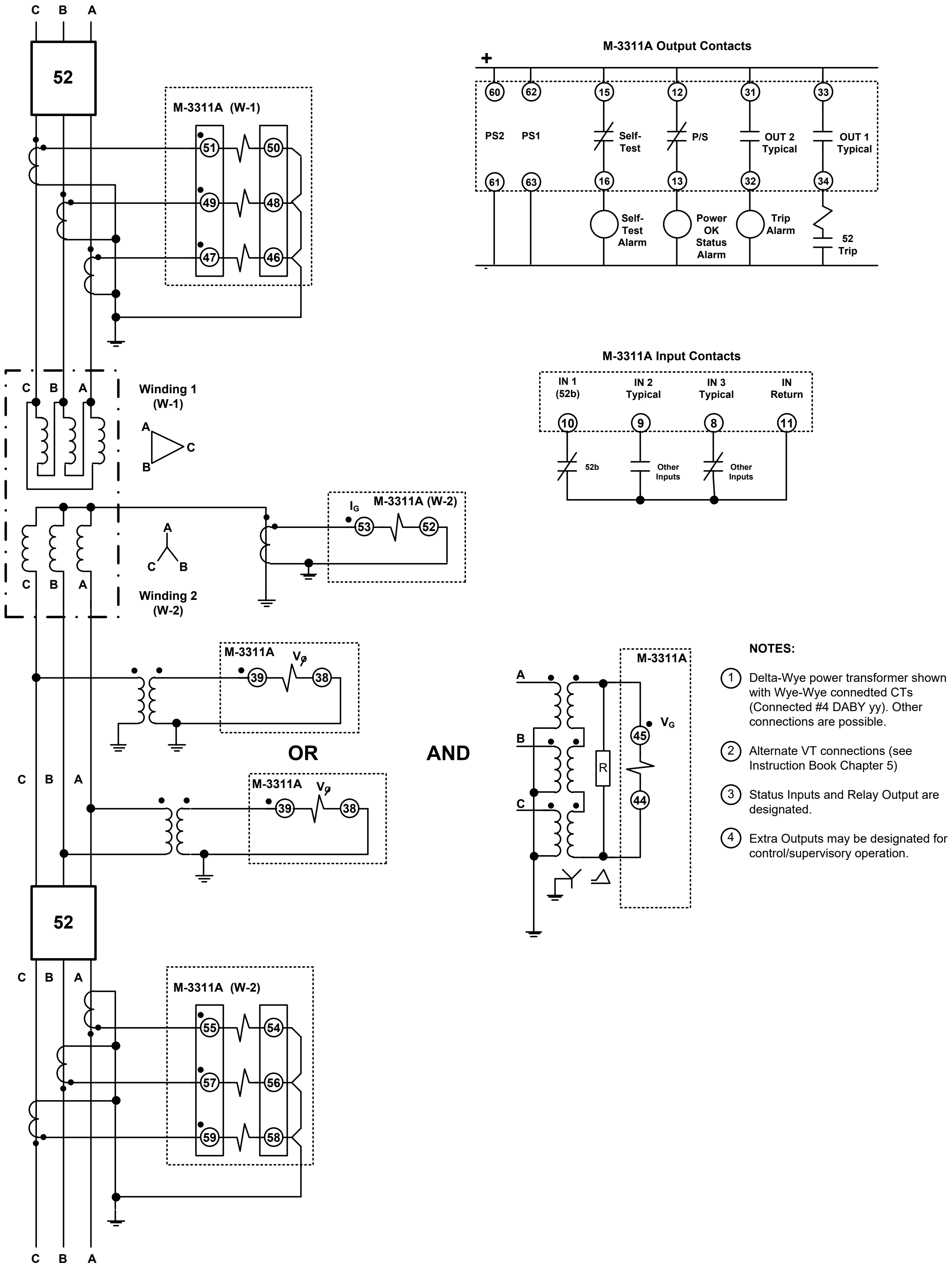


Figure 4-23 Typical (Two Winding – Two Voltage Inputs) Three-Line Connection Diagram

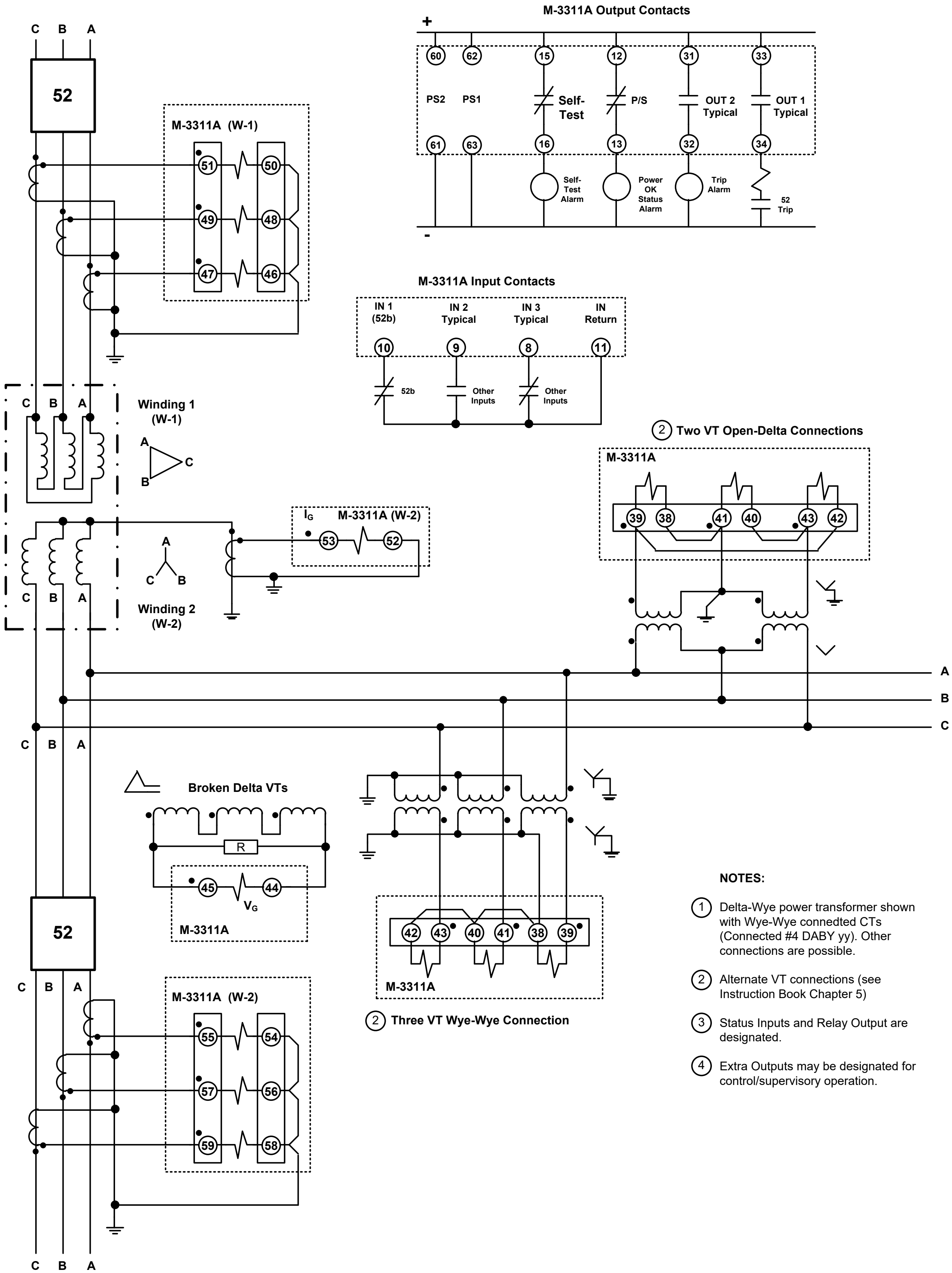


Figure 4-24 Typical (Two Winding – Four Voltage Inputs) Three-Line Connection Diagram

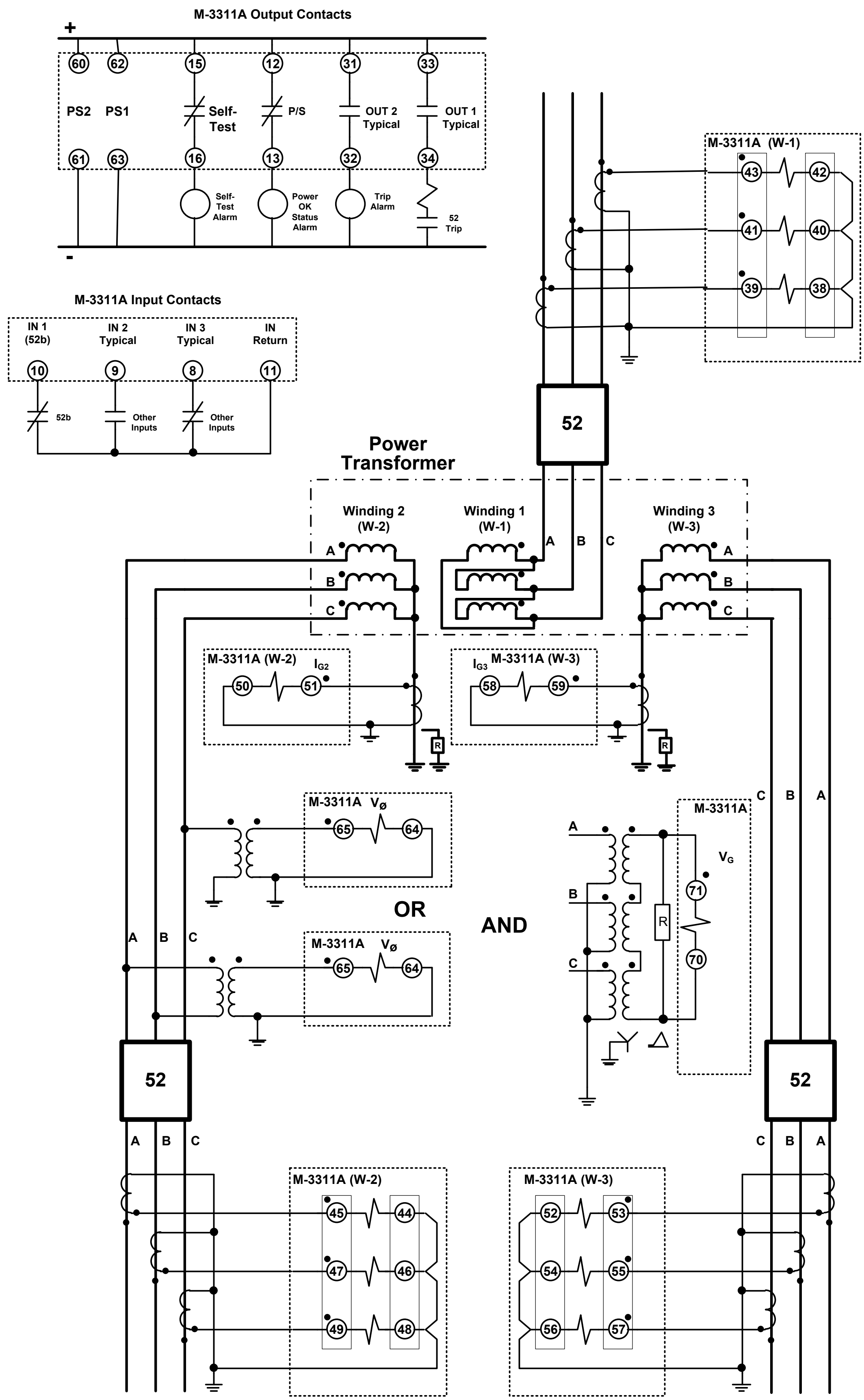


Figure 4-25 Typical (Three Winding – Two Voltage Inputs) Three-Line Connection Diagram

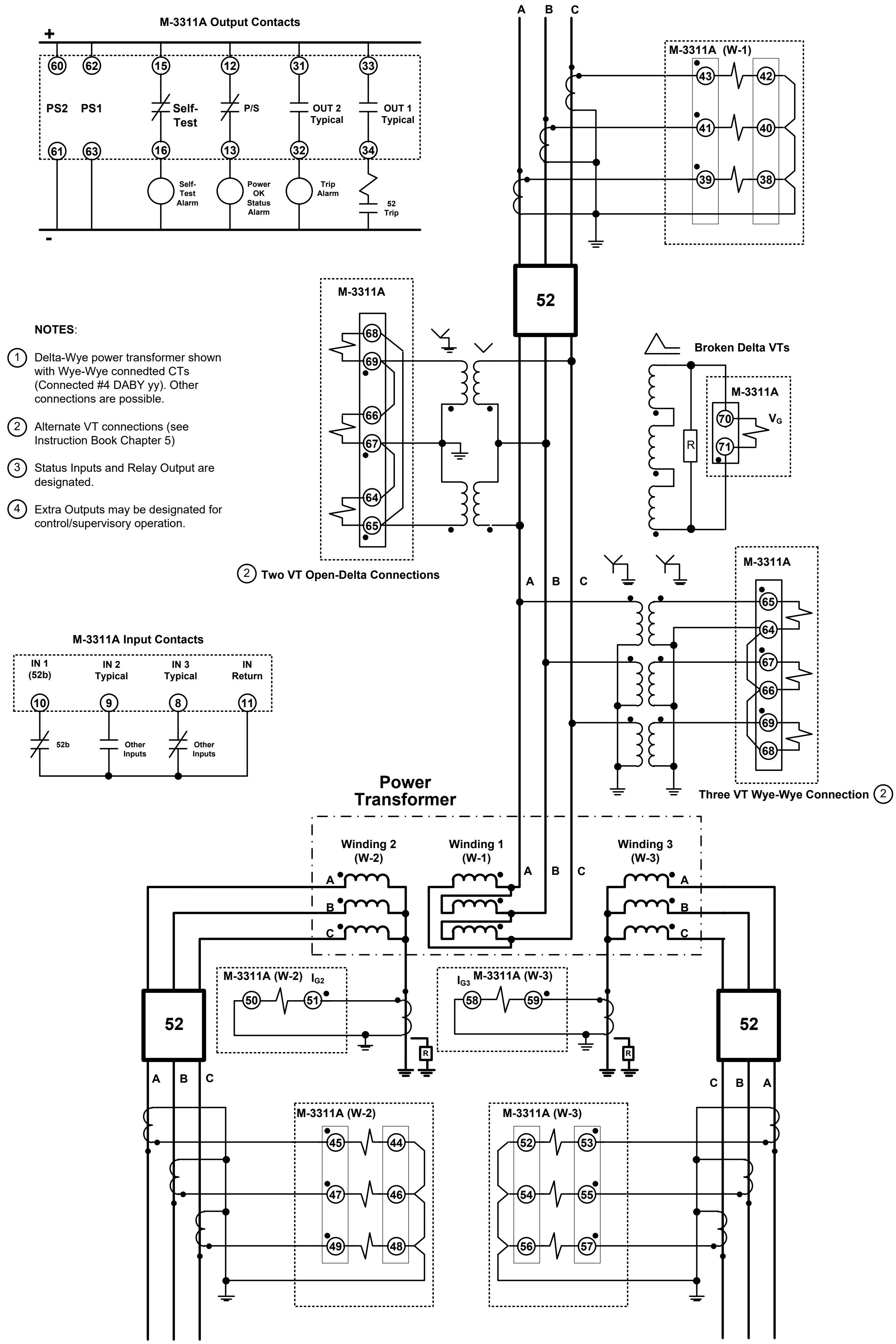


Figure 4-26 Typical (Three Winding – Four Voltage Inputs) Three-Line Connection Diagram

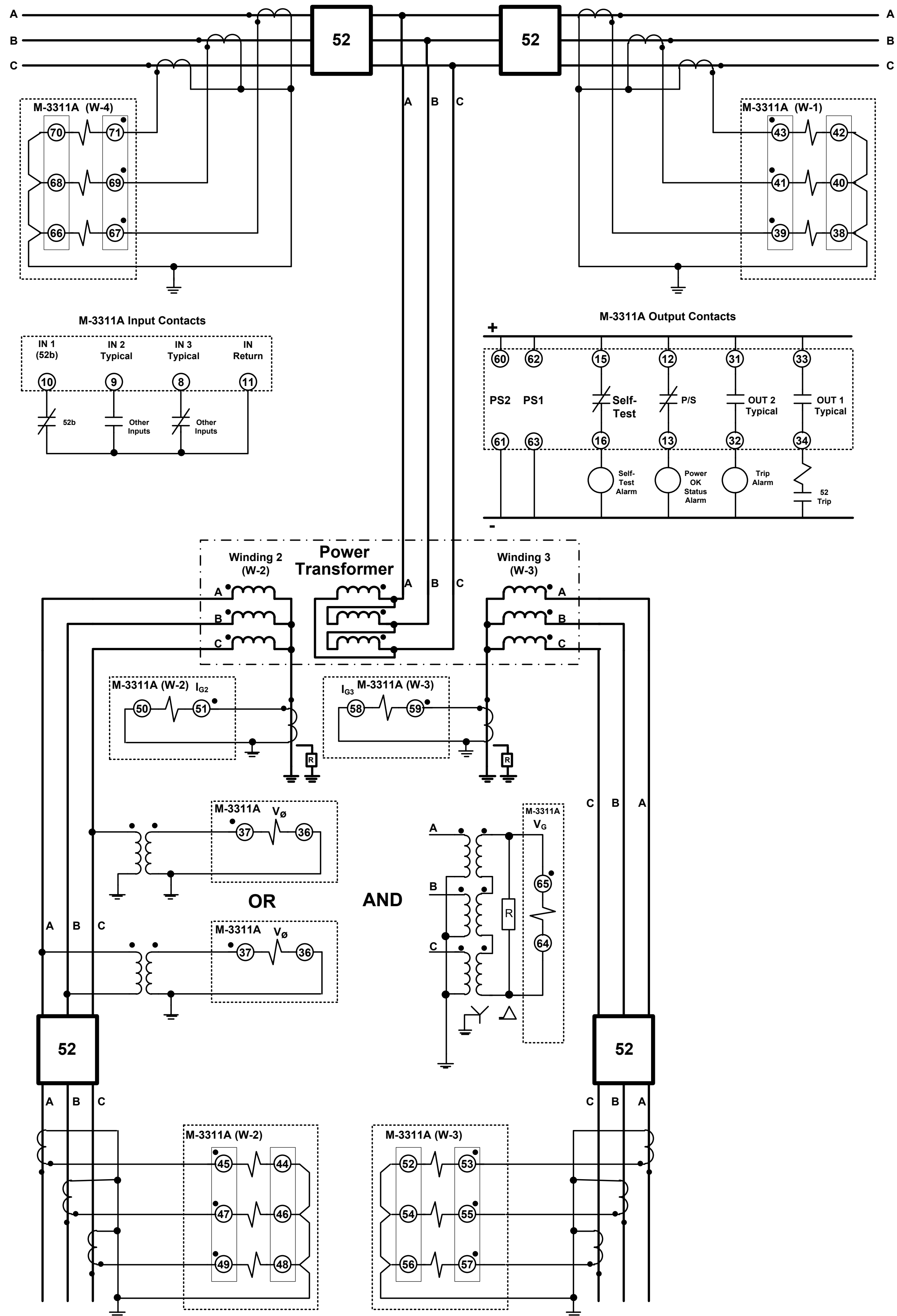


Figure 4-27 Typical (Four-Winding – Two-Voltage Inputs) Three-Line Connection Diagram

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 4-4) 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.

Utilizing the above feature not only accelerates the configuration process, but also removes the possibility of errors if all setpoints are re-entered manually.

Configure Relay Data

The relay is shipped with a certain group of standard functions, including other optional functions, as purchased. Both of these groups define a configurable set of functions. Only members of this set may be enabled/disabled by the end user. (Optional functions not purchased cannot be enabled.)

Functions designated as **DISABLED** are inactive and will not be available for tripping. All menus associated with inactive functions will be unavailable.

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

- Enable/disable function
- Output choices
- Input blocking choices

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
- 51N Inverse Time Residual Overcurrent #1, #2, #3, #4
- 59 Phase Overvoltage, #1, #2, #3*
- 59G Ground Overvoltage, #1, #2*
- 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 Voltage Protection Package Functions

24 Volts/Hz Overexcitation

> ■**NOTE:** Two or four voltage inputs are available for the M-3311A. The Voltage Input can be 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**, Figure D-1 to Figure D-4), 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 4-28, 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 4-28, 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.

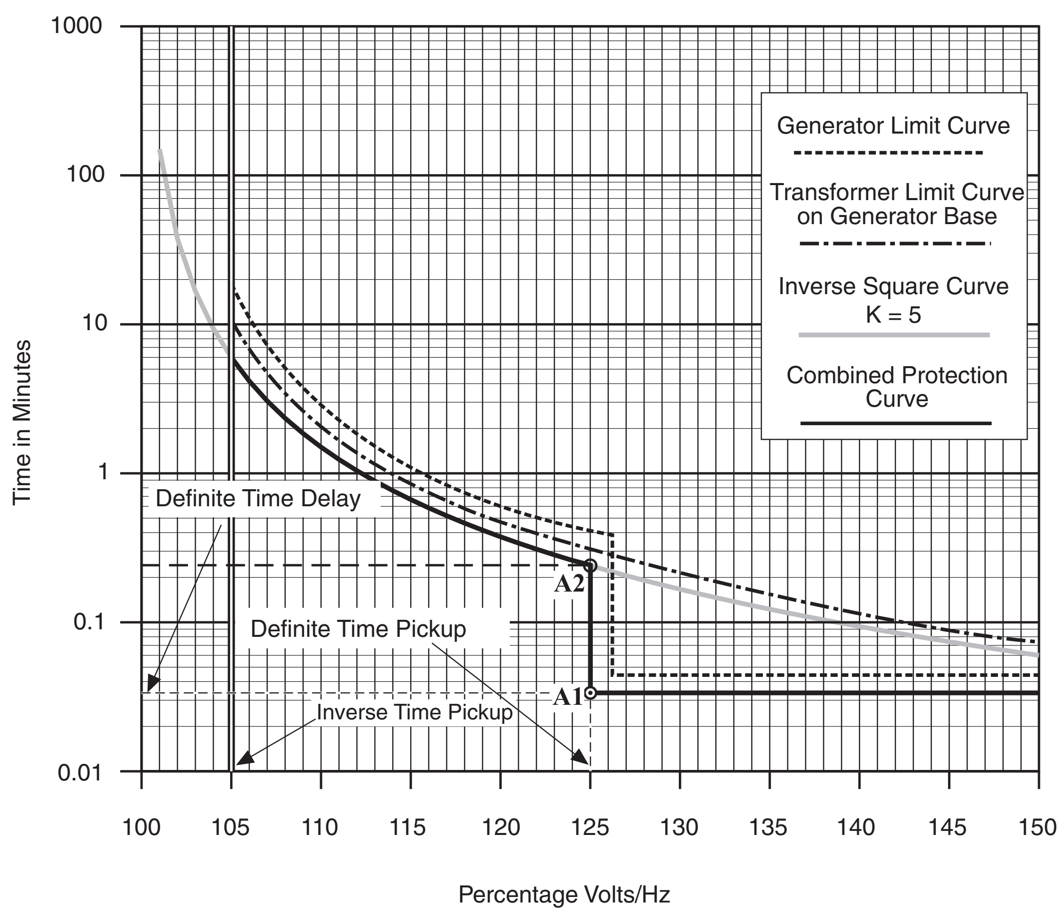


Figure 4-28 Example of V/Hz Capability and Protection Curves

```
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 4-28). 100% is equal to nominal voltage at nominal frequency (50/60 Hz). See **Section 4.2**, **Setup System**.

```
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 4-28) 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 4-28). 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%
```

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.

```
24DT#2 DELAY
360 Cycles
```

```
24IT PICKUP
  105%
```

As shown in Figure 4-28, the pickup value is the V/Hz value (in %) that the chosen inverse curve begins protective operation. Typical value is 105%.

```
24DT#2 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.

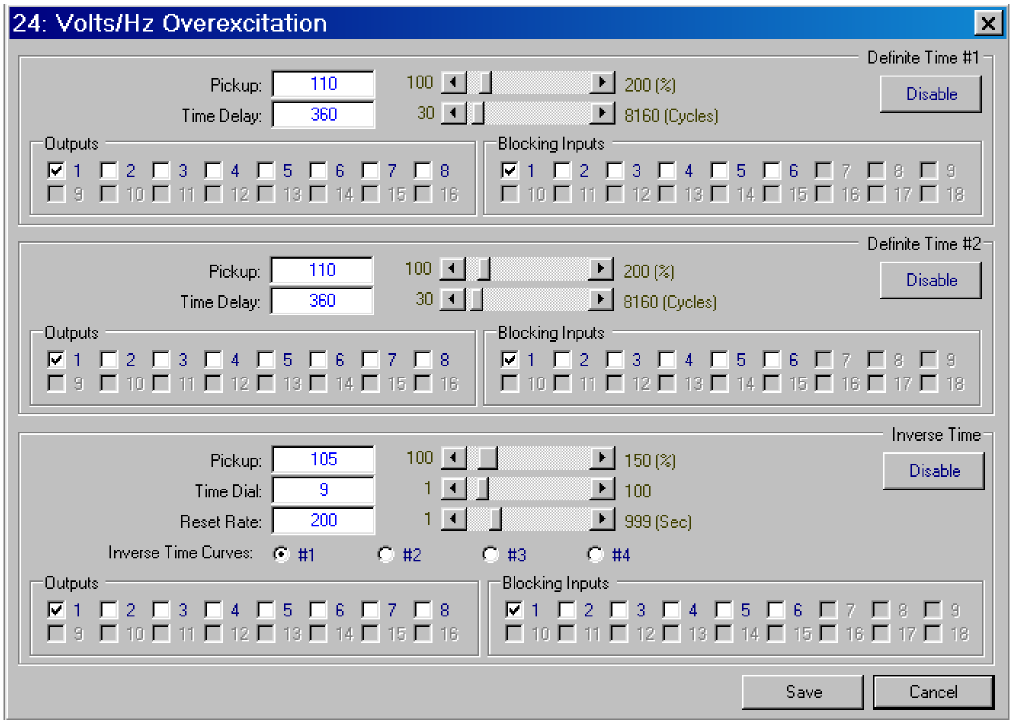


Figure 4-29 IPScom (24) Volts/Hertz Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 24 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 or four voltage inputs are available for the M-3311A. The Voltage Input can be 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.

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.

■ **NOTE:** Only one 27 Phase Undervoltage element is available in four-winding applications.

Four Winding

```
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.

Two- / Three-Winding

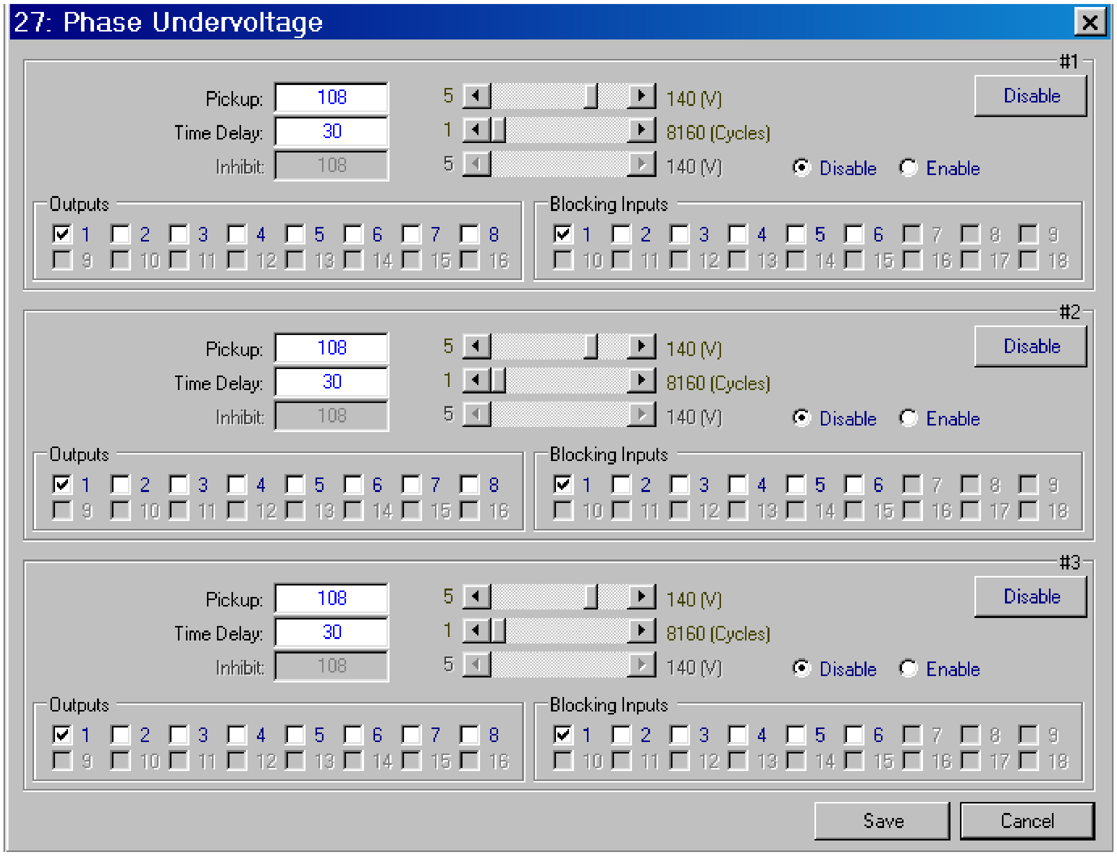
```
27#1 PICKUP
      108 Volts
```

```
27#1 INHIBIT
DISABLE enable
```

```
27#1 INHIBIT
      108 Volts
```

```
27#1 DELAY
      30 Cycles
```

■**NOTE:** These screens are the same for #2 and #3 elements on Two- / Three-W applications.



■ **NOTE:** Elements #2 and #3 are not available in four-winding applications.

Figure 4-30 IPScom (27) Undervoltage Setpoint Ranges (Two- / Three-Winding)

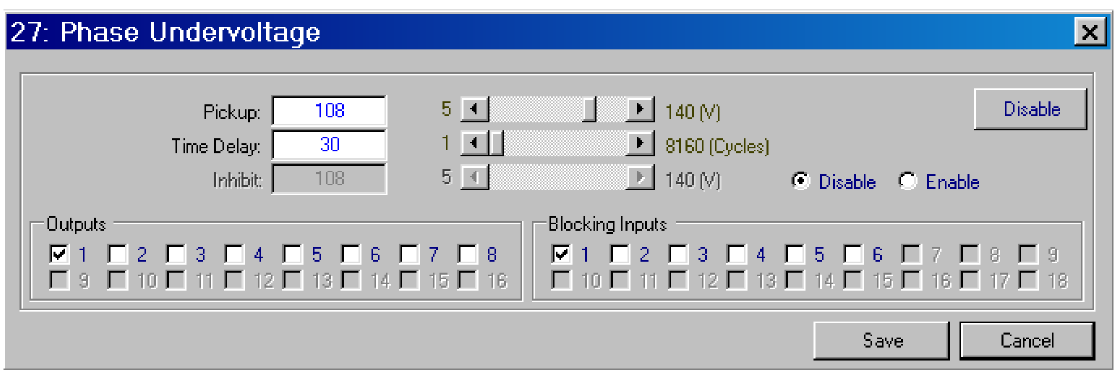


Figure 4-31 IPScom (27) Undervoltage Setpoint Ranges (Four-Winding)

Path: Relay / Setup / Relay Setpoints / 27 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 and three IEEE 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.

■ **NOTE:** Winding Four is not available in Two or Three Winding applications.

```
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. This element operates on I2.

```
46DTW2 DELAY
     120 Cycles
```

This setting is the operating time of the definite time function.

```
46DTW2 PICKUP
      1.00 Amps
```

Negative sequence overcurrent pickup establishes the negative sequence overcurrent level above which the inverse time function timer will start. This element operates on I2.

```
46ITW2 CURVE
BEDEF beinv bevinv beeinv→
```

This setting selects one of eleven families of curves, as shown in **Appendix D**, Figure D-5 through Figure D-15.

```
46ITW2 TIME DIAL
         5.0
```

The appropriate curve in the selected family of curves is chosen here.

```
46DTW3 PICKUP
      0.50 Amps
```

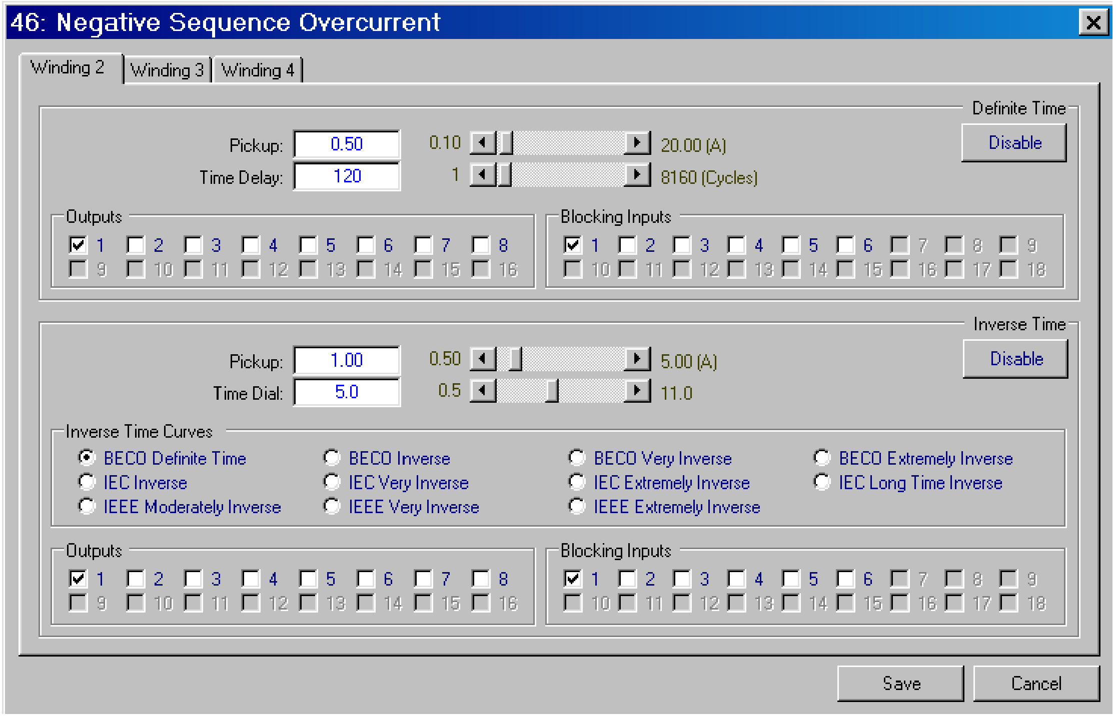
```
46DTW3 DELAY
     120 Cycles
```

```
46ITW3 PICKUP
      1.00 Amps
```

```
46ITW3 CURVE
BEDEF beinv bevinv beeinv→
```

```
46ITW3 TIME DIAL
         5.0
```

■ **NOTE:** These screens are the same for Winding 4.



■**NOTE:** Winding Four is not available in Two or Three Winding applications.

Figure 4-32 IPScom (46) Negative Sequence Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 46 Negative Sequence 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.

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:

$$t = \tau \times \mathrm{Ln} \frac{(I_{load}/I_{max})^2 - (I_{preload}/I_{max})^2}{(I_{load}/I_{max})^2 - 1}$$

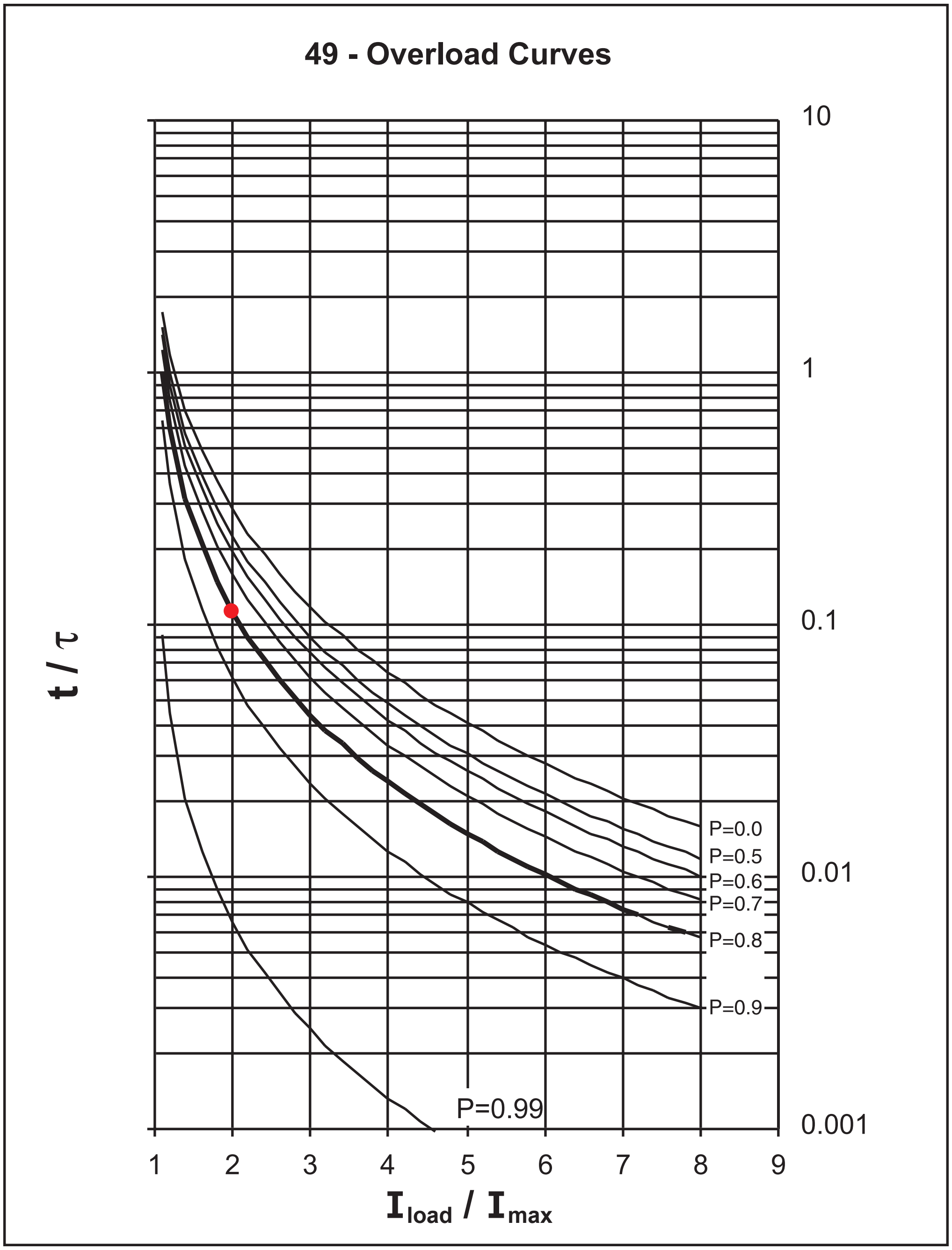
Where: t = time to trip
τ = time constant
I_{load} = relay current
$I_{preload}$ = pre-load current
I_{max} = maximum allowed continuous overload current

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 (I_{load}/I_{max}=2.0). Selecting the curve P=0.8 (see Figure 4-33), 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.

■ **NOTE:** Winding Four is not available for selection in Two or Three Winding applications.



where: $P = \frac{I_{preload}}{I_{max}}$

Figure 4-33 49 Function Overload Curves

```
46 TIME CONSTANT
5.0 Min
```

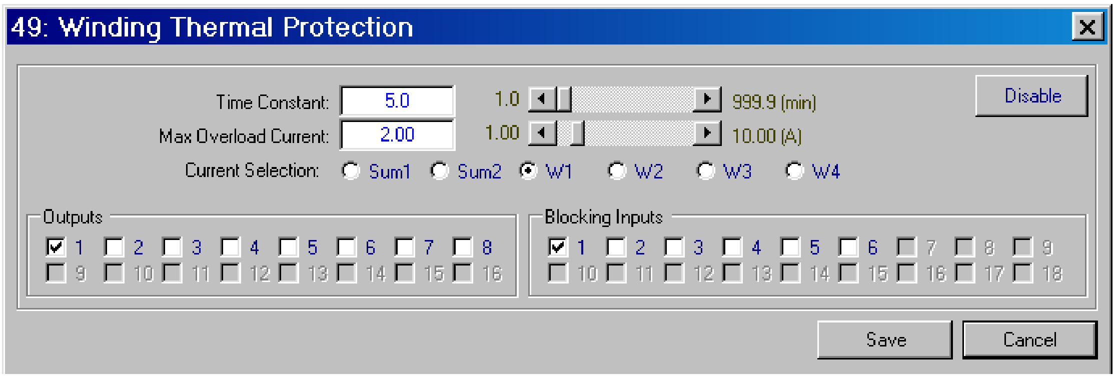
Selects the time constant, 'τ'

```
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.



■**NOTE:** Winding Four is not available for selection in Two or Three Winding applications.

Figure 4-34 IPScom (49) Winding Thermal Protection Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 49 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 4-35). 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 4-35. 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 4-19 through Figure 4-22, One-Line Functional Diagrams. This function is internally identical to the 50BF-Ph element and operates using residual (triple zero sequence) current.

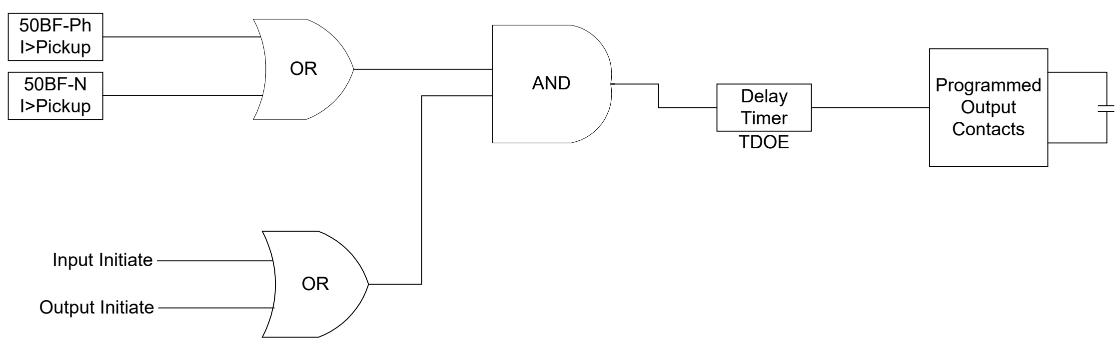


Figure 4-35 Breaker Failure Logic Diagram

```
50BFW1 PICKUP RESIDUAL
       1.00 Amps
```

Sets 50BFW1 residual current pickup. 0.5 A is a typical setting. This element operates on $3I_0$.

```
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.

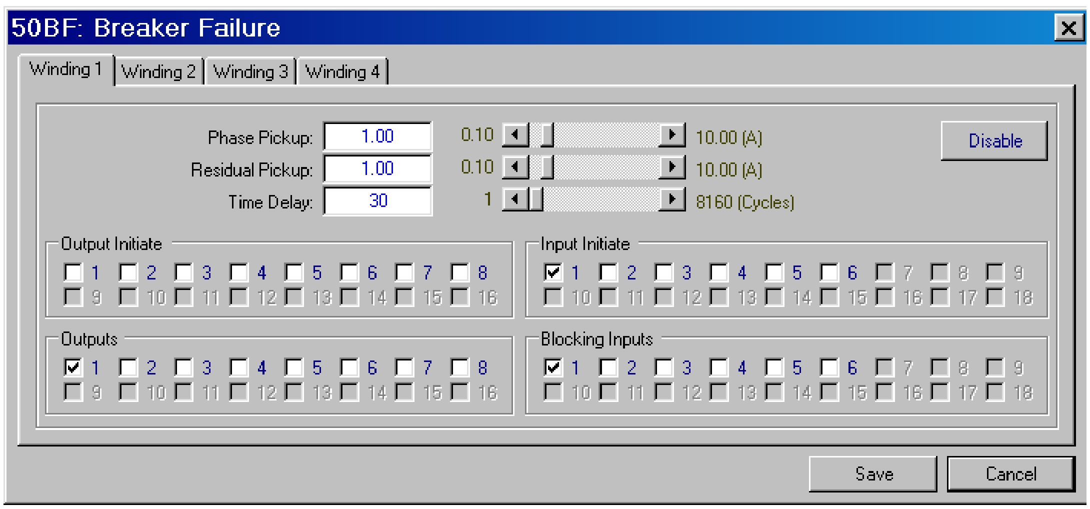
```
50BFW1 OUTPUT INITIATE
o8 o7 o6 o5 o4 o3 o2 O1
```

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.



■**NOTE:** Winding Four is not available in Two or Three Winding applications.

Figure 4-36 IPScom (50BF) Breaker Failure Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 50BF 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 overcurrent elements are available on Windings 2, 3 and 4 for 50G. The phase overcurrent elements (50) operate when any individual Phase A, B or C current exceeds the pickup. These elements also allow the user to program several logic schemes described in Section 4.5, **System Application and Logic Schemes**.

■**NOTE:** 50 Phase Instantaneous Overcurrent Elements #7 and #8 are not available in Two or Three Winding applications.

■**NOTE:** Winding Four is not available in Two or Three Winding applications.

```
50#1 PICKUP
      1.00 Amps
```

Sets ground pickup for instantaneous phase overcurrent element.

```
50#1 CURRENT SELECTION
sum1 sum2 w1 w2 w3 w4
```

Sets the current input for instantaneous phase overcurrent element.

```
50#1 DELAY
      30 Cycles
```

Sets delay for instantaneous phase overcurrent element.

■**NOTE:** These screens are the same for 50#2 thru 50#8.

```
50GW2#1 PICKUP
      1.00 Amps
```

Sets ground pickup for instantaneous phase overcurrent element.

```
50GW2#1 DELAY
      30 Cycles
```

Sets delay for instantaneous ground overcurrent element.

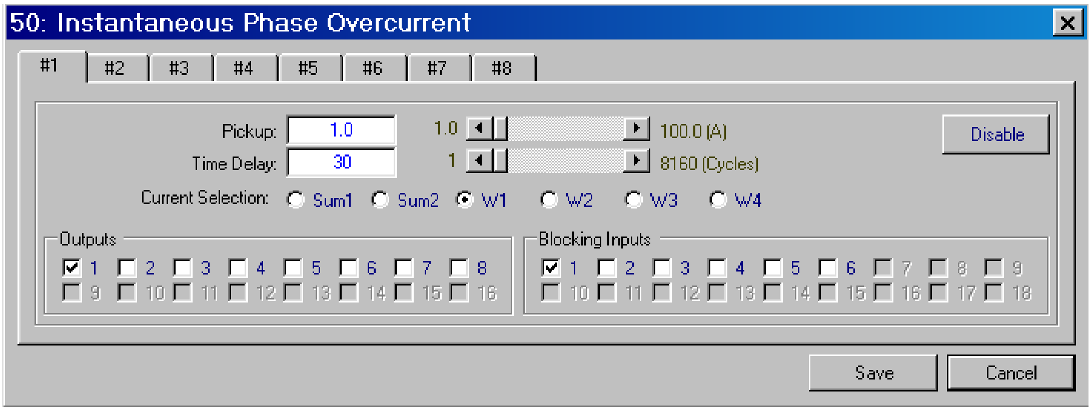
```
50GW2#2 PICKUP
      1.00 Amps
```

Sets ground pickup for instantaneous ground overcurrent element.

```
50GW2#2 DELAY
      30 Cycles
```

Sets delay for instantaneous ground overcurrent element.

■**NOTE:** These screens are also applicable for Windings 3 and 4 (Function 50G).



■**NOTE:** Elements #7 and #8 are not available in Two or Three Winding applications.

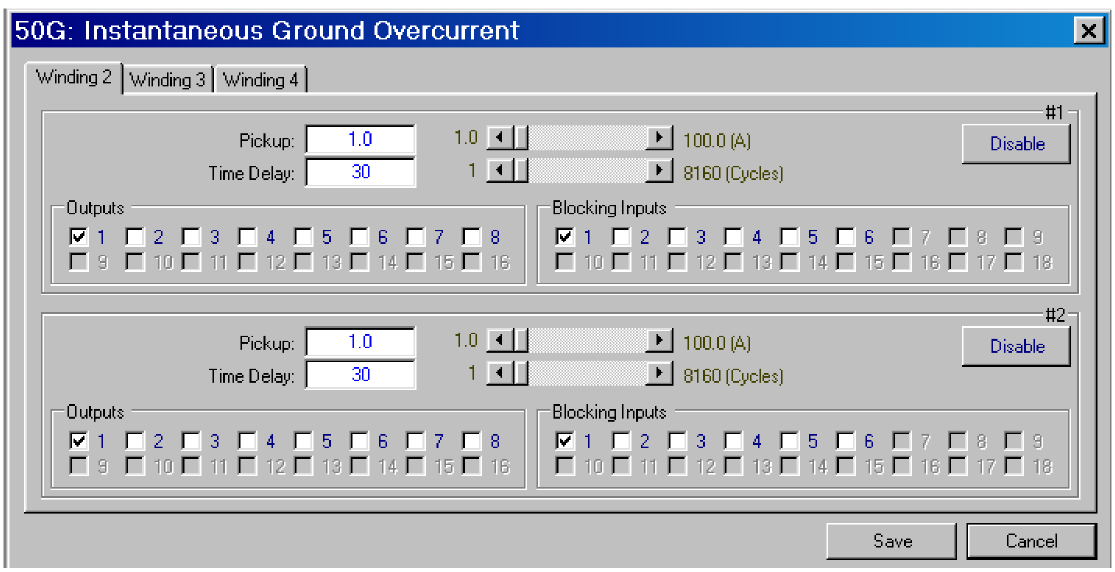
Figure 4-37 IPScom (50) Instantaneous Phase Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 50 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.



■**NOTE:** Winding Four is not available in Two or Three Winding applications.

Figure 4-38 IPScom (50G) Instantaneous Ground Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 50G 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.

■**NOTE:** Instantaneous Residual Overcurrent Elements #7 and #8 are not available in Two or Three Winding applications.

```
50N#1 PICKUP
      1.00 Amps
```

Sets pickup for instantaneous residual overcurrent. This element operates on I_0.

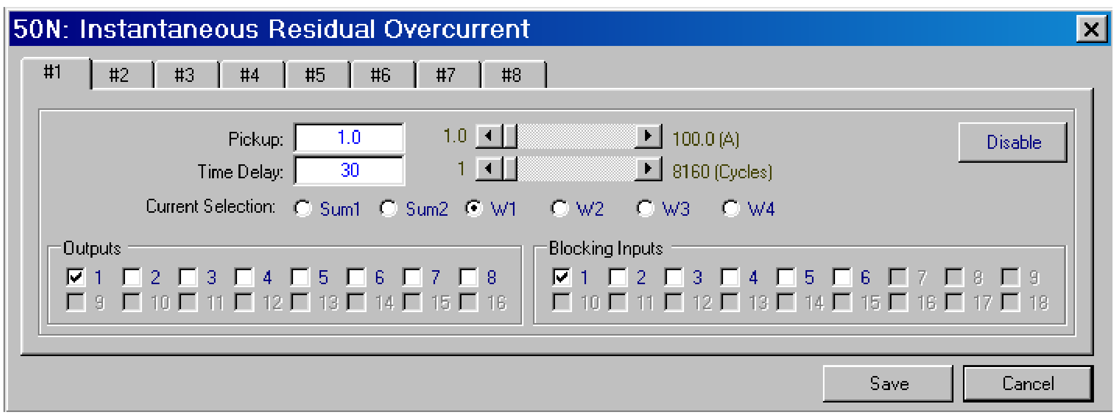
```
50N#1 current selection
sum1 sum2 w1 w2 w3 w4
```

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.



■**NOTE:** Instantaneous Residual Overcurrent Elements #7 and #8 are not available in Two or Three Winding applications.

Figure 4-39 IPScom (50N) Instantaneous Residual Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 50N 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, eleven complete series of inverse time tripping characteristics are included. The eight curve families to be chosen are definite, inverse, very inverse, extremely inverse, four IEC curves and three IEEE 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**, Figure D-5 through Figure 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.

```
51#1 PICKUP
        1.00 Amps
```

Sets phase current pickup for 51W1.

```
51#1 CURVE
BEDEF beinv bevinv beinv →
```

Selects one of the eleven inverse time curves as shown in **Appendix D**, Figure D-5 through Figure D-15.

```
51#1 TIME DIAL
         5.0
```

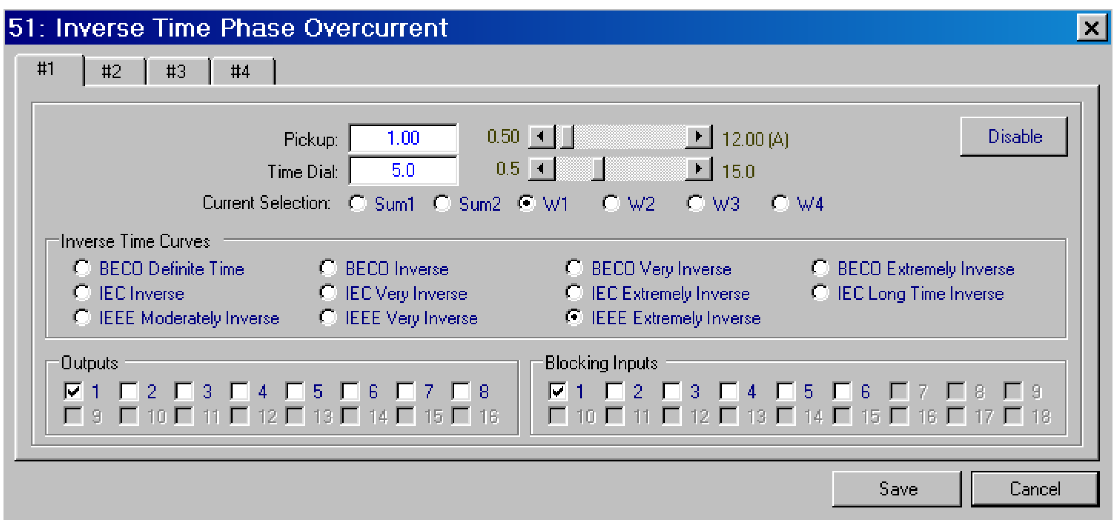
The appropriate curve in the selected family of curves is chosen here.

```
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.

■**NOTE:** Inverse Time Phase Overcurrent Element #4 is not available in Two and Three Winding applications.



■**NOTE:** Inverse Time Phase Overcurrent Element #4 is not available in Two and Three Winding applications.

Figure 4-40 IPScom (51) Inverse Time Phase Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 51 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**, Figure D-5 through Figure 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.

```
51N#1 PICKUP
        1.00 Amps
```

Sets phase current pickup for 51N#1. This element operates on I_0.

```
51N#1 CURVE
BEDEF beinv bevinv beinv →
```

Selects one of the eleven inverse time curves, as shown in **Appendix D**, Figure D-5 through Figure D-15.

```
51N#1 TIME DIAL
           5.0
```

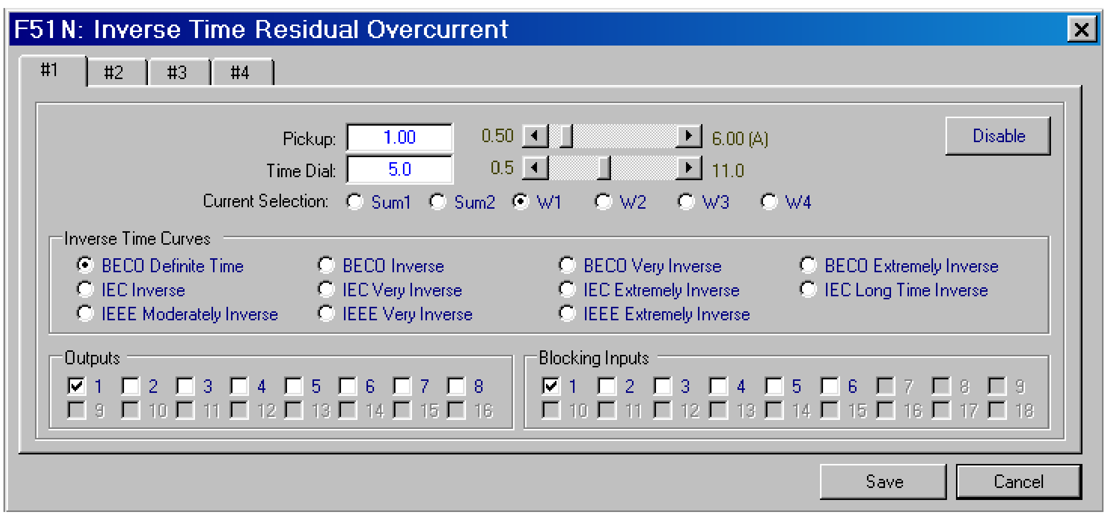
The appropriate curve in the selected family of curves is chosen here.

```
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.

■**NOTE:** Inverse Time Residual Current Element #4 is not available in Two or Three Winding applications.



■**NOTE:** Inverse Time Residual Current Element #4 is not available in Two or Three Winding applications.

Figure 4-41 IPScom (51N) Inverse Time Residual Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 51N 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, eleven 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**, Figure D-5 through Figure 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.

```
51GW2 PICKUP
      1.00 Amps
```

Sets residual pickup for 51G.

```
51GW2 CURVE
BEDEF beinv bevinv beinv →
```

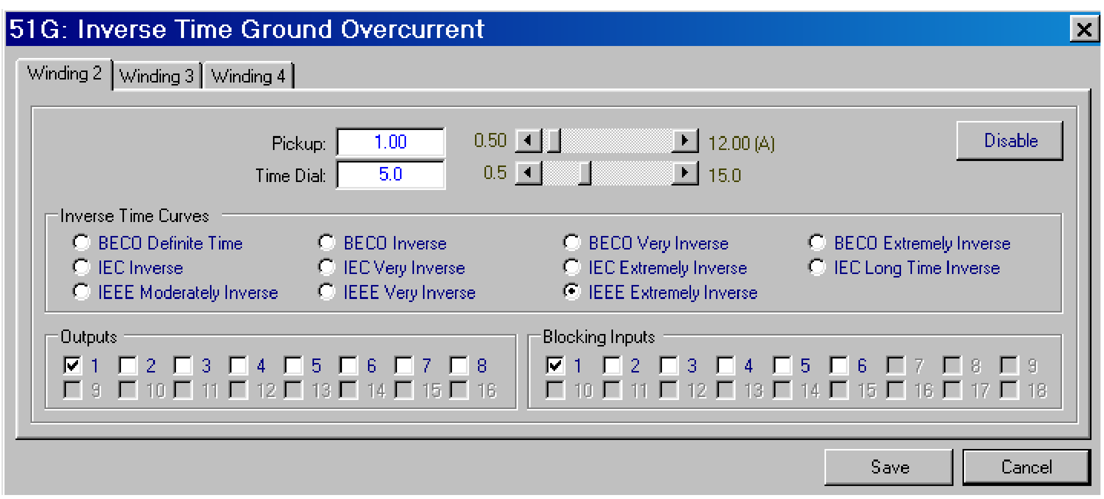
Selects one of the eleven inverse time curves, as shown in **Appendix D**, **Inverse Time Curves**, Figure D-5 through Figure D-15.

```
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.

■**NOTE:** Winding Four is not available in Two or Three Winding Applications.



■**NOTE:** Winding Four is not available in Two or Three Winding Applications.

Figure 4-42 IPScom(51G) Inverse Time Ground Overcurrent Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 51G 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.

59 Phase Overvoltage (Two- / Three-Winding)

The 59 Phase Overvoltage function may be used to provide overvoltage protection for the transformer. Transformers should not be exposed to long periods of overvoltage. If a transformer is operated about 110 percent rated voltage the exciting current becomes very high and can damage the windings. Overvoltage is most likely to occur for step-up units when the generator is brought online or removed from service.

```
59#1 INPUT VOLTAGE SEL.
PHASE_VOLT pos_seq_volt
```

```
59#1 PICKUP
      132 Volts
```

```
59#1 DELAY
      30 Cycles
```

■**NOTE:** 59#2 and 59#3 screens are identical to 59#1.

The relay provides overvoltage protection functions with three voltage levels and three definite-time setpoints, any one or more of which can be programmed to trip the unit or send an alarm. This is true 3-phase function in that each phase has an independent timing element. Each 59 element can be programmed to use phase voltage (any one of the three phases), positive-sequence voltage, or negative-sequence voltage as the input.

The magnitude calculation is accurate near 50 or 60 Hz and the timer accuracy is ±1 cycle. When the input voltage select is set to positive-sequence voltage or negative-sequence voltage, the 59 functions use the DFT to measure the sequence voltage. Ranges and increments are presented in Figure 4-43.

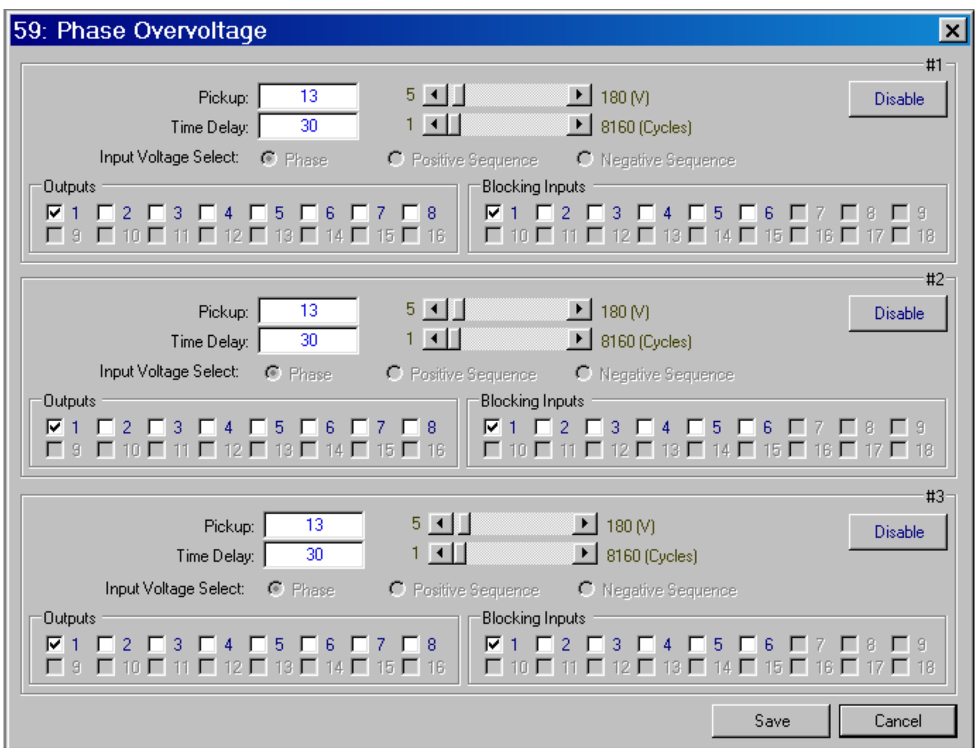


Figure 4-43 IPScom (59) Phase Overvoltage Setpoint Ranges (Two- / Three-Winding)

Path: Relay / Setup / Relay Setpoints / 59 Phase 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.

59G Ground Overvoltage

> ■**NOTE:** Zero, two, or four voltage inputs are available for two- or three-winding M-3311A relays. Zero or two voltage inputs are available for four-winding M-3311A relays. The voltage input can be a phase voltage input or ground voltage input. The 24, 27, 59, and 81O/U functions are only available if one or more phase voltages are wired to the phase voltage input(s).

Function 59G is only available if the V_G voltage input is connected to broken delta VTs or a two- or three-winding M-3311A relay with four voltage inputs wired to three Yg/Yg VTs with VT config equal to LG, which allows 59G to use a calculated $3V_0$ quantity.

The 59G Ground Overvoltage function provides protection for ground faults on the system.

The 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

Four Winding

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.

> ■**NOTE:** The below setting screen is for four-winding applications. For two- and three-winding applications, there are three 59G elements available.

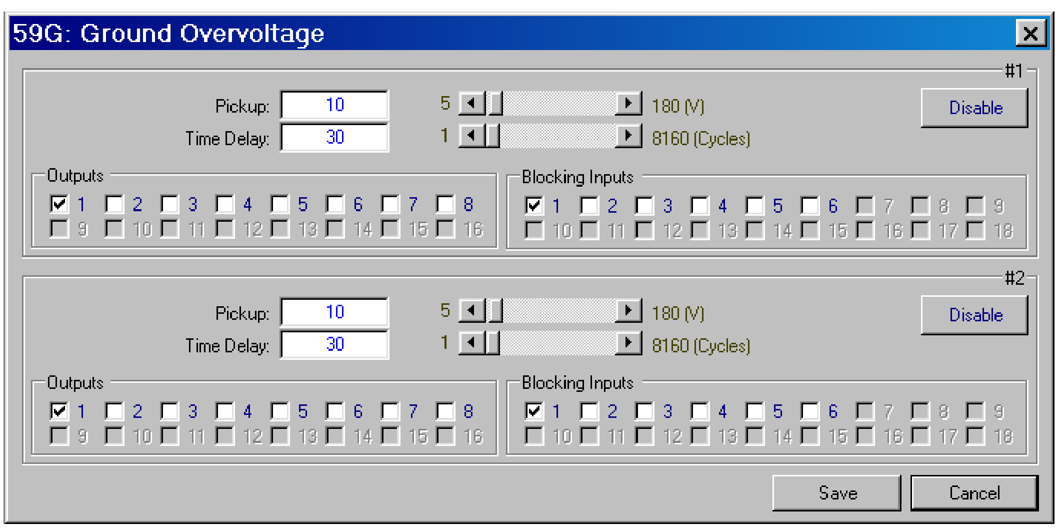


Figure 4-44 IPScom (59G) Ground Overvoltage Setpoint Ranges (Four-Winding)

Path: Relay / Setup / Relay Setpoints / 59G 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.

59G Ground Overvoltage Zero Sequence Voltage Selection (available on Two- or Three-Winding Relays with Four Voltage Inputs)

This selection determines the operating quantity that will be used by the 59G Ground Overvoltage elements. This applies to all three 59G elements.

This selection will be available only for a two- or three-winding relay with four voltage inputs. When $3V_0$ is selected, the operating quantity is the calculated $3V_0$ from the measured quantities of V_A, V_B, V_C. When V_G is selected, the operating quantity is the measured voltage at the V_G terminals of the M-3311A relay from broken delta VTs.

■**NOTE:** This selection is only available with firmware version V02.03.01 and later.

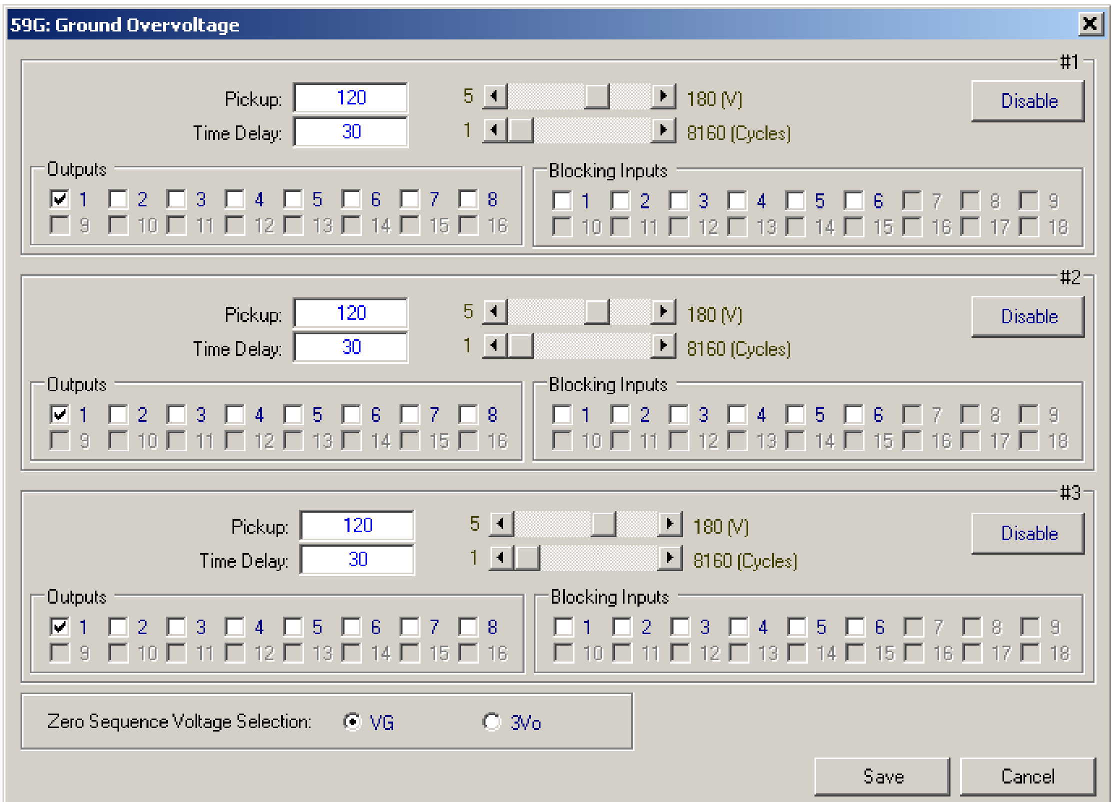


Figure 4-45 IPScom (59G) Ground Overvoltage Setpoint Ranges (Two-/Three-Winding, Four Voltages)

Path: Relay / Setup / Relay Setpoints / 59G 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 or Four voltage inputs are available for the M-3311A. The Voltage Input can be 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.

```
81#1 PICKUP
       55.00 Hz
```

The pickup and time delay setting for load shedding should be selected based on load frequency characteristics of the system.

```
81#1 DELAY
      30 Cycles
```

A minimum time delay of 6 cycles is recommended to prevent relay operation during switching transients.

```
81#2 PICKUP
       55.00 Hz
```

```
81#2 DELAY
      30 Cycles
```

```
81#3 PICKUP
       55.00 Hz
```

```
81#3 DELAY
      30 Cycles
```

```
81#4 PICKUP
       55.00 Hz
```

```
81#4 DELAY
      30 Cycles
```

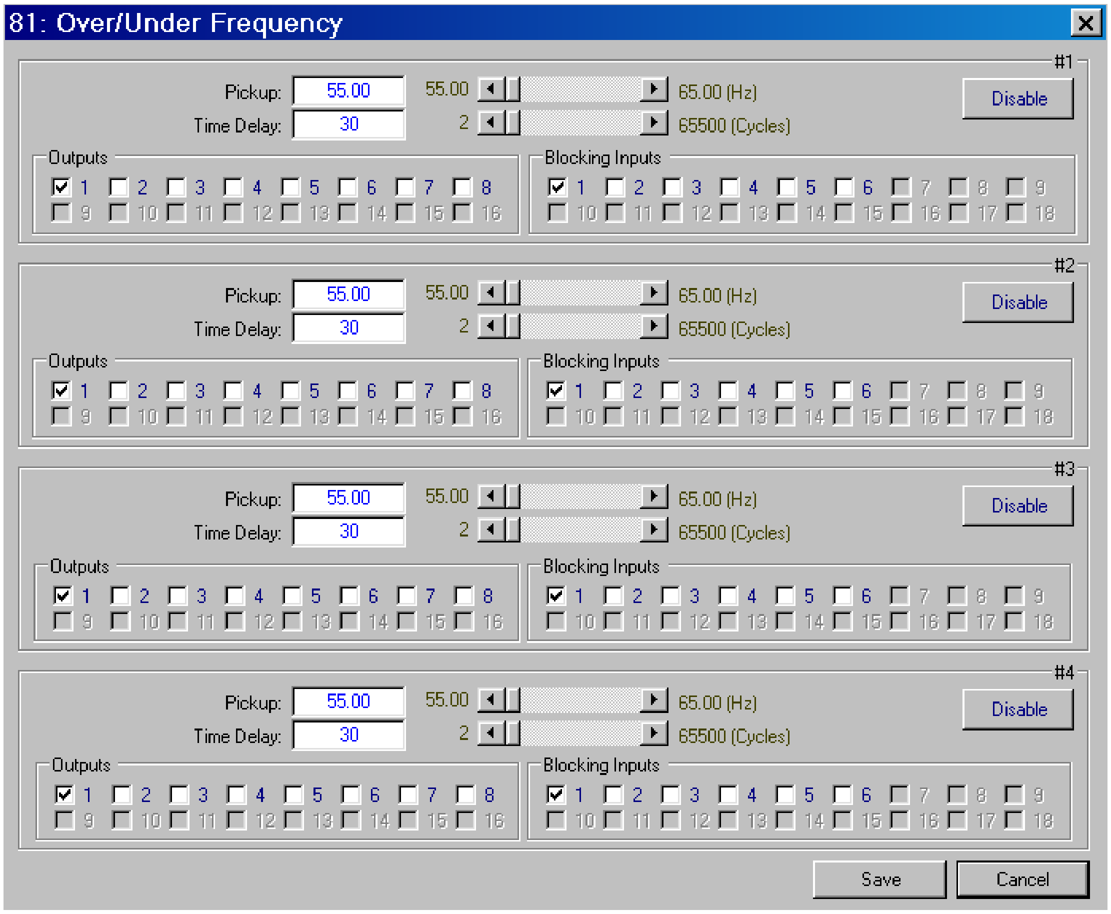


Figure 4-46 IPScom (81O/U) Over/Underfrequency Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 81 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).

```
87H PICKUP
       20.0 PU
```

High-set pickup setting.

```
87H DELAY
       2 Cycles
```

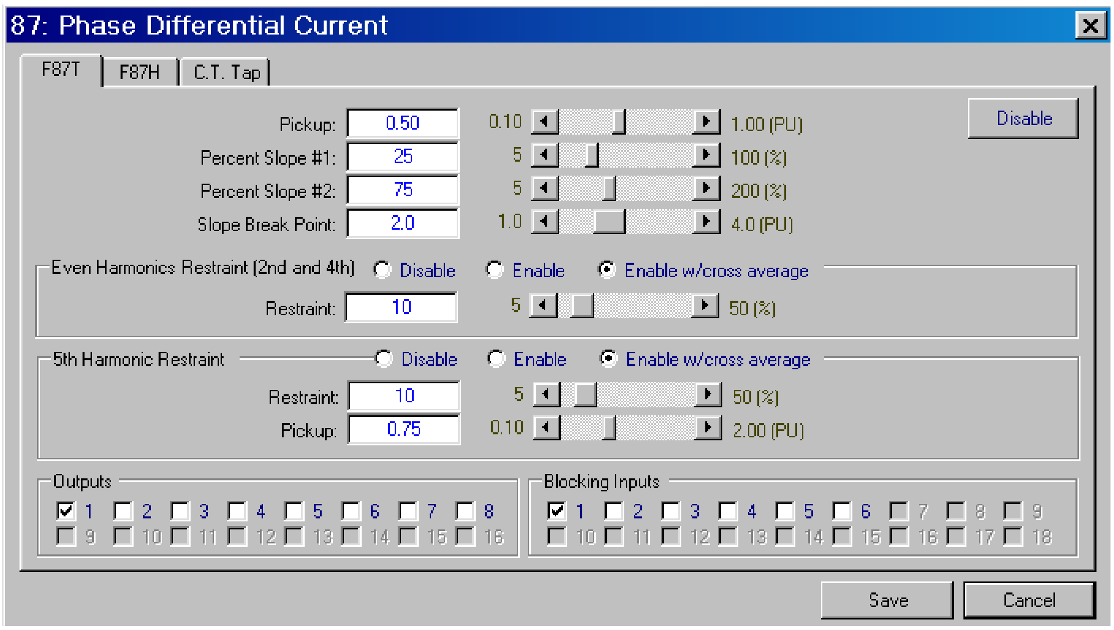


Figure 4-47 IPScom (87T) Phase Differential Current Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 87 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.

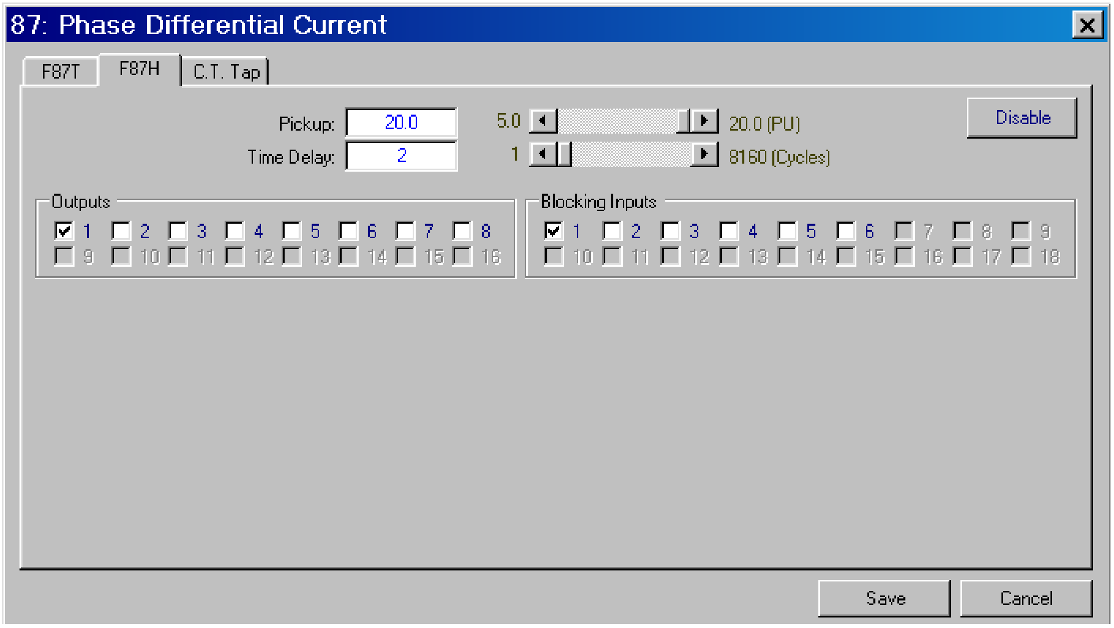


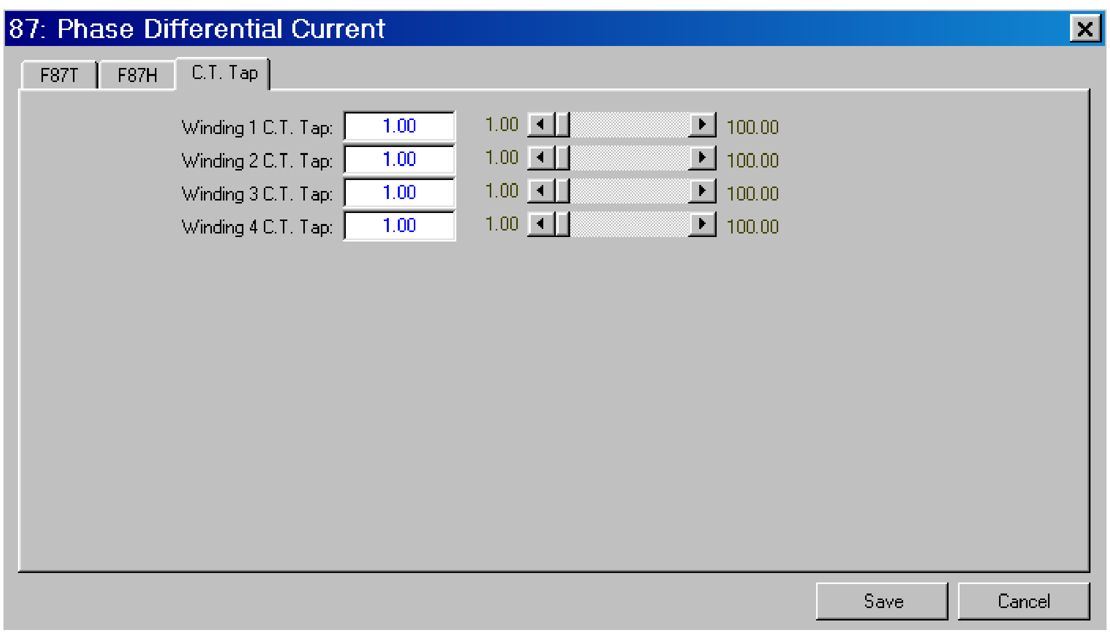
Figure 4-48 IPScom (87H) Phase Differential Current Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 87 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.



■**NOTE:** Winding Four is not available for selection in Two or Three Winding applications.

Figure 4-49 IPScom (C.T. Tap) Phase Differential Current Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 87 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 4-50). 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 $\frac{I_{d24}}{I_{d1}}$. If this ratio is greater than the even harmonic restraint setpoint then 87T is restrained from operating. The equation below illustrates how the restraint works for A-Phase:

I_{d24} > *Even Harmonic Restraint Setpoint* $\cdot \left| I_{AW1} + I_{AW2} + I_{AW3} + I_{AW4} \right|$

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.

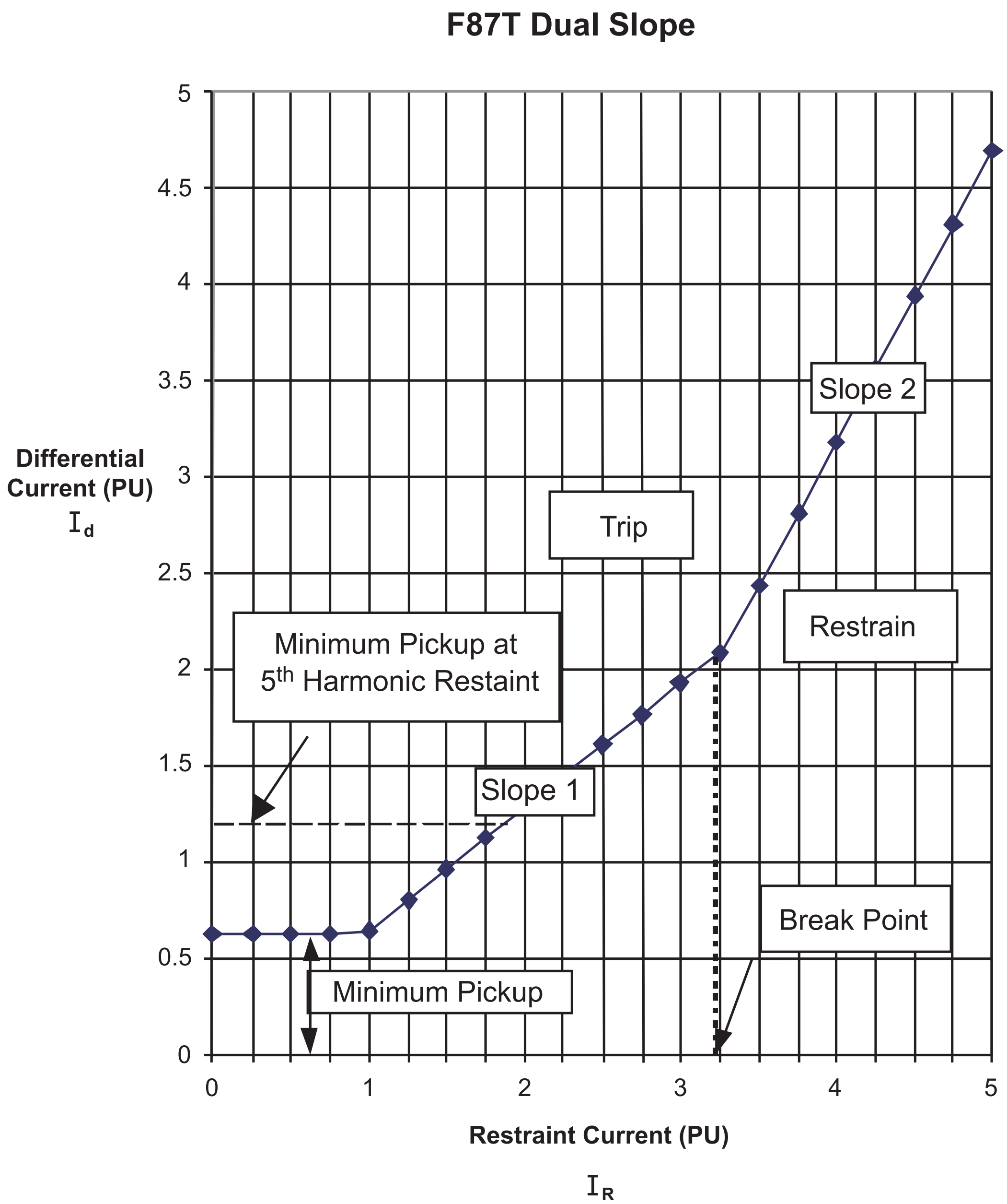
The setting of the even harmonic restraint should be set to a low enough value to provide security against misoperation during transformer magnetizing inrush current and it should not be lower than the amount of even harmonics generated during internal fault conditions with CT saturation so as not to 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.



where

$$I_R = \frac{\Sigma\left|I_{AW1}\right| + \left|I_{AW2}\right| + \left|I_{AW3}\right| \; I_{AW4}\Big|}{2}$$

$$I_d = \Sigma\left|\bar{I}_{AW1} + \bar{I}_{AW2} + \bar{I}_{AW3} + \bar{I}_{AW4}\right|$$

Figure 4-50 87T Programmable Dual Slope Percentage Restraint Characteristic

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 PU. 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 WN is the winding number.

CT Tap Setting Calculation Example

Based on the transformer example in Figure 4-51, 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.

$$87\ CT\ Tap_{W1} = \frac{392.8\ MVA \times 10^3}{\sqrt{3} \times 17.1\ kV \times 1600} = 8.29$$

$$87\ CT\ Tap_{W2} = \frac{392.8\ MVA \times 10^3}{\sqrt{3} \times 17.1\ kV \times 1600} = 8.29$$

$$87\ CT\ Tap_{W3} = \frac{392.8\ MVA \times 10^3}{\sqrt{3} \times 161\ kV \times 400} = 3.52$$

■ **NOTE:** Winding Four is not available for selection in Two or Three Winding applications.

Transformer Rating
392.8 MVA / 196.4 MVA / 196.4 MVA
161 kV / 17.1 kV / 17.1 kV

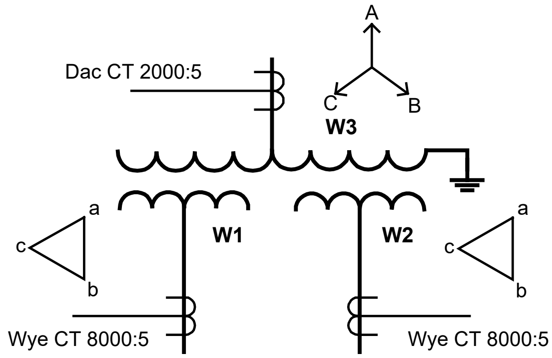


Figure 4-51 Transformer CT Tap Setting Example

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 ($-3I_0I_G$Cosf) 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 (IG). The magnitude of the difference (CTRCF X $3I_0$- IG) 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 IG is less than approximately 0.20 amps.

■ **NOTE:** Winding Four is not available for Two or Three Winding applications.

```
87GDW2#1 PICKUP
      0.20 Amps
```

■ **NOTE:** For higher values of CT Ratio correction, noise may create substantial differential current making higher settings desirable.

```
87GDW2#1 DELAY
       2 Cycles
```

▲ **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.

```
87GDW2#2 PICKUP
      0.20 Amps
```

CT (CTRCF) Ratio Correction Factor = $\dfrac{\textit{Phase C.T. Ratio}}{\textit{Ground C.T. Ratio}}$

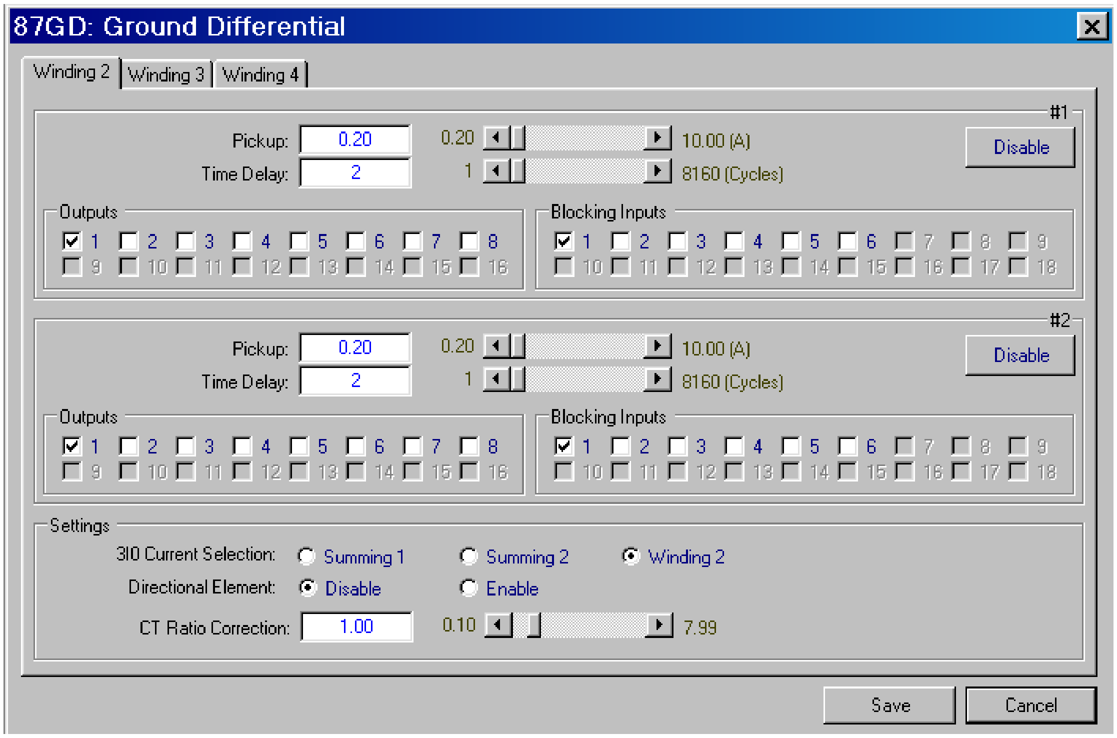
```
87GDW2#2 DELAY
       2 Cycles
```

■ **NOTE:** These screens are also applicable for Windings 3 and 4.

```
87GDW2 C.T. RATIO CORR.
        1.00
```

```
87GDW2 DIR ELEMENT
disable enable
```

```
87GDW2 CURRENT SELECT
sum1 sum2 SNGL_win
```



■**NOTE:** Winding Four is not available for Two or Three Winding applications.

Figure 4-52 IPScom (87GD) Ground Differential Current Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / 87GD 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.

TCM (Trip Circuit Monitoring) Aux Input

External connections for the Trip Circuit Monitoring function are shown in Figure 4-53. The default Trip Circuit Monitor input voltage is 250 Vdc. 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
```

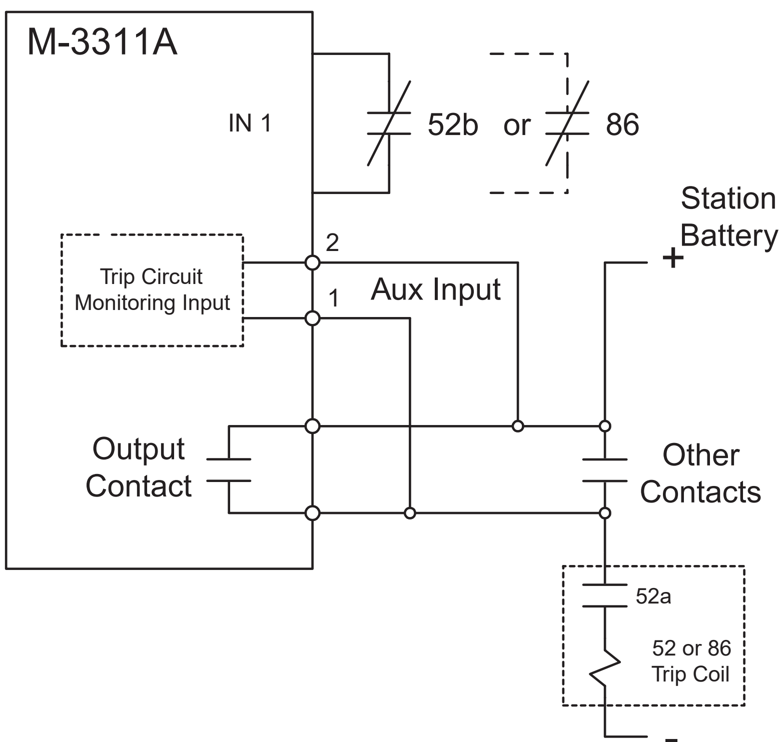


Figure 4-53 Trip Circuit Monitoring Input

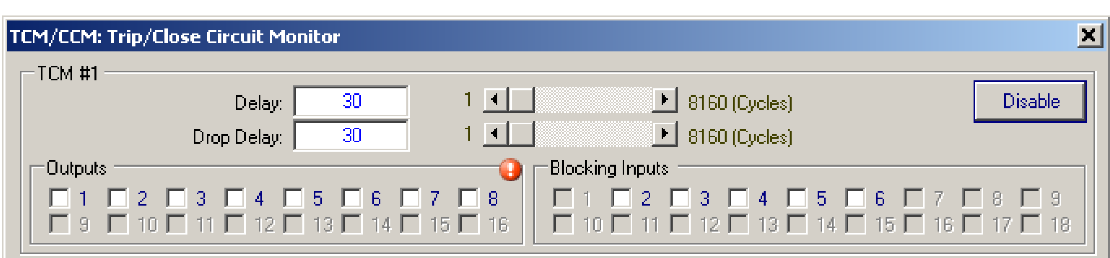


Figure 4-54 Trip Circuit Monitor (Two- / Three-Winding Aux Input) Setpoint Ranges

TCM (Trip Circuit Monitor) Expanded I/O

The TCM inputs are provided for monitoring the continuity of the trip circuits (Figure 4-55). The inputs can be used for nominal trip coil voltages of 24 Vdc to 250 Vdc. Trip circuit monitoring is performed in the active breaker status only. Both the DC supply and continuity for the trip circuit is monitored. If a trip coil is detected as being open for the time delay then the selected Output(s) are set.

External connections for the Trip Circuit Monitoring function are shown in Figure 5-8 through Figure 5-28. The default Trip Circuit Monitor input voltage is 250 Vdc. See **Section 5.5**, **Circuit Board Switches and Jumpers**, (Table 5-3 for TCM#1, Table 5-5 for TCM#2) for other available trip circuit input voltage selections.

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 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 closes the Output Contact and Trip Circuit Monitoring Input remains activated, this is an indication that the Output Contact failed to close.

This function is blocked 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. This function is also blocked when any output contact is closed.

The output of the Trip Circuit Monitoring function can be programmed as an alarm to alert maintenance personnel.

The M-3311A will illuminate the appropriate alarm LED on the unit front panel when all of the following conditions exist:

- The M-3311A TCM is connected to the target trip coil circuit.
- An open condition has been detected in the trip coil circuit for the duration of the Time Delay.

> ■ **NOTE:** The TCM circuit is designed to ensure that continuity exists in the circuit, by monitoring the connection for the presence of a small amount of current. If there is no physical connection to the circuit, the TCM alarm LED will illuminate, regardless of whether the TCM protective function is disabled in the relay.

Figure 4-56 displays the settings for the TCM function for Expanded I/O (TCM-1 and TCM-2) and Figure 4-54 for Non-Expanded I/O units (TCM-1 via Aux Input).

Enable/Disable – The top right corner of the display includes a command button that will disable or enable the function. This selection allows the TCM #1 to be disabled (or enabled) independent from the TCM #2.

```
TCM DELAY
30 Cycles
```

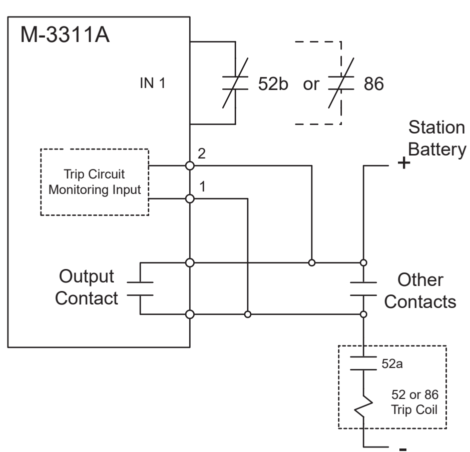


Figure 4-55 Trip Circuit Monitoring Input

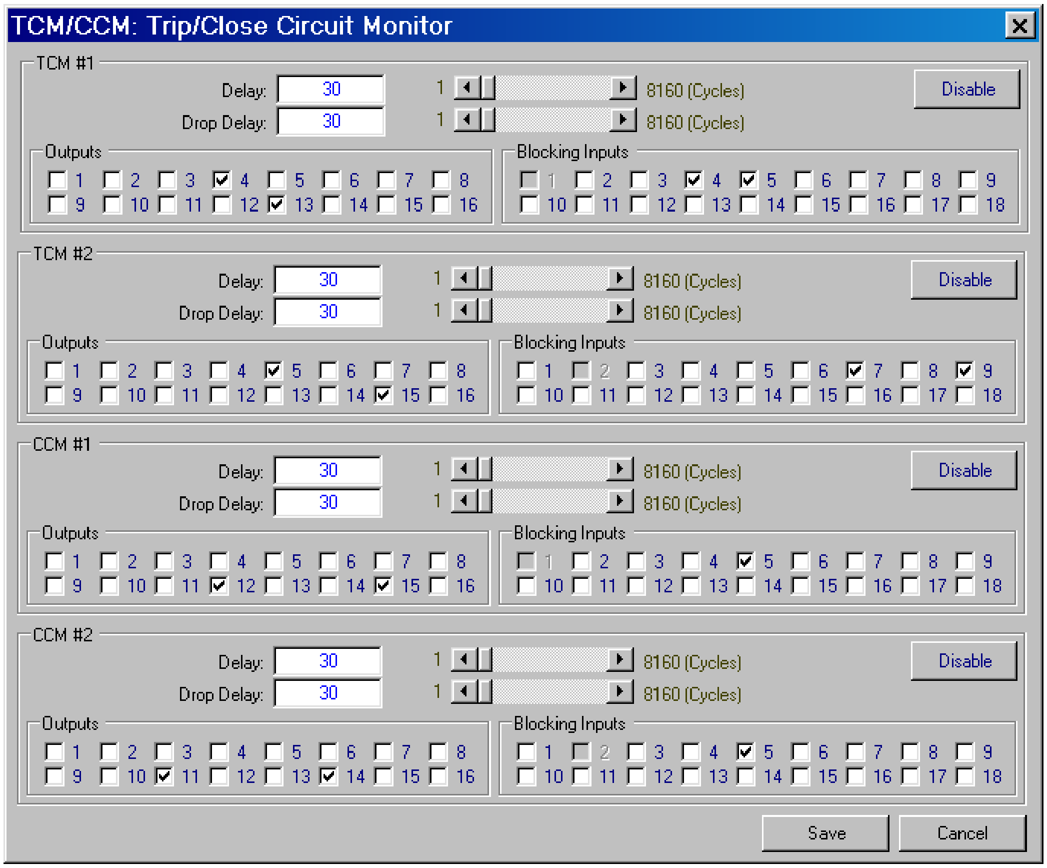


Figure 4-56 Trip/Close Circuit Monitor Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / TCM/CCM

Time Delay – A Time Delay can be applied to delay the TCM function output.

Dropout Time Delay – A Time Delay can be applied to delay the reset of the TCM function output.

I/O Selection – The I/O Selection allows any input to be selected to block the TCM. The TCM #1(2) Function can also be used to activate a selected Output when it times out.

Save/Cancel – The Save selection saves the TCM Function Dialog Screen settings either to an open file or to the target M-3311A. Cancel, returns the user to the previous open screen.

CCM (Close Circuit Monitor)

Figure 4-56 displays the settings for the CCM function. The settings for the CCM #2 Close Circuit Monitor are the same as the CCM #1.

The CCM inputs are provided for monitoring the continuity of the close circuits. The inputs can be used for nominal close coil voltages of 24 Vdc to 250 Vdc. Close circuit monitoring is performed in the active breaker status only. Both the DC supply and continuity for the close circuit is monitored. If a close coil is detected as being open for the time delay then transfers are blocked.

The M-3311A Close Coil Monitor will illuminate the appropriate alarm LED on the unit front panel when all of the following conditions exist:

- The M-3311A CCM is connected to the target close coil circuit.
- An open condition has been detected in the close coil circuit for the duration of the Time Delay.

> ■ **NOTE:** The CCM circuit is designed to ensure that continuity exists in the circuit, by monitoring the connection for the presence of a small amount of current. If there is no physical connection to the circuit, the CCM alarm LED will illuminate, regardless of whether the CCM protective function is disabled in the relay.

The close coil circuit open detection circuit will illuminate the alarm LED even when the M-3311A is not physically connected to the close coil circuit. When the M-3311A is not connected to the close coil circuit, then the appropriate CCM alarm LED on the unit front panel should be labeled as necessary to identify the alarm as not valid.

This function is blocked when the breaker is open, as indicated by 52b Contact Input (IN1). If the CCM is monitoring a lockout relay, a 86 Contact Input (INx) should be used to block when the lockout relay is tripped. This function is also blocked when any output contact is closed.

The output of the Close Circuit Monitoring function can be programmed as an alarm to alert maintenance personnel.

CCM Connection Considerations – External connections for the Close Circuit Monitoring function are shown in Figure 4-57, Figure 4-58 and Figure 5-8 through Figure 5-28.

The default Close Circuit Monitor input voltage is 250 Vdc. See **Section 5.5**, **Circuit Board Switches and Jumpers**, (Table 5-4 for CCM#1, Table 5-6 for CCM#2) for other available close circuit input voltage selections.

Beckwith Electric recommends that the M-3311A CCM circuit be connected directly to the close coil, bypassing the anti-pump "Y" relay portion of the close circuit as illustrated in Figure 4-57.

The type of anti-pump "Y" relay that is often found within the close coil circuit is generally a high impedance type, such as an IDEC RR Series Power Relay. The relay coil resistance is high (approximately 8.5 to 10K Ohms), and it's rated pickup current is 11 to 13 mA, ± 15% at 20° C. However, the relay's dropout voltage is approximately 10 to 15% of rated 110 Vdc voltage. Therefore, the anti-pump relay may be held up and would not drop out until the leakage current is reduced to approximately 2 mA.

> ▲ **CAUTION:** Connecting the M-3311A Close Coil Monitor (CCM) in parallel with other relay CCMs in the close coil circuit where the anti-pump "Y" relay is not bypassed may not provide reliable breaker closing operations.

If the close coil circuit configuration does not support connecting the CCM directly to the close coil (Figure 4-58), then Beckwith Electric does not recommend connecting the M-3311A CCM in parallel with other relay CCMs. If two or more CCMs are connected to the close coil circuit, there is a high probability that the anti-pump "Y" coil will not drop out. Therefore, only one CCM, either a M-3311A or other relay should be used in the close coil circuit to provide reliable breaker closing operation.

Enable/Disable – The top right corner of the display includes a command button that will disable or enable the function. This selection allows the CCM #1 (Close Circuit Monitor) to be disabled (or enabled) independent from the CCM #2.

Time Delay – A Time Delay can be applied to delay the CCM (Close Circuit Monitor) function output.

Dropout Time Delay – A Time Delay can be applied to delay the reset of the CCM (Close Circuit Monitor) function output.

I/O Selection – I/O Selection allows any input to be selected to block the CCM. The CCM #1(2) Function can also be used to activate a selected output when it times out.

Save/Cancel – The Save selection saves the CCM Function Dialog Screen settings either to an open file or to the target M-3311A. Cancel, returns the user to the previous open screen.

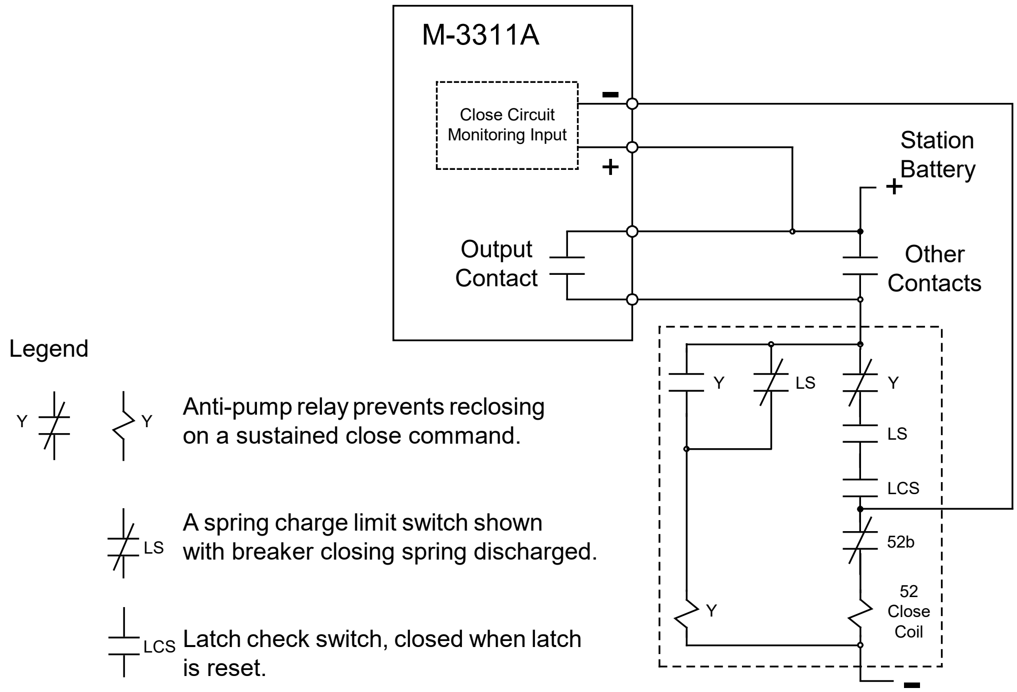


Figure 4-57 Recommended Close Circuit Monitoring Input Configuration

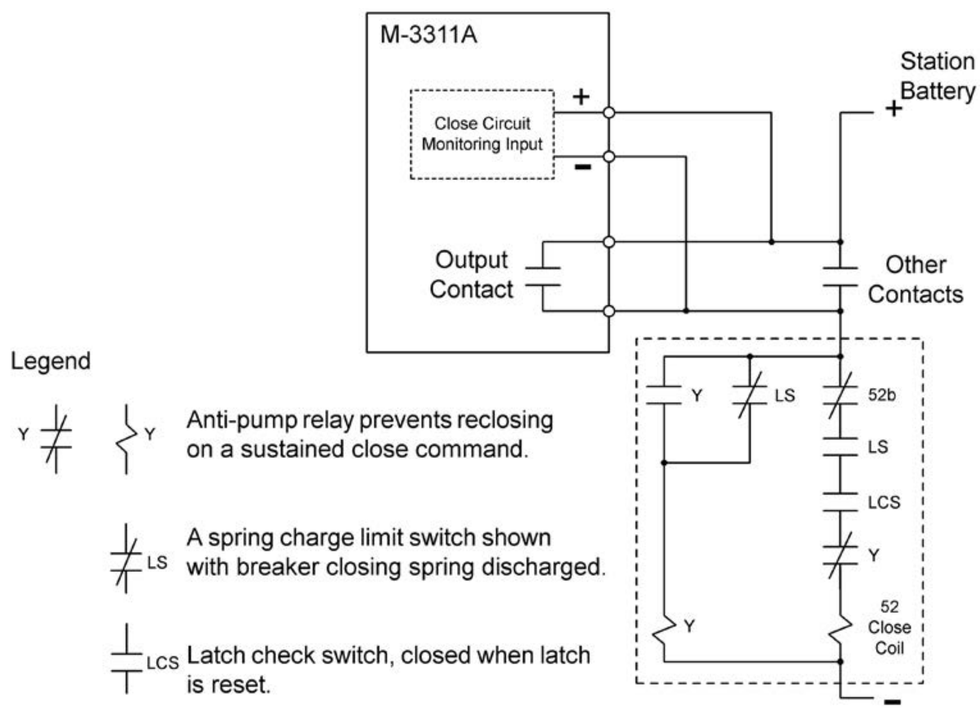


Figure 4-58 Close Circuit Monitoring Input Configuration with Anti-pump Relay Not Bypassed

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.

■**NOTE:** Winding Four is not available in Two or Three Winding applications.

```
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
```

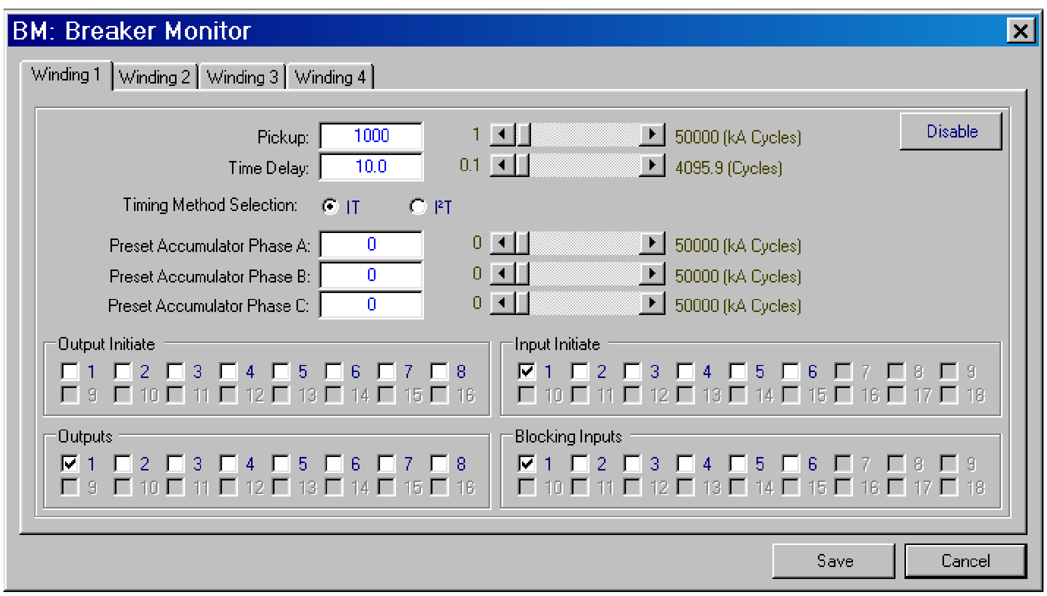
```
BRKRW1 DELAY
10.0 Cycles
```

Time delay until breaker contacts start to open.

```
BRKRW1 TIMING METHOD
it i2t
```

Selects integration timing method. (`it` or `i2t`)

■**NOTE:** These screens are also applicable for BRKRW2,W3 and W4.



■**NOTE:** Winding Four is not available in Two or Three Winding applications.

Path: Relay / Setup / Relay Setpoints / BM Breaker Monitor

Figure 4-59 IPScom Breaker Monitor Setpoint Ranges

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.

■ **NOTE:** Winding Four is not available in Two or Three Winding applications.

```
THFLT CURRENT THRESHOLD
   10 Amps
```

The Through Fault Threshold value is chosen to be above the maximum expected load current and below the minimum expected Through Fault current.

```
THFLT CUM. I^2T LIMIT
  100 kA^2-cycles
```

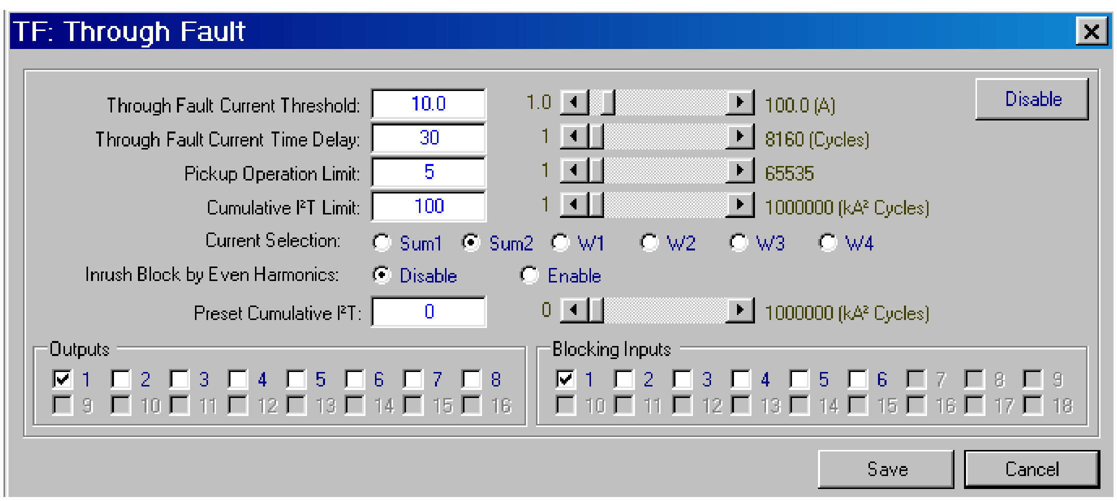
The Through Fault Current Limit and I^2t Threshold Limits are set based on the capability of the transformer. The transformer manufacturer may be consulted for guidance.

```
THFLT PU OPERATIONS LIM.
    5 Records
```

```
THFLT CURRENT SELECT
sum1 sum2 w1 W2 w3 w4
```

```
THFLT DELAY
   30 Cycles
```

The Through Fault Time Delay is typically set at one Cycle



■ **NOTE:** Winding Four is not available in Two or Three Winding applications.

Figure 4-60 IPScom Through Fault Function Setpoint Ranges

Path: Relay / Setup / Relay Setpoints / Through Fault

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

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:

```
THFLT PU OPERATIONS LIM.
    5 Records
```

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.

```
THFLT CURRENT SELECT
sum1 sum2 w1 W2 w3 w4
```

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.

```
THFLT 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 4-61):

- 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**, Table 5-5, **M-3311A External Connections**, and **Chapter 6**, Table 6-2, **Input Contacts**.

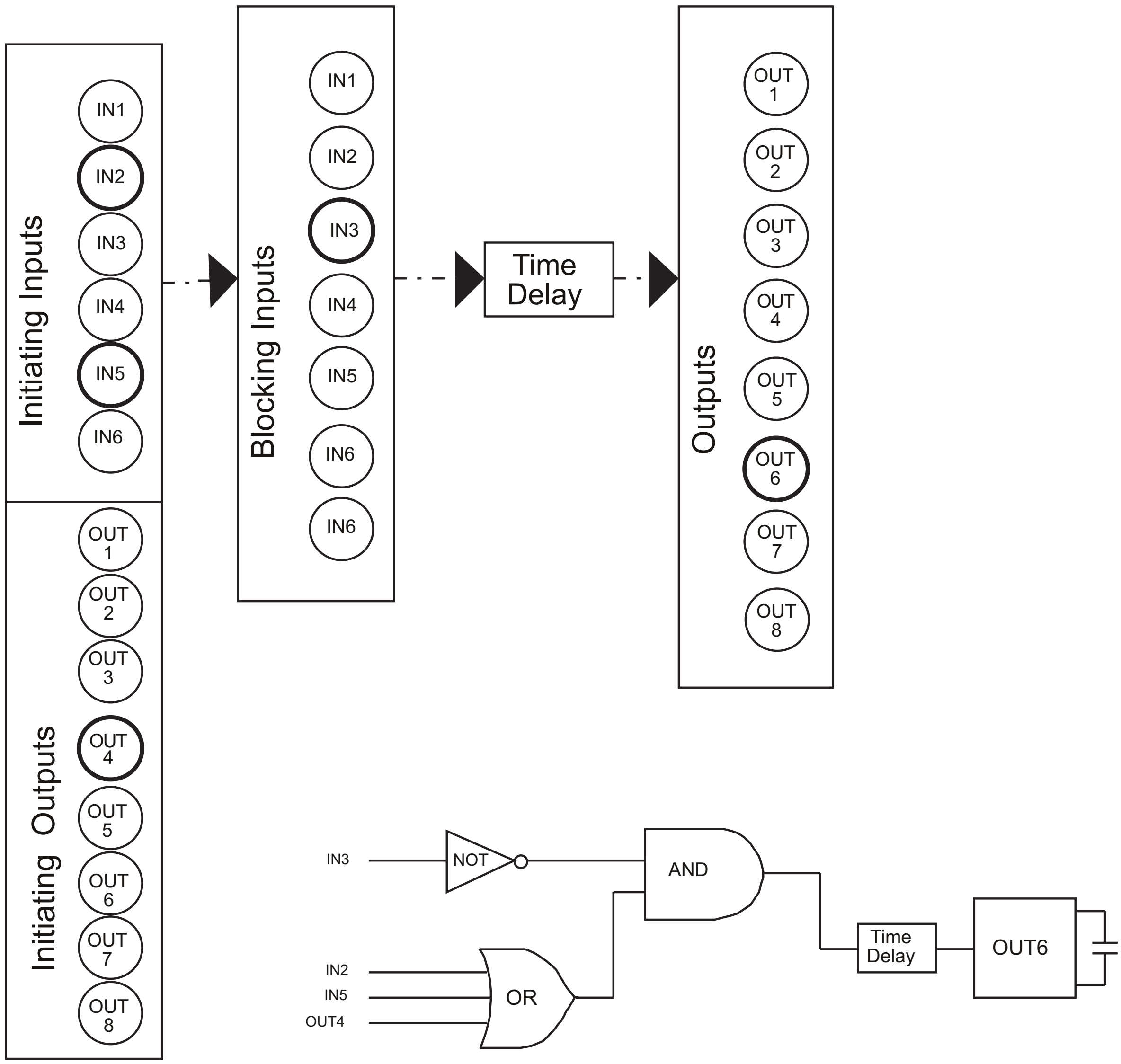


Figure 4-61 IPSlogic Function Setup

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 4-62, Figure 4-63 and Figure 4-64, respectively.

The activation state of the input function selected in the Initiating Function Trip dialog (Figure 4-62) 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 4-61, and the IPScom IPSlogic Function Status programming screens are shown in Figure 4-62 and Figure 4-63.

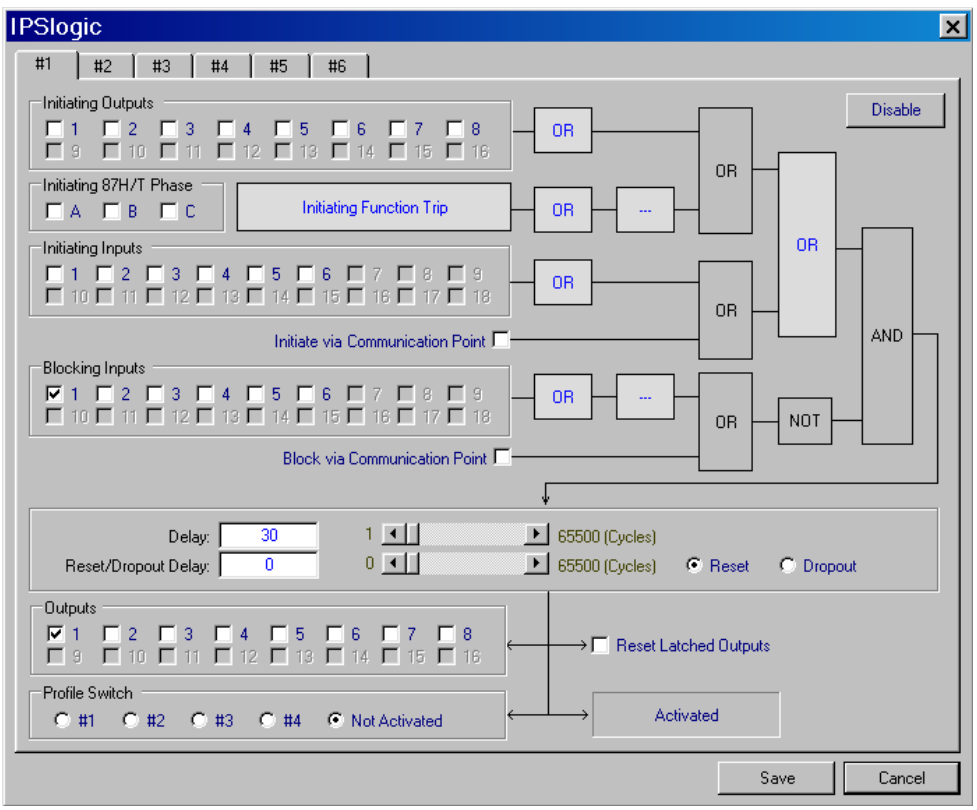


Figure 4-62 IPScom (IPS) IPSlogic Functions Setpoint Ranges

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.

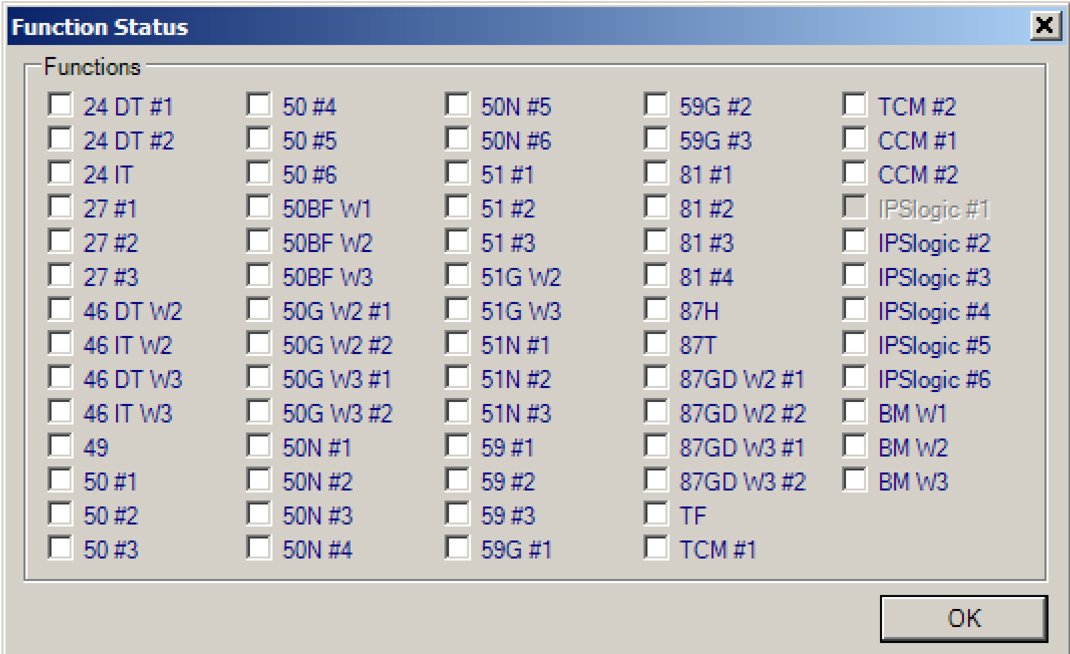


Figure 4-63 Select Initiating Functions Screen (Two- / Three-Winding)

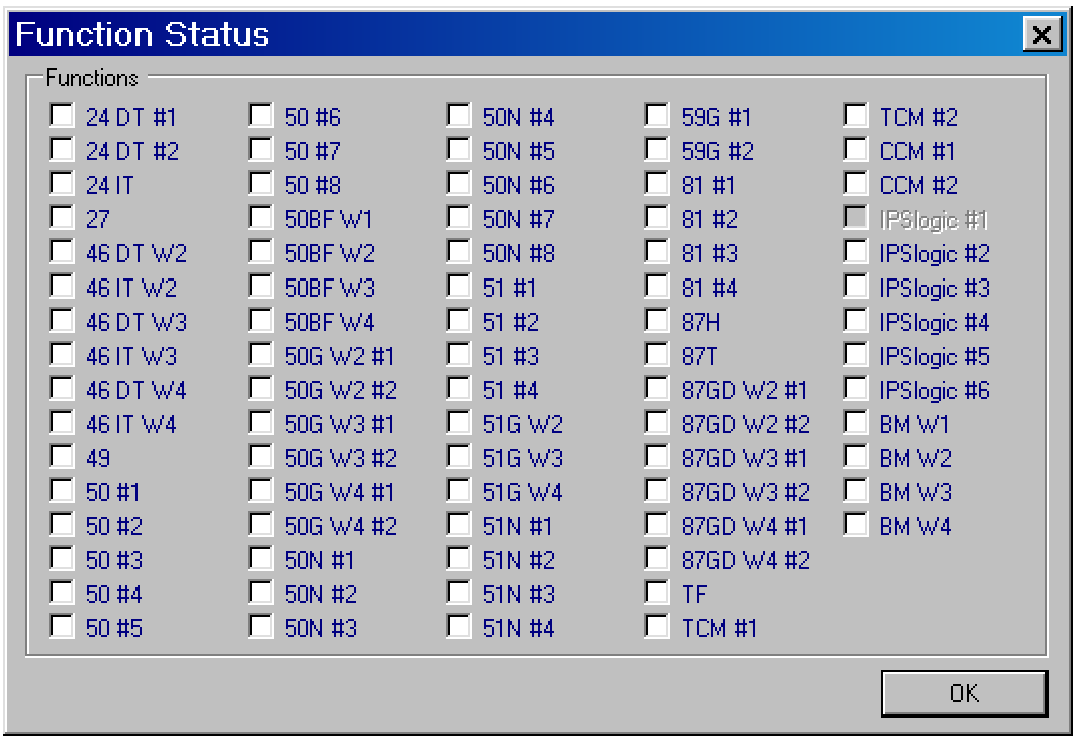


Figure 4-64 Select Initiating Functions Screen (Four-Winding)

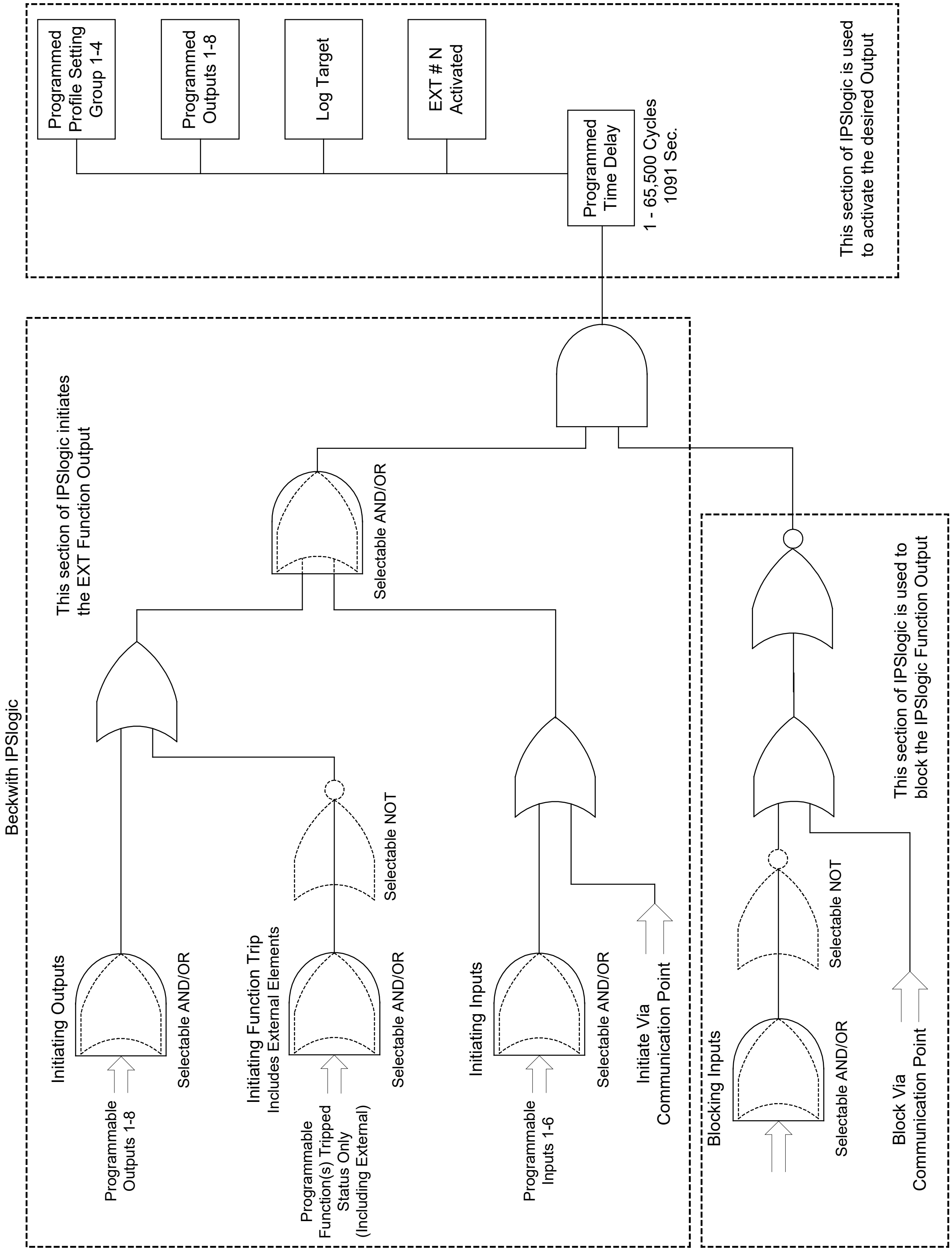


Figure 4-65 IPSlogic Function Setup

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 4-66). 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.

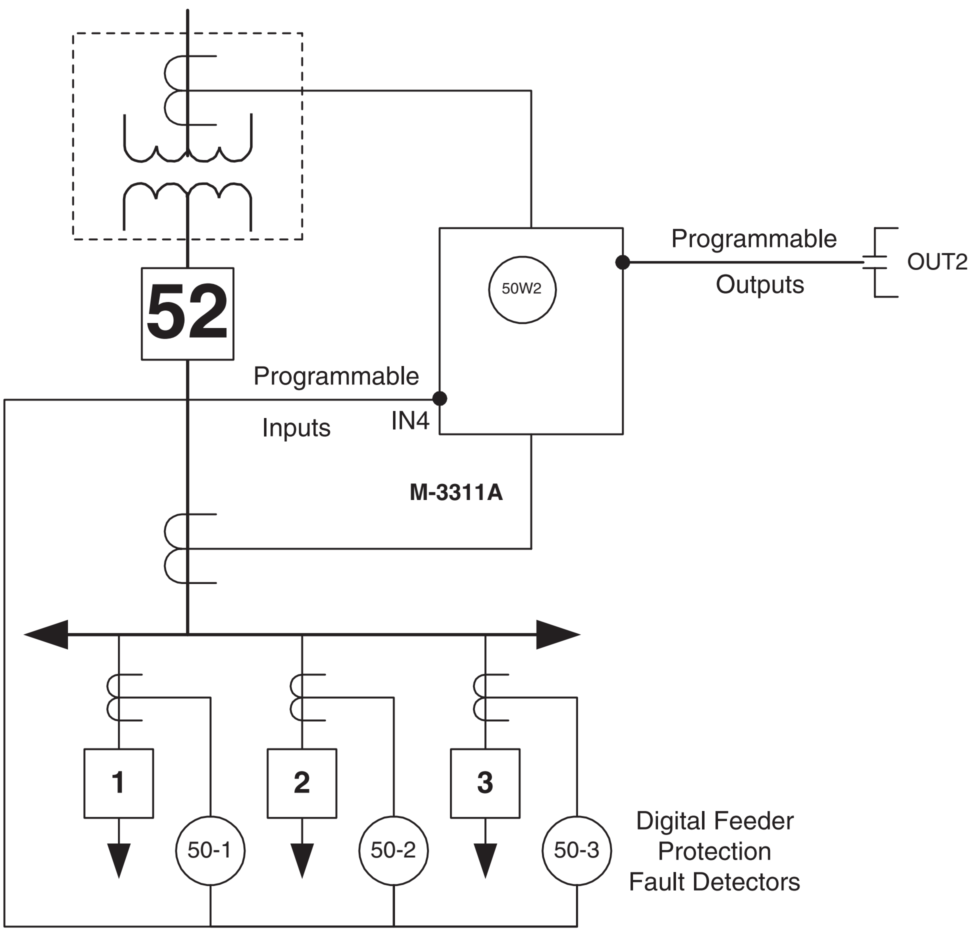


Figure 4-66 Bus Fault Protection Scheme

Backup for Digital feeder Relay Failure

The M-3311A Transformer Protection Relay can provide backup for digital feeder relays (see Figure 4-67 and Figure 4-68). 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 4-68). 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.

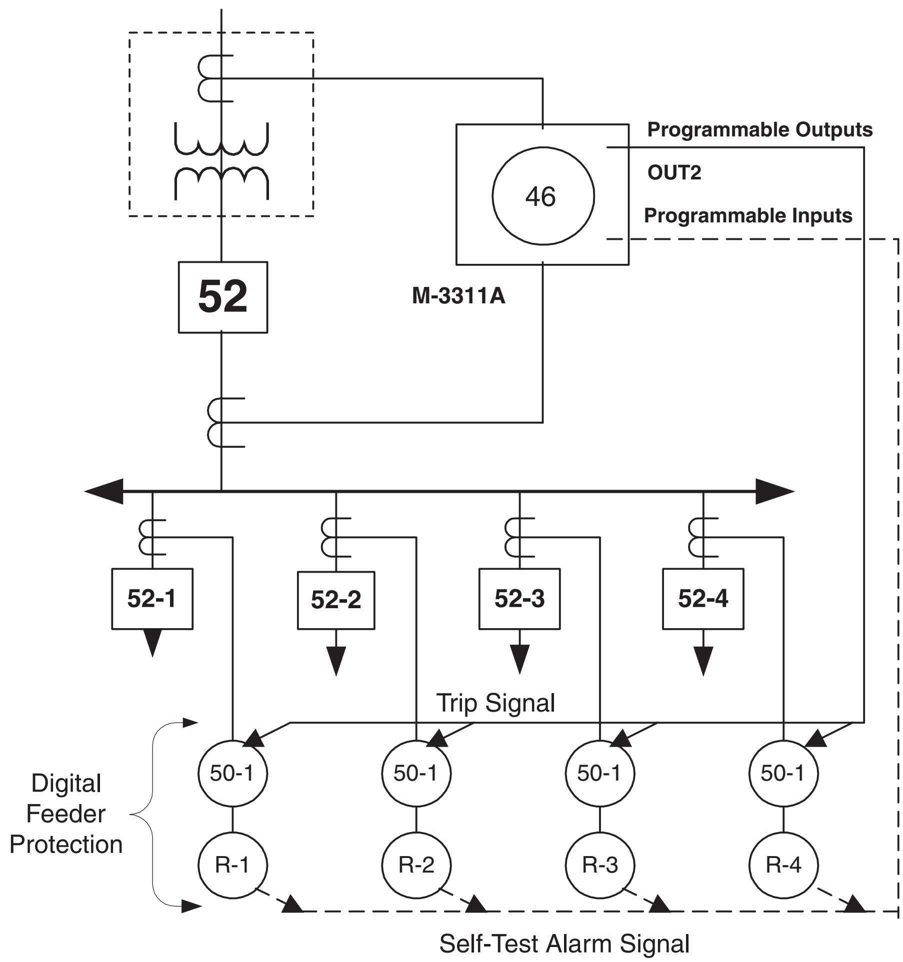


Figure 4-67 Digital Feeder Relay Backup Scheme

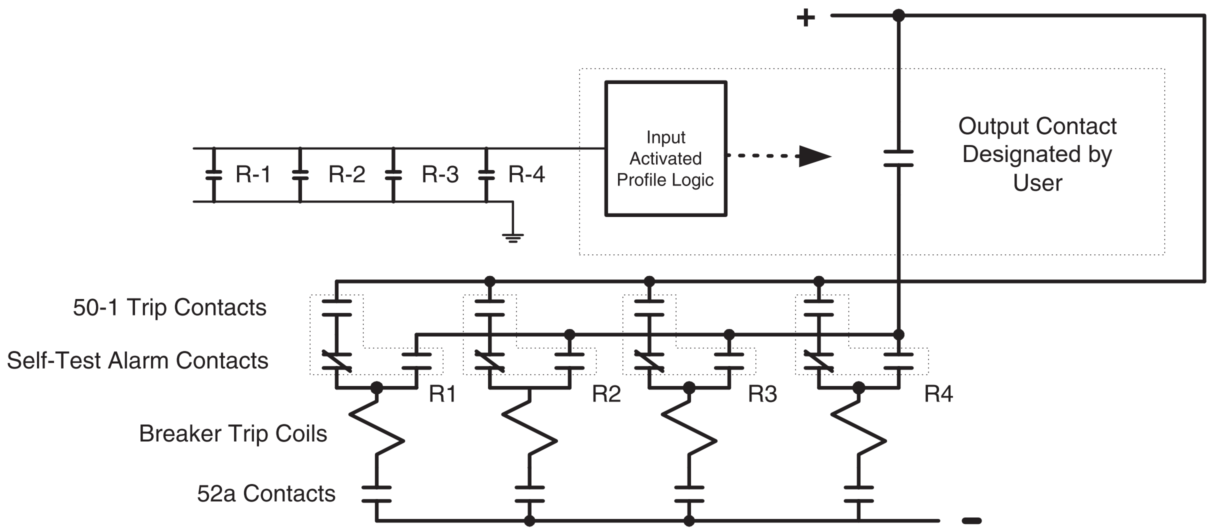


Figure 4-68 Feeder Backup Logic

Load Shedding

Description

In stations where there are two or more transformers (see Figure 4-69), 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 4-70). Each IPSlogic function is programmed with a different time delay setting.

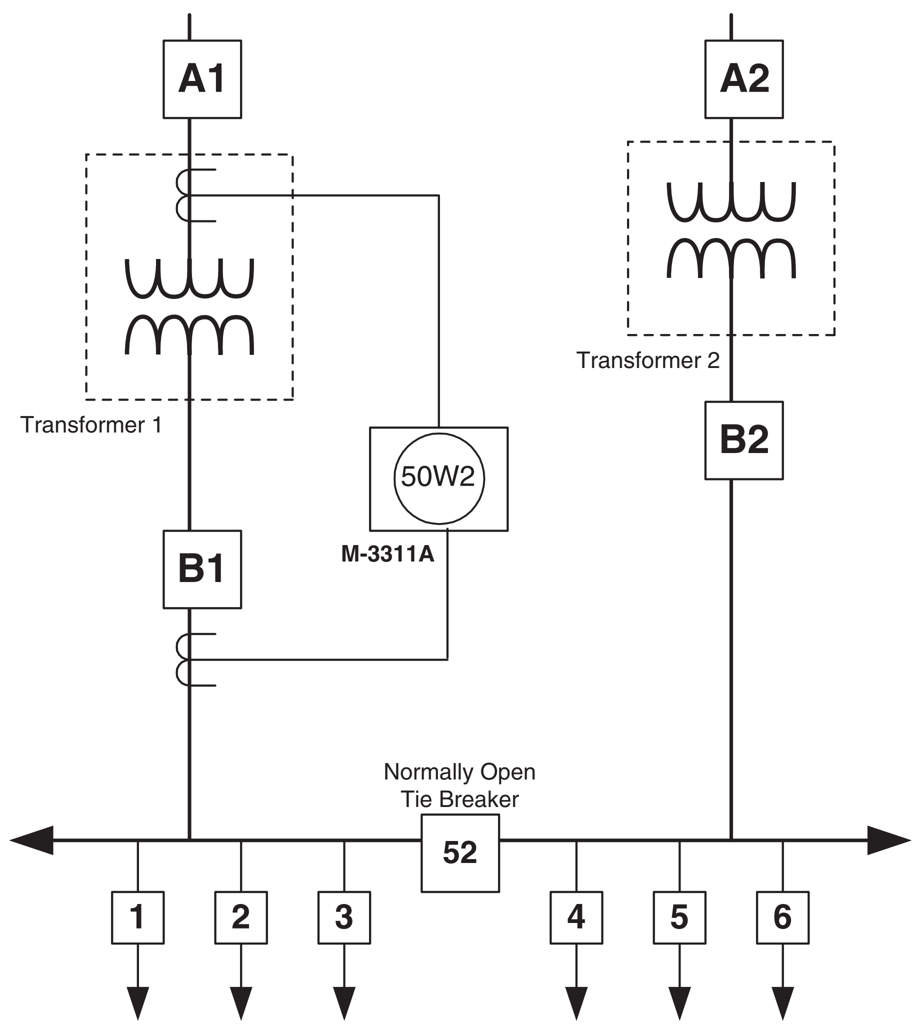


Figure 4-69 Two Bank Load Shedding Scheme

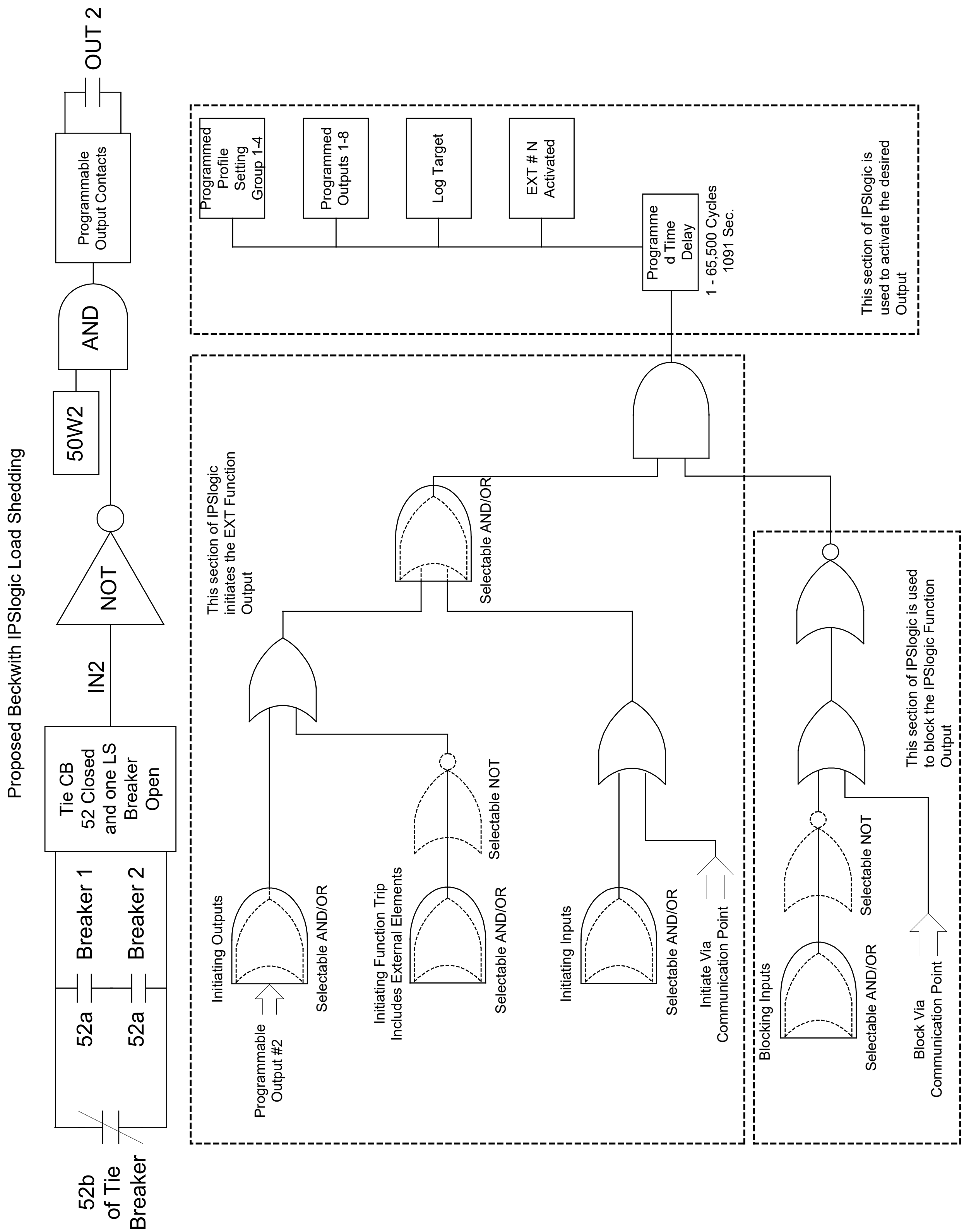


Figure 4-70 Load Shedding Logic

LTC Blocking During Faults

Description

The relay contains logic to block load Tapchangers from operating during feeder fault conditions (see Figure 4-71). 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.

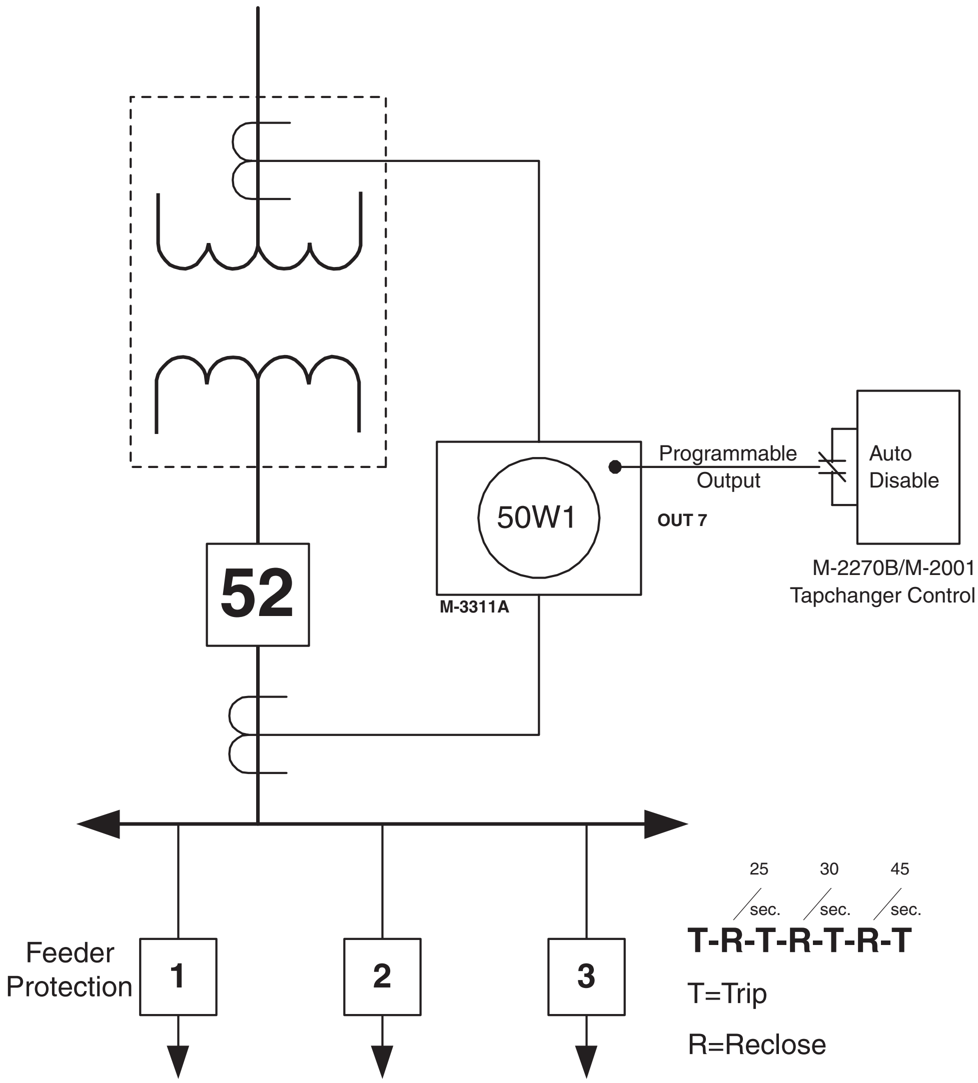


Figure 4-71 LTC Blocking Scheme During Faults

4.6 Transformer Connections

Transformer Winding Selection

The M-3311A can be applied in either a two-, three- or four-winding transformer differential application. For applications where a two or three 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.

$$\begin{pmatrix} I_A\ \text{Comp}W_n \\ I_B\ \text{Comp}W_n \\ I_C\ \text{Comp}W_n \end{pmatrix} = \text{Connect Type (WN)} \begin{pmatrix} I_A W_n \\ I_B W_n \\ I_C W_n \end{pmatrix}$$

Where:

- $I_A W_n$, $I_B W_n$, and $I_C W_n$ 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/√3.

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/√3.

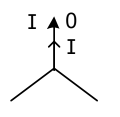
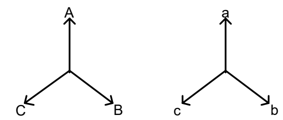
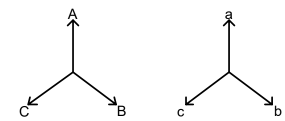
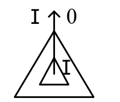
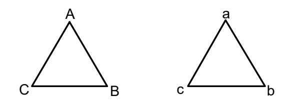
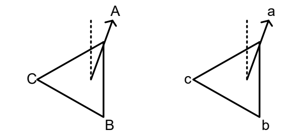
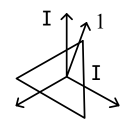
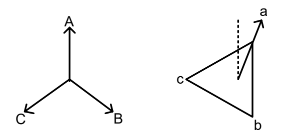
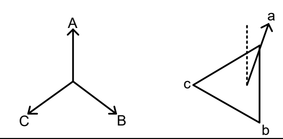
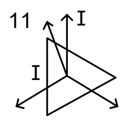
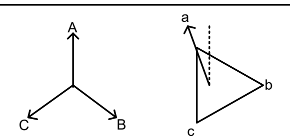
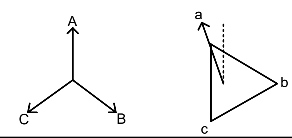
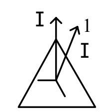
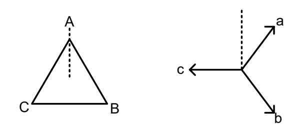
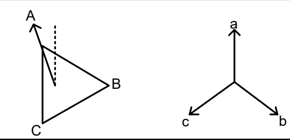
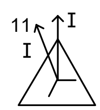
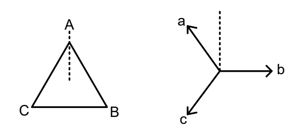
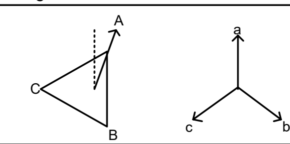
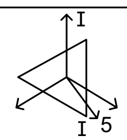
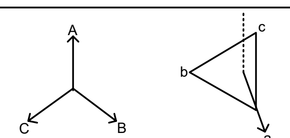
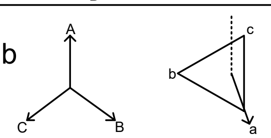
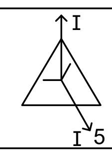
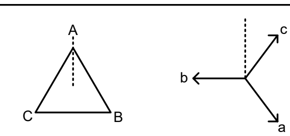
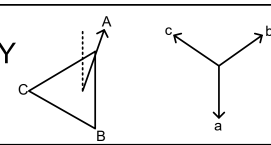
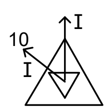
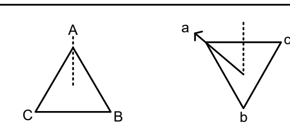
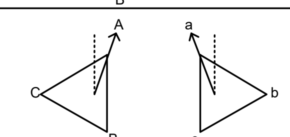
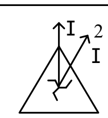
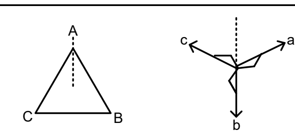
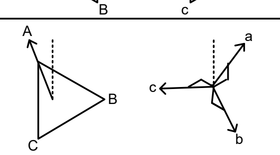
IEC Connection		Beckwith Standard Connection		Beckwith Custom	
Description	Symbol	Description	Symbol	Input Value	Symbol
Yy0		YY		Y Y 0 0	
Dd0		Dac Dac		Dac Dac 1 1	
Yd1		Y Dac		Y Dac 0 1	
Yd11		Y Dab		Y Dab 0 11	
Dy1		Dab Y		Dab Y 11 0	
Dy11		Dac Y		Dac Y 1 0	
Yd5		Y Inverse Dab		Y Inverse Dab 0 5	
Dy5		Dac Inverse Y		Dac Inverse Y 1 5	
Dd10		Dac Dab		Dac Dab 1 11	
Dz2		Dab Custom		Dab Wye 11 1	

Table 4-5 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 4-6. 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/S3

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 4-7. For reference, examples of the transformer phase shift ConnectType numbers are indicated in Table 4-5, under the Custom column.

Transformer Phase Compensation			CT Phase/Magnitude Compensation		
CCW Incremente #	Compensation	Beckwith Connection	CCW Incremente #	Compensation	Beckwith Connection
10	$1 \angle 0°$	Wye	13	$1/\sqrt{3}$	Delta-ac
1	$1 \angle 30°$	Delta-ac	17	$1/\sqrt{3}$	Inverse Delta-ab
5	$1 \angle 150°$	Inverse Delta-ab	19	$1/\sqrt{3}$	Inverse Delta-ab
6	$1 \angle 180°$	Inverse Wye	23	$1/\sqrt{3}$	Delta-ab
7	$1 \angle 210°$	Inverse Delta-ac			
11	$1 \angle 330°$	Delta-ab			

Table 4-6 Standard Transformer and CT Configuration Options

Transformer Phase Compensation		
CCW Incremente #	Compensation	Beckwith Connection
0	1 ∠ 0°	Wye
1	1 ∠ 30°	Delta-ac
2	1 ∠ 60°	
3	1 ∠ 90°	
4	1 ∠ 120°	
5	1 ∠ 150°	Inverse Delta-ab
6	1 ∠ 180°	Inverse Wye
7	1 ∠ 210°	Inverse Delta-ac
8	1 ∠ 240°	
9	1 ∠ 270°	
10	1 ∠ 300°	
11	1 ∠ 330°	Delta-ab

CT Phase/Magnitude Compensation		
CCW Incremente #	Compensation	Beckwith Connection
0	1 ∠ 0°	Wye
1	1 ∠ 30°	
2	1 ∠ 60°	
3	1 ∠ 90°	
4	1 ∠ 120°	
5	1 ∠ 150°	
6	1 ∠ 180°	Inverse Wye
7	1 ∠ 210°	
8	1 ∠ 240°	
9	1 ∠ 270°	
10	1 ∠ 300°	
11	1 ∠ 330°	
12	1/e3 ∠ 0°	
13	1/√3 ∠ 30°	Delta-ac
14	1/√3 ∠ 60°	
15	1/√3 ∠ 90°	
16	1/√3 ∠ 120°	
17	1/√3 ∠ 150°	Inverse Delta-ac
18	1/√3 ∠ 180°	
19	1/√3 ∠ 210°	Inverse Delta-ac
20	1/√3 ∠ 240°	
21	1/√3 ∠ 270°	
22	1/√3 ∠ 300°	
23	1/√3 ∠ 330°	Delta-ab

Table 4-7 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: $$I_d = \Sigma \left| \overline{I}_{AW1} + \overline{I}_{AW2} + \overline{I}_{AW3} + \overline{I}_{AW4} \right|$$

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 4-72 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 4-73. 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 4-74. 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 4-75, 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 4-76. 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

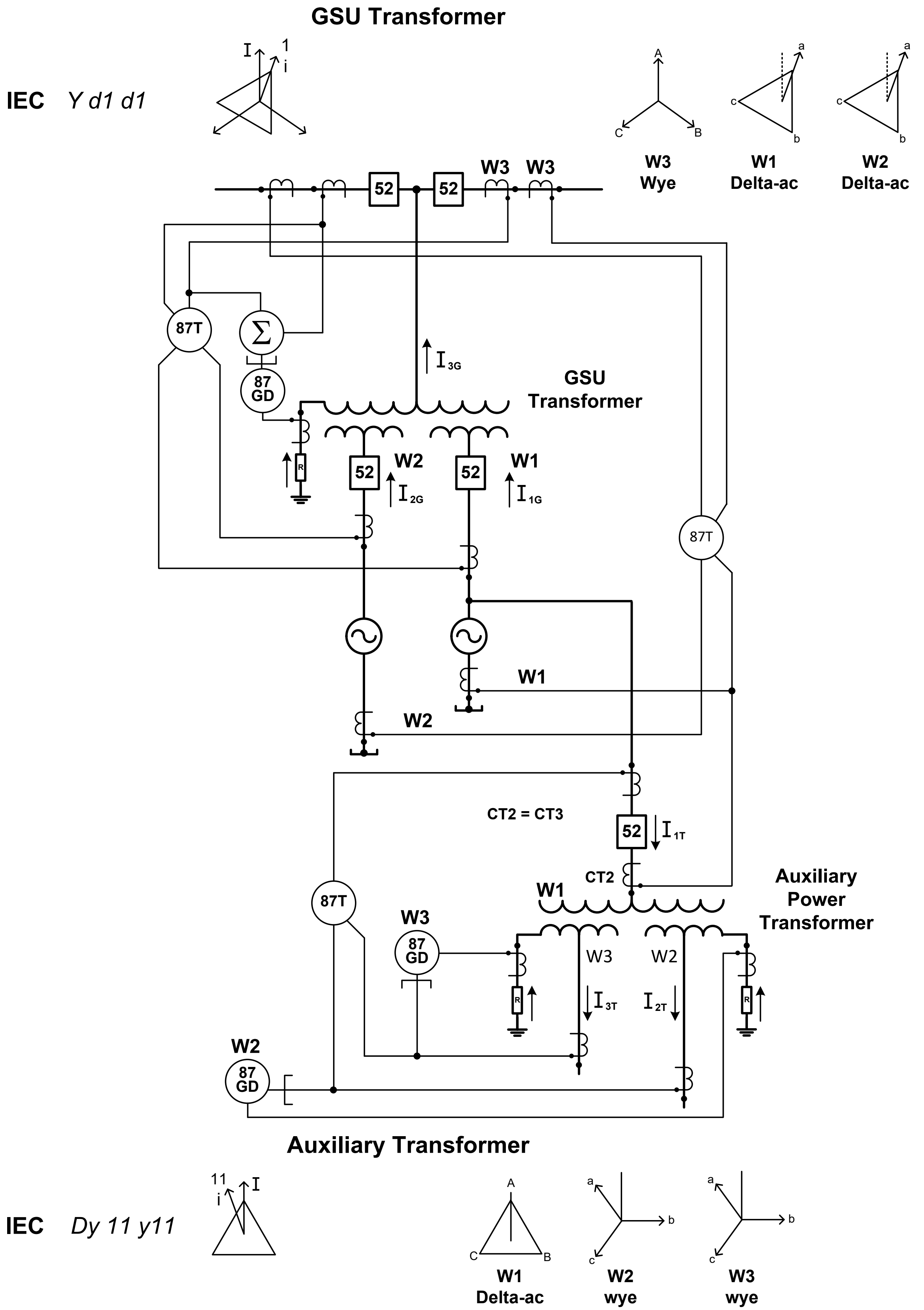
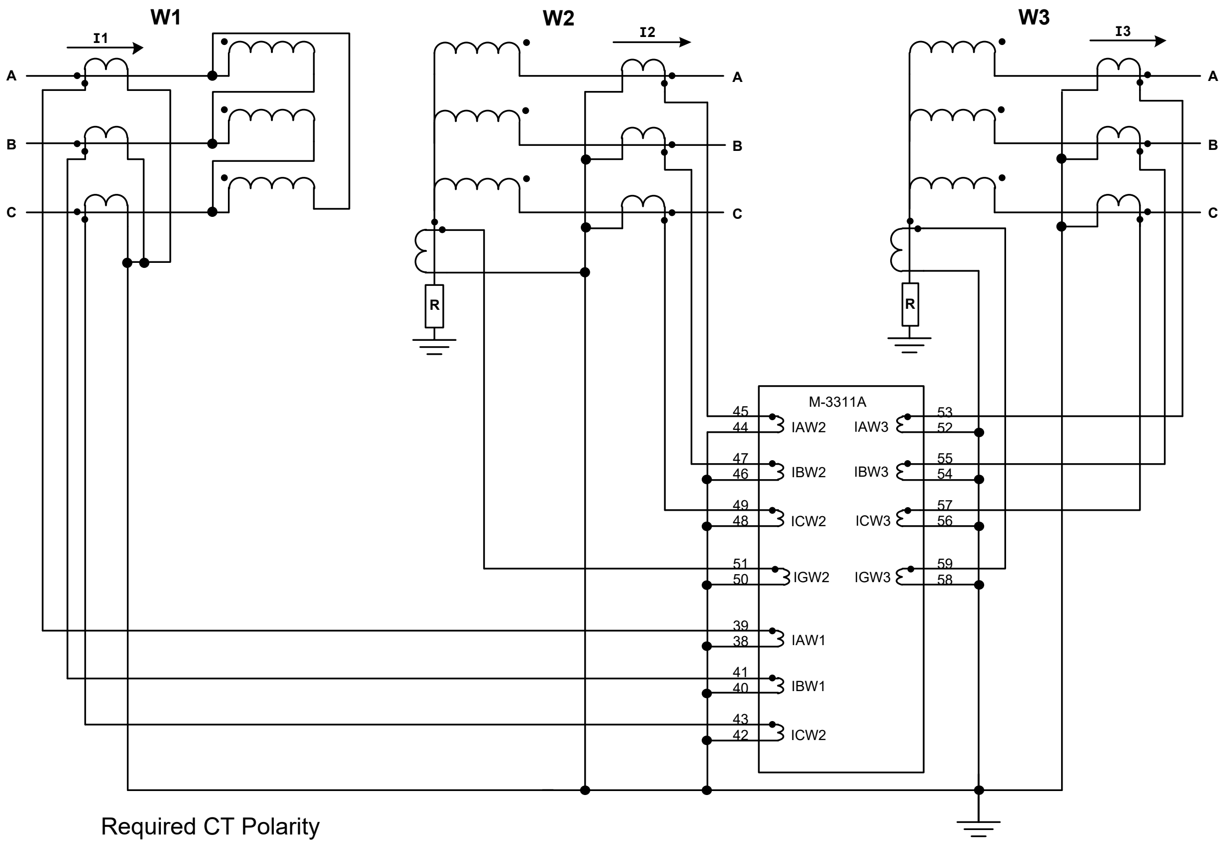


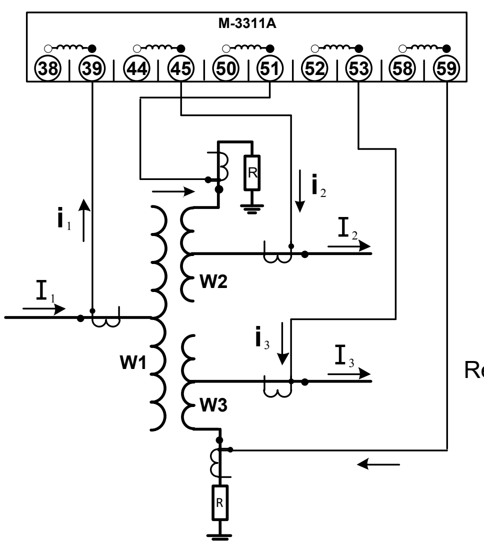
Figure 4-72 Typical Transformer Differential Application

Auxiliary Transformer Example

Beckwith Delta-ac/Wye/Wye with Wye/Wye/Wye CTs

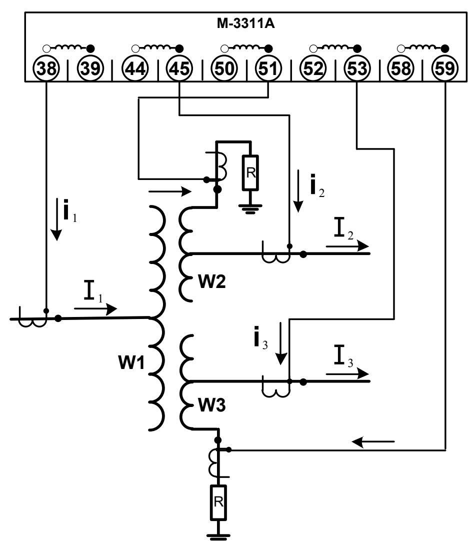


Required CT Polarity



(Phase A Connection Shown)

If W1 CT Polarity is reversed, then use Inverse-wye CT connection for W1.
OR
Reverse CT leads at relay.



(Phase A Connection Shown)

Figure 4-73 Delta-ac/Wye/Wye CT Connection Diagram

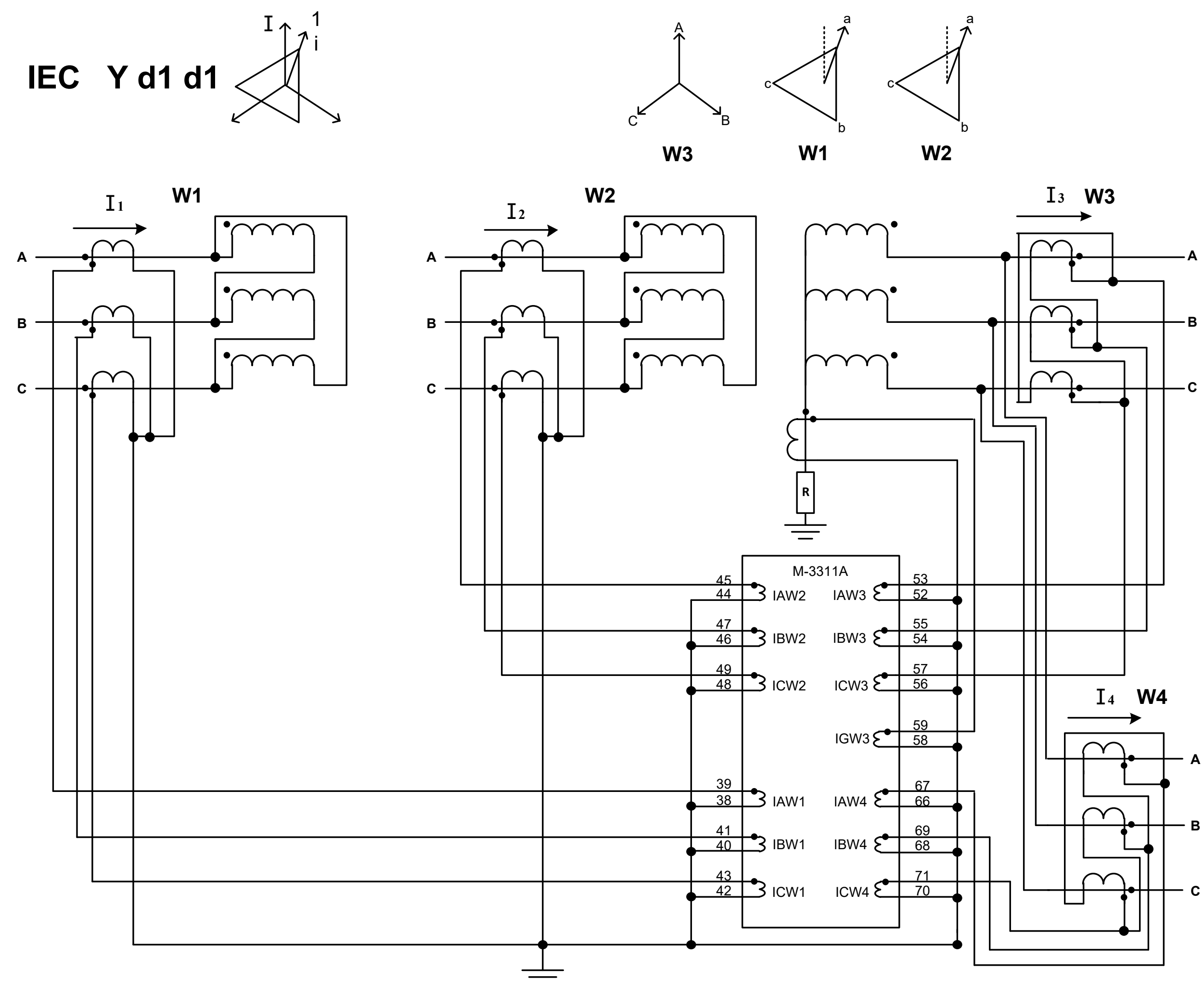
Auxiliary Transformer Example

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.			

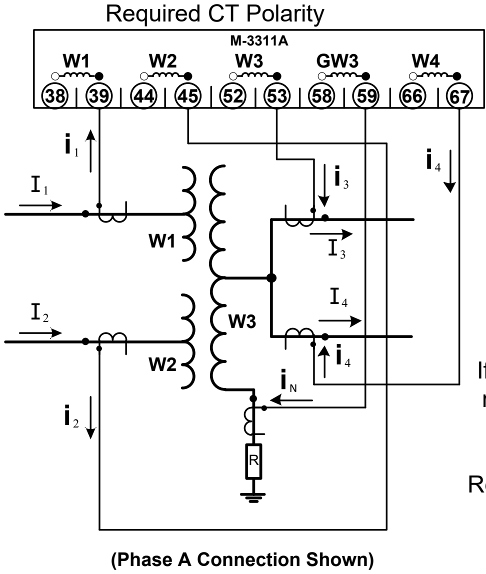
Figure 4-74 Custom Settings for Delta-ac/Wye/Wye

GSU Transformer Example

Beckwith Wye/Delta-ac/Delta-ac with Delta-ac/Wye/Wye CTs



Required CT Polarity



If W3 and W4 CT Polarity is reversed, then use Inverse Delta-ac CT connection.

OR

Reverse W3 and W4 at relay.

Reversed W3 and W4 CT Connections

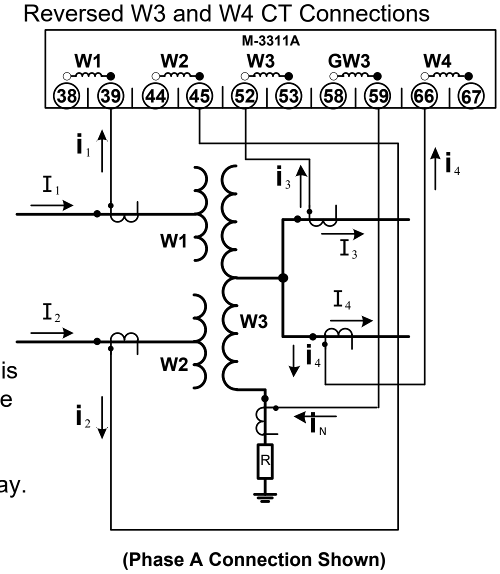


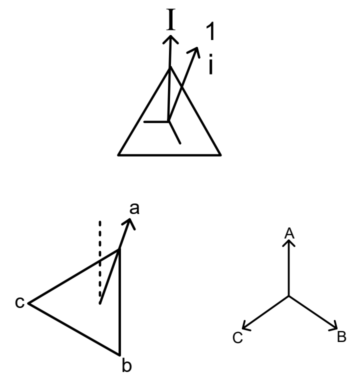
Figure 4-75 Wye/Delta-ac/Delta-ac CT Connection Diagram

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 ∠°	30°	0°	0°	0°
Phase Compensation	To ref winding			
CCW Rotation	30°	30°	0°	0°
Relay Phase Setting	1	1	0	0
CT Compensation				
Phase Degrees	0°	0°	30°	30°
Magnitude	no	no	1/√3	1/√3
Combined Compensation	1 ∠ 0°	1 ∠ 0°	1/√3∠30°	1/√3∠30°
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 4-76 Custom Settings for Wye/Delta-ac/Delta-ac

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5 Installation

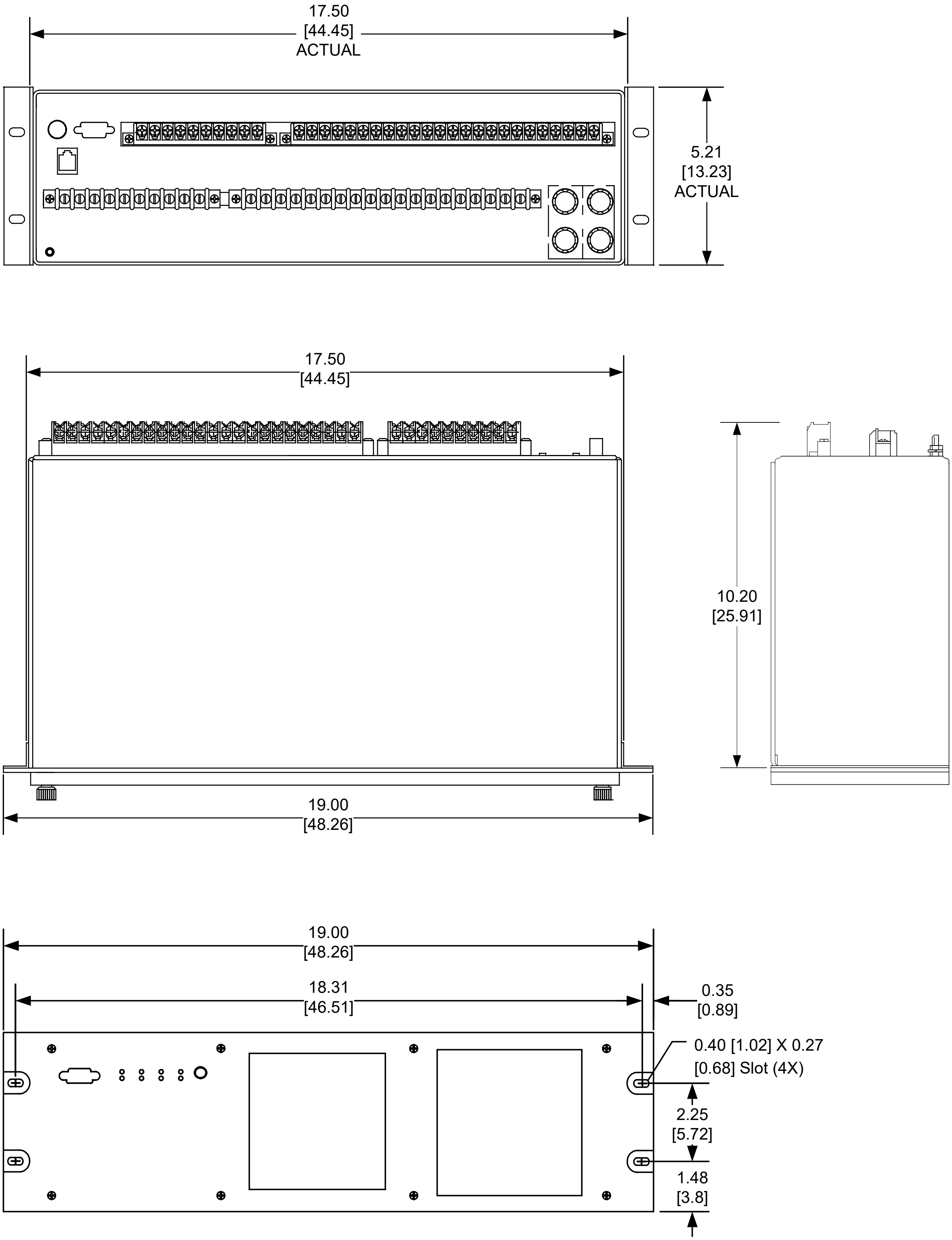
5.1 General Information

■ **NOTE:** Prior to the installation of the equipment, it is essential to review the contents of this manual to locate data which may be of importance during the installation procedures. The following is a quick review of the contents of this chapter.

The person or group responsible for the installation of the relay will find herein all mechanical information required for the physical installation, equipment ratings, and all external connections in this chapter. For reference, the Three-Line Connection Diagrams are repeated from **Chapter 4**, **System Settings and Setpoints**. Further, a pre-commissioning checkout procedure is outlined using the HMI option 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**.

5.2 Mechanical/Physical Dimensions

Figure 5-1 through Figure 5-5 contain physical dimensions of the relay that may be required for mounting the unit to a rack or vertical panel mount.

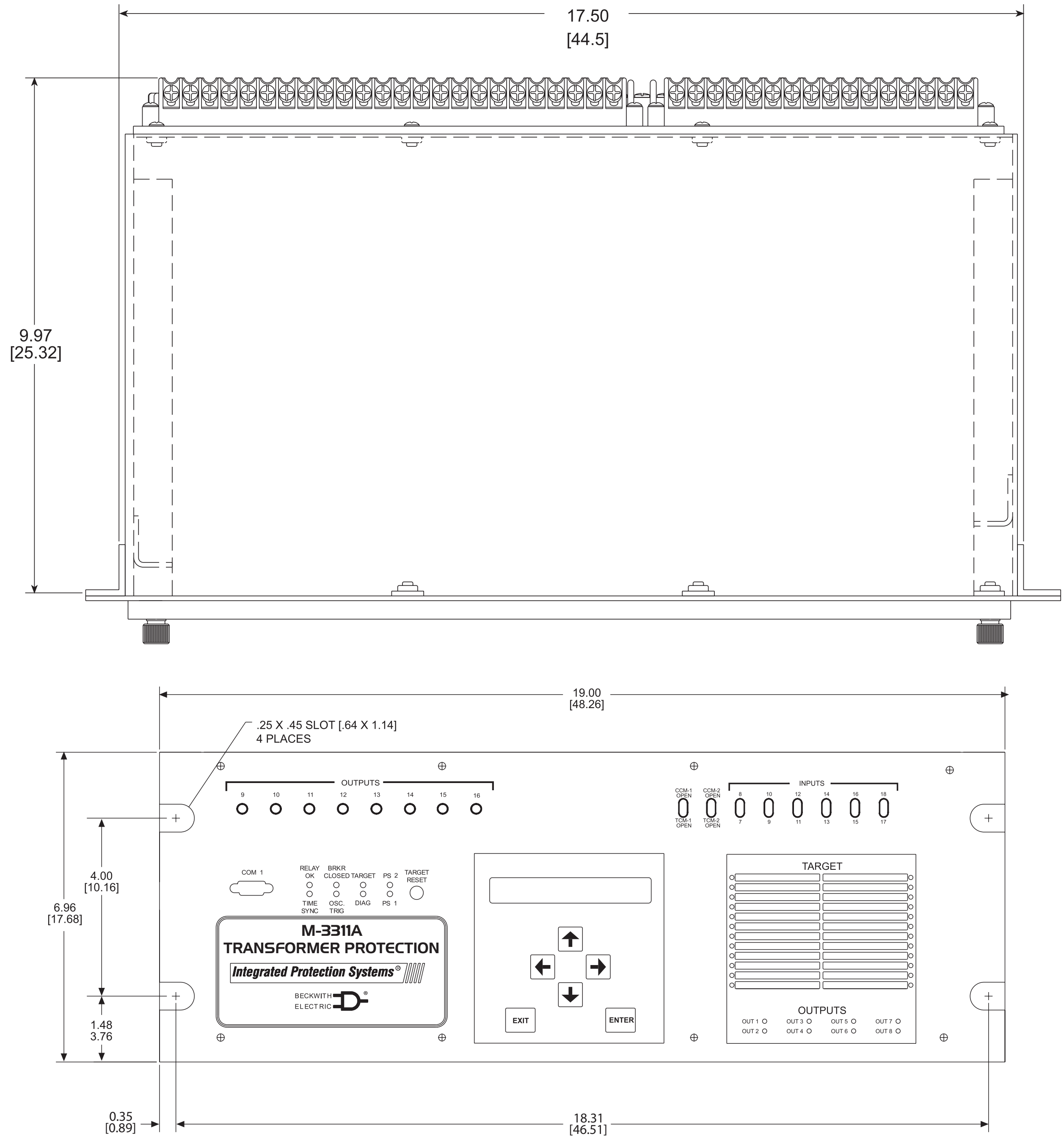


Standard 19" Horizontal Mount Chassis

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

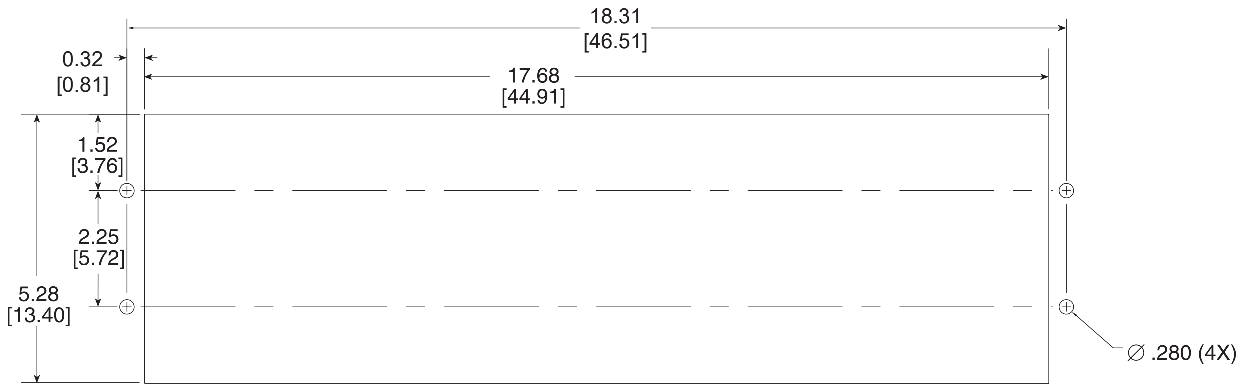
■ **NOTE:** Dimensions in brackets are in centimeters.

Figure 5-1 M-3311A Horizontal Chassis Mounting Dimensions (H1)

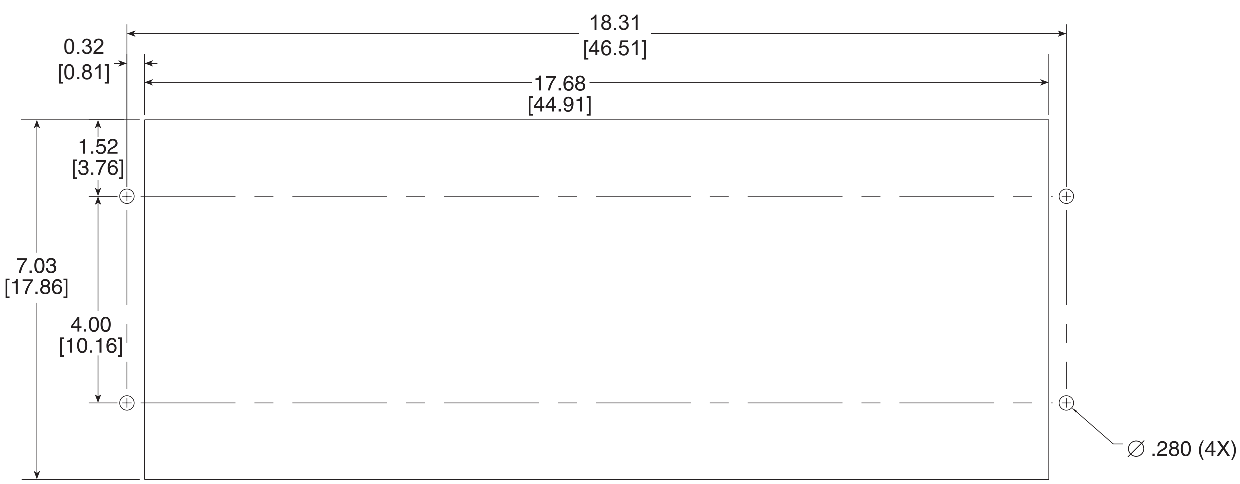


■**NOTE:** Dimensions in brackets are in centimeters.

Figure 5-2 M-3311A Mounting Dimensions – Horizontal Chassis With Expanded I/O



RECOMMENDED CUTOUT (H1)
STANDARD 3 UNIT PANEL M-3311A (HORIZONTAL)

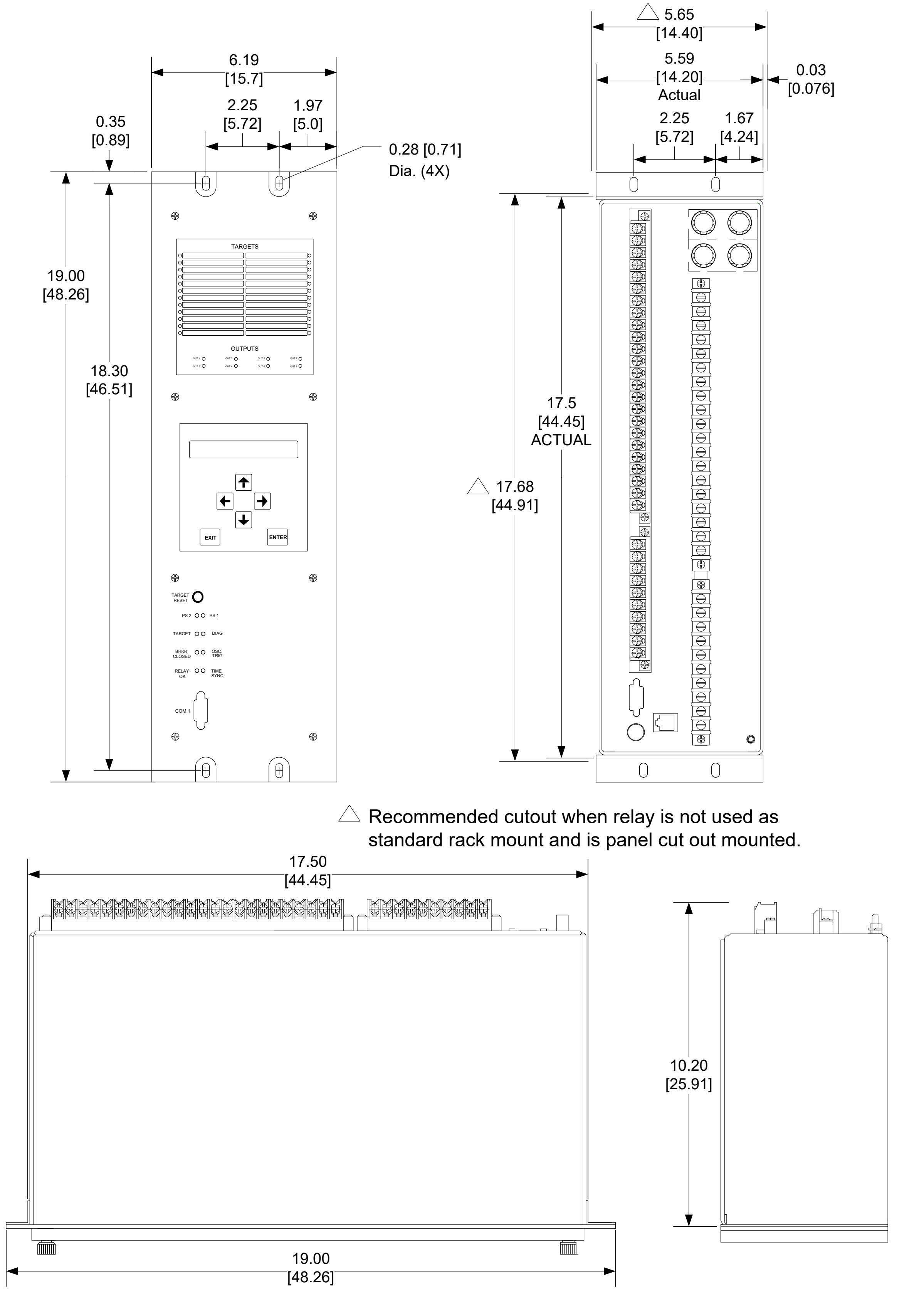


RECOMMENDED CUTOUT
4 UNIT PANEL M-3311A (EXPANDED I/O HORIZONTAL AND VERTICAL) (H5 and H6)

TOLERANCE: .XX±.015

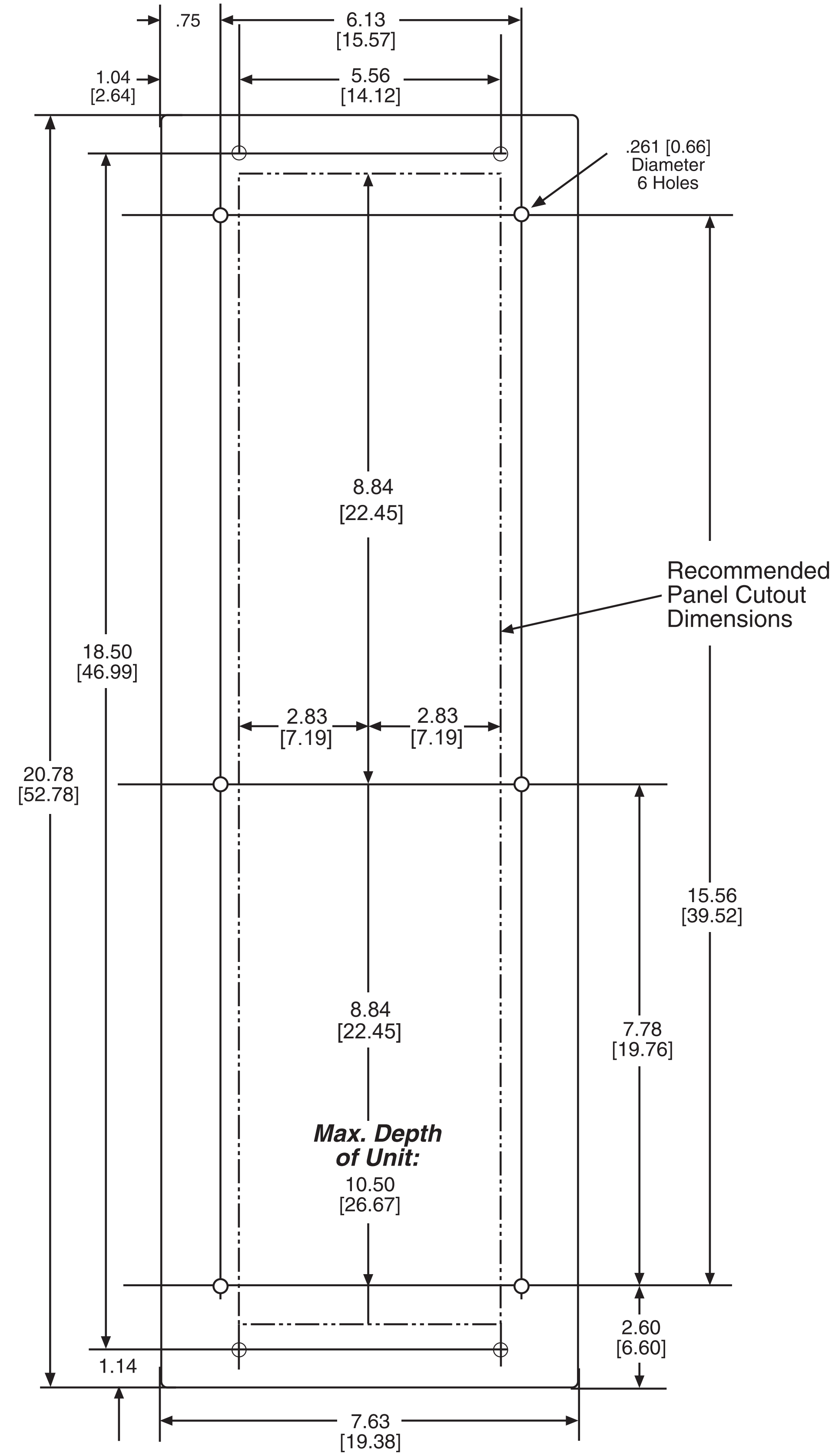
■**NOTE:** Dimensions in brackets are in centimeters.

Figure 5-3 M-3311A Panel Mount Cutout Dimensions



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

Figure 5-4 M-3311A Vertical Chassis Mounting Dimensions Without Expanded I/O (H2)



Front View

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

Figure 5-5 Mounting Dimensions for GE L-2 Cabinet H3 and H4

5.3 External Connections

▲**CAUTION:** The protective grounding terminal must be connected to an earthed ground anytime external connections have been made to the unit.

▲**CAUTION:** Only dry contacts must be connected to inputs because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.

WARNING: Do not open live CT circuits. Live CT circuits should be shorted prior to disconnecting CT wiring to the M-3311A. Death or severe electrical shock may result.

▲**CAUTION:** Mis-operation or permanent damage may result to the unit if a voltage is applied to Terminals 1 and 2 (aux) that does not match the configured Trip Circuit Monitoring input voltage.

To fulfill requirements for UL listings, terminal block connections must be made with No. 22–12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector, and wire insulation used must be rated at 75° C minimum.

Replacement Fuses

F1–F4 replacement fuses must be fast-acting 3 Amp, 250 V (3AB) Beckwith Electric Part Number 420-00885. Connector must be tightened to 8-inch pounds torque.

Power Supply

When the M-3311A without expanded I/O is equipped with the optional second power supply (Figure 5-6), the power source may be the same or two different sources.

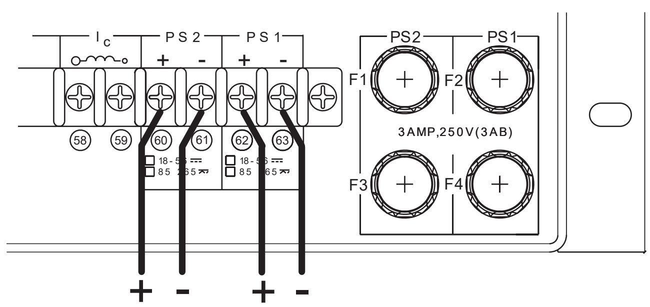


Figure 5-6 Optional Dual Power Supply

When the M-3311A with expanded I/O is equipped with two (not redundant) power supplies, the power supplies must be powered from the same source.

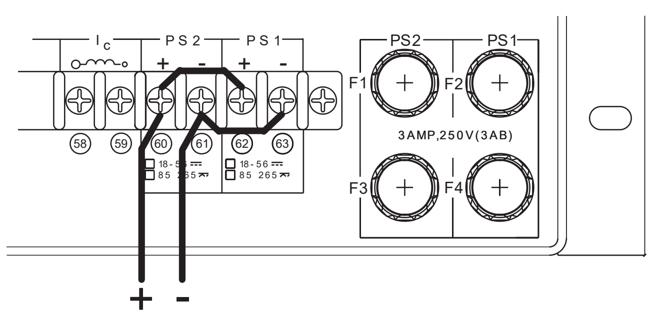


Figure 5-7 Expanded I/O Power Supply

Grounding Requirements

The M-3311A is designed to be mounted in an adequately grounded metal panel, using grounding techniques (metal-to-metal mounting) and hardware that assures a low impedance ground.

Unit Isolation

Sensing inputs should be equipped with test switches and shorting devices where necessary to isolate the unit from external potential or current sources.

A switch or circuit breaker for the M-3311A's power shall be included in the building installation, and shall be in close proximity to the relay and within easy reach of the operator, and shall be plainly marked as being the power disconnect device for the relay.

Insulation Coordination

Sensing Inputs: 60 V to 140 V, Installation Category IV, Transient Voltages not to exceed 5,000 V.

Torque Requirements

Terminal Torque values for Current, Voltage and Aux inputs require a 8.0 in-lbs minimum, and 9.0 in-lbs, maximum. All other terminals require 12 in-lbs.

▲**CAUTION:** Over torquing may result in terminal damage.

Relay Outputs

All outputs are shown in the de-energized state for standard reference. Relay standard reference is defined as protective elements in the non-trip, reconnection and sync logic in the non-asserted state, or power to the relay is removed. Output contacts #1 through #4 are high speed operation contacts and close 4ms faster than all other outputs. Outputs 7 and 8 are form "c" contacts (center taped "a" and "b" contacts), all other outputs are form "a" contacts (normally open).

The power supply relay (P/S) is energized when the power supply is OK. The self-test relay is energized when the relay has performed all self-tests successfully.

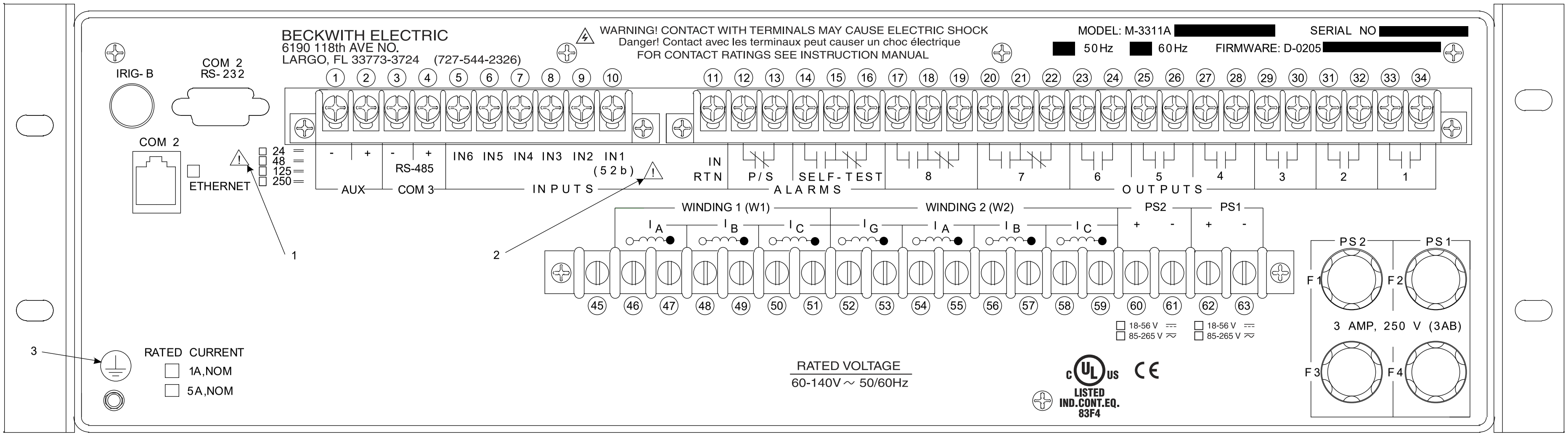


Figure 5-8 Two Winding – Zero Voltage Inputs External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

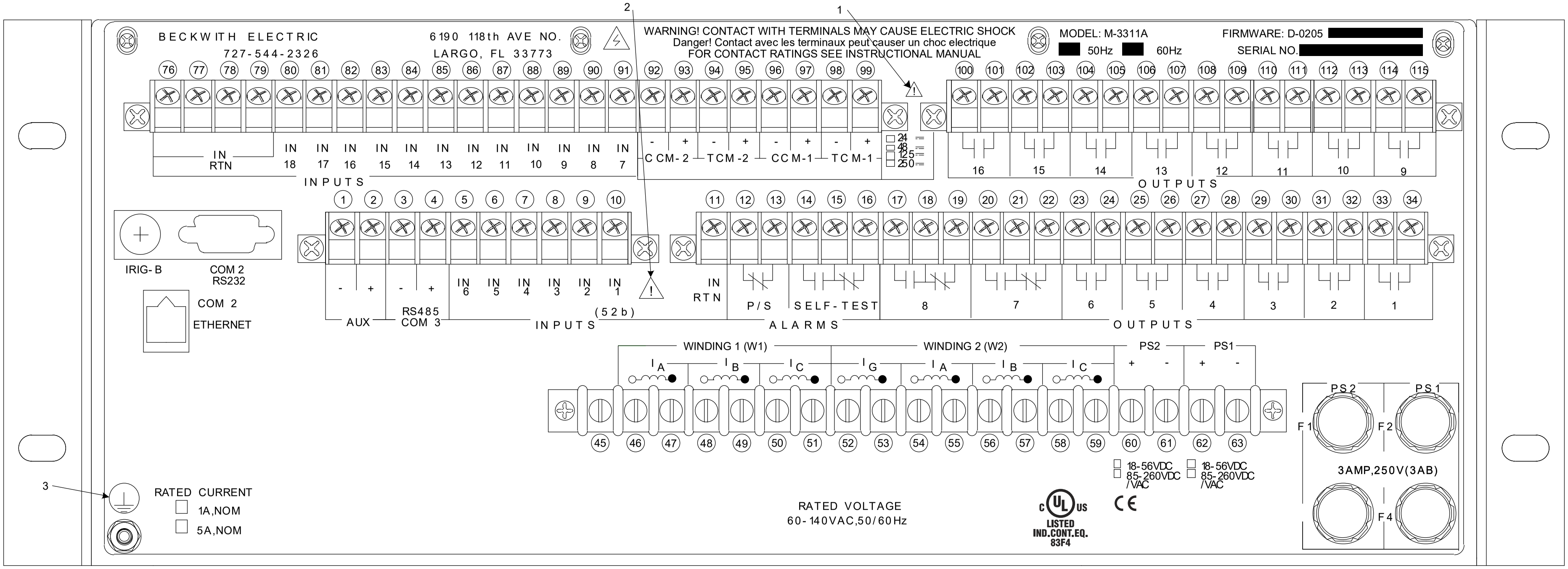


Figure 5-9 Two Winding – Zero Voltage Inputs Extended Output External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

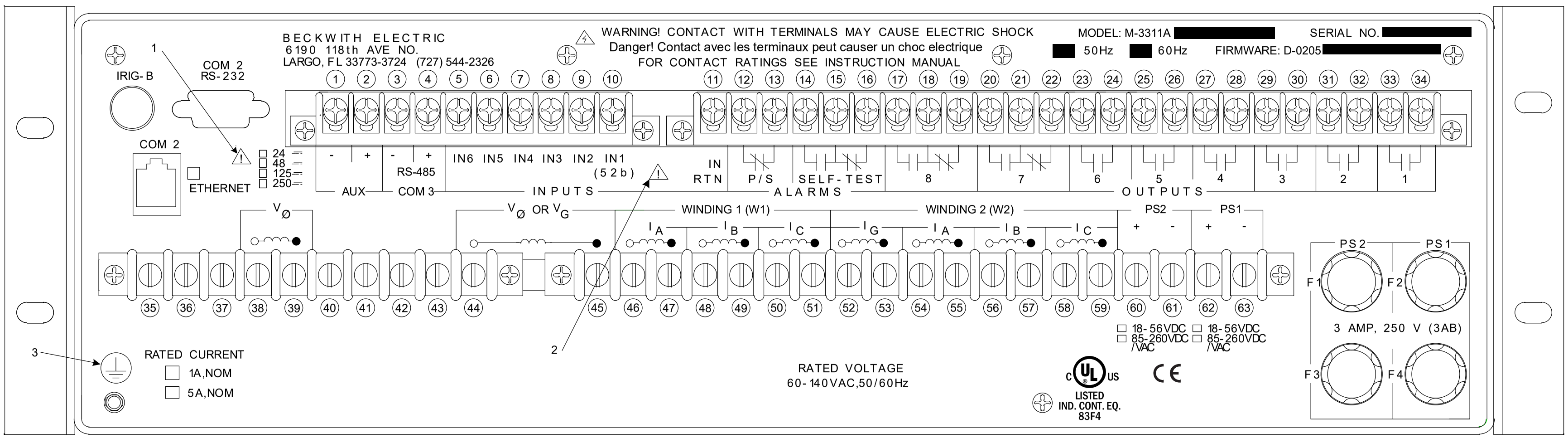


Figure 5-10 Two Winding – Two Voltage Inputs External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

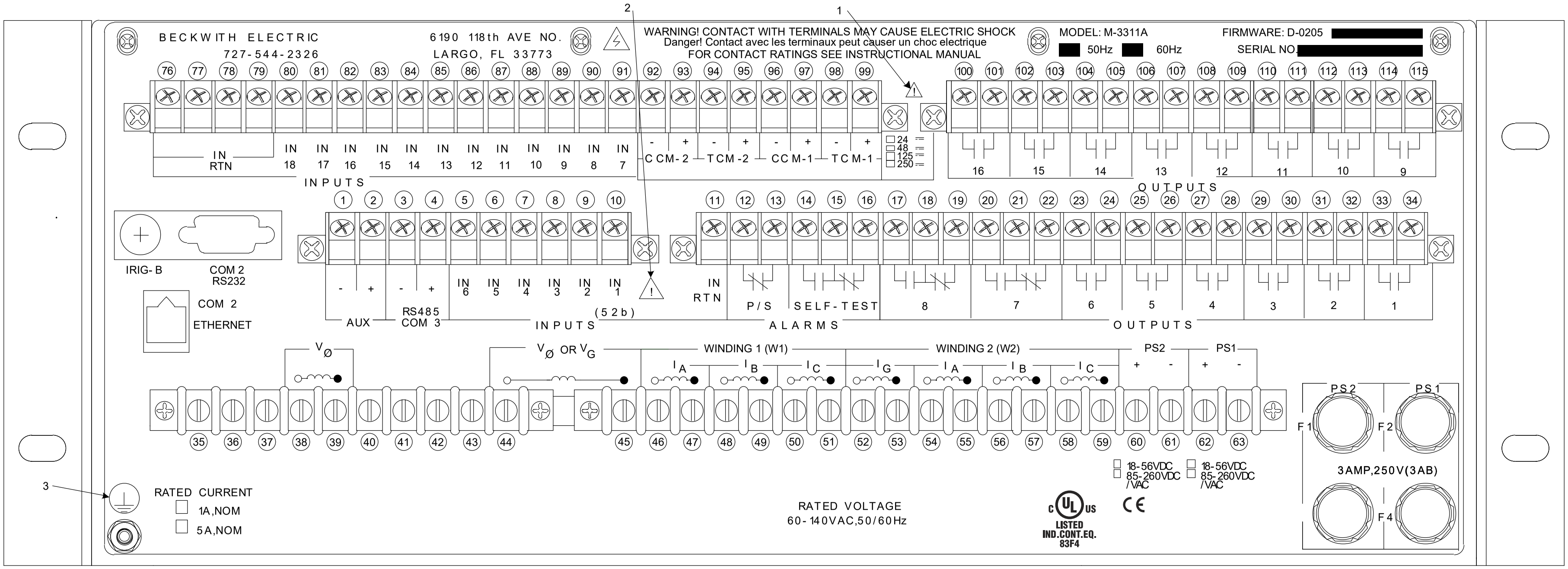


Figure 5-11 Two Winding – Two Voltage Inputs Extended Output External Connections

NOTES: ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

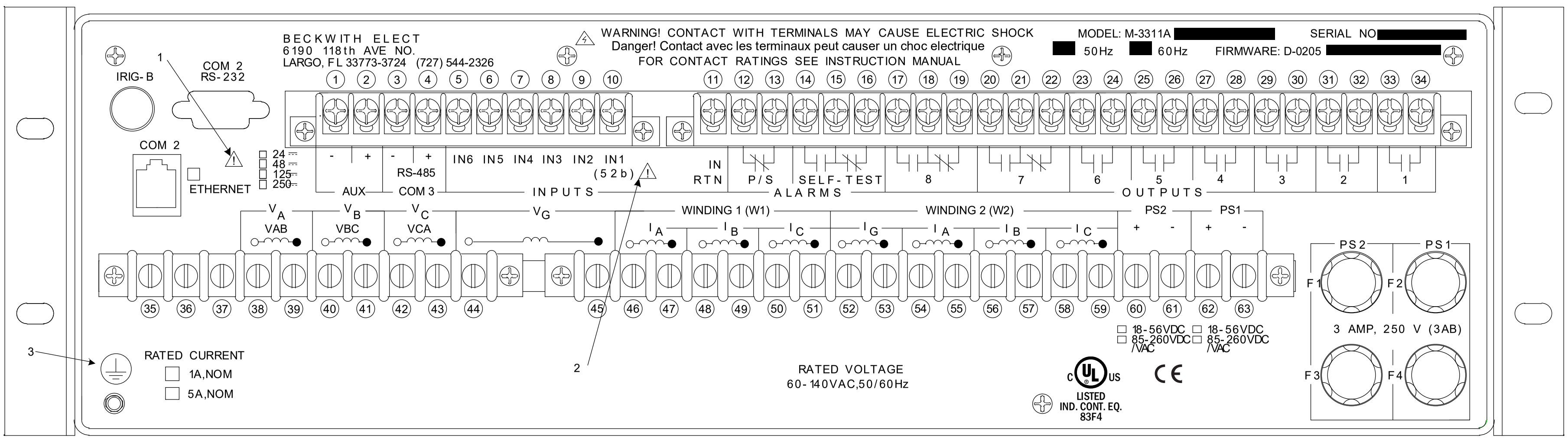


Figure 5-12 Two Winding – Four Voltage Inputs External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see Section 5.5, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See Section 5.3, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

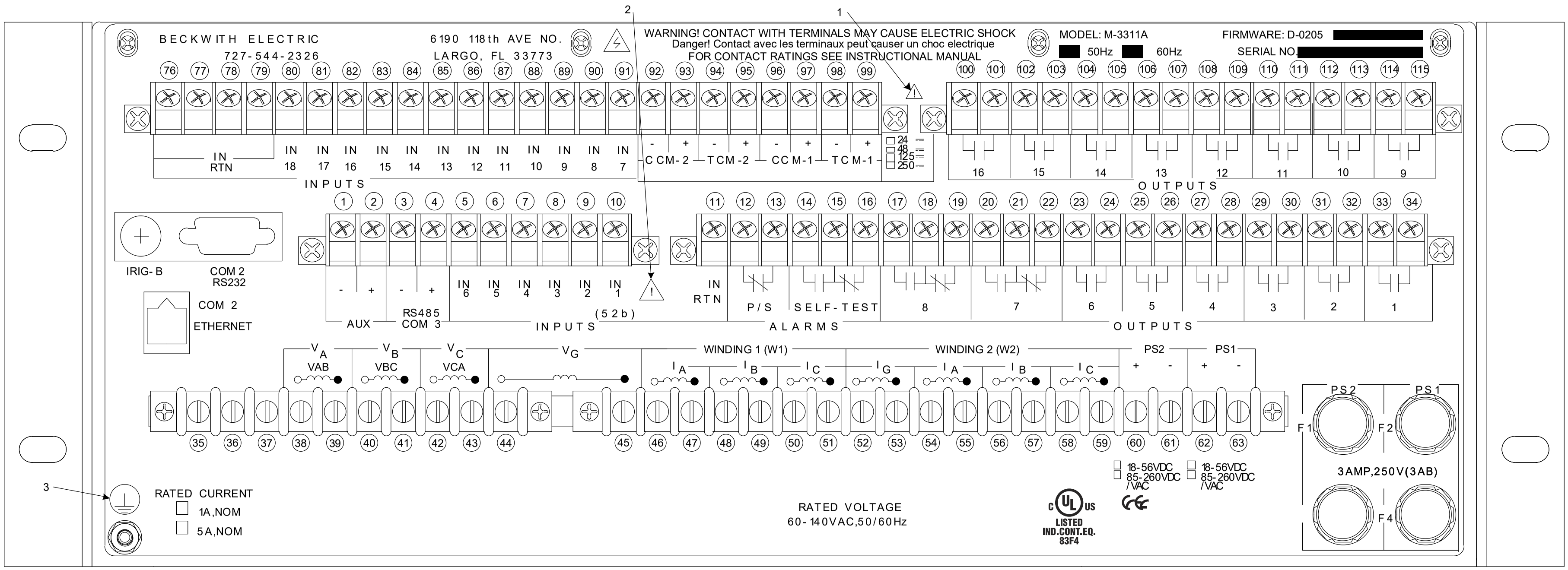


Figure 5-13 Two Winding – Four Voltage Inputs Extended Output External Connections

■ **NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

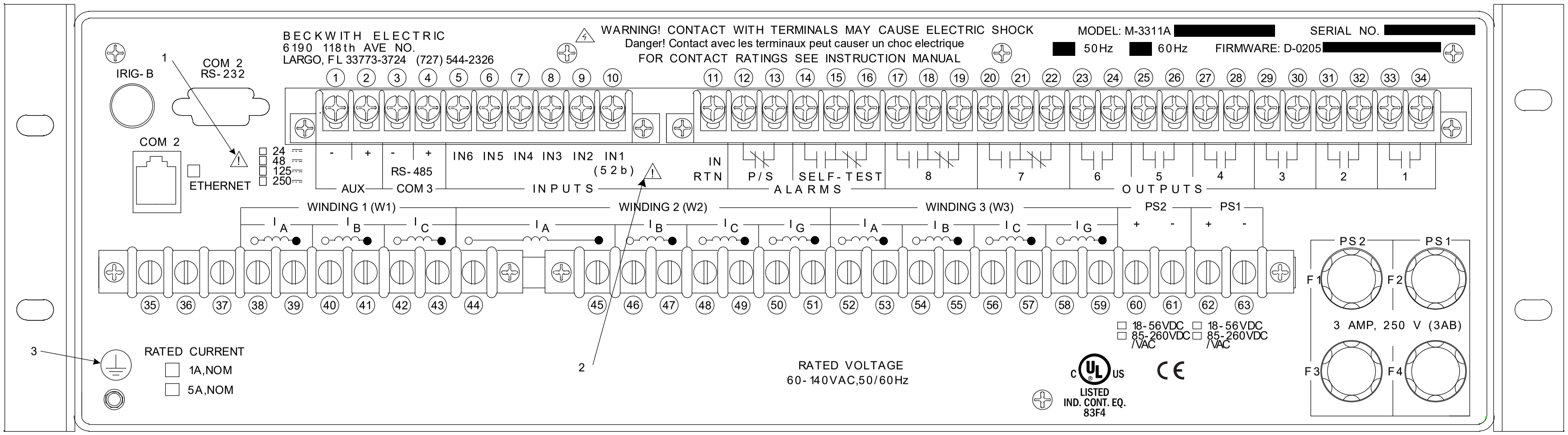


Figure 5-14 Three-Winding – Zero Voltage Inputs External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see Section 5.5, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See Section 5.3, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

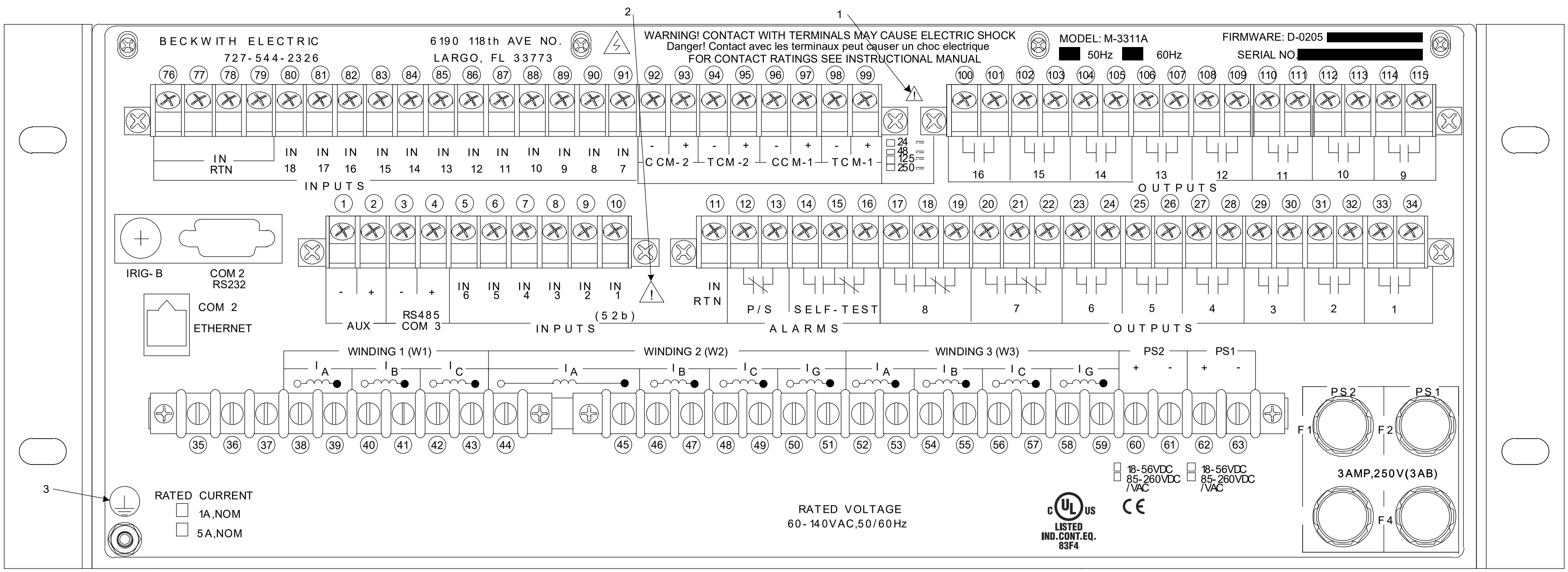


Figure 5-15 Three -Winding – Zero Voltage Inputs Extended Output External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

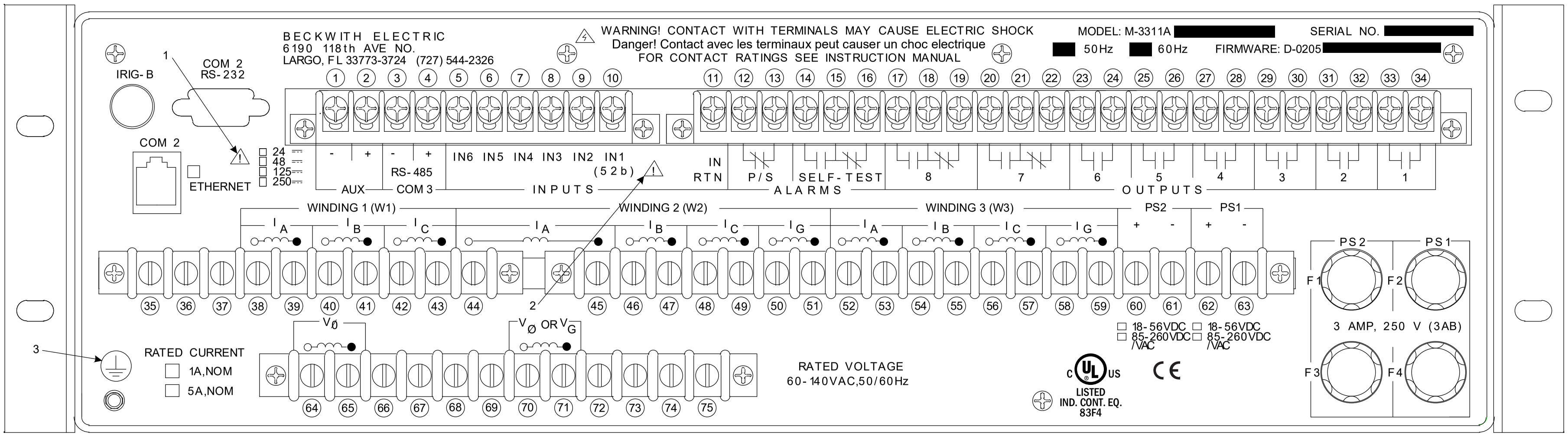


Figure 5-16 Three-Winding – Two-Voltage Inputs External Connections

NOTES: ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

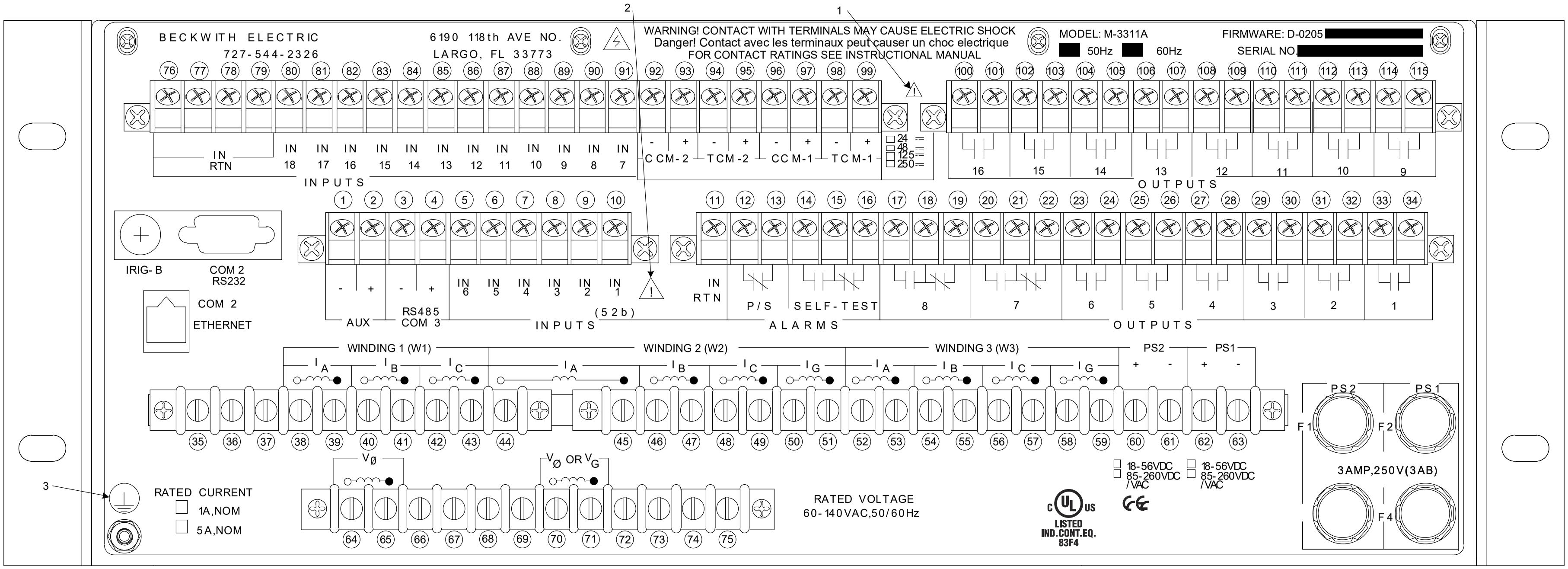


Figure 5-17 Three -Winding – Two Voltage Inputs Extended Output External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see Section 5.5, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See Section 5.3, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

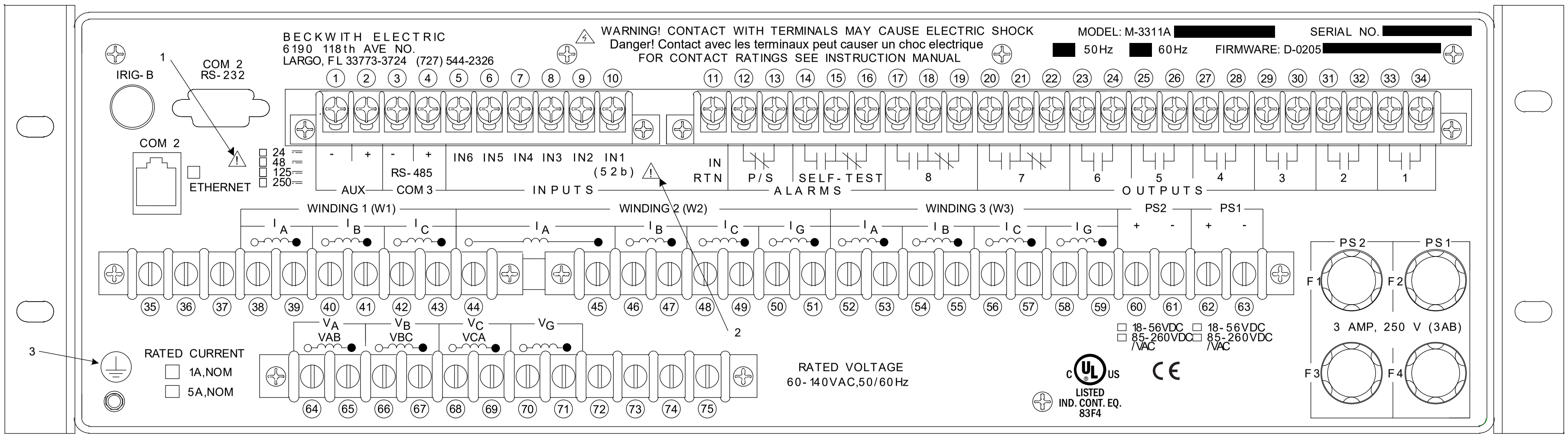


Figure 5-18 Three-Winding – Four-Voltage Inputs External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see Section 5.5, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See Section 5.3, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

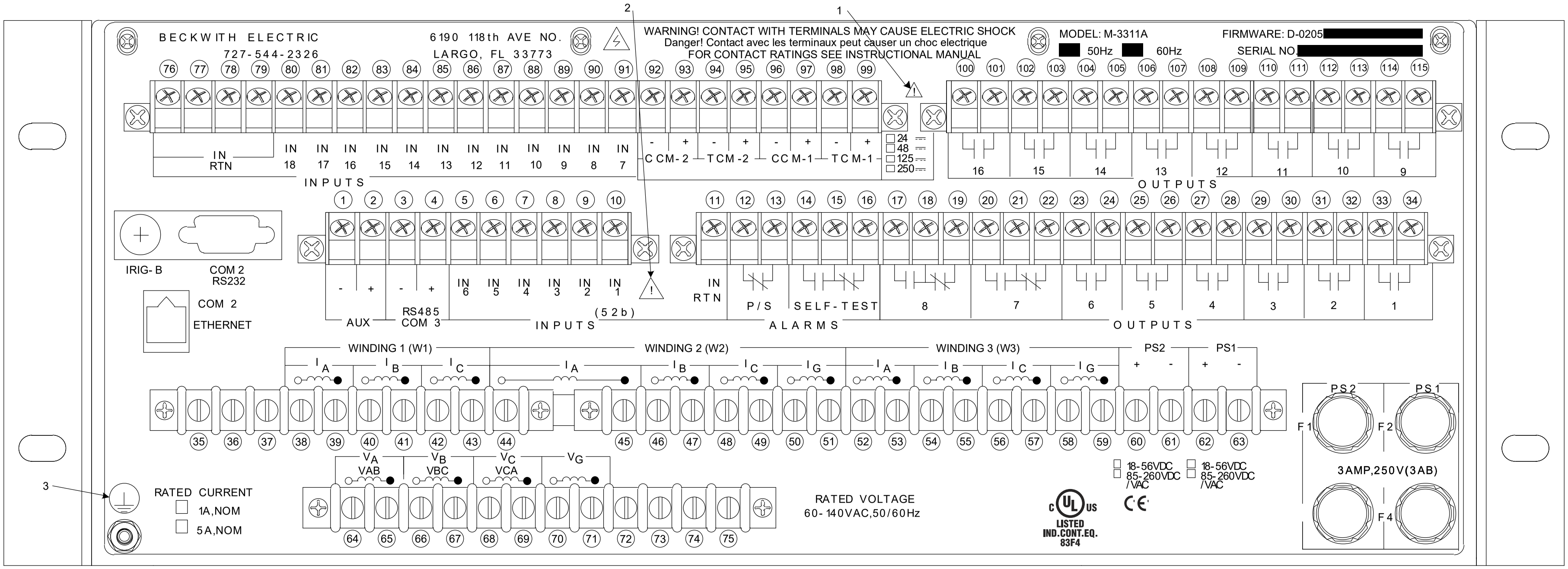


Figure 5-19 Three -Winding – Four Voltage Inputs Extended Output External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

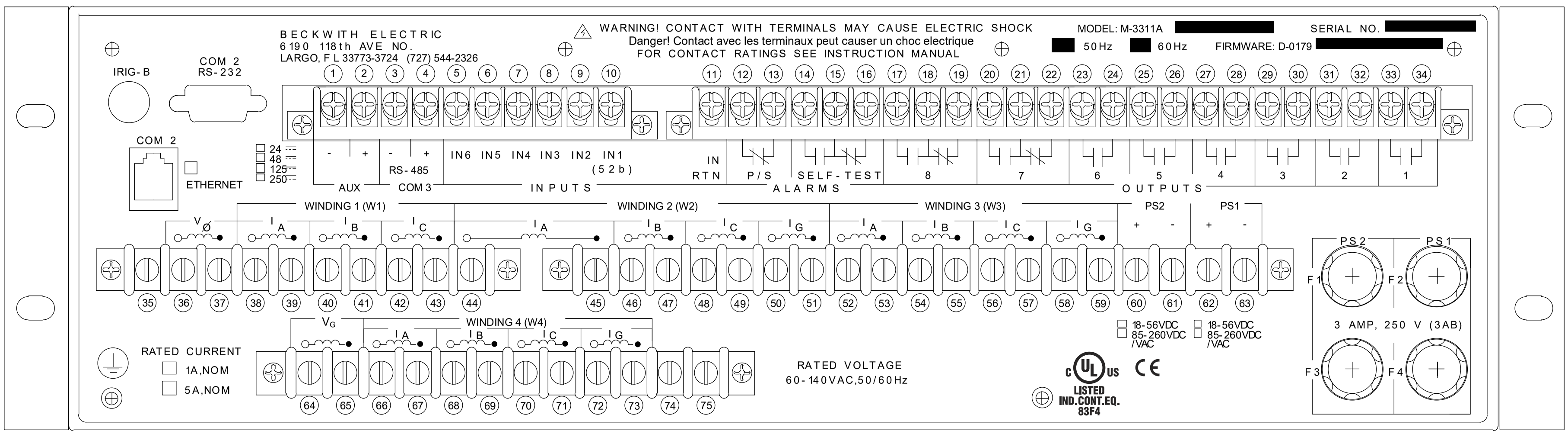


Figure 5-20 Four-Winding – Two-Voltage Inputs External Connections

■**NOTES:** ⚠

1. ▲ **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see **Section 5.5**, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See **Section 5.3**, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

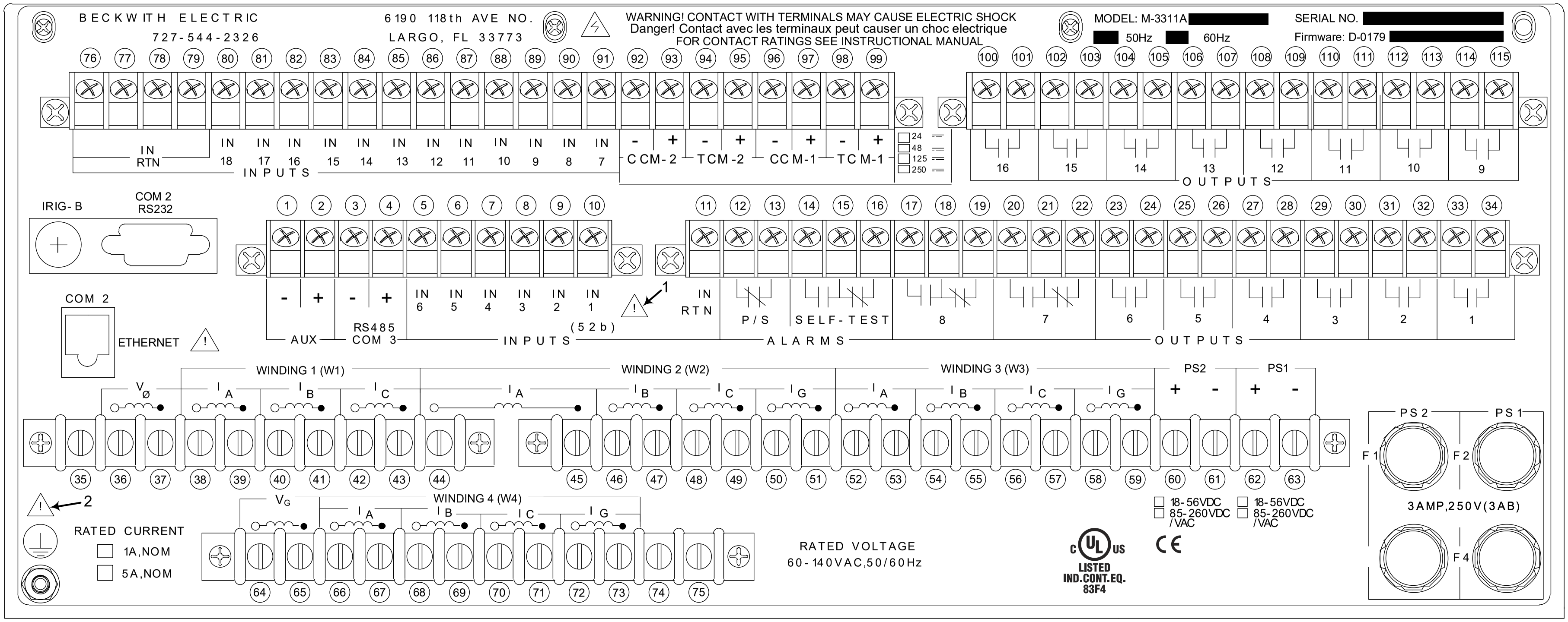


Figure 5-21 Four-Winding – Two-Voltage Inputs Extended Output External Connections

■**NOTES:** ⚠

1. **CAUTION**: Before making connections to the Trip Circuit Monitoring input, see Section 5.5, **Circuit Board Switches and Jumpers**, for the information regarding setting Trip Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.
2. ▲ **CAUTION**: ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
3. ⬣ **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**
4. See Section 5.3, **External Connections** for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL Wire, Connector, Insulation and Terminal Block Torque requirements.

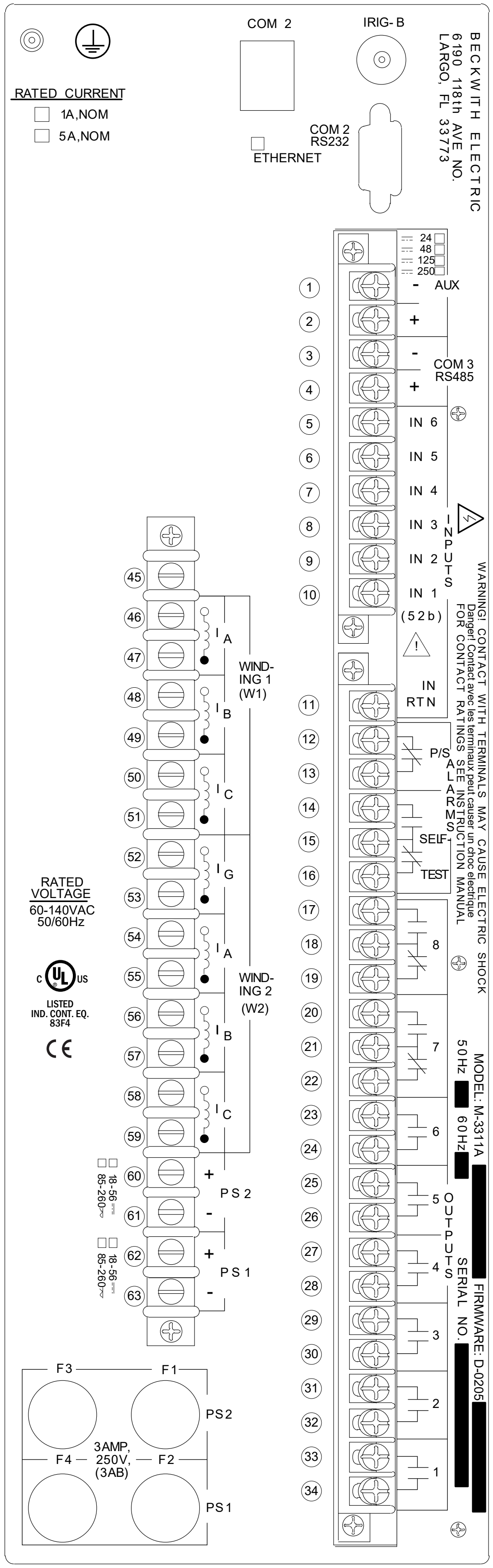


Figure 5-22 Two Winding – One Ground Input – Zero Voltage Inputs Vertical Chassis External Connections

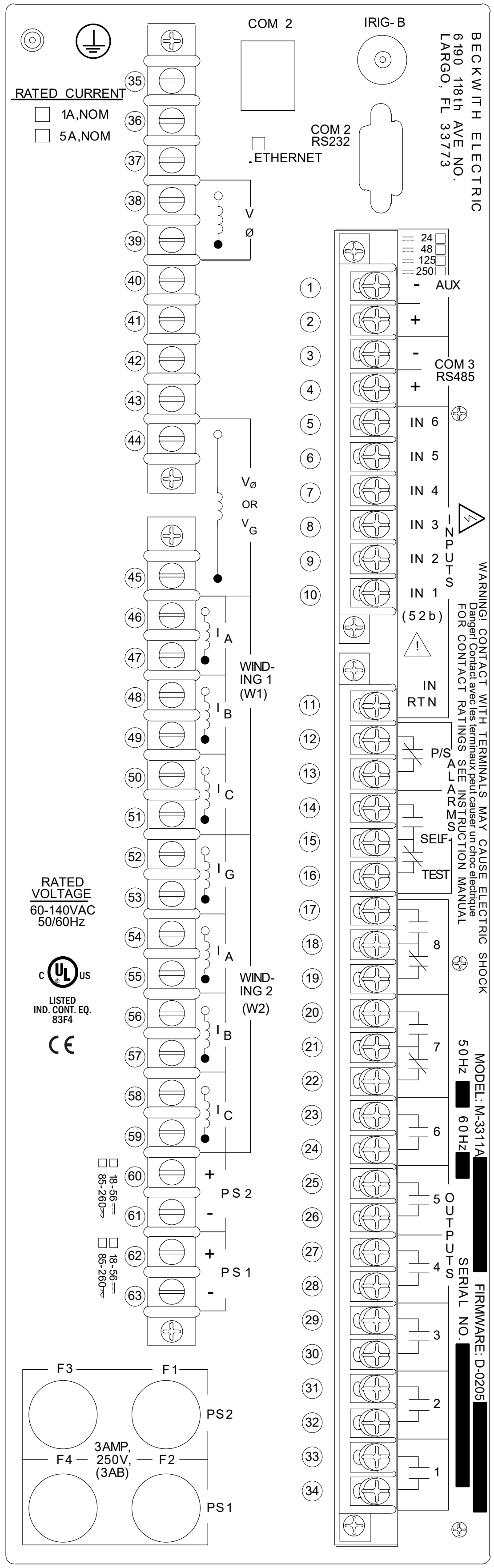


Figure 5-23 Two Winding – One Ground Input – Two Voltage Inputs Vertical Chassis External Connections

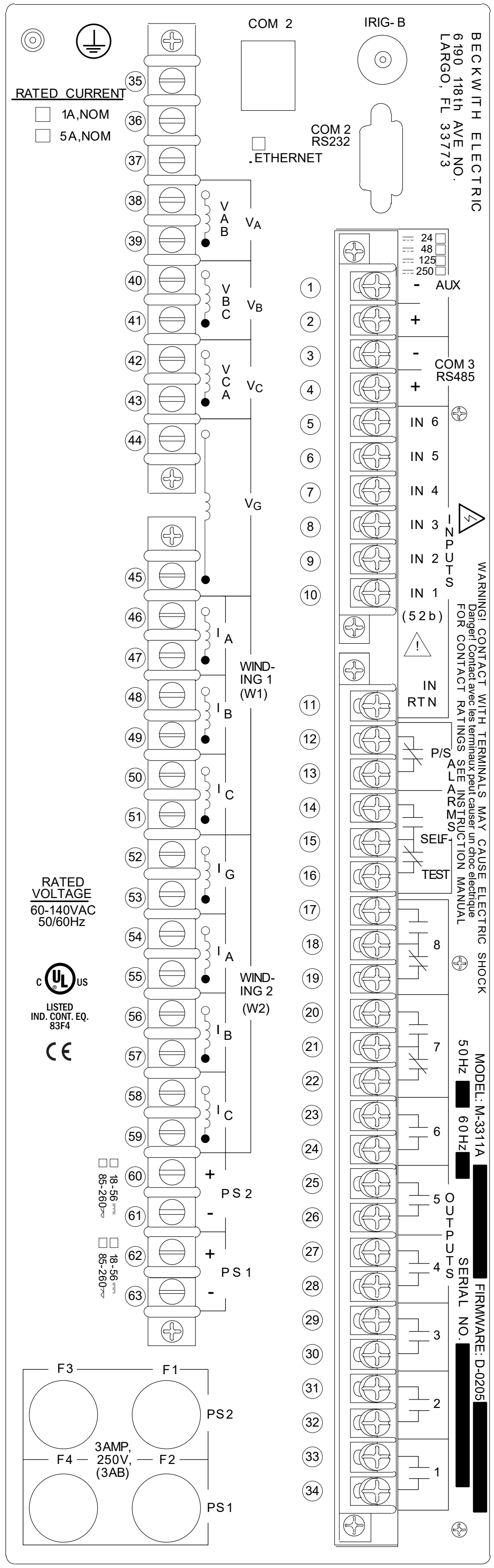


Figure 5-24 Two Winding – One Ground Input – Four Voltage Inputs Vertical Chassis External Connections

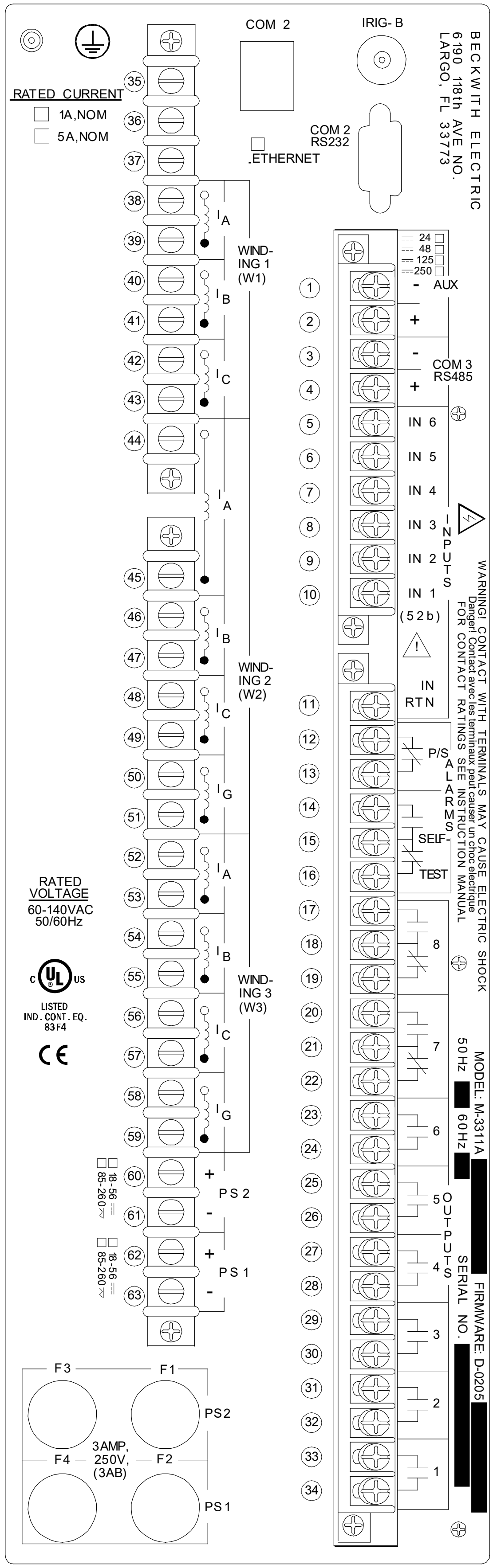


Figure 5-25 Three Winding – Two Ground Inputs – Zero Voltage Inputs Vertical Chassis External Connections

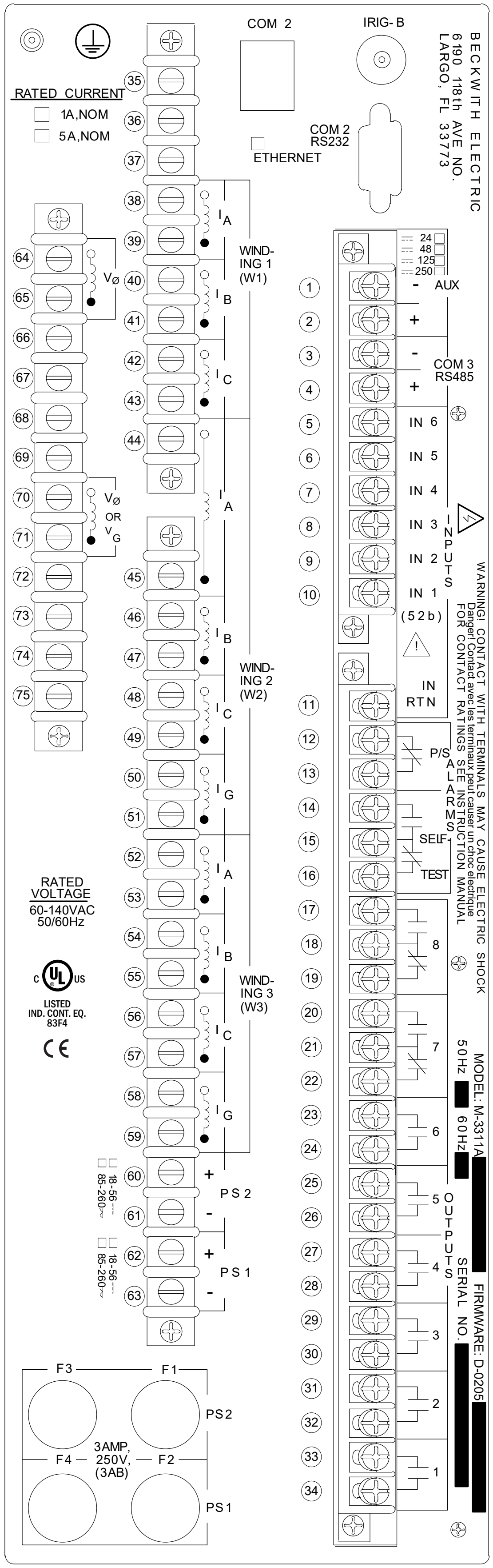


Figure 5-26 Three Winding – Two Ground Inputs – Two Voltage Inputs Vertical Chassis External Connections

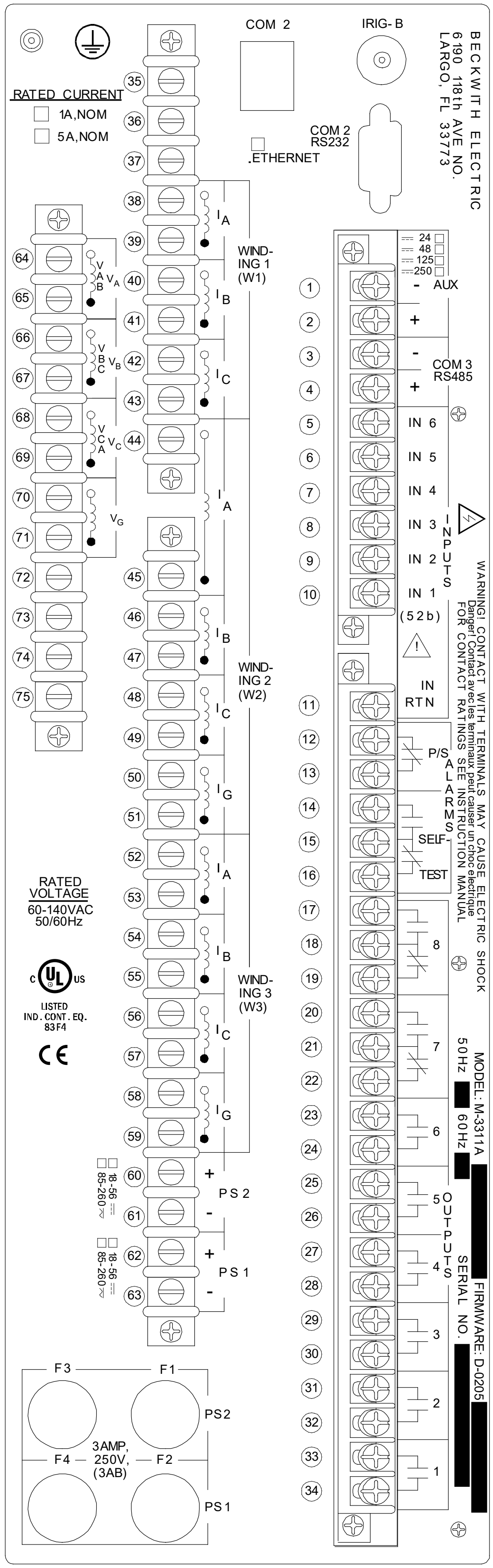


Figure 5-27 Three Winding – Two Ground Inputs – Four Voltage Inputs Vertical Chassis External Connections

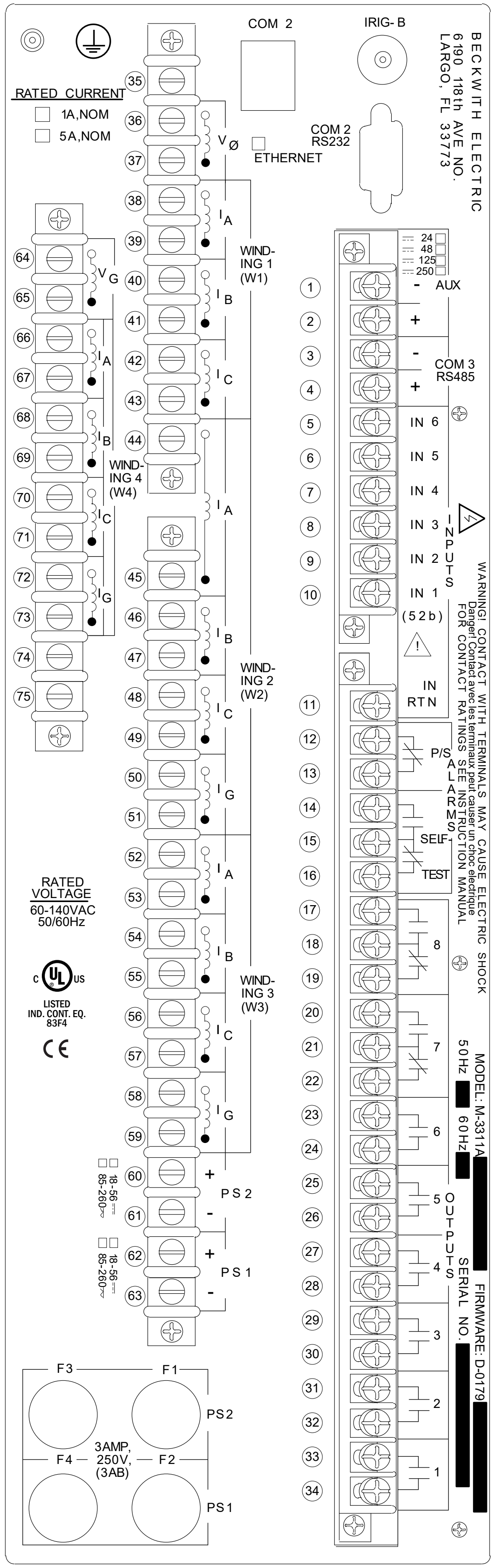


Figure 5-28 Four-Winding – Three-Ground Inputs – Zero- or Two-Voltage Inputs Vertical Chassis External Connections

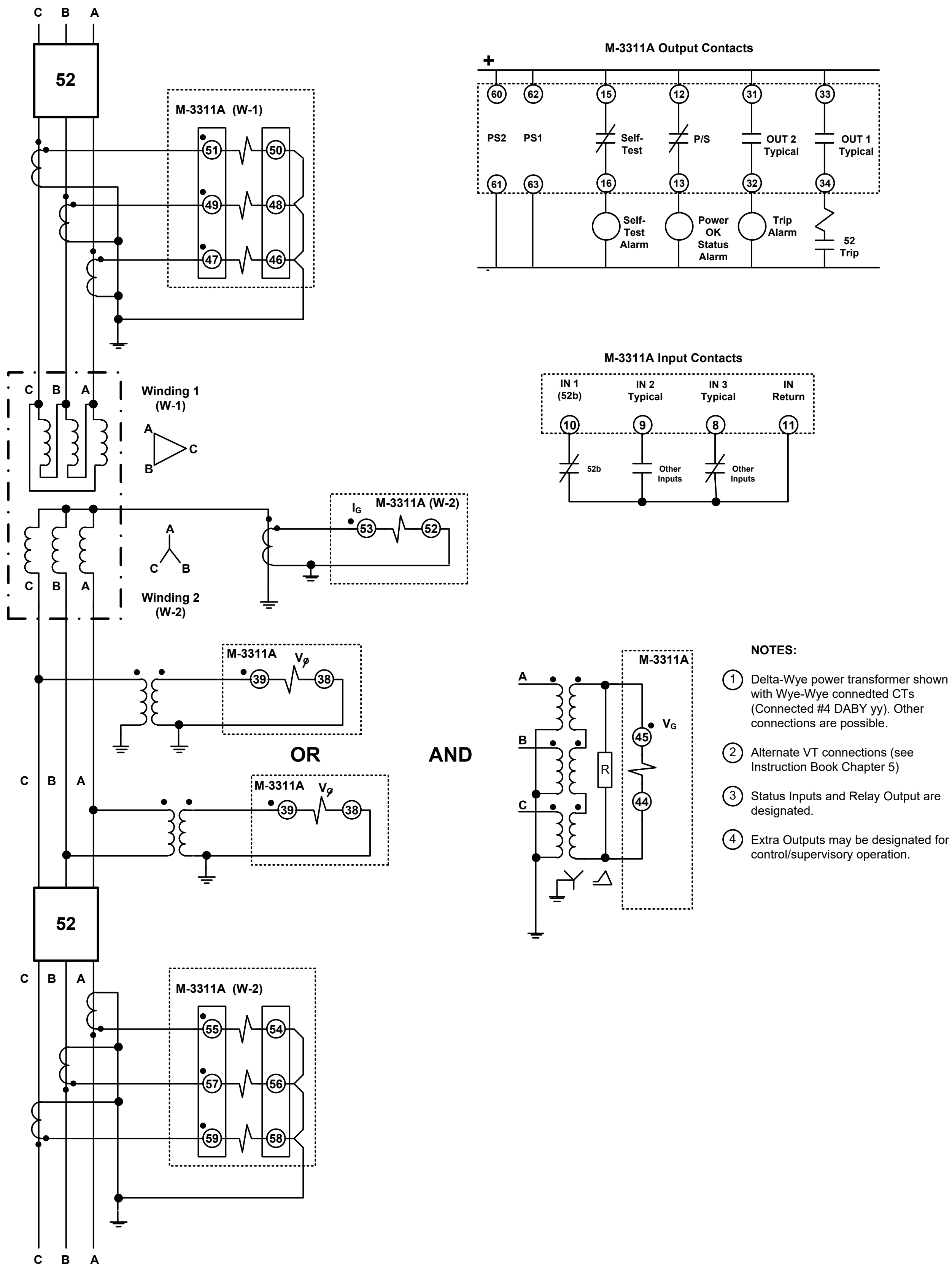


Figure 5-29 Typical (Two Winding – Two Voltage Inputs) Three-Line Connection Diagram

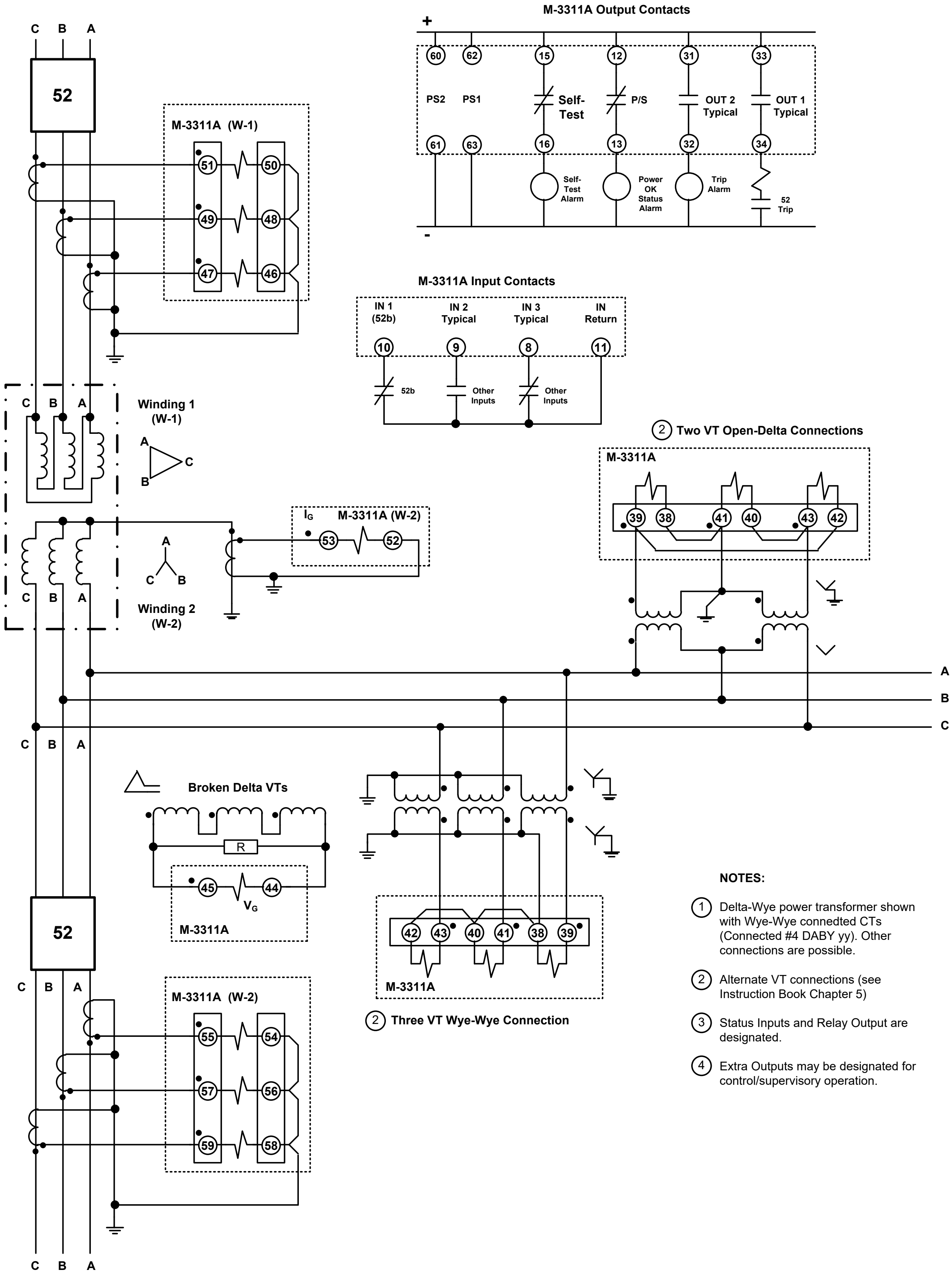


Figure 5-30 Typical (Two Winding – Four Voltage Inputs) Three-Line Connection Diagram

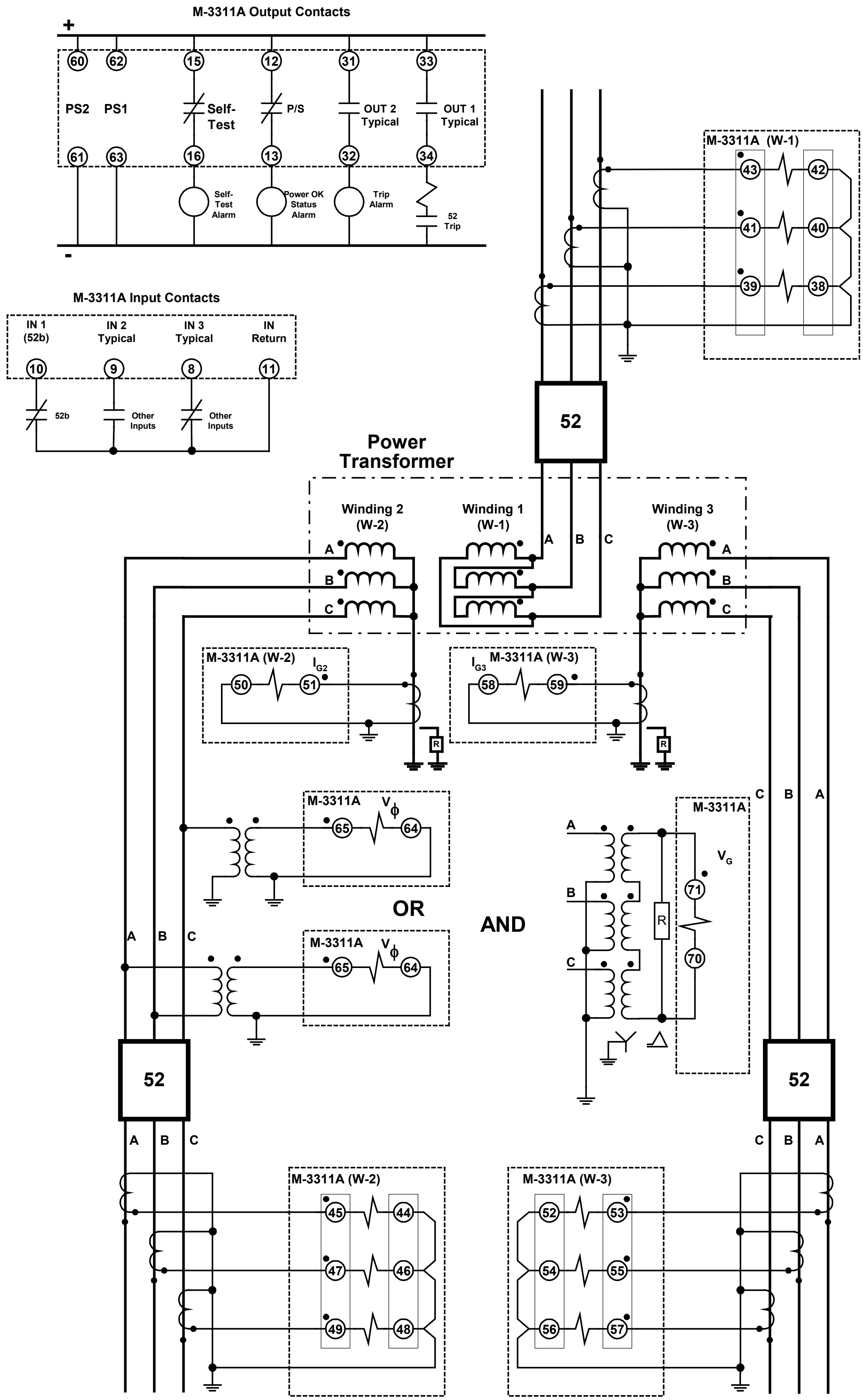


Figure 5-31 Typical (Three Winding – Two Voltage Inputs) Three-Line Connection Diagram

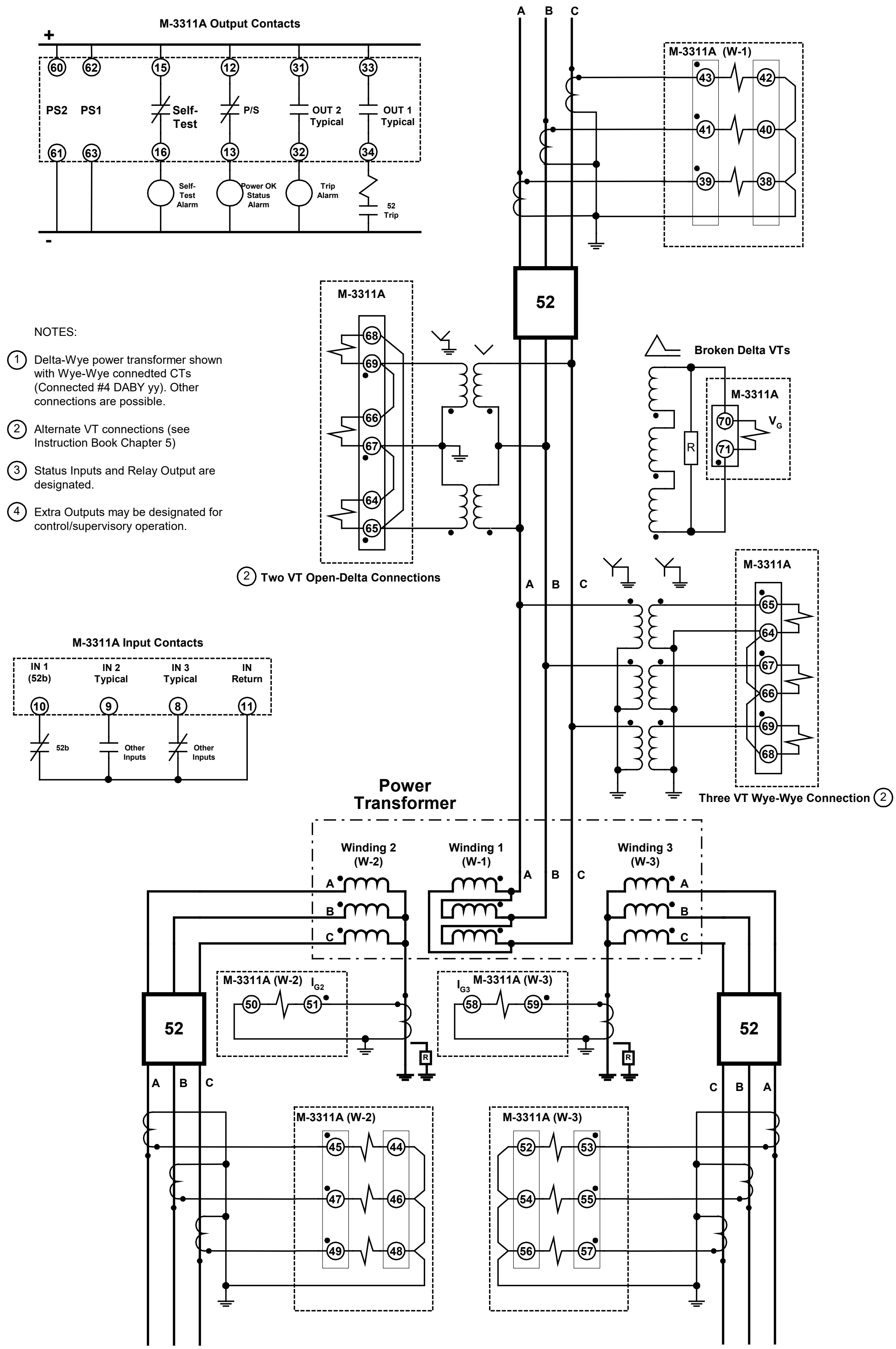


Figure 5-32 Typical (Three Winding – Four Voltage Inputs) Three-Line Connection Diagram

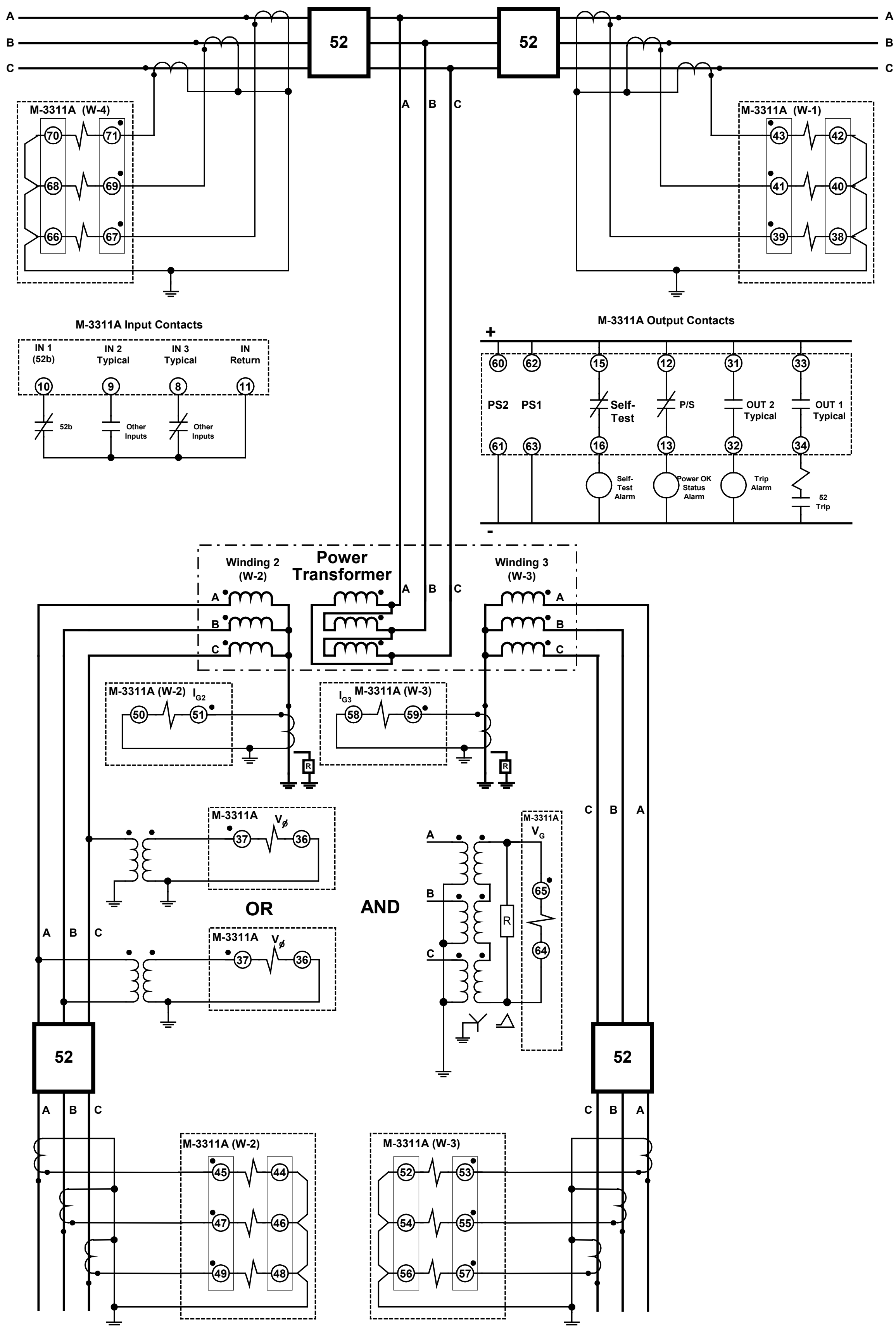


Figure 5-33 Typical (Four-Winding – Two-Voltage Inputs) Three-Line Connection Diagram

5.4 Pre-Commissioning Checkout

During M-3311A Transformer Protection Relay field commissioning, check the following procedure to ensure that the CT and VT connections are correct.

1. On the keypad, press **ENTER**. After a short delay, the unit should display:

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

2. Press the right arrow button until the unit displays:

```
STATUS
← config sys STAT dmd →
```

3. Press **ENTER**. The unit should display:

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

4. Press **ENTER** to display the phase voltage. Use a voltmeter to compare the actual measurement. If there is a discrepancy, check for loose connections to the rear terminal block of the unit.

```
VOLTAGE
VA=          VG=
```

5. Press **EXIT**, the unit displays:

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

6. Press the right arrow once, the unit displays:

```
CURRENT STATUS
volt CURR freq v/hz→
```

7. Press **ENTER** to display line currents for Winding 1 (I_AW_1, I_BW_1, I_CW_1). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W1 PHASE CURRENT
A= 5.00 B= 5.00 C= 5.00
```

8. Press **ENTER** to display line currents for Winding 2 (I_AW_2, I_BW_2, I_CW_2). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W2 PHASE CURRENT
A= 5.00 B=5.00 C=5.00
```

9. Press **ENTER** to display line currents for Winding 3 (I_AW_3, I_BW_3, I_CW_3). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W3 PHASE CURRENT
A= 5.00 B=5.00 C=5.00
```

10. Press **ENTER** to display line currents for Winding 4 (I_AW_4, I_BW_4, I_CW_4). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W4 PHASE CURRENT
A= 5.00 B=5.00 C=5.00
```

11. Press **ENTER** for the unit to display ground current. The Ground current should be $I_GW2 \approx 0$ Amps.

```
W2 GROUND CURRENT
0.00 Amps
```

12. Press **ENTER** for the unit to display ground current. The Ground current should be $I_GW3 \approx 0$ Amps.

```
W3 GROUND CURRENT
0.00 Amps
```

13. Press **ENTER** for the unit to display ground current. The Ground current should be $I_GW4 \approx 0$ Amps.

```
W4 GROUND CURRENT
0.00 Amps
```

14. Press **ENTER** for the unit to display restraint currents. The restraint currents should be $I_{REST} \approx \frac{W_1 + W_2}{2}$ for each phase.

```
restraint current  (PU)
A=5.000 B=5.000 C=5.000
```

15. Press **ENTER** for the unit to display the fundamental differential currents. The fundamental differential currents should be $I_DI_{FF} \approx W_1\text{-}W_2 \approx 0$ for each phase. If a significant amount of differential current is present, check the CT polarities.

```
DIFF CURRENT FUND. (PU)
A=0.000 B=0.000 C=0.000
```

16. Press **ENTER** for the unit to display the second harmonic currents. The second harmonic currents should be $I_{2ND} \approx 0$ for each phase.

```
DIFF CURRENT 2nd h (PU)
A=0.000 B=0.000 C=0.000
```

17. Press **ENTER** for the unit to display the fourth harmonic currents. The fourth harmonic currents should be $I_{4TH} \approx 0$ for each phase.

```
DIFF CURRENT 4th h (PU)
A=0.000 B=0.000 C=0.000
```

18. Press **ENTER** for the unit to display the fifth harmonic currents. The fifth harmonic currents should be $I_{5TH} \approx 0$ for each phase.

```
DIFF CURRENT 5th h (PU)
A=0.000 B=0.000 C=0.000
```

19. Press **ENTER** for the unit to display the ground differential current. The ground differential current should be $I_{GD}I_{FF} \approx 0$.

```
W2 GND DIFF CURRENT
  0.00 Amps
```

Press **ENTER** for W3

```
W3 GND DIFF CURRENT
  0.00 Amps
```

Press **ENTER** for W4

```
W4 GND DIFF CURRENT
  0.00 Amps
```

20. Press **ENTER** for the unit to display the positive sequence current for winding 1. The positive sequence current should be $I_{POS}W_1 \approx I_AW_{1,} \approx I_BW_{1,} \approx I_CW_1$.

```
W1 POS SEQUENCE CURRENT
5.00 Amps
```

21. Press **ENTER** for the unit to display the negative sequence current for winding 1. The negative sequence current should be $I_{NEG}W_1 \approx 0$ Amps.

```
W1 NEG SEQUENCE CURRENT
0.00 Amps
```

22. Press **ENTER** for the unit to display the zero sequence current for winding 1. The zero sequence current should be $I_{ZERO}W_1 \approx 0$ Amps. If a significant amount of negative or zero sequence current is present (greater than 25% of I_AW_1, I_BW_1, I_CW_1), then either the phase sequence or the polarities may be incorrect. Modify connections to obtain the correct phase sequence and polarities.

```
W1 ZERO SEQUENCE CURRENT
0.00 Amps
```

23. Repeat steps 18–20 for winding 2, winding 3 and winding 4 currents.
24. Press **ENTER** for the unit to display the Winding Thermal Current value for the selected winding.

```
F49 THERMAL CURRENT
A=  B=  C=
```

25. Press **EXIT**, the unit displays:

```
CURRENT STATUS
volt CURR freq v/hz →
```

5.5 Circuit Board Switches and Jumpers

Dip Jumper	Position	Description
J60	AB AC	Connects CD signal to COM 2 Pin 1* Connects +15 V to COM 2 Pin 1
J61	BC AB	Connects -15 V to COM 2 Pin 9 Disconnects COM 2 Pin 9
J18	AB BC	COM 3 Termination Resistor Inserted COM 3 Termination Resistor Not Inserted*
J46	AB BC	COM 3 Shares Baud Rate with COM 1 COM 3 Shares Baud Rate with COM 2*
J5	AB BC	Demodulated IRIG-B Signal TTL Pin 6 Modulated IRIG-B Signal BNC*

* Default Setting

Table 5-1 Circuit Board Jumpers

Switch Positions				Description
1	2	3	4	Switches should not be changed while power is applied to unit
U	X	X	X	Up for dual Power Supply, Down for Single
X	X	U	U	Run Mode
X	X	D	D	Factory Use Only
X	X	D	U	Initialize access codes and communication parameters to default values*
X	D	X	X	Flash Update Enabled
* Power down, set switch, then power up. After power up, the RELAY OK LED light remains off and DIAG LED will illuminate when the operation has been satisfactorily completed.				

Table 5-2 Circuit Board Switches

Trip Circuit Monitor 1 Input Voltage Select Units WITH Expanded I/O, Use Jumpers J1, J2 and J3 Units WITHOUT Expanded I/O, Use Jumpers J20, J21 and J22			
Input Voltage	Jumper J1/20 Position	Jumper J2/21 Position	Jumper J3/22 Position
24 Vdc	A to B	A to B	A to B
48 Vdc	B to C	A to B	A to B
125 Vdc	B to C	B to C	A to B
250 Vdc*	B to C	B to C	B to C

* Default from Factory

Table 5-3 Trip Circuit Monitor 1 Input Voltage Select Jumper Configuration

Close Circuit Monitor 1 Input Voltage Select			
Input Voltage	Jumper J4 Position	Jumper J5 Position	Jumper J6 Position
24 Vdc	A to B	A to B	A to B
48 Vdc	B to C	A to B	A to B
125 Vdc	B to C	B to C	A to B
250 Vdc*	B to C	B to C	B to C

* Default from Factory

Table 5-4 Close Circuit Monitor 1 Input Voltage Select Jumper Configuration

Trip Circuit Monitor 2 Input Voltage Select			
Input Voltage	Jumper J13 Position	Jumper J14 Position	Jumper J15 Position
24 Vdc	A to B	A to B	A to B
48 Vdc	B to C	A to B	A to B
125 Vdc	B to C	B to C	A to B
250 Vdc*	B to C	B to C	B to C

* Default from Factory

Table 5-5 Trip Circuit Monitor 2 Input Voltage Select Jumper Configuration

Close Circuit Monitor 2 Input Voltage Select			
Input Voltage	Jumper J16 Position	Jumper J17 Position	Jumper J18 Position
24 Vdc	A to B	A to B	A to B
48 Vdc	B to C	A to B	A to B
125 Vdc	B to C	B to C	A to B
250 Vdc*	B to C	B to C	B to C

* Default from Factory

Table 5-6 Close Circuit Monitor 2 Input Voltage Select Jumper Configuration

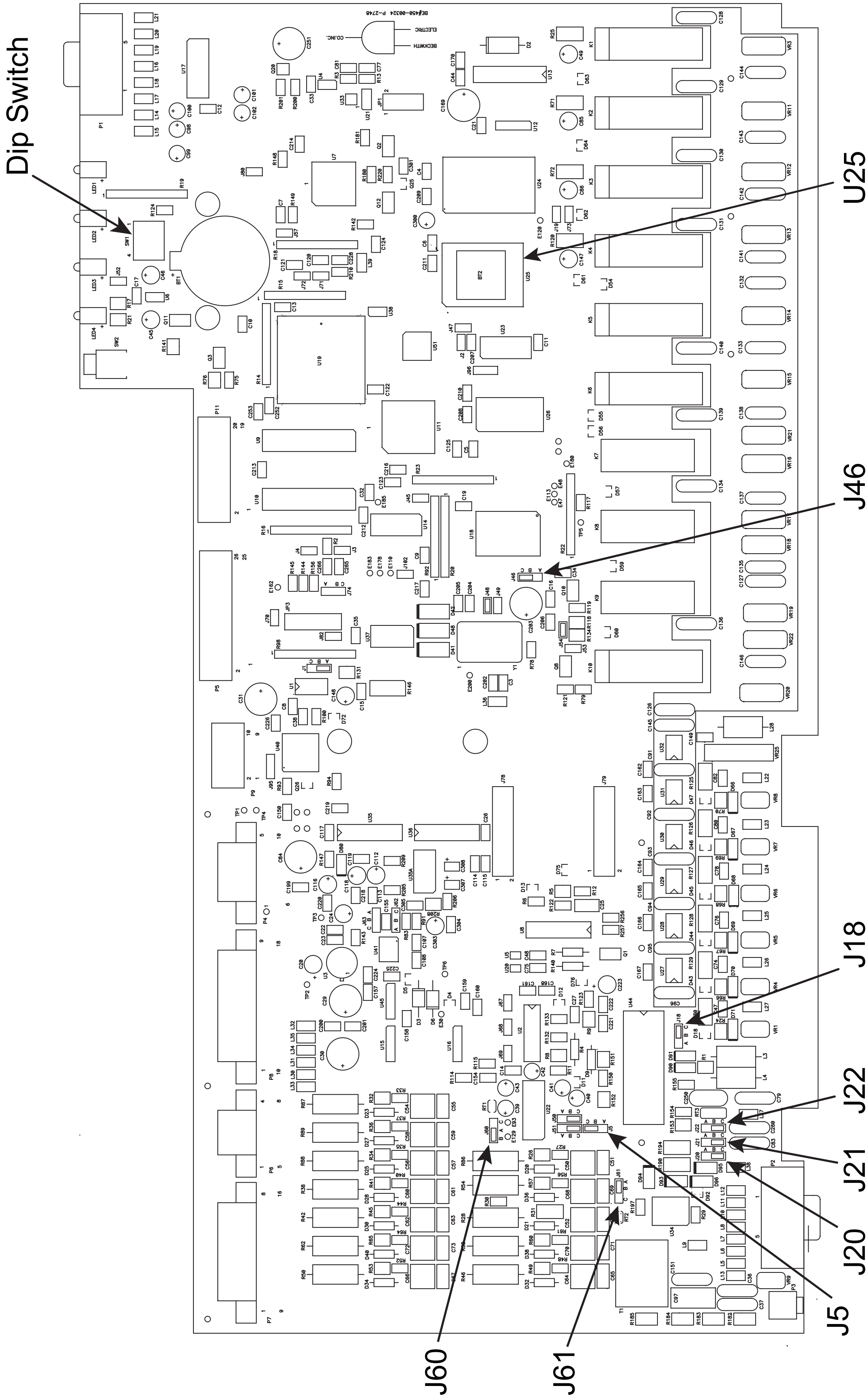


Figure 5-34 M-3311A Circuit Board Standard I/O

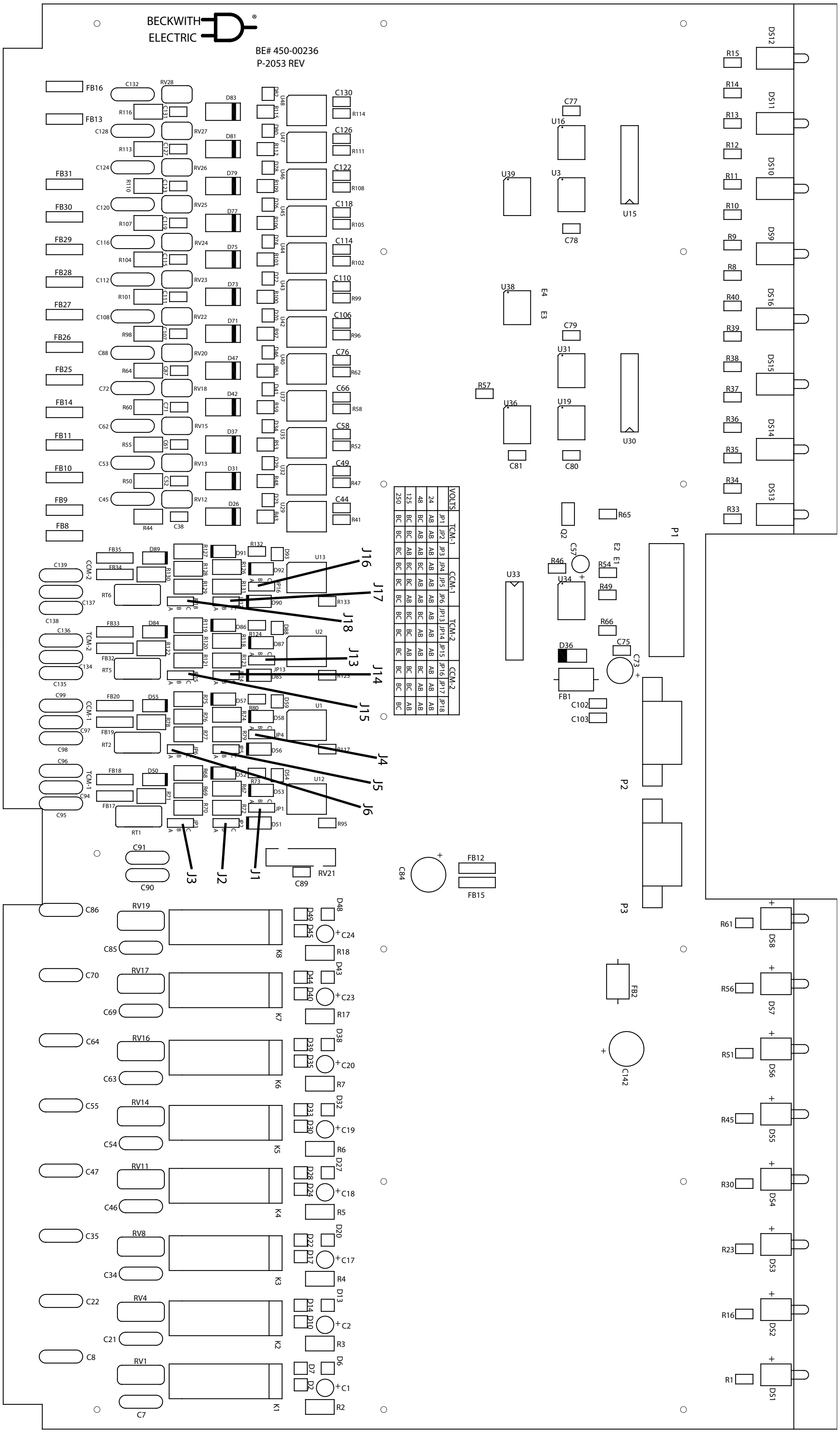


Figure 5-35 M-3311A Circuit Board Expanded I/O

5.6 IPScom Communications and Analysis Software Installation

IPScom Installation and Setup

IPScom is available on CD-ROM, or may be downloaded from our website at www.beckwithelectric.com.

The S-3300 IPScom Communications Software is not copy-protected. For more information on your specific rights and responsibilities, see the licensing agreement enclosed with your software or contact Beckwith Electric.

Hardware Requirements

IPScom will run on any Windows based computer that provides at least the following:

- x86-based personal computer (1 GHz or Higher recommended)
- For CD install, a CD or DVD drive
- RS-232 com port or USB to RS-232 dongle
- Mouse or pointing device
- Microsoft Windows NT or greater
- Microsoft Internet Explorer 4.0 or greater
- At least 1G free hard disk space available

Installing IPScom

1. Insert software CD-ROM into your drive.

   An Auto-Install program will establish a program folder (Becoware) and subdirectory (IPScom). After installation, the IPScom program item icon (Figure 5-36) is located in Becoware. The default location for the application files is on drive C:, in the new subdirectory "IPScom" (C:\Becoware\IPScom).

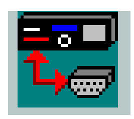


Figure 5-36 IPScom Program Icon

2. If the Auto-Install program does not launch when the CD-ROM is inserted into the drive then proceed as follows:
   a. Select Run from the Start Menu.
   b. In the Run dialog screen, locate the installation file (setup.exe) contained on the IPScom installation disk.
   c. Select Run to start the installation process.

5.7 Activating Initial Local Communications

The relay and IPScom Communications Software are shipped from the factory with the same default communication parameters. Therefore, it may not be necessary to set up communication parameters.

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 relay, and an applicable connector for the computer (usually DB9S or DB25S). Pin-outs for a null modem adapter are provided in **Appendix B**, **Communications**.

Activating initial communications using default communication parameters is accomplished as follows:

1. Verify that a direct serial connection between the PC hosting IPScom and the target relay COM1 (front) is in place.
2. Select the IPScom icon (Figure 5-36) from the Becoware folder or Desktop. The IPScom **Main Screen** (Figure 3-2) is displayed.
3. Select the **Connect** menu item. IPScom will display the **Serial Port Dialog Screen** (Figure 3-6).
4. If the computer is connected through either an RS-232 port or RS-485 port perform the following:
    a. Select the **PC Comm Port** that is connected to the relay.
    b. Select **Connect**. This action attempts to establish communication.
5. If IPScom returns a "COM Opened and Level #(1, 2 or 3) access granted" then communications have been established. Enter any valid IPScom command(s) as desired. To close the communication channel when connected locally, select the **Communication/Disconnect** from the main screen menu bar.
6. If IPScom returns an error message, then determine the relay COM1 communication parameters as follows:
    a. From the relay Front Panel HMI press **ENTER**. The relay will display:

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

    b. Press the right arrow pushbutton until the relay displays:

```
        COMMUNICATION
← stat COMM setup      →
```

    c. Press **ENTER**. The relay will display:

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

    d. Press **ENTER**. The relay will display:

```
COM1 BAUD RATE
← baud_4800  baud_9600
```

Record the Baud Rate that is displayed in all Caps: ___________

    e. Pres **EXIT** as necessary to exit the HMI.
    f. Select the **Connect** menu item. IPScom will display the **Serial Port Dialog Screen** (Figure 3-6).
    g. Verify the IPScom COM Port Baud Rate is the same as relay COM1 Baud Rate.
    h. Verify that the **PC Comm Port** that is connected to the relay is selected.
    i. Select **Connect**. This action will attempt to establish communication.
    j. If IPScom returns a "COM Opened and Level #(1, 2 or 3) access granted" then communications have been established. Enter any valid ISScom command(s) as desired.

To close the communication channel when connected locally, select **Communication/Disconnect** from the main screen menu bar.

5.8 Initial Setup Procedure

The relay is shipped with the initial configuration settings as listed in **Appendix A**, Figure A-1 System Communication Setup, Figure A-2 Setup System (Two or Three Winding), Figure A-3 Setup System (Four Windings), Figure A-4 System Setpoints and Settings. Selected settings that are unique to the application may be recorded on the appropriate record form as calculated from **Chapter 4**, **System Setup and Setpoints**.

Setup Procedure

1. Connect power to the relay's rear power terminals, as marked on the rear panel's power supply label and as shown in Figure 5-6 and Figure 5-7.
2. When power is initially applied, the M-3311A performs a number of self-tests to ensure its proper operation. During the self-tests, an "X" is displayed for each test successfully executed. If all tests are successful, the unit will briefly display the word **PASS**. Then, a series of status screens, including the model number, software version number, serial number, date and time as set in the system clock, and the user logo screen will be displayed. (Figure 2-4 illustrates this sequence of screens.)
3. If any test should fail, the DIAG LED will flash the error code, or the error code will be displayed on units equipped with the HMI and the relay will not allow operation to proceed. In such a case, the error code should be noted and the factory contacted. A list of error codes and their descriptions are provided in **Appendix C**, **Error Codes**. Assuming that various voltage functions are enabled, and there are no voltage inputs connected, various voltage targets will be identified as having operated
4. If remote communication is used, the baud rate, address, and other parameters for the communication ports must be set. See the instructions in **Section 5.7**, **Activating Initial Local Communications**. Also refer to **Chapter 3**, **IPScom**, on S-3300 IPScom Communications Software.

■ **NOTE:** **UNIT SETUP** settings are not considered part of the setpoint profiles. Unit Setup settings are common to all profiles.

5. To setup the unit with general information required, including altering access codes, setting date and time, installing user logos, and other adjustments, refer to **Section 4.1**, **Unit Setup**.

■ **NOTE:** The relay has been fully calibrated at the factory using very precise and accurate test equipment. There is no need for recalibration before initial installation. Further calibration is only necessary if a component was changed and will be only as accurate as the test equipment used.

6. If desired, calibrate the unit following the calibration procedure described in subsection 6.3, Auto Calibration.

■ **NOTE:** System Setup settings are not considered part of the setpoint profiles. System Setup settings are common to all profiles.

7. Setup the relay system parameters for the relay application. **Section 4.2**, **Setup System** includes the general system and equipment information required for the operation of the relay. This includes such items as CT and VT ratios, VT configurations, transformer connections and Nominal values.

■ **NOTE:** Disabling unused functions improves the response time of the indicators and controls.

8. Enable the desired protective functions for the relay application.

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

   - Enable/disable function
   - Output choices (OUT1–8)
   - Input blocking choices (IN1–6)

   The relay is shipped with a certain group of standard functions, including other optional functions, as purchased. Both of these groups define a configurable set of functions. Only members of this set may be enabled/disabled by the end user. (Optional functions not purchased cannot be enabled.)

   Functions designated as **DISABLED** are inactive and will not be available for tripping. All menus associated with inactive functions will be unavailable.

9. Enter the desired setpoints for the enabled functions. See **Section 4.4**, **System Setpoints**.

   The general information that is required to complete the input data in this section includes individual relay function:

   - Pickup settings (converted to relay quantities)
   - Time delay settings
   - Time dials

   Input descriptions are detailed in **Section 4.4**, **System Setpoints**. Complete the System Setpoints and Settings Record Form in **Appendix A** before entering the setpoint and time setting data into the relay.

10. Install the M-3311A and connect external input and output contacts according to the rear panel terminal block markings as shown in Figure 5-8 through Figure 5-28, External Connections as applicable.

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6 Testing

6.1 Equipment and Test Setup

No calibration is necessary, as the M-3311A Transformer Protection Relay is calibrated and fully tested at the factory. If calibration is necessary because of a component replacement, follow the Auto Calibration procedure detailed in Section 6.3.

Required Equipment

The following equipment is required to perform the test procedures outlined in this chapter:

- Two Digital Multimeters (DMM) with a 10 Amp current range. These are not required if using a Pulsar Universal Test System.
- Appropriate power supply for system power.
- Three-phase source capable of 0 to 250 Vac. (Pulsar Universal Test System or equivalent.)
- Three-phase current source capable of 0 to 25 Amps. (Pulsar Universal Test System or equivalent.)
- Electronic timer with a minimum accuracy of 8 msec. (Pulsar Universal Test System or equivalent.)

Equipment Setup

▲CAUTION: The proper voltage range for the relay is clearly marked on the power supply label affixed to the rear cover.

1. Connect system power to the Relay Power Supply:
   a. PS1 Terminals 62 (hot) and 63 (neutral)
   b. PS2 Terminals 60 (hot) and 61 (neutral)

2. Connect the voltage and current sources as indicated in the configuration listed in the individual function test procedure.

6.2 Diagnostic Test Procedures

The diagnostic procedures perform basic functional tests to verify the operation of the front panel indicators, inputs, and outputs, and the communication ports. These tests are performed in relay test mode, which is entered in the following manner:

▲CAUTION: The Diagnostic Mode is intended for bench testing the relay only. Do not use the diagnostic mode in relays that are installed in an active protection scheme.

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

```
ENTER ACCESS CODE
          0
```

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

4. 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.

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

```
SETUP UNIT
←  SETUP →
```

Press **ENTER,** the following is displayed:

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

Press the right arrow pushbutton until the following is displayed:

```
DIAGNOSTIC MODE
← alrm time error DIAG
```

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.

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

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

When testing in **DIAGNOSTIC MODE** is complete, press **EXIT** until the following message is displayed:

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

Press **EXIT** again to exit **DIAGNOSTIC MODE**. The relay will reset and then return to normal running mode.

OUTPUT TEST (RELAY)

The first step in testing the operation of the function outputs is to confirm the positions of the outputs in the unoperated or **OFF** position. This is accomplished by connecting a Digital Multimeter (DMM) across the appropriate contacts and confirming open or closed contact status. The de-energized or **OFF** position for each output is listed in Table 6-1, Output Contacts.

```
OUTPUT TEST (RELAY)
OUTPUT input led target
```

Relay/Output Number	Normally Open Contact*		Normally Closed Contacts*	
1	33	34	N/A	N/A
2	31	32	N/A	N/A
3	29	30	N/A	N/A
4	27	28	N/A	N/A
5	25	26	N/A	N/A
6	23	24	N/A	N/A
7	21	20	21	22
8	18	17	18	19
9 (Self-Test)	15	14	15	16
10 (Power Supply)	13	12	N/A	N/A
* "Normal" position of the contact corresponds to the OFF or de-energized state of the relay.				

Table 6-1 Output Contacts

Following completion of testing, the output contacts, can be turned **ON** in the following manner:

1. Press **ENTER**. The following is displayed:

```
RELAY NUMBER
            1
```

2. Press **ENTER**. The following is displayed:

```
RELAY NUMBER 1
        OFF on
```

   Use the right arrow button to change "on" to uppercase letters, which signifies selection. The following is displayed:

```
RELAY NUMBER 1
        off ON
```

   Press **ENTER**. **Output Relay #1** will energize. The following is displayed:

```
RELAY NUMBER
            1
```

   Choose output numbers 2-9 (self-test) (2-17 for extended version) by using the up and down arrow buttons to turn all relays or outputs to the energized or **ON** position. When each output is turned on, the appropriate red **OUTPUT** LED illuminates.

3. Use the DMM to verify the position of the output contacts in the energized or **ON** position. The readings should be the opposite of the initial reading above. All outputs should be returned to their initial de-energized or **OFF** positions. The **OUTPUT** LEDs will extinguish when each output is turned off.
4. If Output Relay testing is complete, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

INPUT TEST (STATUS)

The **INPUT TEST** menu enables the user to determine the status of the individual status inputs.

Each input can be selected by number using the up and down arrow buttons. The status of the input will then be displayed.

Input Number	Return Terminal	Input Number
1 (52b)	11	10
2	11	9
3	11	8
4	11	7
5	11	6
6	11	5

Table 6-2 Input Contacts

1. When **OUTPUT TEST (RELAY)** is displayed press the right arrow to display the following:

   ```
   INPUT TEST (STATUS)
   output INPUT led target →
   ```

   Press **ENTER**. The following is displayed:

   ```
   INPUT NUMBER
               1
   ```

   Press **ENTER**. The following is displayed:

   ```
   INPUT NUMBER 1
   CIRCUIT OPEN
   ```

   Connect **IN RTN** (terminal #11) to **IN1**, (terminal #10). See Table 6-2, Input Contacts.

2. Alternatively, if this specific input is being used in the application, and the external wiring is complete, the actual external status input contact can be manually closed. This will test the input contact operation *and* the external wiring to the input contacts. The following is immediately displayed:

   ```
   INPUT NUMBER 1
   CIRCUIT CLOSED
   ```

   Disconnect **IN RTN** (terminal #11) from **IN1** (terminal #10). The following is immediately displayed:

   ```
   INPUT NUMBER 1
   CIRCUIT OPEN
   ```

   Press **ENTER**. The following is displayed:

   ```
   INPUT NUMBER
               1
   ```

   Use the up arrow button to advance to the next input. Repeat the procedure using the contacts as shown in Table 6-2, Input Contacts.

3. When testing is complete, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

STATUS LED TEST

The **STATUS LED TEST** menu enables the user to check the front panel LED's Individually.

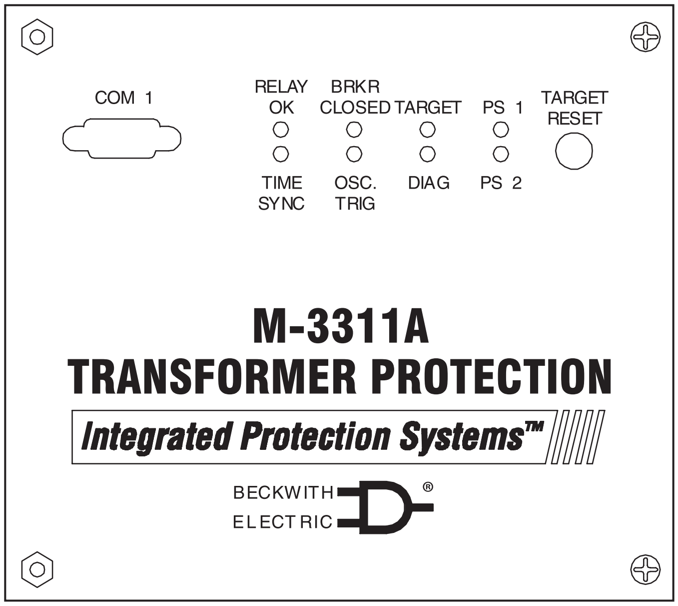


Figure 6-1 Status LED Panel

1. When **INPUT TESTS (STATUS)** is displayed, press the right arrow button until the following is displayed:

```
STATUS LED TEST
output input LED target →
```

Press **ENTER**. LED #1, **RELAY OK**, illuminates and the following is displayed:

```
STATUS LED TEST
LED NUMBER 1 = ON
```

Repeat Step 2 for each of the 5 remaining LED's shown in Figure 6-1. The PS1 and PS2 LED's are not subject to this test.

2. When **STATUS LED** testing is complete, press **EXIT** to return to **DIAGNOSTIC MODE**.

TARGET LED TEST

The **TARGET LED TEST** menu allows the user to check the Target Module LED's individually.

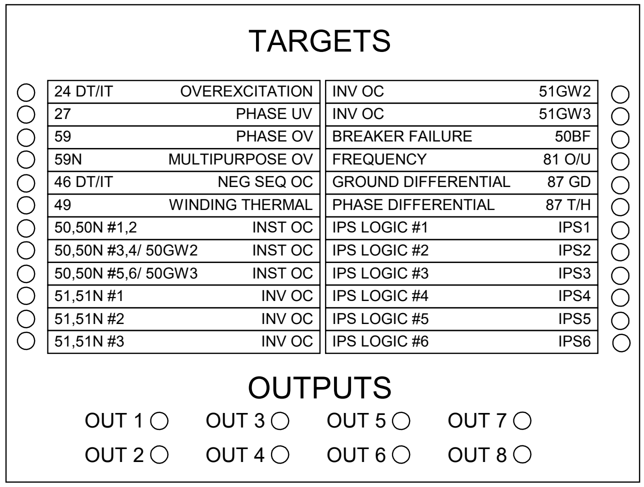


Figure 6-2 Typical Two-/Three-Winding Target Module

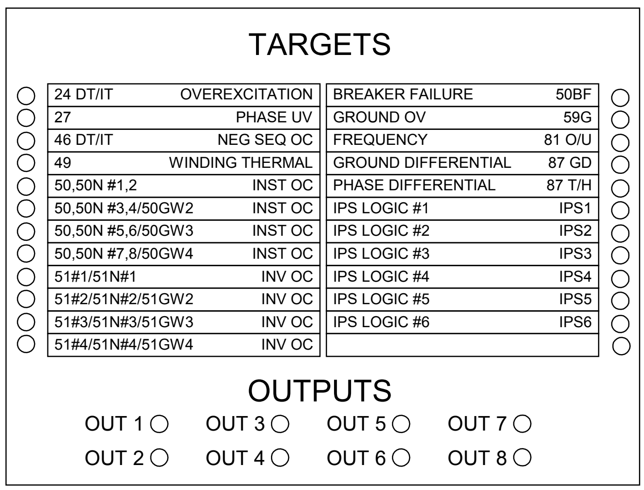


Figure 6-3 Typical Four-Winding Target Module

1. When **STATUS LED TEST** is displayed, press the right button until the following is displayed:

```
TARGET LED TEST
output input led target →
```

2. Press **ENTER**. Target LED #1, **24DT/IT OVEREXCITATION**, illuminates and the following is displayed:

```
TARGET LED TEST
LED NUMBER 1 = ON
```

   Repeat Step 2 for each of the remaining target and output LED's shown in Figure 6-2 and Figure 6-3.

3. When **TARGET LED** testing is complete, press **EXIT** to return to **DIAGNOSTIC MODE**.

   Pressing the **TARGET RESET** button on the front panel also provides a simultaneous test for all **TARGET** LEDs (not applicable in Diagnostic mode).

BUTTON TEST

The **BUTTON TEST** menu selection allows the user to check the HMI Module Keypad. As each button is pressed, its name is displayed.

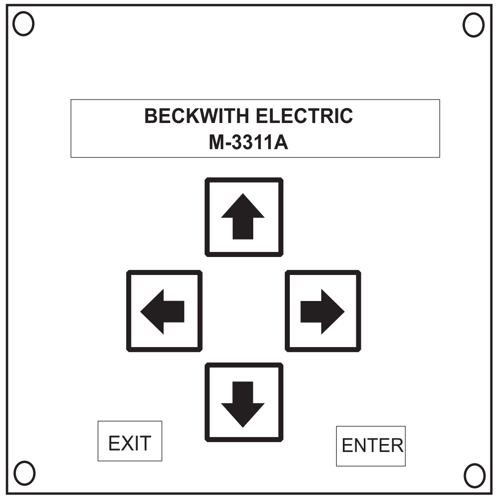


Figure 6-4 Human-Machine Interface Module

1. When the **TARGET LED TEST** is displayed, press the right button until the following is displayed:

```
BUTTON TEST
←BUTTON disp com1 com2→
```

Press and hold **ENTER**. The following is displayed:

```
Button test
ENTER
```

Release **ENTER**. The following is displayed:

```
BUTTON TEST
         0
```

Pressing the **EXIT** button will terminate this test, so it should be tested last. If it is pressed before the test sequence is complete, the test may be restarted by pressing **ENTER**. Notice the word **EXIT** is displayed temporarily before the test sequence is terminated.

2. Repeat this test for each of the buttons on the keypad and the **TARGET RESET** button. As each button is pressed, the display will briefly show the name for each key ("Right Arrow", "Up Arrow", etc).

DISPLAY TEST

The **DISPLAY TEST** menu selection enables the user to check the alphanumeric display. This test cycles through varying test patterns until the **EXIT** button is pressed.

1. When **BUTTON TEST** is displayed, press the right arrow button until the following is displayed:

```
SCREEN TEST
←button DISP com1 com2→
```

Press **ENTER**. The unit will display a sequence of test characters until the **EXIT** button is pressed.

2. After the test has cycled completely through the characters, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

COMMUNICATION TESTS

COM1 and COM2 Test

The **COM1** and **COM2 LOOPBACK TESTS** allow the user to test the front and rear RS-232 ports for proper operation. These tests require the use of a loop-back plug (Figure 6-5).

The loopback plug consists of a DB9P connector (male) with pin 2 (RX) connected to pin 3 (TX) and pin 7 (RTS) connected to pin 8 (CTS). No other connections are necessary.

M-3311A
COM1/COM2
DB9P

	1
RX	2
TX	3
	4
SGND	5
	6
RTS	7
CTS	8
	9

Figure 6-5 COM1/COM2 Loopback Plug

1. When **DISPLAY TEST** is displayed, press the right arrow button until the following is displayed:

```
COM1 LOOPBACK TEST
←button disp COM1 com2→
```

Press **ENTER**. The following is displayed:

```
COM1 LOOPBACK TEST
CONNECT LOOPBACK PLUG
```

Connect the loopback plug to **COM1**, the front-panel RS-232 Connector.

2. Press **ENTER**. After the test, the following is displayed:

```
COM1 LOOPBACK TEST
19200 PASS...
```

Press **ENTER** to test each of the baud rates. When all baud rates have been tested, press **ENTER**. The following is displayed:

```
COM1 LOOPBACK TEST
-DONE-
```

3. Press the right arrow until the following is displayed:

```
COM2 LOOPBACK TEST
←button disp COM1 COM2
```

Repeat Steps 2-5 to test **COM2**.

COM3 Test (2-Wire)

■**NOTE:** This test requires a PC with an RS-485 converter and terminal emulator software installed.

The **COM3 ECHO TEST 2 WIRE** allows the user to test the RS-485 rear terminal connections for proper operation.

1. When **COM2 LOOPBACK TEST** is displayed, press the right arrow button until the following is displayed:

```
COM3 ECHO TEST 2WIRE
←  COM3 clock led coil →
```

   Press **ENTER**. The following is displayed:

```
COM3 ECHO TEST 2WIRE
IDLING....9600, N, 8, 1
```

   On the rear of the unit, connect a PC to the relay at terminals 3 (-) and 4 (+) using an RS-485 converter set for 2 wire operation. See Figure 6-6 for diagram.

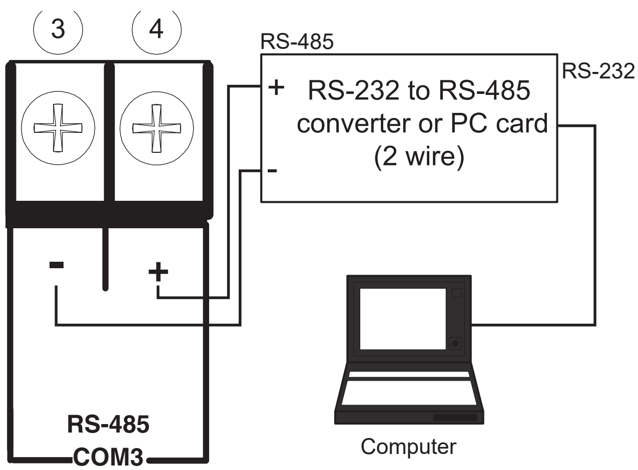


Figure 6-6 RS-485 2-Wire Testing

2. Set the following PC communications parameters:

Baud Rate	9600
Parity	None
Data Bits	8
Stop Bits	1
Duplex	Half

3. Open the terminal emulator program on the PC and open the COM port for the RS-485 converter.
4. Press a key on the PC keyboard. Verify that the character pressed shows temporarily on the display of the relay and appears on the PC monitor.
5. When communications has been verified, press **EXIT**. The following is displayed:

```
COM3 ECHO TEST 2WIRE
-DONE-
```

   Close the COM port on the PC and exit the terminal emulator program.

CLOCK TEST

1. When **COM3 ECHO TEST 2WIRE** is displayed, press the right arrow button until the following is displayed:

```
CLOCK TEST
← com3 CLOCK led cal →
```

Press **ENTER**. A display similar to the following is shown:

```
CLOCK TEST
03-JAN-1998 09:00:00.000
```

Press **ENTER** again to toggle the clock. If the clock is running, it will stop. If clock has stopped, it will start. The clock stop case is shown below.

```
CLOCK TEST
-CLOCK START-
```

Press **ENTER** and verify the relay clock is running. A display similar to the following is shown with the seconds counting:

```
CLOCK TEST
03-JAN-1998 09:0035.000
```

If the unit is removed from service or is to be without power for long periods of time, the clock should be stopped to preserve battery life.

2. Press **ENTER** again to stop the clock. The following is displayed:

```
CLOCK TEST
-CLOCK STOP-
```

A display similar to the following is shown with the seconds stopped:

■ **NOTE:** When the relay clock is stopped, the seconds will be displayed as 80.

```
CLOCK TEST
03-JAN-09:01:80.000
```

Repeat steps 2 and 3 to restart the clock.

FLASH RELAY OK LED

The **Flash Relay OK LED** function is provided to enable or disable the flashing of the **Relay OK LED**. This function only has effect while the relay is in normal operating mode and will not be noticed while in **Diagnostic Mode**.

The operation of this function may be tested by completing the following steps:

1. When **CLOCK TEST** is displayed, press the right arrow button until the following is displayed:

```
FLASH RELAY OK LED
← com3 clock LED cal →
```

   Press **ENTER**. The following is displayed:

```
FLASH RELAY OK LED
off       ON
```

   Programming the OK LED to remain illuminated indefinitely is not recommended. It is possible that the LED OK would remain illuminated even if the relay failed.

2. Use the right arrow key to select **ON**, and press ENTER. The unit will display

```
FLASH RELAY OK LED
—DONE—
```

   Press **EXIT** to return to the former menu.
3. Repeat step 2 and use the left arrow key to select **OFF**, and press **ENTER**.
4. Press **EXIT** to return to the former menu.

Factory Use Only

This function is provided to allow access by factory personnel.

■**NOTE:** Must scroll through:

```
AUTO CALIBRATION
← com3 clock led CAL →
```

to reach FACTORY USE ONLY menu.

```
FACTORY USE ONLY
FACTORY
```

6.3 Automatic Calibration

The M-3311A Transformer Protection Relay has been fully calibrated at the factory. There is no need to recalibrate the unit prior to installation. Further calibration is only necessary if a component was changed.

WARNING: All relay functions and protection will be inoperative while the relay is in Diagnostic Mode.

1. Navigate to the **Auto Calibration** function in the **Diagnostic Mode** menu. The following is displayed:

```
AUTO CALIBRATION
← com3 clock led CAL →
```

Press **ENTER**. The following is displayed:

```
CONNECT REFERENCE INPUTS
PRESS ENTER TO CALIBRATE
```

Connect voltage inputs in parallel to terminal 36,64 (neutral) and terminal 37,65 (hot) and apply 120.00 (±0.01) Vac ∠0°.

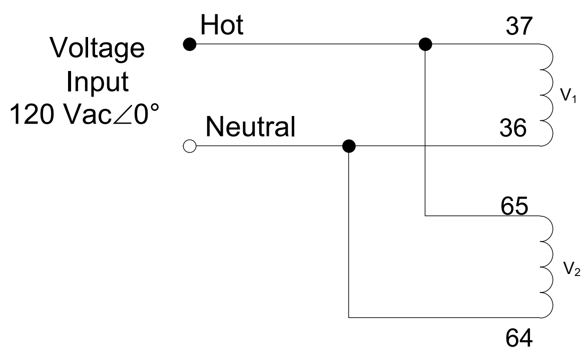


Figure 6-7 Voltage Calibration Configuration (Four-Winding)

2. Connect all current inputs in series ($I_AW_1 = I_BW_1 = I_CW_1 = I_AW_2 = I_BW_2 = I_CW_2 = I_GW_2 = I_AW_3 = I_BW_3 = I_CW_3 = I_GW_3 = I_AW_4 = I_BW_4 = I_CW_4 = I_GW_4$)
3. Apply 5.00 (±0.01) Amps ∠0°. For 1 Amp CT models, use 1.0 (±0.01) Amps ∠0°.

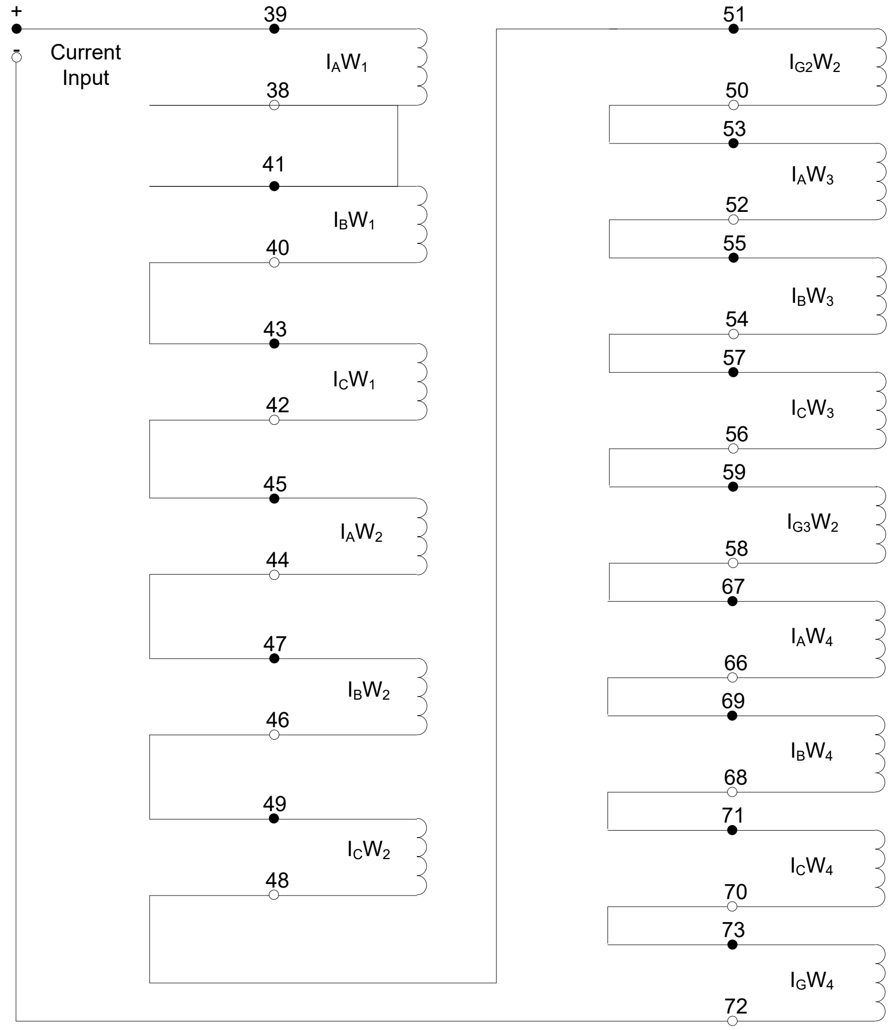


Figure 6-8 Current Calibration Configuration (Four-Winding)

4. Press **ENTER** to start calibration. While the unit is calibrating, the display will show:

```
AUTO CALIBRATION
-WAIT-
```

When the calibration is complete, unit will display:

```
AUTO CALIBRATION
-DONE-
```

The calibration can be verified by reading the Status (see the **Monitor Status** menu, and **Monitor Status/Metering** in **Chapter 3**).

6.4 Input Configurations

Phase angles shown here represent leading angles as positive and lagging angles as negative. Some test equipment manufacturers use lagging angles as positive, in which case $I_BW_1=\angle 20°$ and $I_CW_1=\angle 240°$. Other current phase angles should be adjusted in the same manner.

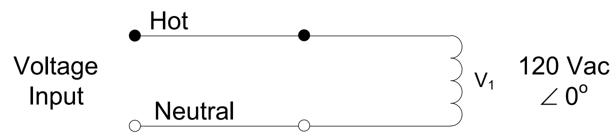


Figure 6-9 Voltage Input, Configuration V1 (Two-Winding)

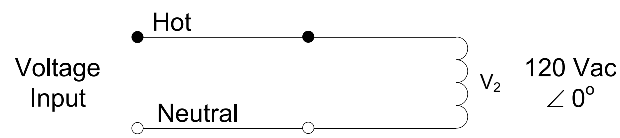


Figure 6-10 Voltage Input, Configuration V2 (Two Voltage Option)

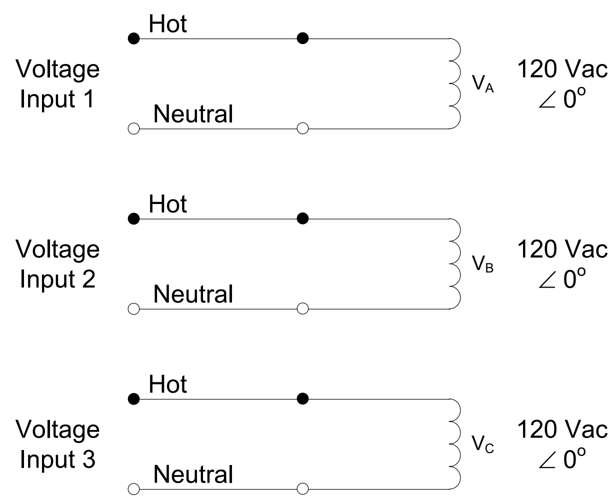


Figure 6-11 Voltage Input, Configuration V3 (Four Voltage Option)

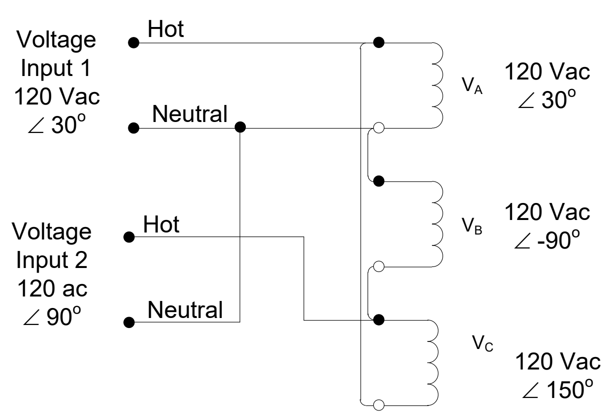


Figure 6-12 Voltage Input, Configuration V4 (Two Voltage Option V_G or Phase)

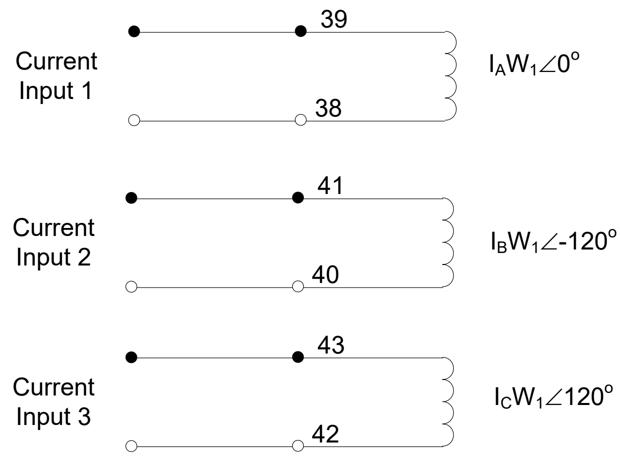


Figure 6-13 Current Inputs, Configuration C1 (Four-Winding)

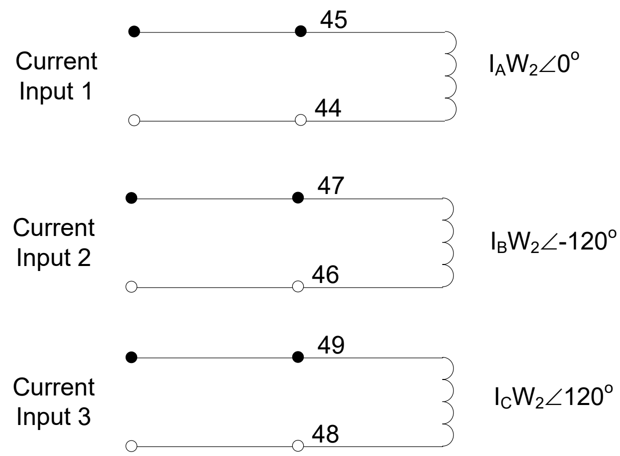


Figure 6-14 Current Inputs, Configuration C2 (Four-Winding)

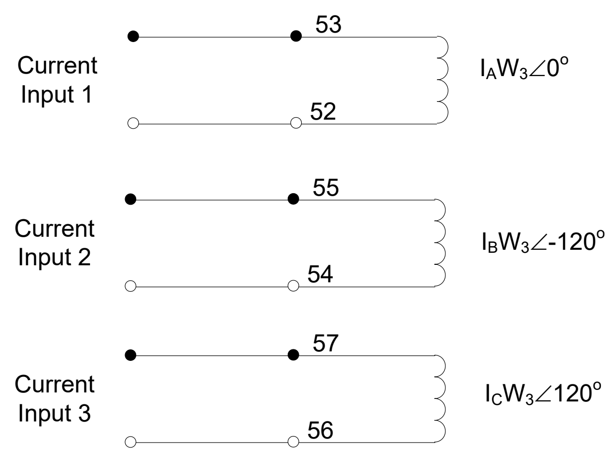


Figure 6-15 Current Inputs, Configuration C3 (Four-Winding)

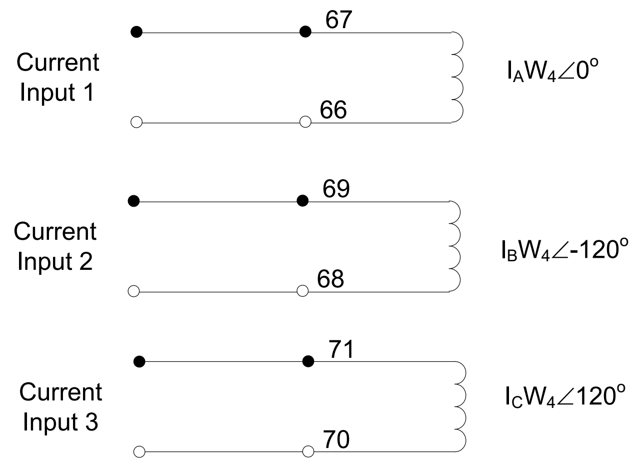


Figure 6-16 Current Inputs, Configuration C4 (Four-Winding)

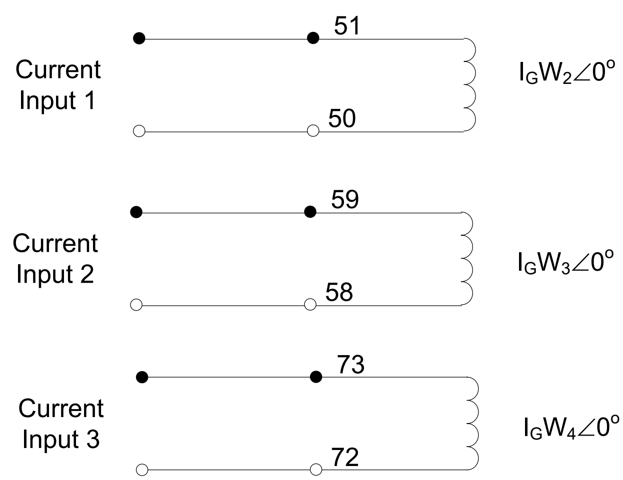


Figure 6-17 Current Inputs, Configuration C5 (Four-Winding)

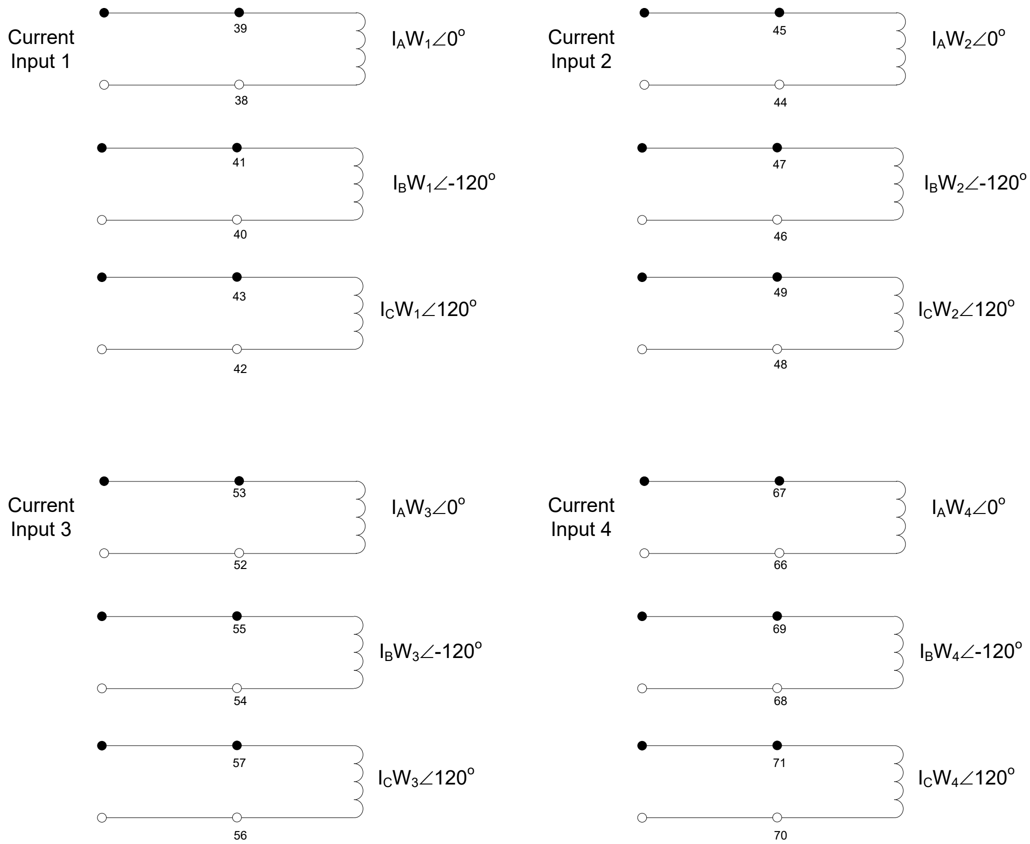


Figure 6-18 Current Configuration C6 (Four-Winding)

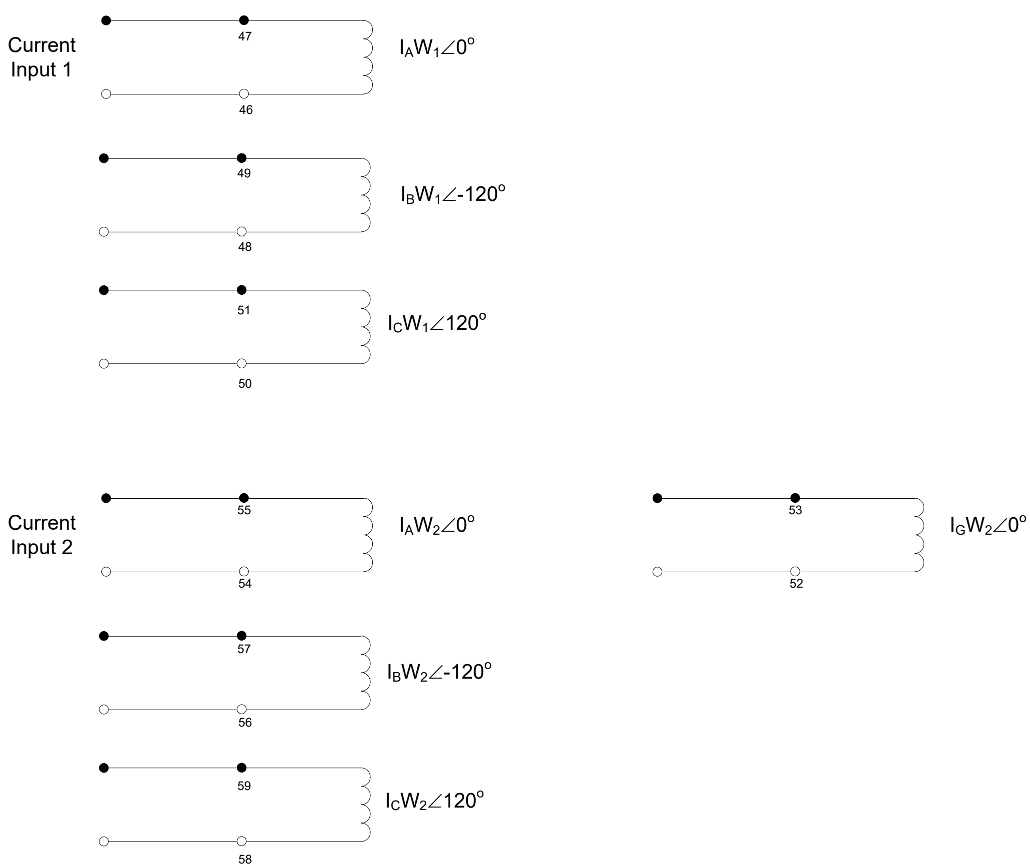


Figure 6-19 Current Inputs, Configuration C7 (Two-Winding)

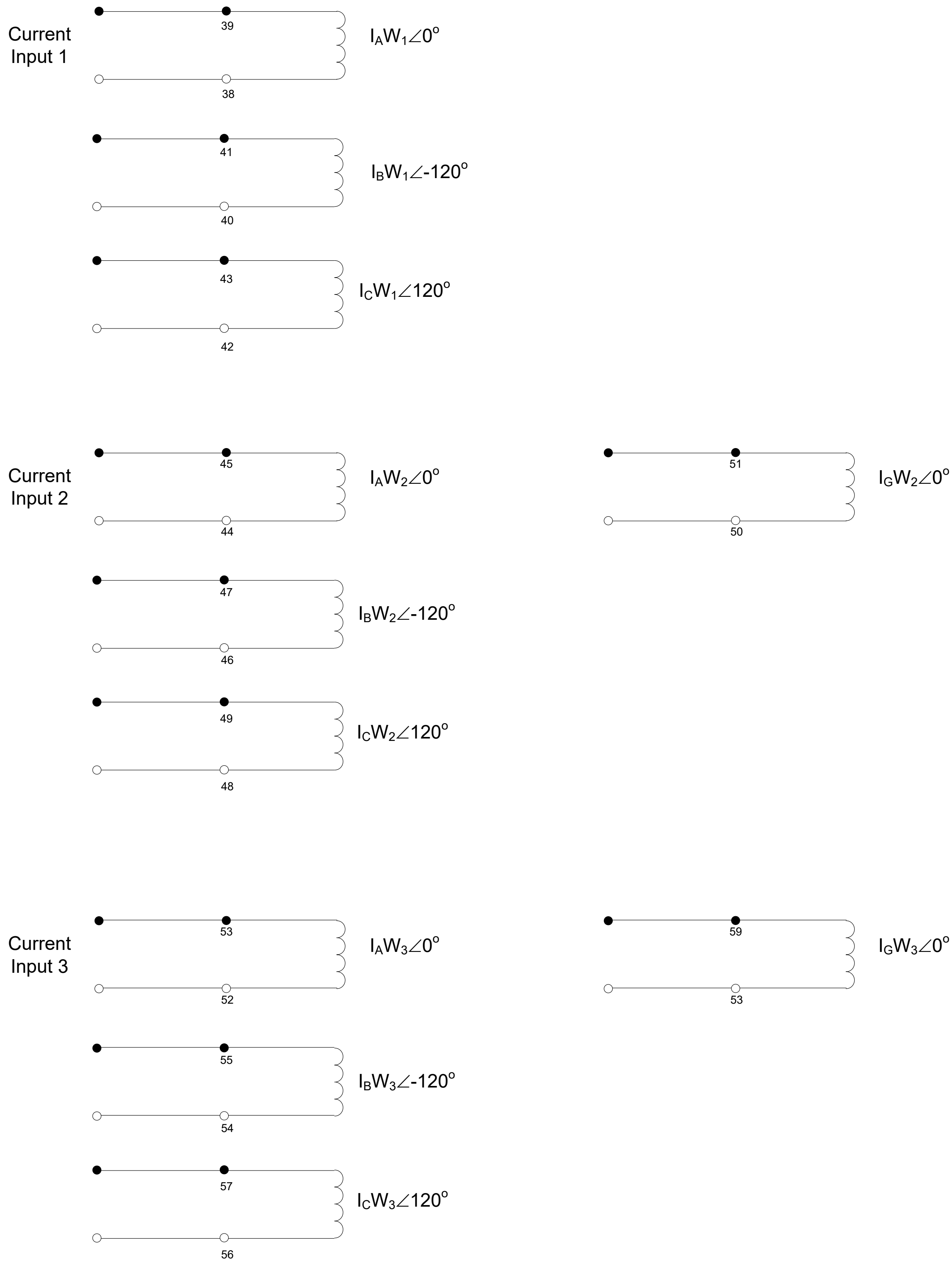


Figure 6-20 Current Inputs, Configuration C8 (Three-Winding)

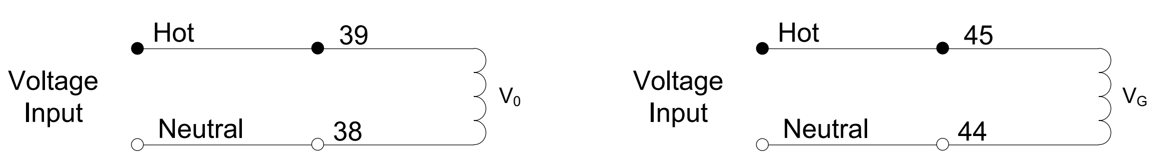


Figure 6-21 Two Voltage Inputs, Configuration V5 (Two-Winding)

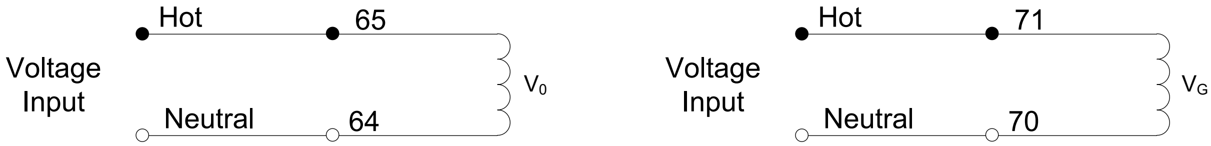


Figure 6-22 Two Voltage Inputs, Configuration V6 (Three-Winding)

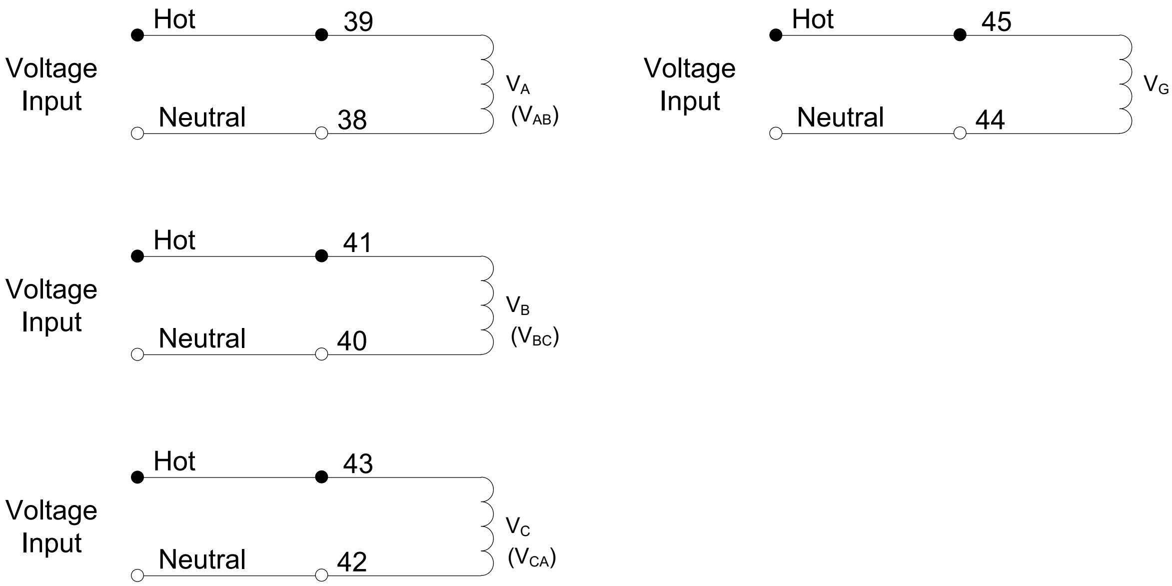


Figure 6-23 Four Voltage Inputs, Configuration V7 (Two-Winding)

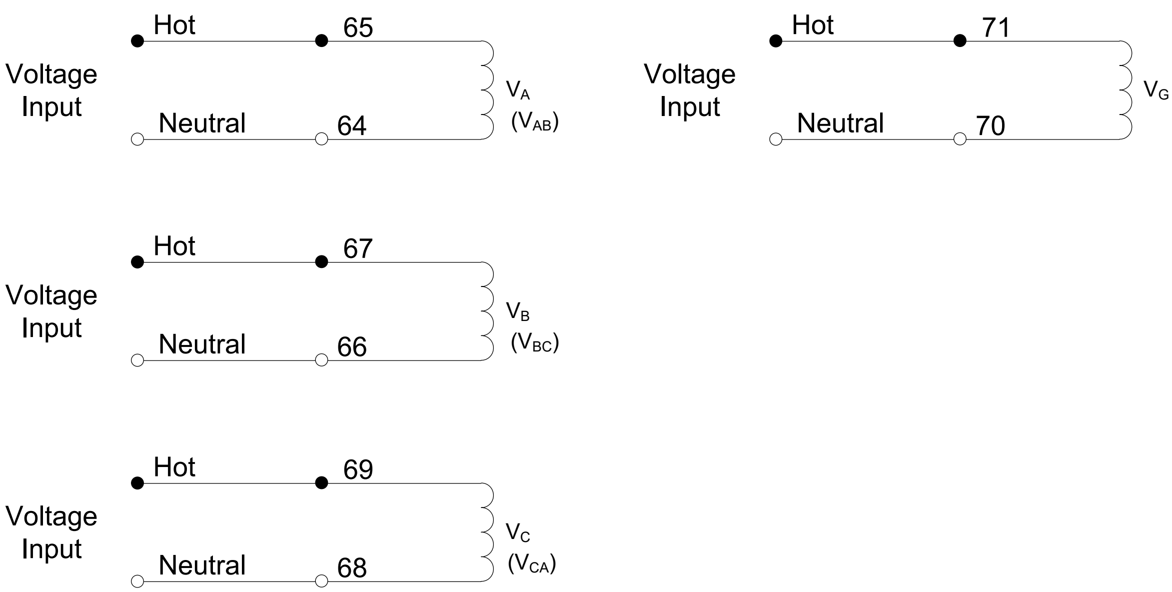


Figure 6-24 Four Voltage Inputs, Configuration V8 (Three-Winding)

6.5 Protection Elements

M-3311A TWO WINDING CONFIGURATION DATA			
PROTECTION FUNCTION	NUMBER OF ELEMENTS	WINDINGS	NOTES
Voltage Based			
24DT	#1, #2	N/A	
24IT	#1	N/A	
27	#1, #2, #3	N/A	
59	#1, #2, #3	N/A	Only for Four Voltage Inputs selectable as: V_{PH}, V_1, or V_2
59G	#1, #2, #3	N/A	
81	#1, #2, #3, #4	N/A	
Current Based			
46DT	#1	W2	
46IT	#1	W2	
49	#1	Sum1, Sum2, W1, W2	
50	#1, #2, #3, #4, #5, #6	Sum1, Sum2, W1, W2	
50N	#1, #2, #3, #4, #5, #6	Sum1, Sum2, W1, W2	
50G	#1, #2	W2	
50BF		W1/W2	
51	#1, #2, #3	Sum1, Sum2, W1, W2	
51N	#1, #2, #3	Sum1, Sum2, W1, W2	
51G		W2	
87T			
87H			
87GD	#1, #2	W2	

Table 6-3 List of Protection Elements for Two-Winding Version (Four Voltages)

M-3311A THREE WINDING CONFIGURATION DATA				
PROTECTION FUNCTION	NUMBER OF ELEMENTS	WINDINGS	SELECTABLE	NOTES
Voltage Based				
24DT	#1, #2	N/A		
24IT	#1	N/A		
27	#1, #2, #3	N/A		
59	#1, #2, #3	N/A		Only for Four Voltage Inputs selectable as: V_{PH}, V_1, or V_2
59G	#1, #2, #3	N/A		
81	#1, #2, #3, #4	N/A		
Current Based				
46DT	#1	W2/W3		
46IT	#1	W2/W3		
49	#1		Sum1, Sum2, W1, W2, W3	
50	#1, #2, #3, #4, #5, #6		Sum1, Sum2, W1, W2, W3	
50N	#1, #2, #3, #4, #5, #6		Sum1, Sum2, W1, W2, W3	
50G	#1, #2	W2/W3		
50BF		W1/W2/W3		
51	#1, #2, #3		Sum1, Sum2, W1, W2, W3	
51N	#1, #2, #3		Sum1, Sum2, W1, W2, W3	
51G		W2/W3		
87T				
87H				
87GD	#1, #2	W2/W3		

Table 6-4 List of Protection Elements for Three-Winding Version (Four Voltages)

6.6 Terminal Connections

INPUT	TERMINAL
IAW1 (+)	47
IAW1 (-)	46
IBW1 (+)	49
IBW1 (-)	48
ICW1 (+)	51
ICW1 (-)	50
IAW2 (+)	55
IAW2 (-)	54
IBW2 (+)	57
IBW2 (-)	56
ICW2 (+)	59
ICW2 (-)	58
IGW2 (+)	53
IGW2 (-)	52

Table 6-5 Terminal Connections for Two-Winding Current Inputs

INPUT	TERMINAL
IAW1 (+)	39
IAW1 (-)	38
IBW1 (+)	41
IBW1 (-)	40
ICW1 (+)	43
ICW1 (-)	42
IAW2 (+)	45
IAW2 (-)	44
IBW2 (+)	47
IBW2 (-)	46
ICW2 (+)	49
ICW2 (-)	48
IGW2 (+)	51
IGW2 (-)	50
IAW3 (+)	53
IAW3 (-)	52
IBW3 (+)	55
IBW3 (-)	54
ICW3 (+)	57
ICW3 (-)	56
IGW3 (+)	59
IGW3 (-)	58

Table 6-6 Terminal Connections for Three-Winding Current Inputs

INPUT	TERMINAL
VØ (+)	39
VØ (-)	38
VG (+)	45
VG (-)	44

Table 6-7 Terminal Connections for Two Voltage Inputs (Two-Winding)

INPUT	TERMINAL
VØ (+)	65
VØ (-)	64
VG (+)	71
VG (-)	70

Table 6-8 Terminal Connections for Two Voltage Inputs (Three-Winding)

INPUT	TERMINAL
VA (+)	39
VA (-)	38
VB (+)	41
VB (-)	40
VC (+)	43
VC (-)	42
VG (+)	45
VG (-)	44

Table 6-9 Terminal Connections for Four Voltage Inputs (Two-Winding)

INPUT	TERMINAL
VA (+)	65
VA (-)	64
VB (+)	67
VB (-)	66
VC (+)	69
VC (-)	68
VG (+)	71
VG (-)	70

Table 6-10 Terminal Connections for Four Voltage Inputs (Three-Winding)

6.7 Accuracy For Voltage Protection Functions

Voltage Function	Two-/Three-Winding Version Two Voltage Inputs ($V_{\text{Ø}}$, V_G)	Two-/Three-Winding Version Four Voltage Inputs (V_A, V_B, V_C, V_G)	Four-Winding Version Two Voltage Inputs ($V_{\text{Ø}}$, V_G)
24DT	Voltage source = $V_{\text{Ø}}$ • Pickup = ±1% • Time Delay = +25 cycles	Voltage source = V_1	Voltage source = $V_{\text{Ø}}$ • Pickup = ±1% • Time Delay = +25 cycles
24IT	Voltage source = $V_{\text{Ø}}$ • Pickup = ±1% • Reset Rate = ±0.06 s or ±1%	Voltage source = V_1	Voltage source = $V_{\text{Ø}}$ • Pickup = ±1% • Reset Rate = ±0.06 s or ±1%
27	Voltage source = $V_{\text{Ø}}$ • Pickup = ±0.5 Volts • Inhibit = ±0.5 Volts • Time Delay = -1 to +3 cycles, or ±1%	Voltage source = V_{Ph}	Voltage source = $V_{\text{Ø}}$ • Pickup = ±0.5 Volts • Inhibit = ±0.5 Volts • Time Delay = -1 to +3 cycles, or ±1%
59	Voltage source = $V_{\text{Ø}}$	Voltage source = V_{Ph}, V_1, or V_2	
59G			Voltage source = V_G • Pickup = ±0.5 Volts or ±0.05% • Time Delay = ±1 cycle or ±1%
59X	Voltage source = V_G	Voltage source = V_G	
81	Voltage source = $V_{\text{Ø}}$ • Pickup = ±0.1 Hz • Time Delay = -1 to +3 cycles, or ±1%	Voltage source = V_1	Voltage source = $V_{\text{Ø}}$ • Pickup = ±0.1 Hz • Time Delay = -1 to +3 cycles, or ±1%

Table 6-11 Accuracy for Voltage Protection Functions

6.8 Functional Test Procedures

The functional tests procedures presented here are for the four-winding version of the relay. Use the tables and figures provided in **Section 6** to test the two- and three-winding versions. Table 6-3 and Table 6-4 provide a list of the protection elements for the two- and three-winding versions. Table 6-5 and Table 6-6 provide the terminal connections for the two- and three-winding versions current inputs. Table 6-7 through Table 6-10 provide the terminal connections for the two- and three-winding versions voltage inputs. Table 6-11 provides the accuracy to test voltage protection for relays with two or four voltage inputs. **Section 6.4** provides all of the various voltage and current configurations for two-, three- and four-winding relays as well as two- or four-voltage inputs.

This section details the test quantities, inputs and procedures for testing each function of the relay. The purpose is to confirm the function's designated output operation, the accuracy of the magnitude pickup settings, and the accuracy of time delay settings. Whereas the first test described, "Power On Self Test," does not require electrical quantity inputs, all other functional tests require inputs, and the necessary connection configurations are shown. IEEE Time Current equations are illustrated in the individual function tests where applicable.

In all test descriptions, a process for calculating input quantities to test the actual settings of the function will be given if needed.

> ▲**CAUTION:** Care must be taken to reset or re-enable any functions that have been changed from the intended application settings when the test procedures are complete. When a function is re-enabled, both output arrangements and blocking input designations must be reestablished.

In many test cases, it will be necessary to disable other functions not being tested at the time. This action is to prevent the operation of multiple functions with one set of input quantities which could cause confusion of operation of outputs or timers.

The complete description of the method to disable/enable functions and the method to enter setting quantities is found in detail in **Section 4.4**, **System Setpoints**.

It is desirable to ***record and confirm*** the actual settings of the individual functions before beginning test procedures. Use the **SETPOINTS AND SETTINGS RECORD FORM** found in **Appendix A** to record settings.

The tests are described in this section in ascending function number order as in **Chapter 4**, **System Setup and Setpoints**.

During the lifetime of the relay, testing of individual functions due to changes in application settings will be more likely than an overall testing routine. An index of the individual test procedures is illustrated at the beginning of this chapter.

It may be desirable to program all test settings in an alternate profile, or to save the relay settings in IPScom to preserve a desired setup.

Many options for test sequences and methods are possible. As an example, the operation of the output contacts can be tested along with the operation of the LED's in the Diagnostic Test Procedures. The operation of the output contacts may also be confirmed with the LED and function operation during **Functional Test Procedures**, **Section 6.8**, if desired.

If timer quantities are to be checked, the timer must be activated by the appropriate output contacts. The contact pin numbers are enumerated in Table 6-1, Output Contacts.

It is suggested that copies of the following be made for easy referral during test procedures:

- Input Configurations – **Section 6.4**
- Output Test (Relay) – page 6–3
- Relay Configuration Table – page A–2 and page A–3
- Setpoint & Timing Record Form – page A–4 to page A–49

Summing

The 49, 50, 50N, 51 and 51N protection functions can be set so that they operate on the summed current of selected windings. The 87GD can also be set so the function uses summed current for the source of $3I_0$. If summing is used for any of these functions either inject current individually into each winding and repeat the pickup tests for each of the selected windings or inject current into the selected windings such that the sum total is above the pickup.

Power On Self Tests

VOLTAGE INPUTS: None

CURRENT INPUTS: None

1. Apply proper power to the power input terminals: 60 (hot) and 61 (neutral)
2. The unit will display:

```
POWER ON SELFTESTS
XXXXXXXXxxxxxxxxxxxxxxxX
```

   All LEDs will illuminate simultaneously for approximately 1 second. The **POWER** and **RELAY OK** LEDs will remain illuminated; the rest of the LEDs will extinguish.

3. The unit will display:

```
POWER ON SELFTESTS
PASS
```

   The model number:

```
BECKWITH ELECTRIC
M-3311A
```

   where "xx.xx.xx" signifies the software revision;

```
BECKWITH ELECTRIC
D-0179Vxx.xx.xx
```

   where "xxx" signifies the unit serial number:

```
BECKWITH ELECTRIC
SERIAL NUMBER XXX
```

   The **POWER** LED will illuminate. The **RELAY OK** LED will flash (or remain illuminated as programmed in the **Setup** menu) and the **BREAKER CLOSED** LED will remain illuminated. The Power On Self-Test ends with the system date and time and the default logo. Any recorded targets are then displayed.

24DT Volts/Hz Overexcitation Definite Time (#1 or #2)

Relays with four voltage inputs use two positive-sequence voltages for 24DT#1 and #2. See Table 6-11 for the accuracy when testing relays with four voltage inputs.

VOLTAGE INPUTS:	Configuration V1			
CURRENT INPUTS:	None			
TEST SETTINGS:	Definite Time Pickup	P	%	(100 to 200)
	Time Delay	D	Cycles	(30 to 8160)
	Programmed Outputs	Z Expanded I/O	OUT	(1 to 8) (9 to 16)
	Function 24DT #1 or 2	Disable		
	Function 24IT, 27	Disable		
	Function 81O/U	Disable		
	Function 59G	Disable		

1. Disable functions as shown. See **Section 4.4**, **System Setpoints**, for procedures.
2. Confirm settings to be tested. Only the function being tested should be enabled; the other should be disabled.
3. Connect voltage input in Configuration V1 designated previously. Set the VT Configuration (**Section 4.2**) as V_A. See **Section 6.4**, **Input Configurations**, for configurations.
4. The Volts/Hz pickup level at a percentage setting of nominal frequency (50 or 60Hz) is Definite Time Pickup = (**P** % ÷ 100) X (**Nominal Voltage**), see example below. The Nominal Values have been programmed in the Setup System data described in **Section 4.2**, **Setup System**, and are recorded on the **SYSTEM COMMUNICATION SETUP & SETUP SYSTEM RECORD FORM**. Test voltage levels may be at any percentage of Nominal Voltage. Choose 4 or 5 test levels and calculate for each.

150% V/Hz	÷ 100	x 120	=180 volts
Pickup (**P**) setting	divided by 100	times **Nominal Voltage**	equals voltage level

5. ***Voltage Pickup Test***:
   a. Apply voltage to input contacts at a level 10% lower than the pickup level calculated in Step 4.
   b. Press and hold the **TARGET RESET** button in, then slowly increase the voltage until the **24DT/IT OVEREXCITATION** LED illuminates or the pickup indicator operates on the computer target screen. The voltage level of operation will be **P** ±1%.
   c. Release the **TARGET RESET** button, then decrease the voltage. The **OUTPUT** LED will extinguish.
   d. Press the **TARGET RESET** button to remove targets.

6. ***Frequency Pickup Test***:
   a. Apply voltage to input contacts at the Nominal Voltage level.
   b. Press and hold the **TARGET RESET** button in, then slowly decrease the frequency until the **24DT/IT OVEREXCITATION** LED illuminates or the pickup indicator operates on the computer target screen. The voltage level of operation will be **P** ±1%.
   c. Release the **TARGET RESET** button, then increase frequency to 1% above the pickup frequency. The **OUTPUT** LED will extinguish.
   d. Press the **TARGET RESET** button to remove targets.

60	÷150% V/Hz	X 100	=40Hz
Nominal Frequency	Pickup (**P**) setting	times 100	equals frequency level

7. Timer Test: With output contacts connected to the timer, apply the calculated voltage from Step 4 and start timing. The contacts will close after **D** cycles within ±25 cycles.
8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

24IT Volts/Hz Overexcitation Inverse Time

Relays with four voltage inputs use the positive-sequence voltages for 24IT. See Table 6-11 for the accuracy when testing relays with four voltage inputs.

VOLTAGE INPUTS:	Configuration V1			
CURRENT INPUTS:	None			
TEST SETTINGS:	Inverse Time Pickup	P	%	(100 to 150)
	Inverse Time Curve	C		(1 to 4)
	Time Dial Curve #1 Curves #2 to #4	K		(1 to 100) (0.0 to 9.0)
	Reset Rate	R	Sec.	(1 to 999)
	Programmed Outputs	Z Expanded I/O	OUT	(1 to 8) (9 to 16)
	Functions 24DT, 27	Disable		
	Function 81O/U	Disable		
	Function 59G	Disable		

1. Disable functions as shown. See **Section 4.4**, **System Setpoints**, for procedures.
2. Confirm settings to be tested.
3. Connect voltage input in Configuration V1 designated previously. Set the VT Configuration (**Section 4.2**) as V_A. See **Section 6.4**, **Input Configurations**, for configurations.
4. The Volts/Hz pickup level at a percentage setting of nominal frequency (50 or 60 Hz) is Definite Time Pickup = (**P** % ÷ 100) X (**Nominal Voltage**), see example below. The Nominal Values have been programmed in the Setup System data described in **Section 4.2**, **Setup System,** and are recorded on the **SYSTEM COMMUNICATION SETUP & SETUP SYSTEM RECORD FORM**. Test voltage levels may be at any percentage of Nominal Voltage. Choose 4 or 5 test levels and calculate for each.

150% V/Hz	÷ 100	x 120	=180 volts
Pickup (**P**) setting	divided by 100	times **Nominal Voltage**	equals voltage level

5. Test voltage levels may be at any percentage of Nominal Voltage that are a minimum of 5% higher than the selected pickup percentage, **P** %. It is suggested that 4 or 5 test levels be chosen and voltage level and operating time be calculated for each from the table below.
6. ***Timer Test***: With output contacts connected to the timer, apply the calculated voltage from Step 4 and start timing. The operating time will be read from the appropriate Inverse Curve Family and **K** (Time Dial) setting (refer to **Appendix D**, **Inverse Time Curves**). The measured time should be within the time corresponding to ±1% of pickup value. Repeat this step for all chosen test levels. The curve portion extending lower than **P**% V/Hz values is inactive and can be ignored.

$$t = \frac{.003*K}{\left[\left(\frac{V/Hz\%}{100}\right)-1\right]^2}$$

Curve 1

$$t = e^\wedge \frac{115+(2.5xK)-V/Hz\%}{4.8858}$$

Curve 2

$$t = e^\wedge \frac{113.5+(2.5xK)-V/Hz\%}{3.04}$$

Curve 3

$$t = e^\wedge \frac{108.75+(2.5xK)-V/Hz\%}{2.4429}$$

Curve 4

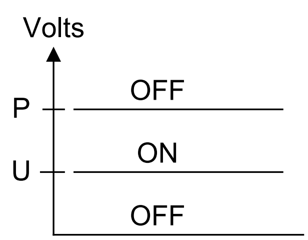
t = time in minutes K = Time Dial setting V/Hz in percent (%)

7. ***Reset Rate Test****:* To test the reset rate, begin timing immediately when the input voltage is reduced below pickup value. Holding the **TARGET RESET** button in, stop timing when **24DT/IT OVEREXCITATION** LED extinguishes. The time will be the Reset Rate (**R**) within ±1 second or ±1%.
8. If re-testing is required, the unit should be powered down or wait for the programmed Reset time period before the next test to ensure complete resetting of the timer.
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

27 Phase Undervoltage

VOLTAGE INPUTS:	Configuration V1			
CURRENT INPUTS:	None			
TEST SETTINGS:	Pickup	P	Volts	(5 to 140)
	Inhibit Setting	U	Volts	(5 to 140)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Functions 24DT, 24IT	Disable		
	Function 81O/U	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested.
3. Connect voltage input in Configuration V1 designated previously. Set the VT Configuration (Section 4.2) as V_A. See Section 6.4, **Input Configurations**, for configurations.
4. Set Phase Voltage Inputs at 1.2 x **P** volts at the Nominal Frequency.
5. ***Pickup Test***:
   a. Press and hold the **TARGET RESET** button in, then slowly decrease the input phase voltage until the **27 PHASE UV** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be **P** volts ±0.5 V.
   b. Release the **TARGET RESET** button, then increase the input to the Nominal Voltage. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets.
6. ***Undervoltage Inhibit Test***: Slowly decrease the input voltage until the **27 PHASE UV** LED extinguishes. The level will be **U** volts ±0.5 volts.
7. ***Time Test***: With output contacts connected to the timer and inhibit setting disabled, apply approximately 50% of **P** volts and start timing. The contacts will close after **D** cycles within -1 or +3 cycles or ±1%.
8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.



46DT Negative Sequence Overcurrent Definite Time

VOLTAGE INPUTS: Configuration V1

CURRENT INPUTS: Configuration C2, C3 or C4 (MODIFIED)

TEST SETTINGS:

Definite Time Pickup	P	Amps	(0.1 to 20)
1 Amp CT Rating			(0.02 to 4)
Time Delay	D	Cycles	(1 to 8160)
Programmed Outputs	Z	OUT	(1 to 8)
	Expanded I/O		(9 to 16)
Functions 46IT, 49	Disable		
Function 50BF	Disable		
Function 50N	Disable		
Functions 50W2, 50W3, 50W4	Disable		
Function 51	Disable		
Function 51N	Disable		
Function 87H/T	Disable		
Function 87GD	Disable		

■ **NOTE:** Although a voltage input is not required for the testing of the 46 Function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation. If other functions operate during these tests they should also be disabled for the test and enabled after the tests are complete.

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 and C2 (MODIFIED) as designated previously. See Section 6.4, **Input Configurations** for configurations. The modification to C2 is to exchange Current Input 2 and 3 (BØ current = Input 3 and CØ current = Input 2). Modification is for ABC phase rotation. Use ABC connection for ACB phase rotation. Set Voltages = Nominal Voltage. Configuration will be Phase B current from Source 3 and Phase C current from Source 2.

■ **NOTE:** For proper testing use $I \leq 3$ X CT rating.

4. ***Pickup Test****:*
   a. Press and hold the **TARGET RESET** button in, then slowly increase the 3-phase currents until the **46DT/IT NEG SEQ O/C** (46DT/IT NEG SEQ O/C) LED illuminates or the pickup indicator operates on the computer screen. The level of operation will be equal to Pickup Current **P** ±0.1 Amp (±*0.02 Amp 1 A CT*) or ±3%, whichever is higher.
   b. Release the **TARGET RESET** button, then decrease the currents to a level below the Pickup Current. The **OUTPUT** LED will extinguish.
   c. Press the **TARGET RESET** button to remove targets.
5. Time Test: With output contacts connected to the timer, apply current of at least 1.1 X Pickup (P) and start timing. The contacts will close after (D) cycles within -1 or +3 cycles or ±1%.
6. Reduce input currents to 0 Amps
7. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
8. Repeat steps 3, 4, 5, and 6 for Winding 3 and Winding 4.
9. If testing is complete, enable any functions disabled for this test.

46IT Negative Sequence Overcurrent Inverse Time

VOLTAGE INPUTS:	Configuration V1			
CURRENT INPUTS:	Configuration C2, C3 or C4 (MODIFIED)			
TEST SETTINGS:	Inverse Time Pickup	P	Amps	(0.50 to 5.00)
	1 Amp CT Rating			(0.10 to 1.00)
	Standard Inverse Time Curves:[1] Curve	C		(1 to 4)
	Time Dial	TD		(0.5 to 11.0)
	IEC Inverse Time Curves:[1] IEC Curve	C		(5 to 8)
	IEC Time Dial	TD		(0.05 to 1.10)
	IEEE Inverse Time Curves:[1] IEEE Curve	C		(9 to 11)
	IEEE Time Dial	TD		(0.5 to 15.0)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Function 46DT, 49	Disable		
	Function 50BF	Disable		
	Function 50W2/W3/W4	Disable		
	Function 50N	Disable		
	Function 51, 51N	Disable		
	Function 87H/87T	Disable		
	Function 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 and C2 (MODIFIED) as designated previously. See Section 6.4, **Input Configurations**, for configurations. The modification to C2 is to exchange Current Input 2 and 3 (BØ current = input 3 and CØ current = input 2). This modification is for ABC phase rotation. Use ABC connection for ACB phase rotation. Set Voltages = Nominal Voltage.

■**NOTE:** For proper testing use I≤ 3 X CT rating.

4. ***IEC Curve Testing***: Test current level may be chosen as a multiple of any level within the Pickup (**P**) range. Calculate the operating time for the applied current and appropriate Time Dial (**TD**) setting from the table below. Choose 4 or 5 test levels and calculate the operating times for each.

IEC Standard Inverse	IEC Very Inverse	IEC Extremely Inverse	IEC Long Time Inverse
$t = TD \times \left[\frac{0.14}{M^{0.02} - 1}\right]$	$t = TD \times \left[\frac{13.5}{M - 1}\right]$	$t = TD \times \left[\frac{80}{M^2 - 1}\right]$	$t = TD \times \left[\frac{120}{M - 1}\right]$

t = time in seconds TD = Time Dial setting M = current in multiples of pickup

[1]Either a Standard Curve, IEC Curve or IEEE Curve must be selected.

***Standard Curve Testing**:* The operating time will be read from **Appendix D**, Negative Sequence Inverse Time Curves for the applied current and appropriate Time Dial (TD) setting. The curve portions extending to lower than P current values are inactive and can be ignored.

IEEE Moderately Inverse

$$t = \frac{TD}{5} \times \left[\frac{0.0515}{M^{0.02} - 1} + 0.114\right]$$

IEEE Very Inverse

$$t = \frac{TD}{5} \times \left[\frac{19.61}{M^{2} - 1} + 0.491\right]$$

IEEE Extremely Inverse

$$t = \frac{TD}{5} \times \left[\frac{28.2}{M^{2} - 1} + 0.1217\right]$$

t = time in seconds TD = Time Dial setting M = current in multiples of pickup

5. ***Time Test**:* With output contacts connected to the timer, apply currents equal to the multiple of the Inverse Time Pickup (**P**) and start timing. The operating time will be as calculated in Step 4, ±3 cycles or ±5%. Observe **46DT/IT NEG SEQ O/C** (46 DT/IT NEG SEQ O/C) LED for pickup.
6. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
7. Repeat steps 3, 4 and 5 for Winding 3 and Winding 4.
8. If testing is complete, enable any functions disabled for this test.

49 Winding Thermal Protection

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	Configuration C1, C2, C3 or C4			
TEST SETTINGS:	Time Constant	τ	Minutes	(1.0 to 999.9)
	Max Overload Current	I_{max}	Amps	(1.00 to 10.00)
	1 Amp CT Rating			(0.20 to 2.00)
	Current Selection			(Sum1,Sum2,W1,W2,W3,W4)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Function 46DT, 49	Disable		
	Function 50BF	Disable		
	Function 50W2/W3/W4	Disable		
	Function 51	Disable		
	Function 87H/87T	Disable		
	Function 87GD	Disable		
	Function 87GD	Disable		

Test Setup:

1. Determine the Function 49 Thermal Overload settings to be tested. This test requires that the values for the following elements (described in detail in **Chapter 4**, **System Setup and Setpoints**) be determined:
   - τ = time to trip
   - τ = time constant
   - I_{load} = relay current
   - $I_{preload}$ = pre-load current
   - I_{max} = maximum allowed continuous overload current
2. Enter the Function 49 Thermal Overload settings to be tested utilizing either the HMI or IPScom Communications Software.
3. Connect test current inputs as shown in Figure 6-13, Current Inputs: Configuration C1.
4. Calculate **t** (time to trip in minutes) for the desired test settings as follows:

$$t = \tau \times Ln \frac{(I_{load}/I_{max})^2 - (I_{preload}/I_{max})^2}{(I_{load}/I_{max})^2 - 1}$$

Where:
- t = time to trip
- τ = time constant
- I_{load} = relay current
- $I_{preload}$ = pre-load current
- I_{max} = maximum allowed continuous overload current

Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the current until the **49 WINDING THERMAL** LED illuminates or the pickup indicator illuminates on the IPScom Function Status screen.

   The current level of operation will be (I_{max}) Amps ±0.1 A or ±2% (±0.02 Amp for 1 A CT).
2. Release the **TARGET RESET** pushbutton, then decrease the current. The **OUTPUT** LED will extinguish.
3. Press **TARGET RESET** button to remove targets.

Time Test (Cold Start):

1. Connect a timer to output contacts **(Z)** so that the timer stops timing when the contacts **(Z)** close.

   ■**NOTE:** The 49 Thermal Overload 49 current value can be obtained utilizing either the HMI (Status/Current Status) or IPScom Communications Software (Relay/Monitor/Secondary Status).

2. Determine the 49 Thermal Overload 49 current value. If the value is greater than 0.00 A, then remove power from the relay and then reapply power to reset the current value.
3. Apply a three phase current **(I)** to the relay greater than (I_{max}) Amps and start timing.

   The time to trip should be **t** minutes ±5 %.

Time Test (Preload):

1. Connect a timer to output contacts **(Z)** so that the timer stops timing when the contacts **(Z)** close.

   ■**NOTE:** The 49 Thermal Overload 49 current value can be obtained utilizing either the HMI (Status/Current Status) or IPScom Communications Software (Relay/Monitor/Secondary Status).

2. Determine the 49 Thermal Overload 49 current value. If the value is greater than 0.00 A, then remove power from the relay and then reapply power to reset the current values.
3. Apply a three phase preload current to the relay equal to ($I_{preload}$) Amps and allow current readings to stabilize.
4. Apply a three phase current **(I)** to the relay greater than (I_{max}) Amps and start timing.

   The time to trip should be **t** minutes ±5 %.

50 Instantaneous Phase Overcurrent 1–8

VOLTAGE INPUTS: None

CURRENT INPUTS: Configurations C1, C2, C3, C4

TEST SETTINGS:

50W1 Pickup	P	Amps	(1.0 to 100)
1 Amp CT Rating			(0.2 to 20)
Current Selection	(Sum1, Sum2, W1, W2, W3, W4)		
Time Delay	D	Cycles	(1 to 8160)
Programmed Outputs	Z	OUT	(1 to 8)
	Expanded I/O		(9 to 16)
Function 27	Disable		
Function 46DT	Disable		
Function 46IT	Disable		
Function 49	Disable		
Function 50W2/W3 or W4	Disable		
Function 50N	Disable		
Function 51	Disable		
Function 51N	Disable		
Function 59G	Disable		
Function 87H/T	Disable		
Function 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect inputs in Configuration C1 as designated previously. See Section 6.4, **Input Configurations**, for configurations.
4. Select W1 in Winding Config Setpoint.

■**NOTE:** Special attention must be taken as to which winding is being tested and which winding is disabled when changing setpoints.

5. ***Pickup Test***:
   a. Press and hold the **TARGET RESET** button in, then slowly increase current input 3 (C phase) until the selected winding target LED illuminates or the pickup indicator operates on the computer target screen. The current level of operation will be (**P**) Amps ±0.1 A (±*0.02 Amp 1 A CT*) or ±3%.
   b. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets. This test may be repeated for each of the other phases.
6. ***Time Test***: With output contacts (**Z**) connected to the timer, apply current 5% above pickup (**P**) Amps and start timing. The operating time will be (**D**) cycles within ±2 cycles or 1%.
7. Repeat Steps 4 and 5 for windings W2, W3 and W4 using configurations C2, C3, and C4.
8. ***Winding Summing Test:*** Later
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

50G Instantaneous Ground Overcurrent

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	Configuration C5			
TEST SETTINGS:	50GW2/W3/W4 Pickup	P	Amps	(1.0 to 100.0)
	1 Amp CT Rating			(0.2 to 20.0)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Function 51G	Disable		
	Function 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested.
3. Connect the inputs in Configuration C5 as designated previously. See Section 6.4, **Input Configurations**, for configurations. The other current phases remain disconnected.
4. ***Pickup Test****:*
   a. Press and hold the **TARGET RESET** button in, then slowly increase the I_GW_2 current until the **50,50N #3,4/50GW2 INST OC** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be **P** Amps ±0.1 A (±0.02 Amp 1 A CT) or ±3%.
   b. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets. This test may be repeated for each of the other phases.
5. ***Time Test****:* With output contacts (**Z**) connected to the timer, apply approximately 5% above pickup (**P**) amps and start timing. The operating time will be (**D**) cycles within ±2 cycles or 1%.
6. Repeat Steps 4 and 5, using I_GW_3 (I_GW_4). Observe the winding being tested LED for pickup.
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

50N Instantaneous Residual Overcurrent

VOLTAGE INPUTS: Configuration V1

CURRENT INPUTS: As Described

TEST SETTINGS:

Pickup	P	Amps	(1.0 to 100.0)
1 Amp CT Rating			(0.2 to 20.0)
Current Selection			(Sum1, Sum2, W1, W2, W3, W4)
Time Delay	D	Cycles	(1 to 8160)
Programmed Outputs	Z	OUT	(1 to 8)
	Expanded I/O		(9 to 16)
Functions 46DT, 46IT	Disable		
Function 49	Disable		
Function 50 1-8	Disable		
Function 50BF	Disable		
Function 51	Disable		
Function 51N	Disable		
Function 87H/T	Disable		
Function 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 and C1 (MODIFIED). Set to Nominal Voltage. See Section 6.4, **Input Configurations**, for configurations. Modification to C1 is to set all three currents to phase angle ∠0°, and inject equal magnitude.
4. Select W1 in Winding Config Setpoint.
5. ***Pickup Test***:
   a. Press and hold the **TARGET RESET** button in, then slowly increase the phase current in all three phases until the selected winding target LED illuminates or the pickup indicator operates on the computer target screen. The current level of operation will be (**P**) Amps ±0.1 A (±0.02 Amp 1A CT) or ±3%.
   b. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets.
6. ***Time Test***: With output contact (**Z**) connected to the timer, apply approximately 5% above pickup (**P**) amps, and start timing. The operating time will be (**D**) cycles within ±2 cycles or 1%.
7. Repeat steps 4 and 5 using current Configuration C2 (modified), C3 (modified) and C4 (modified). Observe the selected winding target LED for pickup.
8. **Winding Summing Test:** Later
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

50BF Breaker Failure

VOLTAGE INPUTS:	Configuration V1			
CURRENT INPUTS:	As Described			
TEST SETTINGS:	50BFW1/W2/W3/W4 Phase Pickup	P	Amps	(0.10 to 10.00)
	1 Amp CT Rating			(0.02 to 2.00)
	50BFW1/W2/W3/W4 Residual Pickup	N	Amps	(0.10 to 10.0)
	1 Amp CT Rating			(0.02 to 2)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Functions 46DT, 46IT	Disable		
	Function 49	Disable		
	Function 50 1-8	Disable		
	Function 50N	Disable		
	Function 51	Disable		
	Function 51N	Disable		
	Function 87H/T	Disable		
	Function 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect inputs in Configuration C1 designated previously to test breaker failure for Winding 1. See Section 6.4, **Input Configurations**, for configurations.

■**NOTE:** For proper testing use $I \leq 3$ X CT rating.

4. Select an input for 50BF Input Initiate (**IN**) and enter the number.
5. Place a jumper from Terminal **11** (RTN) to the selected input terminal (**IN**) on the rear of the unit.
6. Verify that all Output Initiates (**OUT**) are disabled.
7. ***Phase Pickup Test***:
   a. Press and hold the **TARGET RESET** button in, then slowly increase 3-phase current until the **BREAKER FAILURE 50BF** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be **P** Amps ±0.1 Amps (±*0.02 Amps 1 A CT*) or ±2%.
   b. Release the **TARGET RESET** button, then decrease the 3-phase current. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets.
8. ***Residual Pickup Test (Residual Current)***:
   a. Set the 50BF phase to a current higher than the residual pickup to prevent the 50BF phase from tripping.
   b. Connect the inputs in Configuration C1 (modified), designated previously. The modification to C1 is to set all three currents to phase angle ∠0° and inject equal magnitude. In this configuration, the applied value of I_0 is equal to the applied 3-phase currents.
   c. Press and hold the **TARGET RESET** button in, then slowly increase Winding 1 currents until the **BREAKER FAILURE 50BF** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be (**P**) Amps, ±0.1 Amps (±*0.02 Amps 1 A CT*) or ±2%
   d. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.

e. Press **TARGET RESET** button to remove targets.

■**NOTE:** When calculating values for residual current functions, the relay adds the three-phase currents ($3I_0 = I_A + I_B + I_C$). The relay operates on I_0.

9. ***Timer Test :*** With output contacts (**Z**) connected to the timer, apply approximately 110% of above Pickup (**P**) Amps and start timing. The operating time will be **D** cycles within -1 or +3 cycles or ±2%.

■**NOTE:** Both the 50BF Phase and Residual Functions use the same timer, therefore, it is only necessary to perform this test once.

10. Reduce input currents to 0 Amps.
11. Repeat Steps 4 through 10 using current Configuration C2 (modified), C3 (modified) and C4 (modified). Observe **BREAKER FAILURE 50BF** LED for pickup.
12. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

51 Inverse Time Phase Overcurrent

VOLTAGE INPUTS: None

CURRENT INPUTS: Configuration C1 or C2 or C3 or C4

TEST SETTINGS:

51W1/W2/W3/W4 Pickup	P	Amps	(0.50 to 12.00)
Current Selection			(Sum1, Sum2, W1, W2, W3, W4)
1 Amp CT Rating			(0.10 to 1.00)
Standard Inverse Time Curves:[1] Curve	C		(1 to 4)
Time Dial	TD		(0.5 to 11.0)
IEC Inverse Time Curves:[1] IEC Curve	C		(5 to 8)
IEC Time Dial	TD		(0.05 to 1.10)
IEEE Inverse Time Curves:[1] IEEE Curve	C		(9 to 11)
IEEE Time Dial			(0.5 to 15.0)
Programmed Outputs	Z	OUT	(1 to 8)
	Expanded I/O		(9 to 16)
Functions 46DT, 46IT	Disable		
Function 49	Disable		
Function 50	Disable		
Function 50BF	Disable		
Function 50N	Disable		
Function 51N	Disable		
Function 87H/T	Disable		
Function 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect current inputs in Configuration C1 as designated previously. See Section 6.4, **Input Configurations**, for configurations.
4. Select W1 in Winding Config Setpoint.

■ **NOTE:** Special Attention must be paid as to which winding is being tested and which windings are disabled.

5. Refer to **Appendix D**. Calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.
6. ***Time Test**:* With output contacts connected to the timer, apply currents used in calculations from step 4 and start timing. The operating time will be (**D**) cycles within ±3 cycles or 3% of calculated time. Repeat this step for each test level chosen. The tested points verify the operation of this function.
7. Observe selected winding target LED for pickup.

[1]Either a Standard Curve, IEC Curve or IEEE Curve must be selected.

IEC Standard Inverse

$$t = TD \times \left[\frac{0.14}{M^{0.02} - 1}\right]$$

IEC Very Inverse

$$t = TD \times \left[\frac{13.5}{M - 1}\right]$$

IEC Extremely Inverse

$$t = TD \times \left[\frac{80}{M^{2} - 1}\right]$$

IEC Long Time Inverse

$$t = TD \times \left[\frac{120}{M - 1}\right]$$

IEEE Moderately Inverse

$$t = \frac{TD}{5} \times \left[\frac{0.0515}{M^{0.02} - 1} + 0.114\right]$$

IEEE Very Inverse

$$t = \frac{TD}{5} \times \left[\frac{19.61}{M^{2} - 1} + 0.491\right]$$

IEEE Extremely Inverse

$$t = \frac{TD}{5} \times \left[\frac{28.2}{M^{2} - 1} + 0.1217\right]$$

t = time in seconds TD = Time Dial setting M = current in multiples of pickup

8. Repeat Steps 4 and 5 using Configurations C2, C3 and C4. Observe the selected winding target LED for pickup.
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

51G Inverse Time Ground Overcurrent

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	Configuration C5			
TEST SETTINGS:	51GW2/W3/W4 Pickup	P	Amps	(0.50 to 12.00)
	1 Amp CT Rating			(0.1 to 2.4)
	Standard Inverse Time Curves:[1]			
	Curve	C		(1 to 4)
	Time Dial	TD		(0.5 to 11.0)
	IEC Inverse Time Curves:[1]			
	IEC Curve	C		(5 to 8)
	IEC Time Dial	TD		(0.05 to 1.10)
	IEEE Inverse Time Curves:[1]			
	IEEE Curve	C		(9 to 11)
	IEEE Time Dial			(0.5 to 15.0)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Function 50G	Disable		
	Function 87GD	Disable		

1. Disable functions as shown. See **Section 4.4**, **System Setpoints**, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect current inputs in Configuration C5 as designated previously. See **Section 6.4**, **Input Configurations**, for configurations.
4. Refer to **Appendix D**. Calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.

IEC Standard Inverse

$$t = TD \times \left[\frac{0.14}{M^{0.02} - 1}\right]$$

IEC Very Inverse

$$t = TD \times \left[\frac{13.5}{M - 1}\right]$$

IEC Extremely Inverse

$$t = TD \times \left[\frac{80}{M^2 - 1}\right]$$

IEC Long Time Inverse

$$t = TD \times \left[\frac{120}{M - 1}\right]$$

IEEE Moderately Inverse

$$t = \frac{TD}{5} \times \left[\frac{0.0515}{M^{0.02} - 1} + 0.114\right]$$

IEEE Very Inverse

$$t = \frac{TD}{5} \times \left[\frac{19.61}{M^2 - 1} + 0.491\right]$$

IEEE Extremely Inverse

$$t = \frac{TD}{5} \times \left[\frac{28.2}{M^2 - 1} + 0.1217\right]$$

t = time in seconds TD = Time Dial setting M = current in multiples of pickup

5. ***Time Test:*** With output contacts connected to the timer, apply currents used in calculations from Step 4 and start timing while observing selected winding target LED for pickup. The operating time will be (**D**) cycles within ±3 cycles or ±3% of calculated time.
6. Repeat Step 5 for each test level chosen.
7. Repeat Steps 4, 5 & 6 using Currents I_{GW3}, I_{GW4} while observing the selected winding target LED for pickup.
8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

[1]Either a Standard Curve, IEC Curve or IEEE Curve must be selected.

51N Inverse Time Residual Overcurrent

VOLTAGE INPUTS: None

CURRENT INPUTS: As Described

TEST SETTINGS:

51N W1/W2/W3/W4 Pickup	P	Amps	(0.5 to 6)
1 Amp CT Rating			(0.1 to 1.2)
Current Selection			(Sum1, Sum2, W1, W2, W3, W4)
Standard Inverse Time Curves:[1]			
Curve	C		(1 to 4)
Time Dial	TD		(0.5 to 11.0)
IEC Inverse Time Curves:[1]			
IEC Curve	C		(5 to 8)
IEC Time Dial	TD		(0.05 to 1.1)
IEEE Inverse Time Curves:[1]			
IEEE Curve	C		(9 to 11)
IEEE Time Dial			(0.5 to 15.0)
Programmed Outputs	Z	OUT	(1 to 8)
	Expanded I/O		(9 to 16)
Functions 46DT, 46IT, 49	Disable		
Function 50	Disable		
Function 50N	Disable		
Function 50BF	Disable		
Functions 51, 87H/T, 87GD	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect current inputs in Configuration C1 (modified). See Section 6.4, **Input Configurations**, for configurations. The modification to C1 is to set all three currents to phase angle ∠0° and inject equal magnitude. In this configuration, the applied value of I_0 is equal to the applied 3-phase current.

■**NOTE:** Special Attention must be paid to which winding is being tested and which winding is disabled.

[1]Either a Standard Curve, IEC Curve or IEEE Curve must be selected.

4. Refer to **Appendix D**. Calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.

IEC Standard Inverse

$$t = TD \times \left[\frac{0.14}{M^{0.02} - 1}\right]$$

IEC Very Inverse

$$t = TD \times \left[\frac{13.5}{M - 1}\right]$$

IEC Extremely Inverse

$$t = TD \times \left[\frac{80}{M^2 - 1}\right]$$

IEC Long Time Inverse

$$t = TD \times \left[\frac{120}{M - 1}\right]$$

IEEE Moderately Inverse

$$t = \frac{TD}{5} \times \left[\frac{0.0515}{M^{0.02} - 1} + 0.114\right]$$

IEEE Very Inverse

$$t = \frac{TD}{5} \times \left[\frac{19.61}{M^2 - 1} + 0.491\right]$$

IEEE Extremely Inverse

$$t = \frac{TD}{5} \times \left[\frac{28.2}{M^2 - 1} + 0.1217\right]$$

t = time in seconds TD = Time Dial setting M = current in multiples of pickup

> ■ **NOTE:** When calculating values for residual current functions, the relay adds three-phase current ($3I_0 = I_A + I_B + I_C$). The relay operates on I_0.

5. ***Time Test***: With output contacts connected to the timer, apply input current used in calculations from Step 4 and start timing while observing the selected winding target LED for pickup. The operating time will be (**D**) cycles within ±3 cycles or ±5% of calculated time.
6. Repeat Step 5 for each test level chosen. The tested points verify the operation of this function.
7. Repeat Steps 4, 5 & 6 using Configuration C2 (modified), C3 (modified) and C4 (modified). Observe the selected winding target LED for pickup.
8. **Winding Summing Test:** Later
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

59 Phase Overvoltage (#1, #2 or #3)

VOLTAGE INPUTS: Configuration V1 or V3

CURRENT INPUTS: None

TEST SETTINGS:

59 Pickup	P	Volts	(5 to 180)
Time Delay	D	Cycles	(1 to 8160)
Programmed Outputs	Z	OUT	(1 to 8)
	Expanded I/O		(9 to 16)
Function 81O/U	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedure.
2. Confirm settings to be tested.
3. Connect input in Configuration V1 or V3 as designated previously. See Section 6.4, **Input Configurations**, for configurations.
4. Voltage selection:
   - If you select phase or positive sequence for the input voltage, then apply a balanced three-phase voltage. Only models with three-phase voltage have the option to select positive or negative sequence voltage as the operate quantity. The four-winding version with two voltage inputs does not have phase overvoltage protection.
   - If you select negative sequence for the input voltage, then apply a balanced three-phase voltage and roll Phase B and C phase voltages.
5. ***Pickup Test**:*
   a. Press and hold the **TARGET RESET** button, then slowly increase the input voltage until **PHASE OVERVOLTAGE 59** LED illuminates or the pickup indicator operates on the computer target screen. The level should be equal to (**P**) volts ±0.5 V or ±0.5%.
   b. Release the **TARGET RESET** button, then decrease the input voltage. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets.
6. ***Time Test**:* With output contracts being connected to the timer, apply (**P**+1) Volts and start timing. The operating time will be (**D**) cycles within ±1 cycle or ±1%.
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

59G Ground Overvoltage (#1 or #2)

VOLTAGE INPUTS:	Configuration V2			
CURRENT INPUTS:	None			
TEST SETTINGS:	59G Pickup	P	Volts	(5 to 180)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Function 81O/U	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedure.
2. Confirm settings to be tested.
3. Connect input in Configuration V2 as designated previously. See Section 6.4, **Input Configurations**, for configurations.
4. ***Pickup Test***:
   a. Press and hold the **TARGET RESET** button, then slowly increase the input voltage until **NEUTRAL OVERVOLTAGE 59G** LED illuminates or the pickup indicator operates on the computer target screen. The level should be equal to (**P**) volts ±0.5 V or ±0.5%.
   b. Release the **TARGET RESET** button, then decrease the input voltage. The **OUTPUT** LED will extinguish.
   c. Press **TARGET RESET** button to remove targets.
5. ***Time Test***: With output contracts being connected to the timer, apply (**P**+1) Volts and start timing. The operating time will be (**D**) cycles within ±1 cycle or ±1%.
6. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

81 Overfrequency/Underfrequency

VOLTAGE INPUTS:	Configuration V1			
CURRENT INPUTS:	None			
TEST SETTINGS:	Pickup	P	Hz	(55 to 65)
	50 Hz Relay			(45 to 55)
	Time Delay	D	Cycles	(2 to 65,500)
	Programmed Outputs	Z Expanded I/O	OUT	(1 to 8) (9 to 16)
	Functions 24DT, 24IT	Disable		
	Function 27	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedure.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 designated previously. Set the VT Configuration (Section 4.2) as V_A. See Section 6.4, **Input Configurations** for configuration.
4. ***Pickup Test***:

   ■**NOTE:** When using single-phase frequency sources, connect the source to one voltage input.

   a. Set the voltages to the Nominal Frequency. Set the pickup less than nominal frequency.
   b. Press and hold the **TARGET RESET** button in, then slowly decrease the frequency of the input voltage until the **FREQUENCY 81 O/U** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to **P** Volts ±0.1 Hz.
   c. Release the **TARGET BUTTON**, then return to nominal input frequency. The **OUTPUT** LED will extinguish.
   d. Press **TARGET RESET** button to remove targets.
   e. Set the pickup greater than nominal frequency. Repeat Step b through d, except you will have to slowly increase the frequency of the input voltage.

5. ***Time Test***: With output contacts being connected to the timer, input (**P** – 0.5) Hz and start timing. The operating time will be (**D**) cycles within -1 to +3 cycles or ±1%.
6. Complete the testing for the remaining 81 functions by repeating Steps 4 and 5, above.
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

87H Phase Differential Overcurrent

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	Configuration C6			
TEST SETTINGS:	Pickup	P	PU	(5.0 to 20.0)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Functions 46DT, 46IT, 49	Disable		
	Function 50	Disable		
	Function 50N, 50BF	Disable		
	Function 51, 51N	Disable		
	Function 87T	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedure.
2. Confirm settings to be tested.
3. Connect inputs in Configuration C6 as designated previously. See Section 6.4, **Input Configurations** for configuration. For testing purposes it is recommended that the CT Tap Corrections, **CT1**, **CT2**, **CT3** and **CT4** be set to 1.0. If it is desired to test with other CT Tap settings, the current values must be computed by using the following formulas:

   I_{AW1} (Applied) = I_{AW1} (Calculated) multiplied by CT1.

   I_{AW2} (Applied) = I_{AW2} (Calculated) multiplied by CT2.

   I_{AW3} (Applied) = I_{AW3} (Calculated) multiplied by CT3.

   I_{AW4} (Applied) = I_{AW4} (Calculated) multiplied by CT4.

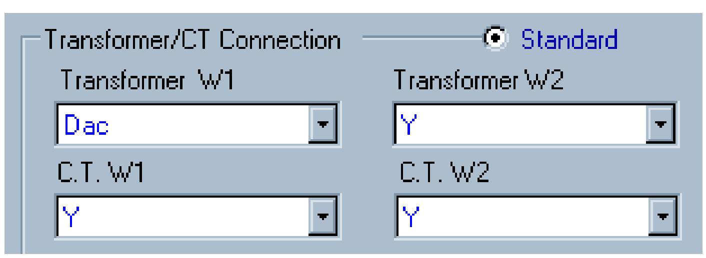
   ■**NOTE:** All values used for this function are measured in PU's, which requires calculating the actual current in Amps to be used for testing: 1 **PU** = CT Tap, for three-phase balanced current injection.

4. ***Minimum Pickup Test***:

   a. Set the I_{AW1} (Input 1) = 0 Amps.

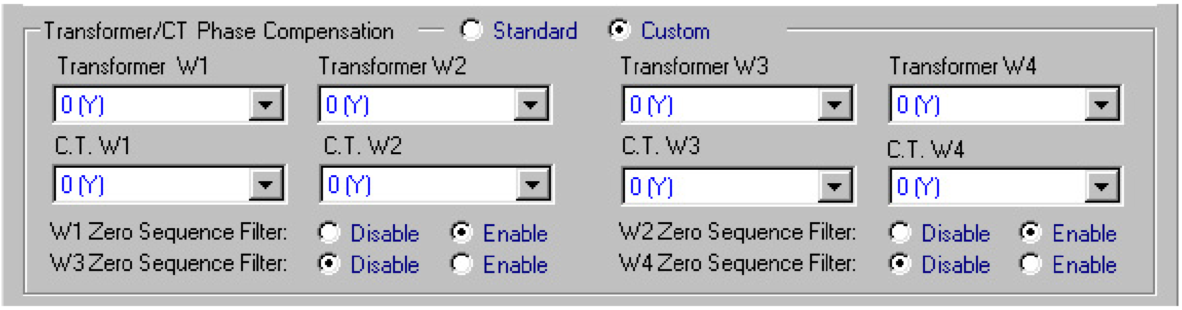
   b. Press and hold the **TARGET RESET** button in, then slowly increase I_{AW2} (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to 1.732•**P** per unit ±3%.

Delta (Winding 1) Wye (Winding 2) Transformer



Press and hold the **TARGET RESET** button in, then slowly increase I_{AW2} (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to 1.5•**P** per unit ±3%.

Wye (Winding 1) Wye (Winding 2) Transformer



c. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.

d. Press **TARGET RESET** button to remove targets. This test may be repeated for testing the opposite winding or another phase.

5. ***Timer Check:*** With output contacts being connected to the timer, apply at least 10% higher I_{AW2} (Input 2) current than the minimum pickup level and start timing. The input current must be multiplied as shown in Step b. The operating time will (**D**) cycles within -1 to +3 cycles or ±1%.

6. If desired, repeat Steps 4 & 5 setting I_{AW2} (Input 2) and/or I_{AW3} (Input 3) or (I_{AW4}) to 0 Amps and increasing I_{AW1} (Input 1).

7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

87T Phase Differential Overcurrent

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	Configuration C6			
TEST SETTINGS:	Pickup	P	PU	(0.10 to 1.00)
	Percent Slope #1	S1	%	(5 to 100)
	Percent Slope #2	S2	%	(5 to 200)
	Slope Break Point	BP	PU	(1.0 to 4.0)
	Even Harmonics Restraint (2nd and 4th)	E	E,D,A	ENABLE/DISABLE/ ENABLE WITH CROSS AVERAGE
	Restraint		%	(5 to 50)
	5th Harmonic Restraint	F	E,D,A	
	Restraint		%	(5 to 50)
	Pickup at 5th Harmonic Restraint	FP	PU	(0.10 to 2.00)
	CT Tap W1/W2/W3/W4	CT1/2/3/4		(1 to 100.0)
	1 Amp CT Rating			(0.2 to 20.00)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Functions 46DT, 46IT, 49	Disable		
	Function 50	Disable		
	Function 50N, 50BF	Disable		
	Function 51, 51N	Disable		
	Function 87T	Disable		

1. Disable functions as shown. See Section 4.4, **System Setpoints**, for procedure.
2. Confirm settings to be tested.
3. Connect inputs in Configuration C6 as designated previously. See Section 6.4, **Input Configurations** for configuration. For testing purposes it is recommended that the CT Tap Corrections, **CT1**, **CT2**, **CT3** and **CT4** be set to 1.0. If it is desired to test with other CT Tap settings, the current values must be computed by using the following formulas:

   I_{AW1} (Applied) = I_{AW1} (Calculated) multiplied by CT1.

   I_{AW2} (Applied) = I_{AW2} (Calculated) multiplied by CT2.

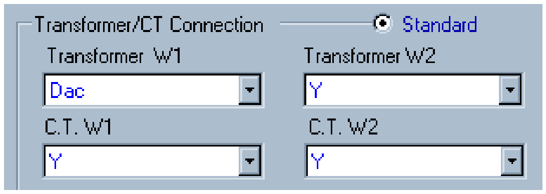
   I_{AW3} (Applied) = I_{AW3} (Calculated) multiplied by CT3.

   I_{AW4} (Applied) = I_{AW4} (Calculated) multiplied by CT4.

   ■ **NOTE:** All values used for this function are measured in PU's, which requires calculating the actual current in Amps to be used for testing: 1 PU = CT Tap, for three-phase balanced current injection.

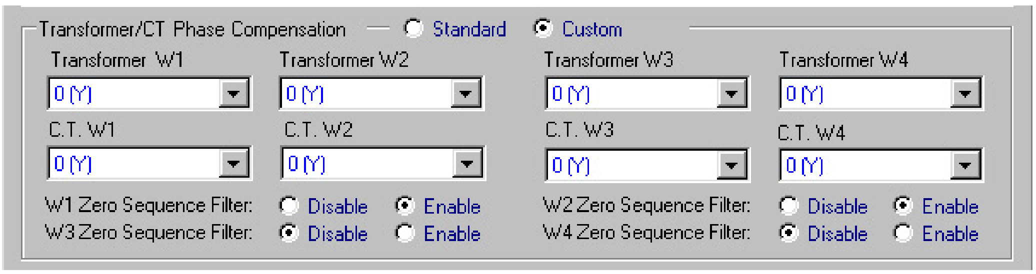
4. ***Minimum Pickup Test**:*
   a. Set I_{AW1} (Input 1) = 0 Amps.
   b. Press and hold the **TARGET RESET** button in, then slowly increase I_{AW2} (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to 1.732•**P** per unit ±3%.

Delta (Winding 1) Wye (Winding 2) Transformer



Press and hold the **TARGET RESET** button in, then slowly increase I_{AW2} (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to 1.5•**P** per unit ±3%.

Wye (Winding 1) Wye (Winding 2) Transformer



c. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.

d. Press the **TARGET RESET** button to remove targets. This test may be repeated for testing the opposite winding or another phase.

5. ***Slope 1 Test***:

a. Define any number of testing points desirable to verify the trip I_{AW2} (Input 2) curve.

b. Choose any values for I_{AW2} (Input 2), and calculate the expected I_{AW1} (Input 1) according to the following:

$I_{AW1} - I_{AW2}$	$>$	$(I_{AW1} + I_{AW2})$	x	S1/100	$\div$ 2
Difference in Currents	is greater than	sum of the currents	times	the per unit Slope1	divided by two.

Or

$$I_{AW1} = I_{AW2}\left[\frac{(200 + S1)}{(200 - S1)}\right]$$

S1= slope in % from above.

■**NOTE:** The differential current $I_{AW1}-I_{AW2}$ must be greater than the minimum pickup current (**P**) and less than the Break Point (**BP**) value for proper operation. Monitor the restraint current using either the HMI or IPScom Secondary Metering and Status Screen. Do not increase the magnitude of I_{AW2} such that the restraint current is less than **BP**.

c. Set I_{AW1} (Input 1) and I_{AW2} (Input 2) at the chosen value.

d. Refer to the Pickup test for the current multipliers to use when testing a delta-wye or wye-wye bank. Press and hold the **TARGET RESET** button in, then slowly increase I_{AW2} (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates, or the pickup indicator operates on the computer target screen. The level of operation will equal to (**P**) ±0.02 PU or ±5%.

e. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.

f. Press the **TARGET RESET** button to remove targets. This test may be repeated for testing the opposite winding or another phase.

6. ***Slope 2 Test***:
   a. Define any number of testing points desirable to verify the trip I_{AW2} (Input 2) current curve.
   b. Choose any values for I_{AW2} (Input 2) and calculate the expected I_{AW1} (Input 1) according to the following:

$$I_{AW1} = \frac{\left[I_{AW2} (1 + \frac{S2}{200}) + BP (\frac{S1-S2}{100}) \right]}{(1 - \frac{S2}{200})}$$

S1 and **S2** = slope in % from above. The differential current, $I_{AW1} - I_{AW2}$ must be greater than both the minimum pickup current (**P**) and the **BP** values. Select $I_{AW2} > (BP - \frac{P}{2})$. Monitor the restraint current using either the HMI or IPScom Secondary Metering and Status Screen. The magnitude of I_{AW2} should be high enough that the restraint current is greater than **BP**.

   a. Set I_{AW1} (Input 1) and I_{AW2} (Input 2) to the chosen value.
   b. Press and hold the **TARGET RESET** button, then slowly increase IAW1 (Input 1) current until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation should be equal to (**P**) PU ±0.02 PU or ±1%.
   c. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   d. Press the **TARGET RESET** button to remove targets. This test may be repeated for testing the opposite winding or another phase.

7. ***Second Harmonic Restraint Test***
   a. Ensure that Even Harmonic Restraint is enabled with the amplitude of I_{AW1} (Input 1) at 60 Hz (or 50 Hz) set to 10% above (**P**) PU setting and verify that the **PHASE DIFFERENTIAL 87T/H** LED illuminates.
   b. Apply 0 Amps at 120 Hz (100 Hz for 50 Hz units) to I_{AW2} (Input 2).
   c. Press and hold the **TARGET RESET** button in, then slowly increase the amplitude of I_{AW1} until the **PHASE DIFFERENTIAL 87T/H** LED extinguishes. This level will be (**E**) times (**P**) PU, ±1% or ±0.1A.

8. ***Fourth Harmonic Restraint Test***:
   a. Ensure that Even Harmonic Restraint is enabled with the amplitude of I_{AW1} (Input 1) at 60 Hz (or 50 Hz) set to 10% above **P** PU setting and verify the **PHASE DIFFERENTIAL 87T/H** LED is illuminated.
   b. Apply 0 Amps at 240 Hz (200 Hz for 50 Hz units) to I_{AW2} (Input 2).
   c. Press and hold the **TARGET RESET** button in, then slowly increase the amplitude of the 4th Harmonic current I_{AW2} until the **PHASE DIFFERENTIAL 87T/H** LED extinguishes. This level will be (**E**) times (**P**) PU, ±1%.

9. ***Fifth Harmonic Restraint Test:***
   a. Ensure that 5th Harmonic Restraint is enabled with the amplitude of I_{AW1} (Input 1) at 60 Hz (or 50 Hz) set to above (**P**) PU, and below (**FP**) PU settings and verify the **PHASE DIFFERENTIAL 87T/H** LED is illuminated.
   b. Apply (**P**) times (**F**) +10% Amps at 300 Hz (250 Hz for 50 Hz units) to I_{AW2} (Input 2), and verify that the **PHASE DIFFERENTIAL 87T/H** LED extinguishes.
   c. Press and hold the **TARGET RESET** button in, then slowly decrease the amplitude of the 5th Harmonic current I_{AW2} until the **PHASE DIFFERENTIAL 87T/H** LED illuminates. This level will be (**F**) times (**P**) PU, ±1% or ±0.1A.

10. ***Elevated Pickup at 5th Harmonic Restraint Test***_
    a. Ensure that 5th Harmonic Restraint is enabled with 60 Hz (or 50 Hz) with the amplitude of I_{AW1} (Input 1) at 60 Hz (or 50 Hz) set to 10% above (**P**) PU and verify that the **PHASE DIFFERENTIAL 87T/H** LED illuminates.
    b. Apply (**P**) times (**F**) + 10% Amps at 300 Hz (250 Hz for 50 Hz units) to I_{AW2} (Input 2), then verify that the **PHASE DIFFERENTIAL 87T/H** LED extinguishes.
    c. Use the HMI or IPScom to enable cross phase averaging. Slowly increase the amplitude of I_{BW1} (Input 3) and verify the **PHASE DIFFERENTIAL 87T/H** LED illuminates. This level will be **FP**, ±0.1 PU or ±5%.

11. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

87GD Ground Differential (#1, #2)

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	As Described Below			
TEST SETTINGS:	87GD Pickup	P	Amps	(0.20 to 10.00)
	1 Amp CT Rating			(0.04 to 2.00)
	Time Delay	D	Cycles	(1 to 8160)
	CT Ratio Correction			(0.10 to 7.99)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Function 46DT, 46IT, 49	Disable		
	Function 50, 50G, 50N, 50BF	Disable		
	Function 51, 51N, 51G	Disable		
	Function 87T, 87H	Disable		

1. Disable functions as shown. See <u>Section 4.4</u>, **System Setpoints**, for procedure.
2. Confirm settings to be tested. For testing purposes, it is recommended that the CT Ratio Corrections be set to 1.0. Otherwise, current values must be computed by using the following formulas:

   I_{GW2} = Applied Current to Winding 2 I_{GW2} divided by CT2.

   I_{GW3} = Applied Current to Winding 3 I_{GW3} divided by CT3.

   I_{GW4} = Applied Current to Winding 3 I_{GW4} divided by CT4.

3. ***Non-Directional Pickup Test***:
   a. Connect current input to I_{GW2}, terminal numbers 50 and 51. No current is inserted into I_{AW2}, I_{BW2} and I_{CW2}
   b. Press and hold the **TARGET RESET** button in, then slowly increase I_G until the **GROUND DIFFERENTIAL 87GD** LED illuminates or the pickup indicator operates on the computer target screen. The level at operation will be equal to **(P)** Amps ±0.1 Amps or 5% (±0.02 Amp 1 A CT).
   c. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   d. Press **TARGET RESET** button to remove targets.
4. ***Directional Pickup Test***:
   a. Connect one current input to I_{GW2}, terminal numbers 50 and 51. Connect another current input to I_{AW2}. Insert current into I_{GW2} with a magnitude equal to ½ (**P**) Amps.
   b. Insert current into I_{AW2} that is 180° out of phase with I_{GW2} then slowly increase the phase current until the **GROUND DIFFERENTIAL 87GD W2** LED illuminates or the pickup indicator operates on the computer screen. Operation will occur when the sum of I_{GW2} and the applied phase current equal (**P**) Amps ±0.1 Amps or ±5% (±*0.02 Amp 1 A CT*).

■ **NOTE:** $3I_{0W2}$ must be greater than 140 mA or the directional element is disabled.

   c. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   d. Reverse either current (currents are now in-phase) and re-test. The relay will not operate.
5. ***Time Test***: With output contacts connected to the timer, apply current at least 10% higher than (**P**) Amps and start timing while observing **GROUND DIFFERENTIAL 87GD** LED for pickup. The operating time will be (**D**) cycles within -1 to +3 cycles or ± 1%.
6. Repeat Step 5 for I_{GW3} and I_{GW4} connecting current to terminals 58 and 59 (I_{GW3}) or 72 and 73 (I_{GW4}).
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

BM Breaker Monitoring

VOLTAGE INPUTS:	None			
CURRENT INPUTS:	As Described Below			
TEST SETTINGS:	Pickup	P	kAmps (kA2)*	(0 to 50,000)
	Delay	D	Cycles	(0.1 to 4095.9)
	Timing Method			(IT or I^2T)
	Preset Accumulators			
	Phase A, B, or C		kAmp (kA^2) Cycles*	(0 to 50,000)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)
	Blocking Inputs			(1 to 6)
		Expanded I/O		(7 to 8)
	Output Initiate			(1 to 8)
		Expanded I/O		(9 to 16)
	Input Initiate			(1 to 6)
		Expanded I/O		(7 to 8)

* kA/kA cycles or kA^2/kA^2 cycles is dependent on the Timing Method that is selected.

Test Setup:

1. Determine the Breaker Monitoring Function settings to be tested (Input Initiate or Output Initiate).
2. Enter the Breaker Monitoring Function settings to be tested utilizing either the HMI or IPScom Communications Software.
3. Connect current inputs to I_A terminals 38 and 39, I_B terminals 40 and 41, and I_C terminals 42 and 43.

Accumulator Test:

1. Apply a current value that considers Timing Method and Pickup Setting to current input I_A.
2. Place a jumper between the designated input or output contact selected as initiate.
3. Utilizing either the HMI (Breaker Monitoring/Breaker Acc. Status) or IPScom Communications Software (Monitor/Metering II), verify that the Accumulator Status value for Phase A increments in D cycles ±1 cycles or ±1%.
4. Remove the jumper placed in Step 2.
5. Decrease applied I_A current to 0 amps.
6. If desired, repeat test for I_B and I_C.

Pickup Test:

1. Apply a current value that considers Timing Method and Pickup Setting to current input I_A.

   ■ **NOTE:** If the target pickup setting is a large value (0 to 50,000) the Preset Accumulator Settings feature can be used to preset the accumulator values to just below the target setting.

2. Utilizing either the HMI (Breaker Monitoring/Breaker Acc. Status) or IPScom Communications Software (Monitor/Metering II) to monitor the accumulator value, place a jumper between the designated input or output contact selected as initiate and then remove the jumper.

   Following the time out of the Delay the accumulator will increment, repeat the placement and removal of the jumper as necessary to increment the accumulator to a point where the pickup setting is exceeded.
3. When the accumulator value exceeds the pickup value the **OUTPUT** LED(s) will illuminate, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.

   The output contacts **Z** will operate in **D** cycles ±1 cycle or ±1% from the last initiate.
4. If desired, repeat test for I_B and I_C.

Trip/Close Circuit Monitoring

VOLTAGE INPUTS:	As Described			
CURRENT INPUTS:	None			
TEST SETTINGS:	Delay	D	Cycles	(1 to 8160)
	Dropout Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 16)

Test Setup:

1. Determine the Trip/Close Circuit Monitoring function settings to be tested.
2. Disable all other functions prior to testing. See **Section 4.4**, **System Setpoints** for details that describe disabling/enabling functions.
3. Connect a DC voltage supply capable of supplying 24/48/125/250 Vdc (marked on the rear of the relay) to the TCM/CCM terminals (Figure 5-8 through Figure 5-28) to be tested on the relay.
4. Connect a timer to output contacts **(Z)** so that the timer stops timing when the contacts **(Z)** close.

Pickup Test:

1. Apply the applicable DC voltage (24/48/125/250 Vdc marked on the rear of the relay) to terminals (Figure 5-8 through Figure 5-28) to be tested on the relay
2. Enable the Trip Circuit Monitoring function and then enter the settings to be tested utilizing either the HMI or IPScom Communications Software.
3. Remove the DC voltage applied in Step 1. The **OUTPUT** LED will illuminate, indicating that the Trip Circuit Monitoring function has actuated.

The contacts will close after **D** cycles within ±1 cycle or 1%.

4. Simulate a 52b contact close by connecting a jumper between terminal 11 (INRTN) and terminal 10 (IN1). The **BRKR CLOSED** and **OUTPUT** LEDs on the front of the relay should extinguish.
5. Remove the jumper installed in Step 4.

   The contacts will close after **D** cycles within ±1 cycle or 1%.

Through Fault

VOLTAGE INPUTS:	As Described		
CURRENT INPUTS:	None		
TEST SETTINGS:	Through Fault Current Threshold	5 Amps	(1.0-100.0)
		1 Amp	(0.2-20.0)
	Pickup Operation Limit	5	(1-65535)
	Cumulative I^2T	100k A^2 Cycles	(10-1000000)
	Time Delay	1 Cycles	(1-8160)
	Current Selection		(Sum1, Sum2, W1, W2, W3, W4)

Threshold and Cumulative I^2 T Limit Tests:

1. Utilize the IPSCom Metering II screen to monitor the counters.
2. Use the System/ Through Fault / Clear command to reset any previous Cumulative Through Current readings.
3. Apply a balanced 4 Amp current to the Winding 1, then verify that counters are not incrementing.
4. Remove the applied current.
5. Press the **TARGET RESET** button to clear any previous target indication.
6. Apply a balanced 6 Amp current to the Winding 1, then verify that counters are now incrementing. Approximately 46 seconds after the current was applied the Target LED will illuminate and the HMI will display the Through Fault information.
7. Remove the applied current.

Pickup Operation Limit Test

1. Use the System/ Through Fault / Clear command to reset any previous Cumulative Through Current readings.
2. Press the **TARGET RESET** pushbutton to clear any previous target indication
3. Apply for approximately 2 seconds a balanced 6 Amp current, then remove the current. Repeat this step a second time and the Target LED will illuminate and the HMI will display the Through Fault information.
4. If testing is complete clear the through fault counters and disable the function.

IPSlogic (#1–6)

VOLTAGE INPUTS:	As required			
CURRENT INPUTS:	As required			
TEST SETTINGS:	Time Delay	D	Cycles	(1 to 65500)
	Reset/Dropout Delay	RD	Cycles	(0 to 65500)
	Programmed Outputs	Z	OUT	(1 to 8)
			Expanded I/O	(9 to 16)
	Blocking Inputs			(1 to 6)
			Expanded I/O	(7 to 8)
	Output Initiate			(1 to 8)
			Expanded I/O	(9 to 16)
	Function Initiate		(All Available Functions)	
	Initiate via Communication			
	Input Initiate			(1 to 6)
			Expanded I/O	(7 to 8)
	Block via Communication			

1. See Figure 4-61, IPSlogic, for logic gate configurations.
2. Select gate configuration (AND/OR) for Output Initiate, Function Initiate, Blocking Inputs and Inputs Main.
3. Select Initiating Inputs for each gate (if AND gate is selected, ensure at least two outputs are chosen). It will be necessary to enable and operate other functions to provide inputs for the Function Initiate and Output Initiate gates.
4. ***Pickup Test***: With output contact(s) **Z** connected to the timer, apply inputs to gates and start timing. The operating time will be (**D**) cycles within ±1 cycle or ±1%, and the selected IPSlogic target LED and the **OUTPUT** LED will illuminate or the pickup indicator will operate on the computer target screen.
5. ***Blocking Input Test***: To test the designated blocking inputs, press and hold the **TARGET RESET** button, then short input terminals designated as blocking inputs. The **IPS** LED will extinguish.
6. Repeat for each designated external triggering contact.
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

A Configuration Record Forms

This Appendix contains forms for photocopying, and recording the configuration and setting of the M-3311A Transformer Protection Relay, and to file the data for future reference. Examples of the suggested use of these forms are illustrated in **Chapter 4**, **System Setup and Setpoints** and **Chapter 2**, **Operation**.

Page A-2 contains a copy of the Relay Configuration Table and is herein provided to define and record the blocking inputs and output configuration for the relay. For each function, check if **DISABLED** or check the output contacts to be operated by the function. Also check the inputs designated to block the function operation.

The Communication Record Form reproduces the Communication and Setup unit menus. This form records definition of the parameters necessary for communication with the relay, as well as access codes, user logo (identifying) lines, date & time setting, and front panel display operation.

The functional Configuration Record Form reproduces the Configure Relay menus including the Setup Relay submenu which is accessible via S-3300 IPScom Communication Software or the HMI front panel module.

For each function or setpoint, refer to the configuration you have defined using the Relay Configuration Table, and circle whether it should be enabled or disabled by the output contacts it will activate, and the inputs that will block its operation.

The Setpoint & Timing Record Form allows recording of the specific values entered for each enabled setpoint or function. The form follows the main menu selections of the relay.

The **AS SHIPPED** settings are included in brackets [ ] to illustrate the factory settings of the relay.

Function		OUTPUTS																	BLOCKING INPUTS																	
		D	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
24 Def Time	1																																			
	2																																			
24 Inv Time																																				
27	1																																			
	2*																																			
	3*																																			
46 Def Time W2																																				
46 Inv Time W2																																				
46 Def Time W3																																				
46 Inv Time W3																																				
46 Def Time W4**																																				
46 Inv Time W4**																																				
49																																				
50	1																																			
	2																																			
	3																																			
	4																																			
	5																																			
	6																																			
	7**																																			
	8**																																			
50 BF W1																																				
50 BF W2																																				
50 BF W3																																				
50 BF W4**																																				
50G W2	1																																			
50G W2	2																																			
50G W3	1																																			
50G W3	2																																			
50G W4**	1																																			
50G W4**	2																																			
50N	1																																			
	2																																			
	3																																			
	4																																			
	5																																			
	6																																			
	7**																																			
	8**																																			

* Not available in four-winding applications.
** Not available in two or three winding applications.

■ **NOTE:** The M-3311A is shipped with all functions disabled.

Table A-1 Relay Configuration (1 of 2)

Function		OUTPUTS																	BLOCKING INPUTS																	
		D	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
51	1																																			
	2																																			
	3																																			
	4**																																			
51G W2																																				
51G W3																																				
51G W4**																																				
51N	1																																			
	2																																			
	3																																			
	4**																																			
59*	1																																			
	2																																			
	3																																			
59G(X)	1																																			
	2																																			
	3*																																			
81	1																																			
	2																																			
	3																																			
	4																																			
87H																																				
87T																																				
87GDW2																																				
87GDW3																																				
87GDW4**																																				
IPS	1																																			
	2																																			
	3																																			
	4																																			
	5																																			
	6																																			
BM	1																																			
	2																																			
	3																																			
	4**																																			
TCM	1																																			
	2***																																			
CCM	1***																																			
	2***																																			
TF																																				

* Not available in four-winding applications.
** Not available in two or three winding applications.
*** Not available in Non-Expanded I/O units

■ **NOTE:** The M-3311A is shipped with all functions disabled.

Table A-1 Relay Configuration (2 of 2)

System Communication Setup

Communication Setup

COM 1

Baud Rate: ❑ 300 ❑ 600 ❑ 1200 ❑ 2400
❑ 4800 ❑ [9600]

COM 2

Baud Rate: ❑ 300 ❑ 600 ❑ 1200 ❑ 2400
❑ 4800 ❑ [9600]

Dead Sync Time: _____ 2 msec – 3000 msecs [50]

Protocol: ❑ [BECO2200] ❑ MODBUS ❑ DNP3

COM 3

Dead Sync Time: _____ 2 msec – 3000 msecs [50]

Protocol: ❑ [BECO2200] ❑ MODBUS ❑ DNP3

Communication Address: _____ [1]

Response Time Delay: _____ msec [100]

Communication (COMM) Access Code: _________________________ [9999]

ETHERNET

❑ Enable ❑ [Disable]

TCP/IP Settings: ❑ [TCP] ❑ PROT

Protocol: ❑ [MODBUS] ❑ SERCONV

DHCP Protocol: ❑ Enable ❑ [Disable]

IP Address: __________ [192.168.1.43]

Net Mask: __________ [255.255.255.0]

Gateway: __________ [192.168.1.1]

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-1 System Communication Setup

Setup System – Two or Three Windings

Nominal Voltage: _____ 60 V – 140 V [120]

Nominal Current: _____ 0.50 A – 15.00 A [5.00]

Phase Rotation ❑ ACB ❑ [ABC]

Demand Timing Method ❑ [15 Minutes] ❑ 30 Minutes ❑ 60 Minutes

Current Summing 1 ❑ W1 ❑ W2 ❑ W3

Current Summing 2 ❑ W1 ❑ W2 ❑ W3

Voltage/Power Selection ❑ [W1] ❑ W2 ❑ W3

Positive Power Flow ❑ [In] ❑ Out

Disable Winding for Function 87 ❑ W1 ❑ W2 ❑ W3 ❑ [None]

VT Phase Configuration:

Two Voltage Inputs:
VT Phase Config ❑ VA ❑ VB ❑ VC ❑ VAB ❑ VBC ❑ VCA
VT G Config ❑ VA ❑ VB ❑ VC ❑ VAB ❑ VBC ❑ VCA ❑ VG

Four Voltage Inputs ❑ Line-Line ❑ [Line-Ground]

Transformer/CT Connection ❑ [Standard] ❑ Custom

Standard Selections:

Transformer W1	Transformer W2	Transformer W3
❑ [Y]	❑ [Y]	❑ [Y]
❑ Dab	❑ Dab	❑ Dab
❑ Dac	❑ Dac	❑ Dac
❑ Inverse Y	❑ Inverse Y	❑ Inverse Y
❑ Inverse Dab	❑ Inverse Dab	❑ Inverse Dab
❑ Inverse Dac	❑ Inverse Dac	❑ Inverse Dac

CT W1	CT W2	CT W3
❑ [Y]	❑ [Y]	❑ [Y]
❑ Dab	❑ Dab	❑ Dab
❑ Dac	❑ Dac	❑ Dac
❑ Inverse Y	❑ Inverse Y	❑ Inverse Y
❑ Inverse Dab	❑ Inverse Dab	❑ Inverse Dab
❑ Inverse Dac	❑ Inverse Dac	❑ Inverse Dac

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-2 Setup System (Two or Three Windings) (1 of 3)

Setup System – Two or Three Windings (Cont.)

Custom Selections:

Transformer W1	Transformer W2	Transformer W3
❑ 0 Y	❑ 0 Y	❑ 0 Y
❑ 1 Dac	❑ 1 Dac	❑ 1 Dac
❑ 2	❑ 2	❑ 2
❑ 3	❑ 3	❑ 3
❑ 4	❑ 4	❑ 4
❑ 5 Inverse Dab	❑ 5 Inverse Dab	❑ 5 Inverse Dab
❑ 6 Inverse Y	❑ 6 Inverse Y	❑ 6 Inverse Y
❑ 7 Inverse Dac	❑ 7 Inverse Dac	❑ 7 Inverse Dac
❑ 8	❑ 8	❑ 8
❑ 9	❑ 9	❑ 9
❑ 10	❑ 10	❑ 10
❑ 11Dab	❑ 11Dab	❑ 11Dab

CT W1	CT W2	CT W3
❑ 1 (Y)	❑ 1 (Y)	❑ 1 (Y)
❑ 2	❑ 2	❑ 2
❑ 3	❑ 3	❑ 3
❑ 4	❑ 4	❑ 4
❑ 5	❑ 5	❑ 5
❑ 6 (Inverse Y)	❑ 6 (Inverse Y)	❑ 6 (Inverse Y)
❑ 7	❑ 7	❑ 7
❑ 8	❑ 8	❑ 8
❑ 9	❑ 9	❑ 9
❑ 10	❑ 10	❑ 10
❑ 11	❑ 11	❑ 11
❑ 12	❑ 12	❑ 12
❑ 13 (Dac)	❑ 13 (Dac)	❑ 13 (Dac)
❑ 14	❑ 14	❑ 14
❑ 15	❑ 15	❑ 15
❑ 16	❑ 16	❑ 16
❑ 17 (Inverse Dab)	❑ 17 (Inverse Dab)	❑ 17 (Inverse Dab)
❑ 18	❑ 18	❑ 18
❑ 19 (Inverse Dac)	❑ 19 (Inverse Dac)	❑ 19 (Inverse Dac)
❑ 20	❑ 20	❑ 20
❑ 21	❑ 21	❑ 21
❑ 22	❑ 22	❑ 22
❑ 23 (Dab)	❑ 23 (Dab)	❑ 23 (Dab)

Custom Transformer/CT Selections (Cont.):

W1 Zero Sequence Filter	❑ Enable	❑ [Disable]
W2 Zero Sequence Filter	❑ Enable	❑ [Disable]
W3 Zero Sequence Filter	❑ Enable	❑ [Disable]

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-2 Setup System (Two or Three Windings) (2 of 3)

Setup System – Two or Three Windings (Cont.)

Setup System – Two or Three Windings (Cont.)

VT a Ratio: ________:1 1.0 – 6550.0 [1.0]

VT Vx Ratio: ________:1 1.0 – 6550.0 [1.0]

CT W1 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W2 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W3 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W2 Ground Ratio: ________:1 1 – 65500.0 [1.0]

CT W3 Ground Ratio: ________:1 1 – 65500.0 [1.0]

OUTPUT SETTINGS

Latched Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Pulsed Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Relay Seal-in Time:

Output 1: _____ 2 – 8160 (Cycles) [30]
Output 2: _____ 2 – 8160 (Cycles) [30]
Output 3: _____ 2 – 8160 (Cycles) [30]
Output 4: _____ 2 – 8160 (Cycles) [30]
Output 5: _____ 2 – 8160 (Cycles) [30]
Output 6: _____ 2 – 8160 (Cycles) [30]
Output 7: _____ 2 – 8160 (Cycles) [30]
Output 8: _____ 2 – 8160 (Cycles) [30]
Output 9: _____ 2 – 8160 (Cycles) [30]
Output 10: _____ 2 – 8160 (Cycles) [30]
Output 11: _____ 2 – 8160 (Cycles) [30]
Output 12: _____ 2 – 8160 (Cycles) [30]
Output 13: _____ 2 – 8160 (Cycles) [30]
Output 14: _____ 2 – 8160 (Cycles) [30]
Output 15: _____ 2 – 8160 (Cycles) [30]
Output 16: _____ 2 – 8160 (Cycles) [30]

INPUT SETTINGS

Input Active State (Open):

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Input Active State (Close):

❑ [#1] ❑ [#2] ❑ [#3] ❑ [#4] ❑ [#5] ❑ [#6] ❑ [#7] ❑ [#8] ❑ [#9]

❑ [#10] ❑ [#11] ❑ [#12] ❑ [#13] ❑ [#14] ❑ [#15] ❑ [#16] ❑ [#17] ❑ [#18]

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-2 Setup System (Two or Three Windings) (3 of 3)

Setup System – Four Windings

Nominal Voltage: ______ 60 V – 140 V [120]

Phase Rotation ❑ [ACB] ❑ ABC

Demand Timing Method ❑ [15 Minutes] ❑ 30 Minutes ❑ 60 Minutes

VT Config. ❑ [VAB] ❑ VBC ❑ VCA ❑ VA ❑ VB ❑ VC

Current Summing 1 ❑ W1 ❑ W2 ❑ W3 ❑ W4

Current Summing 2 ❑ W1 ❑ W2 ❑ W3 ❑ W4

Enable/Disable Windings for 87 Function

[More Than 2 Windings] ❑
Winding 1 and Winding 2 Only ❑
[Enable All Windings] ❑
Disable Winding 1 ❑
Disable Winding 2 ❑
Disable Winding 3 ❑
Disable Winding 4 ❑

Transformer/CT Connection ❑ [Standard] ❑ Custom

Standard Selections:

Transformer W1	Transformer W2	Transformer W3	Transformer W4
❑ [Y]	❑ [Y]	❑ [Y]	❑ [Y]
❑ Dab	❑ Dab	❑ Dab	❑ Dab
❑ Dac	❑ Dac	❑ Dac	❑ Dac
❑ Inverse Y	❑ Inverse Y	❑ Inverse Y	❑ Inverse Y
❑ Inverse Dab	❑ Inverse Dab	❑ Inverse Dab	❑ Inverse Dab
❑ Inverse Dac	❑ Inverse Dac	❑ Inverse Dac	❑ Inverse Dac

CT W1	CT W2	CT W3	CT W4
❑ [Y]	❑ [Y]	❑ [Y]	❑ [Y]
❑ Dab	❑ Dab	❑ Dab	❑ Dab
❑ Dac	❑ Dac	❑ Dac	❑ Dac
❑ Inverse Y	❑ Inverse Y	❑ Inverse Y	❑ Inverse Y
❑ Inverse Dab	❑ Inverse Dab	❑ Inverse Dab	❑ Inverse Dab
❑ Inverse Dac	❑ Inverse Dac	❑ Inverse Dac	❑ Inverse Dac

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-3 Setup System (Four Windings) (1 of 3)

Setup System – Four Windings (Cont.)

Custom Selections:

Transformer W1	Transformer W2	Transformer W3	Transformer W4
❑ 0 (Y)	❑ 0 Y	❑ 0 Y	❑ 0 Y
❑ 1 Dac	❑ 1 Dac	❑ 1 Dac	❑ 1 Dac
❑ 2	❑ 2	❑ 2	❑ 2
❑ 3	❑ 3	❑ 3	❑ 3
❑ 4	❑ 4	❑ 4	❑ 4
❑ 5 (Inverse Dab)	❑ 5 Inverse Dab	❑ 5 Inverse Dab	❑ 5 Inverse Dab
❑ 6 (Inverse Y)	❑ 6 Inverse Y	❑ 6 Inverse Y	❑ 6 Inverse Y
❑ 7 (Inverse Dac)	❑ 7 Inverse Dac	❑ 7 Inverse Dac	❑ 7 Inverse Dac
❑ 8	❑ 8	❑ 8	❑ 8
❑ 9	❑ 9	❑ 9	❑ 9
❑ 10	❑ 10	❑ 10	❑ 10
❑ 11 (Dab)	❑ 11Dab	❑ 11Dab	❑ 11Dab

CT W1	CT W2	CT W3	CTW4
❑ 0 (Y)	❑ 0 (Y)	❑ 0 (Y)	❑ 0 (Y)
❑ 1	❑ 1	❑ 1	❑ 1
❑ 2	❑ 2	❑ 2	❑ 2
❑ 3	❑ 3	❑ 3	❑ 3
❑ 4	❑ 4	❑ 4	❑ 4
❑ 5	❑ 5	❑ 5	❑ 5
❑ 6 (Inverse Y)	❑ 6 (Inverse Y)	❑ 6 (Inverse Y)	❑ 6 (Inverse Y)
❑ 7	❑ 7	❑ 7	❑ 7
❑ 8	❑ 8	❑ 8	❑ 8
❑ 9	❑ 9	❑ 9	❑ 9
❑ 10	❑ 10	❑ 10	❑ 10
❑ 11	❑ 11	❑ 11	❑ 11
❑ 12	❑ 12	❑ 12	❑ 12
❑ 13 (Dac)	❑ 13 (Dac)	❑ 13 (Dac)	❑ 13 (Dac)
❑ 14	❑ 14	❑ 14	❑ 14
❑ 15	❑ 15	❑ 15	❑ 15
❑ 16	❑ 16	❑ 16	❑ 16
❑ 17 (Inverse Dab)	❑ 17 (Inverse Dab)	❑ 17 (Inverse Dab)	❑ 17 (Inverse Dab)
❑ 18	❑ 18	❑ 18	❑ 18
❑ 19 (Inverse Dac)	❑ 19 (Inverse Dac)	❑ 19 (Inverse Dac)	❑ 19 (Inverse Dac)
❑ 20	❑ 20	❑ 20	❑ 20
❑ 21	❑ 21	❑ 21	❑ 21
❑ 22	❑ 22	❑ 22	❑ 22
❑ 23 (Dab)	❑ 23 (Dab)	❑ 23 (Dab)	❑ 23 (Dab)

Custom Transformer/CT Selections (Cont.):

W1 Zero Sequence Filter	❑ Enable	❑ [Disable]
W2 Zero Sequence Filter	❑ Enable	❑ [Disable]
W3 Zero Sequence Filter	❑ Enable	❑ [Disable]
W4 Zero Sequence Filter	❑ Enable	❑ [Disable]

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-3 Setup System (Four Windings) (2 of 3)

Setup System – Four Windings (Cont.)

VT and CT Ratio

VT Ratio: ________:1 1.0 – 6550.0 [1.0]

VT Ground Ratio: ________:1 1.0 – 6550.0 [1.0]

CT W1 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W2 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W3 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W4 Phase Ratio: ________:1 1 – 65500.0 [1.0]

CT W2 Ground Ratio: ________:1 1 – 65500.0 [1.0]

CT W3 Ground Ratio: ________:1 1 – 65500.0 [1.0]

CT W4 Ground Ratio: ________:1 1 – 65500.0 [1.0]

OUTPUT SETTINGS

Latched Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Pulsed Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Relay Seal-in Time:

Output 1: _____ 2 – 8160 (Cycles) [30]
Output 2: _____ 2 – 8160 (Cycles) [30]
Output 3: _____ 2 – 8160 (Cycles) [30]
Output 4: _____ 2 – 8160 (Cycles) [30]
Output 5: _____ 2 – 8160 (Cycles) [30]
Output 6: _____ 2 – 8160 (Cycles) [30]
Output 7: _____ 2 – 8160 (Cycles) [30]
Output 8: _____ 2 – 8160 (Cycles) [30]
Output 9: _____ 2 – 8160 (Cycles) [30]
Output 10: _____ 2 – 8160 (Cycles) [30]
Output 11: _____ 2 – 8160 (Cycles) [30]
Output 12: _____ 2 – 8160 (Cycles) [30]
Output 13: _____ 2 – 8160 (Cycles) [30]
Output 14: _____ 2 – 8160 (Cycles) [30]
Output 15: _____ 2 – 8160 (Cycles) [30]
Output 16: _____ 2 – 8160 (Cycles) [30]

INPUT SETTINGS

Input Active State (Open):

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Input Active State (Close):

❑ [#1] ❑ [#2] ❑ [#3] ❑ [#4] ❑ [#5] ❑ [#6] ❑ [#7] ❑ [#8] ❑ [#9]
❑ [#10] ❑ [#11] ❑ [#12] ❑ [#13] ❑ [#14] ❑ [#15] ❑ [#16] ❑ [#17] ❑ [#18]

■ **NOTE:** ***As Shipped*** settings are contained in brackets [ ] where applicable.

Figure A-3 Setup System (Four Windings) (3 of 3)

System Setpoints and Settings

24–Volts/Hz Overexcitation

Definite Time #1 ❑ Disable ❑ Enable

Pickup: ______ 100–200 (%)

Time Delay: ______ 30 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Definite Time #2 ❑ Disable ❑ Enable

Pickup: ______ 100–200 (%)

Time Delay: ______ 30 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Inverse Time ❑ Disable ❑ Enable

Pickup: ______ 100–150 (%)

Time Dial: ______ 1 –100

Reset Rate: ______ 1–999 (Sec)

Inverse Time Curves: ❑ #1 ❑ #2 ❑ #3 ❑ #4

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (1 of 39)

System Setpoints and Settings (Cont.)

27–Phase Undervoltage

27 #1 ❑ Disable ❑ Enable

Pickup: ______ 5–140 (V)

Time Delay: ______ 1 –8160 (Cycles)

Inhibit: ______ 5–140 (V) ❑ Disable ❑ Enable

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

27 #2 ❑ Disable ❑ Enable (Not available in four-winding applications)

Pickup: ______ 5–140 (V)

Time Delay: ______ 1 –8160 (Cycles)

Inhibit: ______ 5–140 (V) ❑ Disable ❑ Enable

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

27 #3 ❑ Disable ❑ Enable (Not available in four-winding applications)

Pickup: ______ 5–140 (V)

Time Delay: ______ 1 –8160 (Cycles)

Inhibit: ______ 5–140 (V) ❑ Disable ❑ Enable

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (2 of 39)

System Setpoints and Settings (Cont.)

46–Negative Sequence Overcurrent

46-W2

Definite Time ❑ Disable ❑ Enable

Pickup: _____ 0.10–20.00 (A)

Time Delay: _____ 1 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Inverse Time ❑ Disable ❑ Enable

Pickup: _____ 0.50–5.00 (A)

Time Dial: _____ 0.5 –11.0

Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse

❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse

❑ IEC Extremely Inverse ❑ IEC Long Time Inverse

❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

46-W3

Definite Time ❑ Disable ❑ Enable

Pickup: _____ 0.10–20.00 (A)

Time Delay: _____ 1 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (3 of 39)

System Setpoints and Settings (Cont.)

46 – Negative Sequence Overcurrent (Cont.)

46-W3 (Cont.)

Inverse Time ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 5.00 (A)

Time Dial: _____ 0.5 – 11.0

Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

46-W4 (Not available in Two or Three Winding applications)

Definite Time ❑ Disable ❑ Enable

Pickup: _____ 0.10 – 20.00 (A)

Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Inverse Time ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 5.00 (A)

Time Dial: _____ 0.5 – 11.0

Figure A-4 System Setpoints and Settings (4 of 39)

System Setpoints and Settings (Cont.)

46 – Negative Sequence Overcurrent (Cont.)

46-W4 (Cont.) (Not available in Two or Three Winding applications)

Inverse Time Curves:

❏ BECO Definite Time ❏ BECO Inverse ❏ BECO Very Inverse
❏ BECO Extremely Inverse ❏ IEC Inverse ❏ IEC Very Inverse
❏ IEC Extremely Inverse ❏ IEC Long Time Inverse
❏ IEEE Moderately Inverse ❏ IEEE Very Inverse ❏ IEEE Extremely Inverse

I/O Selection:

Outputs

❏ #1 ❏ #2 ❏ #3 ❏ #4 ❏ #5 ❏ #6 ❏ #7 ❏ #8
❏ #9 ❏ #10 ❏ #11 ❏ #12 ❏ #13 ❏ #14 ❏ #15 ❏ #16

Blocking Inputs

❏ #1 ❏ #2 ❏ #3 ❏ #4 ❏ #5 ❏ #6 ❏ #7 ❏ #8 ❏ #9
❏ #10 ❏ #11 ❏ #12 ❏ #13 ❏ #14 ❏ #15 ❏ #16 ❏ #17 ❏ #18

49 – Winding Thermal Protection

❏ Disable ❏ Enable

Time Constant: _____ 1.0 – 999.9 (min)

Max Overload Current: _____ 1.00 – 10.00 (A)

Current Selection:

Current Selection: ❏ Summing 1 ❏ Summing 2 ❏ Winding 1
❏ Winding 2 ❏ Winding 3
❏ Winding 4 (Not available in Two or Three Winding applications)

I/O Selection:

Outputs

❏ #1 ❏ #2 ❏ #3 ❏ #4 ❏ #5 ❏ #6 ❏ #7 ❏ #8
❏ #9 ❏ #10 ❏ #11 ❏ #12 ❏ #13 ❏ #14 ❏ #15 ❏ #16

Blocking Inputs

❏ #1 ❏ #2 ❏ #3 ❏ #4 ❏ #5 ❏ #6 ❏ #7 ❏ #8 ❏ #9
❏ #10 ❏ #11 ❏ #12 ❏ #13 ❏ #14 ❏ #15 ❏ #16 ❏ #17 ❏ #18

Figure A-4 System Setpoints and Settings (5 of 39)

System Setpoints and Settings (Cont.)

50–Instantaneous Phase Overcurrent

50– #1 ❑ Disable ❑ Enable

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50– #2 ❑ Disable ❑ Enable

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50– #3 ❑ Disable ❑ Enable

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (6 of 39)

System Setpoints and Settings (Cont.)

50 – Instantaneous Phase Overcurrent (Cont.)

50 – #4 ❑ Disable ❑ Enable

Pickup: ______ 1.0 – 100.0 (A)

Time Delay: ______ 1 – 8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50 – #5 ❑ Disable ❑ Enable

Pickup: ______ 1.0 – 100.0 (A)

Time Delay: ______ 1 – 8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50 – #6 ❑ Disable ❑ Enable

Pickup: ______ 1.0 – 100.0 (A)

Time Delay: ______ 1 – 8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (7 of 39)

System Setpoints and Settings (Cont.)

50–Instantaneous Phase Overcurrent (Cont.)

50– #7 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: ______ 1.0–100.0 (A)

Time Delay: ______ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3 ❑ Winding 4

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50– #8 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: ______ 1.0–100.0 (A)

Time Delay: ______ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3 ❑ Winding 4

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (8 of 39)

System Setpoints and Settings (Cont.)

50N–Instantaneous Residual Overcurrent

50N– #1 ❑ Disable ❑ Enable

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50N– #2 ❑ Disable ❑ Enable

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50N– #3 ❑ Disable ❑ Enable

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (9 of 39)

System Setpoints and Settings (Cont.)

50N – Instantaneous Residual Overcurrent (Cont.)

50N – #4 ❑ Disable ❑ Enable

Pickup: _____ 1.0 – 100.0 (A)

Time Delay: _____ 1 – 8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50N – #5 ❑ Disable ❑ Enable

Pickup: _____ 1.0 – 100.0 (A)

Time Delay: _____ 1 – 8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50N – #6 ❑ Disable ❑ Enable

Pickup: _____ 1.0 – 100.0 (A)

Time Delay: _____ 1 – 8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1

❑ Winding 2 ❑ Winding 3

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (10 of 39)

System Setpoints and Settings (Cont.)

50N–Instantaneous Residual Overcurrent (Cont.)

50N– #7 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50N– #8 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (11 of 39)

System Setpoints and Settings (Cont.)

50G – Instantaneous Ground Overcurrent

50G-W2-#1 ❑ Disable ❑ Enable

Pickup: ______ 1.0 – 100.0 (A)

Time Delay: ______ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50G-W2-#2 ❑ Disable ❑ Enable

Pickup: ______ 1.0 – 100.0 (A)

Time Delay: ______ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50G-W3-#1 ❑ Disable ❑ Enable

Pickup: ______ 1.0 – 100.0 (A)

Time Delay: ______ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (12 of 39)

System Setpoints and Settings (Cont.)

50G–Instantaneous Ground Overcurrent (Cont.)

50G-W3-#2 ❑ Disable ❑ Enable
Pickup: ______ 1.0–100.0 (A)
Time Delay: ______ 1 –8160 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50G-W4-#1 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)
Pickup: ______ 1.0–100.0 (A)
Time Delay: ______ 1 –8160 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50G-W4-#2 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)
Pickup: ______ 1.0–100.0 (A)
Time Delay: ______ 1 –8160 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (13 of 39)

System Setpoints and Settings (Cont.)

50BF – Breaker Failure

50BF-W1 ❑ Disable ❑ Enable

Phase Pickup: ______ 0.10 – 10.00 (A)

Residual Pickup: ______ 0.10 – 10.00 (A)

Time Delay: ______ 1 – 8160 (Cycles)

I/O Selection:

Output Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50BF – Breaker Failure (Cont.)

50BF-W2 ❑ Disable ❑ Enable

Phase Pickup: ______ 0.10 – 10.00 (A)

Residual Pickup: ______ 0.10 – 10.00 (A)

Time Delay: ______ 1 – 8160 (Cycles)

I/O Selection:

Output Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (14 of 39)

System Setpoints and Settings (Cont.)

50BF-W3 ❑ Disable ❑ Enable

Phase Pickup: _____ 0.10 – 10.00 (A)

Residual Pickup: _____ 0.10 – 10.00 (A)

Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Output Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

50BF-W4 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Phase Pickup: _____ 0.10 – 10.00 (A)

Residual Pickup: _____ 0.10 – 10.00 (A)

Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Output Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (15 of 39)

System Setpoints and Settings (Cont.)

51 – Inverse Time Phase Overcurrent

51 – #1 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Current Selection:
❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4
Inverse Time Curves:
❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

51 – #2 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Current Selection:
❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4
Inverse Time Curves:
❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (16 of 39)

System Setpoints and Settings (Cont.)

51 – Inverse Time Phase Overcurrent (Cont.)

51 – #3 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4

Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

51 – #4 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4

Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (17 of 39)

System Setpoints and Settings (Cont.)

51N – Inverse Time Residual Overcurrent

51N – #1 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 6.00 (A)
Time Dial: _____ 0.5 – 11.0
Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4

Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

51N – #2 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 6.00 (A)
Time Dial: _____ 0.5 – 11.0
Current Selection:

❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4

Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (18 of 39)

System Setpoints and Settings (Cont.)

51N – Inverse Time Residual Overcurrent (Cont.)

51N – #3 ❑ Disable ❑ Enable

Pickup: ______ 0.50 – 6.00 (A)
Time Dial: ______ 0.5 – 11.0
Current Selection:
❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4
Inverse Time Curves:
❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

51N – #4 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: ______ 0.50 – 6.00 (A)
Time Dial: ______ 0.5 – 11.0
Current Selection:
❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3 ❑ Winding 4
Inverse Time Curves:
❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (19 of 39)

System Setpoints and Settings (Cont.)

51G – Inverse Time Ground Overcurrent

51G – W2 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

51G – W3 ❑ Disable ❑ Enable

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Inverse Time Curves:

❑ BECO Definite Time ❑ BECO Inverse ❑ BECO Very Inverse
❑ BECO Extremely Inverse ❑ IEC Inverse ❑ IEC Very Inverse
❑ IEC Extremely Inverse ❑ IEC Long Time Inverse
❑ IEEE Moderately Inverse ❑ IEEE Very Inverse ❑ IEEE Extremely Inverse

I/O Selection:

Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (20 of 39)

System Setpoints and Settings (Cont.)

51G – Inverse Time Ground Overcurrent (Cont.)

51G – W4 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 0.50 – 12.00 (A)
Time Dial: _____ 0.5 – 11.0
Inverse Time Curves:

❑ BECO Definite Time	❑ BECO Inverse	❑ BECO Very Inverse
❑ BECO Extremely Inverse	❑ IEC Inverse	❑ IEC Very Inverse
❑ IEC Extremely Inverse	❑ IEC Long Time Inverse	
❑ IEEE Moderately Inverse	❑ IEEE Very Inverse	❑ IEEE Extremely Inverse

I/O Selection:

Outputs

❑ #1	❑ #2	❑ #3	❑ #4	❑ #5	❑ #6	❑ #7	❑ #8
❑ #9	❑ #10	❑ #11	❑ #12	❑ #13	❑ #14	❑ #15	❑ #16

Blocking Inputs

❑ #1	❑ #2	❑ #3	❑ #4	❑ #5	❑ #6	❑ #7	❑ #8	❑ #9
❑ #10	❑ #11	❑ #12	❑ #13	❑ #14	❑ #15	❑ #16	❑ #17	❑ #18

Figure A-4 System Setpoints and Settings (21 of 39)

System Setpoints and Settings (Cont.)

59 – Phase Overvoltage (Only available in Two or Three Winding applications)

59 – #1 ❑ Disable ❑ Enable

Pickup: _____ 5 – 180 (V)
Time Delay: _____ 1 – 8160 (Cycles)
Input Voltage Select ❑ Phase ❑ Positive Sequence ❑ Negative Sequence
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

59 – #2 ❑ Disable ❑ Enable

Pickup: _____ 5 – 180 (V)
Time Delay: _____ 1 – 8160 (Cycles)
Input Voltage Select ❑ Phase ❑ Positive Sequence ❑ Negative Sequence
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

59 – #3 ❑ Disable ❑ Enable

Pickup: _____ 5 – 180 (V)
Time Delay: _____ 1 – 8160 (Cycles)
Input Voltage Select ❑ Phase ❑ Positive Sequence ❑ Negative Sequence
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (22 of 39)

System Setpoints and Settings (Cont.)

59G–Ground Overvoltage (Only available in four-winding applications)

59G– #1 ❑ Disable ❑ Enable

Pickup: ______ 5–180 (V)
Time Delay: ______ 1 –8160 (Cycles)
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

59G– #2 ❑ Disable ❑ Enable

Pickup: ______ 5–180 (V)
Time Delay: ______ 1 –8160 (Cycles)
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (23 of 39)

System Setpoints and Settings (Cont.)

59G – Ground Overvoltage (Only available in Two or Three Winding applications)

59G – #1 ❑ Disable ❑ Enable

Pickup: _____ 5 – 180 (V)
Time Delay: _____ 1 – 8160 (Cycles)
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

59G – #2 ❑ Disable ❑ Enable

Pickup: _____ 5 – 180 (V)
Time Delay: _____ 1 – 8160 (Cycles)
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

59G – #3 ❑ Disable ❑ Enable

Pickup: _____ 5 – 180 (V)
Time Delay: _____ 1 – 8160 (Cycles)
I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Zero Sequence Voltage ❑ V_G ❑ $3V_0$

■ **NOTE:** This setting is only functional with firmware version V02.03.01 and later.

Figure A-4 System Setpoints and Settings (24 of 39)

System Setpoints and Settings (Cont.)

81 – Over/Under Frequency

81 – #1 ❑ Disable ❑ Enable

Pickup: _____ 55.00 – 65.00 (Hz)
Time Delay: _____ 2 – 65500 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

81 – #2 ❑ Disable ❑ Enable

Pickup: _____ 55.00 – 65.00 (Hz)
Time Delay: _____ 2 – 65500 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

81 – #3 ❑ Disable ❑ Enable

Pickup: _____ 55.00 – 65.00 (Hz)
Time Delay: _____ 2 – 65500 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

81 – #4 ❑ Disable ❑ Enable

Pickup: _____ 55.00 – 65.00 (Hz))
Time Delay: _____ 2 – 65500 (Cycles)
I/O Selection:
Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16
Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (25 of 39)

System Setpoints and Settings (Cont.)

87 – Phase Differential Current

87T ❑ Disable ❑ Enable

Pickup: _____ 0.10 – 1.00 (PU)

Percent Slope #1: _____ 5 – 100 (%)

Percent Slope #2: _____ 5 – 200 (%)

Slope Break Point: _____ 1.0 – 4.0 (PU)

Even Harmonics Restraint ❑ Disable ❑ Enable ❑ Enable w/cross average
(2nd and 4th) Restraint: _____ 5 – 50 (%)

5th Harmonic Restraint ❑ Disable ❑ Enable ❑ Enable w/cross average

Restraint: _____ 5 – 50 (%)

Pickup: _____ 0.10 – 2.00 (PU)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87H ❑ Disable ❑ Enable

Pickup: _____ 5.0 – 20.0 (PU)

Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87 CT Tap

Winding 1 CT Tap: _____ 1.00 – 100.00

Winding 2 CT Tap: _____ 1.00 – 100.00

Winding 3 CT Tap: _____ 1.00 – 100.00

Winding 4 CT Tap: _____ 1.00 – 100.00 (Not available in Two or Three Winding applications)

Figure A-4 System Setpoints and Settings (26 of 39)

System Setpoints and Settings (Cont.)

87GD – Ground Differential

87GD-W2-#1 ❑ Disable ❑ Enable

Pickup: _____ 0.20 – 10.0 (A)

Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87GD-W2-#2 ❑ Disable ❑ Enable

Pickup: _____ 0.20 – 10.0 (A)

Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87GD-W2-Settings

$3I_O$ Current Selection: ❑ Summing 1 ❑ Summing 2 ❑ Winding 2

Directional Element: ❑ Disable ❑ Enable

CT Ratio Correction: _____ 0.10 – 7.99

Figure A-4 System Setpoints and Settings (27 of 39)

System Setpoints and Settings (Cont.)

87GD–Ground Differential (Cont.)

87GD-W3-#1 ❑ Disable ❑ Enable

Pickup: _____ 0.20–10.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87GD-W3-#2 ❑ Disable ❑ Enable

Pickup: _____ 0.20–10.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87GD-W3-Settings

$3I_O$ Current Selection: ❑ Summing 1 ❑ Summing 2 ❑ Winding 3

Directional Element: ❑ Disable ❑ Enable

CT Ratio Correction: _____ 0.10–7.99

Figure A-4 System Setpoints and Settings (28 of 39)

System Setpoints and Settings (Cont.)

87GD–Ground Differential (Cont.)

87GD-W4-#1 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 0.20–10.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87GD-W4-#2 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 0.20–10.0 (A)

Time Delay: _____ 1 –8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

87GD-W4-Settings (Not available in Two or Three Winding applications)

$3I_O$ Current Selection: ❑ Summing 1 ❑ Summing 2 ❑ Winding 4

Directional Element: ❑ Disable ❑ Enable

CT Ratio Correction: _____ 0.10–7.99

Figure A-4 System Setpoints and Settings (29 of 39)

System Setpoints and Settings (Cont.)

IPSlogic

#1 ❑ Disable ❑ Enable

Initiating Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Initiating Outputs Logic Gate: ❑ OR ❑ AND

Initiating 87H/TPhase: ❑ A ❑ B ❑ C

Initiating Function Trip:

❑ 24DT#1 ❑ 24DT #2 ❑ 24IT ❑ 27 #1 ❑ 27 #2 ❑ 27 #3 ❑ 46DT-W2 ❑ 46IT-W2 ❑ 46DT-W3 ❑ 46IT-W3 ❑ 49 ❑ 50 #1 ❑ 50 #2 ❑ 50 #3 ❑ 50 #4 ❑ 50 #5 ❑ 50 #6 ❑ 50BF-W1 ❑ 50BF-W2 ❑ 50BF-W3 ❑ 50G-W2 #1 ❑ 50G-W2 #2 ❑ 50G-W3 #1 ❑ 50G-W3 #2 ❑ 50N#1 ❑ 50N#2 ❑ 50N#3 ❑ 50N#4 ❑ 50N#5 ❑ 50N#6 ❑ 51#1 ❑ 51#2 ❑ 51#3 ❑ 51G-W2 ❑ 51G-W3 ❑ 51N#1 ❑ 51N#2 ❑ 51N#3 ❑ 59#1 ❑ 59#2

❑ 59#3 ❑ 59G#1 ❑ 59G#2 ❑ 59G#3 ❑ 81#1

❑ 81#2 ❑ 81#3 ❑ 81#4 ❑ 87H ❑ 87T

❑ 87GD-W2 #1 ❑ 87GD-W2 #2 ❑ 87GD-W3 #1 ❑ 87GD-W3 #2 ❑ TF

❑ TCM ❑ IPSlogic #2 ❑ IPSlogic #3 ❑ IPSlogic #4 ❑ IPSlogic #5 ❑ IPSlogic #6 ❑ BM-W1 ❑ BM-W2 ❑ BM-W3

Initiating 87H/T Phase Logic Gate: ❑ OR ❑ AND

Initiating 87H/T Phase Logic Gate: ❑ --- ❑ NOT

Initiating Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiate via Communication Point: ❑

Blocking Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiating Inputs Logic Gate: ❑ None ❑ NOT

Block via Communication Point: ❑

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: ❑ OR ❑ AND

Delay: ______ 1 – 65500 (Cycles)

Reset/Dropout Delay: ______ 0 – 65500 (Cycles) ❑ Reset ❑ Dropout

Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Reset Latched Outputs ❑

Profile Switch: ❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ Not Activated

Figure A-4 System Setpoints and Settings (30 of 39)

System Setpoints and Settings (Cont.)

IPSlogic

#2 ❑ Disable ❑ Enable

Initiating Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Initiating Outputs Logic Gate: ❑ OR ❑ AND

Initiating 87H/TPhase: ❑ A ❑ B ❑ C

Initiating Function Trip:

❑ 24DT#1 ❑ 24DT #2 ❑ 24IT ❑ 27 #1 ❑ 27 #2 ❑ 27 #3 ❑ 46DT-W2 ❑ 46IT-W2 ❑ 46DT-W3 ❑ 46IT-W3 ❑ 49 ❑ 50 #1 ❑ 50 #2 ❑ 50 #3 ❑ 50 #4 ❑ 50 #5 ❑ 50 #6 ❑ 50BF-W1 ❑ 50BF-W2 ❑ 50BF-W3 ❑ 50G-W2 #1 ❑ 50G-W2 #2 ❑ 50G-W3 #1 ❑ 50G-W3 #2 ❑ 50N#1 ❑ 50N#2 ❑ 50N#3 ❑ 50N#4 ❑ 50N#5 ❑ 50N#6 ❑ 51#1 ❑ 51#2 ❑ 51#3 ❑ 51G-W2 ❑ 51G-W3 ❑ 51N#1 ❑ 51N#2 ❑ 51N#3 ❑ 59#1 ❑ 59#2

❑ 59#3 ❑ 59G#1 ❑ 59G#2 ❑ 59G#3 ❑ 81#1

❑ 81#2 ❑ 81#3 ❑ 81#4 ❑ 87H ❑ 87T

❑ 87GD-W2 #1 ❑ 87GD-W2 #2 ❑ 87GD-W3 #1 ❑ 87GD-W3 #2 ❑ TF

❑ TCM ❑ IPSlogic #1 ❑ IPSlogic #3 ❑ IPSlogic #4 ❑ IPSlogic #5 ❑ IPSlogic #6 ❑ BM-W1 ❑ BM-W2 ❑ BM-W3

Initiating 87H/T Phase Logic Gate: ❑ OR ❑ AND

Initiating 87H/T Phase Logic Gate: ❑ --- ❑ NOT

Initiating Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiate via Communication Point: ❑

Blocking Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiating Inputs Logic Gate: ❑ None ❑ NOT

Block via Communication Point: ❑

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: ❑ OR ❑ AND

Delay: ______ 1 – 65500 (Cycles)

Reset/Dropout Delay: ______ 0 – 65500 (Cycles) ❑ Reset ❑ Dropout

Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Reset Latched Outputs ❑

Profile Switch: ❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ Not Activated

Figure A-4 System Setpoints and Settings (31 of 39)

System Setpoints and Settings (Cont.)

IPSlogic

#3 ❑ Disable ❑ Enable

Initiating Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Initiating Outputs Logic Gate: ❑ OR ❑ AND

Initiating 87H/TPhase: ❑ A ❑ B ❑ C

Initiating Function Trip:

❑ 24DT#1 ❑ 24DT #2 ❑ 24IT ❑ 27 #1 ❑ 27 #2 ❑ 27
#3 ❑ 46DT-W2 ❑ 46IT-W2 ❑ 46DT-W3 ❑ 46IT-W3 ❑ 49
❑ 50 #1 ❑ 50 #2 ❑ 50 #3 ❑ 50 #4 ❑ 50 #5 ❑ 50
#6 ❑ 50BF-W1 ❑ 50BF-W2 ❑ 50BF-W3 ❑ 50G-W2 #1 ❑ 50G-
W2 #2 ❑ 50G-W3 #1 ❑ 50G-W3 #2 ❑ 50N#1 ❑ 50N#2 ❑
50N#3 ❑ 50N#4 ❑ 50N#5 ❑ 50N#6 ❑ 51#1 ❑ 51#2 ❑ 51#3
❑ 51G-W2 ❑ 51G-W3 ❑ 51N#1 ❑ 51N#2 ❑ 51N#3 ❑ 59#1
❑ 59#2
❑ 59#3 ❑ 59G#1 ❑ 59G#2 ❑ 59G#3 ❑ 81#1
❑ 81#2 ❑ 81#3 ❑ 81#4 ❑ 87H ❑ 87T
❑ 87GD-W2 #1 ❑ 87GD-W2 #2 ❑ 87GD-W3 #1 ❑ 87GD-W3 #2 ❑ TF
❑ TCM ❑ IPSlogic #1 ❑ IPSlogic #2 ❑ IPSlogic #4 ❑ IPSlogic #5 ❑
IPSlogic #6 ❑ BM-W1 ❑ BM-W2 ❑ BM-W3

Initiating 87H/T Phase Logic Gate: ❑ OR ❑ AND

Initiating 87H/T Phase Logic Gate: ❑ --- ❑ NOT

Initiating Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiate via Communication Point: ❑

Blocking Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiating Inputs Logic Gate: ❑ None ❑ NOT

Block via Communication Point: ❑

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: ❑ OR ❑ AND

Delay: ______ 1 – 65500 (Cycles)

Reset/Dropout Delay: ______ 0 – 65500 (Cycles) ❑ Reset ❑ Dropout

Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Reset Latched Outputs ❑

Profile Switch: ❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ Not Activated

Figure A-4 System Setpoints and Settings (32 of 39)

System Setpoints and Settings (Cont.)

IPSlogic

#4 ❑ Disable ❑ Enable

Initiating Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Initiating Outputs Logic Gate: ❑ OR ❑ AND

Initiating 87H/TPhase: ❑ A ❑ B ❑ C

Initiating Function Trip:

❑ 24DT#1 ❑ 24DT #2 ❑ 24IT ❑ 27 #1 ❑ 27 #2 ❑ 27
#3 ❑ 46DT-W2 ❑ 46IT-W2 ❑ 46DT-W3 ❑ 46IT-W3 ❑ 49
❑ 50 #1 ❑ 50 #2 ❑ 50 #3 ❑ 50 #4 ❑ 50 #5 ❑ 50
#6 ❑ 50BF-W1 ❑ 50BF-W2 ❑ 50BF-W3 ❑ 50G-W2 #1 ❑ 50G-
W2 #2 ❑ 50G-W3 #1 ❑ 50G-W3 #2 ❑ 50N#1 ❑ 50N#2 ❑
50N#3 ❑ 50N#4 ❑ 50N#5 ❑ 50N#6 ❑ 51#1 ❑ 51#2 ❑ 51#3
❑ 51G-W2 ❑ 51G-W3 ❑ 51N#1 ❑ 51N#2 ❑ 51N#3 ❑ 59#1
❑ 59#2
❑ 59#3 ❑ 59G#1 ❑ 59G#2 ❑ 59G#3 ❑ 81#1
❑ 81#2 ❑ 81#3 ❑ 81#4 ❑ 87H ❑ 87T
❑ 87GD-W2 #1 ❑ 87GD-W2 #2 ❑ 87GD-W3 #1 ❑ 87GD-W3 #2 ❑ TF
❑ TCM ❑ IPSlogic #1 ❑ IPSlogic #2 ❑ IPSlogic #3 ❑ IPSlogic #5 ❑
IPSlogic #6 ❑ BM-W1 ❑ BM-W2 ❑ BM-W3

Initiating 87H/T Phase Logic Gate: ❑ OR ❑ AND

Initiating 87H/T Phase Logic Gate: ❑ --- ❑ NOT

Initiating Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiate via Communication Point: ❑

Blocking Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND

Initiating Inputs Logic Gate: ❑ None ❑ NOT

Block via Communication Point: ❑

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: ❑ OR ❑ AND

Delay: ______ 1 – 65500 (Cycles)

Reset/Dropout Delay: ______ 0 – 65500 (Cycles) ❑ Reset ❑ Dropout

Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Reset Latched Outputs ❑

Profile Switch: ❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ Not Activated

Figure A-4 System Setpoints and Settings (33 of 39)

System Setpoints and Settings (Cont.)

IPSlogic

#5 ❑ Disable ❑ Enable

Initiating Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Initiating Outputs Logic Gate: ❑ OR ❑ AND
Initiating 87H/TPhase: ❑ A ❑ B ❑ C

Initiating Function Trip:

❑ 24DT#1 ❑ 24DT #2 ❑ 24IT ❑ 27 #1 ❑ 27 #2 ❑ 27
#3 ❑ 46DT-W2 ❑ 46IT-W2 ❑ 46DT-W3 ❑ 46IT-W3 ❑ 49
❑ 50 #1 ❑ 50 #2 ❑ 50 #3 ❑ 50 #4 ❑ 50 #5 ❑ 50
#6 ❑ 50BF-W1 ❑ 50BF-W2 ❑ 50BF-W3 ❑ 50G-W2 #1 ❑ 50G-
W2 #2 ❑ 50G-W3 #1 ❑ 50G-W3 #2 ❑ 50N#1 ❑ 50N#2 ❑
50N#3 ❑ 50N#4 ❑ 50N#5 ❑ 50N#6 ❑ 51#1 ❑ 51#2 ❑ 51#3
❑ 51G-W2 ❑ 51G-W3 ❑ 51N#1 ❑ 51N#2 ❑ 51N#3 ❑ 59#1
❑ 59#2
❑ 59#3 ❑ 59G#1 ❑ 59G#2 ❑ 59G#3 ❑ 81#1
❑ 81#2 ❑ 81#3 ❑ 81#4 ❑ 87H ❑ 87T
❑ 87GD-W2 #1 ❑ 87GD-W2 #2 ❑ 87GD-W3 #1 ❑ 87GD-W3 #2 ❑ TF
❑ TCM ❑ IPSlogic #1 ❑ IPSlogic #2 ❑ IPSlogic #3 ❑ IPSlogic #4 ❑
IPSlogic #6 ❑ BM-W1 ❑ BM-W2 ❑ BM-W3

Initiating 87H/T Phase Logic Gate: ❑ OR ❑ AND
Initiating 87H/T Phase Logic Gate: ❑ --- ❑ NOT
Initiating Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND
Initiate via Communication Point: ❑

Blocking Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND
Initiating Inputs Logic Gate: ❑ None ❑ NOT
Block via Communication Point: ❑

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: ❑ OR ❑ AND
Delay: ______ 1–65500 (Cycles)
Reset/Dropout Delay: ______ 0 –65500 (Cycles) ❑ Reset ❑ Dropout

Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Reset Latched Outputs ❑

Profile Switch: ❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ Not Activated

Figure A-4 System Setpoints and Settings (34 of 39)

System Setpoints and Settings (Cont.)

IPSlogic

#6 ❑ Disable ❑ Enable

Initiating Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Initiating Outputs Logic Gate: ❑ OR ❑ AND
Initiating 87H/TPhase: ❑ A ❑ B ❑ C

Initiating Function Trip:

❑ 24DT#1 ❑ 24DT #2 ❑ 24IT ❑ 27 #1 ❑ 27 #2 ❑ 27
#3 ❑ 46DT-W2 ❑ 46IT-W2 ❑ 46DT-W3 ❑ 46IT-W3 ❑ 49
❑ 50 #1 ❑ 50 #2 ❑ 50 #3 ❑ 50 #4 ❑ 50 #5 ❑ 50
#6 ❑ 50BF-W1 ❑ 50BF-W2 ❑ 50BF-W3 ❑ 50G-W2 #1 ❑ 50G-
W2 #2 ❑ 50G-W3 #1 ❑ 50G-W3 #2 ❑ 50N#1 ❑ 50N#2 ❑
50N#3 ❑ 50N#4 ❑ 50N#5 ❑ 50N#6 ❑ 51#1 ❑ 51#2 ❑ 51#3
❑ 51G-W2 ❑ 51G-W3 ❑ 51N#1 ❑ 51N#2 ❑ 51N#3 ❑ 59#1
❑ 59#2
❑ 59#3 ❑ 59G#1 ❑ 59G#2 ❑ 59G#3 ❑ 81#1
❑ 81#2 ❑ 81#3 ❑ 81#4 ❑ 87H ❑ 87T
❑ 87GD-W2 #1 ❑ 87GD-W2 #2 ❑ 87GD-W3 #1 ❑ 87GD-W3 #2 ❑ TF
❑ TCM ❑ IPSlogic #1 ❑ IPSlogic #2 ❑ IPSlogic #3 ❑ IPSlogic #4 ❑
IPSlogic #5 ❑ BM-W1 ❑ BM-W2 ❑ BM-W3

Initiating 87H/T Phase Logic Gate: ❑ OR ❑ AND
Initiating 87H/T Phase Logic Gate: ❑ --- ❑ NOT
Initiating Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND
Initiate via Communication Point: ❑

Blocking Inputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Initiating Inputs Logic Gate: ❑ OR ❑ AND
Initiating Inputs Logic Gate: ❑ None ❑ NOT
Block via Communication Point: ❑

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: ❑ OR ❑ AND
Delay: ______ 1 – 65500 (Cycles)
Reset/Dropout Delay: ______ 0 – 65500 (Cycles) ❑ Reset ❑ Dropout

Outputs:

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Reset Latched Outputs ❑

Profile Switch: ❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ Not Activated

Figure A-4 System Setpoints and Settings (35 of 39)

System Setpoints and Settings (Cont.)

BM – Breaker Monitor

BM–W1 ❑ Disable ❑ Enable

Pickup: ______ 1 – 50000 (kA Cycles)

Time Delay: ______ 0.1 – 4095.9 (Cycles)

Timing Method Selection ❑ IT ❑ I^2T

Preset Accumulator Phase A: ______ 0 – 50000 (kA Cycles)

Preset Accumulator Phase B: ______ 0 – 50000 (kA Cycles)

Preset Accumulator Phase C: ______ 0 – 50000 (kA Cycles)

I/O Selection:

Outputs Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

BM–W2 ❑ Disable ❑ Enable

Pickup: ______ 1 – 50000 (kA Cycles)

Time Delay: ______ 0.1 – 4095.9 (Cycles)

Timing Method Selection ❑ IT ❑ I^2T

Preset Accumulator Phase A: ______ 0 – 50000 (kA Cycles)

Preset Accumulator Phase B: ______ 0 – 50000 (kA Cycles)

Preset Accumulator Phase C: ______ 0 – 50000 (kA Cycles)

I/O Selection:

Outputs Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (36 of 39)

System Setpoints and Settings (Cont.)

BM–Breaker Monitor (Cont.)

BM–W3 ❑ Disable ❑ Enable

Pickup: ______ 1–50000 (kA Cycles)

Time Delay: ______ 0.1 –4095.9 (Cycles)

Timing Method Selection ❑ IT ❑ I^2T

Preset Accumulator Phase A: ______ 0 –50000 (kA Cycles)

Preset Accumulator Phase B: ______ 0 –50000 (kA Cycles)

Preset Accumulator Phase C: ______ 0 –50000 (kA Cycles)

I/O Selection:

Outputs Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

BM–W4 ❑ Disable ❑ Enable (Not available in Two or Three Winding applications)

Pickup: ______ 1–50000 (kA Cycles)

Time Delay: ______ 0.1 –4095.9 (Cycles)

Timing Method Selection ❑ IT ❑ I^2T

Preset Accumulator Phase A: ______ 0 –50000 (kA Cycles)

Preset Accumulator Phase B: ______ 0 –50000 (kA Cycles)

Preset Accumulator Phase C: ______ 0 –50000 (kA Cycles)

I/O Selection:

Outputs Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8

❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Input Initiate

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9

❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (37 of 39)

System Setpoints and Settings (Cont.)

TCM #1 – Trip Circuit Monitor ❑ Disable ❑ Enable

Delay: _____ 1 – 8160 (Cycles)

Dropout Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

TCM #2 – Trip Circuit Monitor ❑ Disable ❑ Enable

Delay: _____ 1 – 8160 (Cycles)

Dropout Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

CCM #1 – Close Circuit Monitor ❑ Disable ❑ Enable

Delay: _____ 1 – 8160 (Cycles)

Dropout Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

CCM #2 – Close Circuit Monitor ❑ Disable ❑ Enable

Delay: _____ 1 – 8160 (Cycles)

Dropout Time Delay: _____ 1 – 8160 (Cycles)

I/O Selection:

Outputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs

❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (38 of 39)

System Setpoints and Settings (Cont.)

TF – Through Fault ❑ Disable ❑ Enable

Through Fault Current Threshold: _____ 1.0 – 100.0 (A)
Through Fault Current Time Delay: _____ 1 – 8160 (Cycles)
Pickup Operation limit: _____ 1 – 65535
Cumulative I^2T Limit: _____ 1 – 1000000 (kA^2 Cycles)
Current Selection: ❑ Summing 1 ❑ Summing 2 ❑ Winding 1
❑ Winding 2 ❑ Winding 3

Inrush Block by Even Harmonics: ❑ Disable ❑ Enable
Preset Cumulative I^2T: _____ 0 – 1000000 (kA^2 Cycles)
I/O Selection:

Outputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8
❑ #9 ❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16

Blocking Inputs
❑ #1 ❑ #2 ❑ #3 ❑ #4 ❑ #5 ❑ #6 ❑ #7 ❑ #8 ❑ #9
❑ #10 ❑ #11 ❑ #12 ❑ #13 ❑ #14 ❑ #15 ❑ #16 ❑ #17 ❑ #18

Figure A-4 System Setpoints and Settings (39 of 39)

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B Communications

The M-3311A Transformer Protection Relay incorporates three serial ports for intelligent, digital communication with external devices. Equipment such as RTUs, data concentrators, modem, or computers can be interfaced for direct, on-line real time data acquisition and control.

Generally, all data available to the operator through the front panel of the relay with the HMI is also accessible remotely through the BECO 2200 data exchange protocol. This protocol document and the BECO 2200 relay database specified protocol document are available from the factory or our website at www.beckwithelectric.com.

The S-3300 IPScom Communication Software package has been supplied for communication to any IBM compatible computer running under Windows 95 or higher.

The protocol implements serial, byte oriented, asynchronous communication, and can be used to fulfill the following communications functions:

- Real time monitoring of line status.
- Interrogation and modification of setpoints.
- Downloading of recorded oscillograph data.
- Reconfiguration of functions.

■ **NOTE:** The following restrictions apply for MODBUS protocol use:

1. MODBUS protocol is not supported on **COM1**
2. Parity is supported on **COM2** and **COM3** only, valid selections are 8,N,1; 8,O,1; 8,E,1; 8,N,2; 8,O,2; 8,E,2.
3. ASCII mode is not supported (RTU only)
4. Standard baud rates from 300 to 9600 are supported.
5. Only the following MODBUS commands are supported:
   a. Read holding register (function 03)
   b. Read input register (function 04)
   c. Force single coil (function 05)
   d. Preset single register (function 06)

For detailed information about communications, refer to **Chapter 3**, **IPScom Operation.**

DNP Configuration Parameters

M-3311A relays support DNP through the rear RS-232 (COM2) & RS-485 (COM3) communication ports. These ports support baud rates 300, 600, 1200, 2400, 4800, 9600 (default baud rate is 9600). See Figure A-3, Communication Data & Unit Setup, for sequence of DNP setup screens.

M-3311 Slave Address

DNP3 Slave IED address range is from 0 to 65519. Address 65535 (hex FFFF) is used to broadcast messages to all devices. The communication address can be set through the HMI (front panel; optional).

The DNP3 device profile document, including the point list, is available from the factory or our website, www.beckwithelectric.com.

The following restrictions apply for DNP3 protocol use:

- DNP3 is not supported on COM1.
- Parity is not supported.
- DNP3 does not support oscillograph record downloading.

The communication database profile in M-3311A using DNP3 protocol is grouped into five object types:

1. **Single Bit Binary Inputs (Status)**: (object 01, variation 01) These are considered as class 0 data.
2. **16 Bit Analog Output Block /Status (setpoints)**: (object 40, variation 01, variation 02/object 41, variation 01, variation 02) Used to write and read all setpoints and system setup.
3. **Control Relay Output Block (direct control)**: (object 12, variation 01) Used to write all configuration points.
4. **16 Bit Analog Inputs**: (object 30, variation 02) Used to represent all demand metering, target information, and control information of the relay.
5. **16 Bit Binary Counters**: (object 20, variation 02, variation 06) Used to represent all counters. Can be used to reset the counters using freeze and clear function code.
6. **Static (class 0) Data**: (object 60, variation 01) Used to represent all binary inputs, demand metering, target and control information, and counters. All points in the M-3311A relay are of static type, meaning that an integrity poll will dump all data to the querying RTU.

Communication Ports

The relay has both front and rear panel RS-232 ports and a rear RS-485 port. The front and rear panel RS-232 ports are 9-pin (DB9S) connector configured as DTE (Data Terminal Equipment) per the EIA-232D standard. Signals are defined in Table B-1, Communication Port Signals .

The 2-wire RS-485 port is assigned to the rear panel terminal block pins 3 (-) and 4 (+).

Each communication port may be configured to operate at any of the standard baud rates (300, 600, 1200, 2400, 4800, and 9600). The RS-485 port shares the same baud rate with COM 2 (for COM1 see **Section 5.4**, **Circuit Board Switches and Jumpers**).

While the digital communication ports do include some ESD (Electrostatic Discharge) protection circuitry, they are excluded from passing ANSI/IEEE C37.90.1-1989. Beckwith Electric recommends the use of RS-232/485 to fiber optic converters to avoid any question of surge-withstand capability or ground potential rise.

A null modem cable is also shown in Figure B-1, Null Modem Cable: M-0423, if direct connection to a PC (personal computer) is desired.

Circuit		Signal	COM 1	COM 2
BB	RX	Receive Data	Pin 2	Pin 2
BA	TX	Transmit Data	Pin 3	Pin 3
CA	RTS	Request to Send	Pin 7	Pin 7
CB	CTS	Clear to Send		Pin 8
CD	DTR	Data Terminal Ready	Pin 4	Pin 4
CF	DCD	Data Carrier Detect		Pin 1
AB	GND	Signal Ground	Pin 5	Pin 5
		+15 V		Pin 1*
		-15 V		Pin 9*
		IRIG-B (+)		Pin 6*

OPTIONAL - See Section 5.5, **Circuit Board Switches and Jumpers.*
±15 V (±15%) @100 mA Max.

Table B-1 Communication Port Signals

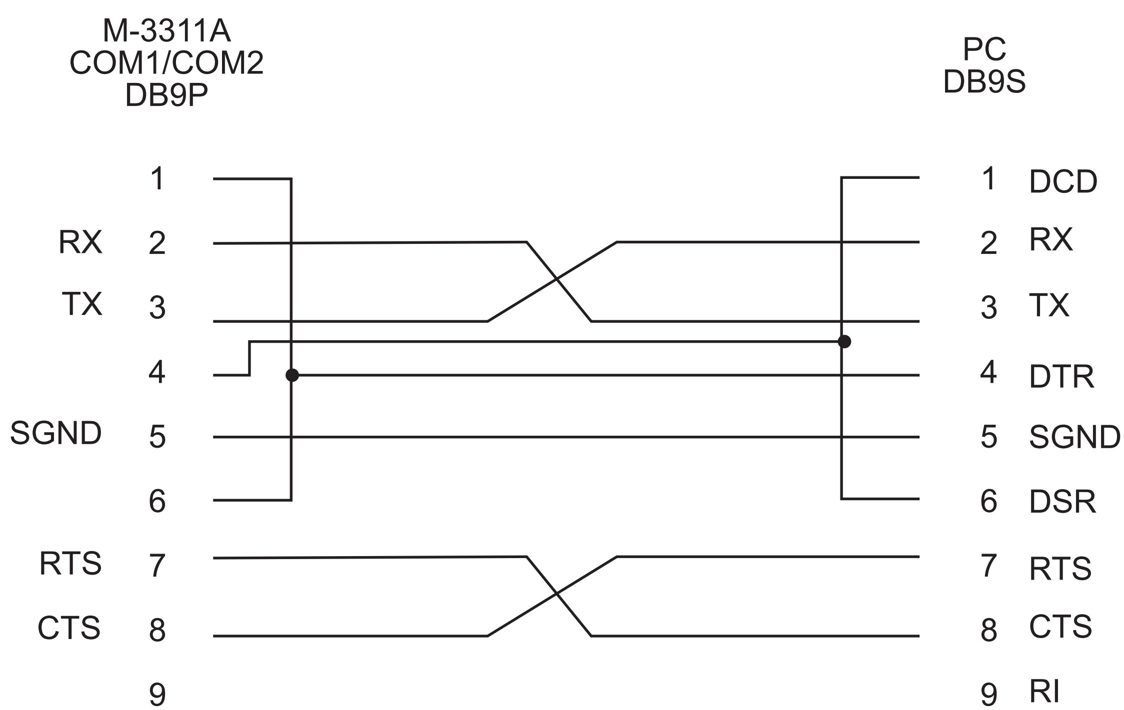


Figure B-1 Null Modem Cable for M-3311A

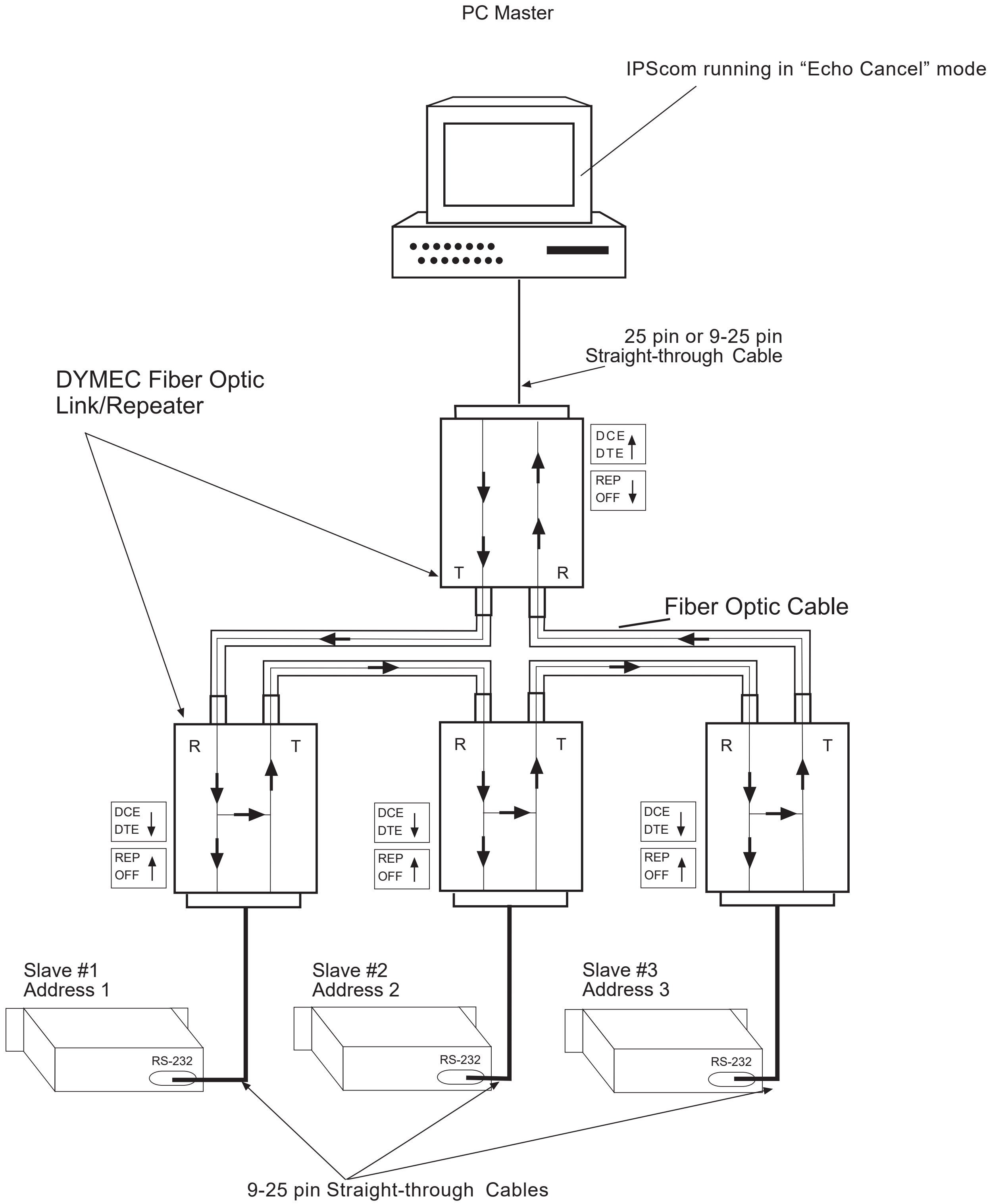
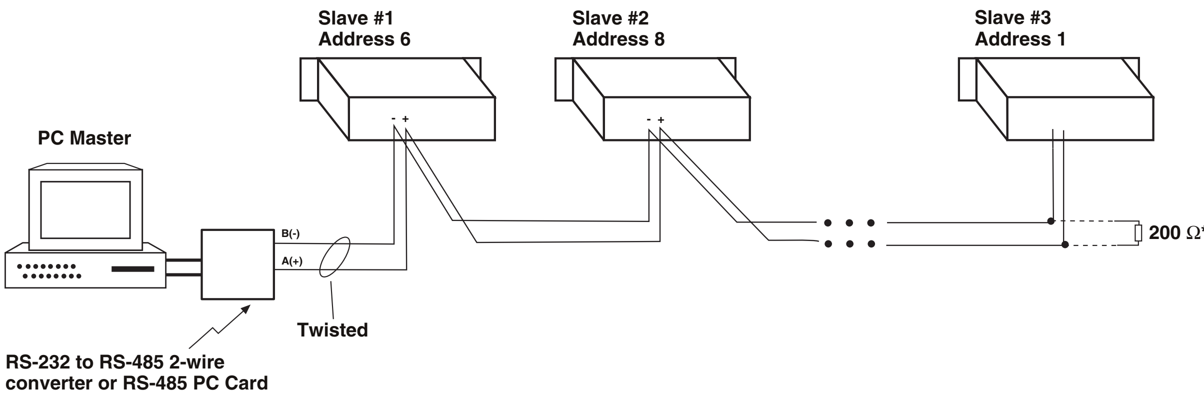


Figure B-2 RS-232 Fiber Optic Network

RS-485 2-Wire Network



▲**CAUTION:** Due to the possibility of ground potential difference between units, all units should be mounted in the same rack. If this is not possible, fiber optics with the appropriate converters should be used for isolation.

■**NOTE:** Each address on the network must be unique. Only the last physical slave on the network should have the termination resistor installed. This may be completed externally or using a dip jumper internal to the unit. See **Section 5.5**, **Circuit Board Switches and Jumpers**.

Figure B-3 RS-485 Network

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C Self-Test Error Codes

Self-Test Error Codes and Corrective Actions

When power is initially applied, the relay performs a number of self-tests to ensure proper operation. If any test should fail, the error code will be displayed on the HMI. Some self-test errors may be "HALT" errors, which will will not allow operation to proceed and the protective function of the relay is disabled. Table C-1 lists the Error Code Number, HALT Action, Name, Description and Type. Error Code **Type 1, 2 or 3** with appropriate Corrective Action is defined as follows:

TYPE 1	Immediate HALT, log the error code, and the Self-Test Alarm asserts. Corrective Action: Reboot the relay, if the error persists, contact Beckwith Electric.
TYPE 2	Increment an error count, log the error code with timestamp: If the error count is ≤ 3, restart relay without asserting the Self-Test Alarm. If the error count is ≥ 4, HALT, and Self-Test Alarm asserts. Corrective Action: Reboot the relay, if the error persists, contact Beckwith Electric.
TYPE 3	Error Log ONLY, does not affect relay operation or protective function. Corrective Action: None required.

The recommended Corrective Action to attempt to resolve a HALT Error Code is to cycle power to the relay. However, this is not always possible. In these situations, the relay can remain on-line, and be **restarted** by pressing and holding either the TARGET RESET or EXIT button, for approximately 3-4 seconds. Although this method resets the relay, and it may reset the error code, it may not reset all locked up conditions. The Error Code may occur again after the relay restarts.

Performing a power cycle reset is the Beckwith Electric recommended action whenever possible. A power cycle reset ensures that the volatile memory and CPU registers are reinitialized properly. A power cycle will also reset certain locked up conditions that are not possible to reset using the TARGET RESET or EXIT button. There are some conditions that will stay in the locked state until power is cycled to the relay.

ERROR CODE	HALT?	Error Code Name and Description	Type
2	YES	Battery Backed RAM test fail – Possible Battery Failure Corrective Action: Reboot the relay, if the error persists then change **U25**. If the error persists after battery is exchanged, contact Beckwith Electric. Beckwith Electric component **U25** is the removable lithium battery backed TIMEKEEPER Module (Figure 5-34).	1
3	YES	EEPROM write power-up fail – Non Volatile settings storage error	1
4	YES	EEPROM read back power-up fail – Non Volatile settings storage error	1
5	YES	Dual port RAM test fail – Possible internal Communication error between two processors	1
6	YES	EEPROM write calibration checksum fail – Non Volatile settings storage error	1

Table C-1 Self-Test Error Codes

ERROR CODE	HALT?	Error Code Name and Description	Type
7	YES	EEPROM write setpoint checksum fail loss of power – Non Volatile settings storage error	1
8	YES	EEPROM write setpoint checksum fail loss of battery backed RAM – Non Volatile settings storage error	1
9	YES	DMA checksum/physical block fail – Possible internal Communication error between two processors	1
10	YES	Oscillograph Memory Test fail – Possible Memory error	1
11	YES	DSP external program RAM fail – Possible Memory error	1
12	YES	DSP A/D convert fail – Possible noisy Data Acquisition circuitry	1
13	YES	DSP ground channel fail – Possible noisy Data Acquisition circuitry	1
14	YES	DSP reference channel fail – Possible noisy Data Acquisition circuitry	1
15	YES	DSP PGA gain fail – Possible noisy Data Acquisition circuitry	1
16	YES	DSP DSP<-> HOST interrupt 1 fail – Possible internal Communication error between two processors	1
17	YES	DSP DSP -> HOST interrupt 2 set fail – Possible internal Communication error between two processors	1
18	YES	DSP DSP -> HOST interrupt 2 reset fail – Possible internal Communication error between two processors	1
19	YES	DSP program load fail – Issue loading Digital Signal Processing program	1
20	YES	DSP not running run mode code – Issue running Digital Signal Processing program	1
21	YES	DSP not running primary boot code – Issue running Digital Signal Processing program	1
22	YES	DSP DPRAM pattern test fail – Possible Memory error	1
23	YES	EEPROM write verify error – Non Volatile settings storage error	1
25	YES	Uninitialized EEPROM – Non Volatile settings storage error	1
26	NO	WARNING calibration checksum mismatch – Non Volatile settings storage error	3
27	NO	WARNING setpoint checksum mismatch – Possible Non Volatile settings storage error due to the relay being rebooted before the checksum task was completed.	3
28	NO	WARNING low battery (BBRAM) – Low Battery indication, does not affect the protection that the relay is providing. The relay can remain in service with this error code present.	3

Table C-1 Self-Test Error Codes

ERROR CODE	HALT?	Error Code Name and Description	Type
29	YES	Supply/mux PGA running test fail – Possible noisy Data Acquisition circuitry	1
30	YES	External DSP RAM test fail – Possible Memory error	1
31	YES if count ≥ 4	Unrecognized INT1 code – Possible internal Communication error between two processors	2
32	YES if count ≥ 4	Values update watchdog fail – Possible internal Communication error between two processors	2
34	YES if count ≥ 4	Restart Error – Possible Memory error	2
35	YES if count ≥ 4	Interrupt Error – Possible Memory error	2
36	YES if count ≥ 4	Trap Error – Possible Memory error	2
37	YES	Calibration running check fail – Possible Memory error	1
38	NO	Ethernet Board not running (Warning) – May be due to the ethernet card being disconnected from the network. Check the internal RJ 45 network cable to ensure it is connected to the communication card securely.	3
40	NO	Interrupt noise INT2 – Possible internal spurious high speed communication error between two processors. If the error persists, check if the electrostatic condition around the relay has changed. If this condition has not changed, contact Beckwith Electric.	3
44	NO	Oscillograph buffer overflow – Noncritical error that can occur with too many Oscillograph records occurring simultaneously.	3
45	NO	Oscillograph buffer underflow – Noncritical error that can be attributed to noise	3
46	YES	Failure of DSP to calculate calibration phasors – If this error is obtained during calibration procedures, check relay connections with signal generating equipment and signals amplitude and phase magnitudes and repeat calibration procedures after reboot. If this error is obtained without calibration procedures being performed, contact Beckwith Electric without rebooting the relay if possible.	1
47	NO	Unable to calibrate input (gain) – If this error is obtained during calibration procedures, check relay connections with signal generating equipment and signals amplitude and phase magnitudes and repeat calibration procedures after reboot. If this error is obtained without calibration procedures being performed, contact Beckwith Electric without rebooting the relay if possible.	3

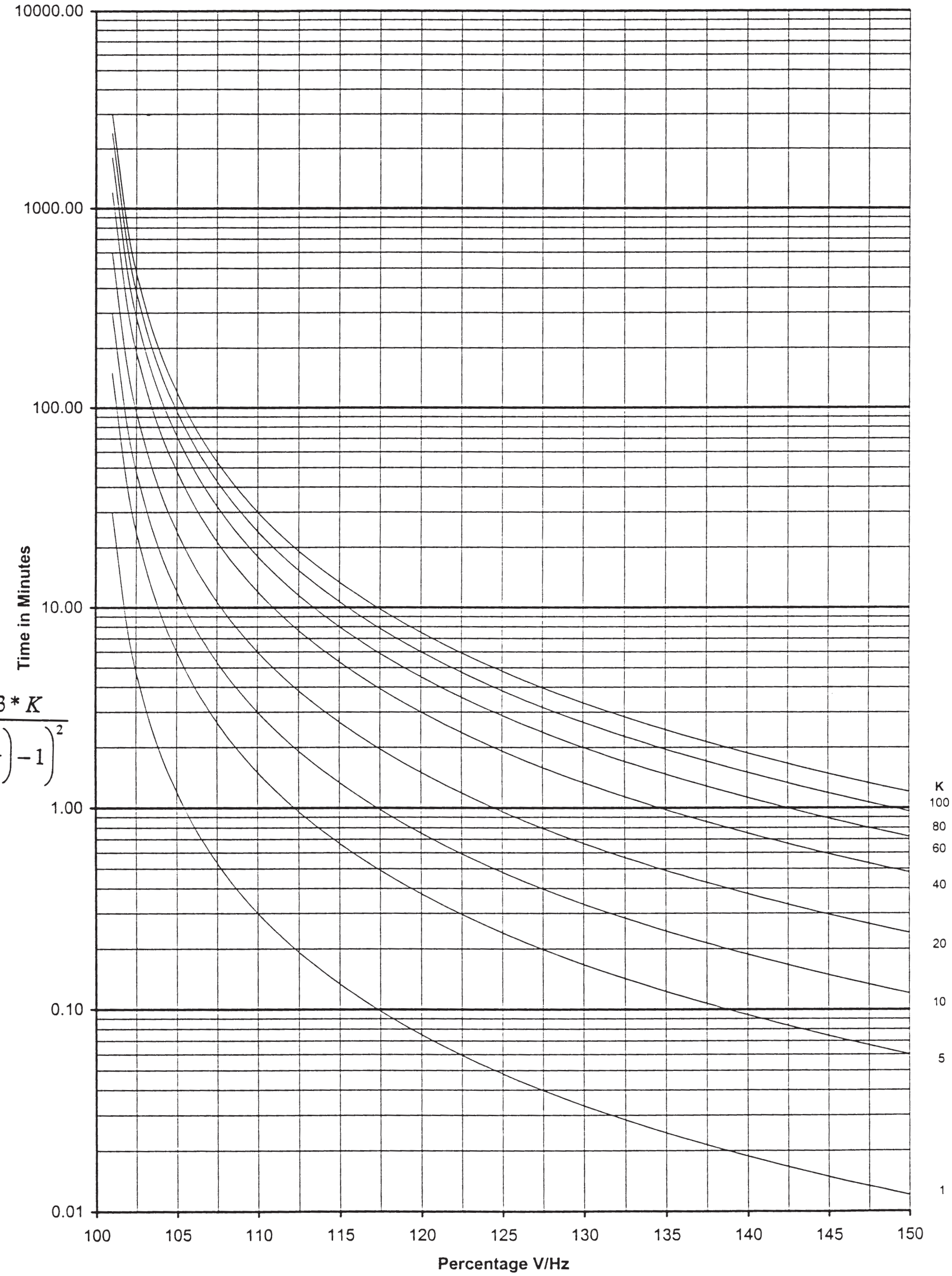
Table C-1 Self-Test Error Codes

ERROR CODE	HALT?	Error Code Name and Description	Type
48	NO	Unable to calibrate input (phase) – If this error is obtained during calibration procedures, check relay connections with signal generating equipment and signals amplitude and phase magnitudes and repeat calibration procedures after reboot. If this error is obtained without calibration procedures being performed, contact Beckwith Electric without rebooting the relay if possible.	3
50	YES if count ≥ 4	Stack Overflow – Possibly a one-time event indicating the system ran out of resources.	2
51	YES if count ≥ 4	Setpoint Write Overflow – This error occurs when the value of a setpoint was not transferred to the Digital Signal Processor in a timely manner. This could cause the relay to operate using an incorrect setting. Reboot the relay and verify that any updated settings have the correct values. If necessary, update the settings accordingly, and transfer the settings to the relay again.	2
52	–	ONLY valid in the M-3425A	–
117	YES	ADC reference voltage error – Possible noisy Data Acquisition circuitry	1
118	YES	Error ADC Timeout – Possible noisy Data Acquisition circuitry	1
119	YES	Error DRR Timeout – Possible noisy Data Acquisition circuitry	1

D Inverse Time Curves

This Appendix contains three sets of Inverse Time Curve Families. The first set is used for Volts per Hertz functions (Figure D-1 through Figure D-4), the second set is for the M-3311A functions which utilize the IEC time over current curves (Figure D-5 through Figure D-12) and the third set is for those functions that utilize the IEEE Inverse Time Overcurrent Curves (Figure D-13 through Figure D-15).

■**NOTE:** Figure D-1 through Figure D-4 are Volts per Hertz curves. Figure D-5 through Figure D-12 are inverse time curves for 51, 51N, 51G and 46 functions.



$$t = \frac{.003 * K}{\left(\left(\frac{M}{100}\right) - 1\right)^2}$$

Figure D-1 Volts/Hz (24IT) Inverse Time Curve Family #1 (Inverse Square)

$$t = e^{\frac{115+(2.5*K)-M}{4.8858}}$$

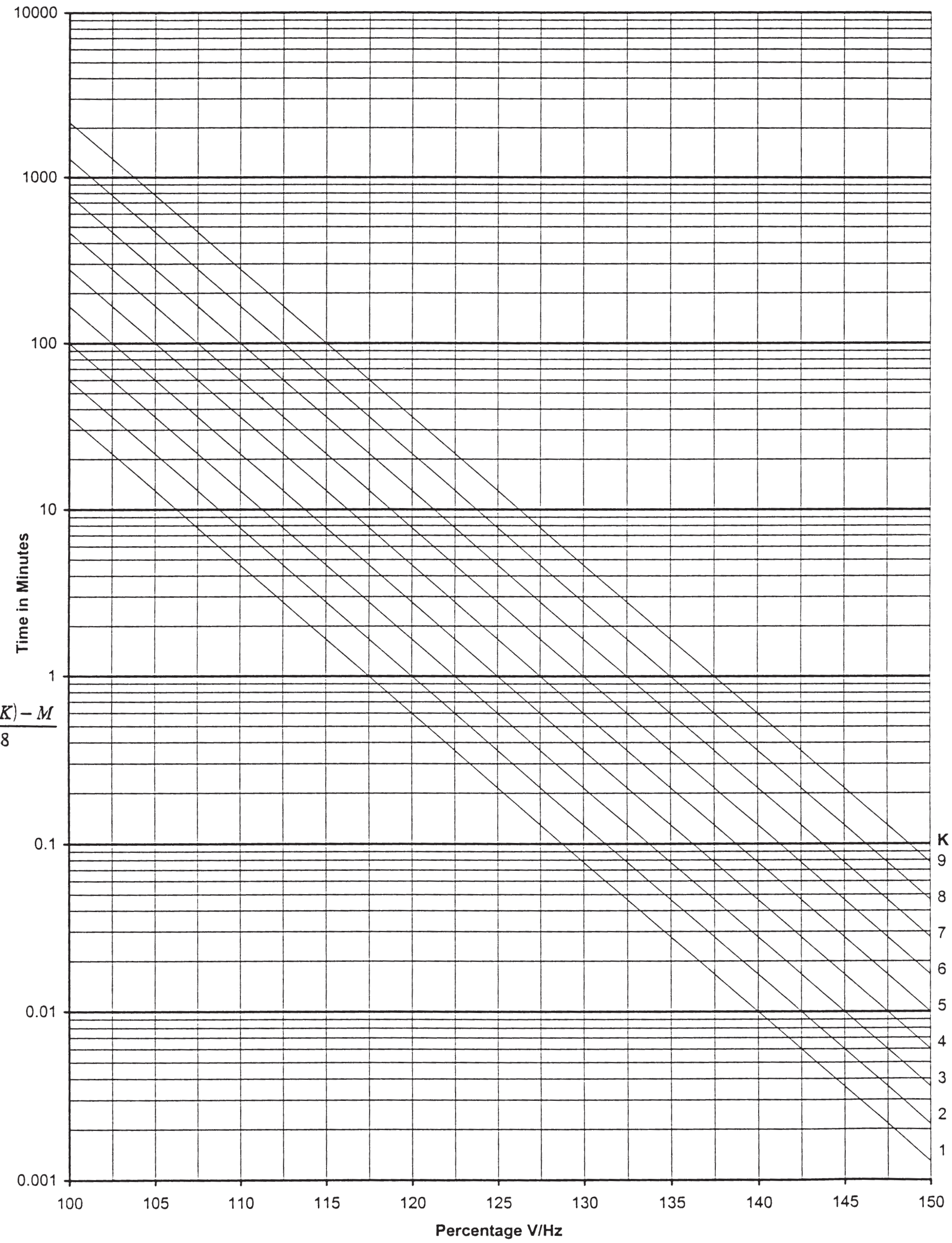


Figure D-2   Volts/Hz (24IT) Inverse Time Curve Family #2

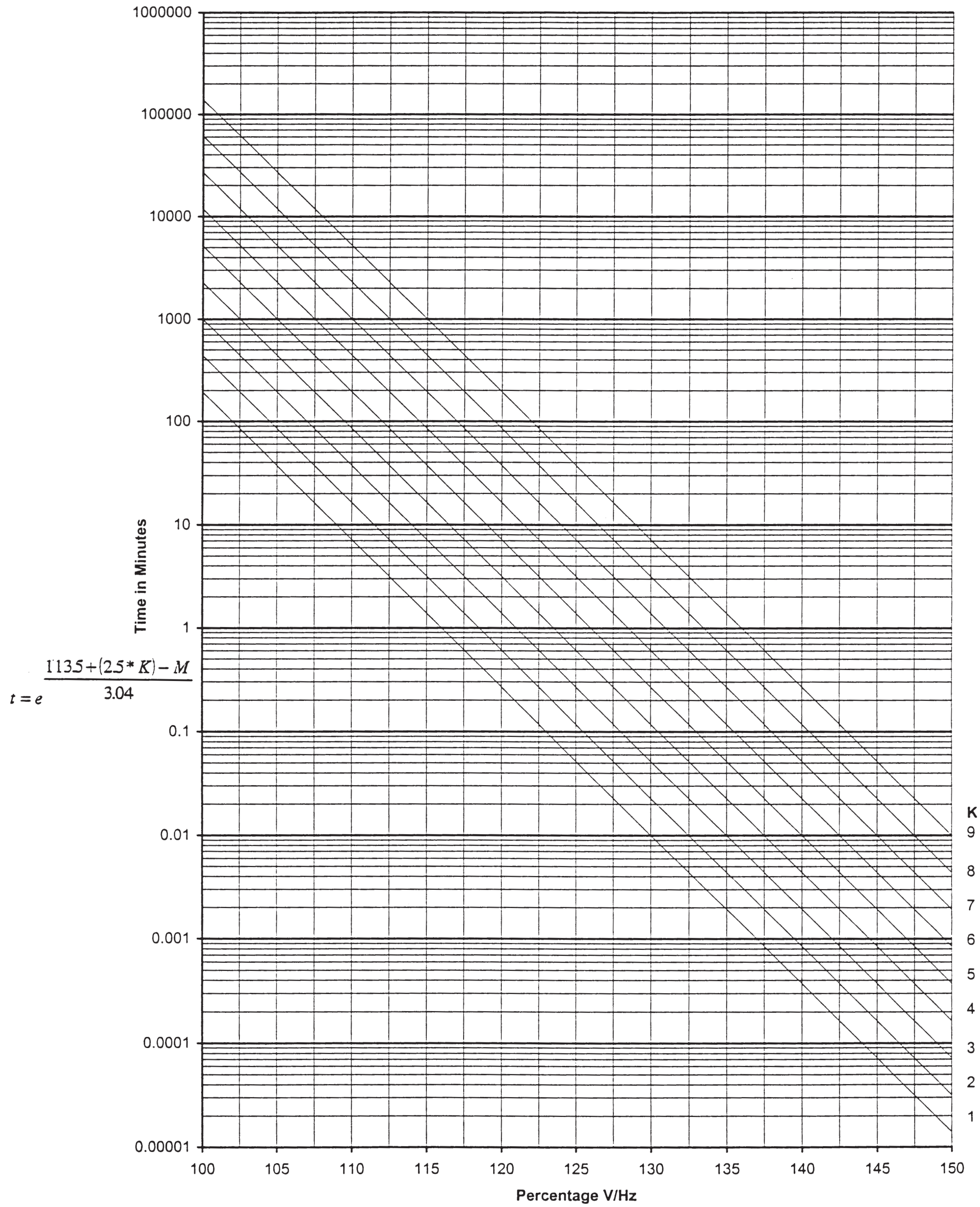


Figure D-3 Volts/Hz (24IT) Inverse Time Curve Family #3

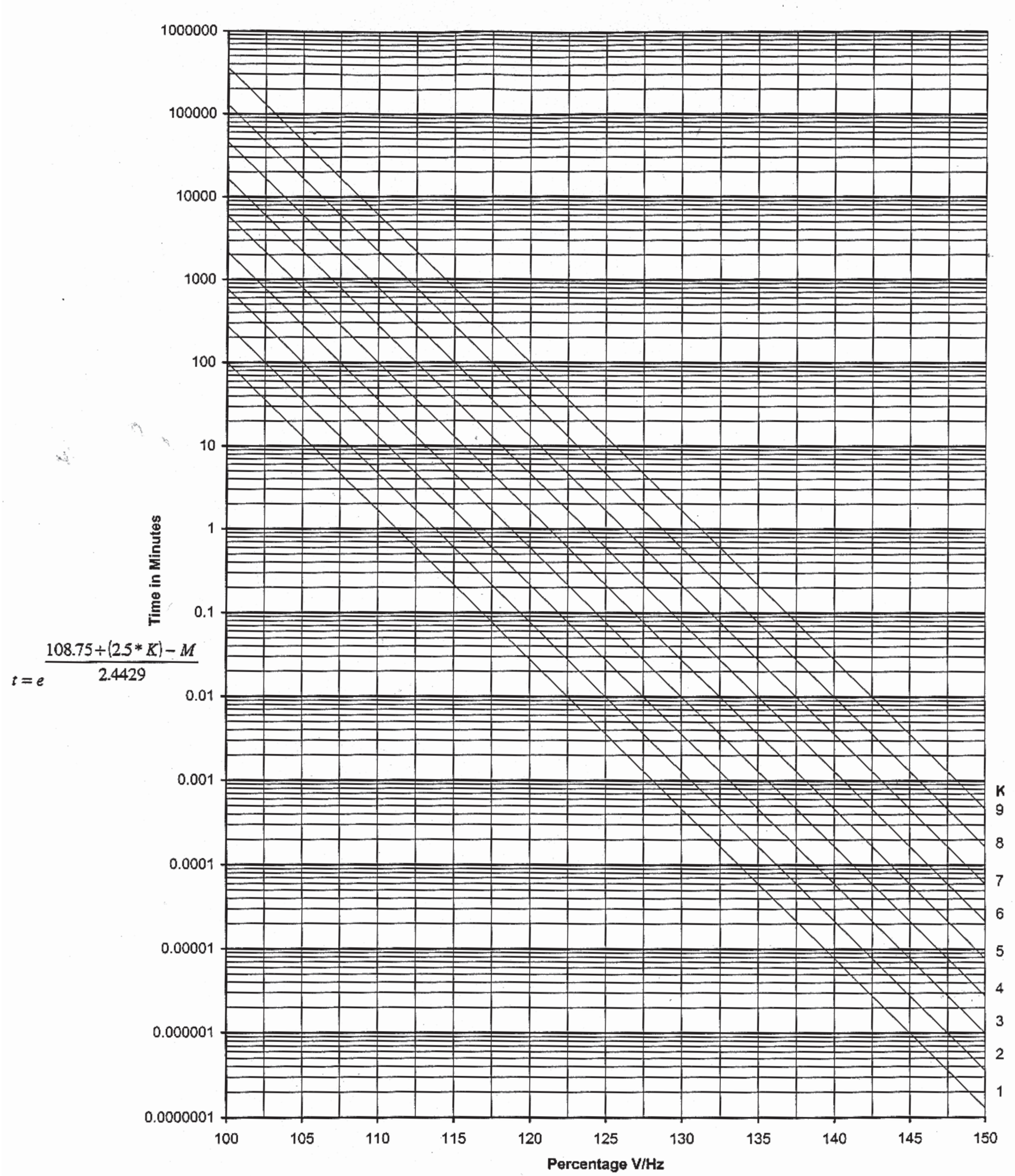


Figure D-4 Volts/Hz (24IT) Inverse Time Curve Family #4

Multiple of Tap Setting	Definite Time	Inverse Time	Very Inverse Time	Extremely Inverse Time
1.50	0.69899	4.53954	3.46578	4.83520
1.55	0.64862	4.15533	3.11203	4.28747
1.60	0.60539	3.81903	2.81228	3.83562
1.65	0.56803	3.52265	2.55654	3.45706
1.70	0.53558	3.25987	2.33607	3.13573
1.75	0.50725	3.02558	2.14431	2.85994
1.80	0.48245	2.81566	1.97620	2.62094
1.85	0.46068	2.62673	1.82779	2.41208
1.90	0.44156	2.45599	1.69597	2.22822
1.95	0.42477	2.30111	1.57823	2.06529
2.00	0.41006	2.16013	1.47254	1.92006
2.05	0.39721	2.03139	1.37723	1.78994
2.10	0.38606	1.91348	1.29093	1.67278
2.15	0.37648	1.80519	1.21249	1.56686
2.20	0.36554	1.72257	1.12812	1.47820
2.30	0.35293	1.54094	1.01626	1.32268
2.40	0.34115	1.39104	0.92207	1.19250
2.50	0.33018	1.26561	0.84190	1.08221
2.60	0.31999	1.15945	0.77301	0.98780
2.70	0.31057	1.06871	0.71334	0.90626
2.80	0.30189	0.99049	0.66127	0.83527
2.90	0.29392	0.92258	0.61554	0.77303
3.00	0.28666	0.86325	0.57515	0.71811
3.10	0.28007	0.81113	0.53930	0.66939
3.20	0.27415	0.76514	0.50733	0.62593
3.30	0.26889	0.72439	0.47870	0.58700
3.40	0.26427	0.68818	0.45297	0.55196
3.50	0.26030	0.65591	0.42977	0.52032
3.60	0.25697	0.62710	0.40879	0.49163
3.70	0.25429	0.60135	0.38977	0.46554
3.80	0.25229	0.57832	0.37248	0.44175
4.00	0.24975	0.53904	0.34102	0.40129
4.20	0.24572	0.50641	0.31528	0.36564
4.40	0.24197	0.47746	0.29332	0.33460
4.60	0.23852	0.45176	0.27453	0.30741
4.80	0.23541	0.42894	0.25841	0.28346
5.00	0.23266	0.40871	0.24456	0.26227

■**NOTE:** The above times are in seconds and are given for a time dial of 1.0. For other time dial values, multiply the above by the time dial value.

Table D-1A M-3311A Inverse Time Overcurrent Relay Characteristic Curves

Multiple of Tap Setting	Definite Time	Inverse Time	Very Inverse Time	Extremely Inverse Time
5.20	0.23029	0.39078	0.23269	0.24343
5.40	0.22834	0.37495	0.22254	0.22660
5.60	0.22684	0.36102	0.21394	0.21151
5.80	0.22583	0.34884	0.20673	0.19793
6.00	0.22534	0.33828	0.20081	0.18567
6.20	0.22526	0.32771	0.19511	0.17531
6.40	0.22492	0.31939	0.19044	0.16586
6.60	0.22360	0.31150	0.18602	0.15731
6.80	0.22230	0.30402	0.18187	0.14957
7.00	0.22102	0.29695	0.17797	0.14253
7.20	0.21977	0.29027	0.17431	0.13611
7.40	0.21855	0.28398	0.17090	0.13027
7.60	0.21736	0.27807	0.16773	0.12492
7.80	0.21621	0.27253	0.16479	0.12003
8.00	0.21510	0.26734	0.16209	0.11555
8.20	0.21403	0.26251	0.15961	0.11144
8.40	0.21300	0.25803	0.15736	0.10768
8.60	0.21203	0.25388	0.15534	0.10422
8.80	0.21111	0.25007	0.15354	0.10105
9.00	0.21025	0.24660	0.15197	0.09814
9.50	0.20813	0.23935	0.14770	0.09070
10.00	0.20740	0.23422	0.14473	0.08474
10.50	0.20667	0.22923	0.14180	0.07943
11.00	0.20594	0.22442	0.13894	0.07469
11.50	0.20521	0.21979	0.13615	0.07046
12.00	0.20449	0.21536	0.13345	0.06667
12.50	0.20378	0.21115	0.13084	0.06329
13.00	0.20310	0.20716	0.12833	0.06026
13.50	0.20243	0.20341	0.12593	0.05755
14.00	0.20179	0.19991	0.12364	0.05513
14.50	0.20119	0.19666	0.12146	0.05297
15.00	0.20062	0.19367	0.11941	0.05104
15.50	0.20009	0.19095	0.11747	0.04934
16.00	0.19961	0.18851	0.11566	0.04784
16.50	0.19918	0.18635	0.11398	0.04652
17.00	0.19881	0.18449	0.11243	0.04539
17.50	0.19851	0.18294	0.11102	0.04442
18.00	0.19827	0.18171	0.10974	0.04362
18.50	0.19811	0.18082	0.10861	0.04298
19.00	0.19803	0.18029	0.10762	0.04250
19.50	0.19803	0.18014	0.10679	0.04219
20.00	0.19803	0.18014	0.10611	0.04205

■**NOTE:** The above times are in seconds and are given for a time dial of 1.0. For other time dial values, multiply the above by the time dial value.

Table D-1B M-3311A Inverse Time Overcurrent Relay Characteristic Curves

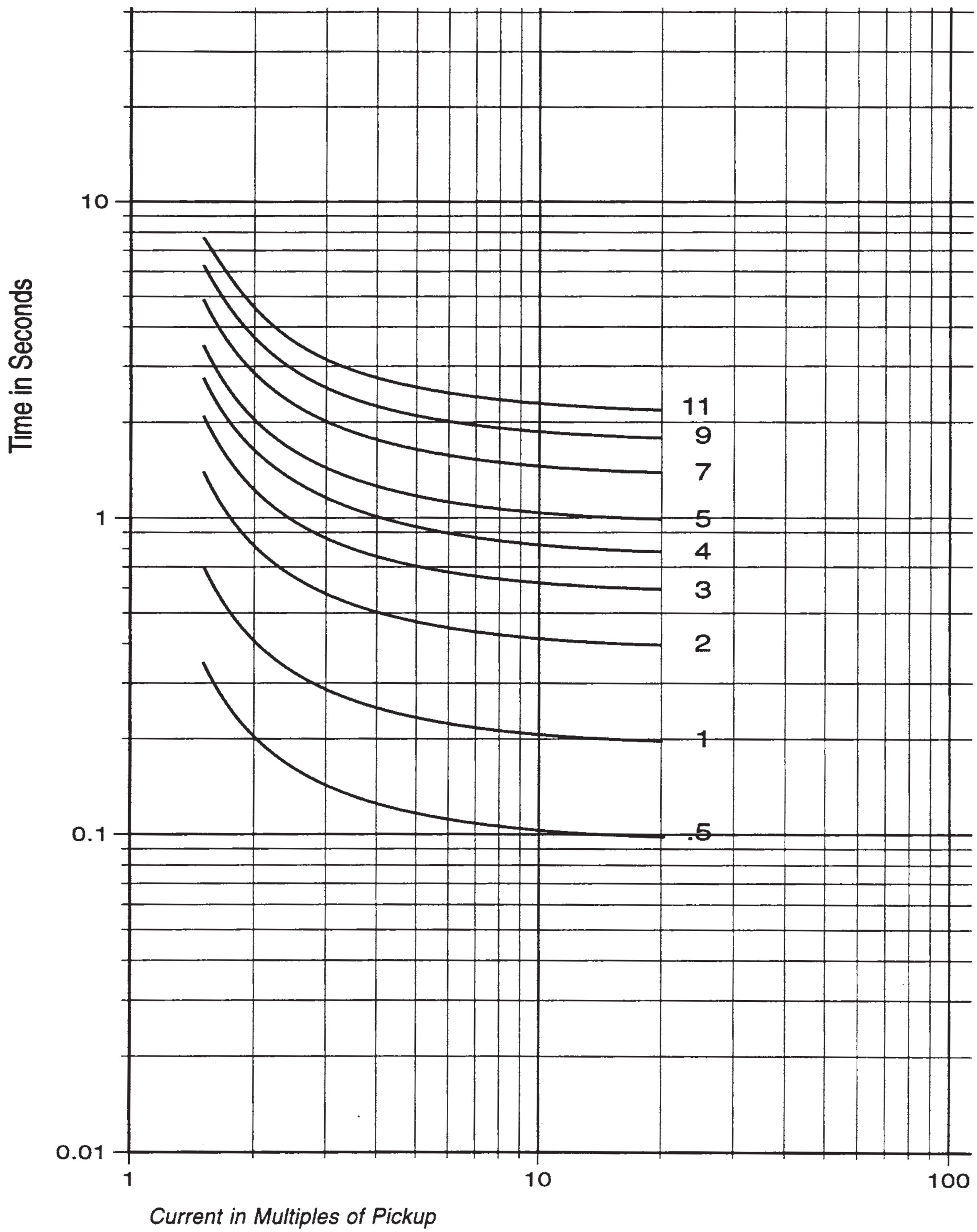


Figure D-5 Definite Time Overcurrent Curve

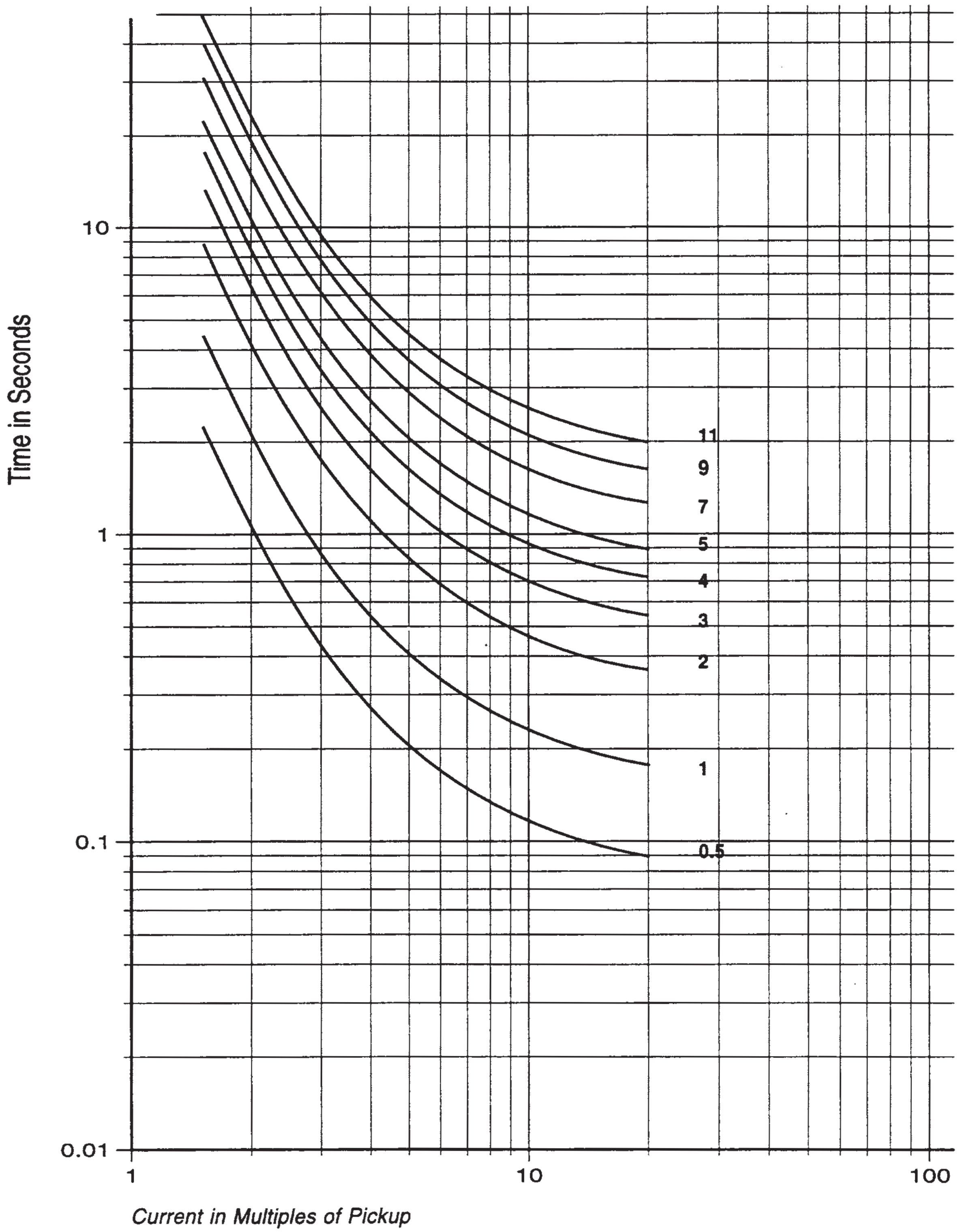


Figure D-6 Inverse Time Overcurrent Curve

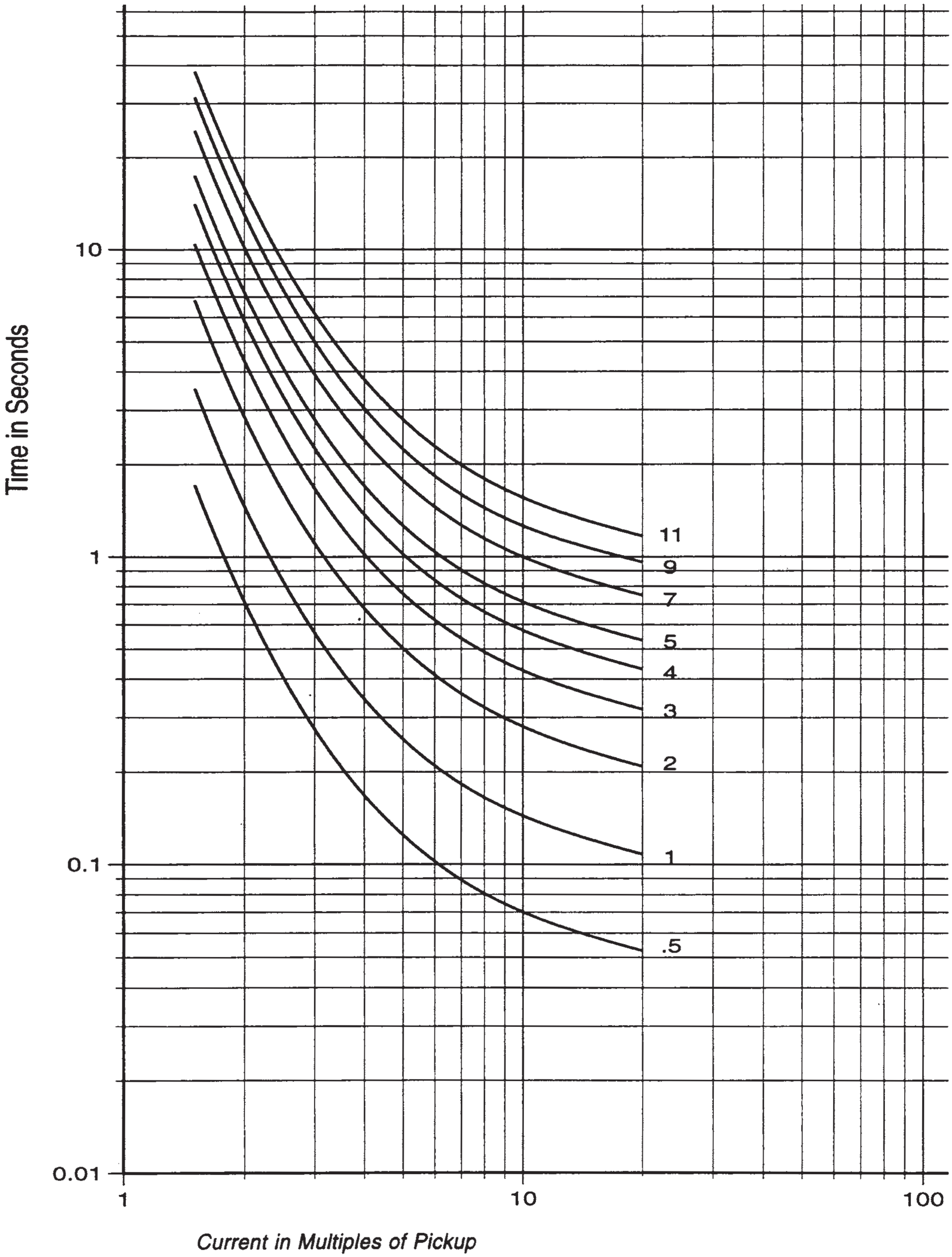


Figure D-7 Very Inverse Time Overcurrent Curve

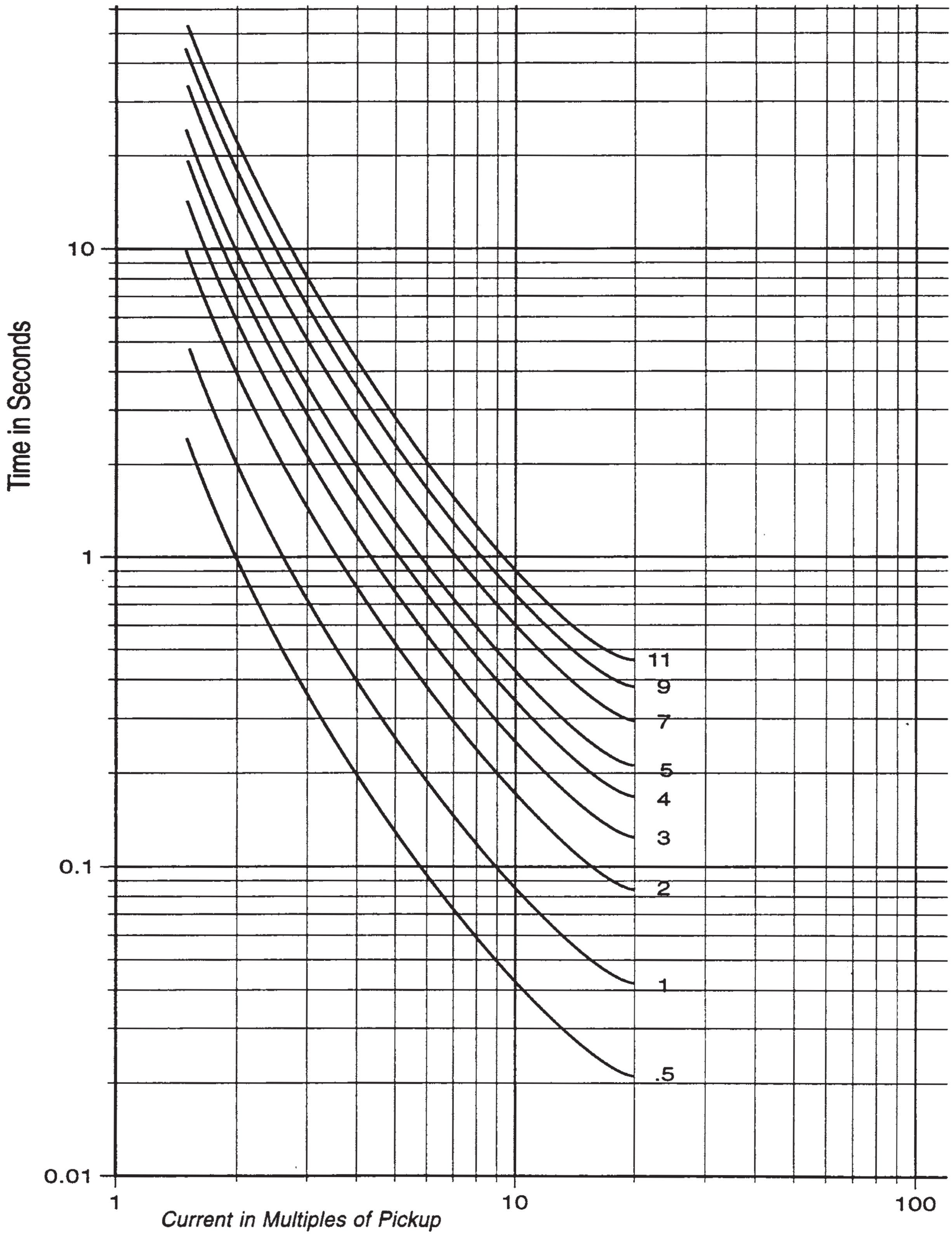
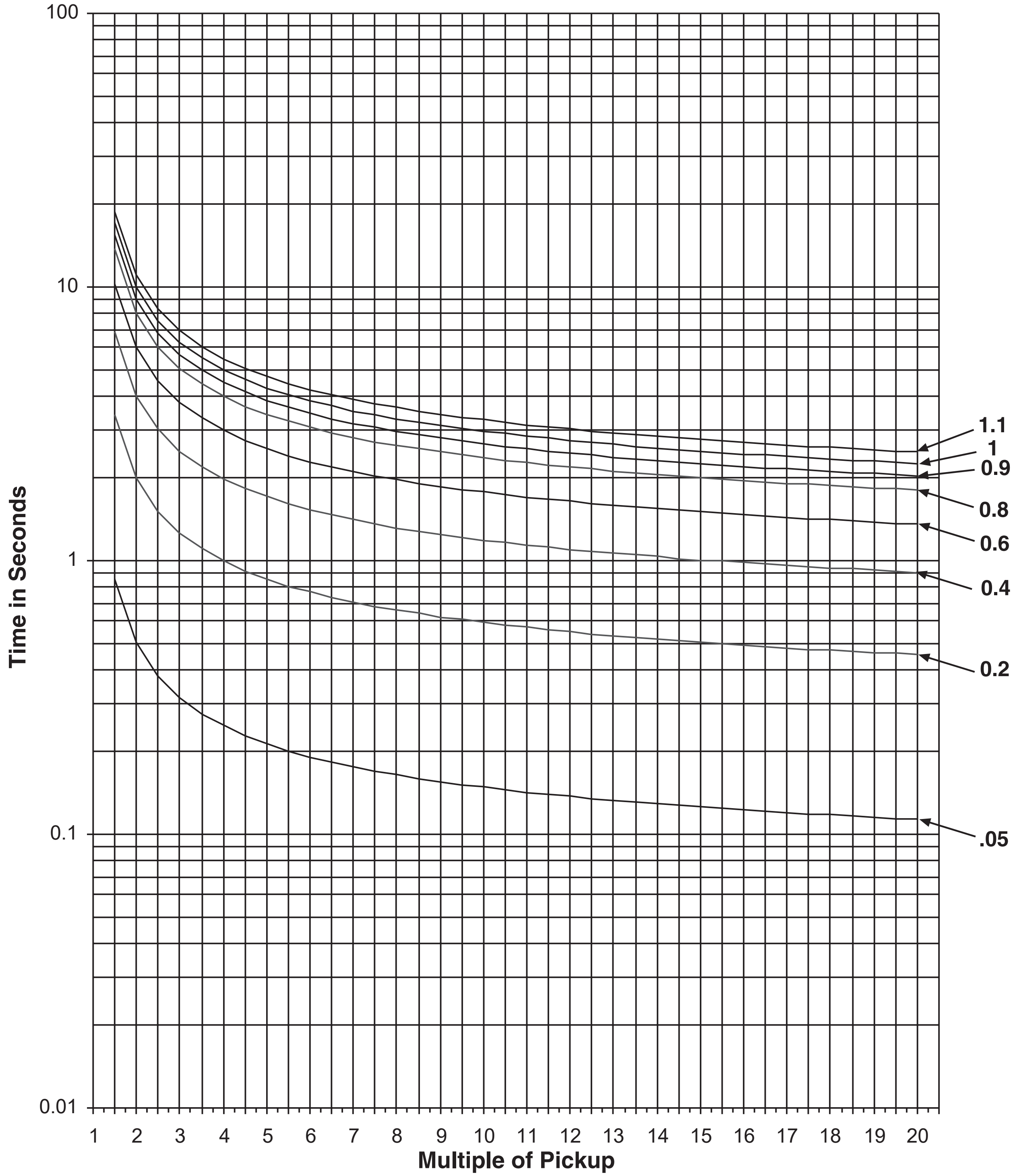
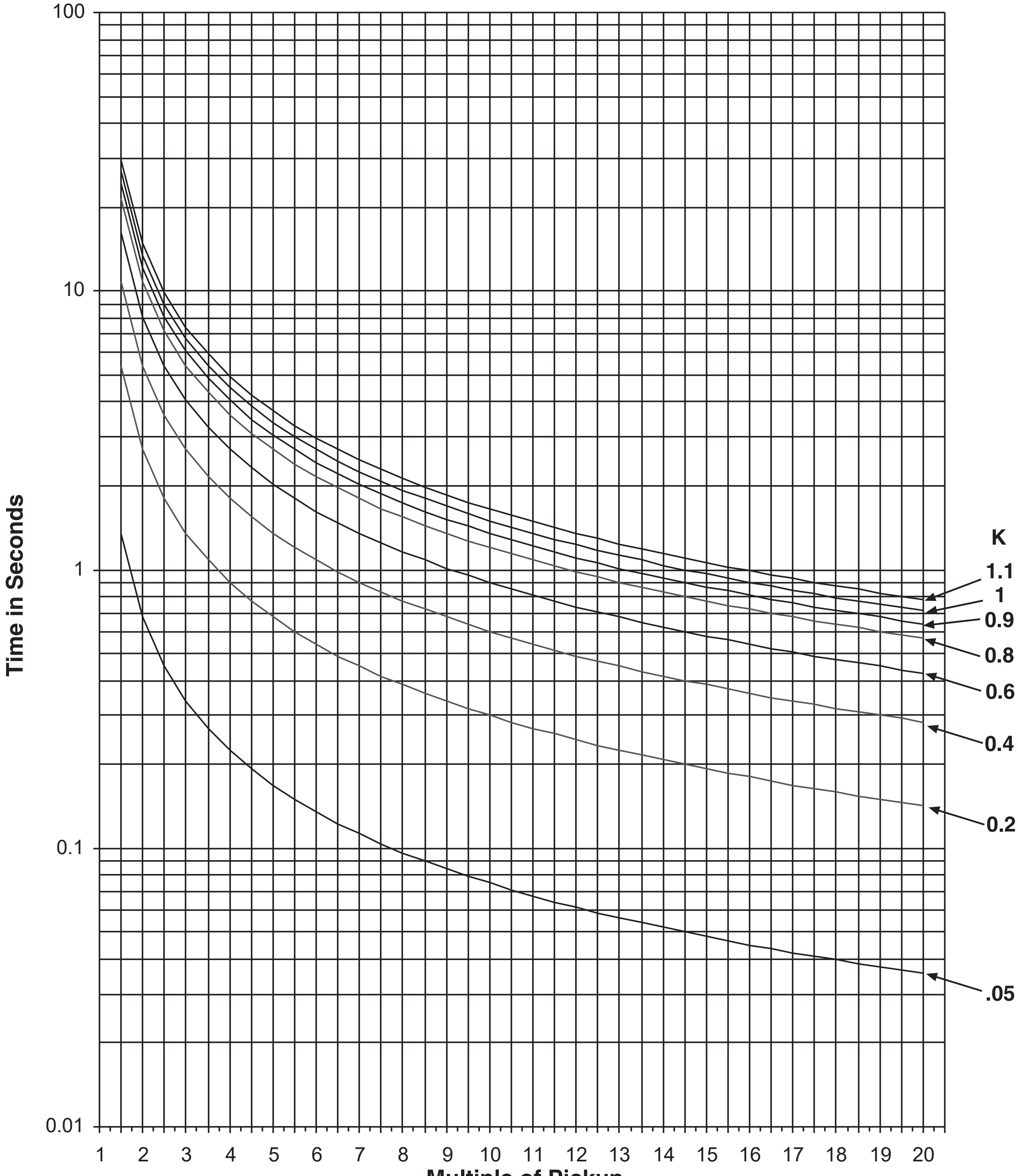


Figure D-8 Extremely Inverse Time Overcurrent Curve



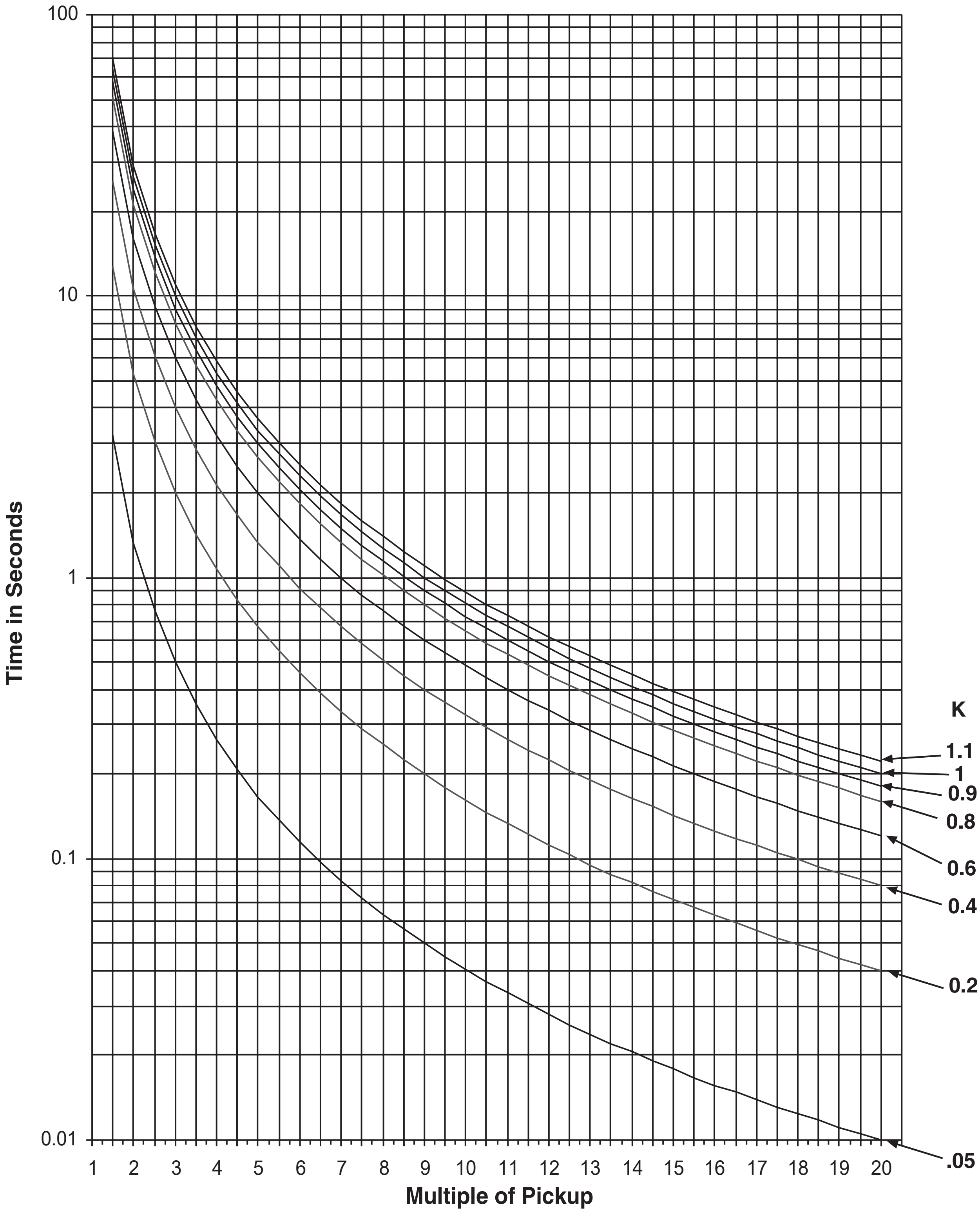
$$t = TD \times \left[\frac{0.14}{M^{0.02} - 1}\right]$$

Figure D-9 IEC Curve #1 Inverse



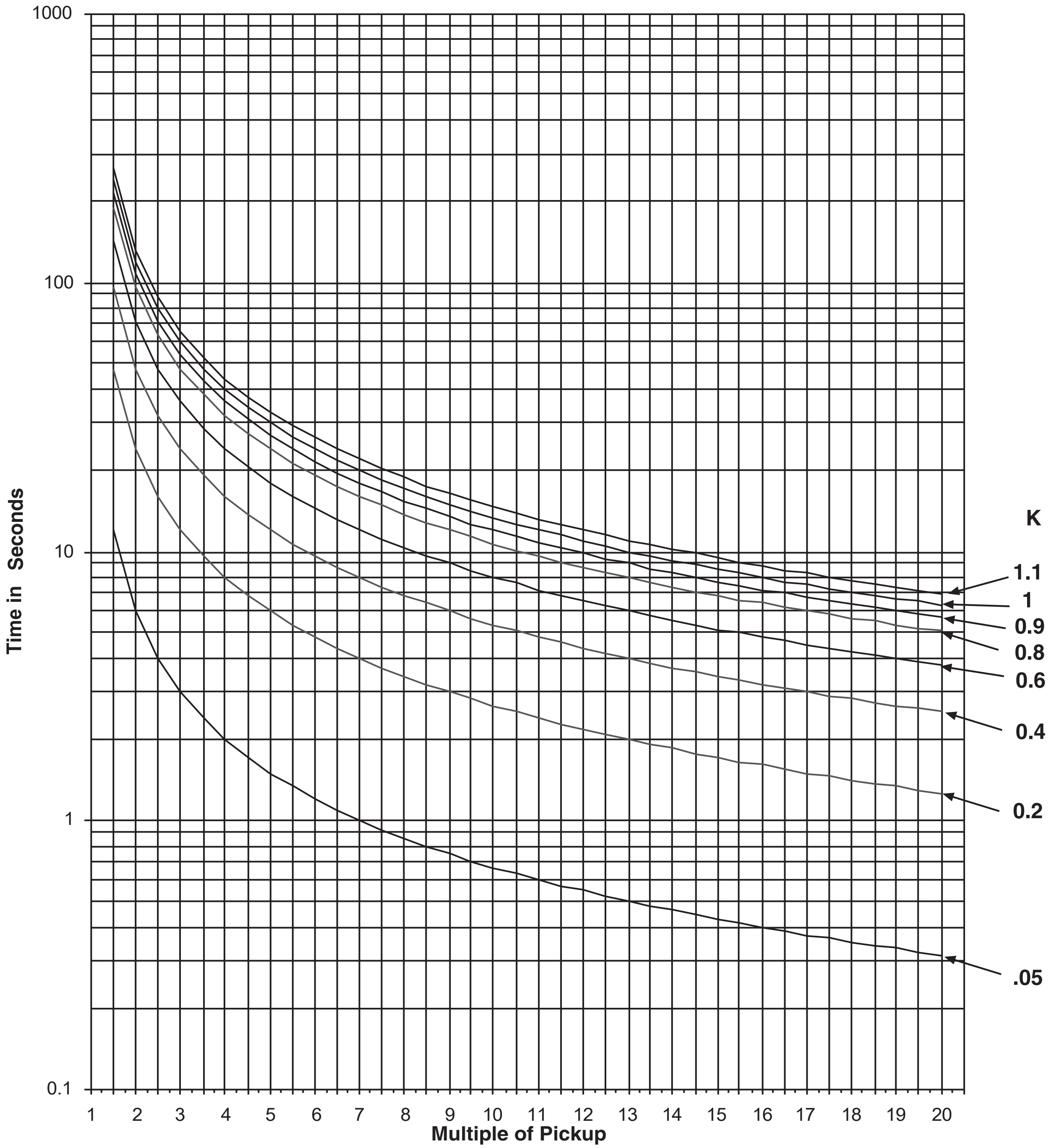
$$t = TD \times \left[\frac{13.5}{M - 1} \right]$$

Figure D-10 IEC Curve #2 Very Inverse



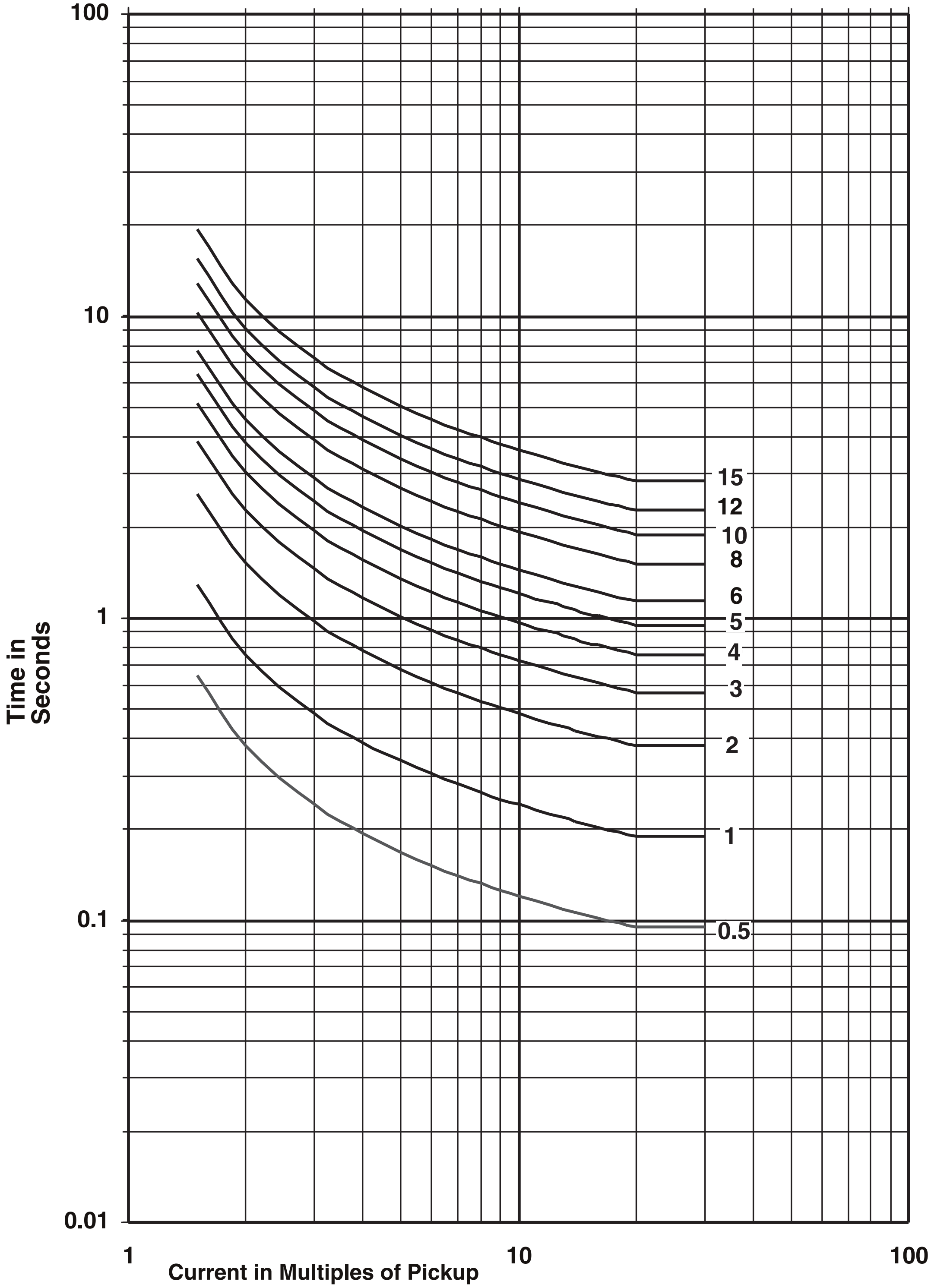
$$t=TD \times \left[\frac{80}{M^2 - 1}\right]$$

Figure D-11 IEC Curve #3 Extremely Inverse



$$t = TD \times \left[\frac{120}{M - 1} \right]$$

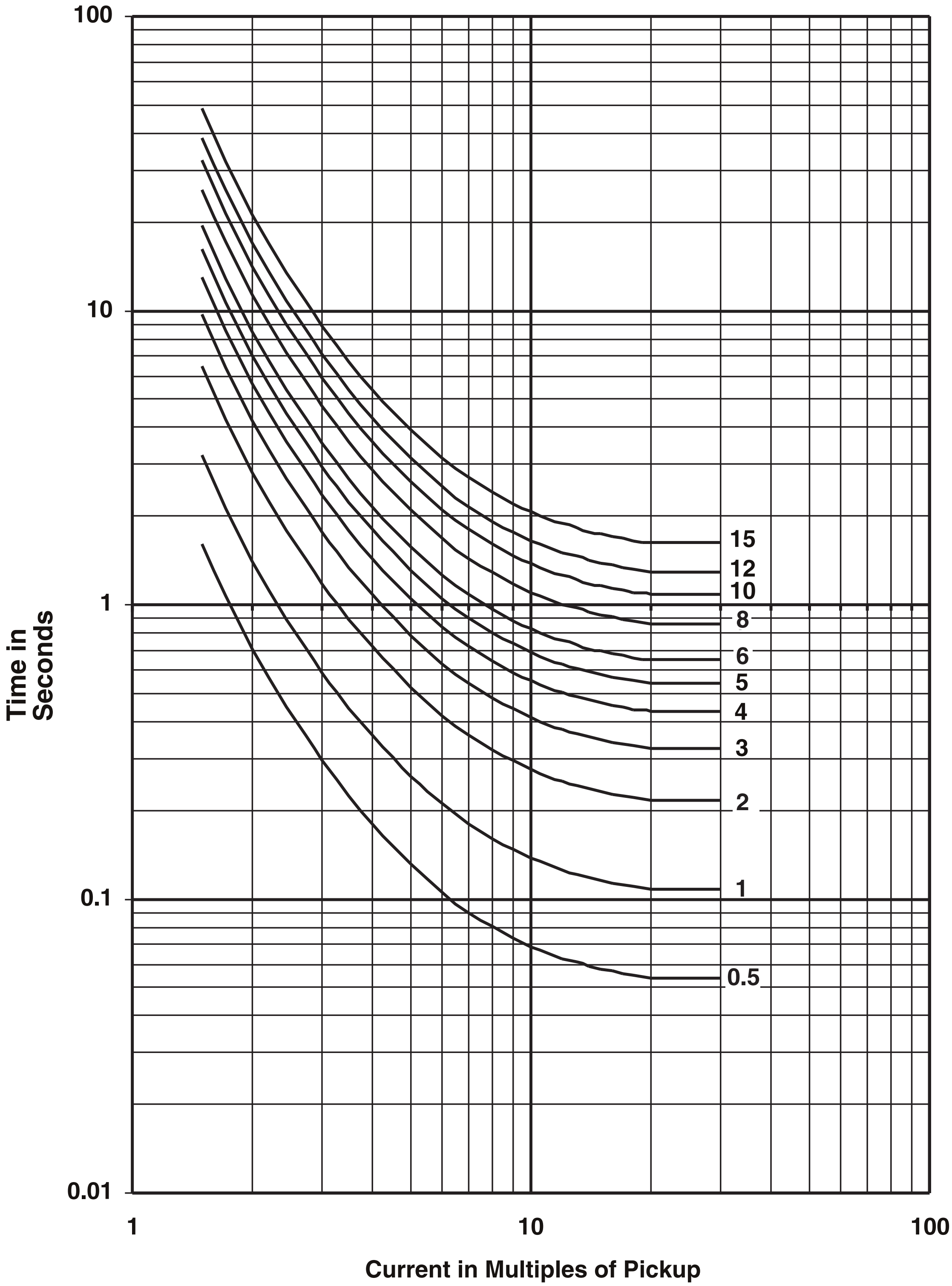
Figure D-12 IEC Curve #4 Long-Time Inverse



IEEE
Moderately Inverse

$$t = \frac{TD}{5} \times \left[\frac{0.0515}{M^{0.02} - 1} + 0.114 \right]$$

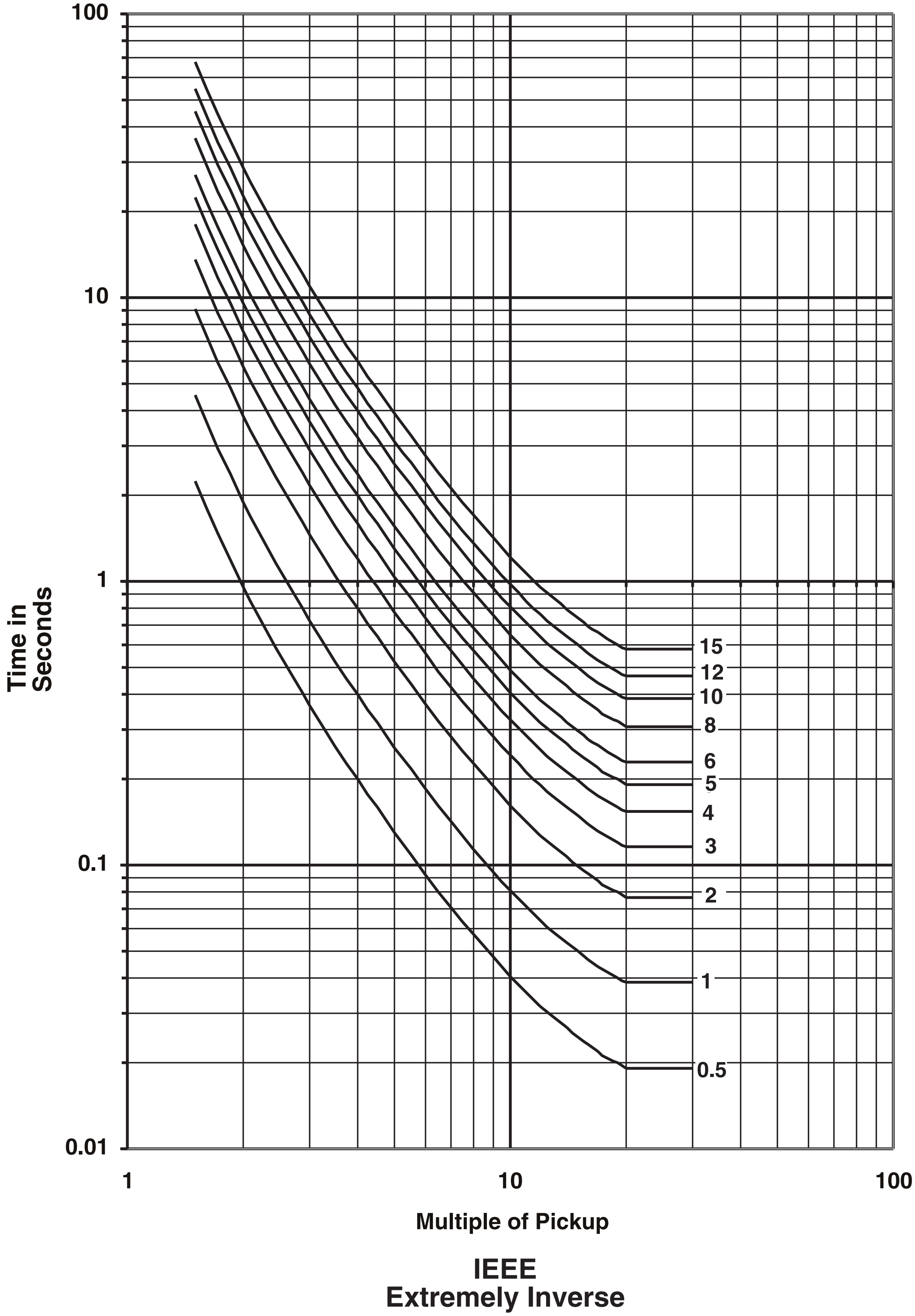
Figure D-13 IEEE (Moderately) Inverse Time Overcurrent Curves



IEEE
Very Inverse

$$t = \frac{TD}{5} \times \left[\frac{19.61}{M^2 - 1} + 0.491 \right]$$

Figure D-14 IEEE Very Inverse Time Overcurrent Curves



$$t = \frac{TD}{5} \times \left[\frac{28.2}{M^2 - 1} + 0.1217 \right]$$

Figure D-15 IEEE Extremely Inverse Time Overcurrent Curves

E Layup and Storage

Appendix E includes the recommended storage parameters, periodic surveillance activities and layup configuration for the M-3311A Transformer Protection Relay

Storage Requirements (Environment)

The recommended storage environment parameters for the M-3311A are:

- The ambient temperature where the M-3311A is stored is within a range of 5° C to 40° C
- The maximum relative humidity is less than or equal to 80% for temperatures up to 31° C, decreasing to 31° C linearly to 50% for relative humidity at 40° C.
- The storage area environment is free of dust, corrosive gases, flammable materials, dew, percolating water, rain and solar radiation.

Storage Requirements (Periodic Surveillance During Storage)

The M-3311A power supply contains electrolytic capacitors. It is recommended that power be applied to the relay (PS1 and optional PS2 redundant power supply when installed) every three to five years for a period of not less than one hour to help prevent the electrolytic capacitors from drying out.

Layup Configuration

The M-3311A includes a removable lithium battery backed TIMEKEEPER module (Beckwith Electric component U25, Figure 5-34). The TIMEKEEPER module is the M-3311A real-time clock and also provides power to the unit's nonvolatile memory when power is not applied to the unit.

Layup of the M-3311A requires verifying that the system clock is stopped. The steps necessary to verify system clock status are as follows:

▲**CAUTION:** Do not use the diagnostic mode in relays that are installed in an active protection scheme.

1. Verify that the Power Supply (PS) fuses are installed.
2. Determine the unit power supply rating by observing the check box below the PS terminals on the rear of the unit.
3. Apply power to the unit consistent with the rating determined in Step 2 (see **Section 5.3**, **External Connections**). The unit will enter the selftest mode.
4. When the selftests are complete, then press **ENTER** to begin main menu.
5. Press the right arrow pushbutton until **SETUP UNIT** is displayed.
6. Press **ENTER** to access the **SETUP UNIT** menu.
7. Press the right arrow pushbutton until **DIAGNOSTIC MODE** is displayed.
8. Press **ENTER**. A reset warning will be displayed:

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

WARNING: All relay functions and protection will be inoperative while the relay is in diagnostic mode.

9. Press **ENTER**. Unit will now reset and **DIAGNOSTIC MODE** will be temporarily displayed, followed by **OUTPUT TEST** (RELAY). This is the beginning of the diagnostic menu.
10. Press the right arrow pushbutton until the following is displayed:

```
CLOCK TEST
← CLOCK led cal factory
```

11. Press **ENTER**. The following is displayed:

```
CLOCK TEST
03-JAN-1998 09:00:00.000
```

12. If the clock is running, press **ENTER** to stop the clock. The following is displayed:

```
CLOCK TEST
-CLOCK STOP-
```

■**NOTE:** When the relay clock is stopped, the seconds will be displayed as 80.

13. Press **ENTER** and verify the relay clock is stopped. A display similar to the following is shown with the seconds stopped:

```
CLOCK TEST
03-JAN-09:01:80.000
```

14. When the clock has been verified to be stopped, then press **EXIT** until the following message appears:

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

15. Press **EXIT** again to exit **DIAGNOSTIC MODE**. The relay will reset and normal running mode will resume.

■**NOTE:** Pressing any button other than **EXIT** will return the user to **DIAGNOSTIC MODE.**

16. Remove power from the unit. The unit can now be placed in storage.

F HMI Menu Flow

F.1 HMI Menu Overview

Appendix F illustrates the Human Machine Interface (HMI) menu flow that is presented on the Human-Machine interface module.

Key to Input Data

1. All heavily bordered screens are either MENU screens which have horizontal choices (made with right - left arrows) or screens displaying a result of a choice previously made.
2. Gray boxes GRAY enclose screens which bound areas that pushbutton **ENTER** will move in. In order to move out of one of the gray boxes it is necessary to either push **EXIT** or make a menu choice change using the Right - Left arrow.
3. The Up/Down arrows only adjust value or letter (lower/upper case) inputs; they do not move within the menus or between menu displays.
4. The Right/Left arrows are used only to make horizontally displayed choices. These can be either menu choices or input value digit choices. The previous choice or location in a menu is highlighted immediately.
5. The **ENTER** pushbutton records the setting change (whatever is in that screen when ENTER is pressed will be installed in memory) and moves down *within* a menu. The operator will notice that after the last menu item, **ENTER** moves to the top of the same menu but does not change menu positions.
6. Pressing **EXIT** at any time will exit the display screen to the last screen containing a horizontal choice. (Return to the preceding menu).

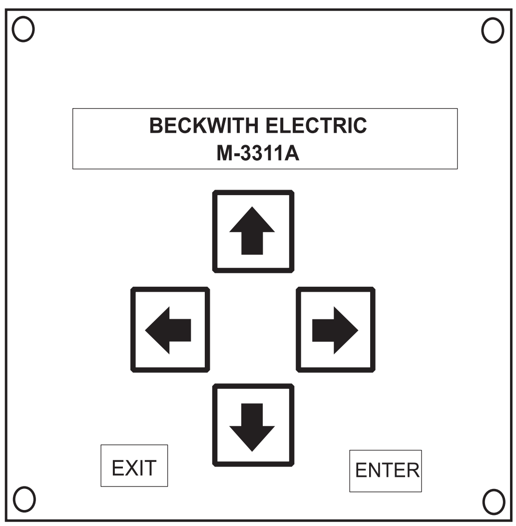


Figure F-1 Human-Machine Interface Module

7. The Left or Right arrow symbol in a screen indicates additional horizontal menu choices are available in the indicated direction. As previously described, the Right and Left arrows will move the operator to those additional choices.

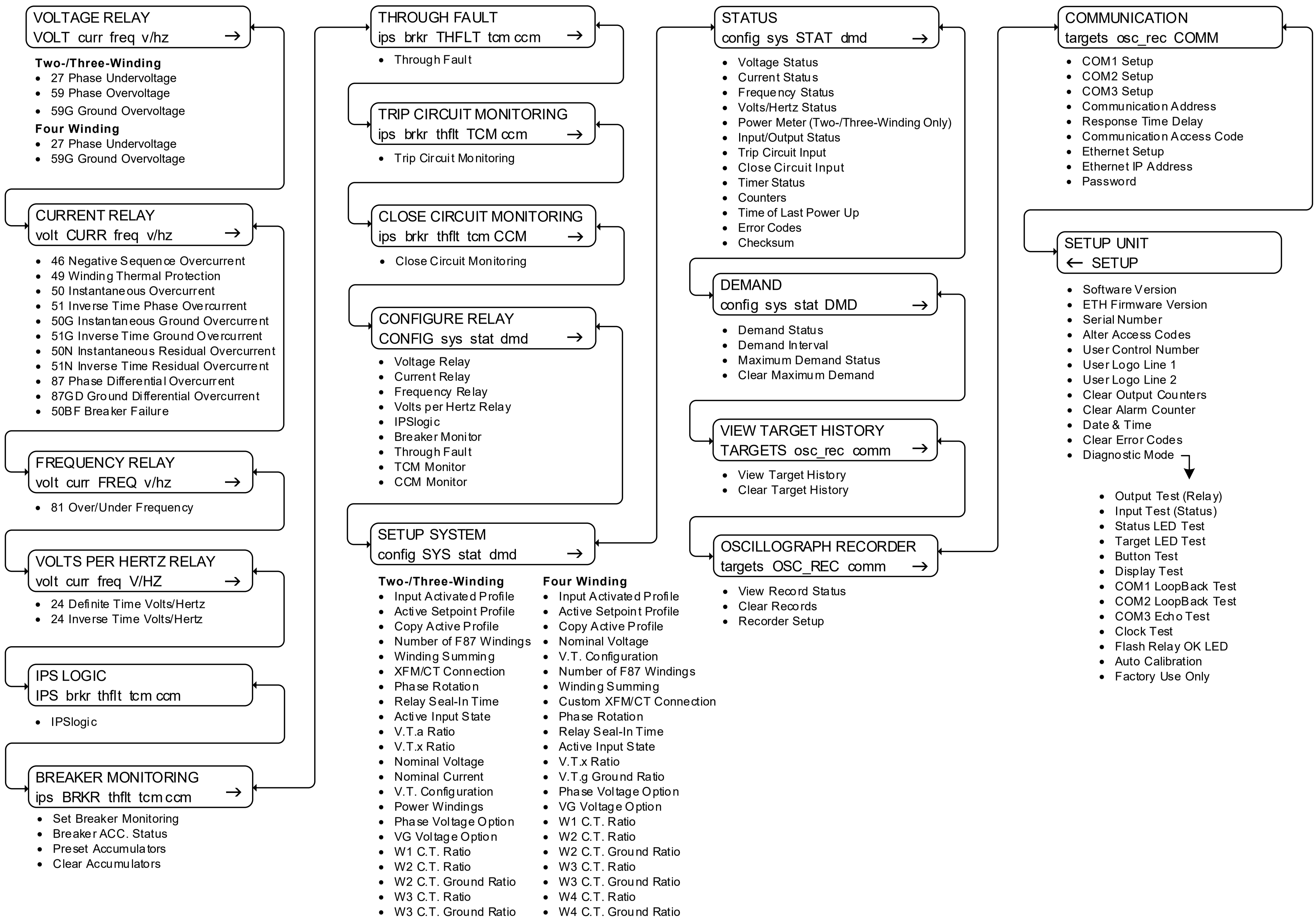


Figure F-2 HMI Menu Flow Overview

F.2 HMI Menu Flow

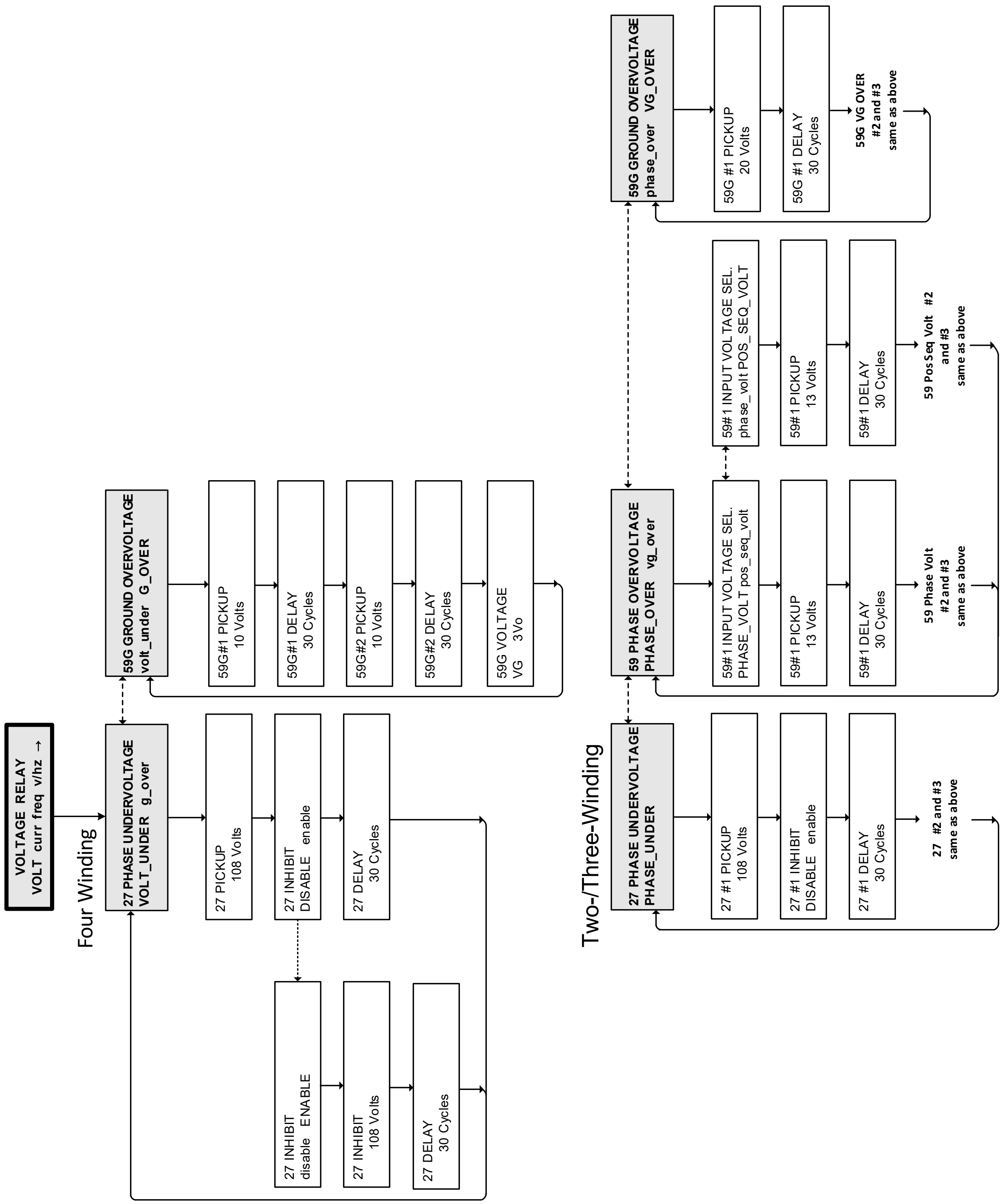


Figure F-3 Voltage Relay Menu Flow

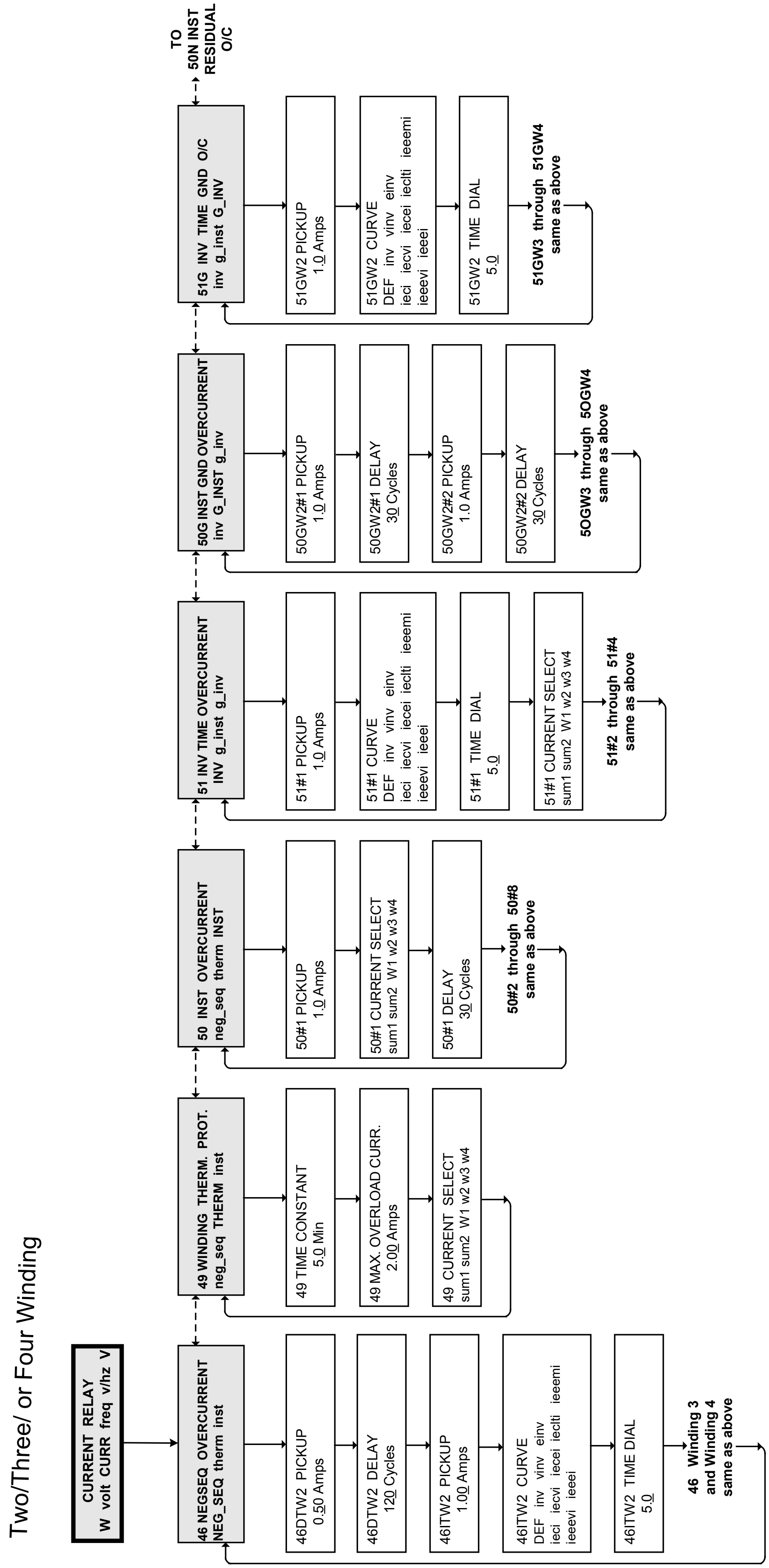


Figure F-4 Current Relay Menu Flow (1 of 2)

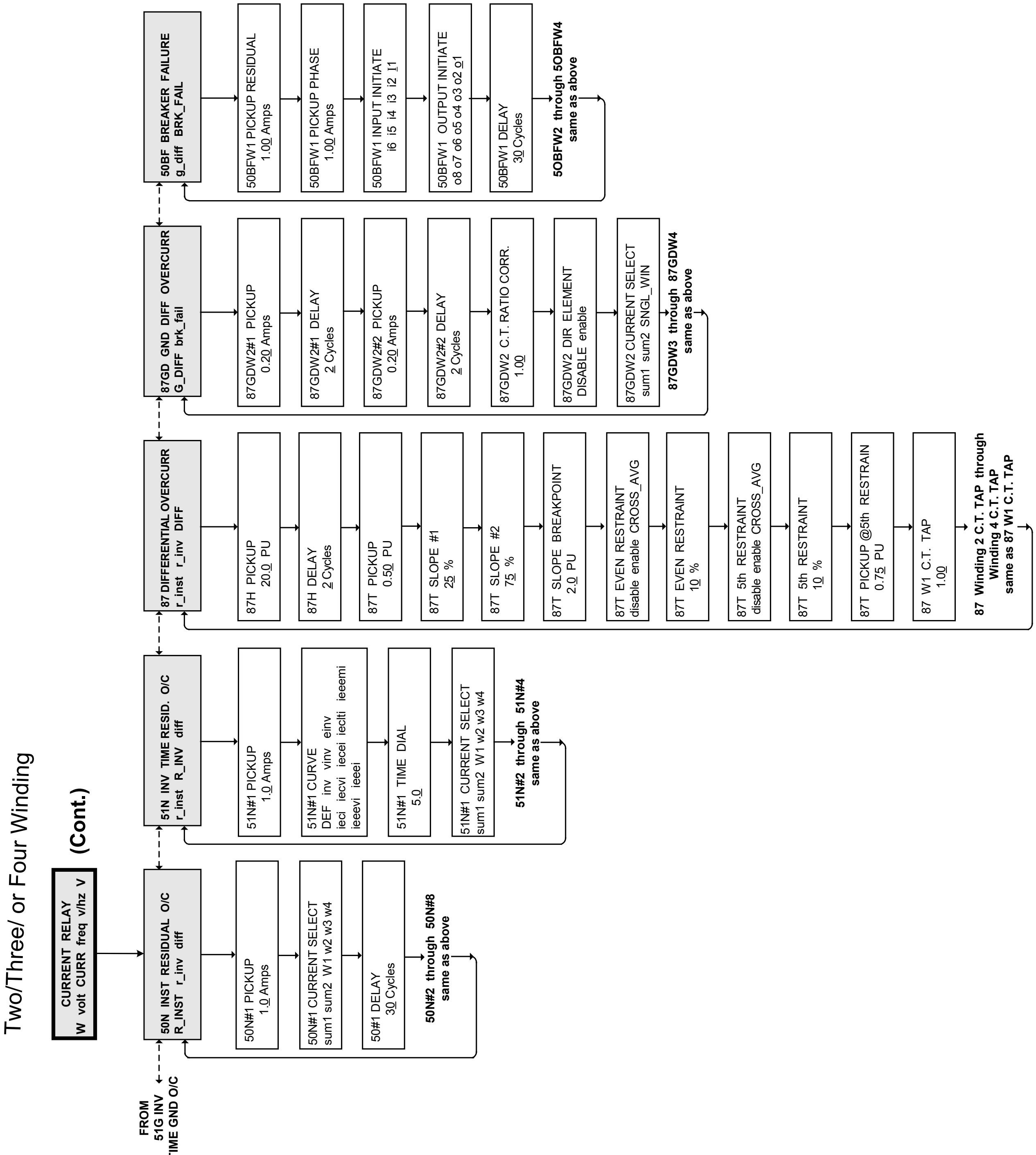


Figure F-4 Current Relay Menu Flow (2 of 2)

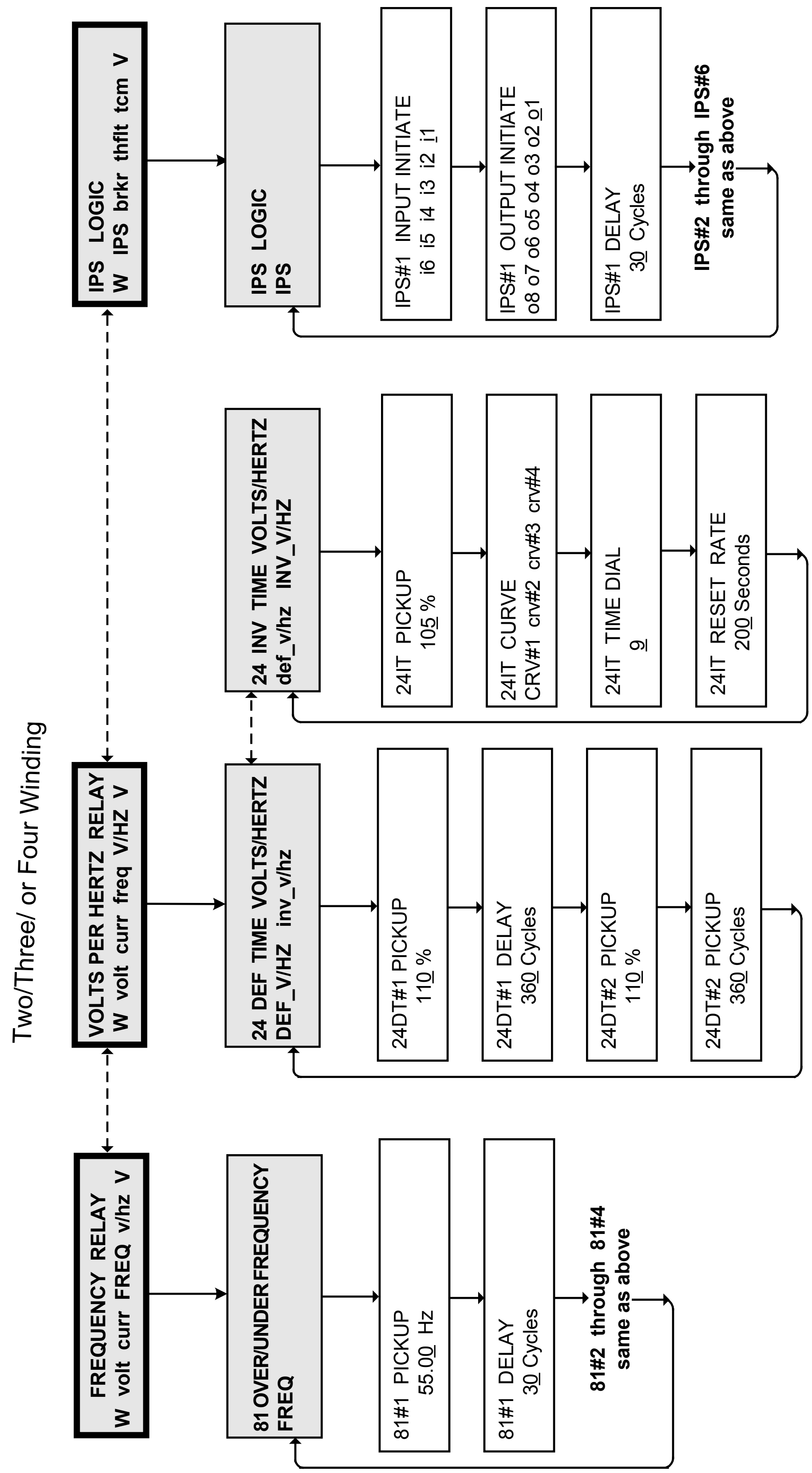


Figure F-5 Frequency Relay, Volts Per Hertz Relay and IPS Logic Menu Flow

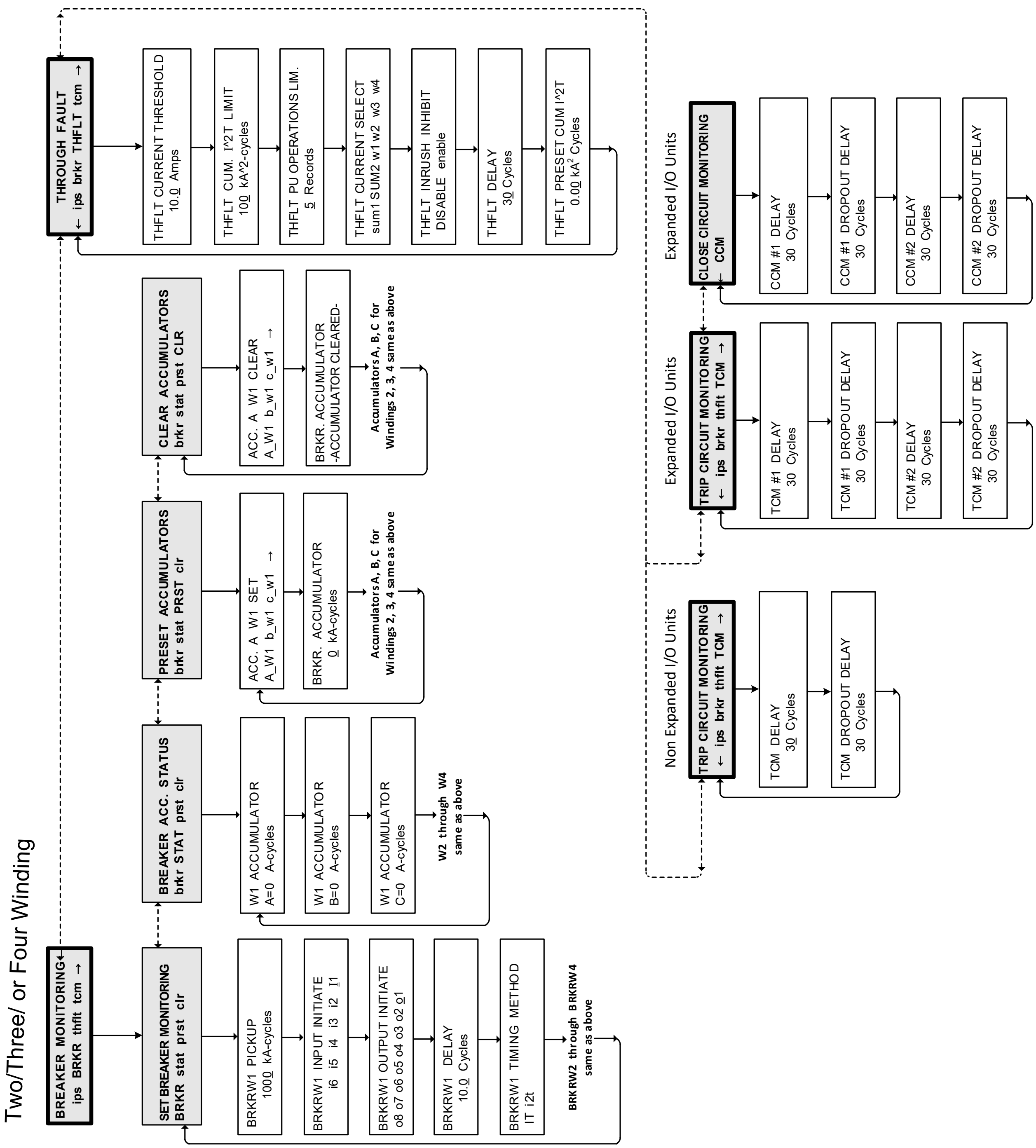


Figure F-6 Breaker Monitoring, Through Fault Monitoring and Trip Circuit Monitoring Menu Flow

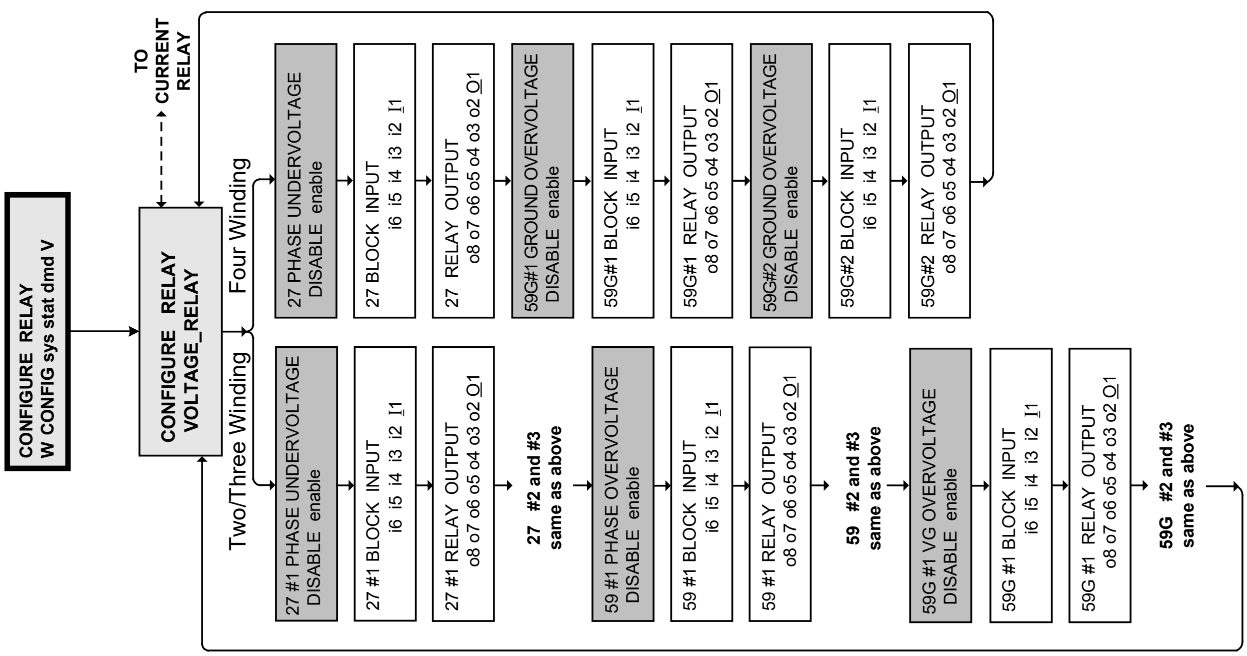


Figure F-7 Configure Relay/Voltage Relay Menu Flow (1 of 3)

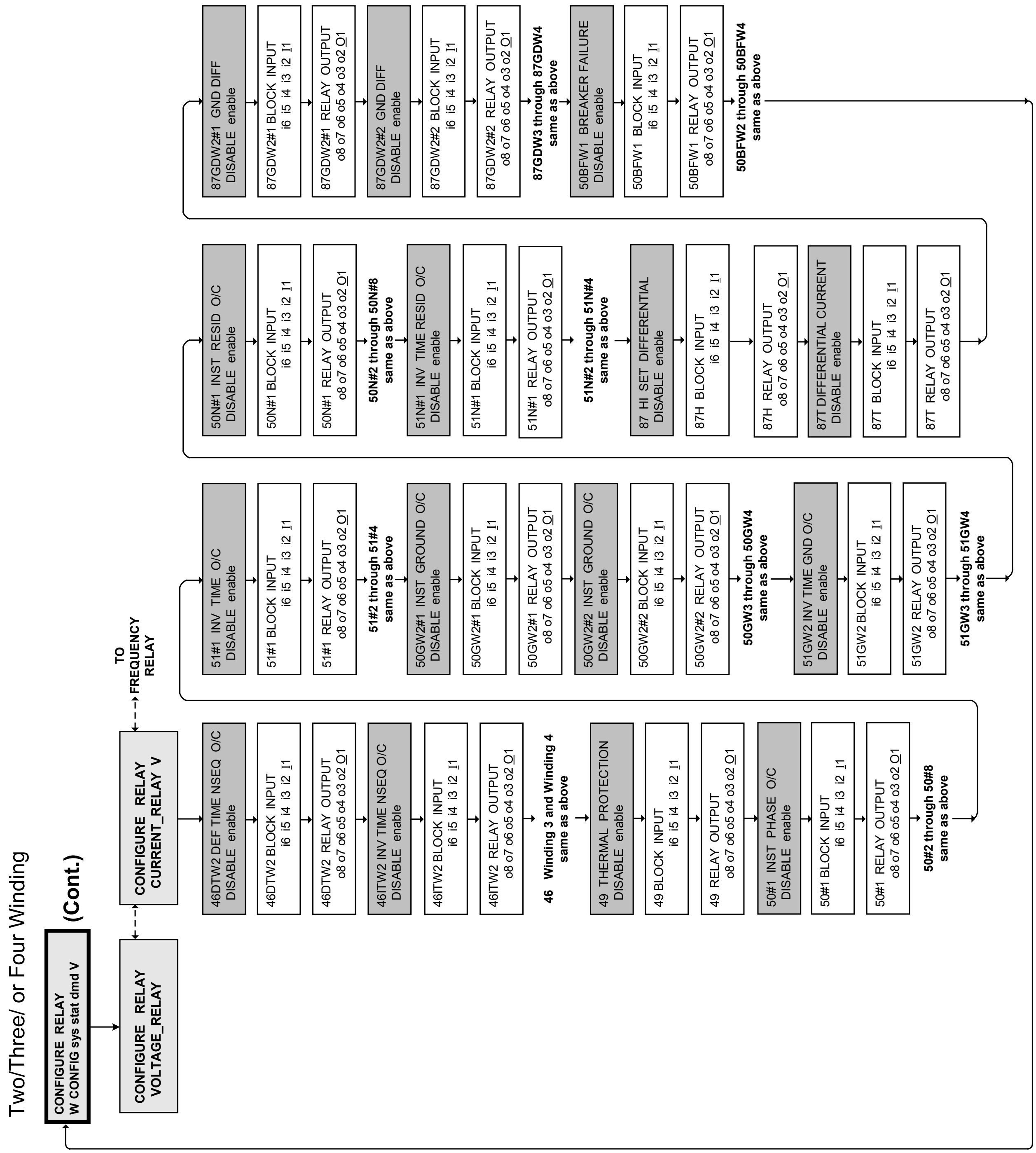


Figure F-7 Configure Relay/Voltage Relay Menu Flow (2 of 3)

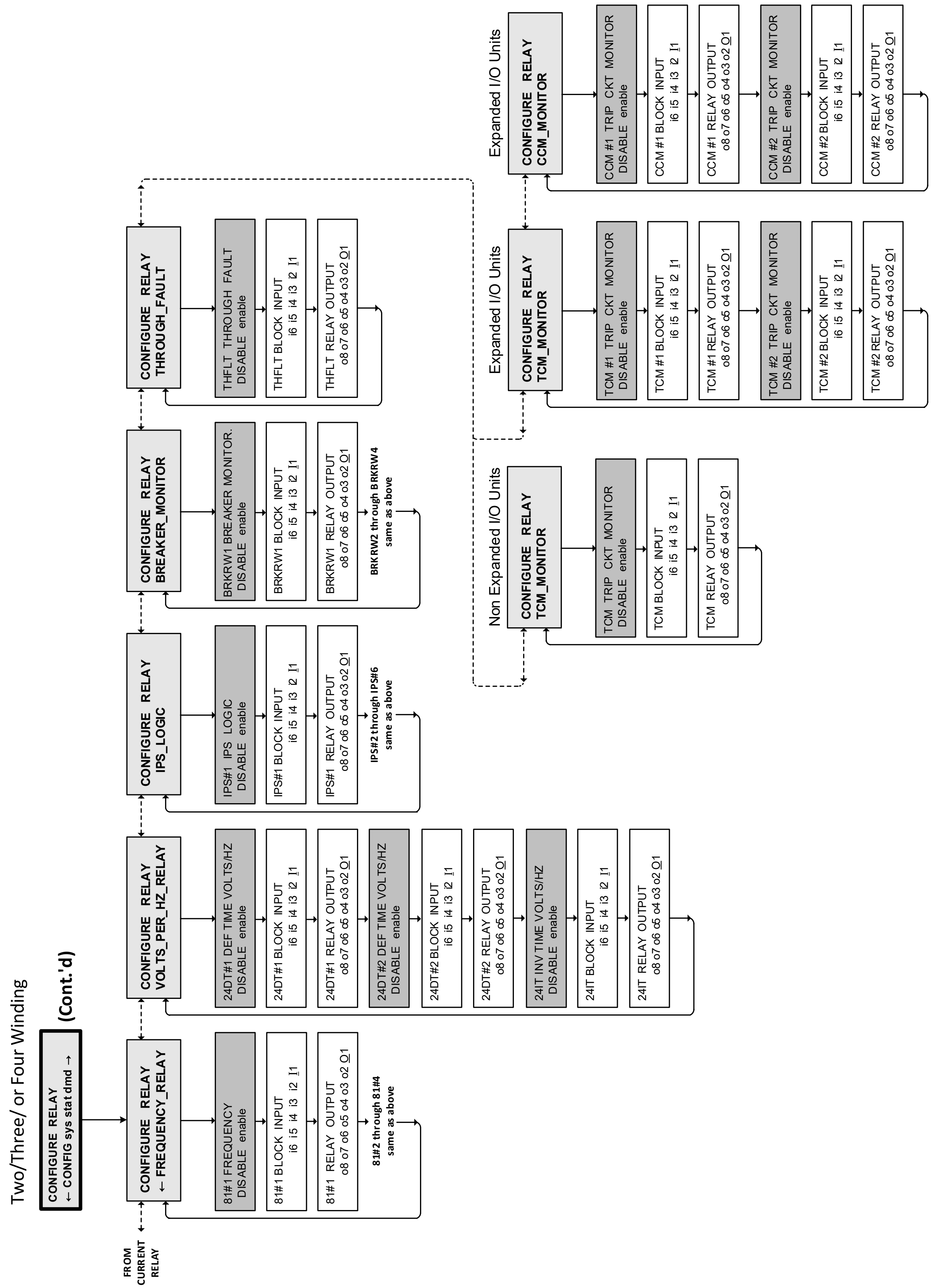


Figure F-7 Configure Relay/Voltage Relay Menu Flow (3 of 3)

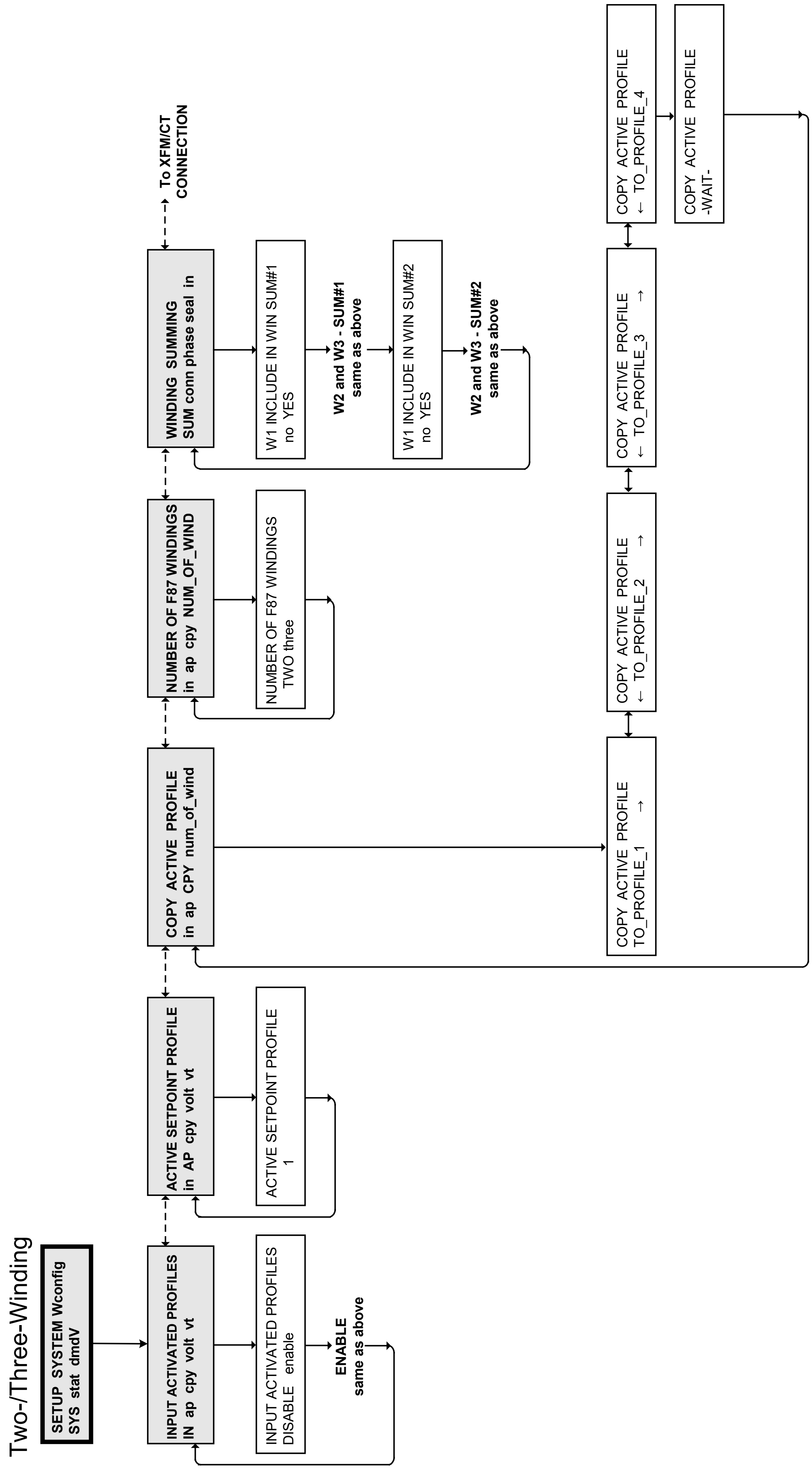


Figure F-8 Two-/Three-Winding Setup System Menu Flow (1 of 3)

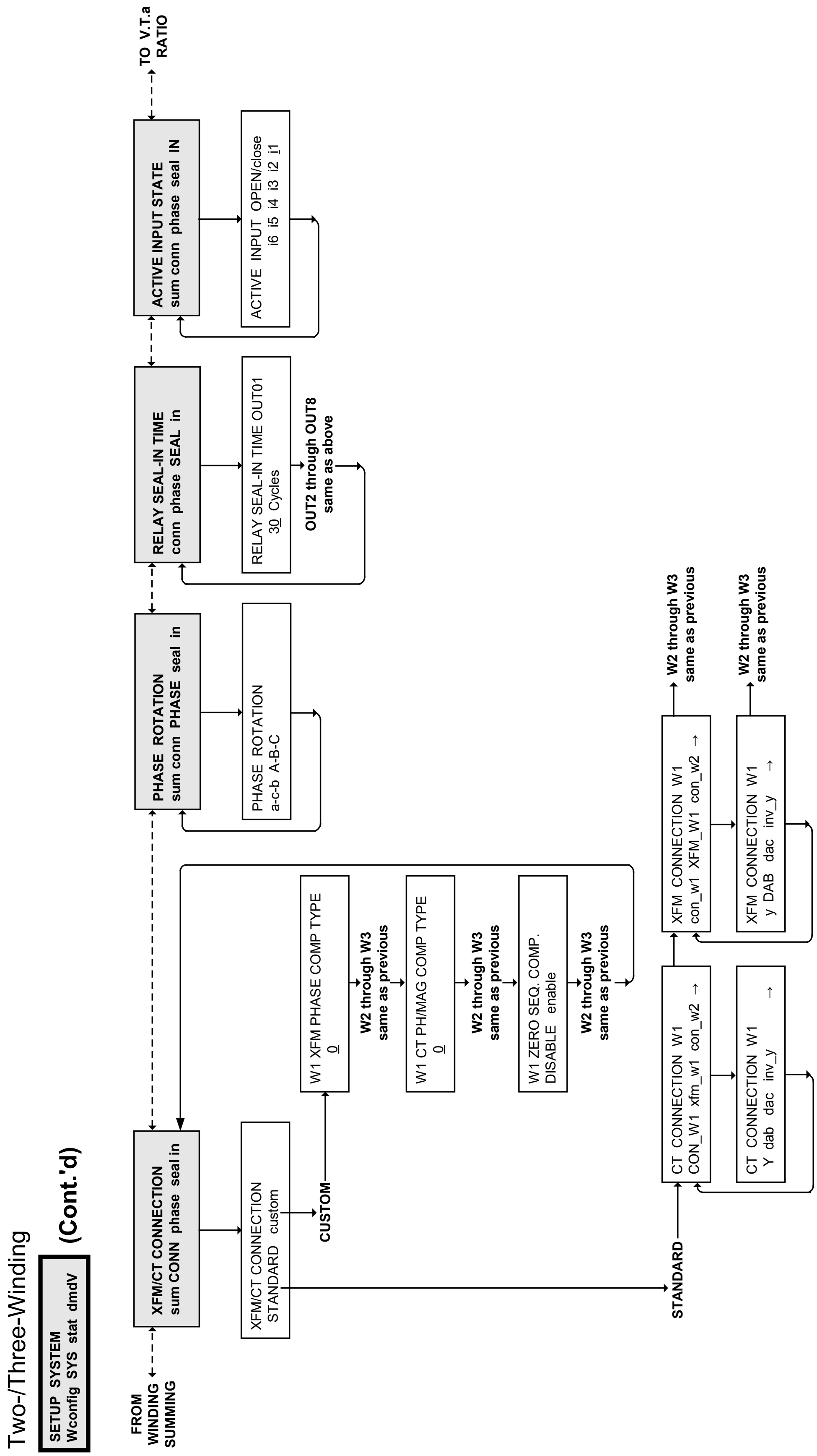


Figure F-8 Two-/Three-Winding Setup System Menu Flow (2 of 3)

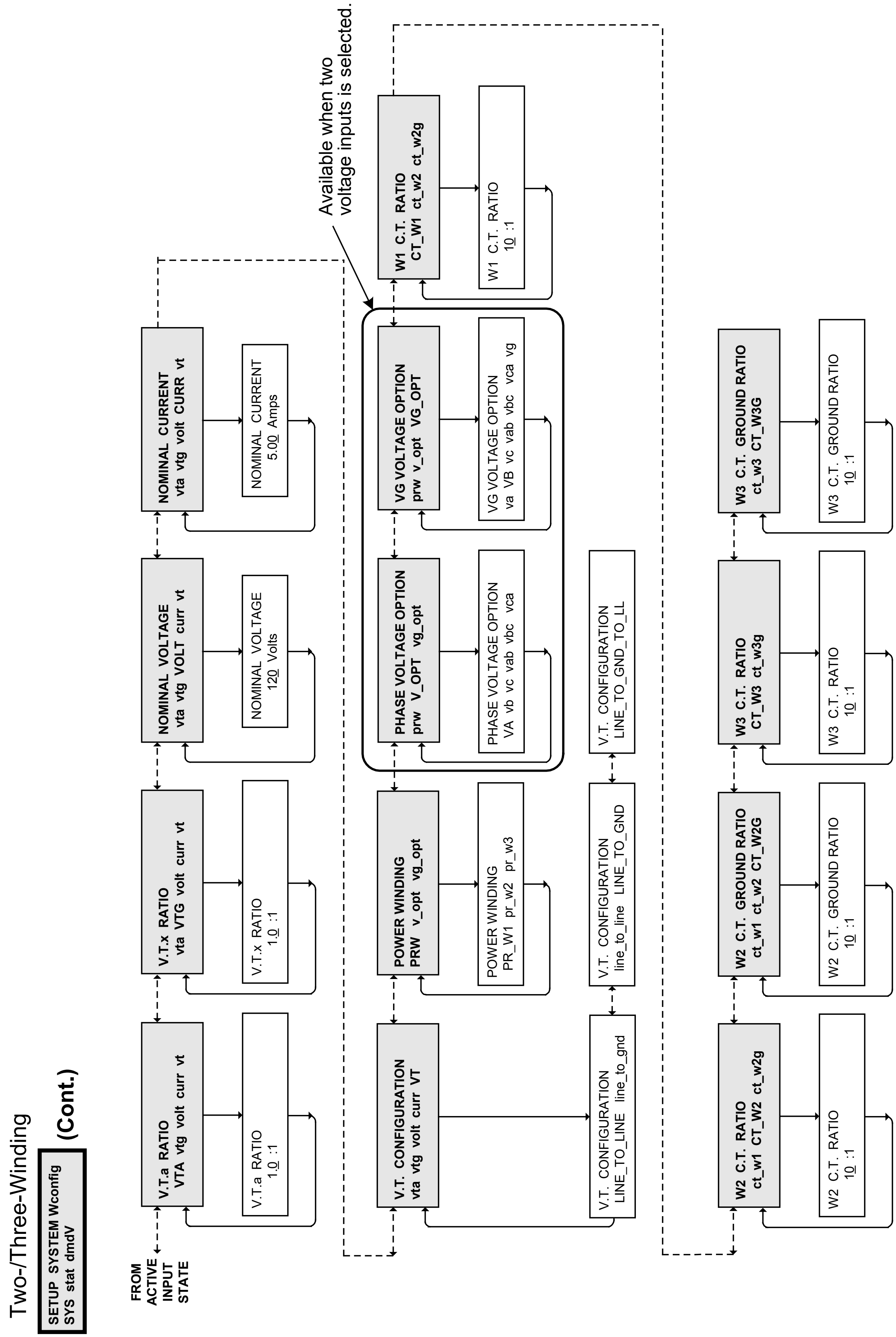


Figure F-8 Two-/Three-Winding Setup System Menu Flow (3 of 3)

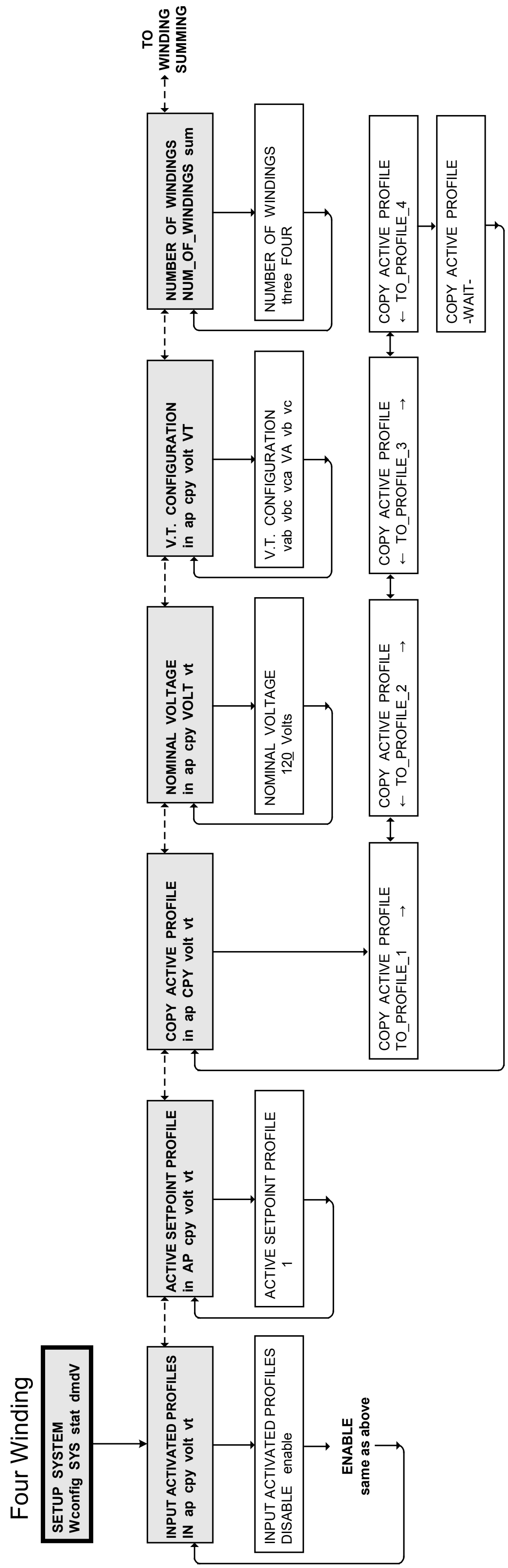


Figure F-9 Four-Winding Setup System Menu Flow (1 of 3)

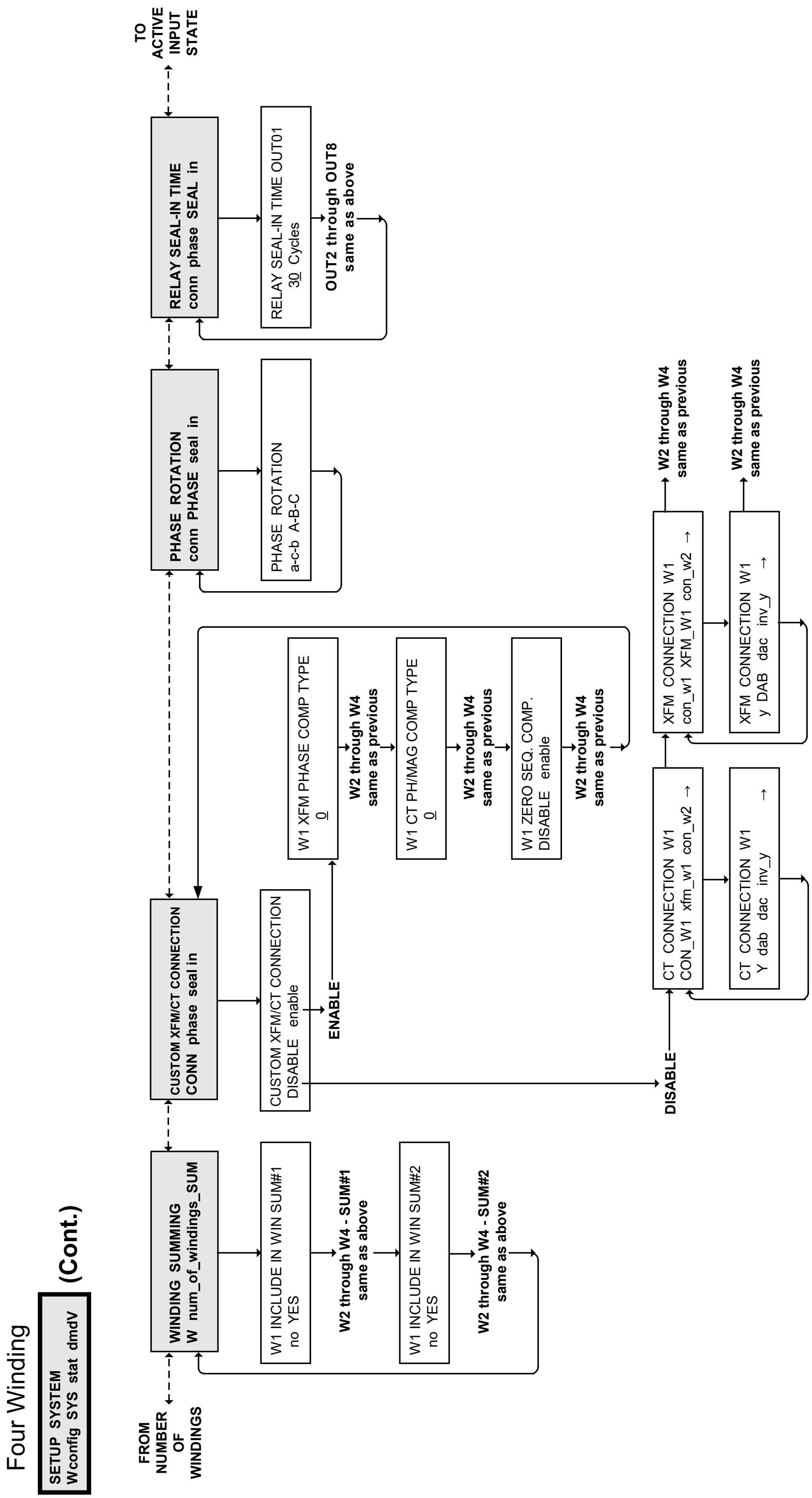


Figure F-9 Four-Winding Setup System Menu Flow (2 of 3)

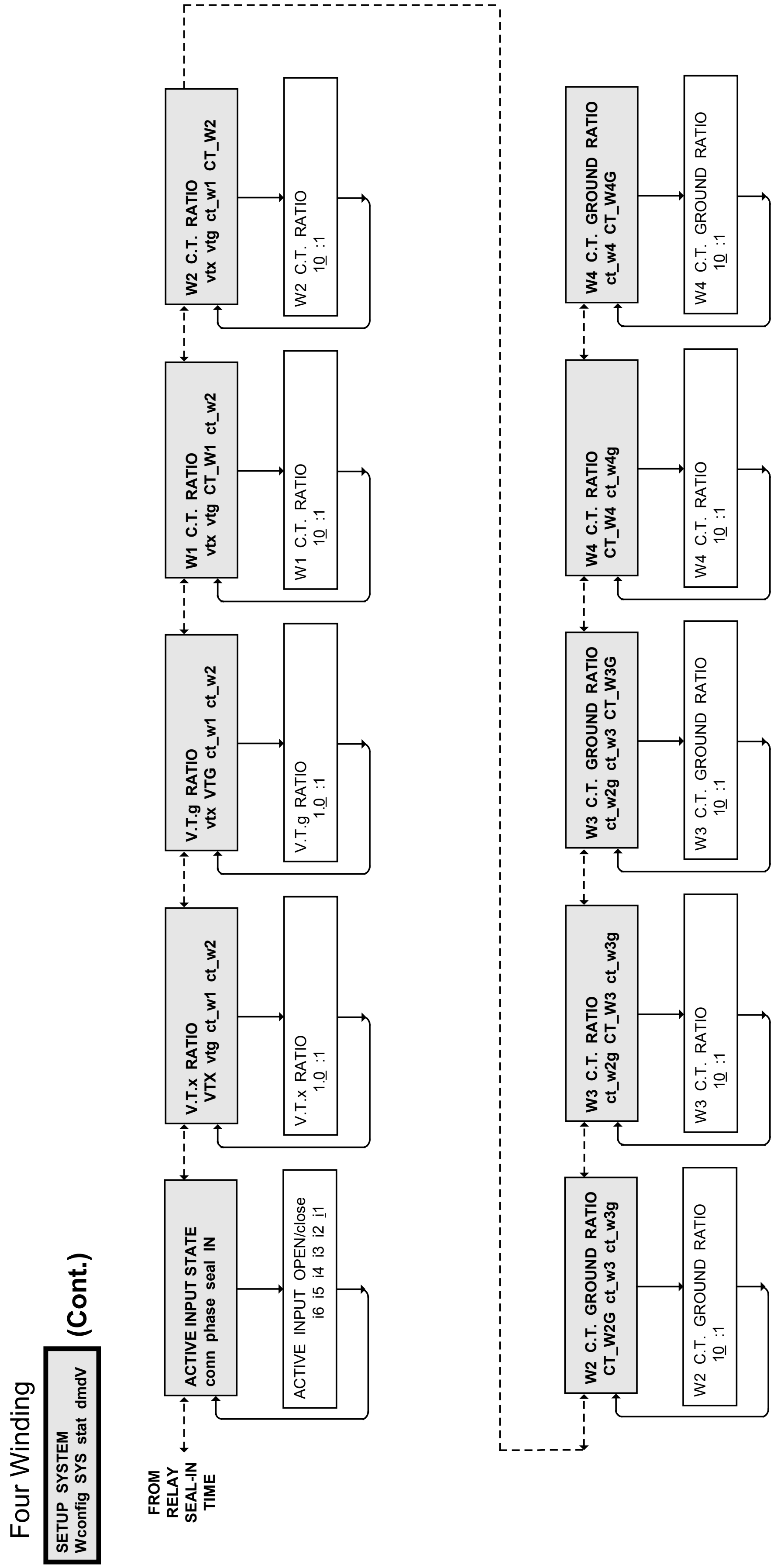


Figure F-9 Four-Winding Setup System Menu Flow (3 of 3)

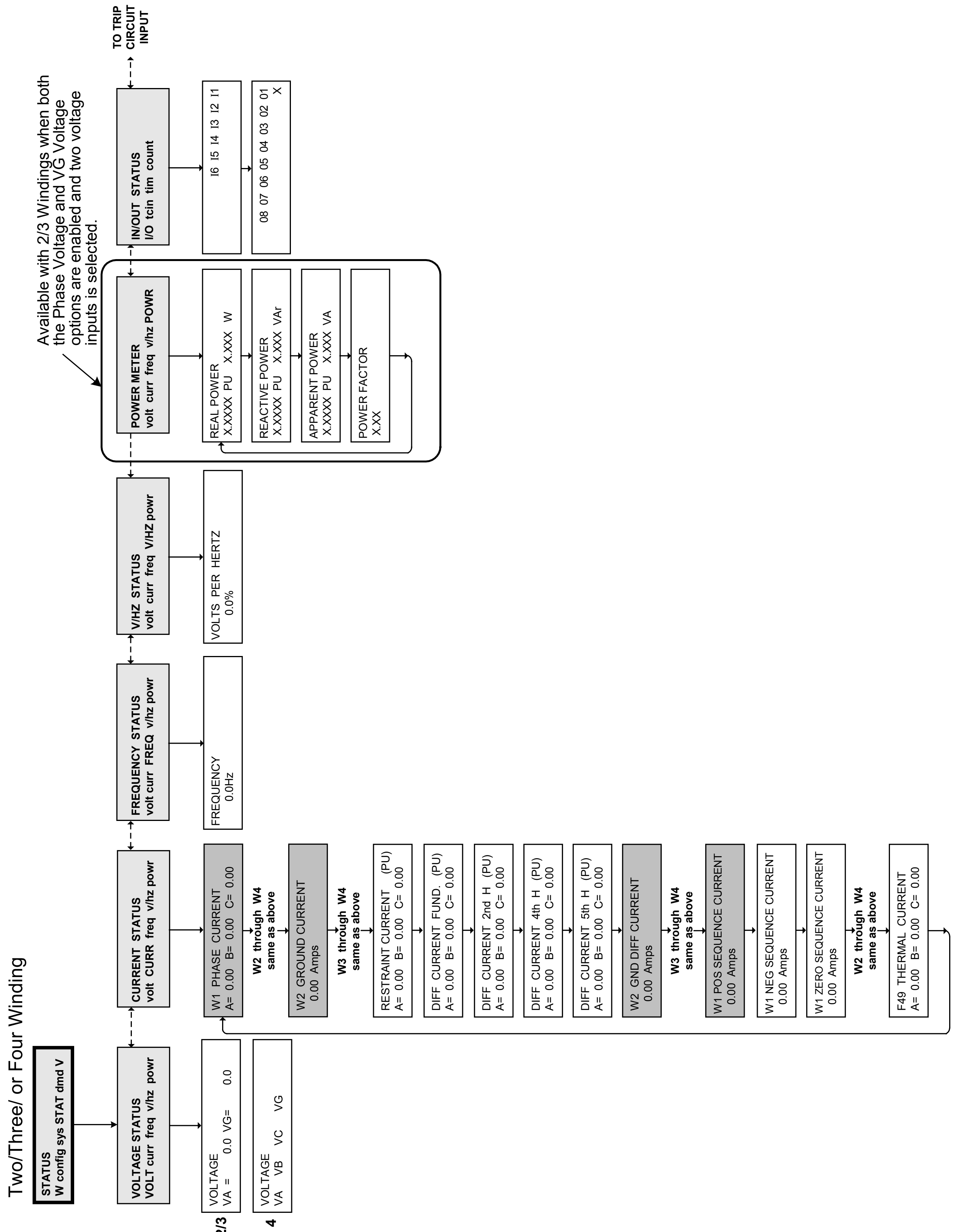


Figure F-10 Relay Status Menu Flow (1 of 2)

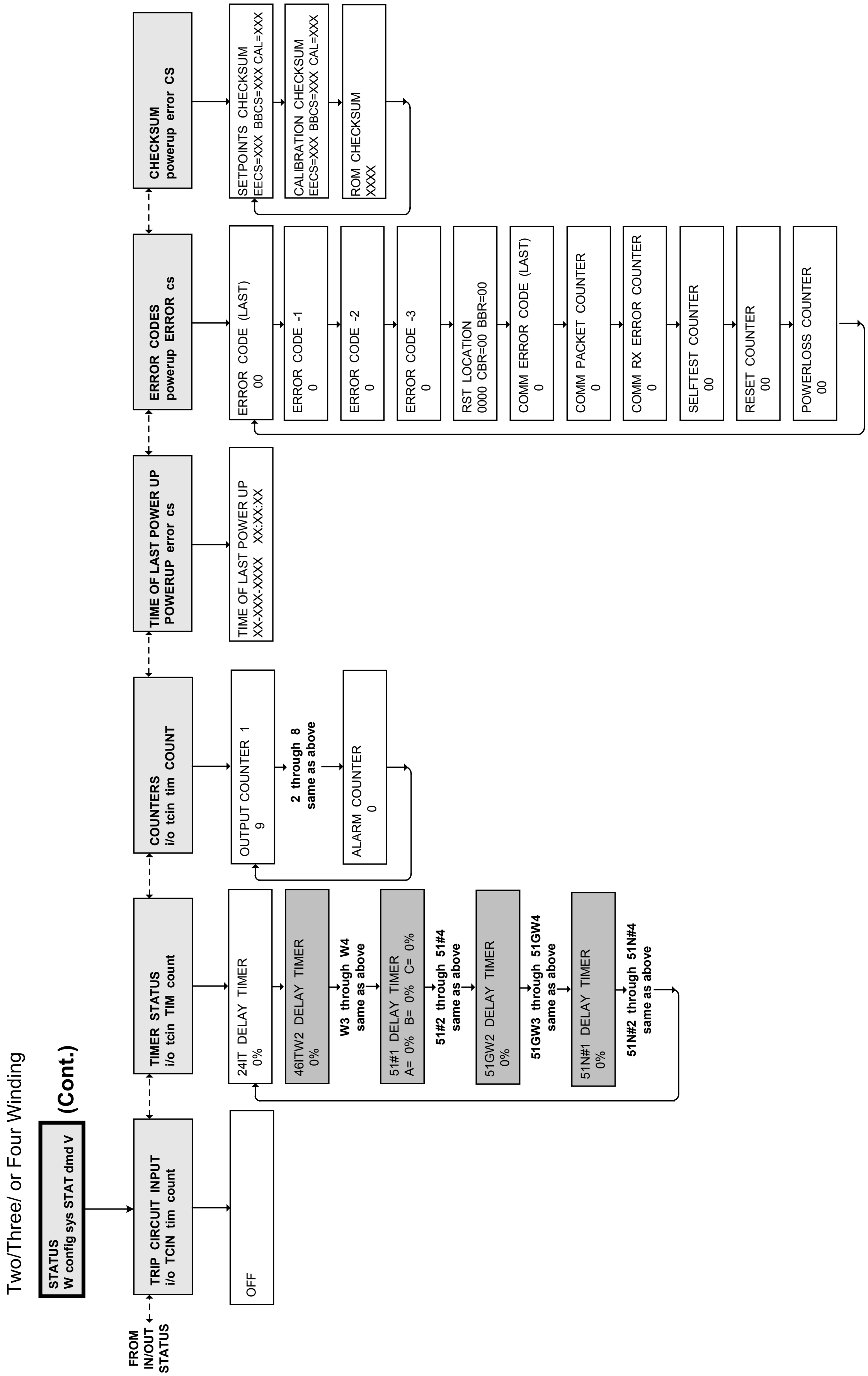


Figure F-10 Relay Status Menu Flow (2 of 2)

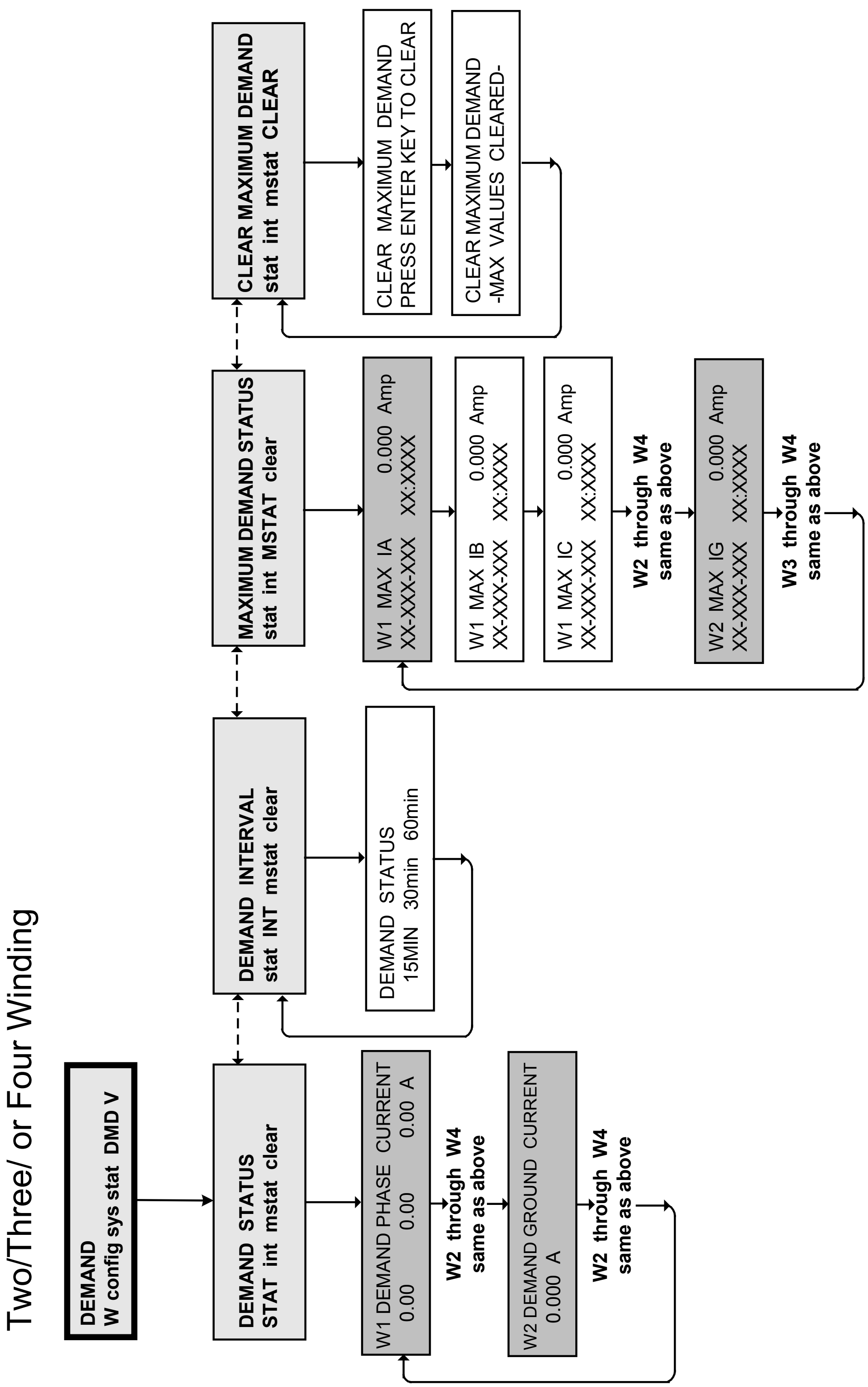


Figure F-11 Relay Demand Menu Flow

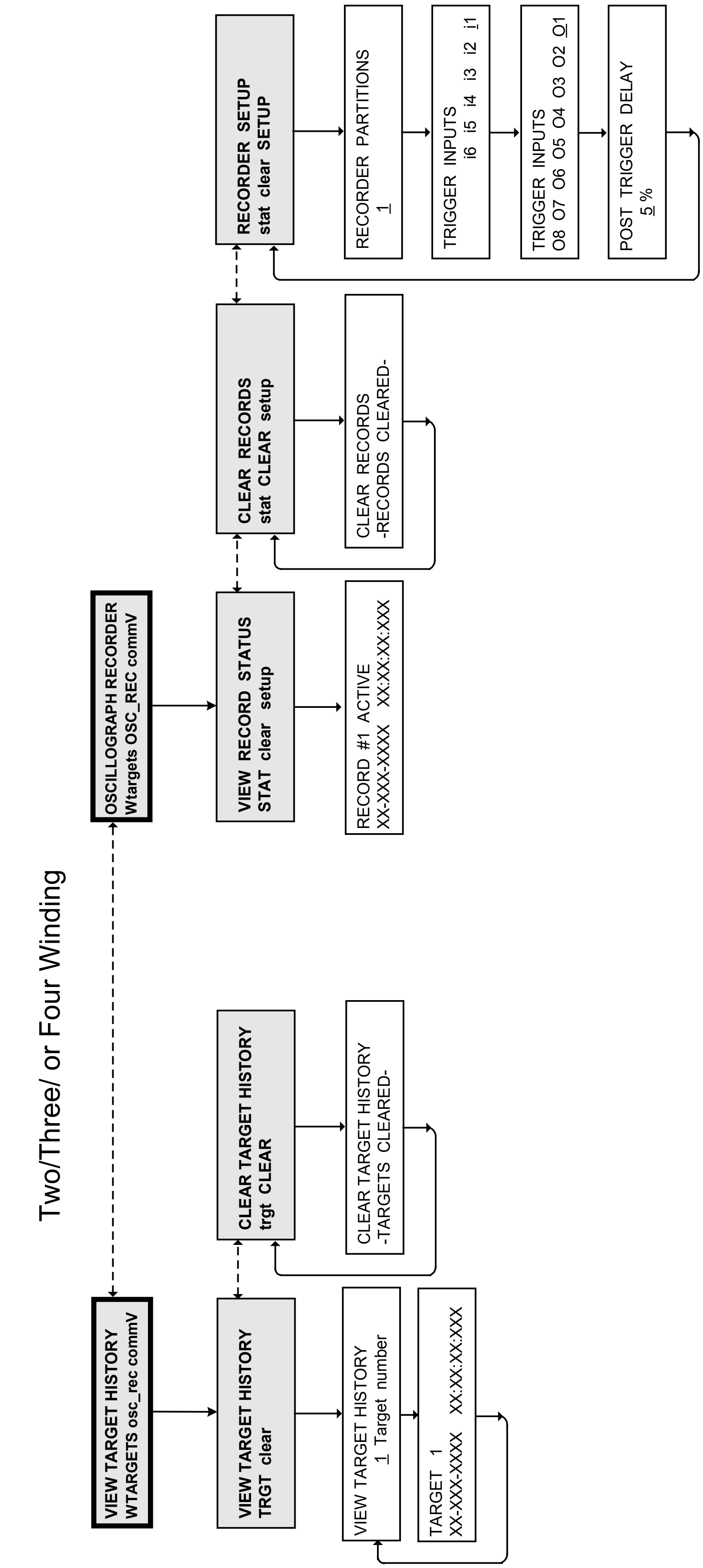


Figure F-12 View Target History and Oscillograph Recorder Menu Flow

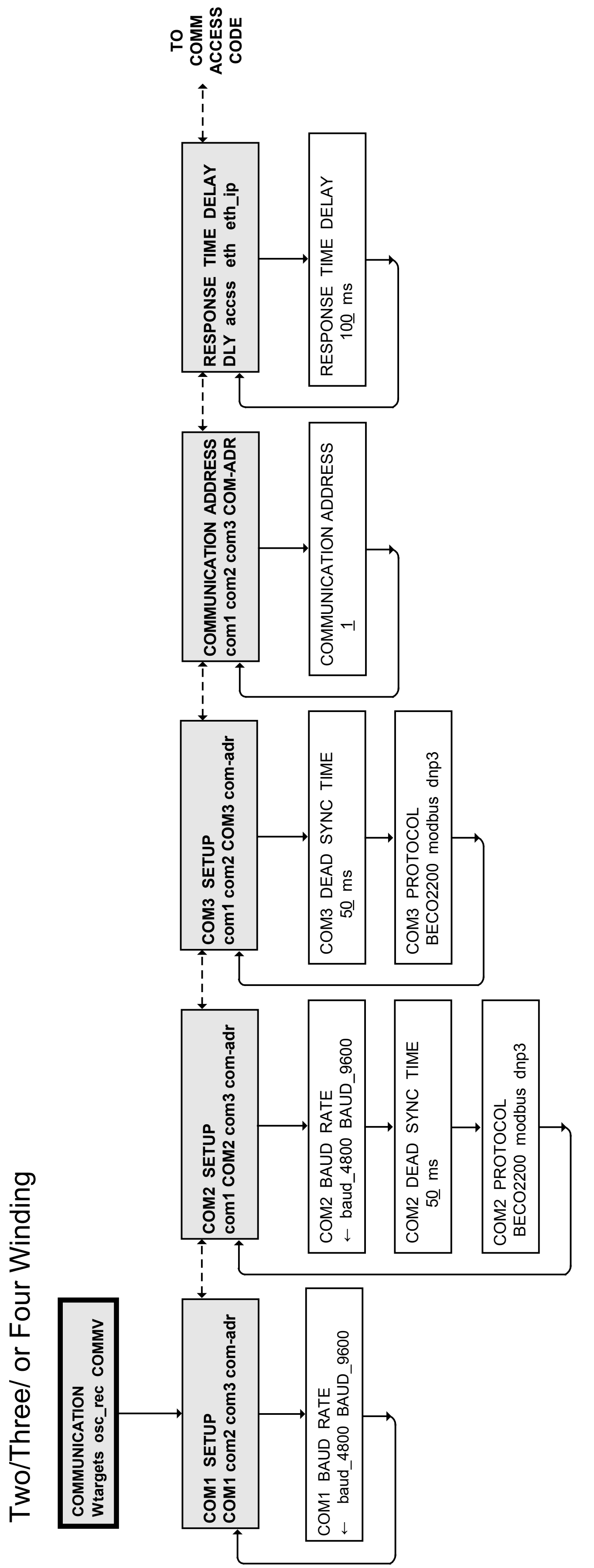


Figure F-13 Relay Communication Menu Flow (1 of 2)

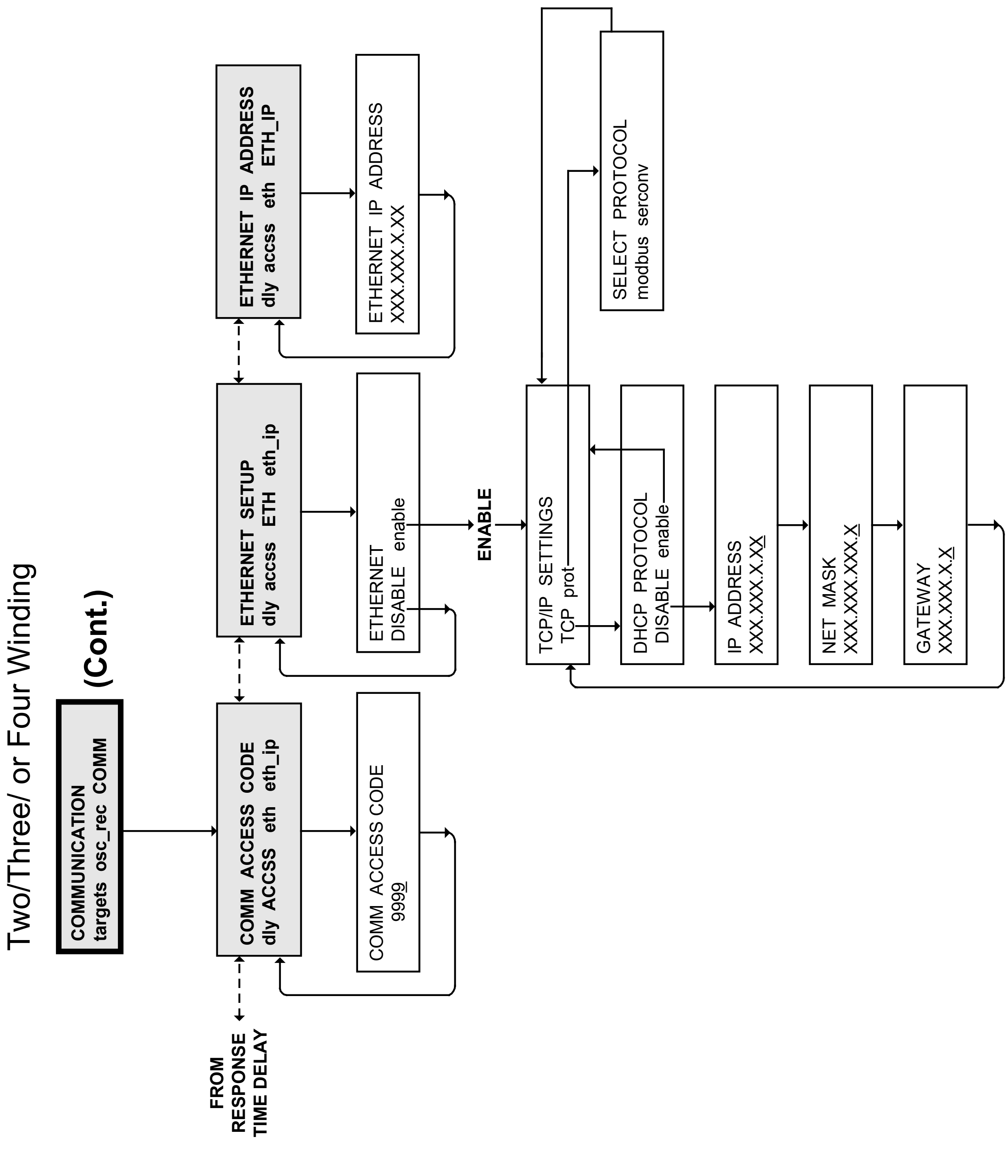


Figure F-13 Relay Communication Menu Flow (2 of 2)

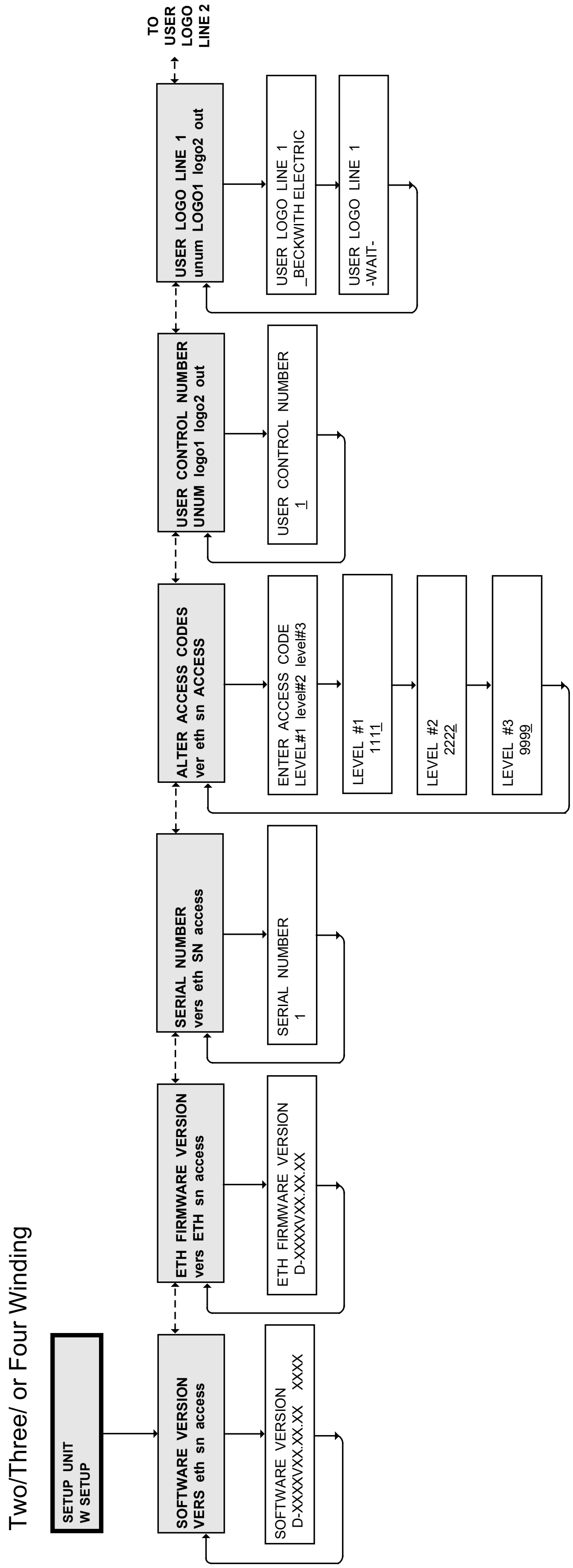


Figure F-14 Relay Setup Menu Flow (1 of 4)

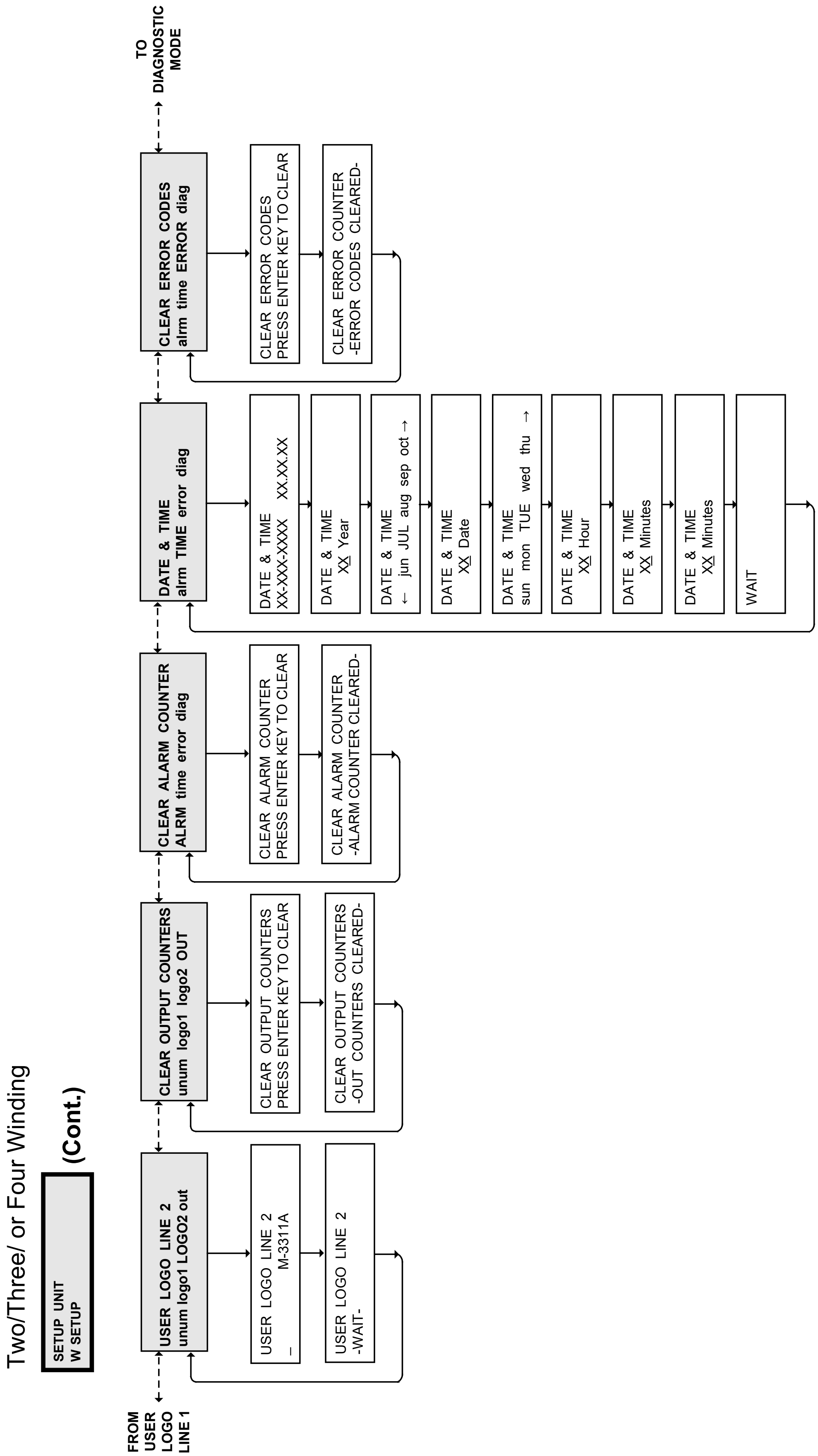


Figure F-14 Relay Setup Menu Flow (2 of 4)

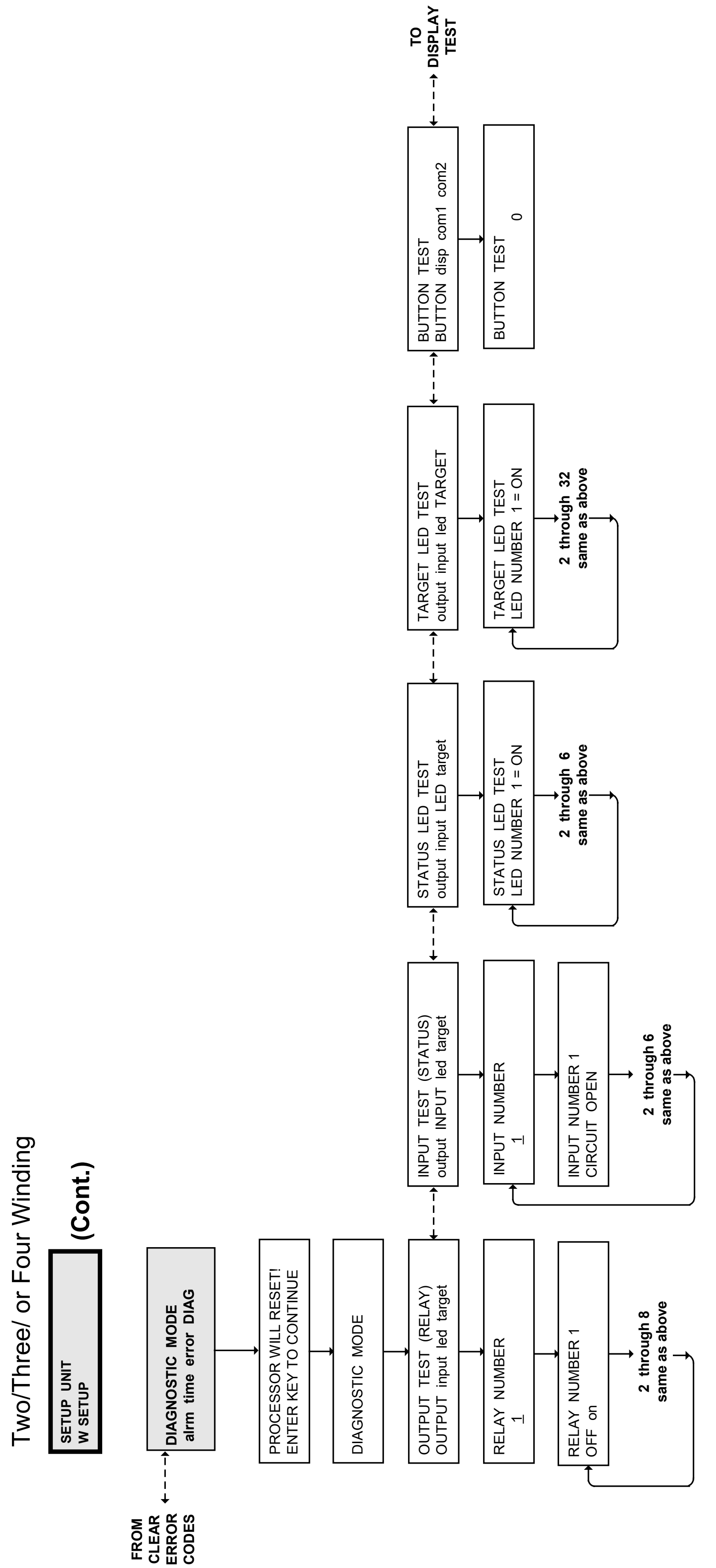


Figure F-14 Relay Setup Menu Flow (3 of 4)

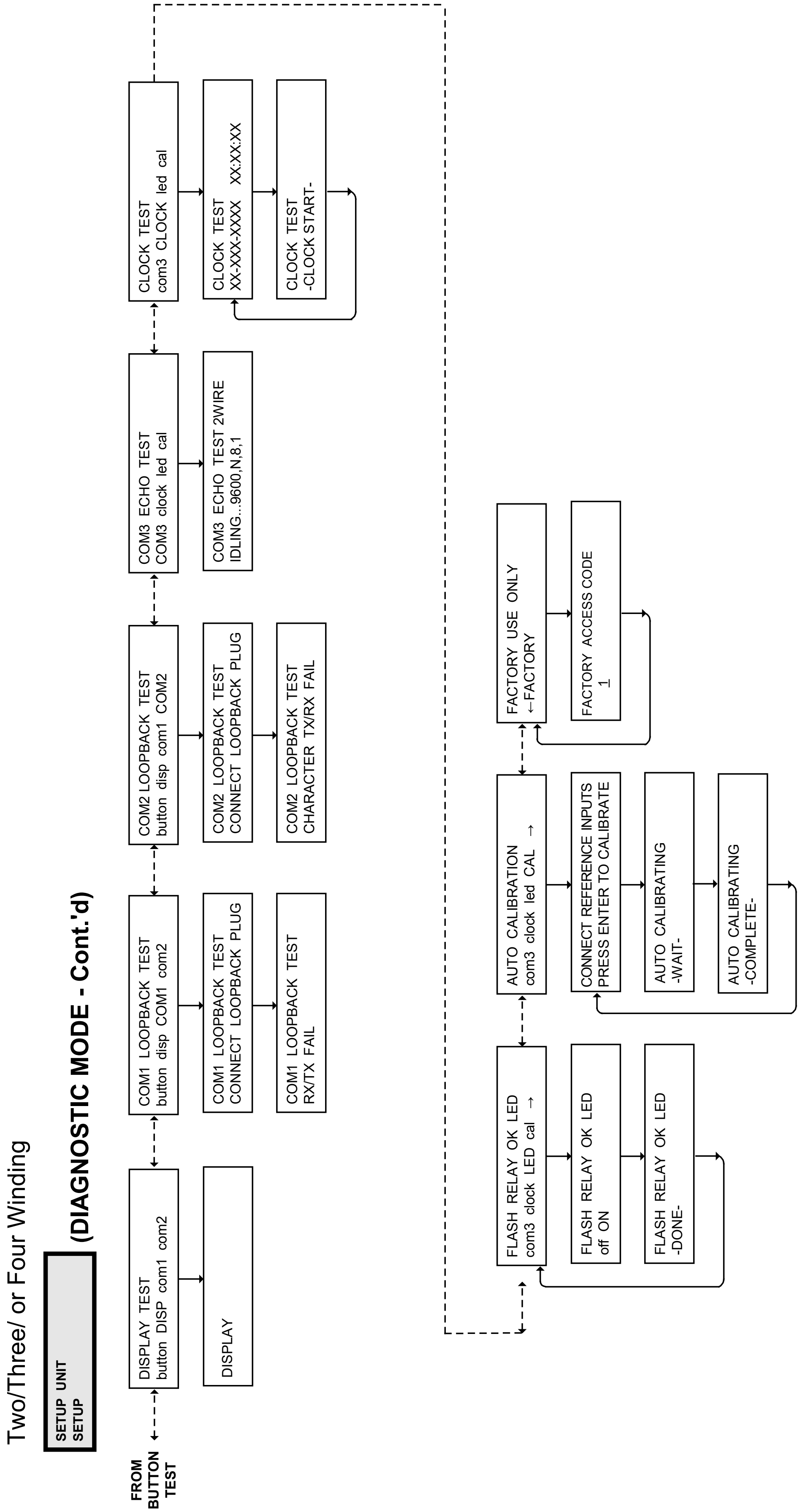


Figure F-14 Relay Setup Menu Flow (4 of 4)

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H Declaration of Conformity

CE

DECLARATION OF CONFORMITY

(In accordance to BS EN ISO/IEC 17050-1:2010)

No. M-3311A

Manufacturer's Name:	***Beckwith Electric***
Manufacturer's Address:	***6190 118th Avenue North***
	Largo, FL 33773-3724

The manufacturer hereby declares under our sole responsibility that the M-3311A relay product conforms to the following EMC product standard as of September 9th, 2014 in accordance to Directive 2014/30/EU for equipment incorporated into stationary fixed installations:

BS EN/ IEC 60255-26:2013

Electromagnetic compatibility (EMC)
Requirements for measuring relays and protection equipment

Electromagnetic Emissions: IEC 60255-26:2013
EN 55022:2010 CISPR 22 Conducted 150 kHz to 30MHz
EN 55022:2010 CISPR 22 Radiated 30MHz to 1000MHz
Class A Limits

Electromagnetic Immunity: IEC 60255-26:2013

Electrostatic Discharge ±8kV Contact; ±15kV Air
IEC 61000-4-2:2008

Radiated Immunity 80MHz to 1000MHz 35V/m, 80% AM (1kHz)
IEC 61000-4-3:2010

Fast Transients ±4kV 5ns/50ns Bursts @ 5kHz, 15ms/ 300ms
IEC 61000-4-4:2012

Surge ±2Kv Line to Line coupling, ±4Kv Line to Earth coupling
IEC 61000-4-5:2014

Conducted Immunity 150KHz to 80MHz 10Vrms
IEC 61000-4-6:2013

Power Frequency Magnetic Field Immunity 100A/m continuous
IEC 61000-4-8:2009
Power frequency disturbance test onto DC input status port
100v 50/60 Hz differential mode
150v 50/60 Hz differential mode
300v 50/60 Hz common mode
IEC 61000-4-16:2011

1 MHz Oscillatory Disturbance ±2,500v differential / common modes
IEC 61000-4-18:2011

Short duration AC/DC Voltage interruptions
0% residual (AC) 5 cycles, (DC) 30ms
40% residual (AC) 5 cycles, (DC) 30ms
70% residual (AC) 30 cycles, (DC) 30ms
IEC 61000-4-11:2010

Environmental: IEC 60255-27:2013 Pollution Degree 2

IEC 60068-2-1:2007 Cold, -20°C
IEC 60068-2-2:2007 Dry Heat, +70°C
IEC 60068-2-78:2012 Damp Heat, +40°C @ 95%rh
IEC 60068-2-30:2005 Damp Heat condensing cycle +25°C, +55°C @ 95%rh

Environmental: IEC 60255-27:2013 Insulation Category III

IEC 60255-27:2013 Impulse ±5,000Vpk
IEC 60255-27:2013 Dielectric 2,000Vac
IEC 60255-27:2013 Insulation Resistance ≥10GΩ

Mechanical Environmental: IEC 60255-27:2013

IEC 60255-21-1:1988 Vibration response Class 1 0.5g
Vibration endurance Class 1 1g

IEC 60255-21-2:1988 Shock response Class 1 5g
Shock Withstand Class 1 15g
Bump Endurance Class 1 10g

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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 infringement of United States Letters Patent or rights accruing therefrom 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 ten years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to perform 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 merchantability 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.

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